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June 6, 2022

VIA EMAIL

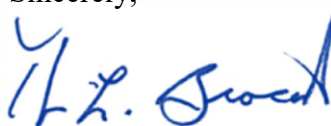
Rate Review Administrator
rate.filings2022@austinenergy.com

RE: Amendment to Austin Energy's Base Rate Filing Package

Attached please find an Amendment to Austin Energy's 2022 Base Rate Filing Package submitted on April 18, 2022. This Amendment contains the correct version of Austin Energy's System Loss Study for Fiscal Year 2018 (Line Loss Study). Austin Energy inadvertently attached a preliminary version of its Line Loss Study as an appendix to its 2022 Base Rate Filing Package submitted on April 18, 2022. The attached document is the correct, final Line Loss Study.

Austin Energy relied on the attached Line Loss Study when proposing its 2022 Base Rate Filing Package. Therefore, this Amendment has no impact on the Cost of Service Study, Base Rate Filing Package, or any previous Request for Information (RFI) responses related to the Line Loss Study.

Sincerely,



Thomas L. Brocato

749/36/8424273
Attachment



Appendix D: Austin Energy System Loss Study for Fiscal Year 2018

For Preparation of a 2019 Rate Study

Final Report – Version 2.0

Prepared by
Austin Energy

Nov. 6, 2019

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1 INTRODUCTION

This report presents the Austin Energy's fiscal year 2018 transmission and distribution system loss study for the preparation of a rate study. It provides a summary of the basis of loss calculations, methodologies used and the results.

The electric system, for the purposes of this study, is defined as the transmission and distribution system equipment required to distribute electrical power to each Austin Energy customer. Information about the Austin Energy power system configuration, equipment types and ratings, primary and secondary circuit types and lengths, historical data, and transformer loads was gathered to perform this analysis. The Austin Energy power system evaluated can be characterized by the following statistics and principal types of equipment as of Fiscal Year 2018:

Type	Quantity	Location of Loss Calculations
System Peak Demand	2,878 MW (1)	
Annual Net Energy for Load	13,950,713 MWh (2)	
Annual Energy Sales	13,338,963 MWh (2)	
Annual Losses	4.39 %	Exhibit A
Circuit-miles of Transmission		Exhibit B
345 kV	276.2 mi.	
138 kV	321.5 mi.	
69 kV	26.1 mi.	
Transmission Transformers	19	Exhibit C
Substation Transformers	168	Exhibit D
Circuit-miles of Distribution Operating at 12.5 kV	5,803 mi.	Exhibit E
Distribution Transformers	84,377	Exhibit F
Circuit-miles of Secondary Operating at 1.0 kV & below	7,522 mi.	Exhibit H
Street & Security Lights	65,042	Exhibit I

Notes:

(1) Peak Demand on July 23, 2018

(2) Based on Fiscal Year 2018

2 ANALYSIS SUMMARY

The calculated transmission and distribution system losses for fiscal year 2018 are summarized in the table below. Additional details of the loss calculations are included in Exhibits A through J. Charts illustrating the calculated losses by voltage level are given in Figure 1 and Figure 2.

Type	Annual Energy Losses (MWh)	Demand Losses at Peak (MW)
Transmission 345 kV	18,183	6.37
Transmission 138 kV	143,383	46.70
Transmission 69 kV	5,710	1.59
Distribution	164,047	51.53
Secondary	259,656	46.06
Non-Technical	20,771	0
TOTALS	611,750	152.25

Note: Lights were assumed to be off during the 2018 system peak.

