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August 30, 2007

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HAND DELIVERED

Ms. Beth O'Donnell
Executive Director
Public Service Commission of Kentucky
211 Sower Boulevard
P.O. Box 615
Frankfort, Kentucky 40602-0615

RE: P.S.C. Case No. 2006-00507 (Kentucky Power Company Two-Year Fuel Clause Review)

Dear Ms. O'Donnell:

Enclosed please find and accept for filing the original and five copies of Kentucky Power Company's Line Loss Study. A copy of the study is being served on the persons below by copy of this letter.

Very truly yours,

Mark R. Overstreet

Enclosure
cc: Michael L. Kurtz
Larry Cook

KE057:KE189:15957:1:FRANKFORT

KENTUCKY POWER COMPANY

2006 Analysis of System Losses

August 13, 2007

Prepared by:

Management Applications Consulting, Inc.
1103 Rocky Drive – Suite 201
Reading, PA 19609
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August 13, 2007

Mr. Meredith Gafford
East Transmission Planning
American Electric Power
700 Morrison Road
Gahanna, OH 43230

RE: 2006 LOSS ANALYSIS

Dear Mr. Gafford:

Transmitted herewith are the results of the 2006 Analysis of System Losses for the Kentucky Power Company's (KPCO) power system. Our analysis develops cumulative expansion factors (loss factors) for both demand (peak/kW) and energy (average/kWh) losses by discrete voltage levels applicable to metered sales data. Table 1 of the Executive Summary presents the results and appropriate loss factors to apply to metered load research or sales data for adjustment to system input.

On behalf of MAC, we appreciate the opportunity to assist you in performing the loss analysis contained herein. The level of detailed load research and sales data by voltage level, coupled with a summary of power flow data and power system model, forms the foundation for determining reasonable and representative power losses on the KPCO system. Our review of these data and calculated loss results support the proposed loss factors as presented herein for your use in various cost of service, rate studies, and demand analyses.

Should you require any additional information, please let us know at your earliest convenience.

Sincerely,

Paul M. Normand
Principal

Enclosure
PMN/rjp

Kentucky Power Company
2006 Analysis of System Losses

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Kentucky Power Company
2006 Analysis of System Losses

1.0 EXECUTIVE SUMMARY

This report presents Kentucky Power Company's (KPCO) 2006 Analysis of System Losses for the power systems as performed by Management Applications Consulting, Inc. (MAC). The study developed separate demand (kW) and energy (kWh) loss factors for each voltage level of service in the power system for KPCO. The cumulative loss factor results by voltage level, as presented herein, can be used to adjust metered kW and kWh sales data for losses in performing cost of service studies, determining voltage discounts, and other analyses which may require a loss adjustment.

The procedures used in the overall loss study were similar to prior studies and emphasized the use of "in house" resources where possible. To this end, extensive use was made of the Company's peak hour power flow data and transformer plant investments in the model. In addition, measured and estimated load data provided a means of calculating reasonable estimates of losses by using a "top-down" and "bottom-up" procedure. In the "top-down" approach, losses from the high voltage system, through and including distribution substations, were calculated along with power flow data, conductor and transformer loss estimates, and energy delivery.

With the recent emergence of transmission as a stand-alone function throughout various regions of the country, a modification to the historical calculation of the transmission loss factors was required. Previous loss studies recognized the multipath approach to losses from high voltage to low voltage delivery. The current definition of transmission losses recognized in the industry is simply to sum all losses at transmission as an integrated system. This approach will typically increase the resulting transmission loss factors.

The load research data provided the starting point for performing a "bottom-up" approach for estimating the remaining distribution losses. Basically, this "bottom-up" approach develops line loadings by first determining loads and losses at each level beginning at a customer's meter and service entrance and then going through secondary lines, line transformers, primary lines and finally distribution substation. These distribution system loads and associated losses are then compared to the initial calculated input into Distribution Substation loadings for reasonableness prior to finalizing the loss factors. An overview of the loss study is shown on Figure 1 on the next page.

Table 1, below, provides the final results from Appendix A for the 2006 calendar year. Exhibit 8 of Appendix A presents a more detailed analysis of the final calculated summary results of losses by segments of the power system. These Table 1 cumulative loss expansion factors are applicable only to metered sales at the point of receipt for adjustment to the power system's input level.

Kentucky Power Company
2006 Analysis of System Losses

TABLE 1
Loss Factors at Sales Level, Calendar Year 2006

Voltage Level of Service	Total KPCO	Distribution Only
Demand (kW)		
Transmission[1]	1.03935	–
Subtransmission	1.05210	1.01227
Primary Lines	1.07402	1.03336
Secondary	1.10790	1.06595
Energy (kWh)		
Transmission[1]	1.02781	–
Subtransmission	1.03780	1.00972
Primary Lines	1.05205	1.02358
Secondary	1.08674	1.05734
Losses – Net System Input[2]	5.91%	
Losses – Net System Output	6.29%	

The loss factors presented in the Distribution Only column of Table 1 are the Total KPCO loss factors divided by the transmission loss factor in order to remove these losses from each service level loss factor. For example, the secondary distribution demand loss factor of 1.06595 includes the recovery of all remaining non-transmission losses from the subtransmission, distribution substation, primary lines, line transformers, secondary conductors and services.

