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Optimization of Distribution
Transformer Efficiency Characteristics

Final Report

APPROVALS

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Optimization of Distribution
Transformer Efficiency Characteristics
Final Report

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Optimization of Distribution
Transformer Efficiency Characteristics

Final Report

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Efficiency Characteristics

Final Report

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2. EXECUTIVE SUMMARY

A method for distribution transformer loss evaluation was derived. The total levelized annual cost method was used and was extended to account properly for conditions of energy cost inflation, peak load growth, and transformer changeout during the evaluation period. The loss costs included were the no-load and load power losses, no-load and load reactive losses, and the energy cost of regulation. The demand and energy components of loss costs were treated separately to account correctly for the diversity of load losses and energy cost inflation. The complete distribution transformer loss evaluation equation is shown in Table 3-1.2, with the nomenclature and definitions for the parameters provided in Table 3-1.1.

It is recommended that the regulation demand savings not be included in the evaluation of distribution transformer losses. It is also suggested that an adequate loss evaluation be obtained by ignoring no-load and load reactive losses and energy regulation losses. These loss costs are small compared to the total transformer cost, and their elimination results in a simplified transformer loss evaluation equation consisting of only the investment and power loss costs.

A range of system cost parameters for use in the distribution transformer loss evaluation equation was derived for alternative types of base-load and peaking generation plants. It is emphasized that a discount factor for system investment should be included to account correctly for the amount of incremental system capacity required for a given increment of loss. In situations where specific utility data is not available, it is suggested that the system cost parameters, as summarized in Table 3-2.13, are representative of 1980 costs for investor-owned utilities and can be used.

The derived parameters are applicable only to investor-owned utilities with generation and transmission facilities. No consideration was given to the components of carrying charge rate for publicly-owned

utilities nor to the cost parameters for utilities which purchase their total power requirements.

Transformer load characteristics vary as a function of the transformer size (load) or the number of customers served by the transformer. Representative distribution transformer load characteristics, as a function of the number of customers served by the transformer, have been developed and are summarized in Table 3-3.1. These load characteristics are representative of residential loads and can be used for distribution transformer loss evaluations in situations where specific utility data is not available.

Peak loss diversity is properly accounted for by applying a peak responsibility factor in the demand component of load loss costs. This considers the peak loss at the time of the system peak rather than the transformer peak. The energy cost component includes the effect of diversity of load losses by using the loss factor applicable to the actual transformer load rather than the system or distribution system loss factor.

This work is being reported to the industry in two technical papers by D. L. Nickel and H. R. Braunstein. The papers have been approved for presentation at the 1980 IEEE PES Winter Meeting in New York, New York on February 3-8, 1980, and recommended for full publication in the IEEE Transactions on Power Apparatus and Systems, entitled: "Distribution Transformer Loss Evaluation: Part I - Proposed Techniques," and "Part II - Load Characteristics and System Cost Parameters."

The loss evaluation equations were modified to evaluate the losses of a multiple efficiency transformer which would be capable of switching into a more efficient, low-capacity mode during off peak hours. The evaluation procedure developed for the multiple efficiency transformer, although more complicated, is equivalent to the single efficiency evaluation.

An analysis was performed to find what level of transformer loss yields the minimum total levelized annual cost for a given kVA rating and a given set of load and cost parameters. In order to do this, initial transformer costs as a function of no-load loss, load loss, and kVA were generated and used in the evaluation.

Both single and multiple efficiency designs were considered. The total levelized annual costs of the two designs were compared. In each case the multiple efficiency design was less costly. However, the cost of the switch used to change modes of the multiple efficiency transformer was not considered.

In the final task of this project, a sensitivity analysis was performed to find the change in total levelized annual cost due to changes in the input parameters. Also, an analysis was conducted to determine the amount of energy required to produce the materials for distribution transformers. Generally, in order to manufacture a more efficient transformer, more materials must be used. These materials have a certain energy content--that is, a certain amount of energy required to manufacture the materials.

It was determined that the energy content of the extra materials used to produce a higher efficiency transformer was less than the amount of energy saved in operating costs. Therefore, from a total energy standpoint, it is worth using the extra energy to manufacture a more efficient transformer.

Recommendations for distribution transformer efficiency characteristics and recommendations for further investigation are included in the final task of this project.

3.1 TASK 1 - ESTABLISH LOSS EVALUATION TECHNIQUES

INTRODUCTION

This task is directed toward the analysis of alternative methods for the evaluation of distribution transformers and the selection of the most applicable loss evaluation technique. This task was performed by the Transmission and Distribution Systems Engineering Department of Westinghouse Electric Corporation located in East Pittsburgh, PA.

EXISTING LOSS EVALUATION TECHNIQUES

A literature search to identify existing industry loss evaluation techniques has been completed. The sources used for the literature search included major trade journals of the electrical industry (Electrical World, Transmission & Distribution, and Electric Light & Power), national technical conference proceedings (IEEE PES, IEEE IAS, and IEEE T&D Conference meetings), and regional technical conference papers (e.g., Southeastern Electric Exchange, Power Distribution Conference, Southwest Electric Distribution Exchange, Pacific Coast Electrical Association, Pennsylvania Electric Association, Rocky Mountain Electric League, and North East Underground Committee). Additionally, a limited number of utility company documents were reviewed. A bibliography of pertinent papers and articles pertaining to loss evaluation procedures is included in this report.

A review of the papers and articles indicates that most distribution transformer loss evaluation procedures proposed, or in use, are very similar in nature. The major differences are in the completeness of the evaluation procedure. For example, some choose to ignore the cost of reactive and/or regulation losses.

Methods of Economic Analysis

Another major difference is in the method of economic analysis used for the evaluation. Four economic analysis methods are in general use:

1. Present worth of annual revenue requirements
2. Levelized annual cost
3. Annual cost
4. Equivalent investment cost

For most distribution transformer applications, the load on the transformer changes over the life of the unit, and is dependent on the rate of load growth. The present worth of annual revenue requirements is the proper method of evaluating economic alternatives in load growth situations. The method of transformer loss evaluation suggested in the 1963 EEI Task Force Report⁽¹⁾ is based on the total levelized annual cost. It will be shown later in this section that the EEI total levelized annual cost method is equivalent to the present worth of annual revenue requirements under conditions of load growth, but no inflation.

Evaluations based on annual costs and equivalent investment costs (or capitalized costs) yield the same results when load growth is not considered. For the equivalent investment cost approach, it is necessary to divide the energy cost component of losses by the carrying charge rate. This converts the energy cost from an annual cost (\$/kW-year) to an investment cost (\$/kW), which can then be added directly to the demand cost component of losses and the transformer cost. Conversely for the annual cost approach, it is necessary to multiply the demand cost component of losses and the transformer cost by the carrying charge rate. This converts these costs from an investment cost to an annual cost, which can then be added directly to the energy cost component of losses to obtain a total annual cost.

Some of the earlier work^(2,3,4) on deriving equations for evaluating transformer losses occurred in the 1958-1961 period and was based on an

annual cost approach. An annual cost was used because these studies were directed to the determination of economic transformer loading. The economic transformer changeout load is determined by comparing the annual costs of two alternative transformer ratings. Other papers^(5,6,7) proposed the evaluation of transformer losses as a part of comparing different transformer designs. Load growth was included in the evaluation, so a present worth analysis was used. The 1963 EEI Task Force⁽¹⁾ then expanded on these efforts by deriving an expression for the equivalent annual peak transformer load such that the levelized annual cost method could be used.

Published papers and articles indicate that most utilities have since followed the EEI method using levelized annual costs. However, details are lacking with regard to the calculation of the transformer peak load used in the evaluation. The EEI procedure for calculating the equivalent annual peak load appears very cumbersome. However, there is a simple closed-form equation for the calculation of the equivalent annual peak load which would undoubtedly make its use more widespread. Shincovich⁽⁸⁾ includes the simplified expression, but unfortunately includes a parameter for inflation rate, without an explanation of the proper system cost values to be used in the levelized annual cost equation. Other published reports^(9,10,11,12) also discuss the effect of system cost inflation on transformer loss evaluation results. The proper treatment of inflation will be covered later in this section.

It is important to note that, although the existing loss evaluation procedures are quite similar, there are major differences in the definitions and values of the system cost and load parameters used in the procedures. A discussion of the differences in the methods used for each of the distribution transformer loss components follows. The losses in a distribution transformer are power losses (both no-load and load loss), reactive losses (no-load and load loss) and regulation losses.

Cost of No-Load Power Losses

It appears that the vast majority of the evaluations separate the demand and energy cost components of no-load losses. One exception was found, ⁽¹³⁾ where a commercial rate, in \$/kWh, was used. It was indicated this commercial rate included a demand and energy charge.

The major difference of opinion in the calculation of no-load loss costs concerns the use of a discount factor for system investment. The question relates to the amount of incremental system capacity required for a given increment of loss. The discount factor does not specifically appear in the EEI evaluation procedure ^(1,8). However, some of the other references ^(9,10,11) indicate discount factor is accounted for in the determination of the system investment cost used in the evaluation.

Cost of Load Power Losses

As in the case of the no-load loss costs, many evaluations do not include discount factor on system investment when calculating load loss costs. The vast majority of the evaluations separate the demand and energy cost components of load losses.

There is a major difference of opinion, and a certain amount of confusion, concerning the diversity of load losses. Some evaluations do not include diversity in the demand component of load loss costs. Since the peak loss occurs at peak load on the transformer, this may or may not be at the same time that the total load, and thus the generation is at its maximum value. This peak loss diversity is accounted for by applying the peak responsibility factor (the ratio of transformer load at the time of system peak to the actual transformer peak load) to the transformer peak load prior to squaring the load ^(9,10,11). Rather than square the peak responsibility factor in the load loss cost formula, the

EEI method^(1,8) uses a parameter called loss coincidence factor, which is the square of the peak responsibility factor. This difference in approach may account for some procedures⁽¹²⁾ applying the peak responsibility factor incorrectly.

One method⁽²⁰⁾ attempts to incorporate the effect of winding temperature on the transformer load losses. However, a valid correction factor would require the annual winding temperature cycle and should recognize that the eddy current loss actually decreases with increased temperature as well as the fact that part of the load loss occurs in the high voltage winding and part in the low voltage winding, which may be at quite different temperatures. Another method⁽²¹⁾ attempts to include an evaluation of transformer loss of life, although it is shown to be insignificant.

Cost of Reactive Losses

The cost of load and no-load reactive losses are extremely small (less than one percent) compared to the total transformer investment and power loss costs and are sometimes ignored in distribution transformer loss evaluations and economic changeout studies⁽¹⁴⁾. When reactive loss costs are considered, similar differences exist in the application of the distribution system peak responsibility factor (the ratio of transformer load at the time of feeder peak to the transformer peak load) in the reactive load loss cost equation, as was the case with the load power loss cost calculation.

Cost of Regulation Losses

The evaluation of regulation, or voltage drop in the transformer, has always been an area of controversy. The EEI Task Force Report⁽¹⁾ in 1963, was intended as a uniform method for the industry to use in transformer loss evaluations. This report was never officially published,

primarily because the Task Force could not resolve the question of how to properly evaluate voltage regulation. The EEI method, unlike others, also accounted for the savings resulting from system demand reduction caused by reduced voltage. It is this factor that has created skepticism among the utilities, since it is possible to get a negative value for the cost of regulation. A new EEI Transformer Evaluation Task Force, organized in August 1977, has concluded that the true cost of regulation is the cost of the voltage regulating equipment itself; that is, voltage regulators, capacitors and load tap changing (LTC) equipment,⁽⁸⁾ and it appears the demand savings are not included in the loss evaluation, whereas the energy cost of regulation, or lost revenue due to reduction in energy minus the utility's cost of this energy, is still under study.

One method⁽¹¹⁾ uses an approximate, although adequate, formula for the per unit voltage regulation (voltage drop) of the transformer, which is supplied by the manufacturer:

$$\text{REG} = R \cos \theta + X \sin \theta + \frac{(X \cos \theta - R \sin \theta)^2}{200}$$

The EEI formula for regulation is even more approximate, but still adequate:

$$\text{REG} = R \cos \theta + X \sin \theta$$

SELECTION OF LOSS EVALUATION TECHNIQUE

The total annual cost equation for a distribution transformer, considering investment plus all loss costs, can be written in simplified form as follows⁽¹¹⁾:

$$\text{AC} = \text{TIC} + \text{NLC} + \text{NRC} + \text{LLC} + \text{LRC} + \text{RGC}$$

where:

- AC = total annual transformer cost, \$/year
- TIC = annual cost of transformer investment, \$/year
- NLC = annual no-load loss cost, \$/year

NRC = annual reactive no-load loss cost, \$/year
 LLC = annual load loss cost, \$/year
 LRC = annual reactive load loss cost, \$/year
 RGC = annual regulation loss cost, \$/year

Selection of Method of Economic Analysis

It should be recognized that the load on distribution transformers changes over the life of the unit, and is dependent on the rate of load growth. Since the loads are different each year, the load losses, and therefore, the cost of load losses, are different each year. The present worth of annual revenue requirements is the proper method of evaluating economic alternatives in load growth situations.

The method of transformer loss evaluation suggested in the 1963 EEI Task Force Report⁽¹⁾ is based on "the total levelized annual cost", defined as the sum of the levelized annual fixed charges on the purchase price and the levelized annual cost of losses. This method uses an "equivalent transformer annual peak load", (PEQ). PEQ is the uniform value of annual peak load on the transformer that would result in an annual cost of load losses equal to the "levelized" annual cost of the load losses that will actually result from the non-uniform series of annual peak loads expected over the life of the transformer. This equivalent annual peak load is calculated as follows:

$$(PEQ)^2 = \frac{\left[\sum_{Y=1}^N P(Y)^2 \times SPPWF(I, Y) \right]}{USPWF(I, N)}$$

where:

PEQ = equivalent transformer annual peak load, p.u.
 P(Y) = transformer annual peak load in year (Y), p.u.