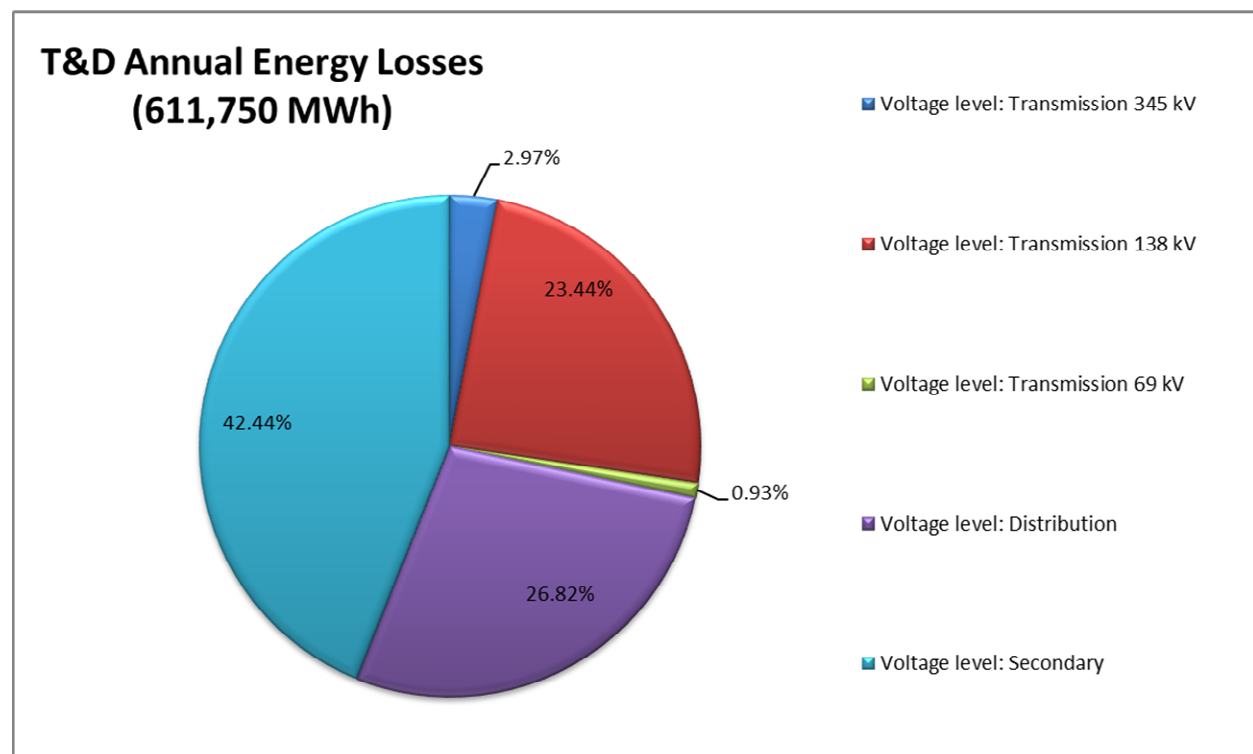


Figure 1. Calculated Annual Energy Losses by Voltage Level

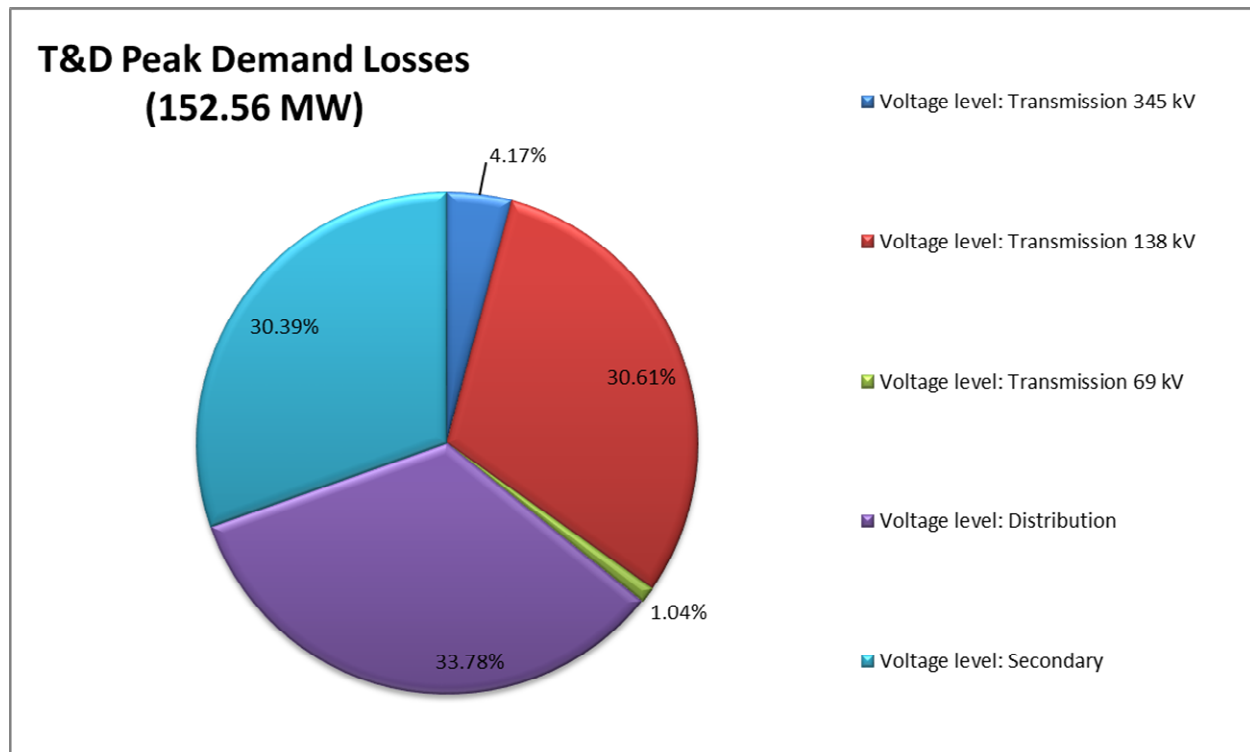


Figure 2. Calculated Demand Losses at Peak by Voltage Level

3 BASIS OF ANALYSIS

System losses can be categorized as technical and non-technical losses. Non-technical losses can be attributed to unmetered loads (such as station service), loose hardware, corona or other mechanical abnormalities, metering inaccuracies, theft, etc. For the purposes of this study, the non-technical losses were estimated based on the total system losses, which are calculated from the annual energy sales and purchases, less the calculated technical losses.

Technical system losses are an unavoidable result of delivering power to electric utility customers, due to the physics of power flow and voltage transformation. In addition, losses can be broken into two groups: 1) constant losses, which are independent of the system loading; and 2) variable losses, which are dependent on system loading.

Constant losses consist primarily of transformer core losses, or no-load losses. The constant system losses included in this study were based on the name plate losses and the assumed time period of one year.

Variable losses include transmission and distribution line losses for the primary and secondary systems, and transformer winding, or load losses. The variable losses included in this study were based on the calculated losses at peak, the assumed time period of one year, and the Loss Factor.

The equation for the Loss Factor is as follows:

$$\text{Loss Factor} = k * \text{Load Factor} + (1 - k) * \text{Load Factor}^2$$

A value of 0.08 was assumed for the constant coefficient “k” for the Loss Factor calculations based on research published¹ in IEEE Transactions on Power Systems on November 1988 using American and Canadian utilities. The average annual Load Factor for the fiscal year 2018 of 55.34% was calculated based on the Austin Energy monthly system peak and energy purchases.

4 TRANSMISSION & DISTRIBUTION SYSTEM

Losses for the transmission and distribution systems were taken from the load flow results from the existing engineering models. The load flow results were based on the 2018 system peak, recorded in July. The transmission system is modeled in PTI Interactive Power System Simulator (PSSE™). The distribution system is modeled in FeederALL®.

The load flow results at the 2018 system peak provided data for transmission and distribution line losses, and substation transformer load losses. Substation transformer no-load losses were obtained from Austin Energy manufacturer test report summaries. If test reports were not available for a given transformer, impedances and no-load loss values were assumed based on similar sized transformers. The transmission and distribution line losses are presented in Exhibit B and Exhibit E, respectively. Transmission substation transformer load and no-load losses are presented in Exhibit C, while the distribution substation transformer losses are presented in Exhibit D.

5 DISTRIBUTION TRANSFORMERS

Inventory of the installed distribution transformer capacities and configurations was obtained from the existing GIS system. Distribution transformer specifications were based on a number of manufacturer test reports and Austin Energy distribution transformer inspection report. If test reports were not available for a given transformer, the load loss and no-load loss values were assumed using regression method. A summary of the test reports and the regression equations used in the loss calculations are given in Exhibit G.

Loading for the distribution transformers was estimated using the total installed distribution transformer capacity and the estimated customer demand at the 2018 peak. Distribution transformer no-load and load losses are listed in Exhibit F.

¹ M.W. Gustafson and J.S. Baylor, “The Equivalent Hours Loss Factor Revisited”, IEEE Trans. On Power Systems, Vol. 3, No. 4. pp 1502-1508, November 1988.

6 SECONDARY SYSTEM

The ADMS database and GIS system together provided information related to the installed secondary conductor types and lengths for each of the following categories: service, secondary, and street lights. Losses in the secondary system were estimated based on the service category, average lengths, conductor types, and the estimated conductor loading.

The conductor loading was estimated based on the total service conductor capacity and the estimated customer demand at the 2018 peak. Secondary lines were assumed to be sized similar to service lines. Conductor loading for the secondary serving security and street lights was calculated based on the estimated lighting load, as provided by Austin Energy, and the total conductor capacity. Secondary line losses are presented in Exhibit H.

7 SECURITY AND STREET LIGHTS

Total consumption estimates for security and street lights were provided by Austin Energy, which accounted for the light, the ballast, and other miscellaneous losses associated with each lamp size. The quantity of lights by size and type were also provided by Austin Energy based on information included in the existing GIS system and the operation time of lights per day was assumed to be 10 hours. The actual energy consumption of lights was the product of the total power of all lights and the annual operation time. Therefore, the losses for security and street lights were calculated based on the difference in the estimated annual energy consumption and the total billed energy derived from the GIS data. Security and street light losses are presented in Exhibit I.

EXHIBIT A: SYSTEM LOSS SUMMARY**AUSTIN ENERGY**

Evaluation of T&D System Losses

Summary of T&D System Losses

SYSTEM LOSSESAustin Energy

2018 Annual Net Available for Sale (MWh)

13,950,713

2018 Annual Energy Sales (MWh)

13,338,963

ANNUAL SYSTEM LOSSES (MWh)**611,750****PERCENT SYSTEM LOSSES****4.39%**

TYPE	ANNUAL ENERGY LOSSES (MWh) ⁽²⁾	PERCENT OF AE ENERGY AVAILABLE	PERCENT OF TOTAL AE LOSSES	DEMAND LOSSES AT PEAK (MW)	PERCENT OF DEMAND AE LOSSES AT PEAK
Voltage Level: Transmission 345 kV	18,183	0.13%	2.97%	6.37	4.17%
Transmission Line Losses	18,183	0.13%	2.97%	6.37	4.17%
Transmission Substation Transformer Losses					
Core	0	0.00%	0.00%	0.00	0.00%
Winding	0	0.00%	0.00%	0.00	0.00%
Voltage Level: Transmission 138 kV	143,383	1.03%	23.44%	46.70	30.61%
Transmission Line Losses	117,828	0.84%	19.26%	41.26	27.05%
Transmission Substation Transformer Losses					
Core	14,863	0.11%	2.43%	1.70	1.11%
Winding	10,692	0.08%	1.75%	3.74	2.45%
Voltage Level: Transmission 69 kV	5,710	0.04%	0.93%	1.59	1.04%
Transmission Line Losses	3,425	0.02%	0.56%	1.20	0.79%
Transmission Substation Transformer Losses					
Core	1,743	0.01%	0.28%	0.20	0.13%
Winding	541	0.00%	0.09%	0.19	0.12%
Voltage Level: Distribution	164,047	1.18%	26.82%	51.53	33.78%
Distribution Line Losses	107,401	0.77%	17.56%	37.61	24.65%
Distribution Substation Transformer Losses					
Core	25,076	0.18%	4.10%	2.86	1.88%
Winding	31,570	0.23%	5.16%	11.06	7.25%
Voltage Level: Secondary	259,656	1.86%	42.44%	46.37	30.39%
Distribution Transformer Losses					
Core	178,834	1.28%	29.23%	20.41	13.38%
Winding	26,261	0.19%	4.29%	9.20	6.03%
Service and Secondary Line Losses	47,842	0.34%	7.82%	16.76	10.98%
Street & Security Lights ⁽¹⁾⁽³⁾	6,718	0.05%	1.10%	0.00	0.00%
Loose Hardware, Corona or Other Mechanical Abnormalities and Metering Inaccuracies	20,771	0.15%	3.40%	0.00	0.00%
TOTALS	611,750	4.39%	100.00%	152.56	100.00%