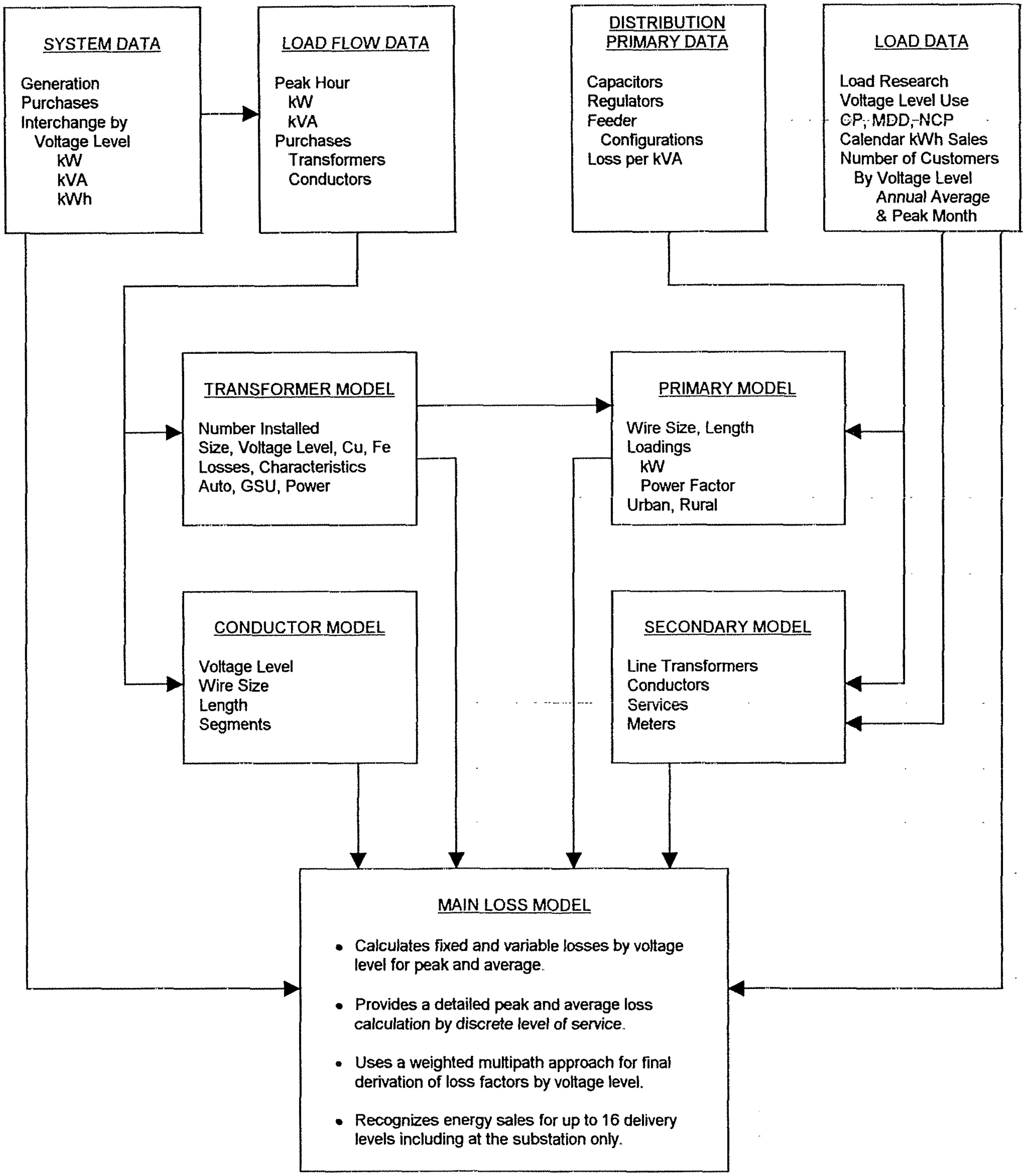
The net system input shown in Table 1 represents percent losses of 5.91% for the total KPCO load using calculated losses divided by the associated input energy to the system. The 6.29% represents the same losses using system output instead of input as a reference.

---

[1] Reflects results for 765 kV, 345 kV 161 kV, and 138 kV.

[2] Net system input equals firm sales plus losses, Company use less non-requirement sales and related losses. See Appendix A, Exhibit 1, for their calculations.

MANAGEMENT APPLICATIONS CONSULTING, INC.
ELECTRIC LOSS MODEL OVERVIEW



2.0 INTRODUCTION

This report of the 2006 Analysis of System Losses for the Kentucky Power Company provides a summary of results, conceptual background or methodology, description of the analyses, and input information related to the study.

2.1 Conduct of Study

Typically, between five to ten percent of the total kWh requirements of an electric utility is lost or unaccounted for in the delivery of power to customers. Investments must be made in facilities which support the total load which includes losses or unaccounted for load. Revenue requirements associated with load losses are an important concern to utilities and regulators in that customers must equitably share in all of these cost responsibilities. Loss expansion factors are the mechanism by which customers' metered demand and energy data are mathematically adjusted to the generation or input level (point of reference) when performing cost and revenue calculations.

An acceptable accounting of losses can be determined for any given time period using available engineering, system, and customer data along with empirical relationships. This loss analysis for the delivery of demand and energy utilizes such an approach. A microcomputer loss model[3] is utilized as the vehicle to organize the available data, develop the relationships, calculate the losses, and provide an efficient and timely avenue for future updates and sensitivity analyses. Our procedures and calculations are similar with prior loss studies, and they rely on numerous databases that include customer statistics and power system investments.

Company personnel performed most of the data gathering and data processing efforts and checked for reasonableness. MAC provided assistance as necessary to construct databases, transfer files, perform calculations, and check the reasonableness of results. A review of the preliminary results provided for additions to the database and modifications to certain initial assumptions based on available data. Efforts in determining the data required to perform the loss analysis centered on information which was available from existing studies or reports within the Company. From an overall perspective, our efforts concentrated on five major areas:

1. System information concerning peak demand and annual energy requirements by voltage level of service using metered data and load research,
2. High voltage power system power flow data and associated loss calculations,
3. Distribution system primary and secondary loss calculations,
4. Derivation of fixed and variable losses by voltage level, and
5. Development of final cumulative expansion factors at each voltage for peak demand (kW) and annual energy (kWh) requirements at the point of delivery (meter).

[3]Copyright by Management Applications Consulting, Inc.

2.2 Description of Model

The loss model is a customized applications model, constructed using the Excel software program. Documentation consists primarily of the model equations at each cell location. A significant advantage of such a model is that the actual formulas and their corresponding computed values at each cell of the model are immediately available to the analyst.

A brief description of the three (3) major categories of effort for the preparation of each loss model is as follows:

- Main sheet which contains calculations for all primary and secondary losses, summaries of all conductor and transformer calculations from other sheets discussed below, output reports and supporting results.

- Transformer sheet which contains data input and loss calculations for each distribution substation and high voltage transformer. Separate iron and copper losses are calculated for each transformer by identified type.

- Conductor sheet containing summary data by major voltage level as to circuit miles, loading assumptions, and kW and kWh loss calculations. Separate loss calculations for each line segment were made using the Company's power flow data by line segment and summarized by voltage level in this model.

Appendix A presents a detailed loss study result which derives the loss factors for the Company's system-wide power system. Appendix A, Exhibit 8, presents the final detailed summary results of the demand and energy losses for each major portion of the total KPCO power system.

3.0 METHODOLOGY

3.1 Background

The objective of a Loss Study is to provide a reasonable set of energy (average) and demand (peak) loss expansion factors which account for system losses associated with the transmission and delivery of power to each voltage level over a designated period of time. The focus of this study is to identify the difference between total energy inputs and the associated sales with the difference being equitably allocated to all delivery levels. Several key elements are important in establishing the methodology for calculating and reporting the Company's losses. These elements are:

- Selection of voltage level of services,
- Recognition of losses associated with conductors, transformations, and other electrical equipment/components within voltage levels,
- Identification of customers and loads at various voltage levels of service,
- Review of generation or net power supply input at each level for the test period studied, and
- Analysis of kW and kWh sales by voltage levels within the test period.

The three major areas of data gathering and calculations in the loss analysis were as follows:

1. System Information (monthly and annual)

    - MWH generation and MWH sales.
    - Coincident peak estimates and net power supply input from all sources and voltage levels.
    - Customer load data estimates from available load research information, adjusted MWH sales, and number of customers in the customer groupings and voltage levels identified in the model.
    - System default values, such as power factor, loading factors, and load factors by voltage level.