N = expected transformer life, years (or number of years to transformer changeout)
 $SPPWF(I,Y)$ = single payment present worth factor for annual return rate (I) and year (Y), assuming end of year values.
 $USPWF(I,N)$ = uniform annual series present worth factor for annual return rate (I) and (N) years, assuming end of year values.
 $USCRF(I,N)$ = uniform annual series capital recovery factor for annual return rate (I) and (N) years, assuming end of year values.

$$SPPWF(I,Y) = \frac{1}{(1+I)^Y}$$

$$USPWF(I,N) = \frac{(1+I)^N - 1}{I(1+I)^N} = \frac{1}{USCRF(I,N)}$$

It will now be shown that the EEI total levelized annual cost method yields the same results as the present worth of annual revenue requirements method under conditions of load growth, but with no cost inflation.

The annual cost of transformer investment (TIC) is the transformer cost times the levelized annual carrying charge rate and is constant each year of the evaluation.

Since no-load (power and reactive) losses are independent of transformer loading, they are constant over the life of the transformer. With no inflation, the cost of these no-load losses are also constant. Therefore, these two terms can be combined:

$$K = NLC + NRC$$

Further, the load (power and reactive) losses and regulation losses are each a function of the peak load squared. However, the cost of these losses can be calculated at rated load:

$$K1 = LLC(\text{rated}) + LRC(\text{rated}) + RGC(\text{rated})$$

Then, for a given year (Y), assuming no inflation, the cost of the load and regulation losses are:

$$K1 \times P(Y)^2 = LLC(Y) + LRC(Y) + RGC(Y)$$

The annual transformer cost for each year of the transformer's life (or to transformer changeout) is:

$$\begin{aligned} AC(1) &= TIC + K + K1 \times P(1)^2 \\ AC(2) &= TIC + K + K1 \times P(2)^2 \\ AC(3) &= TIC + K + K1 \times P(3)^2 \\ &\cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \\ AC(N) &= TIC + K + K1 \times P(N)^2 \end{aligned}$$

The present worth of annual revenue requirements (PWARR) is:

$$PWARR = TIC \times USPWF(I,N) + K \times USPWF(I,N)$$

$$+ K1 \left[P(1)^2 \times SPPWF(I,1) + P(2)^2 \times SPPWF(I,2) + \dots + P(N)^2 \times SPPWF(I,N) \right]$$

The present worth of annual revenue requirements (PWARR) is converted back to a total levelized annual cost (TLAC) by multiplying by the uniform annual series capital recovery factor (USCRF(I,N)). But,

$$\text{USCRF}(I,N) = \frac{1}{\text{USPWF}(I,N)}$$

Then, the total levelized annual cost is:

$$\text{TLAC} = \frac{\text{PWARR}}{\text{USPWF}(I,N)}$$

$$\text{TLAC} = \text{TIC} + K + K1 \left[\frac{P(1)^2 \times \text{SPPWF}(I,1) + P(2)^2 \times \text{SPPWF}(I,2) + \dots + P(N)^2 \times \text{SPPWF}(I,N)}{\text{USPWF}(I,N)} \right]$$

Therefore,

$$\text{TLAC} = \text{TIC} + K + K1 \times (\text{PEQ})^2$$

Therefore, the "total levelized annual cost" method and the "present worth of annual revenue requirements" methods of evaluation are equivalent under conditions of load growth, but with no cost inflation. Following the derivation of the transformer equivalent annual peak load, which is required for the total levelized annual cost method, the methods will be extended to properly account for inflation and transformer changeout during the evaluation period.

Transformer Equivalent Annual Peak Load

A simplified expression for the transformer equivalent annual peak load can be derived. The derivation will first be shown for the condition of load growth, but without cost inflation. It will then be extended to properly account for inflation, and then further generalized to permit a transformer changeout during the evaluation period.

Equivalent Annual Peak Load (No Inflation)

The basic expression for the equivalent annual peak load is:

$$(\text{PEQO})^2 = \left[\sum_{Y=1}^N P(Y)^2 \times \text{SPPWF}(I, Y) \right] \frac{1}{\text{USPWF}(I, N)}$$

where:

$$P(Y) = IP (1 + GR)^{Y-1} \quad \text{and}$$

IP = initial transformer annual peak load, p.u.

GR = levelized annual compound peak load growth rate, p.u.

Then,

$$(\text{PEQO})^2 = \left[\frac{(IP)^2}{(1+I)} + \frac{(IP)^2(1+GR)^2}{(1+I)^2} + \frac{(IP)^2(1+GR)^4}{(1+I)^3} + \dots + \frac{(IP)^2(1+GR)^{2(N-1)}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

The terms in the first bracket are a geometric progression of the form

$$a, ar, ar^2, ar^3, \dots, ar^{N-1}$$

where,

$$a = \frac{(IP)^2}{(1+I)}, \quad r = \frac{(1+GR)^2}{(1+I)}, \quad \text{and the sum } S_N = a \left(\frac{r^N - 1}{r - 1} \right)$$

then,

$$(\text{PEQO})^2 = \frac{(IP)^2}{(1+I)} \left[\frac{\frac{(1+GR)^{2N}}{(1+I)^N} - 1}{\frac{(1+GR)^2}{(1+I)} - 1} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

$$(\text{PEQO})^2 = \frac{(IP)^2}{(1+I)} \left[\frac{(1+GR)^{2N} - (1+I)^N}{(1+I)^N} \right] \left[\frac{(1+I)}{(1+GR)^2 - (1+I)} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

This can be reduced to the following:

$$(PEQO)^2 = (IP)^2 \left[\frac{(1+GR)^{2N} - (1+I)^N}{(1+GR)^2 - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

It should be emphasized that this expression for $(PEQO)^2$ can be applied in the total levelized annual cost equation only if there is no inflation. It should also be noted that if $(1+GR)^2 = (1+I)$, the denominator is zero. In this case:

$$(PEQO)^2 = \frac{N \times (IP)^2}{(1+I)} \left[\frac{I (1+I)^N}{(1+I)^N - 1} \right]$$

Equivalent Annual Peak Load (With Inflation)

The above expression for $(PEQO)^2$ can be extended to properly account for inflation of system cost parameters. Inflation must be included in the system investment cost to properly relate the investment to the time of the capital expenditure. However, once an investment is made, the cost of the capital expenditure will not change. As a result, the investment is not subject to inflation and escalation after the investment is made. However, energy costs (fuel plus O&M) are subject to inflation throughout the period of analysis.

Therefore, the following expression derived for the equivalent annual peak load with inflation $(PEQE)^2$ is applied only to the energy cost component of the load losses and regulation losses in the total levelized annual cost equation. Assuming an annual compound inflation rate (IRP) of the energy cost at peak, the basic expression for the equivalent annual peak load becomes:

$$(PEQE)^2 = \left[\sum_{Y=1}^N \frac{(IP)^2 (1+IRP)^{Y-1} (1+GR)^{2(Y-1)}}{(1+I)^Y} \right] \frac{1}{USPWF(I,N)}$$

The series expression is again a geometric progression

$$\text{where, } a = \frac{(IP)^2}{(1+I)}, \quad r = \frac{(1+IRP)(1+GR)^2}{(1+I)}$$

The generalized expression for the equivalent annual peak load with inflation then becomes:

$$(PEQE)^2 = (IP)^2 \left[\frac{(1+IRP)^N (1+GR)^{2N} - (1+I)^N}{(1+IRP)(1+GR)^2 - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

It should be noted that the above equations are valid only where the transformer is assumed to be installed in one location with an initial peak load (IP), and has an annual peak load growth rate (GR) throughout the entire period of evaluation. Again note that if $(1+IRP) \times (1+GR)^2 = (1+I)$, the expression becomes:

$$(PEQE)^2 = \frac{N \times (IP)^2}{(1+I)} \left[\frac{I (1+I)^N}{(1+I)^N - 1} \right]$$

It is again emphasized that this expression for the equivalent annual peak load $(PEQE)^2$ is applied only to the energy cost components of the load losses and regulation losses. The expression $(PEQO)^2$ with no inflation derived previously is applied to the demand cost component of the load losses.

Equivalent Annual Peak Load (With Inflation and Changeout)

If the load growth is such that the transformer reaches the given changeout load prior to the end of the evaluation period and is assumed re-installed at another location and cost inflation is also considered, the expression for the equivalent annual peak load must be derived in two parts; (1) from the first year of the evaluation period to the year of transformer changeout, and (2) from the year following changeout to the end of the evaluation period. Again, two equivalent annual peak

loads are required; (1) with no inflation-(PEQO)² is applied to the demand cost component of load losses, and (2) with inflation - (PEQE)² is applied to the energy cost component of load losses and regulation losses.

With one transformer changeout in year (NC) and no inflation, the basic expression for the equivalent annual peak load is:

$$(PEQO)^2 = \left\{ \sum_{Y=1}^{NC} \frac{(IP)^2 (1+GR)^{2(Y-1)}}{(1+I)^Y} \right\} + \left\{ \sum_{Y=1}^{N-NC} \frac{(IP)^2 (1+GR)^{2(Y-1)}}{(1+I)^{Y+NC}} \right\} \frac{1}{USPWF(I, N)}$$

Each series expression is a geometric progression with

$$\begin{aligned} a_1 &= \frac{(IP)^2}{(1+I)} , & r_1 &= \frac{(1+GR)^2}{(1+I)} \\ a_2 &= \frac{(IP)^2}{(1+I)^{NC+1}} & r_2 &= \frac{(1+GR)^2}{(1+I)} \end{aligned}$$

Following the procedure as before, the generalized expression for the equivalent annual peak load, with one changeout in year (NC) and no inflation, becomes:

$$(PEQO)^2 = \left[\frac{(IP)^2}{(1+GR)^2 - (1+I)} \right] \left[\frac{(1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC}} + \frac{(1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

With one transformer changeout in year (NC) and with inflation (IRP) of the energy cost at peak, the basic expression for the equivalent annual peak load is:

$$(PEQE)^2 = \left\{ \sum_{Y=1}^{NC} \frac{(IP)^2 (1+IRP)^{Y-1} (1+GR)^{2(Y-1)}}{(1+I)^Y} \right\} + \left\{ \sum_{Y=1}^{N-NC} \frac{(IP)^2 (1+IRP)^{Y+NC-1} (1+GR)^{2(Y-1)}}{(1+I)^{Y+NC}} \right\} \frac{1}{USPWF(I, N)}$$

Each series expression is a geometric progression with

$$a_1 = \frac{(IP)^2}{(1+I)}, \quad r_1 = \frac{(1+IRP)(1+GR)^2}{(1+I)}$$

$$a_2 = \frac{(IP)^2(1+IRP)^{NC}}{(1+I)^{NC+1}}, \quad r_2 = \frac{(1+IRP)(1+GR)^2}{(1+I)}$$

Following the preceding procedure, the generalized expression for the equivalent annual peak load, with one changeout in year (NC) and with inflation of the energy cost at peak, becomes:

$$(PEQE)^2 = \left[\frac{(IP)^2(1+IRP)^{NC}}{(1+IRP)(1+GR)^2 - (1+I)} \right] \left[\frac{(1+IRP)^{NC}(1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC}(1+IRP)^{NC}} + \frac{(1+IRP)^{N-NC}(1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)}{(1+I)^N} \right]$$

In summary, $(PEQO)^2$ is applied to the demand cost component of load losses and $(PEQE)^2$ is applied to the energy cost component of load losses and regulation losses.

Equivalent Annual Peak Load (Linear Growth Rate)

The previous derivations of the equivalent annual peak load assumed a compound annual peak load growth rate. If the load growth rate is linear, an alternative equation for the equivalent annual peak load must be used. As before,

$$(PEQ)^2 = \left[\sum_{Y=1}^N P(Y)^2 \times SPPWF(I, Y) \right] \frac{1}{USPWF(I, N)}$$

But, in this case

$$P(Y) = IP (1 + (Y-1) \times GR)$$

and

$$P(Y)^2 = (IP)^2 (1 + (Y-1) \times GR)^2$$

When $P(Y)^2$ in this form is substituted into the above equation for $(PEQ)^2$, a closed form solution using difference equations ⁽²²⁾ can be derived. However, the expression is not as simplified as in the case of compound growth rate, so the year-by-year summation is recommended.

Verification of Total Levelized Annual Cost Method

It now remains to be shown that the total levelized annual cost method of transformer evaluation is equivalent to the present worth of annual revenue requirements, under conditions of load growth, cost inflation and transformer changeout. It will be shown later in the discussion and establishment of each cost component that the transformer operating costs include those associated with no-load losses, load losses, reactive losses and energy regulation losses. However, for ease of explanation, the derivation of the total levelized annual cost equation will not include the reactive loss and energy regulation loss costs. It will be evident that (1) the reactive no-load loss costs are treated the same as the demand cost component of no-load losses, (2) the reactive load loss costs are treated the same as the demand cost component of load losses, and (3) the energy cost of regulation losses are treated the same as the energy cost component of load losses.

The step-by-step derivation of the total levelized annual cost (TLAC) equation is given in Appendix 3.1. The nomenclature for the parameters used in the derivation is listed in Table 3-1.1.

With reference to Appendix 3.1, the first step in the derivation is to develop the annual cost (AC) for each year (1 to N) of the evaluation period. Intermediate year values are given to illustrate that the year following transformer changeout, the transformer is re-installed at another location with the transformer peak load in year (NC+1) equal to the initial peak (IP) assumed in year (1).