Notes:

(1) Street and Security Light losses are the difference in billed kWh and total kWh for all lights

(2) Annual Energy Losses were determined using the following equations:

Annual Energy Losses = Peak Demand (kW) * Time (hrs) * Loss Factor

Loss Factor = $k * \text{Load Factor} + (1 - k) * (\text{Load Factor})^2$

"k" constant

0.08

Load Factor

55.34%

(3) Street and Security Light were off at the recorded peak

(4) GSU's results are categorized by the high side voltage, all other transformer results are categorized by low side voltage

EXHIBIT B: TRANSMISSION LINE LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Transmission Line Losses

TRANSMISSION VOLTAGE (kV)	MILES OF LINE ⁽¹⁾	DEMAND LOSSES AT 2018 PEAK (MW) ⁽²⁾	ANNUAL ENERGY LOSSES (MWh)
69	26.1	1,200	3,425,488
138	321.5	41,263	117,827,671
345	276.2	6,368	18,182,883
TOTALS	623.8	48,831	139,436,042

Notes:

(1) Transmission line length from AE Transmission Line Database

(2) Peak losses extracted from PSS/E system model

EXHIBIT C: TRANSMISSION TRANSFORMER LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Transmission Substation Transformer Losses

SUBSTATION NAME	TRANSFORMER VOLTAGE	TRANSFORMER BASE RATING (MVA)	TRANSFORMER NO-LOAD LOSSES (kW) ⁽¹⁾	ANNUAL ⁽²⁾ NO- LOAD ENERGY LOSSES (kWh)	TRANSFORMER LOAD LOSSES (kW) ⁽³⁾	ANNUAL ⁽⁴⁾ LOAD ENERGY LOSSES (kWh)
NL AT1	138/69 kV	220	35.6	311,462	33.72	96,282
KB AT1	138/69 kV	220	51.8	453,768	80.95	231,144
MC-AT1 (McNeil)	138/69 kV	220	61.6	539,861	41.38	118,149
PE-AT1	138/69 kV	220	50.0	437,912	33.59	95,908
DL AT1	345/138 kV	672	146.7	1,285,092	390.11	1,113,958
GF AT1	345/138 kV	480	90.0	788,400	165.56	472,757
GF AT2	345/138 kV	480	91.7	803,292	196.67	561,595
LY AT1	345/138 kV	480	124.9	1,093,861	176.09	502,831
LY AT2	345/138 kV	480	98.1	859,356	333.57	952,519
AU AT1	345/138 kV	480	118.0	1,033,855	153.15	437,309
AU AT2	345/138 kV	480	121.2	1,061,975	133.08	380,016
DP MT1	22.8/138 kV	420	219.5	1,922,470	545.17	1,556,721
DP MT2	22.8/138 kV	470	232.6	2,037,313	784.52	2,240,188
DP MPT1 ⁽⁵⁾	13.8/138 kV	139	51.0	446,760	0.49	1,408
DP MPT2 ⁽⁵⁾	13.8/138 kV	139	51.0	446,760	65.09	185,850
SH GSU1 ⁽⁶⁾	13.8/138 kV	130	52.0	455,520	280.59	801,229
SH GSU2 ⁽⁷⁾	13.8/138 kV	130	50.0	438,000	93.98	268,349
SH GSU3 ⁽⁸⁾	13.8/138 kV	150	50.8	445,008	278.58	795,481
SH MPT5 ⁽⁹⁾	18.0/138 kV	480	199.2	1,744,992	147.81	422,072
345 kV TOTALS		0	0.0	0	0	0
138 kV TOTALS ⁽¹⁰⁾		5,610	1,697	14,862,654	3,744	10,692,283
69 kV TOTALS ⁽¹⁰⁾		880	199.0	1,743,003	190	541,483
TOTALS		6,490	1,895.6	16,605,657	3,934	11,233,766

Notes:

- (1) From Austin Energy test reports
- (2) Annual No-Load Energy Losses is based on calculated demand losses times 8760 hours.
- (3) Calculated in PSS/E model with 2018 peak load flows
- (4) Annual Load Energy Losses is based on transformer load losses, 8760 hours, and a loss factor calculated from the annual load factor
- (5) No-Load Demand Losses are estimated to be the same as Sandhill Transformers of similar size
- (6) Losses for SANDH_G1 and SANDH_G2
- (7) Losses for SANDH_G3 and SANDH_G4
- (8) Losses for SANDH_G6 and SANDH_G7
- (9) Losses for SANDHG5A and SANDHG5C
- (10) GSU's results are categorized by the high side voltage, all other transformer results are categorized by low side voltage

EXHIBIT D: SUBSTATION TRANSFORMER LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Distribution Substation Transformer Losses

SUBSTATION NAME	TRANSFORMER BASE RATING (MVA)	2018 COINCIDENT PEAK LOAD (kW)	TRANSFORMER NO-LOAD LOSSES (kW) ⁽¹⁾⁽⁷⁾	ANNUAL ⁽²⁾ NO-LOAD ENERGY LOSSES (kWh)	TRANSFORMER LOAD LOSSES (kW) ⁽³⁾	ANNUAL ⁽⁴⁾ LOAD ENERGY LOSSES (kWh)
AD123	30	11,052	16.8	147,168	25.2	72,019
AD456	30	13,802	16.8	147,076	40.0	114,354
AG123	30	14,251	14.8	130,060	25.7	73,248
AG456	30	22,130	14.7	128,588	102.4	292,362
BAL TX1 ⁽⁵⁾⁽⁶⁾	25	17	14.7	128,772	14.1	40,147
BAL TX2 ⁽⁵⁾⁽⁶⁾	25	9,623	14.7	128,772	14.1	40,147
BA012	30	19,789	13.6	119,206	91.0	259,741
BA123	30	15,117	9.9	86,461	57.9	165,235
BA456	30	18,464	34.2	299,855	81.8	233,596
BA789	30	11,645	16.2	141,557	25.2	71,869
BC123	30	11,365	27.6	241,999	40.8	116,363
BC456	30	11,365	19.9	174,210	24.4	69,680
BC789	30	13,323	12.9	113,319	39.1	111,656
BE123	30	10,341	14.5	127,024	19.0	54,209
BE456	30	12,767	11.2	98,051	38.4	109,617
BL123	30	26,539	14.6	127,852	148.5	424,107
BL456	30	16,673	17.1	149,927	51.4	146,886
BL789	30	23,995	13.3	116,079	126.7	361,832
BR123	70	19,298	52.1	456,221	35.8	102,181
BR456	70	18,465	53.3	466,523	59.6	170,272
BR789	70	19,588	27.8	243,747	29.6	84,551
BU123	30	22,293	14.0	123,069	117.0	334,128
BU456	30	15,192	13.8	121,046	51.0	145,506
BU789	30	25,725	30.5	266,742	313.2	894,447
BW123	50	2,329	21.6	189,479	0.5	1,529
BW456	50	1,166	22.2	194,078	0.1	300
CC123	30	22,405	15.1	132,451	101.4	289,424
CC456	30	8,256	10.6	92,716	16.7	47,733
CC789	30	5,716	12.9	113,227	5.5	15,741
CA123	30	19,178	13.7	120,402	74.8	213,477
CA456	30	24,965	13.6	119,390	127.9	365,130
CF123	30	20,310	16.6	145,788	86.2	246,099
CF456	30	22,232	12.6	110,376	101.2	289,034
CF789	30	15,561	13.4	117,275	52.7	150,454
CL012	30	20,203	14.3	125,277	49.2	140,529
CL123	30	20,490	15.0	131,163	52.9	151,023
CL456	30	25,077	14.6	127,852	130.1	371,457
CL789	30	15,582	14.2	124,633	31.7	90,578
CM123	30	17,541	9.7	84,990	72.7	207,511
CM456	30	6,113	11.0	96,487	8.5	24,196
CM789	30	18,263	13.9	121,874	70.2	200,465
CM101112	30	7,822	14.4	126,564	7.8	22,307
DE123	30	9,870	14.3	125,001	28.9	82,603
DE456	50	24,045	19.4	170,163	78.1	223,102
DE789	50	24,144	19.5	170,991	62.4	178,278
DE101112	50	17,554	20.5	180,005	23.6	67,371
DE131415	50	17,504	19.9	174,302	32.8	93,756
DE161718	67	22,572	27.2	237,860	29.7	84,701

