

Report



Black Hills Power Loss Factor Study – 69kV & Distribution

**Prepared for:
Black Hills Power, Inc.**

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(Revision 1)**

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Submitted By:

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Black Hills Power Demand Loss Study – 69 kV & Distribution
Black Hills Power – Project No.: 22500285

Rev 1



Revision History

Date	Rev	Description
11/21/2025	0	Initial draft
12/01/2025	1	Addressing Black Hills Power comments



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1. Executive Summary

Black Hills Power, Inc. (Black Hills Power) commissioned a loss-factor study to estimate real-power losses across its South Dakota (SD) and Wyoming (WY) 69 kV sub-transmission and distribution systems. The objective was to estimate “Demand Loss” and “Loss Factor” values that estimate real-power losses during high-load conditions. The study incorporated SCADA data, calibrated transmission and distribution power-flow models and equipment-specific loss information.

69 kV Sub-Transmission Losses

For the 69 kV sub-transmission system, the PSS/E transmission model was calibrated based on the SCADA data. The study was based on the 2024 Summer coincident peak recorded on August 2, 2024. This was performed to align system powerflow with the actual recorded system conditions. Losses on Black Hills Power-owned 69 kV transmission lines and associated 230/69 kV transformers were estimated and allocated by state.

The **69 kV loss factors** were estimated at **0.452%** for South Dakota and **0.355%** for Wyoming.

Distribution Losses

For the distribution system, losses were estimated using the Synergi Electric summer-peak model, supplemented with feeder and transformer level SCADA data. Demand Load Adjustment Factors (DLAFs) were estimated for each device to relate modeled peak to representative high-load condition recorded. Distribution losses were estimated for substation transformers, primary feeders, distribution line transformers, and secondary service lines.

The estimated, total **distribution loss factors** are **2.473%** for South Dakota, and **0.118%** for Wyoming.

2. Introduction

Black Hills Power initiated a loss factor estimation study for its SD and WY 69 kV sub-transmission and distribution systems. The analysis focused on losses occurring in 69 kV substation transformers, 69 kV-distribution transformers, primary feeders operating at 24.9 kV, 12.47 kV and 4.16 kV, distribution line transformers, and secondary service lines. The study estimated losses under coincident 2024 peak-load conditions.

In this study, 69 kV sub-transmission losses included real power losses on the 69 kV lines and associated 230/69 kV transformers. These losses were estimated using a calibrated power flow representation of the Black Hills Power system at coincident peak conditions. The 69 kV sub-transmission loss analysis was performed in PSS/E using the heavy summer base case provided by Black Hills Power, while the distribution loss analysis was performed using the Synergi Electric distribution system model. The 2024 Summer coincident peak condition on August 2, 2024 was used as the analytical basis, reflecting the most recent available load allocation and network configuration for the SD and WY service territory.

2.1 69kV Sub-Transmission & Distribution Losses

The 69 kV Sub-Transmission & Distribution system includes the following components:

- 230/69 kV sub transmission transformers
- 69 kV transmission lines (T-lines)
- 69 kV-distribution step-down transformers
- Medium-voltage distribution feeders supplied from the 69 kV system
- Distribution line transformers
- Secondary service lines

The 230/69 kV system provides the interface between the 230 kV bulk transmission system and the lower-voltage distribution feeders. Losses associated with the components listed above were estimated in this study to support the evaluation of demand losses and loss factors for the Black Hills Power 69 kV system.

Demand losses were expressed in kW and Loss Factors were presented as a percentage of the Black Hills Power 69 kV system demand.

2.2 Methodology

2.2.1 - 230/69 kV transformer and 69 kV T-lines loss calculation

The Black Hills Power 69 kV system PSS/E model was calibrated to the SCADA coincident system-peak recorded on August 2, 2024 at 4:10 PM. To align the model with the observed SCADA interchange flows at the Black Hills Power system boundaries:

- Interchanges line flow at the boundary were represented in PSS/E by equivalent sources placed at the boundary buses to match the measured net interchange flows as injection or withdrawal depending on imports or exports.

The 69 kV facilities included in the loss estimation were identified based on the single line diagrams provided by Black Hills Power for the Black Hills Power, Basin Electric Power Co-op (BEPC), and



Powder River Electric Co-op (PREC) regions service territories ¹. The estimated loss factor reflects the total loss on the 69 kV sub-transmission system for the total load served in these 3 areas.

2.2.2 - SCADA data for feeders and distribution transformers

SCADA measurements for 2024 were used, including real power (MW) and reactive power (MVAR) values at substation transformer and feeder level at a five-minute resolution across the full year. Before estimating load-adjustment factors, the SCADA data set was processed to remove values deemed as outliers.

2.2.3 Distribution Demand Load Adjustment Factor (DLAF)

For each device (feeder, or substation transformer) a Demand Load Adjustment Factor (DLAF) was estimated to represent a “typical high-load” condition instead of an instantaneous annual peak.

From the processed 5-minute SCADA data the daily peak of each device was identified and then the monthly peak demand for each device was derived using the daily peaks.

The average of the three highest monthly peaks for each device was divided by the peak value of the corresponding device represented in the Black Hills Power Synergi model. The Synergi model provided by Black Hills Power represented a summer coincident peak scenario, some regions may exhibit their actual annual peak at a different time of the year. As a result, the average of the three highest monthly peaks may exceed the Black Hills Power Synergi model peak, which would produce DLAF values greater than 100%. In some cases, values of 100% or higher may reflect differences in data granularity, timing alignment, or load representation between the SCADA measurements and the Synergi model snapshot.

To maintain consistency in the DLAF estimation while allowing for normal measurement variability, the Synergi peak value was used in the DLAF estimation for cases where the resulting DLAF was up to 110%. For cases where the DLAF estimated exceeds 110%, the recorded annual peak from the SCADA data was substituted in the denominator of the DLAF formula.

$$DLAF(\%) = \frac{\text{Average of highest 3 monthly peaks}}{\text{Device yearly peak}} \times 100$$

DLAF was then used to calibrate modelled losses estimated from the Synergi model based on the coincident 2024 measured SCADA peak condition.

2.2.4 Demand Loss Factors

Once the initial kW losses were obtained from the Black Hills Power Synergi model and calibrated using DLAF, demand loss factors were estimated as a percentage of system demand using the following relationships:

¹ 1. SDE-E-001A, Voltage SD.
2. SDE-E-001B, Voltage WY.

$$\text{Demand Loss Factor(\%)} = \frac{\text{Demand losses (MW at high-load condition)}}{\text{Yearly peak demand (MW)}} \times 100$$

2.2.5 Distribution Substation Transformer Loss Calculations

The available test reports for 69kV substation transformers were used to estimate the no-load and load losses associated with each distribution substation transformer. From each report, the following information was extracted for loss in the loss calculations :

- Transformer ID and location (substation / feeder)
- kVA rating and voltage class
- No-load (core) loss, at rated voltage and test reference temperature
- Load (winding) loss at rated kVA and test reference temperature

Where a test report was unavailable for a specific unit, representative values for similar kVA and voltage class were taken from available manufacturer data.

For each transformer, total losses at the modeled peak loading were estimated as:

- **No-Load Loss (kW):** taken directly from the test report (or typical data) and assumed constant whenever the transformer is energized. The no-load loss was assumed to be independent of the transformer's loading level.
- **Load Loss at modeled peak (kW):** calibrated from the test value using the ratio of modeled kVA loading to nameplate kVA:

$$\text{Transformer Load Loss at peak (kW)} = \text{Load Loss (kW)} \times \left(\frac{\text{Modeled peak load (kVA)}}{\text{Nameplate kVA}} \right)^2$$

This is consistent with the standard assumption that copper losses vary with the square of current (and therefore approximately with the square of kVA for a given voltage). For demand-loss reporting, the peak-load losses were then adjusted using the DLAF to reflect typical high-load conditions.

2.2.6 Distribution Feeder Loss Calculation

The distribution feeder losses were estimated from the total loss for each feeder in the Synergi summer peak model. These loss values were then adjusted using corresponding feeder-specific DLAF to represent peak-related loading conditions. The same treatment applied to substation transformer loss calculations is used here: if the DLAF derived using the Synergi model peak exceeds 110%, the absolute annual peak from the SCADA data is substituted to ensure a realistic and consistent denominator. This approach prevented overestimation of feeder losses in cases where the Synergi model summer peak does not align with the feeder's actual system peak.

2.2.7 Distribution Line Transformer Loss Calculation

The list of distribution line transformers was obtained from the Synergi model. Given that individual test reports might not be available for these units, typical Black Hills Power provided transformer data by the kVA ratings were used to estimate both no-load and load losses. The same methodology applied to substation transformers was used here: the load-loss component for each transformer was adjusted based on its loading level using the standard square-current relationship. Each distribution line transformer's load-loss was then calibrated by the DLAF associated with its respective feeder. The DLAF-adjusted load-loss was combined with the transformer's no-load loss to estimate the total



distribution line transformer loss contribution. The typical no-load and load-loss data for distribution line transformers based on their kVA ratings are presented in Appendix J.

2.2.8 Secondary Line Services Loss Calculation

The secondary service lines were not represented in the Synergi model, so their losses were estimated using a supplementary approach. For each distribution line transformer, the secondary / low voltage side current was estimated based on the transformer's loading and secondary voltage level. The corresponding secondary conductor type was assumed based on the conductor-transformer kVA rating mapping provided by Black Hills Power in Appendix K. This assumed typical resistance value for each secondary service line. Secondary service line losses were estimated using the following relationship:

$$\text{Secondary Service Line Losses (kW)} = (\text{Cable resistance/feet}) \times (\text{Cable length}) \times (\text{Cable Current})^2$$

Where:

- A typical secondary service length of 50 ft was assumed for all secondary lines.
- The losses for each secondary service line were calibrated using the feeder-specific DLAF associated with each distribution line transformer.



3. Study Results

3.1 Black Hills Power 69 kV Loss Factor

Black Hills Power’s 69 kV loss factors were estimated in PSS/E using the 2024 SCADA coincident system-peak data recorded on August 2, 2024 at 4:10PM. Losses were estimated for Black Hills Power-owned 69 kV transmission lines and associated 230/69 kV transformers, with results presented separately for South Dakota and Wyoming.

Table 1: South Dakota - Black Hills Power 69kV Losses and 230/69 kV Losses

Element	Losses (MW)
69 kV Transmission Lines	2.118
230kV/69kV 2-Winding Transformer	0.395
230/69kV 3-Winding Transformer	0.149
Total	2.662
Loss Factor (%)	0.452

Table 2: Wyoming - Black Hills Power 69kV Losses and 230/69 kV Losses

Element	Losses (MW)
69 kV Transmission Lines	2.070
230kV/69kV 2-Winding Transformer	0.023
230/69kV 3-Winding Transformer	N/A
Total	2.093
Loss Factor (%)	0.355

Notes & Assumptions

1. The Black Hills Power 69 kV system was calibrated to the SCADA coincident system-peak data recorded on August 2, 2024, at 4:10 PM.
2. The loss factors are estimated based on the total load for the BHP, BEPC, PREC as defined by the provided system boundary SLDs².
3. Losses were estimated for all Black Hills Power-owned 69 kV transmission lines and all Black Hills Power-owned 230/69 kV two-winding and three-winding transformers located in South Dakota and Wyoming.
 - a. Ownership and configuration for each line and transformer were screened against and visually compared with the Black Hills Power single-line diagrams provided.
 - b. Element were assigned to South Dakota or Wyoming based on physical location. For elements spanning the state boundary, losses were allocated based on the portion of the element within each state.