It can be seen that the energy cost component of no-load losses is inflated each year by applying the inflation rate (IRB) to the incremental energy cost for base-load generation (CEB1). Similarly, the energy cost component of load losses is inflated each year by applying the inflation rate (IRP) to the incremental energy cost for peak generation (CEP1). If the fuel and O&M components of the energy cost inflate at different rates, the precise equation for the incremental cost of energy for base-load generation in any year (Y) is:

$$CEB(Y) = CEB1(1+IRB)^{Y-1} = CEBF1(1+IRBF)^{Y-1} + CEBOM1 (1+IRBOM)^{Y-1}$$

As shown in Appendix 3.1, the second step in the derivation is to determine the present worth of annual revenue requirements (PWARR), which is the sum of the present worth of the annual costs from year (1) to year (N). The third step converts the present worth of annual revenue requirements (PWARR) to the total levelized annual cost (TLAC) by dividing by the uniform annual series present worth factor for (N) years, USPWF(I,N). It can be seen that the three summations from the PWARR equation, when divided by the uniform annual series present worth factor (USPWF(I,N)), reduce to expressions for the levelized value of the incremental energy for base-load generation (CEBL) and the equivalent annual peak loads squared, $(PEQE)^2$ and $(PEQO)^2$, with and without peak energy cost inflation, respectively.

It should be noted that with the first year value for the incremental energy cost for peak generation (CEP1) outside the summation, only one inflation rate (IRP) is used in the summation. If the fuel and O&M components of the energy cost inflate at different rates, the precise equation for the incremental energy cost for peak generation in any year (Y) is:

$$CEP(Y) = CEP1(1+IRP)^{Y-1} = CEPF1(1+IRPF)^{Y-1} + CEBOM1 (1+IRPOM)^{Y-1}$$

However, this precise treatment of inflation cannot be handled mathematically in the closed form solution for the equivalent annual peak load (PEQE)² developed previously.

The final equation for the total levelized annual cost can now be extended to include reactive loss and energy regulation costs as discussed previously. The complete total levelized annual cost equation is shown in Table 3-1.2. The energy regulation loss cost portion of the equation assumes that the average sale price of energy (CCE1) and the average cost of energy (CE1) inflate at the same rate (IRP) as the incremental cost of energy at peak (CEP1), which permits the use of the equivalent annual peak load, (PEQE)², with energy inflation. If the inflation rates are different, an additional equivalent annual peak load must be developed for the energy regulation loss cost component.

Having established the "total levelized annual cost" method for distribution transformer loss evaluation under conditions of both inflation and load growth, each cost component of the loss evaluation equation will be discussed and established. The nomenclature for the parameters used in the loss evaluation procedure is listed in Table 3-1.1.

Annual Cost of Transformer Investment

It is necessary to convert the transformer cost from an investment cost to an annual cost, which can then be added directly to the annual cost of losses. This is done by multiplying the transformer cost by the levelized annual carrying charge rate.

$$TIC = CT \times CC$$

Annual No-Load Loss Cost

No-load losses are essentially constant throughout the year and should be considered to be usually supplied by base-load generation. Both the demand and energy costs of no-load losses should, therefore, be based on the investment and energy costs of these units.

The EPRI Technical Assessment Guide ⁽¹⁵⁾ suggests that a change in losses will not affect the timing of new facilities, but may affect the size. On this basis, a discount factor for system investment should be used to account for the incremental system capacity required for a given increment of loss.

Demand Component:

$$NLC(D) = NLL \times CSYSB \times DISC \times CC$$

When inflation of the system cost parameters is included in the analysis, the incremental energy cost for base-load generation must be a levelized value.

Energy Component:

$$NLC(E) = NLL \times 8760 \times CEBL$$

The total levelized annual cost of no-load losses is the sum of the demand and energy components of the no-load loss costs.

$$NLC = NLC(D) + NLC(E)$$

Annual Load Loss Cost

Since a high percentage of the load losses occur predominantly at the peak periods of the load cycle, the demand and energy costs of load losses should be based on the investment and energy cost of peaking capacity. As in the case of the no-load loss costs, a discount factor for system investment should be used for load loss costs.

The demand and energy cost components must be treated separately to correctly account for the diversity of losses.⁽¹⁶⁾ The demand component includes the effect of diversity of load losses by considering the peak loss at the time of the system peak rather than the transformer peak. This is done by applying the system peak responsibility factor to the transformer peak load prior to squaring the load. The equivalent peak load includes no inflation.

Demand Component:

$$LLC(D) = LL \times (PEQO \times PRFS)^2 \times CSYSP \times DISC \times CC$$

The energy cost component includes the effect of diversity of load losses by using the loss factor applicable to the actual number of customers served rather than the system or distribution system loss factor. This loss factor is applied to the peak loss at the time of the transformer peak. Regardless of whether inflation is considered or not, the incremental energy cost for peak generation must be the first year value, rather than levelized. The equivalent peak load includes the inflation rate for the energy cost at peak.

Energy Component:

$$LLC(E) = LL \times (PEQE)^2 \times 8760 \times LSF \times CEP1$$

The total levelized annual cost of load losses is the sum of the demand and energy components of the load loss costs.

$$LLC = LLC(D) + LLC(E)$$

Reactive Losses

Reactive losses in a transformer consist of two components; the no-load reactive loss (or reactive component of the magnetizing kVA) and the load reactive loss ($I^2 X$ loss). Since these reactive losses must be supplied, there is a cost that involves consideration of the source of supply and any intermediate facilities required to carry the reactive load to the point of loss. The cost of reactive losses is extremely small and are sometimes ignored in distribution transformer loss evaluations. If reactive losses are considered in distribution transformer loss evaluations, the load and no-load losses in kVAR, are determined as follows:

$$\text{Reactive no-load loss} = \sqrt{T^2 \times IO^2 - NLL^2}$$

$$\text{Reactive load loss} = \sqrt{T^2 \times Z^2 - LL^2}$$

Annual Reactive No-Load Loss Cost

The reactive no-load losses for distribution transformers are usually supplied by fixed capacitors installed on the primary distribution feeders.

$$NRC = CCAPF \times CC \times \sqrt{T^2 \times IO^2 - NLL^2}$$

Annual Reactive Load Loss Cost

To determine the cost of reactive load losses, the relationship of the transformer load at the time of distribution feeder or substation peak compared to the transformer peak load must also be considered. This is done by applying the distribution system peak responsibility factor to the transformer peak load prior to squaring the load. The equivalent peak load includes no inflation. The reactive load losses for distribution transformers are usually supplied by switched capacitors installed on the primary distribution feeders.

$$LRC = CCAPS \times CC \times (PEQO \times PRFD)^2 \times \sqrt{T^2 \times Z^2 - LL^2}$$

Regulation Losses

The regulation, or voltage drop, of distribution transformers affects system demand and energy. This, in turn, can affect system facilities required and net revenue derived from voltage sensitive loads, as well as customer satisfaction with voltage conditions. The importance of these effects vary from one system to another, depending on system design and operating practices, load characteristics, cost of power and energy, and rate structures.

As indicated earlier, the 1963 EEI Task Force Report ⁽¹⁾ included an accounting of the savings resulting from system demand reduction caused by reduced voltage. Field tests ^(17,18,19) have demonstrated that a demand reduction is achieved by voltage reduction. However, a new EEI Transformer Evaluation Task Force, organized in August, 1977, has concluded that the true cost of regulation is the cost of the voltage regulating equipment itself: that is, voltage regulators, capacitors, and load tap changing (LTC) equipment ⁽⁸⁾. So there is reason to suggest

that the regulation demand savings be eliminated in distribution transformer loss evaluations. It is also shown in Section 3.3 of this report that inclusion of the regulation demand savings results in an extremely high value for the economic changeout load such that significant transformer loss of life would occur. It is recommended that the regulation demand savings not be included in the evaluation of distribution transformer losses, but, for completeness, the demand reduction, in kW, caused by transformer voltage regulation is shown here.

$$\text{Demand Reduction} = (T \times \text{PEQO} \times \text{PRFS} \times \text{PF}) (\text{REG} \times \text{PEQO} \times \text{PRFS} \times \text{LKW})$$

The first term in parentheses is the load, in kW, at the time of system peak, and the second term is the reduction in demand, in per unit, at the time of system peak.

Annual Energy Cost of Regulation

The energy cost of regulation is the lost revenue due to the reduction in energy minus the utility's cost of this energy. Another area of controversy is the effect of voltage reduction on energy consumption. AEP tests ⁽¹⁷⁾ showed the energy reduction to be less than 0.5 percent for a daily four-hour voltage reduction of 5 percent. On the other hand, Southern California Edison ⁽¹⁸⁾ found an average energy reduction of 3 percent with a 2.38 percent average voltage reduction of one-day or one-week duration. PG&E tests ⁽¹⁹⁾ showed a 2.5 percent decrease in energy requirements with a 2.5 percent voltage reduction.

A question remains regarding the acceptability of including the energy cost associated with regulation. It does seem to represent an actual lost revenue to the utility, although it may be that this factor is more appropriately associated with feeder regulation rather than the

transformer itself. It was decided to include the energy cost of regulation in the loss evaluation equation. The effect of this cost on the total transformer cost and economic changeout load is deferred to a later section of this report.

An expression for the energy not sold as a result of voltage reduction can be derived. With reference to Figure 3-1.1, the following parameters are defined:

- P = Peak load in kVA on the transformer in the year under consideration. In this derivation, P is the peak load which would exist if the transformer had zero regulation.
- PF = Assumed average power factor of the loads served from the transformer.
- $p(t)$ = Instantaneous load in kVA on the transformer at any time t in the year under consideration. This is also the instantaneous load which would exist if the voltage regulation were zero percent.
- REG = The difference between the transformer secondary voltage magnitude at no load and the secondary voltage magnitude with nameplate kVA load at the assumed average power factor (PF), the quantity divided by the secondary voltage magnitude at no load. REG is a per unit quantity.
- T = Transformer nameplate kVA rating.

LKW = The loss or change in kWh sales due to regulation, expressed in per unit of the kWh sales which would occur if regulation were zero, divided by the per unit voltage change which produced the loss or change in sales.

This factor is a function of not only the type of load, but the range over which the voltage changes.

Then $p(t) = P \times f(t)$

where $f(t)$ is some function of time (in hours) which gives the instantaneous load on the transformer in per unit of the peak load on the transformer.

Consider the annual load curve in Figure 3-1.1, which shows $p(t)$ vs. time t . At any time t , the instantaneous load in kW supplied by the transformer with zero regulation is:

$$p(t) \times PF = P \times f(t) \times PF \quad (1)$$

and the energy sales in kWh, during time interval Δt with zero regulation is:

$$P \times f(t) \times PF \times \Delta t \quad (2)$$

At the same value of t , the per unit regulation of the transformer is:

$$REG \frac{P \times f(t)}{T} \quad (3)$$

For any small time interval Δt , the loss in kWh sales at load $P \times f(t)$ in per unit of the kWh sales which occurs for zero regulation is:

$$LKW \times \frac{REG \times P \times f(t)}{T} \quad (4)$$

In the time period Δt , the loss in kWh sales due to finite regulation is the product of (2) and (4), or:

$$P^2 \times PF \times REG \times LKW \times \frac{1}{T} \times [f(t)]^2 \Delta t \quad (5)$$

The energy reduction or total loss in kWh sales in one year is found by letting Δt approach zero, and integrating (5).

$$\text{Energy Reduction} = \frac{P^2 \times PF \times REG \times LKW}{T} \int_0^{8760} [f(t)]^2 dt \quad (6)$$

$$\text{Energy Reduction} = \frac{P^2 \times PF \times REG \times LKW \times 8760}{T} \left[\frac{1}{8760} \int_0^{8760} [f(t)]^2 dt \right] \quad (7)$$

But in equation (7), the expression in brackets is the annual loss factor.

Therefore,

$$\text{Energy Reduction} = \frac{P^2 \times PF \times REG \times LKW \times 8760 \times LSF}{T} \quad (8)$$

Using equation (8), the levelized annual energy cost of regulation, or lost revenue due to reduction in energy minus the utility's cost of this energy is:

$$RGC(E) = (T \times PEQE \times PF \times 8760)(REG \times PEQE) \times (LKW \times LSF)(CCE1 - CE1)$$

The load (P), in kVA was converted to an equivalent annual peak load (PEQE), in per unit and the terms re-arranged. The first term in parentheses is the annual energy sold in kWh, at a constant load PEQE, and the second term is the regulation, in per unit, at load PEQE.

Total Levelized Annual Transformer Cost

The total levelized annual transformer cost is the sum of the levelized annual transformer investment cost and the levelized annual cost of all transformer losses.

$$TLAC = TIC + NLC + LLC + NRC + LRC + RGC(E)$$

SUMMARY OF LOSS EVALUATION TECHNIQUE

The distribution transformer loss evaluation technique has been selected for use in subsequent tasks of this project. The complete equation is shown in Table 3-1.2. The loss evaluation technique selected is based on the "total levelized annual cost" approach and is valid for conditions of inflation and load growth. The equation is shown for the case where a maximum of one transformer changeout occurs during the evaluation period. However, the method can easily be extended to handle additional changeouts. The equation also assumes a compound load growth rate. If the load growth rate is linear, the basic equation for $(PEQ)^2$, using a year-by-year summation, must be substituted for the closed-form expression of $(PEQ)^2$.

The loss costs included are power (no-load and load) loss costs, reactive (no-load and load) loss costs, and the energy cost of regulation. Regulation demand savings are not included in the evaluation procedure. The selection of the system cost and load parameter values are in the scope of Tasks 2 and 3.