2. High Voltage System

- Conductor information was summarized from a database by the Company which reflects the transmission system by voltage level. Extensive use was made of the Company's power flow data with the losses calculated and incorporated into the final loss calculations.

- Transformer information was developed in a database to model transformation at each voltage level. Substation power, step-up, and auto transformers were individually identified along with any operating data related to loads and losses.

- Power flow data of peak condition was the primary source of equipment loadings and derivation of load losses in the high voltage loss calculations.

3. Distribution System

- Distribution Substations – Data was developed for modeling each substation as to its size and loading. Loss calculations were performed from this data to determine load and no load losses separately for each transformer.

- Primary lines – Line loading and loss characteristics for several representative primary circuits were obtained from the Company. These loss results developed kW loss per MW of load and a composite average was calculated to derive the primary loss estimate.

- Line transformers – Losses in line transformers were based on each customer service group's size, as well as the number of customers per transformer. Accounting and load data provided the foundation with which to model the transformer loadings and to calculate load and no load losses.

- Secondary network – Typical secondary networks were estimated for conductor sizes, lengths, loadings, and customer penetration for residential and small general service customers based on data provided by the Company.

- Services – Typical services were estimated for each secondary service class of customers identified in the study with respect to type, length, and loading.

The loss analysis was thus performed by constructing the model in segments and subsequently calculating the composite until the constraints of peak demand and energy were met:

- Information as to the physical characteristics and loading of each transformer and conductor segment was modeled.
- Conductors, transformers, and distribution were grouped by voltage level, and unadjusted losses were calculated.
- The loss factors calculated at each voltage level were determined by "compounding" the per-unit losses. Equivalent sales at the supply point were obtained by dividing sales at a specific level by the compounded loss factor to determine losses by voltage level.
- The resulting demand and energy loss expansion factors were then used to adjust all sales to the generation or input level in order to estimate the difference.
- Reconciliation of kW and kWh sales by voltage level using the reported system kW and kWh was accomplished by adjusting the initial loss factor estimates until the mismatch or difference was eliminated.

3.2 Calculations and Analysis

This section provides a discussion of the input data, assumptions, and calculations performed in the loss analysis. Specific appendices have been included in order to provide documentation of the input data utilized in the model.

3.2.1 Bulk, Transmission and Subtransmission Lines

The transmission and subtransmission line losses were calculated based on a modeling of unique voltage levels identified by the Company's power flow data and configuration for the entire integrated KPCO Power System. Specific information as to length of line, type of conductor, voltage level, peak load, maximum load, etc., were provided based on Company records and utilized as data input in the loss model.

Actual MW and MVA line loadings were based on KPCO's peak loading conditions. Calculations of line losses were performed for each line segment separately and combined by voltage levels for reporting purposes as shown in the Discussion of Results (Section 4.0) of this report. The loss calculations consisted of determining a circuit current value based on MVA line loadings and evaluating the I^2R results for each line segment.

After system coincident peak hour losses were identified for each voltage level, a separate calculation was then made to develop annual average energy losses based on a loss factor approach. Load factors were determined for each voltage level based on system and customer load information. An estimate of the Hoebel coefficient (see Appendix B) was then used to calculate energy losses for the entire period being analyzed. The results are presented in Section 4.0 of this report.

3.2.2 Transformers

The transformer loss analysis required several steps in order to properly consider the characteristics associated with various transformer types; such as, step-up, auto transformers, distribution substations, and line transformers. In addition, further efforts were required to identify both iron and copper losses within each of these transformer types in order to obtain reasonable peak (kW) and average energy (kWh) losses. While iron losses were considered essentially constant for each hour, recognition had to be made for the varying degree of copper losses due to hourly equipment loadings.

Standardized test data tables were used to represent no load (fixed) and full load losses for different types and sizes of transformers. This test data was incorporated into the loss model to develop relationships representing copper and iron losses for the transformer loss calculation. These results were then totaled by various groups, as identified and discussed in Section 4.0.

The remaining miscellaneous losses considered in the loss study consisted of several areas which do not lend themselves to any reasonable level of modeling for estimating their respective losses and were therefore lumped together into a single loss factor of 0.10%. The typical range of values for these losses is from 0.10% to 0.25%, and we have assumed the lower value to be conservative at this time. The losses associated with this loss factor include bus bars, unmetered station use, and grounding transformers.

3.2.3 Distribution System

The load data at the substation and customer level, coupled with primary and secondary network information, was sufficient to model the distribution system in adequate detail to calculate losses.

Primary Lines

Primary line loadings take into consideration the available distribution load along with the actual customer loads including losses. Primary line loss estimates were prepared by the Company for use in this loss study. These estimates considered loads per substation, voltage levels, loadings, total circuit miles, wire size, and single- to three-phase investment estimates. All of these factors were considered in calculating the actual demand (kW) and energy (kWh) for the primary system.

Line Transformers

Losses in line transformers were determined based on typical transformer sizes for each secondary customer service group and an estimated or calculated number of customers per transformer. Accounting records and estimates of load data provided the necessary database with which to model the loadings. These calculations also made it possible to determine separate copper and iron losses for distribution line transformers, based on a table of representative losses for various transformer sizes.

Secondary Line Circuits

A calculation of secondary line circuit losses was performed for loads served through these secondary line investments. Estimates of typical conductor sizes, lengths, loadings and customer class penetrations were made to obtain total circuit miles and losses for the secondary network. Customer loads which do not have secondary line requirements were also identified so that a reasonable estimate of losses and circuit miles of these investments could be made.

Service Drops and Meters

Service drops were estimated for each secondary customer reflecting conductor size, length and loadings to obtain demand losses. A separate calculation was also performed using customer maximum demands to obtain kWh losses. Meter loss estimates were also made for each customer and incorporated into the calculations of kW and kWh losses included in the Summary Results.

4.0 DISCUSSION OF RESULTS

A brief description of each Exhibit provided in Appendix A follows:

Exhibit 1 - Summary of Company Data

This exhibit reflects system information used to determine percent losses and a detailed summary of kW and kWh losses by voltage level. The loss factors developed in Exhibit 7 are also summarized by voltage level.

Exhibit 2 - Summary of Conductor Information

A summary of MW and MWH load and no load losses for conductors by voltage levels is presented. The sum of all calculated losses by voltage level is based on input data information provided in Appendix A. Percent losses are based on equipment loadings.

Exhibit 3 - Summary of Transformer Information

This exhibit summarizes transformer losses by various types and voltage levels throughout the system. Load losses reflect the copper portion of transformer losses while iron losses reflect the no load or constant losses. MWH losses are estimated using a calculated loss factor for copper and the test year hours times no load losses.

Exhibit 4 - Summary of Losses Diagram (2 Pages)

This loss diagram represents the inputs and output of power at system peak conditions. Page 1 details information from all points of the power system and what is provided to the distribution system for primary loads. This portion of the summary can be viewed as a "top down" summary into the distribution system.

Page 2 represents a summary of the development of primary line loads and distribution substations based on a "bottom up" approach. Basically, loadings are developed from the customer meter through the Company's physical investments based on load research and other metered information by voltage level to arrive at MW and MVA requirements during peak load conditions by voltage levels.

