# PACIFICORP

# Oregon

## 2003 Analysis of System Losses

## April 2005

Prepared by:


Management Applications Consulting, Inc.
1103 Rocky Drive – Suite 201
Reading, PA 19609
Phone: (610) 670-9199 / Fax: (610) 670-9190

**MANAGEMENT APPLICATIONS CONSULTING, INC.**

1103 Rocky Drive • Suite 201 • Reading, PA 19609-1157 • 610/670-9199 • fax 610/670-9190 •www.manapp.com

March 31, 2005

Mr. Jack E. Stamper, P.E.
Regulatory Manager, Transmission Systems
PacifiCorp
700 N.E. Multnomah, Suite 550-POP
Portland, Oregon 97232

**RE: 2003 LOSS ANALYSES –Oregon**

Dear Mr. Stamper:

Transmitted herewith are the results of the 2003 Analysis of System Losses for the Oregon operations. These results consist of an Annual analysis which develops cumulative expansion factors (loss factors) for both demand (peak) and energy (average) losses by discrete voltage levels. The loss calculations were made using a separate transmission loss model which was then incorporated into the Oregon loss model to derive the final results prescribed herein. The Loss Models being provided to you in this study represent the most current version.

The continuing reduction in power losses in recent years as a result of system improvements and load growth has resulted in a sizable lowering of loss factors as evidenced in our studies and shown on Tables 1 and 2 of the report's Executive Summary. To this end, future studies should extend review efforts and data gathering enhancement in the area of power flow modeling, estimates of unbilled sales, and primary circuit analyses.

On behalf of MAC, we appreciate the opportunity to assist you in performing the loss analysis contained herein. The level of detail, multiple databases, and state jurisdictions coupled with load flow studies and updates are consistent with prior loss studies and reflect a reasonable representation of the power losses on the PacifiCorp system. Our review of these calculated loss results support the 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

**PACIFICORP - OREGON**

**2003 ANALYSIS OF SYSTEM LOSSES**

**TABLE OF CONTENTS**

## 1.0 EXECUTIVE SUMMARY

This report presents PacifiCorp's 2003 Analysis of System Losses for Oregon's power systems as performed by Management Applications Consulting, Inc. (MAC). The study developed separate demand (kW) and energy (kWh) loss factors (loss factors) for each voltage level of service in the power system. The loss factor results, as presented herein, can be used to adjust metered sales data in Oregon for losses in performing cost of service studies, determining voltage discounts, and other analyses which may require a loss adjustment. Typically, these factors are used to adjust metered kW and kWh data prior to the allocation of costs in order to equitably account for losses related to the consumption of power on the power system.

The procedures used in the overall study were consistent with 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 load flow studies and transformer plant investments in the modeling. In addition, 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 load flow results, transformer loss estimates, and metered sales.

At this point in the analysis, system loads and losses at the input into the distribution substation system are known with reasonable accuracy. However, it is the remaining loads and losses on the distribution substations, primary system, secondary circuits, and services which are generally difficult to estimate. The load 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 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 with 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.

Appendix A presents the results of the PacifiCorp system-wide Transmission 2003 Loss Analysis for the integrated PacifiCorp System. Appendix B presents the PacifiCorp Oregon 2003 Loss Analyses.

Table 1 on Page 2 provides the final results from Appendix A and B for the calendar year. The distribution system losses are calculated in Appendix B for all voltage levels except transmission which was obtained from Appendix A. These loss expansion factors are applicable only to metered sales at the point of receipt for adjustment to the power system's input level.

# MANAGEMENT APPLICATIONS CONSULTING, INC.
# ELECTRIC LOSS MODEL OVERVIEW

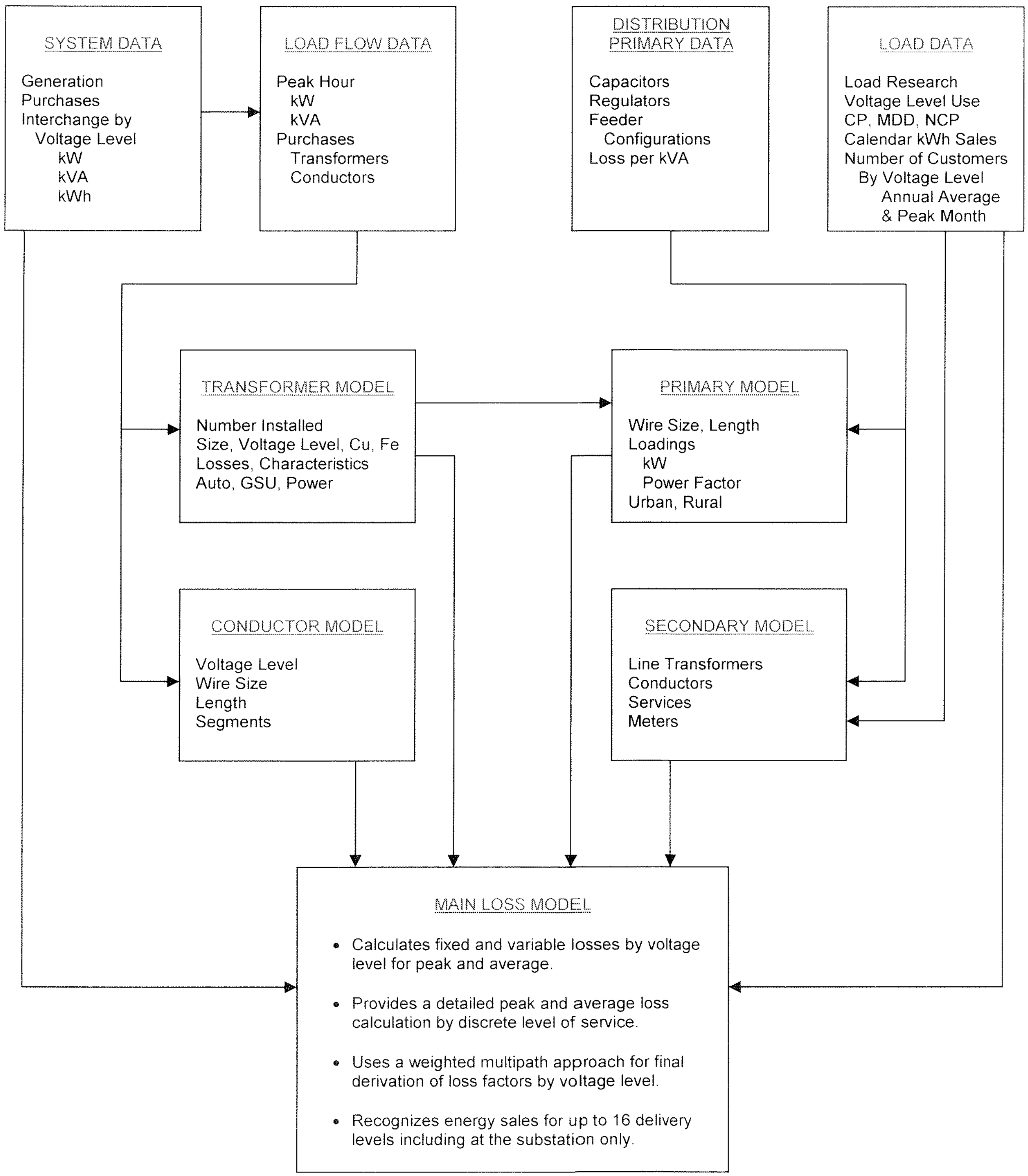


Table 2 presents a three-year summary of the declining PacifiCorp power system losses as well as the Oregon only losses over this same period of time. These major declines in losses have had a marked effect on the loss factors as can be noted in Table 1 by voltage delivery level.