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FIGURE 3-1.1

DISTRIBUTION TRANSFORMER ANNUAL LOAD CYCLE

TABLE 3-1.1

NOMENCLATURE FOR DISTRIBUTION TRANSFORMER LOSS EVALUATION TECHNIQUE

CSYSB	system investment cost per unit of base load, \$/kW
CSYSP	system investment cost per unit of peak load, \$/kW
CEB1	incremental energy cost for base load (first year value), \$/kWh
CEP1	incremental energy cost for peak generation (first year value), \$/kWh
CEBL	incremental energy cost for base load (levelized value), \$/kWh
CEPL	incremental energy cost for peak generation (levelized value), \$/kWh
CCE1	average sale price of incremental energy (first year value), \$/kWh
CE1	average incremental energy cost (first year value), \$/kWh
CEBF1	fuel cost component of CEB1 (first year value), \$/kWh
CEBOM1	O&M cost component of CEB1 (first year value), \$/kWh
IRB	inflation rate for base load energy cost, p.u.
IRP	inflation rate for peak energy cost, p.u.
IRBF	inflation rate for fuel cost component of CEB1, p.u.
IRBOM	inflation rate for O&M cost component of CEB1, p.u.
CC	levelized annual carrying charge rate, p.u.
DISC	discount factor for system investment, p.u.
I	rate of return (weighted cost of capital), p.u.
CCAPF	installed cost of fixed capacitors, \$/kVAR
CCAPS	installed cost of switched capacitors, \$/kVAR
LSF	transformer annual loss factor, p.u.
PEQO	transformer equivalent annual peak load (no inflation), p.u.
PEQE	transformer equivalent annual peak load (energy cost inflation), p.u.
IP	initial transformer annual peak load, p.u.
FP	final transformer annual peak load, p.u.
GR	levelized annual compound peak load growth rate, p.u.
PRFS	peak responsibility factor (system), p.u.
PRFD	peak responsibility factor (distribution system), p.u.
PF	load power factor, p.u.
8760	number of hours per year
LKW	change in kW load for 1 percent change in voltage, percent
N	evaluation period, years
NC	time to transformer changeout, years
T	transformer nameplate rating, kVA
CT	transformer cost to utility, \$
NLL	transformer no-load loss, kW
LL	transformer load loss at rated load, kW
IO	transformer exciting current, p.u.
Z	transformer impedance, p.u.
REG	transformer regulation at rated load, p.u.
TLAC	total levelized annual transformer cost, \$/year
TIC	levelized annual cost of transformer investment, \$/year
NLC	levelized annual no-load loss cost, \$/year
LLC	levelized annual load loss cost, \$/year
NRC	levelized annual reactive no-load loss cost, \$/year
LRC	levelized annual reactive load loss cost, \$/year
RGC(E)	levelized annual energy cost of regulation, \$/year

TABLE 3-1.2

SUMMARY OF DISTRIBUTION TRANSFORMER LOSS EVALUATION TECHNIQUE

$$TLAC = CT \times CC$$

(investment cost)

$$+ (CSYSB \times DISC \times CC + 8760 \times CEBL) \times NLL$$

(no-load loss cost)

$$+ CCAPF \times CC \times \sqrt{T^2 \times IO^2 - NLL^2}$$

(reactive no-load loss cost)

$$+ \left[CSYSP \times DISC \times CC \times PRFS^2 \times LL \right.$$

(load loss demand cost)

$$\left. + CCAPS \times CC \times PRFD^2 \times \sqrt{T^2 \times Z^2 - LL^2} \right] \times PEQO^2$$

(reactive load loss cost)

$$+ \left[8760 \times LSF \times CEP1 \times LL \right.$$

(load loss energy cost)

$$\left. + T \times PF \times 8760 \times REG \times LKW \times LSF \times (CCE1 - CE1) \right] \times PEQE^2$$

(regulation energy cost)

where:

$$PEQO^2 = \left[\frac{IP^2}{(1+GR)^2 - (1+I)} \right] \left[\frac{(1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC}} + \frac{(1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

$$PEQE^2 = \left[\frac{IP^2(1+IRP)^{NC}}{(1+IRP)(1+GR)^2 - (1+I)} \right] \left[\frac{(1+IRP)^{NC}(1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC}(1+IRP)^{NC}} + \frac{(1+IRP)^{N-NC}(1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

$$CEBL = CEBF1 \left[\frac{(1+IRBF)^N - (1+I)^N}{(1+IRBF) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right] + CEBOM1 \left[\frac{(1+IRBOM)^N - (1+I)^N}{(1+IRBOM) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

$$\approx CEB1 \left[\frac{(1+IRB)^N - (1+I)^N}{(1+IRB) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

* Refer to Table 3-1.1 for nomenclature for loss evaluation technique.

APPENDIX 3.1 DERIVATION OF THE TOTAL LEVELIZED ANNUAL COST (TLAC) EQUATION

STEP I. Develop the annual cost (AC) for each year (1-N)

$$\begin{aligned}
 AC(1) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^0] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^0 + [8760 \times LSF \times CEP1(1+IRP)^0] \times LL \times IP^2(1+GR)^0 \\
 AC(2) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^1] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^1 + [8760 \times LSF \times CEP1(1+IRP)^1] \times LL \times IP^2(1+GR)^1 \\
 &\vdots \\
 AC(NC) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^{NC-1}] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^{2(NC-1)} + [8760 \times LSF \times CEP1(1+IRP)^{NC-1}] \times LL \times IP^2(1+GR)^{2(NC-1)} \\
 AC(NC+1) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^{NC}] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^0 + [8760 \times LSF \times CEP1(1+IRP)^{NC}] \times LL \times IP^2(1+GR)^0 \\
 AC(NC+2) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^{NC+1}] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^2 + [8760 \times LSF \times CEP1(1+IRP)^{NC+1}] \times LL \times IP^2(1+GR)^2 \\
 &\vdots \\
 AC(N) &= CT \times CC + CSYSB \times DISC \times CC \times NLL + [8760 \times CEB1(1+IRB)^{N-1}] \times NLL + (CSYSP \times DISC \times CC \times PRFS^2) \times LL \times IP^2(1+GR)^{2(N-NC-1)} + [8760 \times LSF \times CEP1(1+IRP)^{N-1}] \times LL \times IP^2(1+GR)^{2(N-NC-1)}
 \end{aligned}$$

STEP II. Determine the present worth of annual revenue requirements (PWARR)

$$\begin{aligned}
 PWARR &= \sum_{Y=1}^N [AC(Y) \times SPPWF(I, Y)] \\
 PWARR &= CT \times CC \times USPWF(I, N) + (CSYSB \times DISC \times CC \times NLL) \times USPWF(I, N) + 8760 \times NLL \times \sum_{Y=1}^N [CEB1(1+IRB)^{Y-1} \times SPPWF(I, Y)] \\
 &\quad + (CSYSP \times DISC \times CC \times PRFS^2 \times LL) \times \left\{ \sum_{Y=1}^{NC} [IP^2(1+GR)^{2(Y-1)} \times SPPWF(I, Y)] + \sum_{Y=1}^{N-NC} [IP^2(1+GR)^{2(Y-1)} \times SPPWF(I, Y+NC)] \right\} \\
 &\quad + 8760 \times LSF \times CEP1 \times LL \times \left\{ \sum_{Y=1}^{NC} [IP^2(1+IRP)^{Y-1} (1+GR)^{2(Y-1)} \times SPPWF(I, Y)] + \sum_{Y=1}^{N-NC} [IP^2(1+IRP)^{Y+NC-1} (1+GR)^{2(Y-1)} \times SPPWF(I, Y+NC)] \right\}
 \end{aligned}$$

STEP III. Convert to total levelized annual cost (TLAC)

$$\begin{aligned}
 TLAC &= \frac{PWARR}{USPWF(I, N)} \\
 TLAC &= CT \times CC + CSYSB \times DISC \times CC \times NLL + NLL \times 8760 \times CEB1 + CSYSP \times DISC \times CC \times PRFS^2 \times LL \times PEQO^2 + 8760 \times LSF \times CEP1 \times LL \times PEQE^2
 \end{aligned}$$

where

$$\begin{aligned}
 CEB1 &= \left[\sum_{Y=1}^N CEB1(1+IRB)^{Y-1} \times SPPWF(I, Y) \right] \frac{1}{USPWF(I, N)} \\
 PEQO^2 &= \left\{ \sum_{Y=1}^{NC} IP^2(1+GR)^{2(Y-1)} \times SPPWF(I, Y) + \sum_{Y=1}^{N-NC} IP^2(1+GR)^{2(Y-1)} \times SPPWF(I, Y+NC) \right\} \frac{1}{USPWF(I, N)} \\
 PEQE^2 &= \left\{ \sum_{Y=1}^{NC} IP^2(1+IRP)^{Y-1} (1+GR)^{2(Y-1)} \times SPPWF(I, Y) + \sum_{Y=1}^{N-NC} IP^2(1+IRP)^{Y+NC-1} (1+GR)^{2(Y-1)} \times SPPWF(I, Y+NC) \right\} \frac{1}{USPWF(I, N)}
 \end{aligned}$$

3.2 TASK 2 - COMPILE SYSTEM COST PARAMETERS

INTRODUCTION

This task is directed toward selecting the system cost parameters for use with the loss evaluation technique that was selected in Task 1. The system cost parameters required are the system investment cost, incremental energy cost, average sale price of incremental energy, discount factor, inflation rate, carrying charge rate, rate of return and installed cost of capacitors. This task was performed by the T&D Systems Engineering Department of Westinghouse.

INDUSTRY LOSS COSTS

The initial effort in this task was to obtain the loss evaluation formulas recently provided by utilities to the Westinghouse Distribution Transformer Division. It was hoped these formulas would be of a form similar to the evaluation procedure selected in Task 1, with the actual parameter values used. However, the formulas were of the form

$$\begin{aligned} \text{Evaluation} &= A \times \text{First Cost} + \\ &\quad B \times \text{No Load Loss, kW} + \\ &\quad C \times \text{Load Loss, kW} \end{aligned}$$

The values (A, B and C) for this formula for 70 utilities are shown in Table 3-2.1. Although the values in this form are not directly usable to determine each of the necessary system cost parameters, they were analyzed to determine the variability in no-load and load loss costs, which can ultimately be compared to the sensitivity analysis of the cost and load parameters. This should aid in the final selection of parameters used for later tasks of this project.

It can be seen in Table 3-2.1 that the value A varies from 0.12 to 3.45, with the value A = 1.0 used in several formulas. It is evident that the value A is simply the carrying charge rate when it is in the range 0.12 to 0.215. Then, the values B and C are the costs of no-load and load losses, respectively, on an annual cost basis. When the value A is equal to one, the values of B and C are the no-load and load loss costs, respectively, on an equivalent investment cost basis. When A is greater than one, it appears that B and C are the no-load and load loss costs, respectively, on a present worth basis.

In order to analyze the loss values (B and C) they must be converted to the same cost basis. This is done by dividing all the values by A, such that all the loss evaluation formulas are of the form

$$\begin{aligned} \text{Evaluation} &= \text{First Cost} + B \times \text{No Load Loss, kW} \\ &+ C \times \text{Load Loss, kW} \end{aligned}$$

The values (B and C) for this formula are shown in Table 3-2.2. These new values of B and C now represent the no-load and load loss costs, respectively, on an equivalent investment cost basis. Since transformer loss ratio is also of interest, the ratio of no-load loss costs to load loss cost (B/C) is also shown in the table.

Table 3-2.3 shows the statistical analysis of the no-load loss cost data. The costs range from \$365/kW to 4073/kW, with a mean of \$1603/kW and a standard deviation of \$777/kW. Figure 3-2.1 presents a histogram and distribution of this sample of no-load loss costs.

Table 3-2.4 shows the statistical analysis of the load loss cost data. The costs range from \$229/kW to \$1932/kW, with a mean of \$703/kW and a standard deviation of \$328/kW. Figure 3-2.2 presents a histogram and distribution of the load loss cost data.

It is noted that Tables 3-2.3 and 3-2.4 are statistical analyses, treating the no-load loss costs and load loss costs for each utility independent of each other. There may be some validity to consider them together. One attempt at this is shown in Table 3-2.5 where the ratio of no-load loss costs to load loss costs is analyzed. In this analysis, the mean of the ratios is 2.48 and the standard deviation is 1.15. It is noted that in this case, using the mean no-load loss costs (\$1603/kW from Table 3-2.3) as a base, the mean load loss cost is \$646/kW, compared to \$703/kW calculated in Table 3-2.4.

EXISTING SYSTEM COST PARAMETERS

A literature search was completed to identify the system cost parameters used in the industry. Most of this data was provided in the literature listed in the bibliography on loss evaluation and economic changeout. A review of this literature showed the cost data to be quite limited. Therefore, the system cost parameters from a 1978 industry survey of 71 utilities were obtained to supplement the cost data from the literature search. The range of values used by utilities is shown in the following:

	<u>MINIMUM</u>	<u>MAXIMUM</u>
system investment cost (CSYSB)	\$ 100/kW	\$ 1295/kW
incremental energy cost (CEB)	\$0.00436/kWh	\$0.0552/kWh
average sale price of energy (CCE)		\$0.0376/kWh
discount factor (DISC)	-	-
inflation rate (IR)	-	-
carrying charge rate (CC)	0.123 p.u.	0.277 p.u.
rate of return (I)	0.0897 p.u.	0.11 p.u.
installed cost of fixed capacitors (CCAPF)		\$4.27/kVAR
installed cost of switched capacitors (CCAPS)		\$8.22/kVAR

It is obvious from the range of values listed above that not all system cost parameters were identified by the utilities. It should also be recognized that some utilities furnished system investment cost data, without identifying the data to be on an annual cost or equivalent investment cost basis.

The EPRI Technical Assessment Guide⁽¹⁾ provides substantial data on current and projected generating plant and fuel costs. This guide was compiled for industry use to provide a common basis for evaluation of alternatives. A review of this guide suggests that this data should be used for this project. The following sections derive all the system cost parameters for use in subsequent tasks of this project. The EPRI data is combined with other available industry data to project system cost trends. Two cost scenarios are selected to account for the wide range of nuclear and oil-fired base-load generation investment and energy costs.

CARRYING CHARGE RATE

Annual revenue requirements are the revenues necessary to meet all annual costs including return on investment. Many of these costs can be expressed as a percentage of investment and are added together to obtain the levelized carrying (or fixed) charge rate (CC). These components of cost in the carrying charge rate are: 1. minimum acceptable return, 2. depreciation, 3. taxes, and 4. insurance.