EXHIBIT D: SUBSTATION TRANSFORMER LOSSES (PAGE 2)**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Distribution Substation Transformer Losses

SUBSTATION NAME	TRANSFORMER BASE RATING (MVA)	2018 COINCIDENT PEAK LOAD (kW)	TRANSFORMER NO-LOAD LOSSES (kW) ⁽¹⁾⁽⁷⁾	ANNUAL ⁽²⁾ NO-LOAD ENERGY LOSSES (kWh)	TRANSFORMER LOAD LOSSES (kW) ⁽³⁾	ANNUAL ⁽⁴⁾ LOAD ENERGY LOSSES (kWh)
DE192021	67	22,503	26.8	235,009	33.6	95,885
DE222324	30	26,627	15.1	132,175	101.0	288,494
DE2526	30	15,176	15.1	132,175	31.7	90,398
DG123	30	9,219	15.0	130,980	10.7	30,672
DG456	30	17,420	14.1	123,621	64.3	183,615
DL123	30	10,896	18.8	164,552	22.9	65,332
EB012	50	4,861	21.7	190,215	6.0	17,180
EB123	50	(41)	24.2	211,922	0.0	0
EB456	50	4,788	23.1	202,356	6.0	17,240
EB789	50	24,792	23.1	202,356	139.9	399,401
ER123	30	1,924	12.8	111,940	0.5	1,379
FI123	30	22,435	13.5	118,286	99.7	284,717
FI456	30	15,751	14.6	127,852	50.7	144,877
FV123	30	20,374	14.9	130,244	77.4	221,003
FV456	30	18,802	18.9	165,288	61.3	174,920
GR123	30	5,074	16.0	139,994	3.6	10,164
GR456	30	3,757	13.1	114,791	2.8	7,945
GR789	30	25,891	37.9	332,048	154.0	439,758
HC012	30	25,453	12.7	111,572	151.9	433,761
HC123	30	28,272	34.1	298,567	207.2	591,680
HC456	30	23,745	30.2	264,902	124.7	356,046
HC789	30	25,512	12.1	105,777	145.9	416,611
HL123	30	21,273	16.9	147,904	86.1	245,859
HL456	30	24,687	14.9	130,612	127.1	363,002
HM012	30	17,031	14.4	126,105	29.9	85,511
HM123	30	18,561	30.4	266,006	71.7	204,722
HM456	30	23,350	26.8	234,825	170.9	488,090
HM789	30	14,621	14.0	122,241	41.2	117,652
HV123	30	21,757	13.7	120,402	107.7	307,533
HV456	30	27,606	9.6	83,794	169.2	483,233
JE123	30	21,825	30.1	263,983	122.6	350,169
JE456	30	16,779	14.0	122,885	54.4	155,281
JV123	30	25,822	16.0	140,361	142.2	405,997
JV456	30	17,939	9.9	86,369	75.1	214,317
JV789	30	18,370	13.7	119,942	74.4	212,308
JL123	30	17,607	17.7	155,354	42.3	120,831
JL456	30	6,416	17.9	156,550	5.3	14,991
KB123	30	16,478	17.4	152,227	54.7	156,210
KB456	30	22,108	14.5	126,932	106.3	303,576
KL1234	30	18,650	18.2	159,217	56.6	161,517
KL5678	30	19,591	18.3	160,413	53.4	152,552
LS123	30	19,144	14.8	129,692	82.5	235,485
LS456	30	15,580	15.8	137,970	56.9	162,387
LW123	30	18,877	16.0	140,361	64.9	185,384
LW456	30	23,266	9.9	86,553	126.6	361,413
MC012	30	8,198	14.2	124,633	14.6	41,646
MC123	30	15,980	13.0	113,779	34.9	99,633
MC456	30	17,664	30.2	264,443	75.9	216,596

EXHIBIT D: SUBSTATION TRANSFORMER LOSSES (PAGE 3)**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Distribution Substation Transformer Losses

SUBSTATION NAME	TRANSFORMER BASE RATING (MVA)	2018 COINCIDENT PEAK LOAD (kW)	TRANSFORMER NO-LOAD LOSSES (kW) ⁽¹⁾⁽⁷⁾	ANNUAL ⁽²⁾ NO-LOAD ENERGY LOSSES (kWh)	TRANSFORMER LOAD LOSSES (kW) ⁽³⁾	ANNUAL ⁽⁴⁾ LOAD ENERGY LOSSES (kWh)
MC789	30	15,166	16.4	143,765	49.8	142,238
MP123	30	18,724	15.8	137,970	80.0	228,319
MP456	30	20,944	13.7	119,574	93.7	267,626
MP789	30	17,533	12.0	105,409	55.0	157,170
MT123	30	7,625	16.8	147,076	11.8	33,641
MT012	30	10,648	11.5	100,350	24.1	68,930
MU123	30	7,980	15.1	132,359	8.0	22,877
MU456	30	8,494	13.0	113,503	9.6	27,344
NL012	30	19,464	11.9	103,937	70.1	200,255
NL123	20	9,673	16.7	145,880	28.6	81,553
NL345	30	24,123	10.4	90,784	125.6	358,714
NL789	20	6,024	17.1	149,559	25.5	72,918
NW123	30	22,569	14.9	130,152	114.4	326,692
NW456	30	4,223	17.6	153,975	3.4	9,744
OC123	30	4,396	13.7	119,666	4.3	12,263
OC456	30	0	12.1	106,329	0.0	0
OH123	30	15,116	12.7	111,296	54.6	155,821
OH456	30	19,059	12.4	108,536	83.2	237,614
OH789	30	21,594	14.1	123,621	101.0	288,344
PE1234	30	23,433	14.7	129,048	124.8	356,345
PE5678	30	25,747	14.7	129,048	152.7	436,130
PL123	30	26,716	14.8	129,416	135.0	385,519
PL789	50	20,161	21.9	192,238	59.5	169,763
PL101112	30	21,491	17.0	149,008	83.2	237,584
PL131415	30	4,250	14.8	129,600	2.3	6,446
RP123	20	396	15.6	136,498	0.1	240
RP789	30	17,417	15.5	136,038	38.2	108,957
SK123	30	9,236	30.0	262,971	20.9	59,576
SK456	30	23,276	13.3	116,079	122.1	348,610
SL123	30	25,975	15.1	131,991	132.8	379,192
SL456	30	24,754	29.9	261,683	153.6	438,498
SL789	30	23,484	15.5	136,038	115.6	330,200
SP123	30	18,073	13.8	121,138	46.2	131,984
SP789	30	21,930	14.1	123,529	113.3	323,424
SP012	30	22,445	14.6	127,760	113.6	324,264
SP345	70	28,121	21.1	184,512	77.8	222,292
SP678	70	28,004	21.0	183,960	65.8	187,932
SN-NT1	50	0	15.8	137,970	0.0	0
SN-NT2	50	23,056	15.8	137,970	50.2	143,288
SR123	30	17,538	13.1	114,791	44.0	125,658
ST123	30	16,411	15.0	130,980	50.8	145,147
ST456	30	12,624	11.0	96,211	29.0	82,842
ST789	30	18,677	15.5	135,487	78.7	224,841
SU123	30	20,083	12.2	106,881	84.7	241,751
SU456	30	19,448	12.7	110,836	77.1	220,044
SU789	30	9,652	14.7	128,956	12.7	36,279
SU012	30	7,853	15.4	135,119	7.7	22,127
SU345	30	23,868	13.8	120,770	126.8	362,042