These improving loss factors signal an excellent trend in system utilization and efficiency through investments, operations, and load growth. Future studies should encompass an expanded review of the power system by enhancing its power flow model, reviewing the detailed unbilled calculations and additional primary circuit analyses.

**TABLE 1**
**Loss Factors at Sales Level**
**Oregon**

| Voltage Level of Service | 2003 | 2002 | 2001 |
|---|---|---|---|
| Demand (kW) | | | |
| Transmission[1] | 1.04775 | 1.05144 | 1.05697 |
| Primary | 1.08658 | 1.09134 | 1.09755 |
| Secondary | 1.11606 | 1.12187 | 1.12746 |
| Energy (kWh) | | | |
| Transmission[1] | 1.03788 | 1.04020 | 1.04543 |
| Primary | 1.05846 | 1.06240 | 1.06908 |
| Secondary | 1.08421 | 1.09146 | 1.09950 |

**TABLE 2**
**Summary of System MWH Losses**

| | 2003 | 2002 | 2001 |
|---|---|---|---|
| Energy (MWH) | | | |
| Total Company | 61,994,956 | 67,157,785 | 65,985,214 |
| Losses | 3,820,026 | 4,275,859 | 4,655,892 |
| % of Total | 6.16 | 6.37 | 7.06 |
| | | | |
| Total Oregon | 16,718,140 | 18,650,778 | 18,631,289 |
| Losses | 1,107,774 | 1,267,440 | 1,404,993 |
| % of Total | 6.63 | 6.80 | 7.54 |

[1]Reference Appendix A for development of Transmission loss factors.

## 2.0 INTRODUCTION

This report of the 2003 Analysis of System Losses for Oregon 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 its customers. However, investments must be made in facilities which support the total load including 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 these cost responsibilities. Loss expansion factors are the mechanism by which customers' metered demand and energy data are mathematically adjusted to the generation level (point of reference) when performing cost and revenue calculations.

Fortunately, a reasonable accounting of losses can be made on an ongoing basis by 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[2] 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 consistent with prior loss studies and relied 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 load input, 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. Once updated, the loss models were turned over to the Company's staff for further use. 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.

[2]Copyright by Management Applications Consulting, Inc.

From an overall perspective, our efforts concentrated on three major areas:

1. System information by state jurisdiction (monthly and annual)
2. High voltage power system (power flows)
3. Distribution system (primary and secondary)

## 2.2 Description of Model

The Loss Model is a customized applications model, constructed using Excel. Documentation consists primarily of the model equations at each cell location. References can also be made to the applicable paragraphs in the Excel manual to support the technical aspects of the model construction. 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 in the Company's power flow models with summaries by voltage level incorporated in this model.

Appendix A presents a separate loss study result which derived the loss factors for the Company's system wide transmission only portion of the PacifiCorp power system. These transmission results formed the basis and starting point with which to derive the final Oregon loss factors for each remaining voltage level as presented in Appendix B and summarized on Table 1 of the Executive Summary.

# 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 equipment/components within voltage levels,
- Identification of customers and loads at various voltage levels,
- Review of generation or net power supply input at each level for the test period, and
- Analysis of kWh sales by voltage levels within the test period.

The three major areas of concentration with respect to 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 (Appendix A)

- 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 load flow results with the losses 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 load flow analysis of peak condition was the primary source of equipment loadings and load losses in the high voltage loss calculations (greater than 46 kV).

3. Distribution System (Appendix B)

- Distribution Substations – data was developed for modeling each substation, size and estimated loading of the transformers. Loss calculations were developed for load and no load losses separately.

- Primary lines - Line loading and loss characteristics for urban and rural circuits were obtained from distribution feeder analyses from a prior loss study. These loss results developed kW loss per MW of load by Primary Voltage level. An average was calculated to derive the primary loss estimate after weighting the proper rural versus urban customer mix.

- 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 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.

- 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 Analysis and Calculations

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 load flow configuration for the entire integrated PacifiCorp Power System. Specific information as to length of line, type of conductor, voltage level, peak load, maximum load, etc., were also provided based on Company records and utilized as data input summaries in the loss model.

MW and MVA line loadings were based on PacifiCorp's peak load estimate. Calculations of line losses were performed by the Company's power load flow 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 C) was then used to calculate energy losses for the period 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.

### 3.2.3 Distribution System

The results of the distribution substation loadings and customer load data were combined to estimate distribution system losses. 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. Substation transformers final loadings were estimated using the sum of the calculated loads and losses of the distribution system.

<u>Primary Lines</u>

Primary line loadings take into consideration the available distribution load along with the actual customer loads including losses. Based on prior loss analyses, estimates were made of primary line losses by the different levels of distribution voltage. These estimates consider substations, feeders 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 the 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 Network

An analysis of secondary network losses was performed for loads served through 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 investments could be made.

Services and Meters

Services were estimated for each secondary customer reflecting conductor size, length, loadings, and miles of service 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 of this report.

## 4.0 DISCUSSION OF RESULTS

A brief description of each Exhibit provided in Appendices A and B as follows:

Exhibit 1 - Summary of Company Data

Reflects system information used to determine percent losses and any deviations from estimated values.

Exhibit 2 - Summary of Conductor Information

A summary of MW and MWH load and no load losses for conductor circuit miles by voltage levels. The sum of all calculated losses by voltage level is based on input data information provided in Appendix A. Percent losses are based on a ratio to the total system.

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 for no load.

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 into the distribution system for primary loads. This portion of the summary can be viewed as a "top down" summary into the distributor 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.

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 mismatch.

# Appendix A

# Results of 2003 PacifiCorp Transmission System Loss Analysis

## PACIFICORP TRANSMISSION

EXHIBIT 1

### SUMMARY OF COMPANY DATA

| | | |
|---|---|---|
| ANNUAL PEAK | 9,925 | MW |
| ANNUAL ENERGY INPUT | 61,994,956 | MWH |
| ANNUAL SALES | 58,174,930 | MWH |
| Total System Losses | 3,820,026 | ( % of Input) or 6.16% |
| TOTAL TRANS LOSSES | 2,262,596 | ( % of Total ) 59.23% |

### SUMMARY OF LOSSES - OUTPUT RESULTS

| SERVICE | KV | MW | | % TOTAL | MWH | | % TOTAL |
|---|---|---|---|---|---|---|---|
| TRANS | 345,161,115 | 357.2 | | 78.99% | 1,795,865 | | 79.37% |
| | | | 3.60% | | | 2.90% | |
| SUBTRANS | 69, 57, 46 | 95.0 | | 21.01% | 466,731 | | 20.63% |
| | | | 0.96% | | | 0.75% | |
| TOTAL TRANS LOSSES | | 452.3 | | 100.00% | 2,262,596 | | 100.00% |
| (percent at input) | | | 4.56% | | | 3.65% | |

### SUMMARY OF LOSS FACTORS

CUMULATIVE SALES EXPANSION FACTORS

| SERVICE | KV | DEMAND d | DEMAND 1/d | ENERGY e | ENERGY 1/e |
|---|---|---|---|---|---|
| TRANS | 345,161,115<br>69, 57, 46 | 1.04775 | 0.95443 | 1.03788 | 0.96350 |