² 1. SDE-E-001A, Voltage SD.
2. SDE-E-001B, Voltage WY.



2.2 Black Hills Power Distribution Loss Factor

Black Hills Power’s distribution loss factors were estimated using the Synergi summer model provided together with Demand Load Adjustment Factors (DLAFs) estimated from 2024 SCADA coincident system peak data. Losses were estimated for 69 kV–distribution substation transformers, primary distribution lines, distribution line transformers, and secondary service conductors.

Table 3: South Dakota – Black Hills Power Distribution Loss Factors

Element	Losses (MW)	Loss Factor (%)
69kV - Distribution Transformers	1.414	0.410
Distribution Lines	2.784	0.808
Distribution Line Transformers	2.968	0.81
Secondary Service Lines	1.362	0.395
Total	8.528	2.473

Table 4: Wyoming - Black Hills Power Distribution Loss Factors

Element	Losses (MW)	Loss Factor (%)
69kV - Distribution Transformers	0.072	0.021
Distribution Lines	0.182	0.053
Distribution Line Transformers	0.115	0.033
Secondary Service Lines	0.039	0.011
Total	0.408	0.118

Notes & Assumptions

- The loss factor were estimated based on the combined South Dakota and Wyoming 344 MW summer peak load demand represented in the Synergi Electric distribution model provided by Black Hills Power.
- The Demand Load Adjustment Factor (DLAF) were estimated using 2024 SCADA data at each feeder and substation transformer, in combination with the Synergi summer peak model.
- DLAF estimation:
Five-minute SCADA data for each feeder and transformer were reviewed to determine the daily peak. For each element:
 - Monthly average peaks were estimated using the daily peaks.
 - The average of the top three-monthly peaks was divided by the Synergi peak load for that feeder/transformer to obtain the DLAF.
 - If this ratio exceeded a threshold of 110%, the SCADA annual peak was used instead of the Synergi model peak.
 - The 110% threshold was selected following consultation with Black Hills Power to reflect reasonable alignment between SCADA-observed loading and Synergi summer-peak model conditions
- Substation Transformer losses were totaled using the estimated DLAF at substation level.
- The remaining loss components, such as distribution lines, distribution line transformers, and secondary services, were totaled using the estimated feeder level DLAF applied to the Synergi model.
- For substation transformers without available test reports, a typical 10 MVA transformer with representative no-load and load-loss values was assumed.

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7. The Synergi model and data files used in this analysis, BHE_SD_CEM_N4W_LB_11_7_25, BHE_SD_9_29_25-LB, and BHE_Warehouse, were used as received from Black Hills Power. Updates provided by Black Hills Power after the initial transmittal were also incorporated as received, with no additional modifications made as part of this analysis.

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Appendix A – 69kV Sub-Transmission Lines

From Bus	To Bus	Circuit ID	From Name (PSS/E)	To Name (PSS/E)	MW (PSS/E)	MVar (PSS/E)	MW Losses (PSS/E)	From kV	To kV	State
73237	73244	1	38TH ST	CEMETERY	12.905	2.111	0.006	69	69	SD
73237	73279	1	38TH ST	WTRPLANT	-19.226	-3.311	0.003	69	69	SD
73238	73278	1	4THST TP	WESTBLVD	-23.498	4.06	0.008	69	69	SD
73238	73286	1	4THST TP	ANAMOSA	7.222	0.869	0	69	69	SD
73238	73287	1	4THST TP	4TH ST	3.487	-9.435	0	69	69	SD
73238	73290	1	4THST TP	EASTNRTH	12.789	4.506	0.003	69	69	SD
73239	73252	1	ANGOSTUR	WESTHILL	-4.799	0	0.002	69	69	SD
73240	73265	1	ARGYLE	PRINGLE	14.947	-3.06	0.067	69	69	SD
73240	74036	1	ARGYLE	MINNKHAT	-15.624	2.96	0.059	69	69	SD
73241	73242	1	BENFRNCH	BIG BEN	12.061	-0.823	0.027	69	69	SD
73241	73262	1	BENFRNCH	PLSNTVLY	21.285	3.756	0.014	69	69	SD
73241	73266	1	BENFRNCH	LANGE	-23.675	-8.734	0.053	69	69	SD
73241	73279	1	BENFRNCH	WTRPLANT	19.577	3.507	0.008	69	69	SD
73241	73521	1	BENFRNCH	BFRNCH26	5.191	1.069	0	69	69	SD
73241	73522	1	BENFRNCH	CMNTPLNT	16.615	4.669	0	69	69	SD
73241	73523	1	BENFRNCH	CROSS ST	32.998	-1.178	0.026	69	69	SD
73241	74069	1	BENFRNCH	WESTRC	-36.74	7.967	0.005	69	69	SD
73241	74069	2	BENFRNCH	WESTRC	-36.74	7.967	0.005	69	69	SD
73242	73241	1	BIG BEN	BENFRNCH	-12.034	0.78	0.027	69	69	SD
73242	73261	1	BIG BEN	PACTOLA	9.232	-0.78	0.012	69	69	SD
73243	73266	1	CAMBELL	LANGE	-24.243	-3.515	0.113	69	69	SD
73243	73290	1	CAMBELL	EASTNRTH	-2.657	-2.708	0	69	69	SD
73243	73440	1	CAMBELL	CENTRYRD	18.461	1.051	0.01	69	69	SD
73243	73515	1	CAMBELL	ROBNS TP	3.735	3.72	0.001	69	69	SD
73244	73237	1	CEMETERY	38TH ST	-12.899	-2.12	0.006	69	69	SD
73246	73253	1	CUSTER	JWL CAVE	1.576	-0.049	0	69	69	SD
73246	73265	1	CUSTER	PRINGLE	-13.086	3.273	0.127	69	69	SD
73248	73284	1	DUMONT	YELLOWCRK	-0.977	0.169	0.001	69	69	SD
73249	74036	1	EDGEMONT	MINNKHAT	-4.39	3.63	0.017	69	69	SD
73250	73261	1	HILLCITY	PACTOLA	-8.33	0.344	0.022	69	69	SD
73251	73264	1	HILLSVW	POPE&TAL	12.832	4.088	0.001	69	69	SD
73251	73270	1	HILLSVW	SPFSHBE	-18.432	-5.589	0.018	69	69	SD

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73252	73239	1	WESTHILL	ANGOSTUR	4.801	-0.074	0.002	69	69	SD
73253	73246	1	JWL CAVE	CUSTER	-1.576	0	0	69	69	SD
73254	73284	1	KIRK	YELLOWCRK	-1.488	0.882	0	69	69	SD
73254	73284	2	KIRK	YELLOWCRK	-1.421	0.857	0	69	69	SD
73257	73515	1	MERILLAT	ROBNS TP	-3.733	-3.794	0.001	69	69	SD
73257	74028	1	MERILLAT	RCSOUTH2	-9.288	-2.613	0.007	69	69	SD
73258	73295	1	MCFT PR	HUGHES	-22.966	-8.112	0.181	69	69	WY
73259	73282	1	NSS1	WYODAK	15.023	-20.73	0.005	69	69	WY
73259	73342	1	NSS1	NSS2	-45.499	12.81	0.045	69	69	WY
73259	74012	1	NSS1	GILLETTE	29.1	6.979	0.247	69	69	WY
73260	74004	1	OSAGE	NWCL TAP	0	-0.372	0	69	69	WY
73260	74007	1	OSAGE	OSAG CTY	5.726	-0.66	0.002	69	69	WY
73261	73242	1	PACTOLA	BIG BEN	-9.221	0.703	0.012	69	69	SD
73261	73250	1	PACTOLA	HILLCITY	8.352	-0.543	0.022	69	69	SD
73262	73241	1	PLSNTVLY	BENFRNCH	-21.272	-3.715	0.014	69	69	SD
73262	73519	1	PLSNTVLY	44TH ST	13.029	1.68	0.006	69	69	SD
73263	73284	1	PLUMA	YELLOWCRK	-48.11	-4.77	0.285	69	69	SD
73263	74006	1	PLUMA	SPRUCEGL	36.17	1.951	0.058	69	69	SD
73264	73251	1	POPE&TAL	HILLSVW	-12.831	-4.088	0.001	69	69	SD
73264	73271	1	POPE&TAL	SPFSHCIT	8.551	2.198	0.002	69	69	SD
73265	73240	1	PRINGLE	ARGYLE	-14.879	3.095	0.067	69	69	SD
73265	73246	1	PRINGLE	CUSTER	13.213	-3.095	0.127	69	69	SD
73266	73241	1	LANGE	BENFRNCH	23.727	8.932	0.053	69	69	SD
73266	73243	1	LANGE	CAMBELL	24.356	3.858	0.113	69	69	SD
73266	74013	1	LANGE	PEDMNT	16.941	1.218	0.135	69	69	SD
73266	74069	1	LANGE	WESTRC	22.168	9.322	0.047	69	69	SD
73267	73277	1	RICHMHIL	TROJAN	-1.14	-0.5	0	69	69	SD
73268	73514	1	5TH ST	E.MEAD	9.455	2.968	0.004	69	69	SD
73268	74055	1	5TH ST	CLEVL D ST	-23.112	-4.365	0.037	69	69	SD
73269	74003	1	SALT CRK	S.CRK TP	-3.772	0	0.007	69	69	WY
73270	73251	1	SPFSHBEC	HILLSVW	18.45	5.637	0.018	69	69	SD
73270	73272	1	SPFSHBEC	LOOKOUT	-24.6	-5.637	0.033	69	69	SD
73271	73264	1	SPFSHCIT	POPE&TAL	-8.549	-2.216	0.002	69	69	SD
73271	76502	1	SPFSHCIT	SPFSHPRK	4.897	1.242	0.003	69	69	SD
73272	73270	1	LOOKOUT	SPFSHBEC	24.634	5.762	0.033	69	69	SD
73272	73275	1	LOOKOUT	SUNDHILL	20.897	-0.396	0.144	69	69	SD