EXHIBIT D: SUBSTATION TRANSFORMER LOSSES (PAGE 4)**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Distribution Substation Transformer Losses

SUBSTATION NAME	TRANSFORMER BASE RATING (MVA)	2018 COINCIDENT PEAK LOAD (kW)	TRANSFORMER NO-LOAD LOSSES (kW) ⁽¹⁾⁽⁷⁾	ANNUAL ⁽²⁾ NO-LOAD ENERGY LOSSES (kWh)	TRANSFORMER LOAD LOSSES (kW) ⁽³⁾	ANNUAL ⁽⁴⁾ LOAD ENERGY LOSSES (kWh)
SW123	30	24,113	16.8	147,168	115.4	329,571
SW456	30	23,448	18.2	159,125	105.1	299,978
SW789	30	21,416	13.2	115,895	95.1	271,464
TP123	30	20,630	10.4	91,060	86.7	247,628
TP456	30	17,075	11.3	98,879	61.5	175,489
TP789	30	20,066	16.6	145,604	78.4	224,001
TR123	30	25,964	13.7	120,310	185.1	528,477
TR456	30	11,468	14.1	123,621	32.3	92,197
TR789	30	19,891	13.5	118,654	90.7	258,991
VE123	50	0	16.2	142,201	0.0	0
WA123	30	16,702	26.9	235,653	88.5	252,845
WA456	30	7,675	26.8	234,457	17.9	50,971
WA789	30	6,974	16.9	147,812	9.7	27,704
WB123	50	3,233	15.7	137,878	0.8	2,369
WB456	50	3,221	22.0	192,698	0.9	2,429
WC012	30	15,324	12.2	107,065	46.5	132,734
WC789	30	14,429	10.3	90,600	58.5	166,944
WI012	30	14,869	12.1	105,593	41.1	117,233
WI123	40	22,578	14.3	125,093	106.0	302,586
WI456	40	28,787	16.2	141,833	164.3	469,051
WI789	30	17,333	16.2	141,833	57.5	164,186
WL123	30	13,387	22.7	198,677	39.9	113,935
WL456	30	23,343	13.4	117,366	73.2	208,890
WL789	30	18,502	13.8	120,494	78.9	225,381
TOTALS	5,613	2,792,030	2,862.5	25,075,680	11,055.8	31,570,019

Notes:

(1) From Austin Energy test reports

(2) Annual No-Load Energy Losses is based on calculated demand losses times 8760 hours.

(3) Calculated in Feederall model with 2018 peak load flows

(4) Annual Load Energy Losses is based on transformer load losses, 8760 hours, and a loss factor calculated from the annual load factor

(5) No-Load Loss values were estimated based on the average No-Load Loss of th 30 MVA Transformers

(6) Load Loss values were estimated based on 30 MVA Transformers of similar loading

(7) Units with no No-Load Losses are de-energized or out of service

EXHIBIT E: DISTRIBUTION LINE LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Primary Distribution Line Losses

DISTRIBUTION VOLTAGE (kV)	LENGTH OF LINE (Miles)	DEMAND LOSSES ⁽¹⁾ AT 2018 PEAK (kW)	ANNUAL ENERGY LOSSES (kWh)
12.5	5,803.0	37,612.1	107,401,352
TOTALS	5,803.0	37,612.1	107,401,352

Notes:

(1) Peak losses extracted from Feederall model

EXHIBIT F: DISTRIBUTION TRANSFORMER LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Distribution Transformer Losses

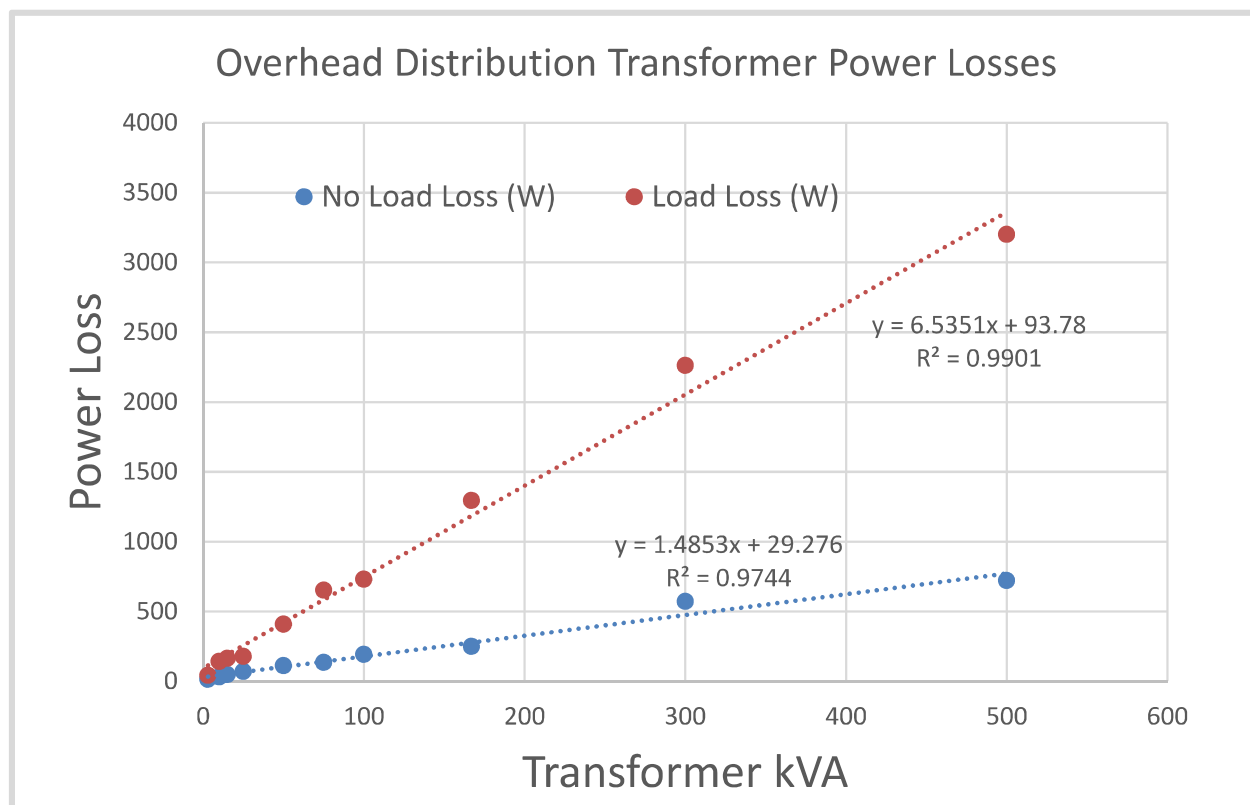
LOCATION	TOTAL NO-LOAD LOSSES (kW)	TOTAL LOAD LOSSES (kW)	NUMBER OF XFMRs	TOTAL XFMR kVA	TOTAL ANNUAL ENERGY NO-LOAD LOSS (kWh)	TOTAL ANNUAL ENERGY LOAD LOSS (kWh)
Distribution Transformers	20,415	9,197	84,377	7,485,681	178,834,475	26,260,895
TOTALS	20,415	9,197	84,377	7,485,681	178,834,475	26,260,895