The following values are assumed for the base parameters used to determine the levelized carrying charge rate⁽¹⁾:

debt ratio (B)	50%
debt cost (b)	8%/year
preferred stock ratio	15%
preferred stock cost	8.5%/year
common stock ratio	35%
common stock cost	13.5%/year
federal & state income tax rate (t)	50%
property taxes and insurance	2%
book life (N)	30 years

Rate of Return

The rate of return is the weighted cost of capital, including inflation:

$$I = (0.50 \times 0.08) + (0.15 \times 0.085) + (0.35 \times 0.135) = 0.10 \text{ p.u.}$$

This value of 10 percent weighted cost of capital implies a 6 percent/year inflation rate. The weighted cost of capital is also used as the discount rate.

Depreciation

The annual cost of depreciation is the book depreciation plus retirement dispersion allowance. The levelized annual cost of book depreciation is independent of the accounting method used and is a function only of the rate of return and expected lifetime of the investment. Book depreciation, as a percentage of investment, is equal to the sinking fund factor for 10 percent return rate and 30 year life:

$$D = \frac{I}{(1+I)^N - 1} = 0.0061$$

Book depreciation (0.61 percent) and return (10 percent) together make up the capital recovery (10.61 percent).

The allowance for retirement dispersion resulting from the Iowa Type S₁ Retirement Dispersion pattern using a 10 percent weighted cost of capital and 30 year book life is $d = 0.0056$, or 0.56 percent.

Income Tax

The levelized annual federal and state income tax, as a percentage of investment, is calculated as follows:

$$\begin{aligned} T &= \frac{t}{(1-t)} \left[I + D + d - \frac{1}{N} \right] \left[1 - \frac{Bb}{I} \right] \\ &= \frac{0.50}{1-0.50} \left[0.10 + 0.0061 + 0.0056 - \frac{1}{30} \right] \left[1 - \frac{0.50 \times 0.08}{0.10} \right] \\ &= 0.047, \text{ or } 4.7 \text{ percent} \end{aligned}$$

Levelized Annual Carrying Charge Rate

It should be noted that income tax preference allowances are not included in the carrying charge rate. Although accelerated depreciation and investment tax credit are included in the current income tax laws, they are often neglected in investment analyses because of their history of frequent changes. The EPRI guide recommends that income tax preference allowances be excluded from long-term analyses.

The levelized annual carrying charge rate is the sum of the components calculated above plus property taxes and insurance, assumed to be 2 per cent:

Rate of Return	10.00%
Book Depreciation	0.61
Retirement Dispersion Allowance	0.56
Levelized Annual Income Tax	4.70
Property Taxes and Insurance	2.00
	<u>17.87%</u>

Therefore, the levelized annual carrying charge rate to be used is:

$$CC = 0.18 \text{ p.u.}$$

SYSTEM INVESTMENT COSTS

System investment costs are the costs of additional system facilities required to supply the transformer losses. For distribution transformer evaluation these system facilities include transmission and distribution system facilities in addition to generating plant capacity. The EPRI Technical Assessment Guide⁽¹⁾ provides some guidance on the proper system investment cost to use. They suggest using the average cost of new capacity rather than historical costs.

Two system investment cost values are required. Since no-load losses are present continuously, they are usually supplied by base-load generation, and the demand costs are usually based on the facility costs of base-load units. Load losses occur primarily at peak load periods, so the demand costs should reflect the facility costs of peaking generation.

Generation Plant Costs

The EPRI guide provides capitalized plant cost data for alternative types of generating plants. This data is summarized in Table 3-2.6 by region, except for oil power plants and combustion turbines, where only one value is provided. These capitalized costs are 1977 costs in end-of-the-year 1977 dollars.

The cost data in this table is extended to the years 1978-1980 using a 6 percent/year rate of inflation as shown in Table 3-2.7. Inflation must be included to properly relate the investment cost to the time of the capital expenditure. However, once an investment is made, the cost of the capital expenditure will not change. As a result, the investment is not subject to inflation and escalation after the investment is made.

It is recommended that 1980 costs in end-of-the-year 1980 dollars be used in subsequent tasks of this project. The generation plant portion of the system investment cost is:

$$\begin{aligned}\text{CSYSB (generation only)} &= \$524 - \$962/\text{kW} \\ \text{CSYSP (generation only)} &= \$191/\text{kW}\end{aligned}$$

where the CSYSB and CSYSP values represent base-load and peaking generation costs, respectively. Two system cost scenarios are recommended because of the wide range of base-load (oil and nuclear) generation costs:

Transmission and Distribution System Costs

For distribution transformer loss evaluation, the proper system investment cost includes the costs of transmission and distribution lines and substations added to the generation investment cost. The 1978 Statistical Report⁽²⁾ includes data on the 1977 capital expenditures by U. S. utilities for new transmission lines (overhead and underground), transmission substations, distribution substations and primary distribution lines (overhead and underground). The report also indicates that new generation capability additions in 1977 for all U. S. utilities totalled 26,609 MW.

From this data, the 1977 transmission and distribution system costs were calculated and are shown in Table 3-2.8. These costs were extended to the years 1978-1980 using a 6 percent/year rate of inflation, and are also shown in Table 3-2.8.

The 1980 transmission and distribution system portion of the system investment cost is:

$$\begin{array}{ll} \text{CSYSB (T\&D only)} & = \quad \$220/\text{kW} \\ \text{CSYSP (T\&D only)} & = \quad \$220/\text{kW} \end{array}$$

Total System Investment Costs

The generation and T&D portions of the system investment costs must be added together to obtain the total system investment cost values. The range of values for system investment cost per unit of base load is:

$$\text{CSYSB} = \$744 - \$1182/\text{kW}$$

The value for system investment cost per unit of peak load is:

$$\text{CSYSP} = \$411/\text{kW}$$

DISCOUNT FACTOR

Evaluation of the capital cost component of incremental losses is difficult because small changes in peak load have an uncertain effect on future capacity additions. Studies reported in 1961⁽³⁾ suggested a varying discount on system investment for both generation and transmission depending on the amount of loss in question and the capacity expansion anticipated. The paper concluded that, in any event, an estimate of pro rata cost to supply very small incremental loads is impossible to defend and an estimate of zero incremental demand cost is difficult to defend except for exceptionally small incremental loads or for expansion patterns using very large generating units.

The EPRI Technical Assessment Guide⁽¹⁾ suggests that a reasonable approach seems to be to consider that a change in losses will not affect the timing of new facilities, but may affect the size. On this basis, the EPRI guide recommends that the capacity component of losses should be evaluated at the incremental cost of increasing the size of new facilities, which is typically about two-thirds of the average cost. For generating facilities, with an assumed reserve margin of 20 percent, a kilowatt of incremental loss would be evaluated at $2/3 \times 1.20$, or 80 percent of the cost per kilowatt of new generating capacity. For transmission and distribution facilities, a kilowatt of incremental loss would be evaluated at two-thirds, or 67 percent of the cost required to supply a kilowatt of new load.

Since only one discount factor (DISC) is used in the loss evaluation equations presented in Task 1, an equivalent value for the discount factor will be developed, based on the 0.80 factor for generating facilities and the 0.67 factor for T&D facilities. Using the appropriate system investment costs, the equivalent discount factor varies from 73-77 percent when applied to the system investment cost per unit of peak load and base load, respectively. The discount factor for system investment to be used in subsequent tasks of this project is:

$$\text{DISC} = 0.75 \text{ p.u.}$$

INCREMENTAL ENERGY COSTS

Energy charges are based on the average incremental cost of delivered power as obtained from generating units that are in a position to pick up the load. This value varies with time-of-day, week, month and year, and is the quantity that is used for automatic economic load dispatching. As in the case of system investment costs, two energy cost values are required. The energy charges for no-load losses are reflected by the production costs associated with base-load generation and the energy charge for load losses are based on peaking generation production costs.

Energy costs are comprised of fuel costs plus operation and maintenance costs, including fixed, variable and consumable O&M costs. The EPRI guide provides fuel and O&M cost data for alternative fuel and generating plant types. This production cost data (fuel plus O&M) is summarized in Table 3-2.9, using the regional cost data (where available) from the EPRI guide to develop national average data. These energy costs are 1977 costs in end-of-the-year 1977 dollars.

Operating costs (fuel plus O&M) are subject to general inflation throughout the period of analysis, and may be subject to an escalation relative to general inflation as well. These inflation and escalation effects must be included in the annual values of operating costs. The EPRI guide again suggests an inflation rate of 6 percent/year for all operating costs. An escalation rate is also given (or calculable) for the fuel cost of each fuel type.

The energy costs are extended to the years 1978-1980 as shown in Table 3-2.10. These costs are derived by escalating the fuel cost each year by the inflation and escalation rates shown below and by subjecting

the O&M costs to inflation only.

<u>Fuel Type</u>	<u>Fuel Escalation/Inflation</u>	<u>O&M Inflation</u>
Nuclear	(1.0165)(1.06) = 1.077	1.06
Coal	(1.0043)(1.06) = 1.0646	1.06
Residual Oil	(1.076)(1.06) = 1.1406	1.06
Distillate #2 Oil	(1.072)(1.06) = 1.1363	1.06

The 1980 incremental costs of energy for base-load generation and generation at peak, respectively, are

$$\begin{aligned} \text{CEB1} &= \$0.0085 - \$0.0350/\text{kWh} \\ \text{CEP1} &= \$0.0557/\text{kWh} \end{aligned}$$

If transformer losses were evaluated on a year-by-year basis and present worthed, it would be necessary to calculate the properly inflated and escalated energy cost for each year of the study. When losses are evaluated using the "total levelized annual cost" approach, levelized energy costs must also be determined. If a cost escalates at a constant annual rate, a levelized cost can be calculated for the stream of escalating values by multiplying the cost in the initial year by the appropriate levelizing factor (L_f). The levelizing factor is calculated as follows:

$$L_f = \left[\frac{(1 + IR)^N - (1 + I)^N}{(1 + IR) - (1 + I)} \right] \left[\frac{I}{(1 + I)^N - 1} \right]$$

where:

$$\begin{aligned} I &= \text{rate of return (discount rate), p.u.} \\ N &= \text{book life} \\ IR &= \text{the apparent escalation rate such that} \\ &\quad (1 + IR) = (1 + \text{real escalation})(1 + \text{inflation rate}) \end{aligned}$$

It should be noted that the levelizing factor is based on end-of-year values and differs from the equation derived in the EPRI guide by the factor $(1 + IR)$. Note that if $(1 + IR) = (1 + I)$, the denominator is zero and

$$L_f = \frac{N}{(1+I)} \left[\frac{I (1+I)^N}{(1+I)^N - 1} \right]$$

Levelizing factors for a 10 percent discount rate, 6 percent inflation rate, and 30-year period are listed in Table 3-2.11 for each fuel cost and all O&M costs. These levelizing factors, when applied, give levelized costs beginning at the date on which the costs were expressed. The end-of-the-year 1980 fuel and O&M costs were levelized, resulting in the 1980 levelized energy costs shown in Table 3-2.12. The levelized incremental costs of energy for base-load generation and generation at peak, respectively are:

$$\text{CEBL} = \$0.0180 - \$0.0765/\text{kWh}$$

$$\text{CEPL} = \$0.1198/\text{kWh}$$

Equivalent levelizing factors and inflation rates, assuming they were the same for both fuel and O&M costs, but which result in the correct levelized energy cost are also shown in Table 3-2.12. The inflation rates for base-load generation (nuclear and oil) and generation at peak, respectively are:

$$\text{IRB} = 0.07527 - 0.07775 \text{ p.u.}$$

$$\text{IRP} = 0.07641 \text{ p.u.}$$

As in the case of system investment cost, a range of values is used for the incremental cost of energy for base-load generation.

SALE PRICE OF INCREMENTAL ENERGY

The 1978 Electrical World Forecast⁽⁴⁾ includes historical and projected data on the average revenue per kWh from residential customers. The 1980 revenue is \$0.0416/kWh in 1978 dollars. Using the forecasted GNP price deflator of 113.5, the average 1980 sale price of energy in 1980 dollars becomes:

$$\text{CCE1} = \$0.0472/\text{kWh}$$

Since an average sale price of energy is being used, an average cost of energy should also be used when determining the lost revenue due to regulation. The 1978 Statistical Report⁽²⁾ provides a breakdown of the amount of energy generated in 1977 by type of fuel:

Nuclear	13.2%
Coal	51.9%
Oil	18.8%
Gas	16.1%

In forecasting energy resource prices, the EPRI Guide assumed that firm supplies of natural gas will not be available to electric utilities. Therefore, it is assumed here that the 16 percent of the energy generated by gas will move equally (8 percent each) into the coal and oil categories. It is also assumed that 10 percent of the total energy generated is by peaking units. With these assumptions, and the 1980 energy costs from Table 3-2.10, an approximate (weighted) average energy cost can be determined.

Nuclear (base load)	13% x 8.49	=	1.104
Coal (base load)	60% x 14.91	=	8.946
Oil (base load)	17% x 35	=	5.950
Oil (peaking)	10% x 55.71	=	5.571
			<u>21.571</u> mils/kWh

The average 1980 energy cost to be used (when lost revenue due to regulation is determined) is:

CE1 = \$0.0216/kWh

FIXED AND SWITCHED CAPACITOR COST

The no-load and load reactive losses for distribution transformers are usually supplied by fixed and switched capacitors, respectively, which are installed on the primary distribution feeders. There is a very limited amount of data published regarding the installed cost of capacitors. However, since the cost of reactive losses is so small (less than 0.5 percent) compared to the total transformer cost, a precise cost for the installed cost of capacitors is not required.

Westinghouse Price List 39-360, dated November 21, 1978, on pole mounted capacitor equipments was used to estimate the installed cost of fixed and switched capacitors. The cost estimates were based on 600 kVAR, 13200/7620 volt pre-engineered and assembled capacitor equipments using single-phase 200 kVAR units.

The cost of the fixed capacitor equipment is \$2.17/kVAR. A "rule of thumb" often used to relate equipment cost to installed cost is a multiplier of two. The estimated installed cost of fixed capacitors is $\$2.17 \times 2 = \$4.34/\text{kVAR}$. The cost of the switched capacitor equipment, assuming voltage control, is \$4.22/kVAR. The estimated installed cost of switched capacitors is $\$4.22 \times 2 = \$8.44/\text{kVAR}$.