**SUMMARY OF CONDUCTOR INFORMATION**

EXHIBIT 2

| 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 ----------- | 345 KV | OR GREATER | | | | | | | | | | |
| TIE LINES | | | | 0.0 | | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| BULK TRANS | | | | 2,593.0 | | 0.00% | 79.600 | 10.372 | 89.972 | 457,426 | 90,859 | 548,285 |
| SUBTOT | | | | 2,593.0 | | | 79.600 | 10.372 | 89.972 | 457,426 | 90,859 | 548,285 |
| --- TRANS --------- | 115 KV | TO | | 345.00 | KV | | | | | | | |
| TIE LINES | | | | 0 | | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS1 | 161 KV | | | 3,525.0 | | 0.00% | 79.100 | 3.525 | 82.625 | 298,051 | 30,879 | 328,930 |
| TRANS2 | 115 KV | | | 3,261.0 | | 0.00% | 103.100 | 0.000 | 103.100 | 432,502 | 0 | 432,502 |
| SUBTOT | | | | 6,786.0 | | | 182.200 | 3.525 | 185.725 | 730,553 | 30,879 | 761,432 |
| --- SUBTRANS ------ | 34 KV | TO | | 115 | KV | | | | | | | |
| TIE LINES | | | | 0 | | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRANS1 | 60 KV | | | 2,973.0 | | 0.00% | 32.700 | 0.000 | 32.700 | 142,507 | 0 | 142,507 |
| SUBTRANS2 | 40 KV | | | 2,624.0 | | 0.00% | 40.500 | 0.000 | 40.500 | 149,082 | 0 | 149,082 |
| SUBTRANS3 | 34 KV | | | 0.0 | | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTOT | | | | 5,597.0 | | | 73.200 | 0.000 | 73.200 | 291,589 | 0 | 291,589 |
| TOTAL | | | | 14,976 | | | 335.000 | 13.897 | 348.897 | 1,479,568 | 121,738 | 1,601,306 |

## SUMMARY OF TRANSFORMER INFORMATION

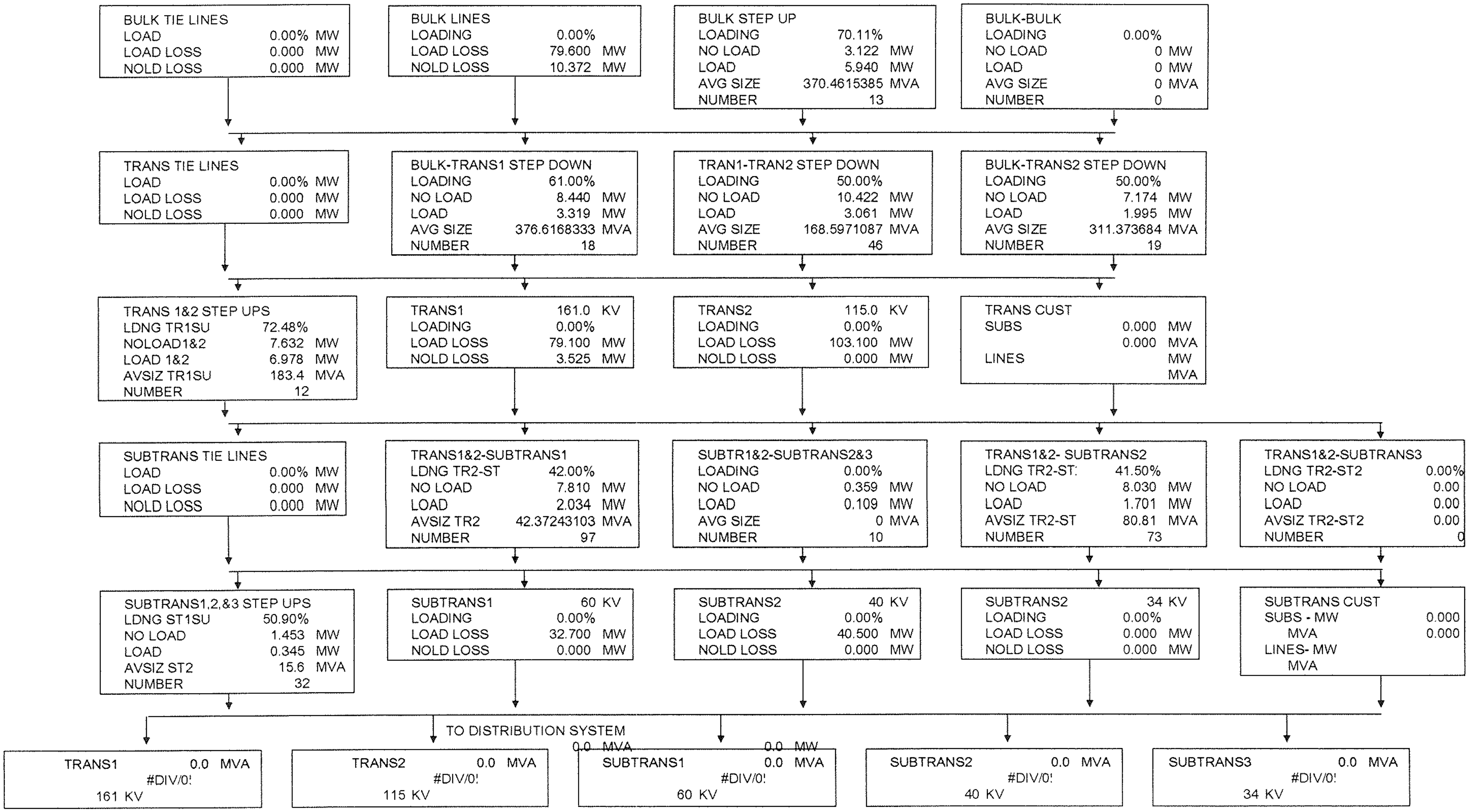
EXHIBIT 3

| DESCRIPTION | | KV CAPACITY VOLTAGE | 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 | | 345 | 4,816.0 | 13 | 370.5 | 70.11% | 3,377 | 5.940 | 3.122 | 9.061 | 41,494 | 27,346 | 68,841 |
| BULK - BULK | | | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| BULK - TRANS1 | | 161 | 6,779.1 | 18 | 376.6 | 61.00% | 4,135 | 3.319 | 8.440 | 11.759 | 12,507 | 73,934 | 86,441 |
| BULK - TRANS2 | | 115 | 5,916.1 | 19 | 311.4 | 50.00% | 2,958 | 1.995 | 7.174 | 9.169 | 8,367 | 62,847 | 71,214 |
| TRANS1 STEP-UP | | 161 | 2,200.6 | 12 | 183.4 | 72.48% | 1,595 | 3.388 | 3.420 | 6.808 | 22,030 | 29,961 | 51,991 |
| TRANS1 - TRANS2 | | 115 | 7,755.5 | 46 | 168.6 | 50.00% | 3,878 | 3.061 | 10.422 | 13.483 | 12,843 | 91,294 | 104,136 |
| TRANS1-SUBTRANS1 | | 60 | 3,181.0 | 39 | 81.6 | 42.00% | 1,336 | 1.086 | 4.221 | 5.307 | 4,733 | 36,980 | 41,713 |
| TRANS1-SUBTRANS2 | | 40 | 383.8 | 7 | 54.8 | 41.50% | 159 | 0.148 | 0.540 | 0.687 | 544 | 4,726 | 5,270 |
| TRANS1-SUBTRANS3 | | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2 STEP-UP | | 115 | 1,613.8 | 33 | 48.9 | 60.70% | 980 | 3.589 | 4.212 | 7.801 | 15,614 | 36,895 | 52,508 |
| TRANS2-SUBTRANS1 | | 60 | 2,457.6 | 58 | 42.4 | 42.00% | 1,032 | 0.948 | 3.588 | 4.536 | 4,132 | 31,434 | 35,566 |
| TRANS2-SUBTRANS2 | | 40 | 5,333.2 | 66 | 80.8 | 41.50% | 2,213 | 1.553 | 7.490 | 9.043 | 5,716 | 65,615 | 71,332 |
| TRANS2-SUBTRANS3 | | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN1 STEP-UP | | 60 | 155.6 | 15 | 10.4 | 50.90% | 79 | 0.254 | 0.601 | 0.855 | 2,782 | 5,264 | 8,046 |
| SUBTRAN2 STEP-UP | | 40 | 264.7 | 17 | 15.6 | 11.71% | 31 | 0.091 | 0.852 | 0.943 | 2,201 | 7,465 | 9,667 |
| SUBTRAN3 STEP-UP | | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN1-SUBTRAN2 | | 40 | 217.9 | 10 | 21.8 | 41.50% | 90 | 0.109 | 0.359 | 0.469 | 402 | 3,147 | 3,549 |
| SUBTRAN1-SUBTRAN3 | | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN2-SUBTRAN3 | | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| DISTRIBUTION SUBSTATIONS | | | | | | | | | | | | | |
| TRANS1 - | 161 | 33 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| 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 - | 115 | 33 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2 - | 115 | 12 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2 - | 115 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN1- | 60 | 33 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN1- | 60 | 12 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN1- | 60 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN2- | 40 | 33 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN2- | 40 | 12 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN2- | 40 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN3- | 34 | 33 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN3- | 34 | 12 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN3- | 34 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| | | | =========== | =========== | =========== | =========== | | =========== | =========== | =========== | =========== | ========== | =========== |
| TOTAL | | | 41,075 | 353 | | | | 25.482 | 54.442 | 79.923 | 133,365 | 476,909 | 610,273 |