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73272	73275	2	LOOKOUT	SUNDHILL	28.014	-2.298	0.267	69	69	SD
73272	73528	1	LOOKOUT	MTNVIEW	16.737	-0.921	0.039	69	69	SD
73273	73280	1	STURG_CI	WHEWOOD	-15.111	-3.444	0.041	69	69	SD
73273	74000	1	STURG_CI	STURGIS	15.111	3.444	0	69	69	SD
73275	73272	1	SUNDHILL	LOOKOUT	-20.753	0.842	0.144	69	69	SD
73275	73272	2	SUNDHILL	LOOKOUT	-27.748	3.118	0.267	69	69	SD
73275	76398	1	SUNDHILL	STURGBEC	6.593	-0.453	0.021	69	69	SD
73275	76501	1	SUNDHILL	BLFCH_TP	27.875	-5.915	0.126	69	69	SD
73277	73267	1	TROJAN	RICHMHIL	1.14	0.378	0	69	69	SD
73277	73284	1	TROJAN	YELOWCRK	-4.431	-2.041	0.002	69	69	SD
73278	73238	1	WESTBLVD	4THST TP	23.506	-4.025	0.008	69	69	SD
73278	73513	1	WESTBLVD	LANGE TP	-24.095	3.805	0.008	69	69	SD
73279	73237	1	WTRPLANT	38TH ST	19.23	3.319	0.003	69	69	SD
73279	73241	1	WTRPLANT	BENFRNCH	-19.57	-3.489	0.008	69	69	SD
73280	73273	1	WHEWOOD	STURG_CI	15.152	3.507	0.041	69	69	SD
73280	74006	1	WHEWOOD	SPRUCEGL	-29.986	1.124	0.278	69	69	SD
73281	74005	1	WNDYFLAT	PLUMA TP	-1.779	-0.3	0.001	69	69	SD
73282	73259	1	WYODAK	NSS1	-15.018	20.751	0.005	69	69	WY
73282	73295	1	WYODAK	HUGHES	19.43	15.601	0.17	69	69	WY
73282	73342	1	WYODAK	NSS2	-41.559	17.451	0.051	69	69	WY
73282	76121	1	WYODAK	PWDRS PR	0	-0.087	0	69	69	WY
73284	73248	1	YELOWCRK	DUMONT	0.978	-0.342	0.001	69	69	SD
73284	73254	1	YELOWCRK	KIRK	1.489	-0.942	0	69	69	SD
73284	73254	2	YELOWCRK	KIRK	1.421	-0.927	0	69	69	SD
73284	73263	1	YELOWCRK	PLUMA	48.395	6.304	0.285	69	69	SD
73284	73277	1	YELOWCRK	TROJAN	4.433	1.961	0.002	69	69	SD
73284	74005	1	YELOWCRK	PLUMA TP	1.78	-0.043	0	69	69	SD
73286	73238	1	ANAMOSA	4THST TP	-7.222	-0.869	0	69	69	SD
73287	73238	1	4TH ST	4THST TP	-3.487	9.436	0	69	69	SD
73290	73238	1	EASTNRTH	4THST TP	-12.786	-4.51	0.003	69	69	SD
73290	73243	1	EASTNRTH	CAMBELL	2.658	2.673	0	69	69	SD
73295	73258	1	HUGHES	MCFT PR	23.147	8.918	0.181	69	69	WY
73295	73282	1	HUGHES	WYODAK	-19.26	-14.945	0.17	69	69	WY
73342	73259	1	NSS2	NSS1	45.544	-12.6	0.045	69	69	WY
73342	73282	1	NSS2	WYODAK	41.61	-17.216	0.051	69	69	WY
73342	74019	1	NSS2	GILLETTS	45.106	11.06	0.596	69	69	WY

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73342	76120	1	NSS2	PWDRN PR	0	-0.087	0	69	69	WY
73440	73243	1	CENTRYRD	CAMBELL	-18.451	-1.032	0.01	69	69	SD
73440	73511	1	CENTRYRD	MALL	7.909	-1.312	0.006	69	69	SD
73511	73440	1	MALL	CENTRYRD	-7.903	1.254	0.006	69	69	SD
73511	73512	1	MALL	NLOOP TP	0	-0.032	0	69	69	SD
73512	73511	1	NLOOP TP	MALL	0	0	0	69	69	SD
73513	73278	1	LANGE TP	WESTBLVD	24.103	-3.779	0.008	69	69	SD
73513	73523	1	LANGE TP	CROSS ST	-24.103	3.779	0.008	69	69	SD
73514	73268	1	E.MEAD	5TH ST	-9.451	-2.998	0.004	69	69	SD
73515	73243	1	ROBNS TP	CAMBELL	-3.734	-3.751	0.001	69	69	SD
73515	73257	1	ROBNS TP	MERILLAT	3.734	3.751	0.001	69	69	SD
73516	74028	1	5THST TP	RCSOUTH2	-30.665	-5.943	0.06	69	69	WY
73516	74055	1	5THST TP	CLEVL D ST	30.665	5.943	0	69	69	SD
73518	74028	1	RADIO_DR	RCSOUTH2	-5.957	-2.228	0.002	69	69	SD
73518	74075	1	RADIO_DR	RED ROCK	-3.156	0.298	0.001	69	69	SD
73519	73262	1	44TH ST	PLSNTVLY	-13.023	-1.687	0.006	69	69	SD
73519	74075	1	44TH ST	RED ROCK	5.208	0.001	0.003	69	69	SD
73521	73241	1	BFRNCH26	BENFRNCH	-5.191	-1.069	0	69	69	SD
73522	73241	1	CMNTPLNT	BENFRNCH	-16.615	-4.669	0	69	69	SD
73523	73241	1	CROSS ST	BENFRNCH	-32.972	1.28	0.026	69	69	SD
73523	73513	1	CROSS ST	LANGE TP	24.111	-3.754	0.008	69	69	SD
73524	73526	1	AMCOLOID	COLONY	26.032	-6.069	0.73	69	69	WY
73524	76501	1	AMCOLOID	BLFCH_TP	-27.732	6.109	0.017	69	69	WY
73525	73527	1	BELLECRK	BUTTEPMP	-16.727	8.96	0.252	69	69	WY
73525	74050	1	BELLECRK	DENBURY	16.287	1.983	0.007	69	69	WY
73526	73524	1	COLONY	AMCOLOID	-25.302	7.501	0.73	69	69	WY
73526	73527	1	COLONY	BUTTEPMP	18.752	-7.331	0.544	69	69	WY
73527	73525	1	BUTTEPMP	BELLECRK	16.978	-8.501	0.252	69	69	WY
73527	73526	1	BUTTEPMP	COLONY	-18.208	8.531	0.544	69	69	WY
73528	73272	1	MTNVIEW	LOOKOUT	-16.698	0.989	0.039	69	69	SD
73530	74001	1	NEWCASTLE	WY REFIN	-6.6	-1	0.001	69	69	WY
73603	73602	1	LAR.RIVR	WHEATLND	7.815	2.51	0.015	69	69	WY
74000	73273	1	STURGIS	STURG_CI	-15.111	-3.444	0	69	69	SD
74001	73530	1	WY REFIN	NEWCASTLE	6.601	0.988	0.001	69	69	WY
74001	74003	1	WY REFIN	S.CRK TP	-14.664	-2.212	0	69	69	WY
74002	74057	1	88 OIL	SGBRUSH	-2.87	0.28	0.004	69	69	WY

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74003	73269	1	S.CRK TP	SALT CRK	3.779	-0.11	0.007	69	69	WY
74003	74001	1	S.CRK TP	WY REFIN	14.664	2.212	0	69	69	WY
74003	74057	1	S.CRK TP	SGBRUSH	-18.443	-2.102	0.087	69	69	WY
74004	73260	1	NWCL TAP	OSAGE	0	0	0	69	69	WY
74005	73281	1	PLUMA TP	WNDYFLAT	1.78	0.078	0.001	69	69	SD
74005	73284	1	PLUMA TP	YELLOWCRK	-1.78	-0.078	0	69	69	SD
74006	73263	1	SPRUCEGL	PLUMA	-36.112	-1.697	0.058	69	69	SD
74006	73280	1	SPRUCEGL	WTEWOOD	30.264	0.138	0.278	69	69	SD
74007	73260	1	OSAG CTY	OSAGE	-5.724	0.613	0.002	69	69	WY
74007	74008	1	OSAG CTY	BENTON	3.754	-0.443	0.006	69	69	WY
74008	74007	1	BENTON	OSAG CTY	-3.748	0.108	0.006	69	69	WY
74008	74009	1	BENTON	UPTON C	1.01	-0.108	0	69	69	WY
74009	74008	1	UPTON C	BENTON	-1.01	0.09	0	69	69	WY
74012	73259	1	GILLETTE	NSS1	-28.853	-6.402	0.247	69	69	WY
74013	73266	1	PEDMNT	LANGE	-16.807	-0.956	0.135	69	69	SD
74013	74021	1	PEDMNT	BLUCKSBERG	5.208	0.245	0.008	69	69	SD
74019	73342	1	GILLETTS	NSS2	-44.51	-9.457	0.596	69	69	WY
74021	74013	1	BLUCKSBERG	PEDMNT	-5.2	-0.5	0.008	69	69	SD
74028	73257	1	RCSOUTH2	MERILLAT	9.295	2.565	0.007	69	69	SD
74028	73516	1	RCSOUTH2	5THST TP	30.725	6.188	0.06	69	69	WY
74028	73518	1	RCSOUTH2	RADIO_DR	5.959	1.698	0.002	69	69	SD
74036	73240	1	MINNKHAT	ARGYLE	15.682	-2.914	0.059	69	69	SD
74036	73249	1	MINNKHAT	EDGEMONT	4.407	-3.955	0.017	69	69	SD
74050	73525	1	DENBURY	BELLECRK	-16.28	-1.975	0.007	69	69	WY
74055	73268	1	CLEVL D ST	5TH ST	23.15	4.378	0.037	69	69	SD
74055	73516	1	CLEVL D ST	5THST TP	-30.665	-5.941	0	69	69	SD
74057	74002	1	SGBRUSH	88 OIL	2.874	-0.518	0.004	69	69	WY
74057	74003	1	SGBRUSH	S.CRK TP	18.53	2.212	0.087	69	69	WY
74069	73241	1	WESTRC	BENFRNCH	36.745	-7.944	0.005	69	69	SD
74069	73241	2	WESTRC	BENFRNCH	36.745	-7.944	0.005	69	69	SD
74069	73266	1	WESTRC	LANGE	-22.121	-9.153	0.047	69	69	SD
74075	73518	1	RED ROCK	RADIO_DR	3.157	-0.395	0.001	69	69	SD
74075	73519	1	RED ROCK	44TH ST	-5.204	-0.105	0.003	69	69	SD
76120	73342	1	PWDRN PR	NSS2	0	0	0	69	69	WY
76121	73282	1	PWDRS PR	WYODAK	0	0	0	69	69	WY
76398	73275	1	STURGBEC	SUNDHILL	-6.572	0	0.021	69	69	SD

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76500	76501	1	BELLEBEC	BLFCH_TP	0	0	0	69	69	WY
76501	73275	1	BLFCH_TP	SUNDHILL	-27.749	6.17	0.126	69	69	WY
76501	73524	1	BLFCH_TP	AMCOLOID	27.749	-6.066	0.017	69	69	WY
76501	76500	1	BLFCH_TP	BELLEBEC	0	-0.104	0	69	69	WY
76502	73271	1	SPFSHPRK	SPFSHCIT	-4.894	-1.28	0.003	69	69	SD

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Appendix B – 230/69kV 3W-Transformers