One utility⁽⁵⁾ uses 1978 values of \$4.27/kVAR and \$8.22/kVAR for the installed cost of fixed and switched capacitors, respectively. These values are almost identical to those derived above and will be considered as reasonable. These values are converted to 1980 dollars using 6 percent/year inflation, and become:

$$\text{CCAPF} = \$4.80/\text{kVAR}$$

$$\text{CCAPS} = \$9.24/\text{kVAR}$$

LOSS COST COMPARISON

Earlier in this section, the no-load and load loss costs, in \$/kW, provided by 70 utilities to the Westinghouse Distribution Transformer Division were listed and a statistical analysis was performed. The no-load and load loss costs for a 25 kVA transformer that result from using the loss evaluation technique selected in Task 1, the system cost parameters selected in Task 2, and the load characteristics selected in Task 3 can be compared to the loss costs recently used by utilities.

Comparison of No Load Loss Costs

Using the loss evaluation method and system data developed in this project, and with energy cost inflation, the no-load loss costs range from \$1763/kW to \$4281/kW, assuming nuclear and oil base-load generation, respectively. This compares to the range of \$365/kW to \$4073/kW shown in Table 3-2.3. If energy cost inflation is not included, the method and system data developed in this project result in no-load loss costs ranging from \$1300/kW to \$2261/kW, assuming nuclear and oil base-load generation, respectively. These two sets of costs, with and without inflation, can be seen to correspond to the upper range of the values listed in Table 3-2.3. It must be remembered, however, that the evaluations in this project are based on 1980 costs, whereas the evaluations provided by the utilities are probably based on 1977 or 1978 costs.

Using the loss evaluation method and 1977 system cost data (with no inflation) developed in this project, the no-load loss costs are reduced to the range of \$1078/kW to 1622/kW, assuming nuclear and oil base-load generation, respectively. This range of costs is still above the lower part of the cost range in Table 3-2.3. However, if one assumes the lowest 1977 energy cost that is available, \$0.00685/kWh for a nuclear

plant, the energy cost component of no-load losses is \$333/kW, which leaves essentially nothing for the generation plant cost in the demand cost component in order to arrive at the lowest total no-load loss cost of \$365/kW in Table 3-2.3. This would indicate that the smallest no-load loss costs in Table 3-2.3 cannot be correct.

Comparison of Load Loss Costs

Similarly, using the loss evaluation method and 1980 system data developed in this project, and with energy cost inflation, the load loss costs range from \$924/kW to \$1188/kW, assuming nuclear and oil base-load generation, respectively. The annual peak load growth was varied from two percent to six percent in calculating these load loss costs. If energy cost inflation is not included, the method and system data developed in this project result in load loss costs ranging from \$488/kW to \$847/kW, assuming nuclear and oil base-load generation, respectively. These two sets of costs can be compared to the range of \$229/kW to \$1932/kW shown in Table 3-2.4. As in the case of the no-load loss costs, these calculated load loss costs can be seen to correspond to the upper range of values listed in Table 3-2.4.

Using 1977 system cost data (with no inflation) the load loss costs are reduced to the range of \$465/kW to \$752/kW. With the system cost data and load characteristics used, the equivalent annual peak load would have to be 0.76 per unit in order to arrive at the lowest load loss cost of \$229/kW in Table 3-2.4.

SUMMARY OF SYSTEM COST PARAMETERS

The system cost parameters have been determined and two representative cost scenarios have been selected for use in subsequent tasks. These two scenarios represent the range of projected capital and energy costs for oil-fired and nuclear base-load generation, respectively. The cost parameters and their selected values are shown in Table 3-2.13.

REFERENCES

1. Technical Assessment Group, "Technical Assessment Guide," EPRI PS-866-SR Special Report, Electric Power Research Institute, Palo Alto, CA, June 1978.
2. Electrical World Editors, "1978 Annual Statistical Report," Electrical World, March 15, 1978, pp. 86-91.
3. C. J. Baldwin, C. H. Hoffman, and P. H. Jeynes, "A Further Look at the Cost of Losses, "AIEE Transactions, Part III, Vol. 80, 1961, pp. 1001-1005.
4. Electrical World Editors, "29th Annual Electrical Industry Forecast," Electrical World, September 15, 1978, pp. 65-70.
5. J. T. Shinvovich, "Distribution System Transformer Loss Evaluation," Thirty-First Annual Power Distribution Conference, Austin, TX, October 23-25, 1978.

TABLE 3-2.1

EVALUATION FORMULAS - POLE TYPE

$$\begin{aligned} \text{Evaluation} &= A * \text{First Cost} + \\ &B * \text{No Load (KW)} + \\ &C * \text{Load Loss (KW)} \end{aligned}$$

<u>CUSTOMER</u>	<u>A</u>	<u>B</u>	<u>C</u>
A	1.454	1817	789
B	0.18	400	219
C	3.45	1890	790
D	1.00	2095	1245
E	0.20	237	75
F	1.00	1109	593
G	1.00	3681	865
H	0.163	335	112
I	1.000	2076	952
J	1.00	943	475
K	0.18	231	128
L	0.160	254	132
M	1.00	1320	890
N	1.00	1850	450
O	1.000	365	390
P	1.000	2102	1204
Q	1.00	1064	835
R	0.12	183	105
S	1.00	600	400
T	0.170	140	41
U	1.00	1950	1200
V	1.00	944	624
W	2.176	2300	1212
X	0.17	142	76
Y	1.00	2373	356
Z	1.00	1513	679
AA	1.06	3614	966
BB	0.185	205	91
CC	1.00	938	627
DD	1.00	660	275
EE	1.000	1060	252
FF	1.00	1060	578
GG	1.000	1689	623
HH	1.00	1274	917
II	1.00	814	466
JJ	1.000	1362	435
KK	1.00	2100	480
LL	1.00	1640	933
MM	1.396	3470	1680
NN	1.00	1200	375
OO	1.68	4300	1020
PP	1.00	1340	1000
QQ	1.00	1460	1389
RR	1.01	684	254
SS	1.00	875	435
TT	1.00	839	523
UU	1.41	3900	1000

TABLE 3-2.1 (Continued)

<u>CUSTOMER</u>	<u>A</u>	<u>B</u>	<u>C</u>
VV	0.18	365	258
WW	0.215	322	69
XX	0.180	289	177
YY	1.00	1048	651
ZZ	1.334	2243	1613
AAA	1.00	3200	800
BBB	1.74	2901	1800
CCC	1.225	3024	966
DDD	1.00	970	660
EEE	1.00	1210	695
FFF	1.00	2550	938
GGG	1.00	1835	787
HHH	1.00	3419	1932
III	0.17	229	131
JJJ	0.21	325	110
KKK	0.1735	355	98
LLL	0.173	200	101
MMM	1.00	4073	665
NNN	1.00	892	312
OOO	1.470	3230	904
PPP	1.00	970	423
QQQ	1.00	1672	502
RRR	1.43	2082	965

TABLE 3-2.2

LOSS EVALUATION FORMULAS - POLE TYPE
(INVESTMENT COST BASIS)

Evaluation = First Cost + B* No Load (kW) + C* Load Loss (kW)

<u>CUSTOMER</u>	<u>B</u>	<u>C</u>	<u>B/C</u>
A	\$1250	\$ 543	2.30
B	2222	1217	1.83
C	548	229	2.39
D	2095	1245	1.68
E	1185	375	3.16
F	1109	593	1.87
G	3681	865	4.26
H	2055	687	2.99
I	2076	952	2.18
J	943	475	1.99
K	1283	711	1.80
L	1588	825	1.92
M	1320	890	1.48
N	1850	450	4.11
O	365	390	0.94
P	2102	1204	1.74
Q	1064	835	1.27
R	1525	875	1.74
S	600	400	1.50
T	824	241	3.42
U	1950	1200	1.63
V	944	624	1.51
W	1057	557	1.90
X	835	447	1.87
Y	2373	356	6.67
Z	1513	679	2.23
AA	3409	911	3.74
BB	1108	492	2.25
CC	938	627	1.50
DD	660	275	2.40
EE	1060	252	4.21
FF	1060	578	1.83
GG	1689	623	2.71
HH	1274	917	1.39
II	814	466	1.75
JJ	1362	435	3.13
KK	2100	480	4.38
LL	1640	933	1.76
MM	2486	1203	2.07
NN	1200	375	3.20
OO	2560	607	4.22
PP	1340	1000	1.34
QQ	1460	1389	1.05
RR	677	251	2.70
SS	875	435	2.01
TT	839	523	1.60

TABLE 3-2.2 (Continued)

<u>CUSTOMER</u>	<u>B</u>	<u>C</u>	<u>B/C</u>
UU	\$2766	\$ 709	3.90
VV	2028	1433	1.42
WW	1498	321	4.67
XX	1606	983	1.63
YY	1048	651	1.61
ZZ	1681	1209	1.39
AAA	3200	800	4.00
BBB	1667	1034	1.61
CCC	2469	789	3.13
DDD	970	660	1.47
EEE	1210	695	1.74
FFF	2550	938	2.72
GCC	1835	787	2.33
HHH	3419	1932	1.77
III	1347	771	1.75
JJJ	1548	524	2.95
KKK	2046	565	3.62
LLL	1156	584	1.98
MMM	4073	665	6.12
NNN	892	312	2.86
OOO	2197	615	3.57
PPP	970	423	2.29
QQQ	1672	502	3.33
RRR	1456	675	2.16

TABLE 3-2.3

NO-LOAD LOSS COSTS (\$/KW)

\$ 365	\$ 1460
548	1498
600	1513
660	1525
677	1548
814	1588
824	1606
835	1640
839	1667
875	1672
892	1681
938	1689
943	1835
944	1850
970	1950
970	2028
1048	2046
1057	2055
1060	2076
1060	2095
1064	2100
1108	2102
1109	2197
1156	2222
1185	2373
1200	2469
1210	2486
1250	2550
1274	2560
1283	2766
1320	3200
1340	3409
1347	3419
1362	3681
1456	4073

$$\Sigma y = 112212$$

$$(\Sigma y)^2 = 12,591,532,000$$

$$\text{Avg} = \frac{112212}{70} = \$1603/\text{KW}$$

$$\text{Median} = \$1458$$

$$S^2 = \frac{\Sigma(Y_i)^2 - \frac{(\Sigma Y_i)^2}{n}}{n-1}$$

$$S^2 = \frac{221529362 - \frac{1.2591532 \times 10^{10}}{70}}{69}$$

$$S^2 = \frac{221529362 - 179879020}{69}$$

$$S^2 = \frac{41650342}{69} = 603628$$

$$S = \$777 = \sigma$$

$$n - \sigma = 1603 - 777 = \$826$$

$$n + \sigma = 1603 + 777 = \$2380$$

FIG. 3-2.1

TABLE 3-2.4

LOAD LOSS COSTS (\$/kW)

\$ 229	\$ 651
241	660
251	665
252	675
275	679
312	687
321	695
356	709
375	711
375	771
390	787
400	789
423	800
435	825
435	835
447	865
450	875
466	890
475	911
480	917
492	933
502	938
523	952
524	983
543	1000
557	1034
565	1200
578	1203
584	1204
593	1209
607	1217
615	1245
623	1389
624	1433
627	<u>1932</u>

$$\text{Avg} = \frac{49214}{70} = \$703/\text{kW}$$

$$\text{Median} = \$639$$

$$S^2 = \frac{\sum(Y1)^2 - \frac{(\sum Y1)^2}{n}}{n-1}$$

$$S^2 = \frac{42,026,150 - \frac{2,422,017,796}{70}}{69}$$

$$S^2 = \frac{42,026,150 - 34,600,254}{69}$$

$$S^2 = \frac{7425896}{69} = 107622$$

$$S = \$328 = \sigma$$

$$n - \sigma = 703 - 328 = \$375$$

$$n + \sigma = 703 + 328 = \$1031$$

$$\sum y = 49214$$

$$(\sum y)^2 = 2,422,017,796$$

FIG. 3-2.2

TABLE 3-2.5

RATIO OF NO-LOAD LOSS COST/LOAD LOSS COST

0.94	2.07	
1.05	2.16	
1.27	2.18	
1.34	2.23	
1.39	2.25	
1.39	2.29	
1.42	2.30	
1.47	2.33	
1.48	2.39	
1.50	2.40	
1.50	2.70	
1.51	2.71	
1.60	2.72	
1.61	2.86	
1.61	2.95	
1.63	2.99	
1.63	3.13	
1.68	3.13	
1.74	3.16	
1.74	3.20	
1.74	3.33	
1.75	3.42	
1.75	3.57	
1.76	3.62	
1.77	3.74	
1.80	3.90	
1.83	4.00	
1.83	4.11	
1.87	4.21	
1.87	4.22	
1.90	4.26	
1.92	4.38	
1.98	4.67	
1.99	6.12	
2.01	6.67	

$$\text{Avg} = \frac{173.64}{70} = 2.48$$

$$\text{Median} = 2.04$$

$$S^2 = \frac{\sum(Y_i)^2 - \frac{(\sum Y_i)^2}{n}}{n-1}$$

$$S^2 = \frac{522.0624 - \frac{30150.85}{70}}{69}$$

$$S^2 = \frac{522.06 - 430.73}{69}$$

$$S^2 = \frac{91.33}{69} = 1.32$$

$$S = 1.15 = \sigma$$

$$n - \sigma = 1.33$$

$$n + \sigma = 3.63$$

$$\text{Avg. load loss cost} = \frac{\$1603}{2.48} = \$646/\text{kW}$$

$$n - \sigma = \frac{1.33}{2.48} \times 646 = \$346$$

$$n + \sigma = \frac{3.63}{2.48} \times 646 = \$946$$

$$\sum Y = 173.64$$

$$(\sum Y)^2 = 30150.85$$

TABLE 3-2.6

GENERATION PLANT COSTS (1977)

<u>REGION</u>	<u>NUCLEAR</u>	<u>COAL</u> ⁽²⁾	<u>OIL</u> <u>(residual)</u>	<u>COMBINED</u> <u>CYCLE</u> <u>(Residual)</u>	<u>COMBINED</u> <u>CYCLE</u> <u>(Distillate #2)</u>	<u>COMBUSTION</u> <u>TURBINE</u> <u>(Distillate #2)</u>
Northeast	\$875/kW	\$735/kW		\$370/kW	\$330/kW	
Southeast	750	600		340	300	
East Central	830	700		345	300	
West Central	795	690		340	300	
South Central	775	706 ⁽³⁾		325	285	
West	<u>825</u>	<u>715</u>	—	<u>335</u>	<u>295</u>	—
National Avg.	\$808/kW	\$691/kW	\$440/kW	\$343/kW	\$302/kW	\$160/kW

- Notes:
1. All capitalized costs are 1977 costs in end-of-the-year 1977 dollars
 2. Coal plant costs include FGD.
 3. South Central region coal plant cost includes \$66/kW for additional transmission associated with lignite burning minemouth station.