PACIFICORP TRANSMISSION 2003 LOSS ANALYSIS



**SUMMARY OF LOSSES DIAGRAM - DEMAND MODEL - SYSTEM PEAK** 9924.692893 MW



## SUMMARY of SALES and CALCULATED LOSSES

EXHIBIT 5

| 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 | 3,309.0 | 13.49 | 85.54 | 99.03 | 1.030852 | 1.030852 | 25,339,614 | 118,205 | 498,920 | 617,125 | 1.0249621 | 1.0249621 |
| 3 TRANS1 XFMR | 4,052.5 | 8.44 | 3.32 | 11.76 | 1.002910 | 1.033852 | 22,649,203 | 73,934 | 12,507 | 86,441 | 1.0038312 | 1.0288889 |
| 4 TRANS1 LINES | 5,639.0 | 6.95 | 105.94 | 112.89 | 1.020428 | 1.045253 | 34,193,410 | 60,840 | 371,098 | 431,938 | 1.0127938 | 1.0321742 |
| 5 TRANS2TR1 SD | 3,800.2 | 10.42 | 3.06 | 13.48 | 1.003561 | 1.048974 | 22,503,747 | 91,294 | 12,843 | 104,136 | 1.0046490 | 1.0369728 |
| 6 TRANS2BLK SD | 2,898.9 | 7.17 | 1.99 | 9.17 | 1.003173 | 1.034123 | 17,166,525 | 62,847 | 8,367 | 71,214 | 1.0041657 | 1.0292318 |
| 7 TRANS2 LINES | 7,659.1 | 4.21 | 106.69 | 110.90 | 1.014692 | 1.052454 | 45,604,033 | 36,895 | 448,116 | 485,010 | 1.0107496 | 1.0403122 |
| SUB TOTAL TRAN | 9,924.7 | 50.69 | 306.54 | 357.23 | 1.037338 | 1.037338 | 61,994,956 | 444,014 | 1,351,851 | 1,795,865 | 1.0298321 | 1.0298321 |
| 8 STR1BLK SD | | | | | | | | | | | | |
| 9 STR1T1 SD | 1309.3 | 4.22 | 1.09 | 5.31 | 1.004070 | 1.049507 | 7,913,856 | 36,980 | 4,733 | 41,713 | 1.0052988 | 1.0376435 |
| 10 SRT1T2 SD | 1,011.5 | 3.59 | 0.95 | 4.54 | 1.004505 | 1.057195 | 6,114,204 | 31,434 | 4,132 | 35,566 | 1.0058509 | 1.0463990 |
| 11 SUBTRANS1 LINES | 2,398.5 | 0.60 | 32.95 | 33.56 | 1.014189 | 1.066061 | 14,752,127 | 5,264 | 145,289 | 150,553 | 1.0103107 | 1.0501419 |
| 12 STR2T1 SD | 156.1 | 0.54 | 0.15 | 0.69 | 1.004422 | 1.049875 | 861,433 | 4,726 | 544 | 5,270 | 1.0061553 | 1.0385275 |
| 13 STR2T2 SD | 2,169.0 | 7.49 | 1.55 | 9.04 | 1.004187 | 1.056860 | 11,970,348 | 65,615 | 5,716 | 71,332 | 1.0059947 | 1.0465486 |
| 14 STR2S1 SD | 88.6 | 0.36 | 0.11 | 0.47 | 1.005315 | 1.071728 | 489,076 | 3,147 | 402 | 3,549 | 1.0073102 | 1.0578186 |
| 15 SUBTRANS2 LINES | 2,444.1 | 0.85 | 40.59 | 41.44 | 1.017249 | 1.074465 | 13,964,476 | 7,465 | 151,283 | 158,749 | 1.0114988 | 1.0563112 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 21 SUBTRANS LOSS FAC | | | | | 0.000000 | | | | | | 0.0000000 | |
| 22 TRANSMSN LOSS FAC | 9,924.7 | 68.34 | 383.93 | 452.27 | 1.047746 | 1.047746 | 61,994,956 | 598,646 | 1,663,950 | 2,262,596 | 1.0378789 | 1.0378789 |
| DISTRIBUTION SUBST | | | | | | | | | | | | |
| TRANS1 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| TRANS2 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| SUBTR1 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| SUBTR2 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| SUBTR3 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| WEIGHTED AVERAGE | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| PRIMARY INTRCHNGE | 0.0 | | | | 0.000000 | | 0 | | | | 0.0000000 | |
| Average Dist Sub Losses | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| | | =========== | =========== | =========== | | | | =========== | =========== | =========== | | |
| TOTAL SYSTEM | | 68.34 | 383.93 | 452.27 | | | | 598,646 | 1,663,950 | 2,262,596 | | |

EXHIBIT 6

**DEVELOPMENT of LOSS FACTORS**
SYSTEM WIDE
DEMAND

| LOSS FACTOR LEVEL | CUSTOMER SALES MW<br>a | CALC LOSS TO LEVEL<br>b | SALES MW @ GEN<br>c | CUM SALES EXPANSION FACTORS<br>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 | 9,472.4 | 452.3 | 9,924.7 | 1.04775 | 0.95443 |
| SUBTRANS SUBS | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| TOTALS | 9,472.4 | 452.3 | 9,924.7 | | |

DEVELOPMENT of LOSS FACTORS
SYSTEM WIDE
ENERGY

| LOSS FACTOR LEVEL | CUSTOMER SALES MWH<br>a | CALC LOSS TO LEVEL<br>b | SALES MWH @ GEN<br>c | CUM SALES EXPANSION FACTORS<br>d | 1/d |
|---|---|---|---|---|---|
| BULK LINES | 0 | 0 | 0 | 0.00000 | 0.00000 |
| TRANS SUBS | 0 | 0 | 0 | 0.00000 | 0.00000 |
| TRANS LINES | 59,732,360 | 2,262,596 | 61,994,956 | 1.03788 | 0.96350 |
| SUBTRANS SUBS | 0 | 0 | 0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0 | 0 | 0 | 0.00000 | 0.00000 |
| TOTALS | 59,732,360 | 2,262,596 | 61,994,956 | | |