Exhibit 5 - Summary of Sales and Calculated Losses

Summary of Calculated Losses represents a tabular summary of MW and MWH load and no load losses by discrete areas of delivery within each voltage level. Losses have been identified and are derived based on summaries obtained from Exhibits 2 and 3 and losses associated with meters, capacitors and regulators.

Exhibit 6 - Development of Loss Factors, Unadjusted

This exhibit calculates demand and energy losses and loss factors by specific voltage levels based on sales level requirements. The actual results reflect loads by level and summary totals of losses at that level, or up to that level, based on the results as shown in Exhibit 5. Finally, the estimated values at generation are developed and compared to actual generation to obtain any difference or mismatch.

Exhibit 7 - Development of Loss Factors, Adjusted

The adjusted loss factors are the results of adjusting Exhibit 6 for any difference. All differences between estimated and actual are prorated to each level based on the ratio of each level's total load plus losses to the system total. These new loss factors reflect an adjustment in losses due only to the kW and kWh mismatch.

Exhibit 8 – Adjusted Losses and Loss Factors by Facility

These calculations present an expanded summary detail of Exhibit 7 for each segment of the power system with respect to the flow of power and associated losses from the receipt of energy at the meter to the generation for the KPCO power system.

Appendix A

Results of 2006 KPCO Integrated Power System Loss Analysis

KENTUCKY POWER

EXHIBIT 1

SUMMARY OF COMPANY DATA

ANNUAL PEAK	1,539	MW
ANNUAL SYSTEM INPUT	7,750,202	MWH
ANNUAL SALES OUTPUT	7,291,865	MWH
SYSTEM LOSSES @ INPUT	458,337	or 5.91%
SYSTEM LOSSES @ OUTPUT	458,337	or 6.29%
SYSTEM LOAD FACTOR	57.5%	

SUMMARY OF LOSSES - OUTPUT RESULTS

SERVICE	KV	--- MW ---	Input	% TOTAL	--- MWH ---	Input	% TOTAL
TRANS	765,345 161,138	50.9	3.31%	40.31%	181,171	2.34%	39.53%
SUBTRANS	69,46,34	13.7	0.89%	10.87%	58,146	0.75%	12.69%
PRIMARY	34,12,1	30.0	1.95%	23.73%	87,695	1.13%	19.13%
SECONDARY	120/240,to,477	31.7	2.06%	25.09%	131,324	1.69%	28.65%
TOTAL		126.3	8.21%	100.00%	458,337	5.91%	100.00%

SUMMARY OF LOSS FACTORS

SERVICE	KV	CUMMULATIVE SALES EXPANSION FACTORS DEMAND (Peak) d	1/d	ENERGY (Annual) e	1/e
TOT TRANS	765,345 161,138	1.03935	0.96214	1.02781	0.97294
SUBTRAN	69,46,34	1.05210	0.95048	1.03780	0.96358
PRIMARY	34,12,1	1.07402	0.93108	1.05205	0.95053
SECONDARY	120/240,to,477	1.10790	0.90261	1.08674	0.92018

KENTUCKY POWER 2006 LOSS ANALYSIS

EXHIBIT 2

SUMMARY OF CONDUCTOR INFORMATION

DESCRIPTION		CIRCUIT MILES	LOADING % RATING	MW LOSSES LOAD	MW LOSSES NO LOAD	MW LOSSES TOTAL	MWH LOSSES LOAD	MWH LOSSES NO LOAD	MWH LOSSES TOTAL
--- BULK ---	765 KV OR GREATER								
TIE LINES		0.0	0.00%	0.000	0.000	0.000	0	0	0
BULK TRANS		183.5	0.00%	0.566	0.014	0.580	1,568	12,700	14,268
SUBTOT		183.5		0.566	0.014	0.580	1,568	12,700	14,268
--- TRANS ---	138 KV TO 765.00 KV								
TIE LINES		0	0.00%	0.000	0.000	0.000	0	0	0
TRANS1	161 KV	56.5	0.00%	1.149	0.040	1.189	2,973	352	3,325
TRANS2	138 KV	328.1	0.00%	41.861	0.135	41.996	124,032	1,182	125,214
SUBTOT		384.7		43.010	0.175	43.185	127,006	1,533	128,539
--- SUBTRANS ---	35 KV TO 138 KV								
TIE LINES		0	0.00%	0.000	0.000	0.000	0	0	0
SUBTRANS1	69 KV	997.5	0.00%	7.066	0.489	7.556	21,629	2,431	24,060
SUBTRANS2	46 KV	169.2	0.00%	1.879	0.000	1.879	5,753	0	5,753
SUBTRANS3	35 KV	3.2	0.00%	0.071	0.008	0.079	210	73	283
SUBTOT		1,169.8		9.017	0.497	9.514	27,592	2,504	30,097
PRIMARY LINES		8,089		15.358	1.287	16.645	30,565	11,273	41,838
SECONDARY LINES		2,632		6.249	0.000	6.249	13,182	0	13,182
SERVICES		3,175		5.420	0.366	5.786	12,575	3,207	15,781
TOTAL		15,634		79.619	2.339	81.959	212,488	31,217	243,705