TABLE 3-2.7

GENERATION PLANT COSTS

<u>PLANT TYPE</u>	<u>USE</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
NUCLEAR	(B)	\$808/kW	\$856/kW	\$908/kW	\$962/kW
COAL	(B)	691	732	776	823
OIL (residual)	(B)	440	466	494	524
COMBINED CYCLE (residual)	(I)	343	364	385	408
COMBINED CYCLE (distillate #2)	(I)	302	320	339	360
COMBUSTION TURBINE (distillate #2)	(P)	160	170	180	191

- Notes:
1. Capitalized plant costs are in end-of-the-year dollars.
 2. A 6 percent/year inflation rate is used.
 3. Use - (B) base-load generation
(I) intermediate generation
(P) peaking generation

TABLE 3-2.8

TRANSMISSION & DISTRIBUTION SYSTEM COSTS

	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
TRANSMISSION LINES	\$51/kW	\$54/kW	\$57/kW	\$61/kW
TRANSMISSION SUBSTATIONS	38	40	43	45
DISTRIBUTION SUBSTATIONS	20	21	22	24
PRIMARY DISTRIBUTION LINES	<u>76</u>	<u>80</u>	<u>85</u>	<u>90</u>
TOTAL T&D SYSTEM COST	\$185/kW	\$195/kW	\$207/kW	\$220/kW

TABLE 3-2.9
ENERGY COST DATA (1977)

<u>PLANT TYPE</u>	<u>FUEL COST (Mils/kWh)</u>	<u>O&M COST (Mils/kWh)</u>	<u>ENERGY COST (Mils/kWh)</u>
NUCLEAR	5.824 ⁽¹⁾	1.019	6.843
COAL	9.447 ⁽²⁾	2.950	12.397
OIL (residual)	23.180 ⁽³⁾	0.510	23.690
COMBINED CYCLE (residual)	21.472 ⁽⁴⁾	2.110	23.582
COMBINED CYCLE (distillate #2)	22.533 ⁽⁴⁾	1.416	23.949
COMBUSTION TURBINE (distillate #2)	36.260 ⁽⁵⁾	2.110	38.370

- Notes:
1. Nuclear fuel cost based on average of \$/million Btu with and without plutonium recycling and 10400 Btu/kWh average annual heat rate.
 2. Coal fuel cost based on regional coal price in \$/million Btu and the average annual heat rate for each regional plant reference design.
 3. Oil plant fuel cost based on residual oil (0.3-0.5% sulfur) and 9500 Btu/kWh average annual heat rate.
 4. Combined cycle fuel costs based on (0.3-0.5% sulfur) residual or distillate #2 oil and 8800 Btu/kWh and 8700 Btu/kWh average annual heat rates for residual and distillate #2 oils, respectively.
 5. Combustion turbine fuel cost based on distillate #2 oil (0.3-0.5% sulfur) and 14000 Btu/kWh average annual heat rate.
 6. All O&M costs include fixed and variable costs. O&M cost for coal plant includes consumable cost (limestone plus sludge and ash disposal).
 7. Fixed O&M cost derived from \$/kW-yr. divided by 8760.

TABLE 3-2.10
ENERGY COST DATA

<u>PLANT TYPE</u>	<u>ENERGY COST (MILS/KWH)</u>			
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
NUCLEAR	6.84	7.35	7.90	8.49
COAL	12.40	13.18	14.02	14.91
OIL (residual)	23.69	26.98	30.73	35.00
COMBINED CYCLE (residual)	23.58	26.73	30.31	34.38
COMBINED CYCLE (distillate #2)	23.95	27.11	30.69	34.75
COMBUSTION TURBINE (distillate #2)	38.37	43.44	49.19	55.71

TABLE 3-2.11

LEVELIZING FACTORS

<u>PRODUCTION COST ITEM</u>	<u>REAL ESCALATION RATE</u>	<u>INFLATION RATE</u>	<u>APPARENT RATE</u>	<u>LEVELIZING FACTOR</u>
NUCLEAR FUEL	1.65%	6%	7.749%	2.178
COAL	0.43%	6%	6.459%	1.873
RESIDUAL OIL	1.70%	6%	7.802%	2.192
DISTILLATE #2 OIL	1.61%	6%	7.707%	2.167
ALL O&M COSTS	0.00%	6%	6.000%	1.779

TABLE 3-2.12
LEVELIZED ENERGY COSTS (1980)

<u>PLANT TYPE</u>	<u>USE</u>	<u>LEVELIZED FUEL COST</u>	<u>LEVELIZED C&M CGST</u>	<u>LEVELIZED ENERGY COST</u>	<u>EQUIVALENT LEVELIZING FACTOR</u>	<u>EQUIVALENT INFLATION RATE</u>
NUCLEAR	(B)	15.85 mils/kWh	2.16 mils/kWh	18.01 mils/kWh	2.121	7.527%
COAL	(B)	21.55	6.25	27.60	1.851	6.354
OIL (residual)	(B)	75.40	1.08	76.48	2.185	7.775
COMBINED CYCLE (residual)	(I)	69.84	4.47	74.31	2.161	7.683
COMBINED CYCLE (distillate #2)	(I)	71.64	3.00	74.64	2.148	7.633
COMBUSTION TURBINE (distillate #2)	(F)	115.28	4.47	119.75	2.150	7.641

- Notes:
1. All costs are levelized costs at the end-of-the-year 1980.
 2. Use - (B) base-load generation
(I) intermediate generation
(P) peaking generation

TABLE 3 - 2.13
SUMMARY OF SYSTEM COST PARAMETERS

		<u>Scenario 1</u>	<u>Scenario 2</u>
CSYSB	System investment cost per unit of base load	\$ 744/kW	\$ 1182/kW
CSYSP	System investment cost per unit of peak load	\$ 411/kW	\$ 411/kW
CEB1	Incremental energy cost for base load (first year value)	\$0.0350/kWh	\$0.0085/kWh
CEP1	Incremental energy cost for peak generation (first year value)	\$0.0557/kWh	\$0.0557/kWh
CEBL	Incremental energy cost for base load (levelized value)	\$0.0765/kWh	\$0.0180/kWh
CEPL	Incremental energy cost for peak generation (levelized value)	\$0.1198/kWh	\$0.1198/kWh
IRB	Inflation rate for base load energy cost	0.07775 p.u.	0.07527 p.u.
IRP	Inflation rate for peak energy cost	0.07641 p.u.	0.07641 p.u.
DISC	Discount factor for system investment	0.75 p.u.	0.75 p.u.
CC	Levelized annual carrying charge rate	0.18 p.u.	0.18 p.u.
I	Rate of return (weighted cost of capital)	0.10 p.u.	0.10 p.u.
CCAPF	Installed cost of fixed capacitors	\$4.80/kVAR	\$4.80/kVAR
CCAPS	Installed cost of switched capacitors	\$9.24/kVAR	\$9.24/kVAR
CCE1	Average sale price of incremental energy to customer (first year value)	\$0.0472/kWh	\$0.0472/kWh
CE1	Average energy cost (first year value)	\$0.0216/kWh	\$0.0216/kWh

NOTE: Scenario 1 represents oil-fired base-load generation
Scenario 2 represents nuclear base-load generation

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3.3 TASK 3 - COMPILE LOAD PARAMETERS AND LOADING POLICIES

INTRODUCTION

This task is directed toward selecting the transformer load parameters and utilities' transformer loading policies for use in the loss evaluation technique that was selected in Task 1. The load characteristics required are the annual transformer peak load, transformer loss factor, peak responsibility factor (both system and distribution system), load power factor, and the change in kW load as a function of change in voltage.

It was shown in Task 1 that the "total levelized annual cost" method and the "present worth of annual revenue requirements" method of loss evaluation are equivalent. Regardless of the alternative method used, it is necessary to determine the annual transformer peak load for each year of the evaluation. These annual transformer peak loads are a function of the initial annual peak load, the levelized annual compound peak load growth rate, and the final annual peak load, all in per unit. The final peak load can be one of two possible quantities; either (1) the economic transformer changeout load, or (2) the annual peak load at the end of the transformer's expected life. The equivalent annual peak load is required for two conditions; with no inflation and with energy cost inflation. This task was performed by the T&D Systems Engineering Department of Westinghouse.

TRANSFORMER LOAD CHARACTERISTICS

The principal load characteristics required for loss calculations are maximum demand, load factor, loss factor and peak responsibility

factor. To define the specific load characteristics, the units of the load (kW, kVA), the demand interval, or period over which the load is averaged (15-minute, 30-minute, one-hour), and period during which the load is measured (daily, weekly, monthly, annual) must also be defined⁽¹⁾. For example, the maximum demand for transformer loss evaluation is usually considered to be maximum annual, 30-minute, integrated kVA demand. The load factor (ratio of average load to peak load), loss factor (ratio of average power loss to peak power loss), and peak responsibility factor (ratio of transformer load at the time of system peak to the transformer peak load) must be defined consistent with the maximum demand; that is, using the same load units (kVA), demand interval (30-minute), and time period (annual).

Existing Load Characteristics

A literature search was completed to identify values for load factor, loss factor, power factor, peak responsibility factors and change in kW load as a function of voltage change used in the industry. A bibliography of pertinent papers and articles pertaining to transformer load characteristics is included in this report. Transformer load characteristics from a 1978 industry survey of 71 utilities were also obtained to supplement the load data from the literature search.

A review of the available data reveals a wide variation in the load characteristics measured or used. For example, the range of values found were as follows:

	<u>Minimum</u>	<u>Maximum</u>
load factor (LDF)	0.19 p.u.	0.62 p.u.
loss factor (LSF)	0.06 p.u.	0.68 p.u.
power factor (PF)	0.80 p.u.	0.95 p.u.
annual peak load (P)	0.60 p.u.	2.00 p.u.
peak responsibility factor (system) (PRFS)	0.46 p.u.	0.95 p.u.
peak responsibility factor (dist. system) (PRFD)		0.866 p.u.
% kW change/% voltage change (LKW)	0.50 %	1.00 %

Although some variation in these load characteristics is to be expected, many of the ranges are too wide to be considered reasonable. A few possible explanations are offered.

1. The upper range on LDF (0.62 p.u.) and LSF (0.68 p.u.) are more representative of system quantities than transformer characteristics. Daily load factors and loss factors would also be expected to be this high, whereas annual values should be used.
2. There is some confusion in the industry regarding the definition and use of peak responsibility factor. Some use the term as a ratio of losses (or load squared) as opposed to a ratio of loads which could account for the lower range of PRFS.
3. The annual peak load was identified in some cases to be initial load or final load on the transformer which accounts for the two extreme values of P. Some intermediate values were identified as an equivalent (levelized) annual peak load.
4. The effect of voltage reduction on energy consumption is a controversial area and would account for the variability of LKW.
5. Some of the variability is due to the well known fact that load characteristics vary as a function of the transformer size (load) or the number of customers served by the transformer. An example of this is shown in Table 3-3.1.

If it is assumed that each customer has the same annual energy consumption, and since load factor can be expressed in terms of annual

energy and maximum demand, then each customer has the same individual load factor and loss factor.

$$\text{LDF}(N) = \frac{e}{8760 \times \bar{D}(N)}$$

where

LDF(N)	=	load factor for N customers, per unit
e	=	annual energy consumption, kWh
8760	=	number of hours per year
$\bar{D}(N)$	=	average maximum diversified demand per customer as a function of the number of customers (N), kVA

The maximum diversified demand of a composite group of loads, such as the load on a transformer, is obtained by applying coincidence factors to the average maximum individual customer demand, and multiplying by the number of customers on the transformer. The coincidence factors must relate to the same statements of demand interval, time period, and load units as the maximum demand itself. Therefore, the maximum diversified demands, load factors, loss factors and distribution system peak responsibility factors can be calculated for each group of N customers by knowing the maximum demand and load factor of an individual customer and the coincidence factors for each group of N customers.

Coincidence Factor

The coincidence factor is usually applied to a set of individual maximum demands to obtain the maximum diversified demand. A particular group of loads which impose a particular set of individual demands and a particular group maximum demand on the system has a specific coincidence factor. However, the maximum demands apply to a specific set of loads

and particular conditions, such as ambient temperature and relative humidity.

It is impractical to develop, or to attempt to apply, a coincidence curve to other than a group of relatively homogeneous loads. Homogeneous loads are considered to have equal individual maximum demands and similar load cycles, but the individual cycles are not necessarily coincident, with respect to time, throughout the load cycle period. An average coincidence characteristic may have accuracy limitations for very small numbers of loads (or customers), but as the number of homogeneous loads is increased, the contribution of each load to the group maximum demand decreases, and reasonable accuracy should be attained.