PACIFICORP TRANSMISSION 2003 LOSS ANALYSIS

**Adjusted Losses and Loss Factors by Facitliy**

EXHIBIT 8

**Losses by Segment**

| | MW | MWH |
|---|---|---|
| 46-57 kV Line Losses (ST2) | 41.44293 | 158,749 |
| T1 - ST2 Transformation Losses | 0.68720 | 5,270 |
| T2 - ST2 Transformation Losses | 9.04323 | 71,332 |
| ST1 - ST2 Transformation Losses | 0.46853 | 3,549 |
| 69 kV Line Losses (ST1) | 33.55514 | 150,553 |
| T1 - ST1 Transformation Losses | 5.30749 | 41,713 |
| T2 - ST1 Transformation Losses | 4.53645 | 35,566 |
| 115-138 kV Line Losses (T2) | 110.90120 | 485,010 |
| B - T2 Transformation Losses | 9.16887 | 71,214 |
| T1 - T2 Transformation Losses | 13.48309 | 104,136 |
| 161-230 kV Line Losses (T1) | 112.88506 | 431,938 |
| B - T1 Transformation Losses | 11.75931 | 86,441 |
| 345-500 kV Line Losses (B) | 99.03345 | 617,125 |
| Total | 452.27195 | 2,262,596 |

**Loss Factors by Segment**

| | MW | MWH |
|---|---|---|
| Deliveries from Sub Transmission 2 Lines | 2444.10 | 13,964,476 |
| ST2 Line Losses | 41.44 | 158,749 |
| T1 - ST2 Transformation Losses | 0.69 | 5,270 |
| T2 - ST2 Transformation Losses | 9.04 | 71,332 |
| ST1 - ST2 Transformation Losses | 0.47 | 3,549 |
| Input to ST2 System | 2495.74 | 14,203,375 |
| **ST2 Loss Factor** | **1.02113** | **1.01711** |
| | | |
| Deliveries from Sub Transmission 1 Lines | 2398.47 | 14,752,127 |
| ST1 Line Losses | 33.56 | 150,553 |
| T1 - ST1 Transformation Losses | 5.31 | 41,713 |
| T2 - ST1 Transformation Losses | 4.54 | 35,566 |
| Input to ST1 System | 2441.87 | 14,979,958 |
| **ST1 Loss Factor** | **1.01809** | **1.01544** |
| | | |
| Deliveries from Transmission 2 Lines | 7659.07 | 45,604,033 |
| T2 Line Losses | 110.90 | 485,010 |
| B - T2 Transformation Losses | 9.17 | 71,214 |
| T1 - T2 Transformation Losses | 13.48 | 104,136 |
| Input to T2 System | 7792.62 | 46,264,394 |
| **T2 Loss Factor** | **1.01744** | **1.01448** |
| | | |
| Deliveries from Transmission 1 Lines | 5639.00 | 34,193,410 |
| T1 Line Losses | 112.89 | 431,938 |
| B - T1 Transformation Losses | 11.76 | 86,441 |
| Input to T1 System | 5763.64 | 34,711,790 |
| **T1 Loss Factor** | **1.02210** | **1.01516** |
| | | |
| Deliveries from Bulk Lines | 3309.00 | 25,339,614 |
| B Line Losses | 99.03 | 617,125 |
| Input to B System | 3408.03 | 25,956,739 |
| **B Loss Factor** | **1.02993** | **1.02435** |
| | | |
| Total Deliveries from Transmission | 9472.42 | 59,732,360 |
| Total Transmission Losses | 452.27 | 2,262,596 |
| Input to Transmission System | 9924.69 | 61,994,956 |
| **Transmission Loss Factor** | **1.04775** | **1.03788** |

# Appendix B

# Results of PacifiCorp Oregon 2003 Loss Analysis

PACIFICORP OREGON

EXHIBIT 1

## SUMMARY OF COMPANY DATA

| | | |
|---|---|---|
| ANNUAL PEAK | 2,661 | MW |
| ANNUAL GENERATION | 16,718,140 | MWH |
| ANNUAL SALES | 15,610,366 | MWH |
| System Losses | 1,107,774 | or 6.63% |
| SYSTEM LOAD FACTOR | 71.7% | |

## SUMMARY OF LOSSES - OUTPUT RESULTS

| SERVICE | KV | MW | | % TOTAL | MWH | | % TOTAL |
|---|---|---|---|---|---|---|---|
| TRANS | 345,161,115 | 121.3 | 4.56% | 50.78% | 610,153 | 3.65% | 55.08% |
| PRIMARY | 69,34,12,1 | 73.3 | 2.75% | 30.69% | 246,993 | 1.48% | 22.30% |
| SECONDARY | | 44.3 | 1.66% | 18.53% | 250,629 | 1.50% | 22.62% |
| TOTAL | | 238.9 | 8.97% | 100.00% | 1,107,774 | 6.63% | 100.00% |

## SUMMARY OF LOSS FACTORS

| SERVICE | KV | CUMMULATIVE SALES EXPANSION FACTORS DEMAND d | DEMAND 1/d | ENERGY e | ENERGY 1/e |
|---|---|---|---|---|---|
| TRANS | 345,161,115 | 1.04775 | 0.95443 | 1.03788 | 0.96350 |
| PRIM SUBS | 69,46,35 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| PRIMARY | 69,34,12,1 | 1.08658 | 0.92032 | 1.05846 | 0.94477 |
| SECONDARY | | 1.11606 | 0.89601 | 1.08421 | 0.92233 |

PACIFICORP OREGON 2003 LOSS ANALYSIS

## SUMMARY OF CONDUCTOR INFORMATION

EXHIBIT 2

| 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 ----------- | 345 KV | OR GREATER | | | | | | | | | | |
| TIE LINES | | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| BULK TRANS | | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTOT | | | | | 0.0 | | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| --- TRANS --------- | 115 KV | TO | 345.00 | KV | | | | | | | | |
| TIE LINES | | | | | 0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS1 | 161 KV | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2 | 115 KV | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 3 | 3 |
| SUBTOT | | | | | 0.0 | | 0.000 | 0.000 | 0.000 | 0 | 3 | 3 |
| --- SUBTRANS ------ | 35 KV | TO | 115 | KV | | | | | | | | |
| TIE LINES | | | | | 0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRANS1 | 69 KV | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRANS2 | 46 KV | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRANS3 | 35 KV | | | | 0.0 | 0.00% | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTOT | | | | | 0.0 | | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| PRIMARY LINES | | | | | 18,455 | | 59.182 | 6.263 | 65.444 | 185,867 | 57,818 | 243,685 |
| SECONDARY LINES | | | | | 5,412 | | 2.867 | 0.000 | 2.867 | 15,055 | 0 | 15,055 |
| SERVICES | | | | | 11,684 | | 9.322 | 1.487 | 10.808 | 49,215 | 13,024 | 62,239 |
| TOTAL | | | | | 35,550 | | 71.371 | 7.750 | 79.120 | 250,137 | 70,845 | 320,982 |