SUMMARY OF TRANSFORMER INFORMATION

DESCRIPTION	VOLTAGE	KV CAPACITY	MVA	NUMBER TRANSFMR	AVERAGE SIZE	LOADING %	MVA LOAD	MW LOSSES LOAD	MW LOSSES NO LOAD	MW LOSSES TOTAL	MWH LOSSES LOAD	MWH LOSSES NO LOAD	MWH LOSSES TOTAL
BULK STEP-UP		765	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
BULK - BULK			0.0	0	0.0	0.00%	0	0	0.000	0.000	0	0	0
BULK - TRANS1		161	1,500.0	3	500.0	22.56%	338	0.418	1.507	1.925	1,082	11,941	13,022
BULK - TRANS2		138	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1 STEP-UP		161	950.0	1	950.0	61.01%	580	0.970	1.028	1.998	2,257	6,448	8,705
TRANS1 - TRANS2		138	735.0	4	183.8	86.06%	633	0.785	1.239	2.024	2,326	8,498	10,824
TRANS1-SUBTRANS1		69	54.0	1	54.0	104.12%	56	0.098	0.112	0.210	596	770	1,366
TRANS1-SUBTRANS2		46	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1-SUBTRANS3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS2 STEP-UP		138	354.0	3	118.0	62.61%	222	0.656	0.550	1.206	1,906	3,907	5,813
TRANS2-SUBTRANS1		69	826.5	15	55.1	109.65%	906	1.555	1.776	3.331	11,277	12,181	23,459
TRANS2-SUBTRANS2		46	75.0	2	37.5	92.79%	70	0.269	0.150	0.419	785	1,059	1,843
TRANS2-SUBTRANS3		35	57.0	2	28.5	32.40%	18	0.036	0.081	0.117	75	637	711
SUBTRAN1 STEP-UP		69	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN2 STEP-UP		46	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN3 STEP-UP		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN1-SUBTRAN2		46	24.0	2	12.0	91.84%	22	0.082	0.053	0.135	283	386	670
SUBTRAN1-SUBTRAN3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN2-SUBTRAN3		35	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
DISTRIBUTION SUBSTATIONS													
TRANS1 -	161	33	22.0	2	11.0	86.73%	19	0.080	0.049	0.129	173	356	529
TRANS1 -	161	12	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS1 -	161	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
TRANS2 -	138	33	183.0	9	20.3	96.56%	177	0.850	0.395	1.245	1,837	2,806	4,643
TRANS2 -	138	12	43.5	4	10.9	103.30%	45	0.247	0.104	0.351	533	744	1,277
TRANS2 -	138	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN1-	69	33	147.5	12	12.3	120.83%	178	1.143	0.372	1.515	2,471	2,595	5,067
SUBTRAN1-	69	12	448.5	54	8.3	107.07%	480	2.861	1.136	3.997	6,184	8,164	14,348
SUBTRAN1-	69	1	25.0	4	6.3	44.27%	11	0.035	0.053	0.088	77	419	495
SUBTRAN2-	46	33	63.0	4	15.8	104.95%	66	0.378	0.146	0.524	817	1,034	1,851
SUBTRAN2-	46	12	121.3	15	8.1	75.22%	91	0.680	0.267	0.946	1,469	1,995	3,464
SUBTRAN2-	46	1	0.7	1	0.7	28.61%	0	0.000	0.002	0.002	1	13	14
SUBTRAN3-	35	33	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
SUBTRAN3-	35	12	5.0	1	5.0	135.48%	7	0.057	0.016	0.073	123	111	235
SUBTRAN3-	35	1	0.0	0	0.0	0.00%	0	0.000	0.000	0.000	0	0	0
PRIMARY - PRIMARY			21.3	4	5.3	63.76%	14	0.055	0.037	0.092	119	321	440
LINE TRANSFRMR			2,982.7	95,534	31.2	34.92%	1,041	5.012	9.988	15.000	11,054	87,498	98,553
			==========	==========	==========	==========		==========	==========	==========	==========	==========	==========
TOTAL			8,639	95,677				16.267	19.059	35.327	45,446	151,883	197,329

SUMMARY OF LOSSES DIAGRAM - DEMAND MODEL - SYSTEM PEAK

1539 MW

BULK TIE LINES		
LOAD	0.00%	MW
LOAD LOSS	0.000	MW
NOLD LOSS	0.000	MW

BULK LINES		
LOADING	0.00%	
LOAD LOSS	0.566	MW
NOLD LOSS	0.014	MW

BULK STEP UP		
LOADING	0.00%	
NO LOAD	0.000	MW
LOAD	0.000	MW
AVG SIZE	0	MVA
NUMBER	0	

BULK-BULK		
LOADING	0.00%	
NO LOAD	0	MW
LOAD	0	MW
AVG SIZE	0	MVA
NUMBER	0	

TRANS TIE LINES		
LOAD	0.00%	MW
LOAD LOSS	0.000	MW
NOLD LOSS	0.000	MW

BULK-TRANS1 STEP DOWN		
LOADING	22.56%	
NO LOAD	1.507	MW
LOAD	0.418	MW
AVG SIZE	500	MVA
NUMBER	3	

TRAN1-TRAN2 STEP DOWN		
LOADING	86.06%	
NO LOAD	1.239	MW
LOAD	0.785	MW
AVG SIZE	183.75	MVA
NUMBER	4	

BULK-TRANS2 STEP DOWN		
LOADING	0.00%	
NO LOAD	0.000	MW
LOAD	0.000	MW
AVG SIZE	0	MVA
NUMBER	0	

TRANS 1&2 STEP UPS		
LDNG TR1SU	61.01%	
NOLOAD1&2	1.578	MW
LOAD 1&2	1.626	MW
AVSIZ TR1SU	950.0	MVA
NUMBER	1	

TRANS1	161.0	KV
LOADING	0.00%	
LOAD LOSS	1.149	MW
NOLD LOSS	0.040	MW

TRANS2	138.0	KV
LOADING	0.00%	
LOAD LOSS	41.861	MW
NOLD LOSS	0.135	MW

TRANS CUST		
SUBS	0.000	MW
	0.000	MVA
LINES		MW
		MVA

SUBTRANS TIE LINES		
LOAD	0.00%	MW
LOAD LOSS	0.000	MW
NOLD LOSS	0.000	MW

TRANS1&2-SUBTRANS1		
LDNG TR2-ST	109.65%	
NO LOAD	1.888	MW
LOAD	1.653	MW
AVSIZ TR2	55.1	MVA
NUMBER	16	

SUBTR1&2-SUBTRANS2&3		
LOADING	0.00%	
NO LOAD	0.053	MW
LOAD	0.082	MW
AVG SIZE	0	MVA
NUMBER	2	

TRANS1&2- SUBTRANS2		
LDNG TR2-ST.	92.79%	
NO LOAD	0.150	MW
LOAD	0.269	MW
AVSIZ TR2-ST	37.50	MVA
NUMBER	2	

TRANS1&2-SUBTRANS3	
LDNG TR2-ST2	32.40%
NO LOAD	0.08
LOAD	0.04
AVSIZ TR2-ST2	28.50
NUMBER	2

SUBTRANS1,2,&3 STEP UPS		
LDNG ST1SU	0.00%	
NO LOAD	0.000	MW
LOAD	0.000	MW
AVSIZ ST2	0.0	MVA
NUMBER	0	

SUBTRANS1	69	KV
LOADING	0.00%	
LOAD LOSS	7.066	MW
NOLD LOSS	0.489	MW

SUBTRANS2	46	KV
LOADING	0.00%	
LOAD LOSS	1.879	MW
NOLD LOSS	0.000	MW

SUBTRANS2	35	KV
LOADING	0.00%	
LOAD LOSS	0.071	MW
NOLD LOSS	0.008	MW

SUBTRANS CUST	
SUBS - MW	0.000
MVA	0.000
LINES- MW	
MVA	

TO DISTRIBUTION SYSTEM

TOTAL 1074.5 MVA 1053.0 MW

TRANS1	19.1 MVA
	1.78%
161 KV	

TRANS2	221.6 MVA
	20.63%
138 KV	

SUBTRANS1	669.5 MVA
	62.31%
69 KV	

SUBTRANS2	157.5 MVA
	14.66%
46 KV	

SUBTRANS3	6.8 MVA
	0.63%
35 KV	

FROM HIGH VOLTAGE SYSTEM

TOTAL 1,074 MVA 1,053 MW

TRANS1	161 KV	19.1 MVA	1.78%
TRANS2	138 KV	221.6 MVA	20.63%
SUBTRANS1	69 KV	669.5 MVA	62.31%
SUBTRANS2	46 KV	157.5 MVA	14.66%
SUBTRANS3	35 KV	6.8 MVA	0.63%