Notes:

- (1) Losses were estimated for each distribution transformer size based on the manufacturer test reports for similar sized transformers
(2) Transformer loading based on customer sales and total transformer capacity
(3) Results excludes primary metered transformers
(4) Calculated Transformer Loading Percentage 36.62%

EXHIBIT G: TEST REPORT OF DISTRIBUTION TRANSFORMER LOSSES**A: OVERHEAD DISTRIBUTION TRANSFORMERS**

kVA	No Load Loss (W)	Load Loss (W)
3	14	43
10	31	141
15	47	164
25	70	178
50	111	409
75	135	652
100	192	730
167	250	1295
300	571	2262
500	721	3200



B: UNDERGROUND DISTRIBUTION TRANSFORMERS

KVA	Transformer	No-Load Loss (W)	Load Loss (W)
75	75KVA, 120/208V	221	923
75	75KVA, 120/208V	207	910.9
75	75KVA, 277/480V	224	565
75	75KVA, 277/480V	196	861
150	150KVA, 120/208V	367	1249
150	150KVA, 120/208V	291	1445
150	150KVA, 277/480V	374.2	1263.9
225	225KVA, 120/208V	455	1634
225	225KVA, 120/208V	393	2319
300	300KVA, 120/208V	634	2280
300	300KVA, 277/480V	571	2262
300	300KVA, 277/480V	500	2904
500	500KVA, 120/208V	882	3417
500	500KVA, 120/208V	968	3841
500	500KVA, 120/208V	845	3582
500	500KVA, 277/480V	721	3200
500	500KVA, 277/480V	816	3888
500	500KVA, 277/480V	862	2841
750	750KVA, 120/208V	1225	5744
750	750KVA, 120/208V	1363	5118
750	750KVA, 120/208V	1037	5884
750	750KVA, 277/480V	1261	4718
1000	1000KVA, 277/480V	1251	6236
1000	1000KVA, 277/480V	1389	5855
1500	1500KVA, 277/480V	1789	8939
1500	1500KVA, 277/480V	2329	9345
2000	2000KVA, 277/480V	2561.9	14964.2
2500	2500KVA, 277/480V	2493	15200

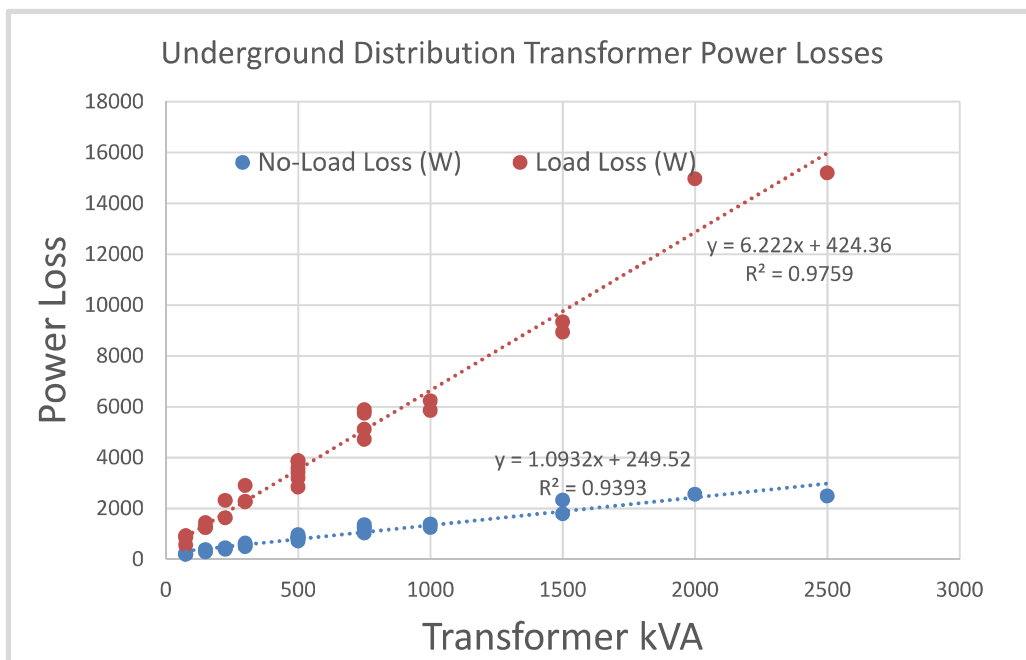


EXHIBIT H: SECONDARY LINE LOSSES**AUSTIN ENERGY**

Evaluation of System Losses

Estimated Service Line Losses

Type	MILES OF CONDUCTOR	PERCENT CONDUCTOR PEAK LOADING/CAPACITY ⁽¹⁾	PEAK DEMAND LOSS (kW)	ANNUAL ENERGY LOSSES (kWh)
Service and Secondary Conductor	5,896	31.7%	16,751	47,832,685
Streetlight Conductor	1,626	1.5%	6.8	9,767
TOTAL	7,522		16,758	47,842,452

Notes

(1) Conductor loading percentage is as follows:

Secondary Conductor = $(\text{Annual Energy Sales (kWh)} - \text{Streetlight Annual Energy Sales (kWh)}) / (\text{Time} * \text{Load Factor}) / \text{Conductor Capacity (kVA)}$ Streetlight Conductor = $(\text{Streetlight Annual Energy Sales (kWh)}) / (\text{Time} * \text{Load Factor}) / \text{Conductor Capacity (kVA)}$

EXHIBIT I: SECURITY AND STREETLIGHT LOSSES**AUSTIN ENERGY**

Evaluation of T&D System Losses

Estimated Street & Security Light Losses

SECURITY & STREET LIGHT SIZES	ASSUMED USAGE (WATTS)	NUMBER OF LIGHTS FROM GIS	ASSUMED DEMAND (kW)	ANNUAL ENERGY CONSUMPTION (kWh)
30 Watt	33	1	0.0	120
51 Watt	56	17	1.0	3,481
70 Watt	77	64	4.9	17,987
75 Watt	83	8,829	728.4	2,658,633
80 Watt	88	26	2.3	8,351
100 Watt	110	30,194	3,321.3	12,122,891
150 Watt	165	521	86.0	313,772
175 Watt	193	2,197	422.9	1,543,667
250 Watt	275	18,157	4,993.2	18,225,089
400 Watt	440	4,937	2,172.3	7,928,822
1000 Watt	1,100	87	95.7	349,305
1500 Watt	1,650	12	19.8	72,270
TOTALS		65,042	11,847.8	43,244,389
TOTAL BILLED kWh				49,962,729
UNACCOUNTED FOR LIGHT CONSUMPTION				6,718,340

Notes:

(1) Estimated 10 hours of operation per day

EXHIBIT J: SYSTEM LOSSES PIE CHARTS

AUSTIN ENERGY
Evaluation of T&D System
Losses

T&D Energy Losses by Voltage

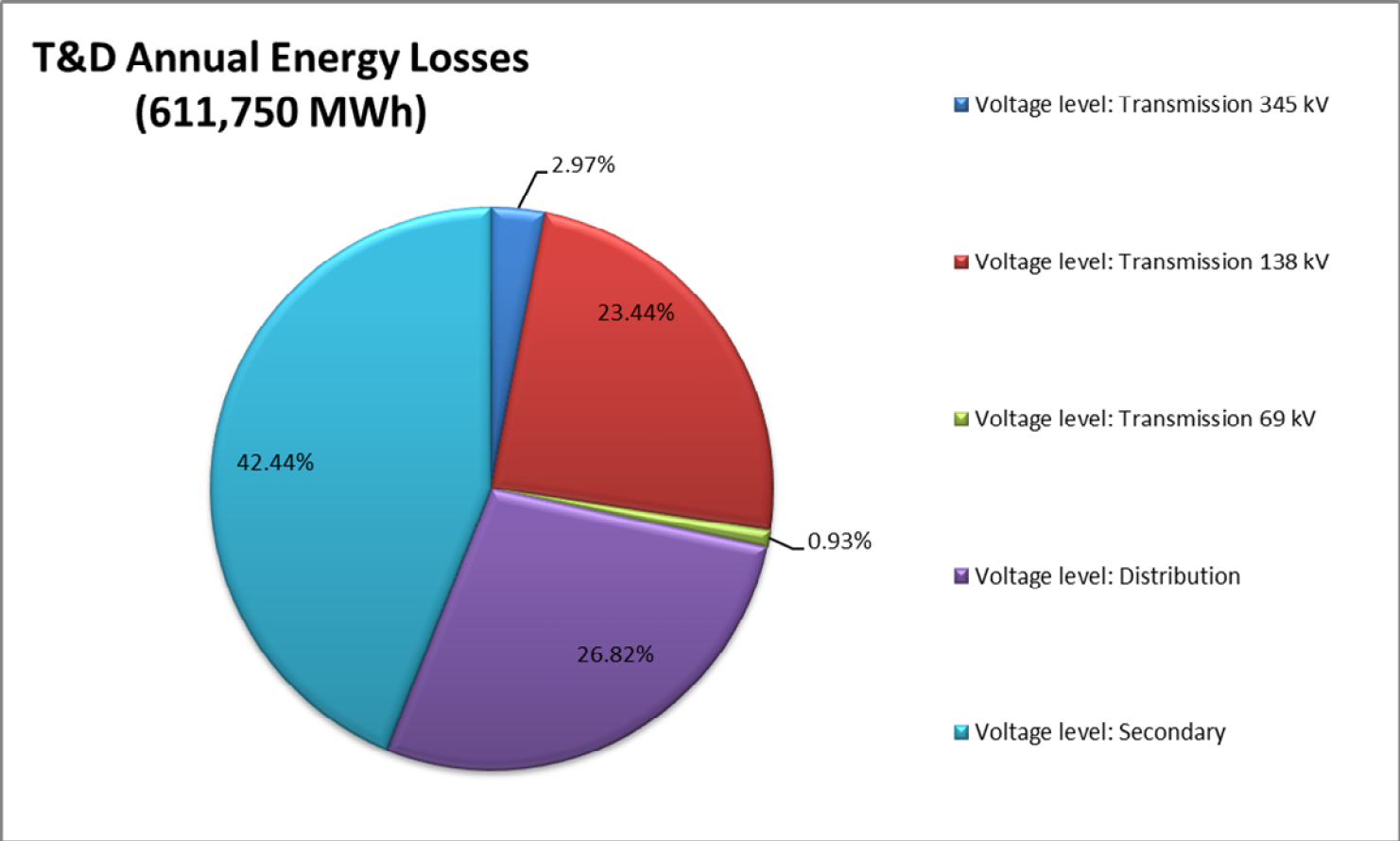


EXHIBIT J: SYSTEM LOSSES PIE CHARTS (page 2)

AUSTIN ENERGY
Evaluation of T&D System Losses

T&D Energy Losses by Equipment Type

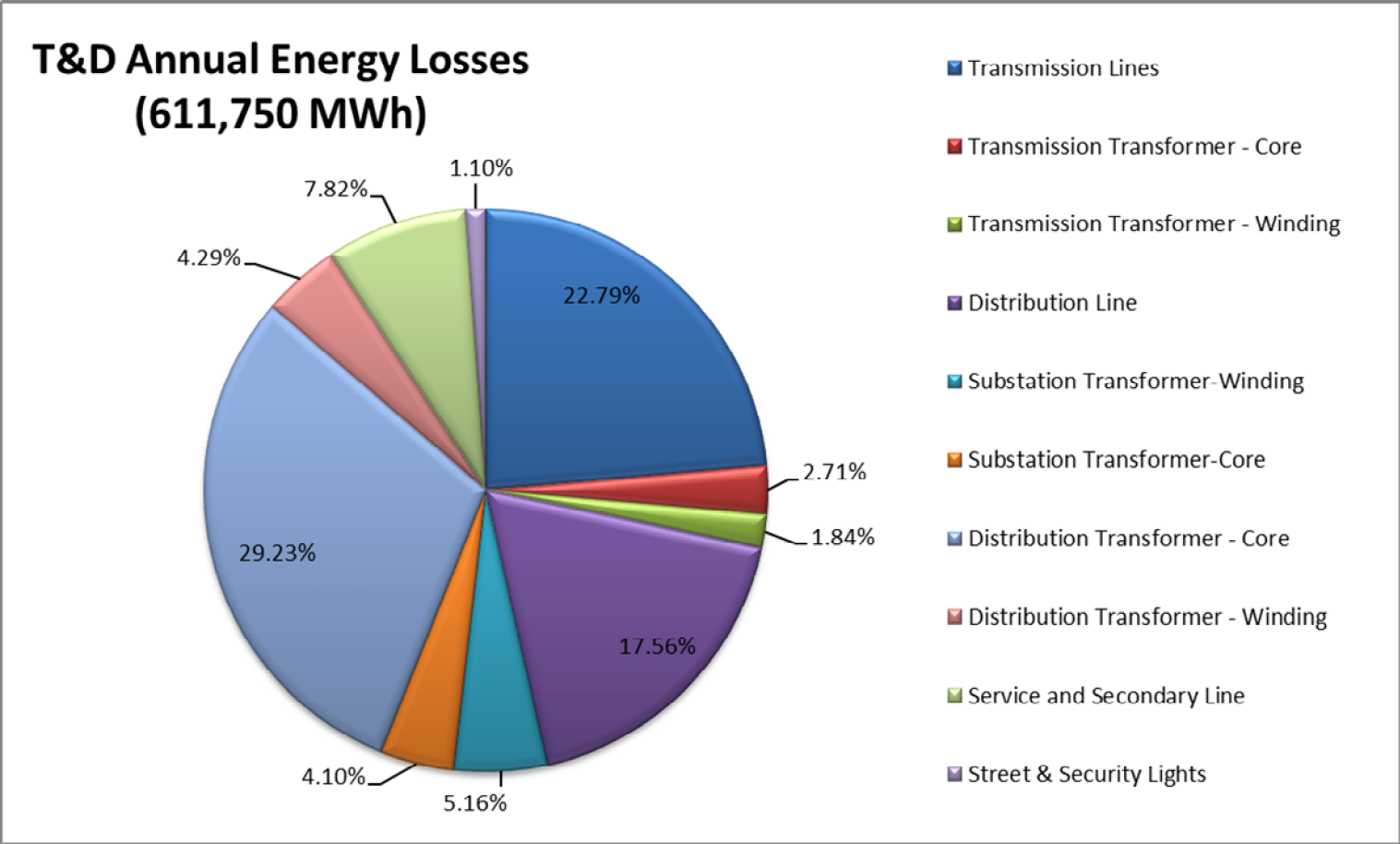


EXHIBIT J: SYSTEM LOSSES PIE CHARTS (PAGE 3)