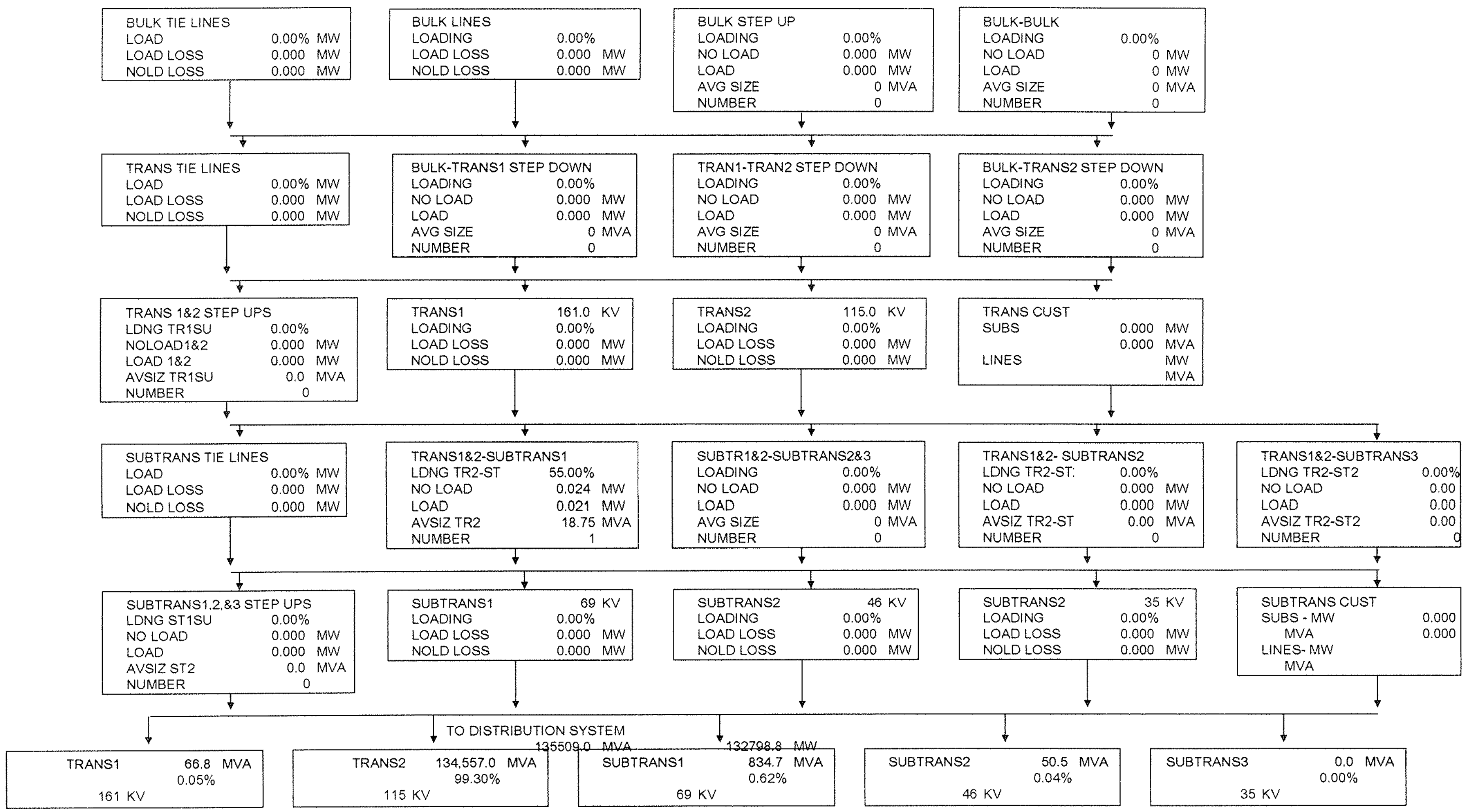
## SUMMARY OF TRANSFORMER INFORMATION

EXHIBIT 3

| DESCRIPTION | | KV CAPACITY VOLTAGE | 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 | | 345 | 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 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| BULK - TRANS2 | | 115 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS1 STEP-UP | | 161 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS1 - TRANS2 | | 115 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS1-SUBTRANS1 | | 69 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| 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 | | 115 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2-SUBTRANS1 | | 69 | 18.8 | 1 | 18.8 | 55.00% | 10 | 0.021 | 0.024 | 0.045 | 96 | 207 | 303 |
| TRANS2-SUBTRANS2 | | 46 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2-SUBTRANS3 | | 35 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| 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 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| 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 | 34 | 70.0 | 3 | 23.3 | 42.00% | 29 | 0.037 | 0.082 | 0.118 | 170 | 714 | 884 |
| TRANS1 - | 161 | 12 | 85.0 | 3 | 28.3 | 44.00% | 37 | 0.038 | 0.099 | 0.137 | 176 | 863 | 1,040 |
| TRANS1 - | 161 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 863 | 863 |
| TRANS2 - | 115 | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| TRANS2 - | 115 | 12 | 2,548.4 | 120 | 21.2 | 44.00% | 1,121 | 1.518 | 3.042 | 4.561 | 6,997 | 26,652 | 33,649 |
| TRANS2 - | 115 | 1 | 7.3 | 2 | 3.6 | 44.00% | 3 | 0.008 | 0.015 | 0.022 | 37 | 127 | 164 |
| SUBTRAN1- | 69 | 34 | 9.4 | 2 | 4.7 | 42.00% | 4 | 0.010 | 0.019 | 0.029 | 47 | 166 | 213 |
| SUBTRAN1- | 69 | 12 | 1,799.9 | 130 | 13.8 | 44.00% | 792 | 1.312 | 2.489 | 3.800 | 6,045 | 21,801 | 27,846 |
| SUBTRAN1- | 69 | 1 | 88.2 | 21 | 4.2 | 44.00% | 39 | 0.095 | 0.171 | 0.266 | 440 | 1,496 | 1,936 |
| SUBTRAN2- | 46 | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN2- | 46 | 12 | 39.6 | 4 | 9.9 | 44.00% | 17 | 0.029 | 0.051 | 0.080 | 132 | 446 | 578 |
| SUBTRAN2- | 46 | 1 | 75.2 | 8 | 9.4 | 44.00% | 33 | 0.067 | 0.119 | 0.186 | 308 | 1,044 | 1,352 |
| SUBTRAN3- | 35 | 34 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN3- | 35 | 12 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| SUBTRAN3- | 35 | 1 | 0.0 | 0 | 0.0 | 0.00% | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 |
| PRIMARY - PRIMARY | | | 174.1 | 41 | 4.2 | 44.00% | 77 | 0.187 | 0.334 | 0.521 | 863 | 2,925 | 3,788 |
| LINE TRANSFRMR | | | 7,815.8 | 201,430 | 38.8 | 23.35% | 1,825 | 5.925 | 25.791 | 31.716 | 13,551 | 225,927 | 239,478 |
| | | | =========== | =========== | =========== | =========== | | =========== | =========== | =========== | =========== | =========== | =========== |
| TOTAL | | | 12,732 | 201,765 | | | | 9.248 | 32.234 | 41.482 | 28,862 | 283,233 | 312,095 |

**SUMMARY OF LOSSES DIAGRAM - DEMAND MODEL - SYSTEM PEAK** 2661.351324 MW





# PACIFICORP OREGON 2003 LOSS ANALYSIS

FROM HIGH VOLTAGE SYSTEM

TOTAL 135,509 MVA 132,799 MW

| TRANS1 | TRANS2 | SUBTRANS1 | SUBTRANS2 | SUBTRANS3 |
|---|---|---|---|---|
| 66.8 MVA | 134,557.0 MVA | 834.7 MVA | 50.5 MVA | 0.0 MVA |
| 0.05% | 99.30% | 0.62% | 0.04% | 0.00% |
| 161 KV | 115 KV | 69 KV | 46 KV | 35 KV |

DISTRIBUTION SYSTEM LOAD

| | PRIM1 | PRIM2 | PRIM3 | PRIM1 | PRIM2 | PRIM3 | PRIM1 | PRIM2 | PRIM3 | PRIM1 | PRIM2 | PRIM3 | PRIM1 | PRIM2 | PRIM3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOLTAGE | 34 | 12 | 1 | 34 | 12 | 1 | 34 | 12 | 1 | 34 | 12 | 1 | 34 | 12 | 1 |
| LOAD MVA | 29 | 37 | 0 | 0 | 134,554 | 3 | 4 | 792 | 39 | 0 | 17 | 33 | 0 | 0 | 0 |
| % SYS TOT | 0.02% | 0.03% | 0.00% | 0.00% | 99.30% | 0.00% | 0.00% | 0.58% | 0.03% | 0.00% | 0.01% | 0.02% | 0.00% | 0.00% | 0.00% |
| NOLD LOSS | 0.082 | 0.099 | 0.000 | 0.000 | 3.042 | 0.015 | 0.019 | 2.489 | 0.171 | 0.000 | 0.051 | 0.119 | 0.000 | 0.000 | 0.000 |
| LOAD LOSS | 0.037 | 0.038 | 0.000 | 0.000 | 1.518 | 0.008 | 0.010 | 1.312 | 0.095 | 0.000 | 0.029 | 0.067 | 0.000 | 0.000 | 0.000 |
| AVG SIZE | 23.3 | 28.3 | 0.0 | 0.0 | 21.2 | 3.6 | 4.7 | 13.8 | 4.2 | 0.0 | 9.9 | 9.4 | 0.0 | 0.0 | 0.0 |
| NUMBER | 3 | 3 | 0 | 0 | 120 | 2 | 2 | 130 | 21 | 0 | 4 | 8 | 0 | 0 | 0 |
| DIVERSITY RATIO | 1.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.000 | 1.000 | 1.000 | 0.000 | 0.000 | 0.000 |