DISTRIBUTION SYSTEM LOAD

	TRANS1 PRIM1	TRANS1 PRIM2	TRANS1 PRIM3	TRANS2 PRIM1	TRANS2 PRIM2	TRANS2 PRIM3	SUBTRANS1 PRIM1	SUBTRANS1 PRIM2	SUBTRANS1 PRIM3	SUBTRANS2 PRIM1	SUBTRANS2 PRIM2	SUBTRANS2 PRIM3	SUBTRANS3 PRIM1	SUBTRANS3 PRIM2	SUBTRANS3 PRIM3
VOLTAGE	33	12	1	33	12	1	33	12	1	33	12	1	33	12	1
LOAD MVA	19	0	0	177	45	0	178	480	11	66	91	0	0	7	0
% SYS TOT	1.78%	0.00%	0.00%	16.44%	4.18%	0.00%	16.59%	44.69%	1.03%	6.15%	8.49%	0.02%	0.00%	0.63%	0.00%
NOLD LOSS	0.049	0.000	0.000	0.395	0.104	0.000	0.372	1.136	0.053	0.146	0.267	0.002	0.000	0.016	0.000
LOAD LOSS	0.080	0.000	0.000	0.850	0.247	0.000	1.143	2.861	0.035	0.378	0.680	0.000	0.000	0.057	0.000
AVG SIZE	11.0	0.0	0.0	20.3	10.9	0.0	12.3	8.3	6.3	15.8	8.1	0.7	0.0	5.0	0.0
NUMBER	2	0	0	9	4	0	12	54	4	4	15	1	0	1	0
DIVERSITY RATIO	1.000	0.000	0.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	0.000

PRIMARY LINES		
LOADING	1042.772	MW
@ SYS PF	1064.053	MVA
LOAD LOSS	15.358	MW
NOLD LOSS	1.287	MW
TOT LOSS	16.645	MW

PRIM/PRIM TRANSF		
LOADING	13.548	MW
NOLD LOSS	0.037	MW
LOAD LOSS	0.055	MW
AVG SIZE	5.31	
NUMBER	4	

PRIM CUST	LOADS	
NO LINES	0.000	MW
CUST SUB	0.000	MVA
NO LINES	0.000	MW
CO. SUB	0.000	MVA
PRIM WITH	72.200	MW
LINES	78.478	MVA

LINE TRANSFORMERS			
LOADING	953.835	MW	MVA 1056.447
NOLD LOSS	9.988	MW	
LOAD LOSS	5.012	MW	
AVG SIZE	31.2	KVA	
NUMBER	95534		

SECONDARY LINES		
LOAD	412.036	MW
LOAD LOSS	6.249	MW
NOLD LOSS	0.000	MW
TOT LOSS	6.249	MW

NO SECONDARY LINES		
LOAD	526.798	MW

SERVICES		
LOAD	932.586	MW
LOAD LOSS	5.420	MW
NOLD LOSS	0.366	MW
TOT LOSS	5.786	MW

CUSTOMER SECONDARY LOAD	
926.800	MW

EXHIBIT 5

SUMMARY of SALES and CALCULATED LOSSES

LOSS # AND LEVEL	MW LOAD	NO LOAD +	LOAD =	TOT LOSS	EXP FACTOR	CUM EXP FAC	MWH LOAD	NO LOAD +	LOAD =	TOT LOSS	EXP FACTOR	CUM EXP FAC
1 BULK XFMMR	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0	0
2 BULK LINES	350.0	0.01	0.57	0.58	1.001659	1.001659	1,600,000	12,700	1,568	14,268	1.0089978	1.0089978
3 TRANS1 XFMR	331.7	1.51	0.42	1.92	1.005837	1.007506	1,510,960	11,941	1,082	13,022	1.0086933	1.0177694
4 TRANS1 LINES	899.7	1.07	2.12	3.19	1.003555	1.006332	6,943,169	6,800	5,230	12,030	1.0017357	1.0056093
5 TRANS2TR1 SD	619.9	1.24	0.79	2.02	1.003276	1.009628	3,040,981	8,498	2,326	10,824	1.0035721	1.0092014
6 TRANS2BLK SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
7 TRANS2 LINES	1,257.1	0.68	42.52	43.20	1.035589	1.040506	6,174,465	5,089	125,938	131,027	1.0216809	1.0263109
TOTAL TRAN	1,345.0	4.51	46.40	50.92	1.039346	1.039346	6,696,350	45,027	136,145	181,171	1.0278076	1.0278076
8 STR1BLK SD												
9 STR1T1 SD	55.1	0.11	0.10	0.21	1.003823	1.043319	275,125	770	596	1,366	1.0049913	1.0329377
10 SRT1T2 SD	888.1	1.78	1.55	3.33	1.003765	1.043259	4,434,461	12,181	11,277	23,459	1.0053182	1.0332737
11 SUBTRANS1 LINES	1,108.2	0.49	7.07	7.56	1.006865	1.046481	5,559,224	2,431	21,629	24,060	1.0043468	1.0322753
12 STR2T1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
13 STR2T2 SD	68.2	0.15	0.27	0.42	1.006188	1.045778	340,536	1,059	785	1,843	1.0054429	1.0334018
14 STR2S1 SD	21.6	0.05	0.08	0.14	1.006312	1.053086	107,853	386	283	670	1.0062500	1.0387270
15 SUBTRANS2 LINES	118.8	0.00	1.88	1.88	1.016075	1.056053	569,792	0	5,753	5,753	1.0101992	1.038290
16 STR3T1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
17 STR3T2 SD	18.1	0.08	0.04	0.12	1.006480	1.046081	88,791	637	75	711	1.0080774	1.0361096
18 STR3S1 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
19 STR3S2 SD	0.0	0.00	0.00	0.00	0.000000	0.000000	0	0	0	0	0.0000000	0.0000000
20 SUBTRANS3 LINES	18.1	0.01	0.07	0.08	1.004403	1.043922	88,791	73	210	283	1.0032023	1.0310990
21 SUBTRANS TOTAL	1,132.0	2.67	11.06	13.73	1.012275	1.052104	6,041,339	17,538	40,609	58,146	1.0097183	1.037796
DISTRIBUTION SUBST												
TRANS1	18.7	0.05	0.08	0.13	1.006936	1.046555	77,155	356	173	529	1.0068999	1.0348993
TRANS2	217.2	0.50	1.10	1.60	1.007402	1.047039	896,161	3,550	2,370	5,920	1.0066500	1.0346425
SUBTR1	656.1	1.56	4.04	5.60	1.008609	1.055490	2,706,999	11,178	8,732	19,910	1.0074094	1.0399238
SUBTR2	154.4	0.41	1.06	1.47	1.009630	1.066223	636,918	3,042	2,287	5,329	1.0084378	1.0470513
SUBTR3	6.6	0.02	0.06	0.07	1.011066	1.055474	27,390	111	123	235	1.0086388	1.0400064
WEIGHTED AVERAGE	1,053.0	2.54	6.33	8.87	1.008495	1.055162	4,344,624	18,236	13,686	31,922	1.0074019	1.0397906
PRIMARY INTRCHNGE	0.0				0.000000		0				0.0000000	
PRIMARY LINES	1,042.7	1.29	15.41	16.70	1.016277	1.072336	4,315,778	22,547	30,684	53,230	1.0124879	1.0527754
LINE TRANSF	953.8	9.99	5.01	15.00	1.015978	1.089469	3,808,609	87,498	11,054	98,553	1.0265636	1.0807410
SECONDARY	938.8	0.00	6.25	6.25	1.006700	1.096769	3,710,057	0	13,182	13,182	1.0035658	1.0845946
SERVICES	932.6	0.37	5.42	5.79	1.006243	1.103616	3,696,874	3,207	12,575	15,781	1.0042872	1.0892445
		===========	===========	===========				===========	===========	===========		
TOTAL SYSTEM		21.36	95.89	117.25				194,053	257,934	451,987		