Circuit ID	W1 Bus	W1 Bus Name	W1 kV	W2 Bus	W2 Bus Name	W2 kV	W3 Bus	W3 Bus Name	W3 kV	Total MW Loss (PSS/E)	State
1	73164	LANGE	230	73266	LANGE	69	74606	LNGTER1	13.2	0.035	SD
2	73164	LANGE	230	73266	LANGE	69	74607	LNGTER2	13.2	0.037	SD
1	73186	LOOKOUT1	230	73272	LOOKOUT	69	74608	LKOTER1	13.2	0.055	SD
2	73186	LOOKOUT1	230	73272	LOOKOUT	69	74609	LKOTER2	13.2	0.059	SD
1	74035	MINNKHAT	230	74036	MINNKHAT	69	74611	MKTTER	13.2	0.091	SD
1	73148	OSAGE	230	73260	OSAGE	69	74613	O23TER	13.2	0.005	WY
1	74057	SGBRUSH	69	74058	SGBRUSH	230	74612	SGBTER	13.2	0.016	WY
1	73087	WESTHILL	230	73252	WESTHILL	69	74610	WHLTER	13.2	0.091	SD
2	66725	WYODAK	230	73282	WYODAK	69	74615	WYDTER	13.2	0.002	WY
1	73283	YELOWCRK	230	73284	YELOWCRK	69	74614	YWCTER	13.2	0.027	SD

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Appendix C – 230/69kV 2W-Transformers

From Bus	To Bus	Circuit ID	From Name (PSS/E)	To Name (PSS/E)	MW (PSS/E)	MVar (PSS/E)	MW Losses (PSS/E)	From kV	To kV	State
73283	73284	2	YELOWCRK	YELOWCRK	36.547	-2.115	0.025	230	69	SD
74027	74028	1	RCSOUTH1	RCSOUTH2	56.969	15.685	0.064	230	69	SD
74068	74069	1	WESTRC	WESTRC	51.429	-22.299	0.06	230	69	SD

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Appendix D – Generation & Interchange Calibration

Number	ID	NAME	MW (SCADA)	MVAR (SCADA)	MW (PSS/E)	MVAR (PSS/E)	MW MISMATCH	MVAR MISMATCH
66730	1	WYODAK	307.534	-6.44	307.534	-6.44	0%	0%
73190	1	STEGALL	24.928	-19.717	24.928	-19.717	0%	0%
73289	1	RCCT1	-0.012	0	-0.012	0	0%	0%
73291	2	RCCT2	10.663	0.903	10.663	0.903	0%	0%
73292	3	RCCT3	0.012	-0.012	0.012	-0.012	0%	0%
73293	4	RCCT4	-0.012	0	-0.012	0	0%	0%
73341	2	NSS2	88.542	8.789	88.542	8.789	0%	0%
73520	1	BFDIESEL	-0.051	0	-0.051	0	0%	0%
74014	1	NSS CT1	31.251	-5.936	31.251	-5.936	0%	0%
74015	1	NSS CT2	34.006	-2.744	34.006	-2.744	0%	0%
74016	1	WYGEN	0	-0.44	0	-0.44	0%	0%
74017	1	WYGEN2	93.3	3.156	93.3	3.156	0%	0%
74018	1	WYGEN3	83.235	8.32	83.235	8.32	0%	0%
74029	1	LNG CT1	31.812	-6.125	31.812	-6.125	0%	0%
74635	PV	FALLRVR_PV	67.417	-2.683	67.417	-2.683	0%	0%
76351	1	RCDC W	25.701	-4.599	25.701	-4.599	0%	0%
76404	1	DRYFORK	362.484	22.967	362.484	22.967	0%	0%

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Appendix E – Load Calibration

ID	Bus Number	Substation	kV	MW (SCADA)	MVAR (SCADA)	MW (PSS/E)	MVAR (PSS/E)	MW MISMATC H	MVAR MISMATC H	Confirmed Owner (PSS/E)	COMMENTS
BA	65293	CARR DRA	230	9.218	0.528	9.218	0.528	0%	0%	94	69 kV element aggregated/modelled on the 230 kV network
BA	76400	PUMPKIN_B TS	230	20.546	-0.584	20.546	-0.584	0%	0%	94	69 kV element aggregated/modelled on the 230 kV network
BA	73168	RENO	230	36.138	9.286	36.138	9.286	0%	0%	7	69 kV element aggregated/modelled on the 230 kV network
BA	76315	TEKLA T1	69	29.573	15.871	29.573	15.871	0%	0%	94	
BA	76316	TEKLA T2	69	20.747	4.676	20.747	4.676	0%	0%	94	
BA	76401	BARBERCK	230	18.301	-2.401	18.301	-2.401	0%	0%	94	69 kV element aggregated/modelled on the 230 kV network
BH	73237	38TH ST	69	6.321	1.2	6.321	1.2	0%	0%	60	
BA	73239	ANGUSTORA	69	4.799	0	4.799	0	0%	0%	94	
BH	73240	ARGYLE	69	0.677	0.1	0.677	0.1	0%	0%	60	
BA	73242	BIG BEND	69	2.802	0	2.802	0	0%	0%	94	
BH	73243	CAMBELL	69	4.704	1.452	4.704	1.452	0%	0%	60	
BH	73244	CEMETERY	69	12.899	2.12	12.899	2.12	0%	0%	60	
BH	73246	CUSTER	69	11.51	1.189	11.51	1.189	0%	0%	60	
BA	73248	DUMONT	69	0.977	-0.169	0.977	-0.169	0%	0%	94	
BH	73249	EDGEMONT	69	2.4	0.5	2.4	0.5	0%	0%	94	
BH	73250	HILLCITY	69	7.506	-0.454	7.506	-0.454	0%	0%	94	
BA	73250	HILLCITY - BA	69	0.824	0.11	0.824	0.11	0%	0%	94	
BH	73251	HILLSVW	69	5.6	1.501	5.6	1.501	0%	0%	60	
BH	73252	WESTHILL	69	11.708	-0.959	11.708	-0.959	0%	0%	60	
BA	73253	JWL CAVE	69	1.576	0	1.576	0	0%	0%	94	
BH	73254	KIRK	69	2.909	-1.739	2.909	-1.739	0%	0%	60	
BH	73257	MERILLAT	69	13.021	6.407	13.021	6.407	0%	0%	60	
BA	73258	MCFT PR	69	22.966	8.112	22.966	8.112	0%	0%	94	

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BH	73259	NSS1	69	1.376	0.941	1.376	0.941	0%	0%	60
BA	73260	OSAGE	69	3.238	0.67	3.238	0.67	0%	0%	94
BH	73261	PACTOLA	69	0.869	-0.16	0.869	-0.16	0%	0%	60
BH	73262	PLSNTVLY	69	8.243	2.035	8.243	2.035	0%	0%	60
BH	73263	PLUMA	69	11.94	2.819	11.94	2.819	0%	0%	60
BA	73265	PRINGLE	69	1.666	0	1.666	0	0%	0%	94
BH	73266	LANGE	69	10.103	2.399	10.103	2.399	0%	0%	60
BH	73268	5TH ST	69	13.657	1.397	13.657	1.397	0%	0%	60
BA	73269	SALT CRK	69	3.772	0	3.772	0	0%	0%	94
BA	73270	SPFSHBEC	69	6.15	0	6.15	0	0%	0%	94
BH	73271	SPFSHCIT	69	3.652	0.974	3.652	0.974	0%	0%	60
BH	73275	SUNDHILL	69	14.032	2.408	14.032	2.408	0%	0%	60
BH	73277	TROJAN	69	3.291	1.663	3.291	1.663	0%	0%	60
BH	73278	WESTBLVD	69	0.589	0.22	0.589	0.22	0%	0%	60
BH	73280	WHTWOOD	69	8.024	-2.121	8.024	-2.121	0%	0%	94
BH	73281	WNDYFLAT	69	1.779	0.3	1.779	0.3	0%	0%	60
BA	73282	WYODAK 69	69	25.536	10.603	25.536	10.603	0%	0%	94
BH	73286	ANAMOSA	69	7.222	0.869	7.222	0.869	0%	0%	60
BH	73287	4TH ST	69	3.487	0.684	3.487	0.684	0%	0%	60
BH	73290	EASTNRTH	69	10.128	1.837	10.128	1.837	0%	0%	60
BA	73295	HUGHES	69	9.117	2.096	9.117	2.096	0%	0%	94
BA	73342	NSS2 - BA	69	9.663	-1.91	9.663	-1.91	0%	0%	94
BH	73440	CENTRYRD	69	10.542	2.344	10.542	2.344	0%	0%	60
BH	73511	MALL	69	7.903	-1.222	7.903	-1.222	0%	0%	60
BH	73514	E.MEAD	69	9.451	2.998	9.451	2.998	0%	0%	60
BH	73518	RADIO_DR	69	9.113	1.93	9.113	1.93	0%	0%	60
BH	73519	44TH ST	69	7.815	1.686	7.815	1.686	0%	0%	60
BH	73521	BFRNCH26	69	5.191	1.069	5.191	1.069	0%	0%	60
BH	73522	CMNTPLNT	69	16.615	4.669	16.615	4.669	0%	0%	60
BH	73523	CROSS ST	69	8.861	2.474	8.861	2.474	0%	0%	60
BH	73525	BELLECRK	69	0.401	-0.242	0.401	-0.242	0%	0%	60
BH	73528	MTNVIEW	69	9.798	-0.989	9.798	-0.989	0%	0%	94
BA	73528	MTNVIEW	69	6.9	0	6.9	0	0%	0%	94
BH	73530	NEWCASTLE	69	6.6	1	6.6	1	0%	0%	60
BH	74000	STURGIS	69	15.111	3.444	15.111	3.444	0%	0%	60
BH	74001	WY REFIN	69	8.063	1.224	8.063	1.224	0%	0%	60

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BH	74006	SPRUCEGL	69	5.848	1.559	5.848	1.559	0%	0%	60	
BH	74008	BENTON	69	1.368	0	1.368	0	0%	0%	94	
BH	74011	CLOVIS	69	0.235	-0.095	0.235	-0.095	0	0	60	
BH	74012	GILLETTE	69	28.853	6.402	28.853	6.402	0	0	60	outside of Black Hills Power boundaries
BH	74013	PEDMNT	69	11.599	0.711	11.599	0.711	0	0	60	
BH	74019	GILLETTS	69	44.51	9.457	44.51	9.457	0	0	60	outside of Black Hills Power boundaries
BH	74021	BLUCKSBERG	69	5.2	0.5	5.2	0.5	0	0	60	
BH	74028	RCSOUTH2	69	10.926	1.947	10.926	1.947	0	0	60	
BH	74050	DENBURY	69	16.28	1.975	16.28	1.975	0%	0%	60	
BH	74055	CLEVLDT ST	69	7.515	1.563	7.515	1.563	0%	0%	60	
BH	74075	RED ROCK	69	2.047	0.5	2.047	0.5	0%	0%	60	
BA	76398	STURGBEC	69	6.572	0	6.572	0	0%	0%	94	
BA	76412	B.DURFEE	230	12.489	2.538	12.489	2.538	0%	0%	94	69 kV element aggregated/modelled on the 230 kV network
BH	76500	BELLEBEC	69	0	0	0	0	0%	0%	60	
BH	76502	SPFSHPRK	69	4.894	1.28	4.894	1.28	0%	0%	60	