| PRIMARY LINES | | |
|---|---|---|
| LOADING | 2044.718 | MW |
| @ SYS PF | 2086.446 | MVA |
| LOAD LOSS | 59.182 | MW |
| NOLD LOSS | 6.263 | MW |
| TOT LOSS | 65.444 | MW |

| PRIM/PRIM TRANSF | | |
|---|---|---|
| LOADING | 76.607 | MW |
| NOLD LOSS | 0.334 | MW |
| LOAD LOSS | 0.187 | MW |
| AVG SIZE | 4.25 | |
| NUMBER | 41 | |

| 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 | 301.528 | MW |
| LINES | 317.398 | MVA |

| LINE TRANSFORMERS | | | | |
|---|---|---|---|---|
| LOADING | 1677.224 | MW | MVA | 1857.052 |
| NOLD LOSS | 25.791 | | MW | |
| LOAD LOSS | 5.925 | | MW | |
| AVG SIZE | 38.8 | | KVA | |
| NUMBER | 201430 | | | |

| SECONDARY LINES | | |
|---|---|---|
| LOAD | 590.576 | MW |
| LOAD LOSS | 2.867 | MW |
| NOLD LOSS | 0.000 | MW |
| TOT LOSS | 2.867 | MW |

| NO SECONDARY LINES | | |
|---|---|---|
| LOAD | 1054.932 | MW |

| SERVICES | | |
|---|---|---|
| LOAD | 1642.641 | MW |
| LOAD LOSS | 9.322 | MW |
| NOLD LOSS | 1.487 | MW |
| TOT LOSS | 10.808 | MW |

CUSTOMER SECONDARY LOAD

1631.832 MW

## SUMMARY of SALES and CALCULATED LOSSES

EXHIBIT 5

| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 3 TRANS1 XFMR | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 4 TRANS1 LINES | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 5 TRANS2TR1 SD | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 3 | 0 | 3 | 0.0000000 | 0.0000000 |
| TOTAL TRAN | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 3 | 0 | 3 | 0.0000000 | 0.0000000 |
| 8 STR1BLK SD | | | | | | | | | | | | |
| 9 STR1T1 SD | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 10 SRT1T2 SD | 10.1 | 0.02 | 0.02 | 0.04 | 1.004428 | 0.000000 | 62,945 | 207 | 96 | 303 | 1.0048435 | 0.0000000 |
| 11 SUBTRANS1 LINES | 10.1 | 0.00 | 0.00 | 0.00 | 1.000000 | 0.000000 | 62,945 | 0 | 0 | 0 | 1.0000000 | 0.0000000 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 14 STR2S1 SD | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 15 SUBTRANS2 LINES | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 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 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| 21 SUBTRANS TOTAL | 10.1 | 0.02 | 0.02 | 0.04 | 1.004428 | | 62,945 | 207 | 96 | 303 | 1.0048435 | |
| 22 TRANSMSN LOSS FAC | 2,661.4 | 18.33 | 102.95 | 121.28 | 1.047746 | 1.047746 | 16,718,140 | 161,437 | 448,716 | 610,153 | 1.0378789 | 1.0378789 |
| DISTRIBUTION SUBST | | | | | | | | | | | | |
| TRANS1 | 65.5 | 0.18 | 0.08 | 0.26 | 1.003913 | 0.000000 | 407,733 | 2,441 | 346 | 2,787 | 1.0068818 | 0.0000000 |
| TRANS2 | 1,098.9 | 3.06 | 1.53 | 4.58 | 1.004188 | 0.000000 | 6,863,587 | 26,779 | 7,034 | 33,813 | 1.0049509 | 0.0000000 |
| SUBTR1 | 818.0 | 2.68 | 1.42 | 4.10 | 1.005032 | 0.000000 | 5,094,839 | 23,464 | 6,531 | 29,995 | 1.0059223 | 0.0000000 |
| SUBTR2 | 49.5 | 0.17 | 0.10 | 0.27 | 1.005394 | 0.000000 | 308,223 | 1,490 | 439 | 1,930 | 1.0063003 | 0.0000000 |
| SUBTR3 | 0.0 | 0.00 | 0.00 | 0.00 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0.0000000 | 0.0000000 |
| WEIGHTED AVERAGE | 2,031.8 | 6.1 | 3.1 | 9.20 | 1.004548 | 1.052512 | 12,674,383 | 54,174 | 14,351 | 68,525 | 1.0054360 | 1.0435208 |
| PRIMARY INTRCHNGE | 14.5 | | | | 1.000000 | | 103,020 | | | | 1.0000000 | |
| PRIMARY LINES | 2,044.7 | 6.60 | 59.37 | 65.97 | 1.033337 | 1.087599 | 12,768,016 | 57,786 | 185,867 | 243,653 | 1.0194543 | 1.0638217 |
| LINE TRANSF | 1,677.2 | 25.79 | 5.93 | 31.72 | 1.019274 | 1.108562 | 10,616,800 | 225,927 | 13,551 | 239,478 | 1.0230771 | 1.0883716 |
| SECONDARY | 1,645.5 | 0.00 | 2.87 | 2.87 | 1.001745 | 1.110497 | 10,377,321 | 0 | 15,055 | 15,055 | 1.0014529 | 1.0899529 |
| SERVICES | 1,642.6 | 1.49 | 9.32 | 10.81 | 1.006624 | 1.117852 | 10,362,266 | 13,024 | 49,215 | 62,239 | 1.0060426 | 1.0965391 |
| | | =========== | =========== | =========== | | | | =========== | =========== | =========== | | |
| TOTAL SYSTEM | | 58.33 | 183.59 | 241.93 | | | | 512,768 | 726,949 | 1,239,716 | | |

PACIFICORP OREGON 2003 LOSS ANALYSIS

**DEVELOPMENT of LOSS FACTORS**
UNADJUSTED
DEMAND

EXHIBIT 6

| LOSS FACTOR LEVEL | CUSTOMER SALES MW a | CALC LOSS TO LEVEL b | SALES MW @ GEN c | CUM 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 | 489.1 | 23.4 | 512.5 | 1.04775 | 0.95443 |
| SUBTRANS SUBS | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| PRIM SUBS | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| PRIM LINES | 301.5 | 26.4 | 327.9 | 1.08760 | 0.91946 |
| SECONDARY | 1,631.8 | 192.3 | 1,824.1 | 1.11785 | 0.89457 |
| TOTALS | 2,422.5 | 242.1 | 2,664.6 | | |

DEVELOPMENT of LOSS FACTORS
UNADJUSTED
ENERGY

| LOSS FACTOR LEVEL | CUSTOMER SALES MWH a | CALC LOSS TO LEVEL b | SALES MWH @ GEN c | CUM 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 | 3,402,775 | 128,893 | 3,531,668 | 1.03788 | 0.96350 |
| SUBTRANS SUBS | 0 | 0 | 0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0 | 0 | 0 | 0.00000 | 0.00000 |
| PRIM SUBS | 0 | 0 | 0 | 0.00000 | 0.00000 |
| PRIM LINES | 1,907,564 | 121,744 | 2,029,308 | 1.06382 | 0.94001 |
| SECONDARY | 10,300,027 | 994,356 | 11,294,382 | 1.09654 | 0.91196 |
| TOTALS | 15,610,366 | 1,244,993 | 16,855,359 | | |