DEVELOPMENT of LOSS FACTORS EXHIBIT 6

UNADJUSTED

DEMAND

LOSS FACTOR LEVEL	CUSTOMER SALES MW a	CALC LOSS TO LEVEL b	SALES MW @ GEN c	CUM PEAK EXPANSION FACTORS d	1/d
BULK LINES	0.0	0.0	0.0	0.00000	0.00000
TRANS SUBS	0.0	0.0	0.0	0.00000	0.00000
TRANS LINES	46.8	1.8	48.6	1.03935	0.96214
TOTAL TRANS	0.0	0.0	0.0	0.00000	0.00000
SUBTRANS	366.9	19.1	386.0	1.05210	0.95048
PRIM SUBS	0.0	0.0	0.0	0.00000	0.00000
PRIM LINES	72.2	5.2	77.4	1.07234	0.93254
SECONDARY	926.8	96.0	1,022.8	1.10362	0.90611
TOTALS	1,412.7	122.2	1,534.9		

DEVELOPMENT of LOSS FACTORS

UNADJUSTED

ENERGY

LOSS FACTOR LEVEL	CUSTOMER SALES MWH a	CALC LOSS TO LEVEL b	SALES MWH @ GEN c	CUM ANNUAL EXPANSION FACTORS d	1/d
BULK LINES	0	0	0	0.00000	0.00000
TRANS SUBS	0	0	0	0.00000	0.00000
TRANS LINES	390,468	10,858	401,326	1.02781	0.97294
TOTAL TRANS	0	0	0	0.00000	0.00000
SUBTRANS	2,766,366	104,558	2,870,924	1.03780	0.96358
PRIM SUBS	0	0	0	0.00000	0.00000
PRIM LINES	453,938	23,957	477,895	1.05278	0.94987
SECONDARY	3,681,093	328,517	4,009,610	1.08924	0.91807
TOTALS	7,291,865	467,890	7,759,755		

ESTIMATED VALUES AT GENERATION

LOSS FACTOR AT VOLTAGE LEVEL	MW	MWH
BULK LINES	0.00	0
TRANS SUBS	0.00	0
TRANS LINES	48.64	401,326
SUBTRANS SUBS	0.00	0
SUBTRANS LINES	386.02	2,870,924
PRIM SUBS	0.00	0
PRIM LINES	77.42	477,895
SECONDARY	1,022.83	4,009,610
SUBTOTAL	1,534.91	7,759,755
ACTUAL ENERGY	1,539.00	7,750,202
MISSMATCH	(4.09)	9,553
% MISSMATCH	-0.27%	0.12%

DEVELOPMENT of LOSS FACTORS EXHIBIT 7
ADJUSTED
DEMAND

LOSS FACTOR LEVEL	CUSTOMER SALES MW a	SALES ADJUST b	CALC LOSS TO LEVEL c	SALES MW @ GEN d	CUM PEAK EXPANSION FACTORS e	f=1/e
BULK LINES	0.0	0.0	0.0	0.0	0.00000	0.00000
TRANS SUBS	0.0	0.0	0.0	0.0	0.00000	0.00000
TRANS LINES	46.8	0.0	1.8	48.6	1.03935	0.96214
TOTAL TRANS	0.0	0.0	0.0	0.0	0.00000	0.00000
SUBTRANS	366.9	0.0	19.1	386.0	1.05210	0.95048
PRIM SUBS	0.0	0.0	0.0	0.0	0.00000	0.00000
PRIM LINES	72.2	0.0	5.3	77.5	1.07402	0.93108
SECONDARY	926.8	0.0	100.0	1,026.8	1.10790	0.90261
			126.3			
TOTALS	1,412.7	0.0	126.3	1,539.0		

DEVELOPMENT of LOSS FACTORS
ADJUSTED
ENERGY

LOSS FACTOR LEVEL	CUSTOMER SALES MWH a	SALES ADJUST b	CALC LOSS TO LEVEL c	SALES MWH @ GEN d	CUM ANNUAL EXPANSION FACTORS e	f=1/e
BULK LINES	0	0	0	0	0.00000	0.00000
TRANS SUBS	0	0	0	0	0.00000	0.00000
TRANS LINES	390,468	0	10,858	401,326	1.02781	0.97294
TOTAL TRANS	0	0	0	0	0.00000	0.00000
SUBTRANS	2,766,366	0	104,558	2,870,924	1.03780	0.96358
PRIM SUBS	0	0	0	0	0.00000	0.00000
PRIM LINES	453,938	0	23,626	477,564	1.05205	0.95053
SECONDARY	3,681,093	0	319,295	4,000,388	1.08674	0.92018
			458,337			
TOTALS	7,291,865	0	458,337	7,750,202		

ESTIMATED VALUES AT GENERATION

LOSS FACTOR AT VOLTAGE LEVEL	MW	MWH
BULK LINES	0.00	0
TRANS SUBS	0.00	0
TRANS LINES	48.64	401,326
SUBTRANS SUBS	0.00	0
SUBTRANS LINES	386.02	2,870,924
PRIM SUBS	0.00	0
PRIM LINES	77.54	477,564
SECONDARY	1,026.80	4,000,388
	1,539.00	7,750,202
ACTUAL ENERGY	1,539.00	7,750,202
MISSMATCH	0.00	0
% MISSMATCH	0.00%	0.00%

Adjusted Losses and Loss Factors by Facility EXHIBIT 8

Unadjusted Losses by Segment

	MW	Unadjusted	MWH	Unadjusted
Service Drop Losses	5.79	6.33	15,781	16,962
Secondary Losses	6.25	6.84	13,182	14,168
Line Transformer Losses	15.00	16.42	98,553	105,922
Primary Line Losses	16.70	18.28	53,230	57,211
Distribution Substation Losses	8.87	9.71	31,922	34,309
Subtransmission Losses	13.73	13.73	58,146	58,146
Transmission System Losses	50.92	50.92	181,171	181,171
Total	117.25	122.21	451,987	467,890