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Appendix F – Substation Transformer DLAF Calculation Details

69kV Substation Transformer	Average of Top 3 Monthly Peaks	SCADA Peak (MVA)	DLAF using SCADA%	Synergi Peak (MVA)	DLAF using Synergi(%)	Final DLAF%	Region
Northern Hills - Blucksberg - XFMR T1	2.72	5.533	49.09%	5.503	49.4%	49.4%	SD
Northern Hills - Hillsview - XFMR T1	3.80	6.356	59.80%	6.261	60.7%	60.7%	SD
Northern Hills - Mountain View - XFMR T1	6.86	10.738	63.90%	10.321	66.5%	66.5%	SD
Northern Hills - Pluma - XFMR T1	7.37	11.308	65.21%	8.372	88.1%	88.1%	SD
Northern Hills - Pluma - XFMR T2	4.60	7.234	63.57%	4.313	106.6%	106.6%	SD
Northern Hills - Spearfish Park - XFMR T1	2.77	5.576	49.74%	5.287	52.5%	52.5%	SD
Northern Hills - Spearfish City - XFMR T1	3.01	4.397	68.37%	4.352	69.1%	69.1%	SD
Northern Hills - Spruce Gulch - XFMR T1	4.73	7.297	64.87%	6.191	76.5%	76.5%	SD
Northern Hills - Sturgis - XFMR T1	4.32	6.828	63.31%	5.863	73.7%	73.7%	SD
Northern Hills - Sturgis - XFMR T2	4.23	8.524	49.64%	10.399	40.7%	40.7%	SD
SUNDANCE HILL SUB (SHL) 50 T1	6.52	11.449	56.94%	9.989	65.3%	65.3%	SD
SUNDANCE HILL 4160 SUB (SH4) 88 T1	3.40	5.558	61.22%	6.343	53.6%	53.6%	SD
Northern Hills - Trojan - XFMR T1	5.76	7.998	72.04%	4.272	134.9%	72.0%	SD
Northern Hills - WHITEWOOD - XFMR T1	6.47	10.301	62.77%	8.428	76.7%	76.7%	SD
Northern Hills - Windy Flats - XFMR T1	1.89	3.046	62.04%	1.839	102.8%	102.8%	SD
Rapid City - 38th Street - XFMR T1	4.85	7.335	66.08%	6.752	71.8%	71.8%	SD
Rapid City - 44th Street - XFMR T1	5.86	9.026	64.88%	8.225	71.2%	71.2%	SD
Rapid City - 4th Street - XFMR T1	2.25	2.864	78.62%	3.31	68.0%	68.0%	SD
Rapid City - 4th Street - XFMR T2	0.89	1.7	52.15%	1.059	83.7%	83.7%	SD
Rapid City - 5th Street - XFMR T1	10.89	16.362	66.56%	14.939	72.9%	72.9%	SD
Rapid City - Anamosa - XFMR T1	6.38	8.174	78.05%	8.165	78.1%	78.1%	SD
Rapid City - CABBELL STREET - XFMR T3	3.72	6.538	56.92%	5.474	68.0%	68.0%	SD
Rapid City - Cemetery - XFMR T1	5.34	8.132	65.62%	7.802	68.4%	68.4%	SD
Rapid City - Cemetery - XFMR T2	4.58	6.44	71.13%	6.347	72.2%	72.2%	SD
Rapid City - Century Road - XFMR T1	5.69	7.666	74.24%	6.514	87.4%	87.4%	SD
Rapid City - Century Road - XFMR T2	4.04	5.128	78.72%	5.205	77.6%	77.6%	SD
Rapid City - Cleveland Street - XFMR T1	7.03	8.493	82.76%	8.763	80.2%	80.2%	SD
Rapid City - Cross Street - XFMR T1	7.42	10.097	73.48%	9.985	74.3%	74.3%	SD
Rapid City - East North Street - XFMR T1	4.46	7.203	61.90%	5.829	76.5%	76.5%	SD
Rapid City - East North Street - XFMR T2	5.32	8.732	60.87%	5.829	91.2%	91.2%	SD

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Rapid City - East Meade - XFMR T1	8.70	14.053	61.90%	10.643	81.7%	81.7%	SD
LANGE SUB (LNG) 36 T1	9.81	29.922	32.77%	12.809	76.6%	76.6%	SD
Rapid City - Mall - XFMR T1	6.71	8.386	79.97%	8.48	79.1%	79.1%	SD
Rapid City - Merillat - XFMR T1	6.48	9.708	66.74%	8.185	79.2%	79.2%	SD
Rapid City - Merillat - XFMR T2	10.03	11.411	87.91%	9.806	102.3%	102.3%	SD
Rapid City - PACTOLA - XFMR T1	1.02	1.997	51.25%	0.9	113.7%	51.3%	SD
Rapid City - Piedmont - XFMR T1	8.66	14.891	58.16%	12.29	70.5%	70.5%	SD
Rapid City - Pleasant Valley - XFMR T1	6.65	11.364	58.56%	9.344	71.2%	71.2%	SD
Rapid City - Radio Drive - XFMR T1	3.91	5.479	71.32%	5.354	73.0%	73.0%	SD
Rapid City - Radio Drive - XFMR T2	4.40	5.903	74.53%	4.991	88.1%	88.1%	SD
Rapid City - Red Rock - XFMR T1	1.65	2.354	70.08%	2.454	67.2%	67.2%	SD
Rapid City - South Rapid Dist - XFMR T2	8.66	11.871	72.99%	11.925	72.7%	72.7%	SD
Rapid City - South Rapid Dist - XFMR T3	7.33	11.241	65.17%	0.32	2289.3%	65.2%	SD
Rapid City - West Blvd - XFMR T1	0.57	0.826	68.89%	0.791	71.9%	71.9%	SD
Southern Hills - Argyle - XFMR T1	1.48	2.202	67.09%	0.809	182.6%	67.1%	SD
Southern Hills - CUSTER - XFMR T1	4.57	7.187	63.52%	4.239	107.7%	107.7%	SD
Southern Hills - CUSTER - XFMR T2	6.28	10.801	58.15%	6.206	101.2%	101.2%	SD
Southern Hills - Edgemont City - XFMR T1	2.37	4.301	55.16%	2.173	109.2%	109.2%	SD
Southern Hills - Hot Springs City - XFMR T1	6.44	9.158	70.33%	8.886	72.5%	72.5%	SD
Southern Hills - Neil Simpson West - XFMR T1	1.81	2.987	60.70%	0.389	466.1%	60.7%	SD
Southern Hills - Neil Simpson Dist - XFMR T1	3.21	3.956	81.17%	0.459	699.6%	81.2%	SD
Southern Hills - Newcastle - XFMR T1	5.34	7.058	75.62%	6.753	79.0%	79.0%	WY
Southern Hills - UPTON BENTONITE - XFMR T1	1.93	2.972	64.81%	1.408	136.8%	64.8%	WY

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Appendix G – Feeder DLAF Calculation Details

Feeder	Average of Top 3 Monthly Peaks	SCADA Peak (MVA)	DLAF-SCADA%	Synergi Peak (MVA)	DLAF-Synergi(%)	Final DLAF%	Region
Northern Hills - BELLE CREEK - RECL 2010	0.558	1.85	30.18%	0.182	306.7%	30.18%	MT
Northern Hills - BELLE CREEK - RECL 2016	0.189	0.654	28.93%	0.025	756.8%	28.9%	MT
Northern Hills - BELLE CREEK - RECL 2033	0.472	0.847	55.77%	0.334	141.4%	55.8%	MT
Northern Hills - Blucksberg - BKR 2488	0.771	1.093	70.58%	0.899	85.8%	85.8%	SD
Northern Hills - Blucksberg - BKR 2489	1.468	2.707	54.24%	2.904	50.6%	50.6%	SD
Northern Hills - Blucksberg - BKR 2490	0.537	1.26	42.58%	1.221	43.9%	43.9%	SD
Northern Hills - Blucksberg - BKR 2491	0.092	0.154	59.70%	0.422	21.8%	21.8%	SD
Northern Hills - Hillsview - RECL 1215	2.561	4.498	56.95%	4.241	60.4%	60.4%	SD
Northern Hills - Hillsview - RECL 1216	1.401	2.583	54.25%	1.955	71.7%	71.7%	SD
Northern Hills - Mountain View - BKR 2416	1.924	3.311	58.11%	3.224	59.7%	59.7%	SD
Northern Hills - Mountain View - BKR 2417	1.766	3.058	57.76%	1.973	89.5%	89.5%	SD
Northern Hills - Mountain View - BKR 2418	2.047	3.275	62.51%	2.956	69.3%	69.3%	SD
Northern Hills - Mountain View - BKR 2419	1.457	2.341	62.26%	2.017	72.3%	72.3%	SD
Northern Hills - Pluma - RECL 1204	4.118	7.377	55.82%	3.38	121.8%	55.8%	SD
Northern Hills - Pluma - RECL 1205	1.273	2.01	63.31%	1.81	70.3%	70.3%	SD
Northern Hills - Pluma - RECL 1206	2.225	3.518	63.24%	3.136	70.9%	70.9%	SD
Northern Hills - Pluma - RECL 1201	3.906	6.277	62.22%	3.583	109.0%	109.0%	SD
Northern Hills - Pluma - RECL 1202	0.744	1.077	69.07%	0.688	108.1%	108.1%	SD
Northern Hills - Pluma - RECL 1203	0.003	2.593	0.12%	0.001	319.4%	0.1%	SD
Northern Hills - Spearfish Park - BKR 1286	0.646	1.389	46.53%	1.114	58.0%	58.0%	SD
Northern Hills - Spearfish Park - BKR 1287	2.185	4.39	49.78%	4.117	53.1%	53.1%	SD
Northern Hills - Spearfish City - BKR 1291	1.357	2.766	49.07%	2.048	66.3%	66.3%	SD
Northern Hills - Spearfish City - BKR 1292	0.542	0.985	55.00%	0.836	64.8%	64.8%	SD
Northern Hills - Spearfish City - BKR 1293	1.189	2.002	59.40%	1.448	82.1%	82.1%	SD
Northern Hills - Spruce Gulch - BKR 1221	3.384	5.258	64.36%	4.724	71.6%	71.6%	SD
Northern Hills - Spruce Gulch - BKR 1222	1.045	1.6	65.32%	1.007	103.8%	103.8%	SD
Northern Hills - Spruce Gulch - BKR 1223	0.519	0.856	60.63%	0.43	120.7%	60.6%	SD
Northern Hills - Sturgis - BKR 1201	1.214	1.905	63.75%	0.322	377.2%	63.8%	SD
Northern Hills - Sturgis - BKR 1202	0.949	1.878	50.52%	2.48	38.3%	38.3%	SD
Northern Hills - Sturgis - BKR 1203	2.251	3.892	57.83%	3.84	58.6%	58.6%	SD
Northern Hills - Sturgis - BKR 1209	1.226	2.389	51.31%	2.144	57.2%	57.2%	SD