ESTIMATED VALUES AT GENERATION

| LOSS FACTOR AT VOLTAGE LEVEL | MW | MWH |
|---|---|---|
| BULK LINES | 0.00 | 0 |
| TRANS SUBS | 0.00 | 0 |
| TRANS LINES | 512.50 | 3,531,668 |
| SUBTRANS SUBS | 0.00 | 0 |
| SUBTRANS LINES | 0.00 | 0 |
| PRIM SUBS | 0.00 | 0 |
| PRIM LINES | 327.94 | 2,029,308 |
| SECONDARY | 1,824.15 | 11,294,382 |
| SUBTOTAL | 2,664.58 | 16,855,359 |
| ACTUAL ENERGY LESS THI | 2,661.35 | 16,718,140 |
| MISSMATCH | 3.23 | 137,219 |
| % MISSMATCH | 0.12% | 0.82% |

**Adjusted Losses and Loss Factors by Facitliy**

EXHIBIT 8

PACIFICORP OREGON 2003 LOSS ANALYSIS

**DEVELOPMENT of LOSS FACTORS**
ADJUSTED
DEMAND

EXHIBIT 7

| LOSS FACTOR LEVEL | CUSTOMER SALES MW a | SALES ADJUST b | CALC LOSS TO LEVEL c | SALES MW @ GEN d | CUM 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 | 489.1 | 0.0 | 23.4 | 512.5 | 1.04775 | 0.95443 |
| SUBTRANS SUBS | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| PRIM SUBS | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 | 0.00000 |
| PRIM LINES | 301.5 | 0.0 | 26.1 | 327.6 | 1.08658 | 0.92032 |
| SECONDARY | 1,631.8 | 0.0 | 189.4 | 1,821.2 | 1.11606 | 0.89601 |
| TOTALS | 2,422.5 | 0.0 | 238.9 | 2,661.4 | | |

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 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 | 3,402,775 | 0 | 128,893 | 3,531,668 | 1.03788 | 0.96350 |
| SUBTRANS SUBS | 0 | 0 | 0 | 0 | 0.00000 | 0.00000 |
| SUBTRANS LINES | 0 | 0 | 0 | 0 | 0.00000 | 0.00000 |
| PRIM SUBS | 0 | 0 | 0 | 0 | 0.00000 | 0.00000 |
| PRIM LINES | 1,907,564 | 0 | 111,508 | 2,019,072 | 1.05846 | 0.94477 |
| SECONDARY | 10,300,027 | 0 | 867,373 | 11,167,400 | 1.08421 | 0.92233 |
| TOTALS | 15,610,366 | 0 | 1,107,774 | 16,718,140 | | |

ESTIMATED VALUES AT GENERATION

| LOSS FACTOR AT VOLTAGE LEVEL | MW | MWH |
|---|---|---|
| BULK LINES | 0.00 | 0 |
| TRANS SUBS | 0.00 | 0 |
| TRANS LINES | 512.50 | 3,531,668 |
| SUBTRANS SUBS | 0.00 | 0 |
| SUBTRANS LINES | 0.00 | 0 |
| PRIM SUBS | 0.00 | 0 |
| PRIM LINES | 327.63 | 2,019,072 |
| SECONDARY | 1,821.22 | 11,167,400 |
| | 2,661.35 | 16,718,140 |
| ACTUAL ENERGY LESS THI | 2,661.35 | 16,718,140 |
| MISSMATCH | 0.00 | 0 |
| % MISSMATCH | 0.00% | 0.00% |

## Adjusted Losses and Loss Factors by Facitliy

EXHIBIT 8

### Unadjusted Losses by Segment

| | MW | MWH |
|---|---|---|
| Service Drop Losses | 10.83 | 62,822 |
| Secondary Losses | 2.87 | 15,196 |
| Line Transformer Losses | 31.78 | 241,721 |
| Primary Line Losses | 66.10 | 245,934 |
| Distribution Substation Losses | 9.22 | 69,167 |
| Transmission System Losses | 121.28 | 610,153 |
| Total | 242.08 | 1,244,993 |

### Mismatch Allocation by Segment

| | MW | MWH |
|---|---|---|
| Service Drop Losses | 0.29 | 13,579 |
| Secondary Losses | 0.08 | 3,285 |
| Line Transformer Losses | 0.85 | 52,247 |
| Primary Line Losses | 1.77 | 53,158 |
| Distribution Substation Losses | 0.25 | 14,950 |
| Transmission System Losses | 0.00 | 0 |
| Total | 3.23 | 137,219 |

### Adjusted Losses by Segment

| | MW | MWH |
|---|---|---|
| Service Drop Losses | 10.54082 | 49,243 |
| Secondary Losses | 2.79614 | 11,912 |
| Line Transformer Losses | 30.93061 | 189,474 |
| Primary Line Losses | 64.33214 | 192,776 |
| Distribution Substation Losses | 8.97202 | 54,217 |
| Transmission System Losses | 121.27877 | 610,153 |
| Total | 238.85050 | 1,107,774 |

### Loss Factors by Segment

| | | |
|---|---|---|
| Retail Sales from Service Drops | 1631.83 | 10,300,027 |
| Adjusted Service Drop Losses | 10.54 | 49,243 |
| Input to Service Drops | 1642.37 | 10,349,270 |
| **Service Drop Loss Factor** | **1.00646** | **1.00478** |
| | | |
| Output from Secondary | 1642.37 | 10,349,270 |
| Adjusted Secondary Losses | 2.80 | 11,912 |
| Input to Secondary | 1645.17 | 10,361,182 |
| **Secondary Loss Factor** | **1.00170** | **1.00115** |
| | | |
| Output from Line Transformers | 1645.17 | 10,361,182 |
| Adjusted Line Transformer Losses | 30.93 | 189,474 |
| Input to Line Transformers | 1676.10 | 10,550,655 |
| **Line Transformer Loss Factor** | **1.01880** | **1.01829** |
| | | |
| Retail Sales from Primary | 301.53 | 1,907,564 |
| Req. Whls Sales from Primary | 0.00 | 0 |
| Input to Line Transformers | 1676.10 | 10,550,655 |
| Output from Primary Lines | 1977.63 | 12,458,219 |
| Adjusted Primary Line Losses | 64.33 | 192,776 |
| Input to Primary Lines | 2041.96 | 12,650,995 |
| **Primary Line Loss Factor** | **1.03253** | **1.01547** |
| | | |
| Output from Distribution Substations | 2041.96 | 12,650,995 |
| Adjusted Distribution Substation Losses | 8.97202 | 54,217 |
| Input to Distribution Substations | 2050.93 | 12,705,212 |
| **Distribution Substation Loss Factor** | **1.00439** | **1.00429** |
| | | |
| Retail Sales at from Transmission | 119.106 | 753,505 |
| Req. Whls Sales from Transmission | 67.73 | 70,195 |
| Non-Req. Whls Sales from Transmission | 302.309 | 2,579,075 |
| Third Party Wheeling Losses | 0.000 | 0 |
| Input to Distribution Substations | 2050.93 | 12,705,212 |
| Output from Transmission | 2,540.073 | 16,107,987 |
| Adjusted Transmission System Losses | 121.27877 | 610,153 |
| Input to Transmission | 2,661.351 | 16,718,140 |
| **Transmission System Loss Factor** | **1.04775** | **1.03788** |

# Appendix C

# Discussion of Hoebel Coefficient

## COMMENTS ON HOEBEL COEFFICIENTS

The Hoebel constant 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:

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

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:

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

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:

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

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:

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

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.