Mismatch Allocation by Segment

	MW	MWH
Service Drop Losses	-0.45	709
Secondary Losses	-0.49	592
Line Transformer Losses	-1.17	4,427
Primary Line Losses	-1.30	2,391
Distribution Substation Losses	-0.69	1,434
Subtransmission Losses	0.00	0
Transmission System Losses	0.00	0
Total	-4.09	9,553

Adjusted Losses by Segment

	MW	% of Total	MWH	% of Total
Service Drop Losses	6.78	5.4%	16,253	3.5%
Secondary Losses	7.32	5.8%	13,576	3.0%
Line Transformer Losses	17.58	13.9%	101,495	22.1%
Primary Line Losses	19.57	15.5%	54,820	12.0%
Distribution Substation Losses	10.40	8.2%	32,875	7.2%
Subtransmission Losses	13.73	10.9%	58,146	12.7%
Transmission System Losses	50.92	40.3%	181,171	39.5%
Total	126.30	100.0%	458,337	100.0%

Loss Factors by Segment	**MW**	**MWH**
Retail Sales from Service Drops	926.80	3,681,093
Adjusted Service Drop Losses	6.78	16,253
Input to Service Drops	933.58	3,697,346
Service Drop Loss Factor	**1.00732**	**1.00442**
Output from Secondary	933.58	3,697,346
Adjusted Secondary Losses	7.32	13,576
Input to Secondary	940.91	3,710,922
Secondary Conductor Loss Factor	**1.00784**	**1.00367**
Output from Line Transformers	940.91	3,710,922
Adjusted Line Transformer Losses	17.58	101,495
Input to Line Transformers	958.49	3,812,417
Line Transformer Loss Factor	**1.01869**	**1.02735**
Secondary Composite	1.03419	1.03568
Retail Sales from Primary	69.20	432,151
Req. Whls Sales from Primary	3.00	21,787
Input to Line Transformers	958.49	3,812,417
Output from Primary Lines	1030.69	4,266,355
Adjusted Primary Line Losses	19.57	54,820
Input to Primary Lines	1050.26	4,321,175
Primary Line Loss Factor	**1.01899**	**1.01285**
Output Pl from Distribution Substations	1050.26	4,321,175
Req. Whls Sales from Substations	0.00	0
Retail Sales from Substations	0.00	0
TotalOutput from Distribution Substations	1050.26	4,321,175
Adjusted Distribution Substation Losses	10.40	32,875
Input to Distribution Substations	1060.66	4,354,050
Distribution Substation Loss Factor	**1.00990**	**1.00761**
Retail Sales at from SubTransmission	351.90	2,695,544
Req. Whls Sales from SubTransmission	15.00	70,822
Input to Distribution Substations	751.37	3,216,827
Output from SubTransmission	1118.27	5,983,193
Adjusted SubTransmission System Losses	13.73	58,146
Input to SubTransmission	1132.00	6,041,339
SubTransmission Loss Factor	**1.01227**	**1.00972**
Retail Sales at from Transmission	32.80	320,160
Req. Whls Sales from Transmission	14.00	70,308
Input Subtransmission	1247.28	6,041,339
Output from Transmission	1294.08	6,515,179
Adjusted Transmission System Losses	50.92	181,171
Input to Transmission	1345.00	6,696,350
Transmission Loss Factor	**1.03935**	**1.02781**

Appendix B

Discussion of Hoebel Coefficient

COMMENTS ON THE HOEBEL COEFFICIENT

The Hoebel coefficient represents an established industry standard relationship between peak losses and average losses and is used in a loss study to estimate energy losses from peak demand losses. H. F. Hoebel described this relationship in his article, "Cost of Electric Distribution Losses," Electric Light and Power, March 15, 1959. A copy of this article is attached.

Within any loss evaluation study, peak demand losses can readily be calculated given equipment resistance and approximate loading. Energy losses, however, are much more difficult to determine given their time-varying nature. This difficulty can be reduced by the use of an equation which relates peak load losses (demand) to average losses (energy). Once the relationship between peak and average losses is known, average losses can be estimated from the known peak load losses.

Within the electric utility industry, the relationship between peak and average losses is known as the loss factor. For definitional purposes, loss factor is the ratio of the average power loss to the peak load power loss, during a specified period of time. This relationship is expressed mathematically as follows:

$$(1)\ F_{LS} \approx A_{LS} \div P_{LS}$$

where: F_{LS} = Loss Factor
A_{LS} = Average Losses
P_{LS} = Peak Losses

The loss factor provides an estimate of the degree to which the load loss is maintained throughout the period in which the loss is being considered. In other words, loss factor is the ratio of the actual kWh losses incurred to the kWh losses which would have occurred if full load had continued throughout the period under study.

Examining the loss factor expression in light of a similar expression for load factor indicates a high degree of similarity. The mathematical expression for load factor is as follows:

$$(2)\ F_{LD} \approx A_{LD} \div P_{LD}$$

where: F_{LD} = Load Factor
A_{LD} = Average Load
P_{LD} = Peak Load

This load factor result provides an estimate of the degree to which the load loss is maintained throughout the period in which the load is being considered. Because of the similarities in definition, the loss factor is sometimes called the "load factor of losses." While the definitions are similar, a strict equating of the two factors cannot be made. There does exist, however, a relationship between these two factors which is dependent upon the shape of the load duration curve. Since resistive losses vary as the square of the load, it can be shown mathematically that the loss factor can vary between the extreme limits of load factor and load factor squared. The relationship between load factor and loss factor has become an industry standard and is as follows:

$$(3)\ F_{LS} \approx H*F_{LD}^2 + (1\text{-}H)*F_{LD}$$

where: F_{LS} = Loss Factor
F_{LD} = Load Factor
H = Hoebel Coeff

As noted in the attached article, the suggested value for H (the Hoebel coefficient) is 0.7. The exact value of H will vary as a function of the shape of the utility's load duration curve. In recent years, values of H have been computed directly for a number of utilities based on EEI load data. It appears on this basis, the suggested value of 0.7 should be considered a lower bound and that values approaching unity may be considered a reasonable upper bound. Based on experience, values of H have ranged from approximately 0.85 to 0.95. The standard default value of 0.9 is generally used.

Inserting the Hoebel coefficient estimate gives the following loss factor relationship using Equation (3):

$$(4)\ F_{LS} \approx 0.90*F_{LD}^2 + 0.10*F_{LD}$$

Once the Hoebel constant has been estimated and the load factor and peak losses associated with a piece of equipment have been estimated, one can calculate the average, or energy losses as follows:

$$(5)\ A_{LS} \approx P_{LS} * [H*F_{LD}^2 + (1\text{-}H)*F_{LD}]$$

where: A_{LS} = Average Losses
P_{LS} = Peak Losses
H = Hoebel Coefficient
F_{LD} = Load Factor

Loss studies use this equation to calculate energy losses at each major voltage level in the analysis.