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Northern Hills - Sturgis - BKR 1210	1.110	2.385	46.54%	2.663	41.7%	41.7%	SD
Northern Hills - Sturgis - BKR 1211	2.110	4.085	51.66%	5.361	39.4%	39.4%	SD
Northern Hills - SUNDANCE HILL - RECL 2470	3.142	4.809	65.35%	4.496	69.9%	69.9%	SD
Northern Hills - SUNDANCE HILL - RECL 2471	0.892	1.603	55.63%	1.05	84.9%	84.9%	SD
Northern Hills - SUNDANCE HILL - RECL 2472	1.273	1.863	68.36%	1.763	72.2%	72.2%	SD
Northern Hills - SUNDANCE HILL - RECL 2473	1.745	2.865	60.92%	2.455	71.1%	71.1%	SD
Northern Hills - Sundance Hill - BKR 411	1.480	2.608	56.75%	3.071	48.2%	48.2%	SD
Northern Hills - Sundance Hill - BKR 412	0.814	1.217	66.88%	1.493	54.5%	54.5%	SD
Northern Hills - Sundance Hill - BKR 414	1.064	1.712	62.16%	1.612	66.0%	66.0%	SD
Northern Hills - Trojan - RECL 1209	4.818	6.605	72.95%	4.261	113.1%	72.9%	SD
Northern Hills - Trojan - RECL 1210	0.123	0.295	41.84%	0.021	587.8%	41.8%	SD
Northern Hills - WHITEWOOD - BKR 2W5	3.772	4.57	82.54%	3.533	106.8%	106.8%	SD
Northern Hills - WHITEWOOD - BKR 2W9	1.583	2.025	78.15%	1.827	86.6%	86.6%	SD
Northern Hills - WHITEWOOD - BKR 2W13	2.075	3.914	53.01%	3.725	55.7%	55.7%	SD
Northern Hills - Windy Flats - RECL 1207	1.141	1.622	70.37%	0.988	115.5%	70.4%	SD
Northern Hills - Windy Flats - RECL 1212	0.792	1.225	64.65%	0.795	99.6%	99.6%	SD
Rapid City - 38th Street - RECL 343	0.428	0.553	77.39%	0.512	83.6%	83.6%	SD
Rapid City - 38th Street - RECL 347	4.143	6.208	66.73%	5.684	72.9%	72.9%	SD
Rapid City - 38th Street - RECL 355	0.451	0.717	62.87%	0.431	104.6%	104.6%	SD
Rapid City - 44th Street - BKR 1256	2.588	4.328	59.80%	3.271	79.1%	79.1%	SD
Rapid City - 44th Street - BKR 1257	2.341	3.318	70.55%	2.913	80.4%	80.4%	SD
Rapid City - 44th Street - BKR 1258	1.589	2.922	54.39%	1.843	86.2%	86.2%	SD
Rapid City - 4th Street - RECL 408	1.142	1.497	76.32%	1.466	77.9%	77.9%	SD
Rapid City - 4th Street - RECL 409	1.351	1.79	75.47%	1.844	73.3%	73.3%	SD
Rapid City - 4th Street - RECL 410	0.159	0.232	68.69%	0.182	87.6%	87.6%	SD
Rapid City - 4th Street - RECL 411	0.761	1.436	52.97%	0.91	83.6%	83.6%	SD
Rapid City - 5th Street - BKR 1214	2.222	2.915	76.21%	2.807	79.1%	79.1%	SD
Rapid City - 5th Street - BKR 1215	5.922	9.872	59.99%	4.925	120.2%	60.0%	SD
Rapid City - 5th Street - RECL 1220	5.012	7.376	67.95%	6.768	74.1%	74.1%	SD
Rapid City - Anamosa - BKR 1225	2.988	3.825	78.11%	3.709	80.6%	80.6%	SD
Rapid City - Anamosa - BKR 1226	2.187	2.837	77.07%	2.773	78.9%	78.9%	SD
Rapid City - Anamosa - BKR 1227	2.032	3.902	52.08%	1.842	110.3%	52.1%	SD
Rapid City - Ben French 24.9 - RECL 242	3.015	4.27	70.61%	4.085	73.8%	73.8%	SD
Rapid City - Ben French 24.9 - RECL 245	0.166	0.25	66.31%	0.154	107.6%	107.6%	SD
Rapid City - Ben French 24.9 - RECL 269	0.730	0.951	76.78%	0.981	74.4%	74.4%	SD
Rapid City - Ben French 24.9 - RECL 2L34	1.004	1.734	57.92%	0.891	112.7%	57.9%	SD

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Rapid City - CAMBELL STREET - RECL 325	0.687	0.925	74.26%	0.792	86.7%	86.7%	SD
Rapid City - CAMBELL STREET - RECL 326	2.406	3.55	67.78%	2.406	100.0%	100.0%	SD
Rapid City - CAMBELL STREET - RECL 327	2.112	2.931	72.04%	2.235	94.5%	94.5%	SD
Rapid City - Cemetery - RECL 1211	3.533	4.913	71.91%	4.592	76.9%	76.9%	SD
Rapid City - Cemetery - RECL 1212	1.369	2.094	65.37%	1.864	73.4%	73.4%	SD
Rapid City - Cemetery - RECL 1213	0.911	1.223	74.45%	1.159	78.6%	78.6%	SD
Rapid City - Cemetery - RECL 1223	2.905	3.846	75.53%	3.824	76.0%	76.0%	SD
Rapid City - Cemetery - RECL 1224	1.886	2.757	68.40%	2.431	77.6%	77.6%	SD
Rapid City - Century Road - BKR 1251	1.476	1.917	76.98%	1.835	80.4%	80.4%	SD
Rapid City - Century Road - BKR 1252	1.278	1.611	79.33%	1.539	83.0%	83.0%	SD
Rapid City - Century Road - BKR 1253	2.425	3.737	64.88%	3.035	79.9%	79.9%	SD
Rapid City - Century Road - BKR 1260	1.201	1.963	61.18%	1.344	89.4%	89.4%	SD
Rapid City - Century Road - BKR 1262	0.698	0.837	83.43%	0.781	89.4%	89.4%	SD
Rapid City - Century Road - BKR 1263	2.523	3.217	78.43%	3.033	83.2%	83.2%	SD
Rapid City - Cleveland Street - BKR 1287	1.173	1.676	69.96%	1.649	71.1%	71.1%	SD
Rapid City - Cleveland Street - BKR 1288	3.931	4.727	83.16%	4.494	87.5%	87.5%	SD
Rapid City - Cleveland Street - BKR 1289	1.412	2.01	70.23%	1.523	92.7%	92.7%	SD
Rapid City - Cleveland Street - BKR 1290	0.813	1.005	80.88%	0.985	82.5%	82.5%	SD
Rapid City - Cross Street - RECL 1216	3.863	5.354	72.16%	5.073	76.2%	76.2%	SD
Rapid City - Cross Street - RECL 1217	1.358	2.102	64.61%	2.056	66.1%	66.1%	SD
Rapid City - Cross Street - RECL 1218	2.201	3.549	62.00%	2.63	83.7%	83.7%	SD
Rapid City - East North Street - BKR 1241	2.228	3.172	70.24%	2.455	90.8%	90.8%	SD
Rapid City - East North Street - BKR 1242	1.577	2.715	58.09%	1.917	82.3%	82.3%	SD
Rapid City - East North Street - BKR 1243	0.994	1.448	68.67%	1.377	72.2%	72.2%	SD
Rapid City - East North Street - BKR 1246	2.822	4.721	59.79%	2.493	113.2%	59.8%	SD
Rapid City - East North Street - BKR 1247	0.882	1.11	79.45%	1.005	87.8%	87.8%	SD
Rapid City - East North Street - BKR 1248	1.958	2.533	77.31%	2.36	83.0%	83.0%	SD
Rapid City - East Meade - BKR 1232	2.024	2.6	77.84%	2.354	86.0%	86.0%	SD
Rapid City - East Meade - BKR 1233	3.387	4.948	68.45%	4.655	72.8%	72.8%	SD
Rapid City - East Meade - BKR 1234	0.796	2.214	35.95%	1.019	78.1%	78.1%	SD
Rapid City - East Meade - BKR 1235	3.169	7.201	44.01%	2.307	137.4%	44.0%	SD
Rapid City - LANGE - BKR 212	0.743	15.801	4.70%	0.498	149.2%	4.7%	SD
Rapid City - LANGE - BKR 287	1.478	3.536	41.80%	1.918	77.1%	77.1%	SD
Rapid City - LANGE - BKR 291	7.586	10.585	71.67%	10.097	75.1%	75.1%	SD
Rapid City - Mall - BKR 2436	4.310	5.39	79.97%	5.187	83.1%	83.1%	SD
Rapid City - Mall - BKR 2437	1.405	2.49	56.43%	1.541	91.2%	91.2%	SD