AUSTIN ENERGY
Evaluation of T&D System Losses

T&D Energy Losses by Equipment Type

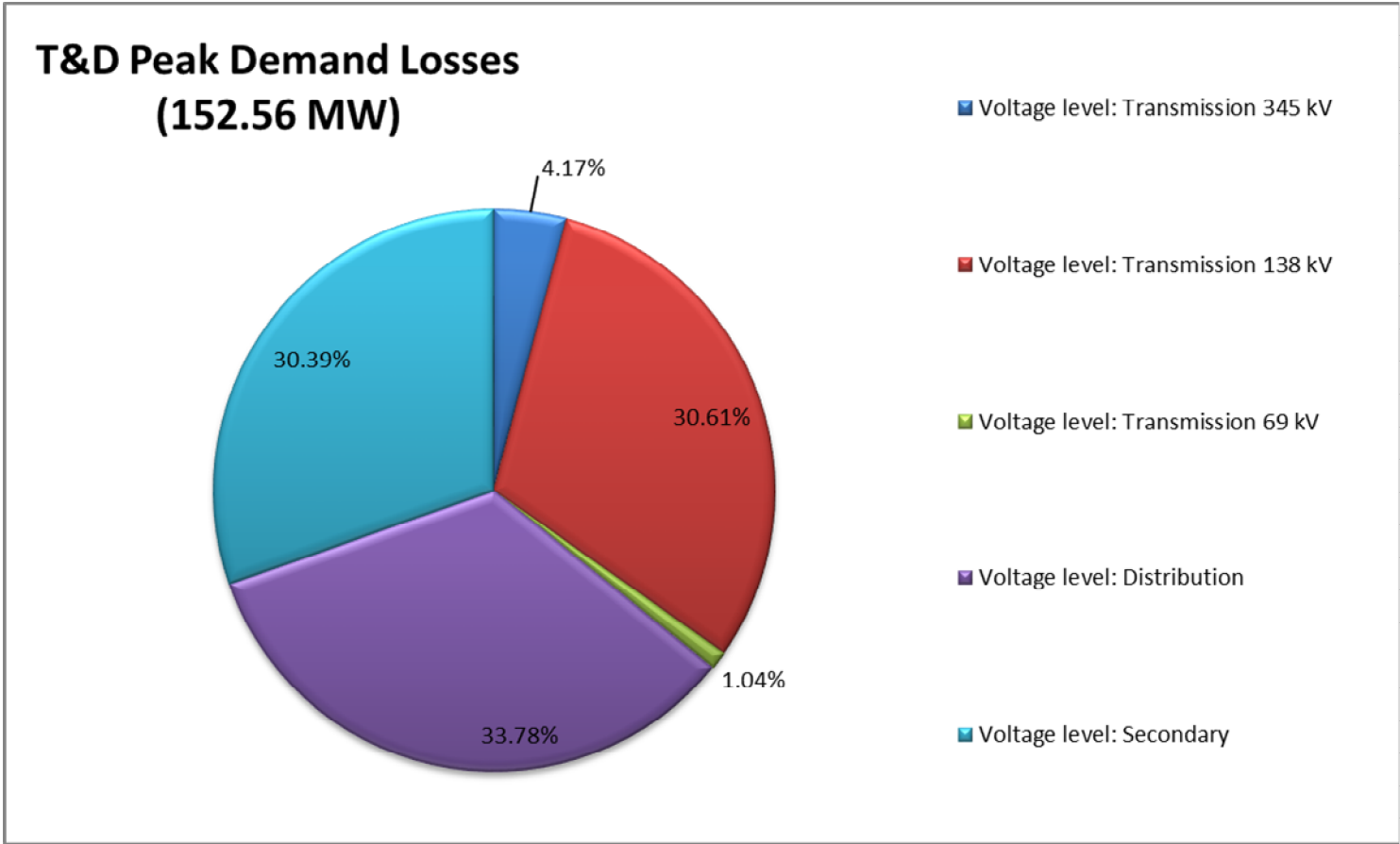
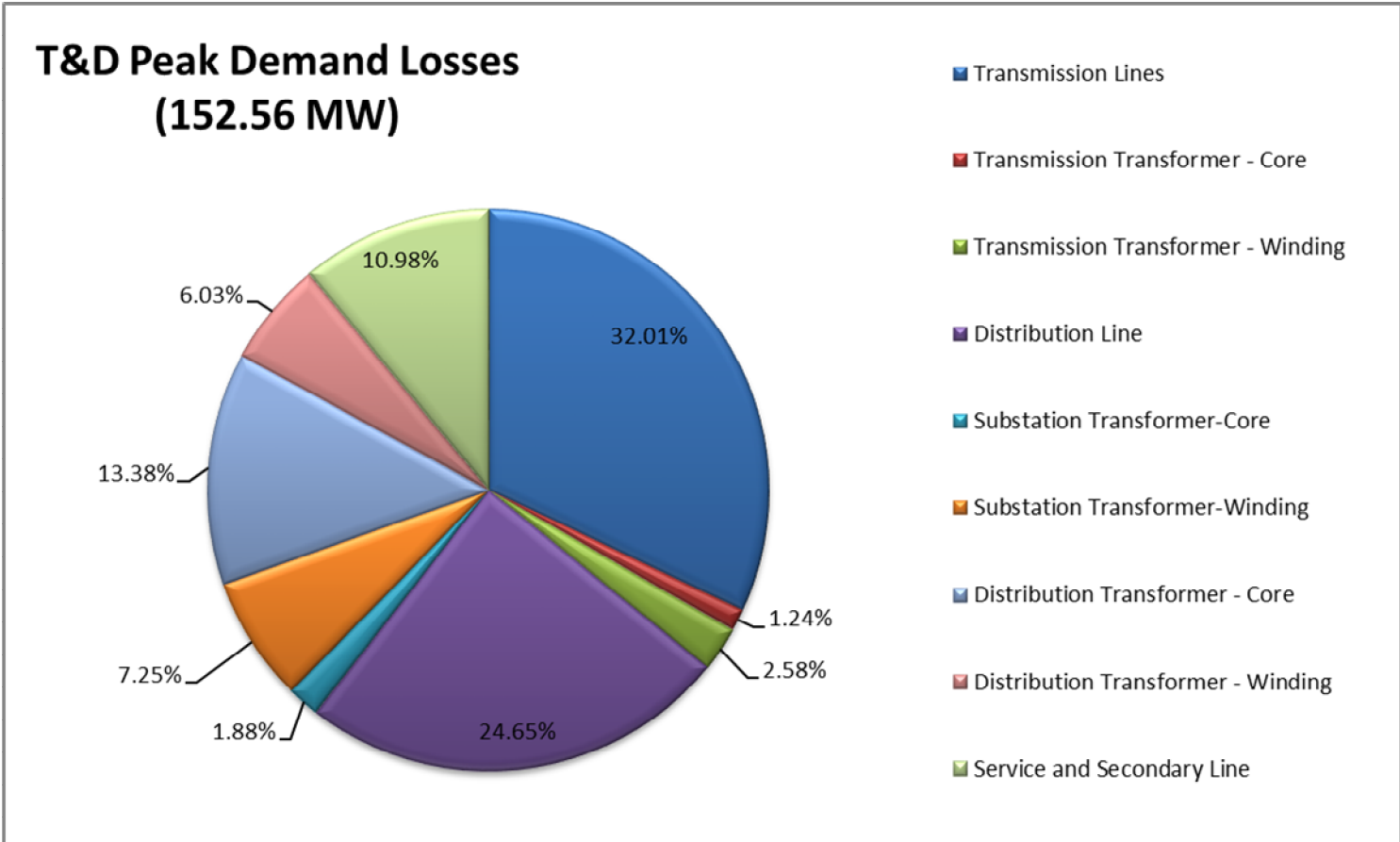


EXHIBIT J: SYSTEM LOSSES PIE CHARTS (PAGE 4)

AUSTIN ENERGY
Evaluation of T&D System Losses

T&D Energy Losses by Equipment Type



DOCUMENT CHANGE AND REVIEW HISTORY

The change history below reflects changes to the contents or format of this document.

Change History:

Date	Author(s)	Description	Version	Company
5/2/2019	Reza Ebrahimian	Final Report Version 1.0	1.0	Austin Energy
11/6/2019	Jianhui Zhang	Final Report Version 2.0	2.0	Austin Energy

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Date	Reviewed by	Version	Company