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Rapid City - Mall - BKR 2438	1.441	1.89	76.22%	1.891	76.2%	76.2%	SD
Rapid City - Merillat - RECL 1208	2.301	3.143	73.20%	3.127	73.6%	73.6%	SD
Rapid City - Merillat - RECL 1209	0.984	1.329	74.07%	0.538	183.0%	74.1%	SD
Rapid City - Merillat - RECL 1210	4.123	8.14	50.65%	4.426	93.2%	93.2%	SD
Rapid City - Merillat - RECL 1261	9.982	11.356	87.90%	9.629	103.7%	103.7%	SD
Rapid City - Piedmont - BKR 2456	3.146	6.153	51.13%	3.8	82.8%	82.8%	SD
Rapid City - Piedmont - BKR 2457	4.376	6.563	66.68%	6.134	71.3%	71.3%	SD
Rapid City - Piedmont - BKR 2458	2.394	3.746	63.90%	2.147	111.5%	63.9%	SD
Rapid City - Pleasant Valley - RECL RC300	3.409	5.491	62.08%	4.291	79.4%	79.4%	SD
Rapid City - Pleasant Valley - RECL RC301	2.164	3.04	71.17%	2.956	73.2%	73.2%	SD
Rapid City - Pleasant Valley - RECL RC302	1.430	2.064	69.29%	1.883	75.9%	75.9%	SD
Rapid City - Radio Drive - BKR 1272	1.003	1.501	66.84%	1.258	79.8%	79.8%	SD
Rapid City - Radio Drive - BKR 1273	2.975	4.032	73.79%	4.027	73.9%	73.9%	SD
Rapid City - Radio Drive - BKR 1275	1.275	1.552	82.14%	1.431	89.1%	89.1%	SD
Rapid City - Radio Drive - BKR 1276	3.167	4.501	70.36%	3.504	90.4%	90.4%	SD
Rapid City - South Rapid Dist - BKR 1281	0.029	0.036	79.99%	0.016	180.0%	80.0%	SD
Rapid City - South Rapid Dist - BKR 1282	4.502	6.251	72.03%	6.154	73.2%	73.2%	SD
Rapid City - South Rapid Dist - BKR 1283	4.276	5.917	72.27%	5.338	80.1%	80.1%	SD
Rapid City - South Rapid Dist - BKR 1297	0.169	0.339	49.98%	0.146	116.0%	50.0%	SD
Rapid City - West Blvd - RECL 401	0.018	0.023	78.98%	0.012	151.4%	79.0%	SD
Rapid City - West Blvd - RECL 402	0.331	0.566	58.48%	0.397	83.4%	83.4%	SD
Rapid City - West Blvd - RECL 403	0.106	0.163	65.07%	0.129	82.2%	82.2%	SD
Rapid City - West Blvd - RECL 404	0.169	0.237	71.12%	0.216	78.0%	78.0%	SD
Southern Hills - Argyle - RECL 704	0.960	1.834	52.33%	0.739	129.9%	52.3%	SD
Southern Hills - CUSTER - BKR 2400	2.250	3.881	57.98%	1.685	133.5%	58.0%	SD
Southern Hills - CUSTER - BKR 2S45	2.449	4.669	52.45%	2.471	99.1%	99.1%	SD
Southern Hills - CUSTER - RECL 1201	2.256	4.205	53.65%	2.572	87.7%	87.7%	SD
Southern Hills - CUSTER - RECL 1202	2.553	7.63	33.46%	2.503	102.0%	102.0%	SD
Southern Hills - CUSTER - RECL 1203	4.057	7.595	53.41%	1.011	401.3%	53.4%	SD
Southern Hills - Edgemont City - BKR 1241	1.189	1.487	79.96%	0.601	197.8%	80.0%	SD
Southern Hills - Edgemont City - BKR 1242	2.836	5.921	47.90%	1.02	278.1%	47.9%	SD
Southern Hills - Edgemont City - BKR 1243	0.100	0.1	100.00%	0.076	131.6%	100.0%	SD
Southern Hills - Edgemont City - BKR 1244	0.651	1.1	59.17%	0.432	150.7%	59.2%	SD
Southern Hills - Hill City - RECL 2S54	0.886	1.373	64.53%	0.888	99.8%	99.8%	SD
Southern Hills - Hill City - RECL 2S67	3.485	4.467	78.01%	4.31	80.9%	80.9%	SD
Southern Hills - Hill City - RECL 2S72	2.926	4.731	61.84%	3.481	84.0%	84.0%	SD

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Southern Hills - Hot Springs City - BKR 1206	4.966	8.389	59.19%	6.357	78.1%	78.1%	SD
Southern Hills - Hot Springs City - BKR 1207	0.861	1.336	64.43%	0.986	87.3%	87.3%	SD
Southern Hills - Hot Springs City - BKR 1208	0.037	0.061	60.63%	0.104	35.6%	35.6%	SD
Southern Hills - Hot Springs City - BKR 1209	1.139	1.319	86.32%	1.324	86.0%	86.0%	SD
Southern Hills - Neil Simpson West - BKR 422	0.837	1.843	45.41%	0.063	1328.4%	45.4%	SD
Southern Hills - Neil Simpson West - BKR 423	0.709	1.23	57.67%	0.308	230.3%	57.7%	SD
Southern Hills - Neil Simpson Dist - BKR 484	1.198	1.72	69.66%	0.267	448.8%	69.7%	SD
Southern Hills - Newcastle - BKR 401	1.023	1.304	78.42%	1.304	78.4%	78.4%	WY
Southern Hills - Newcastle - BKR 403	1.377	1.924	71.58%	1.496	92.1%	92.1%	WY
Southern Hills - Newcastle - BKR 404	2.126	2.915	72.94%	2.764	76.9%	76.9%	WY
Southern Hills - Newcastle - BKR 405	0.941	1.304	72.12%	1.102	85.3%	85.3%	WY
Southern Hills - WESTHILL - RECL 1201	1.631	2.512	64.92%	1.636	99.7%	99.7%	SD
Southern Hills - WESTHILL - RECL 1202	3.568	4.987	71.54%	3.079	115.9%	71.5%	SD



Appendix H - Substation Transformer Losses (69kV)

Transformer - Id	Nominal KVA	No load loss (kW)	Load loss (kW)	DLAF%	Loading (MVA)	Loading %	Total Loss (kW)	State
Rapid City - 38th Street - XFMR T1	10000	8.3	38.7	71.79%	6.752	67.52%	20.97	SD
Rapid City - 44th Street - XFMR T1	10000	10.119	43.887	71.19%	8.225	82.25%	31.26	SD
Rapid City - 4th Street - XFMR T1	7500	10.4	35.469	68.02%	4.369	58.25%	18.59	SD
Rapid City - 4th Street - XFMR T2	7500	10.4	35.469	83.71%	4.369	58.25%	20.48	SD
Rapid City - 5th Street - XFMR T1	12000	8	53.5	72.90%	14.939	124.49%	68.45	SD
Rapid City - Anamosa - XFMR T1	12000	7.062	53.323	78.14%	8.165	68.04%	26.35	SD
Southern Hills - Argyle - XFMR T1	3750	3.877	21.404	67.09%	0.809	21.57%	4.55	SD
Northern Hills - Blucksberg - XFMR T1	12000	12.6	44.5	49.36%	5.503	45.86%	17.22	SD
Rapid City - CABELL STREET - XFMR T3	10000	8.33	42.47	67.98%	5.474	54.74%	16.98	SD
Rapid City - Cemetery - XFMR T1	10000	9.8	56	68.40%	6.232	62.32%	24.68	SD
Rapid City - Century Road - XFMR T2	10000	10.266	43.514	77.56%	5.205	52.05%	19.41	SD
Rapid City - Cleveland Street - XFMR T1	12000	8.2	52.8	80.21%	8.763	73.03%	30.78	SD
Rapid City - Cross Street - XFMR T1	10000	8.3	38.4	74.30%	9.985	99.85%	36.75	SD
Southern Hills - CUSTER - XFMR T1	7500	5.924	33.369	107.70%	4.239	56.52%	17.40	SD
Southern Hills - CUSTER - XFMR T2	7500	5.924	33.369	101.21%	6.206	82.75%	29.05	SD
Rapid City - East Meade - XFMR T1	12000	12.094	43.405	81.73%	10.643	88.69%	40.00	SD
Rapid City - East North Street - XFMR T1	10000	16.1	40.1	76.49%	5.829	58.29%	26.52	SD
Rapid City - East North Street - XFMR T2	10000	8.58	37.183	91.19%	5.829	58.29%	20.10	SD
Northern Hills - Hillsvie - XFMR T1	10000	8.01	44.12	60.70%	6.261	62.61%	18.51	SD
Rapid City - Mall - XFMR T1	10000	8.4	31.5	79.09%	8.48	84.80%	26.31	SD
Rapid City - Merillat - XFMR T2	10000	8.2	39.2	102.30%	9.806	98.06%	46.76	SD
Northern Hills - Mountain View - XFMR T1	10000	9.1	31.1	66.48%	10.321	103.21%	31.13	SD
Southern Hills - Neil Simpson Dist - XFMR T1	10000	8.93	51.435	81.17%	0.459	4.59%	9.02	SD
Southern Hills - Neil Simpson West - XFMR T1	7500	6.4	25.8	60.70%	0.516	6.88%	6.47	SD
Southern Hills - Newcastle - XFMR T1	7500	11.47	45.984	79.04%	6.753	90.04%	40.94	WY
Rapid City - PACTOLA - XFMR T1	7500	7.44	36.92	51.25%	0.9	12.00%	7.71	SD
Rapid City - Piedmont - XFMR T1	10000	8.4	31.5	70.47%	12.29	122.90%	41.93	SD
Rapid City - Pleasant Valley - XFMR T1	12000	6.63	54.941	71.22%	9.344	77.87%	30.35	SD
Northern Hills - Pluma - XFMR T1	10000	9.2	54.472	88.08%	8.372	83.72%	42.83	SD
Northern Hills - Pluma - XFMR T2	7500	10.56	47.488	106.63%	4.313	57.51%	27.31	SD
Rapid City - Radio Drive - XFMR T1	10000	8.2	39.4	72.98%	5.354	53.54%	16.44	SD
Rapid City - Red Rock - XFMR T1	12000	10.376	43.942	67.23%	2.454	20.45%	11.61	SD
Rapid City - South Rapid Dist - XFMR T2	10000	8.15	41.23	72.66%	11.925	119.25%	50.75	SD
Rapid City - South Rapid Dist - XFMR T3	12000	8.31	49.34	65.17%	0.32	2.67%	8.33	SD
Northern Hills - Spearfish City - XFMR T1	10000	7.199	45.436	69.07%	4.352	43.52%	13.14	SD
Northern Hills - Spearfish Park - XFMR T1	10000	9.139	42.205	52.46%	5.287	52.87%	15.33	SD
Northern Hills - Spruce Gulch - XFMR T1	10000	8.5	39	76.46%	6.191	61.91%	19.93	SD
Northern Hills - SUNDANCE HILL - XFMR T1	5000	5.1	34.1	53.64%	6.344	126.88%	34.55	SD
Northern Hills - Sundance Hill - XFMR T1	5000	5.1	34.1	65.26%	9.989	199.78%	93.92	SD
Rapid City - West Blvd - XFMR T1	7500	11.59	44.198	71.94%	0.791	10.55%	11.94	SD
Northern Hills - Windy Flats - XFMR T1	5000	8.84	22.827	102.75%	1.839	36.78%	12.01	SD
Northern Hills - Sturgis - XFMR T1	10000	8.35	43.28	73.73%	5.863	58.63%	19.32	SD
Northern Hills - Sturgis - XFMR T2	10000	8.35	43.28	40.69%	10.399	103.99%	27.39	SD
Northern Hills - Trojan - XFMR T1	10000	8.35	43.28	72.04%	4.272	42.72%	14.04	SD
Northern Hills - WHITEWOOD - XFMR T1	10000	8.35	43.28	76.72%	8.428	84.28%	31.94	SD
Southern Hills - Edgemont City - XFMR T1	10000	10	42	109.18%	2.173	21.73%	12.17	SD
Southern Hills - Hot Springs City - XFMR T1	7500	10.129	34.173	72.48%	8.886	118.48%	44.90	SD
Southern Hills - UPTON BENTONITE - XFMR T1	10000	8.35	43.28	64.81%	1.408	14.08%	8.91	WY
Rapid City - Cemetery - XFMR T2	10000	9.8	56	72.17%	7.802	78.02%	34.40	SD

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Rapid City - Century Road - XFMR T1	10000	10.266	43.514	87.37%	6.347	63.47%	25.58	SD
Rapid City - Merillat - XFMR T1	10000	8.2	39.2	79.15%	8.185	81.85%	28.99	SD
Rapid City - Radio Drive - XFMR T2	10000	8.2	39.4	88.15%	4.991	49.91%	16.85	SD
BEN FRENCH 24.9 SUB (B24) 23 T1 Tran	15000	10.91	43.95	80.71%	6.105	40.70%	16.79	SD
BEN FRENCH DIESELS (BFD) 90 Tran	10000	8.35	43.28	0.00%	0.32	3.20%		SD
BELLE CREEK (BLC) 21 T1 Tran	10000	8.8	31	36.40%	0.683	6.83%	8.85	MT
LANGE SUB (LNG) 36 T1 Tran	10000	8.3	31.6	76.56%	12.809	128.09%	47.99	SD
LANGE SUB (LNG) 36 T3	10000	8.35	43.28	0.00%	0.32	3.20%	8.35	SD
WEST HILL SUB (WHL) 53 Tran	10000	8.35	43.28	0.00%	0.32	3.20%	8.35	SD
WEST HILL SUB (WHL) 53 T1 Tran	10000	8.35	43.28	108.76%	4.78	47.80%	19.11	SD
COLONY SUB. (COL) 25 T1 Tran	10000	14.338	46.348	0.00%	4.102	41.02%	14.34	WY
OSAGE CITY SUB (OSC) 43 T1 Tran	7500	7.968	28.235	0.00%	0.297	3.96%	7.97	WY
Richmon Hill SUB(RHL) 75 T1	10000	8.35	43.28	0.00%	0.298	2.98%	8.35	SD
Pop and Talbot	10000	8.35	43.28	0.00%	0.321	3.21%	8.35	SD
Neil Simpson East (N43)	10000	8.35	43.28	0.00%	0.32	3.20%	8.35	SD
Southern Hills - Hill City - XFMR	10000	8.35	43.28	83.51%	8.737	87.37%	35.94	SD
BUTTE PUMP (BTP) 79	10000	8.35	43.28	0.00%	0.281	2.81%	8.35	SD



Appendix I – Distribution Line Losses

Feeder - Id	kW Loss - Total	LADF	Loss Total	Region
ANA_1225	16	80.56%	12.89	SD
ANA_1226	11	78.85%	8.67	SD
ANA_1227	5	52.08%	2.60	SD
ARG_704	6	52.33%	3.14	SD
B24_242	20	73.81%	14.76	SD
B24_269	2	74.43%	1.49	SD
B24_2L34	1	57.92%	0.58	SD
BLC_2010	3	30.18%	0.91	MT
BLC_2033	11	55.77%	6.14	MT
BLX_2488	3	85.81%	2.57	SD
BLX_2489	28	50.56%	14.16	SD
BLX_2490	7	43.94%	3.08	SD
BLX_2491	0	21.79%	0.00	SD
CBL_RC325	4	86.73%	3.47	SD
CBL_RC326	14	100.00%	14.00	SD
CBL_RC327	10	94.48%	9.45	SD
CEM_1211	61	76.94%	46.93	SD
CEM_1212	10	73.44%	7.34	SD
CEM_1213	3	78.56%	2.36	SD
CEM_1223	36	75.96%	27.35	SD
CEM_1224	9	77.58%	6.98	SD
CLV_1287	6	71.11%	4.27	SD
CLV_1288	25	87.47%	21.87	SD
CLV_1289	1	92.68%	0.93	SD
CLV_1290	1	82.52%	0.83	SD
CSS_1216	39	76.16%	29.70	SD
CSS_1217	8	66.05%	5.28	SD
CSS_1218	8	83.67%	6.69	SD
CUS_1201	15	87.71%	13.16	SD
CUS_1202	35	102.01%	35.70	SD
CUS_1203	20	53.41%	10.68	SD
CUS_2400	2	57.98%	1.16	SD
CUS_2S45	27	99.11%	26.76	SD
CYR_1251	4	80.42%	3.22	SD
CYR_1252	4	83.04%	3.32	SD
CYR_1253	47	79.89%	37.55	SD
CYR_1260	8	89.36%	7.15	SD
CYR_1262	1	89.41%	0.89	SD
CYR_1263	8	83.19%	6.66	SD
EDC_1241	8	79.96%	6.40	SD
EDC_1242	6	47.90%	2.87	SD
EDC_1243	0	100.00%	0.00	SD
EDC_1244	0	59.17%	0.00	SD
EMD_1232	11	85.98%	9.46	SD
EMD_1233	46	72.75%	33.47	SD
EMD_1234	3	78.10%	2.34	SD

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EMD_1235	6	44.01%	2.64	SD
ENS_1241	6	90.75%	5.45	SD
ENS_1242	5	82.26%	4.11	SD
ENS_1243	4	72.22%	2.89	SD
ENS_1246	7	59.79%	4.19	SD
ENS_1247	1	87.75%	0.88	SD
ENS_1248	3	82.97%	2.49	SD
FFS_1256	34	79.13%	26.90	SD
FFS_1257	27	80.35%	21.70	SD
FFS_1258	45	86.24%	38.81	SD
FIF_1214	8	79.15%	6.33	SD
FIF_1215	15	59.99%	9.00	SD
FIF_1220	70	74.06%	51.84	SD
FST_408	8	77.93%	6.23	SD
FST_409	17	73.26%	12.45	SD
FST_410	1	87.56%	0.88	SD
FST_411	6	83.59%	5.02	SD
HIL_2S54	3	99.78%	2.99	SD
HIL_2S67	104	80.85%	84.09	SD
HIL_2S72	14	84.04%	11.77	SD
HSC_1206	13	78.11%	10.15	SD
HSC_1207	2	87.31%	1.75	SD
HSC_1208	0	35.56%	0.00	SD
HSC_1209	12	85.99%	10.32	SD
HVW_1215	44	60.40%	26.57	SD
HVW_1216	7	71.67%	5.02	SD
LNG_212	1	4.70%	0.05	SD
LNG_287	5	77.05%	3.85	SD
LNG_291	302	75.13%	226.89	SD
MER_1208	24	73.57%	17.66	SD
MER_1209	1	74.07%	0.74	SD
MER_1210	133	93.15%	123.89	SD
MER_1261	26	103.67%	26.95	SD
MLL_2436	77	83.10%	63.98	SD
MLL_2437	0	91.19%	0.00	SD
MLL_2438	2	76.18%	1.52	SD
MTV_2416	27	59.68%	16.11	SD
MTV_2417	20	89.53%	17.91	SD
MTV_2418	19	69.25%	13.16	SD
MTV_2419	32	72.26%	23.12	SD
N4W_422	0	45.41%	0.00	SD
N4W_423	2	57.67%	1.15	SD
NEW_401	42	78.42%	32.93	WY
NEW_403	23	92.05%	21.17	WY
NEW_404	135	76.93%	103.85	WY
NEW_405	14	85.35%	11.95	WY
NSD_484	0	69.66%	0.00	SD
PAC_2S82	3	51.25%	1.54	SD
PLM_1201	39	109.00%	42.51	SD
PLM_1202	4	108.12%	4.32	SD

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PLM_1203	0	0.12%	0.00	SD
PLM_1204	99	55.82%	55.26	SD
PLM_1205	11	70.31%	7.73	SD
PLM_1206	19	70.94%	13.48	SD
PLV_RC300	133	79.45%	105.66	SD
PLV_RC301	10	73.20%	7.32	SD
PLV_RC302	30	75.95%	22.78	SD
PMT_2456	23	82.79%	19.04	SD
PMT_2457	84	71.34%	59.93	SD
PMT_2458	10	63.90%	6.39	SD
RAD_1272	6	79.76%	4.79	SD
RAD_1273	49	73.88%	36.20	SD
RAD_1275	5	89.09%	4.45	SD
RAD_1276	35	90.38%	31.63	SD
RED_6004	41	68.29%	28.00	SD
SH4_411	173	48.19%	83.38	SD
SH4_412	54	54.51%	29.44	SD
SH4_414	32	66.01%	21.12	SD
SHL_2470	32	69.89%	22.37	SD
SHL_2471	3	84.93%	2.55	SD
SHL_2472	9	72.23%	6.50	SD
SHL_2473	6	71.09%	4.27	SD
SPC_1291	4	66.27%	2.65	SD
SPC_1292	0	64.80%	0.00	SD
SPC_1293	2	82.13%	1.64	SD
SPG_1221	39	71.64%	27.94	SD
SPG_1222	20	103.78%	20.76	SD
SPG_1223	2	60.63%	1.21	SD
SPP_1286	2	58.02%	1.16	SD
SPP_1287	33	53.08%	17.52	SD
SRD_1281	0	79.99%	0.00	SD
SRD_1282	108	73.16%	79.02	SD
SRD_1283	100	80.11%	80.11	SD
SRD_1297	0	49.98%	0.00	SD
STG_1201	2	63.75%	1.28	SD
STG_1202	25	38.26%	9.57	SD
STG_1203	16	58.61%	9.38	SD
STG_1209	11	57.18%	6.29	SD
STG_1210	10	41.68%	4.17	SD
STG_1211	47	39.36%	18.50	SD
TES_RC343	0	83.59%	0.00	SD
TES_RC347	74	72.89%	53.94	SD
TES_RC355	0	104.59%	0.00	SD
TRO_1209	207	72.95%	151.00	SD
TRO_1210	0	41.84%	0.00	SD
UPT_401	6	64.81%	3.89	WY
UPT_402	8	99.69%	7.98	WY
WBV_401	0	78.98%	0.00	SD
WBV_402	1	83.38%	0.83	SD
WBV_403	0	82.22%	0.00	SD

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WBV_404	0	78.03%	0.00	SD
WFL_1207	41	70.37%	28.85	SD
WFL_1212	14	99.61%	13.95	SD
WHL_1201	20	71.54%	14.31	SD
WHL_1202	33	108.76%	35.89	SD
WTW_2W13	67	106.77%	71.53	SD
WTW_2W5	178	86.62%	154.18	SD
WTW_2W9	26	55.70%	14.48	SD



Appendix J – Distribution Line Transformer Load and No-Load Losses

Transformer (kVA)	No Load Losses (W)	Load Losses (W)	Impedance %
10	33	150	1.94
15	46	196	1.88
25	60	310	1.93
37.5	81	421	1.97
45	132	636	2.43
50	103	536	2.24
75	165	677	1.71
100	190	830	2
112	217	1466	5.66
150	292	1711	4.3
167	281	1332	2.1
225	361	1936	1.79
300	416	3156	4.73
500	656	4517	5.27
750	859	5070	5.69
1000	1142	7652	5.46
1500	1577	10785	5.77
2000	2191	11837	5.58
2500	2738	13188	5.55
3000	3342	14056	5.89



Appendix K – Secondary Cable Impedance Values

Cable Size	Transformer Size (kVA)	Resistance ohm/1000ft
1/0	1	0.1748
	5	0.1748
	10	0.1748
	15	0.1748
	20	0.1748
	25	0.1748
	30	0.1748
	35	0.1748
	37.5	0.1748
	38	0.1748
	40	0.1748
	45	0.1748
	50	0.1748
	60	0.1748
	63	0.1748
4/0	65	0.1748
	75	0.1748
	80	0.0904
	100	0.0904
	112	0.0904
	113	0.0904
	115	0.0904
	125	0.0904
350	130	0.0904
	150	0.0904
	167	0.0564
	175	0.0564
	200	0.0564
500	225	0.0564
	250	0.0564
	300	0.0564
	450	0.0415
	500	0.0415
	501	0.0415
	750	0.0415
	1000	0.0415
1500	0.0415	
2000	0.0415	
2500	0.0415	
3000	0.0415	