Figure 3-3.1 shows a plot of several load coincidence curves presently used in the industry. All of the curves supposedly result from measured load data. The curve used by Arkansas Power & Light is of interest. It falls roughly in the middle of all other curves. Furthermore, the utility found an equation which fit the measured data:⁽²⁾

$$CF = 0.5 \left(1 + \frac{5}{2N+3} \right)$$

when N is the number of customers served by the transformer. This curve is reproduced in Figure 3-3.2. The coincidence factors resulting from this equation are considered representative and will be used.

Load Factor/Loss Factor Relationship

The load factor is the ratio of the average load over a designated period of time to the peak load occurring in that period. In actual practice, it is relatively easy to continuously monitor the load on a distribution transformer and determine the annual load factor for a

given demand interval. Determination of the loss factor, or ratio of average power loss to the peak load power loss over a given period of time, is more difficult. Although loss factor cannot be determined directly from load factor, losses are proportional to the square of the load, and it can be shown that loss factor is between the limits of load factor and load factor squared⁽¹⁾.

A considerable number of studies have been performed, using actual distribution transformer load data, and a general formula or "rule of thumb" has been established that relates loss factor to the more easily determined load factor:

$$LSF = A \times LDF + B \times (LDF)^2$$

where A and B are constants, such that $A+B = 1$, and A is usually between 0.15 and 0.30.

Two recent field tests help to verify this relationship. Analysis of the Coral Springs Laboratory data⁽³⁾ resulted in the equation, without the constraint that $A+B = 1$:

$$LSF = 0.111 \times LDF + 0.894 \times (LDF)^2$$

Transformer load measurements at Detroit Edison⁽⁴⁾ were analyzed incorporating the effect of the percent saturation of air conditioning load on the transformer. Based on load data from 200 transformers, the constant A varied from 0.20 (B = 0.80) for 20 percent saturation to A = 0.11 (B = 0.89) for 100 percent saturation of air conditioning. The Detroit Edison value of A = 0.11 compares favorably to the Coral Springs value of A = 0.111, where the transformers also had a 100 percent saturation of air conditioning load.

An earlier set of data results from a field measurement program involving 600 distribution transformer installations was published in 1965⁽⁵⁾. This load data was obtained for one year from test installations throughout the country on all sizes of distribution transformers serving predominantly residential loads. The relationship between the annual load factor and loss factor for this data representing the entire residential load class was found to be

$$LSF = 0.15 \times LDF + 0.85 (LDF)^2$$

This relationship also compares favorably with that obtained at Coral Springs and Detroit Edison and is considered to be a good approximation for distribution transformer loads. It will therefore be used in the following development of a set of transformer load characteristics.

Derivation of Load Characteristics

It was pointed out earlier that, with the coincidence factors for each group of N customers, and the maximum demand and load factor of an individual customer, the remaining load characteristics can be calculated. Reference 5 contains a comprehensive set of load factors as a function of the number of customers. In particular, the load factor for one customer is $LDF(1) = 0.19$. The Electrical World forecast⁽⁶⁾ also provides a good estimate of the annual energy consumption per residential customer in 1979, $e = 9108$ kWh. Then the average maximum diversified demand for one customer is:

$$\bar{D}(1) = \frac{e}{8760 \times LDF(1)} = \frac{9108}{8760 \times 0.19} = 5.472 \text{ kW}$$

Table 3-3.1 is a set of load characteristics developed for various numbers of customers using $\bar{D}(1) = 5.472$ kW, $LDF(1) = 0.19$ and the Arkansas Power & Light coincidence factors. The characteristics were developed using the following relationships:

$$\bar{D}(N) = \bar{D}(1) \times CF(N)$$

$$D(N) = N \times \bar{D}(N)$$

$$LDF(N) = \frac{e}{8760 \times \bar{D}(N)}$$

$$LSF(N) = 0.15 \times LDF(N) + 0.85 \times LDF(N)^2$$

$$PRFD(N) = \frac{CF(m)}{CF(N)}, \text{ where } m \text{ is some large number}$$

Once the load characteristics have been determined, it remains to determine which set of characteristics to use; that is, selection of the number of customers per transformer. This determination is dependent on the transformer size to be evaluated. For example, using Table 3-3.1, if a 50 kVA transformer is to be evaluated, and an initial 1.0 p.u. peak load is assumed, the characteristics for 16 customers per transformer would be used since the cumulative maximum diversified demand (D) is 49.99 kW. Since transformers rated 25- to 50-kVA are to be evaluated, the range of load characteristics applicable to 6 to 25 customers per transformer might be used. In particular, it appears that a 25-kVA transformer would serve 6 to 12 customers and a 50-kVA unit, 12 to 25 customers. For this project, a single estimate of the load characteristics seems reasonable.

Annual Loss Factor

With reference to Table 3-3.1, the range of loss factors applicable to a 25-kVA transformer (6 to 12 customers) is 0.112 to 0.135 p.u., with an average value of 0.124 p.u. being a good approximation over the loading range of the transformer. The range of loss factors applicable to a 50-kVA transformer (12 to 25 customers) is 0.135 to 0.154 p.u., with an average value of 0.144 per unit.

The annual loss factor representing 12 customers per transformer is selected for use in subsequent tasks of this project:

$$\text{LSF} = 0.135 \text{ p.u.}$$

Peak Responsibility Factor (Distribution System)

The distribution system peak responsibility factor is the ratio of the transformer load at the time of distribution feeder or substation peak to the actual transformer peak load. As in the case of loss factor selection, the distribution system peak responsibility factor representing 12 customers per transformer (from Table 3-3.1) is selected:

$$\text{PRFD} = 0.843 \text{ p.u.}$$

Peak Responsibility Factor (System)

The system peak responsibility factor, which is the ratio of transformer load at the time of system peak to the actual transformer peak load, is used to account for load diversity. Since the peak load loss occurs at peak load on the transformer, this may or may not be at the same time that the total load, and thus the generation, is at its maximum value.

Based on the 1978 industry survey of 71 utilities, the system peak responsibility factors being used range from 0.46 to 0.95 p.u., with an average value of 0.77 p.u. The load measurement program at Detroit Edison ⁽⁴⁾ resulted in calculated system peak responsibility factors ranging from 0.712 p.u. for 20 percent saturation of air conditioning load to 0.797 p.u. for 100 percent saturation of air conditioning, with an average value of 0.75 p.u.

Tampa Electric Company also conducted a load measurement program to study residential load characteristics ⁽⁷⁾. Figure 3-3.3 shows the actual load cycles for the system, feeder and distribution transformer for the 1968 winter system peak day. Figure 3-3.3 shows the system peak occurring at 7:00 P.M. The peak load on the feeder is 1080 kW occurring at 8:00 P.M. With the feeder load of 930 kW at the time of system peak, the system peak responsibility factor for the feeder is 0.86 p.u. Similarly, the peak load on the transformer is 43 kW occurring at 11:00 A.M. The distribution transformer load of 31.5 kW at the time of system peak results in a system peak responsibility factor of 0.73 p.u. for the transformer.

Since the above three sources of information results in responsibility factors ranging from 0.73 p.u. to 0.77 p.u., the system peak responsibility factor selected is:

$$\text{PRFS} = 0.75 \text{ p.u.}$$

Power Factor

Power factor is basically defined as the ratio of active power to apparent power. Since distribution transformer loads are continually changing, the defined power factor must be applicable to a particular

load condition, such as peak load, light load or average load. Values for peak load power factor were obtained from the literature search on load characteristics supplemented by the 1978 industry survey of 71 utilities. The values, some of which result from actual field measurements, range from 0.80 p.u. to 0.95 p.u., with an average value of 0.90 p.u. The peak load power factor for use in subsequent tasks is:

$$PF = 0.90 \text{ p.u.}$$

Load Change as a Function of Voltage Change

The effect of voltage reduction on energy consumption is a controversial area. Field tests by AEP⁽⁸⁾, Southern California Edison⁽⁹⁾, and Pacific Gas & Electric⁽¹⁰⁾ show a wide range of results, from 0.1 percent to 1.25 percent energy reduction for each one percent voltage reduction, with an average value of 0.78 percent energy reduction. The 1978 industry survey of 71 utilities provided only a limited number of values, ranging from 0.5 percent to 1.0 percent energy reduction for each one percent voltage reduction, with an average value of 0.75 percent. The best estimate of the percent load change for a one percent voltage change is:

$$LKW = 0.75 \%$$

ECONOMIC TRANSFORMER CHANGEOUT LOAD

The economic transformer changeout load (point B on Figure 3-3.4) is the annual peak load at which the annual cost of the transformer in use (transformer T1) is greater than the annual cost of the replacement transformer (transformer T2) by an amount equal to the return on delaying the changeout by one year⁽¹¹⁾. That return (shown as C on Figure 3-3.4) is equal to the changeout expense multiplied by the expected rate of return.

A literature search to identify existing transformer loading policies, including methods of determining the economic transformer changeout load was completed. A bibliography of papers and articles pertaining to economic changeout methods is included in this report. Recognizing that determination of the economic changeout load involves the calculation of transformer loss costs, it is not surprising that existing economic changeout procedures differ in the same manner as existing loss evaluation methods. These differences were discussed under Task 1.

The determination of the economic transformer changeout load must be consistent with the loss evaluation procedure used. Therefore, the derivation of the "economic transformer changeout load" equation will use the loss cost equations selected in Task 1.

The total annual transformer cost consists of:

1. Annual cost of transformer investment
2. Annual no-load loss cost
3. Annual load loss cost
4. Annual reactive no-load loss cost
5. Annual reactive load loss cost
6. Annual regulation loss cost

The total annual cost equation for the transformer can be written in simplified form as follows⁽¹²⁾:

$$\begin{aligned} \text{TAC} = & (\text{CT} \times \text{CC}) + \text{ADC (no-load)} + \text{AEC (no-load)} \\ & + \text{ADC (load)} + \text{AEC (load)} + \text{ARC (no-load)} \\ & + \text{ARC (load)} + \text{AEC (reg.)} - \text{ADC (reg.)} \end{aligned}$$

where:

TAC = total annual cost, \$/year
 CT = transformer cost to utility, \$

- CC = levelized annual carrying charge rate, p.u.
 ADC = annual demand cost of losses for no-load, load, and regulation losses, respectively, \$/year.
 AEC = annual energy cost of losses for no-load, load, and regulation losses, respectively, \$/year.
 ARC = annual cost of reactive losses for no-load and load reactive losses, respectively, \$/year

Using the proper equations for each of the loss cost parameters for each transformer then leads to the following "economic transformer changeout load" equation, where the parameters identified with the numbers 1 and 2 (e.g., CT1, CT2) refer to transformer T1 (transformer in use) and transformer T2 (replacement transformer), respectively. The nomenclature for the parameters used in the economic changeout load equation is listed in Table 3-3.2.

$$\begin{aligned}
 & (CT1 \times CC) \times NLL1 (CSYSB \times DISC \times CC + 8760 \times CEB1) \\
 & + (LL1 \times P1^2) (CSYSP \times DISC \times CC \times PRFS^2 + 8760 \times LSF \times CEP1) \\
 & + (CCAPF \times CC) \times \sqrt{T1^2 \times I01^2 - NLL1^2} \\
 & + (CCAPS \times CC \times PRFD^2 \times P1^2) \times \sqrt{T1^2 \times Z1^2 - LL1^2} \\
 & + (REG1 \times T1 \times P1^2) (PF \times LKW \times 8760 \times LSF) (CCE1 - CE1) \\
 & - (REG1 \times T1 \times P1^2) \times (PF \times LKW \times PRFS^2 \times CSYSP \times DISC \times CC) \\
 & = (CT2 \times CC) + NLL2 (CSYSB \times DISC \times CC + 8760 \times CEB1) + (COE \times I) \\
 & + (LL2 \times P2^2) (CSYSP \times DISC \times CC \times PRFS^2 + 8760 \times LSF \times CEP1) \\
 & + (CCAPF \times CC) \times \sqrt{T2^2 \times I02^2 - NLL2^2} \\
 & + (CCAPS \times CC \times PRFD^2 \times P2^2) \times \sqrt{T2^2 \times Z2^2 - LL2^2} \\
 & + (REG2 \times T2 \times P2^2) (PF \times LKW \times 8760 \times LSF) (CCE1 - CE1) \\
 & - (REG2 \times T2 \times P2^2) (PF \times LKW \times PRFS^2 \times CSYSP \times DISC \times CC)
 \end{aligned}$$

Then, combining terms:

$$\begin{aligned}
 & (P_1^2 \times LL_1 - P_2^2 \times LL_2) (CSYSP \times DISC \times CC \times PRFS^2 + 8760 \times LSF \times CEP_1) \\
 & + (PRFD^2 \times CCAPS \times CC) (P_1^2 \times \sqrt{T_1^2 \times Z_1^2 - LL_1^2} - P_2^2 \times \sqrt{T_2^2 \times Z_2^2 - LL_2^2}) \\
 & + (P_1^2 \times REG_1 \times T_1 - P_2^2 \times REG_2 \times T_2) (PF \times LKW) (8760 \times LSF) (CCE_1 - CE_1) - PRFS^2 \times CSYSP \times DISC \times CC \\
 & = CC(CT_2 - CT_1) + (CSYSB \times DISC \times CC + 8760 \times CEB_1) (NLL_2 - NLL_1) \\
 & + (COE \times I) + (CCAPF \times CC) (\sqrt{T_2^2 \times I_{O2}^2 - NLL_2^2} - \sqrt{T_1^2 \times I_{O1}^2 - NLL_1^2})
 \end{aligned}$$

Since the peak load (P) is in per unit of the transformer nameplate rating (T), the peak load (P2) on the replacement transformer can be expressed in terms of the peak load (P1) on the transformer in use:

$$P_2 \times T_2 = P_1 \times T_1$$

then

$$P_2 = P_1 \times \frac{T_1}{T_2}$$

and

$$P_2^2 = P_1^2 \times \left(\frac{T_1}{T_2}\right)^2$$

Substituting and solving for (P1), the complete "economic transformer changeout load" equation becomes:

$$P_1^2 = \frac{A}{B} \text{ or } P_1 = \sqrt{\frac{A}{B}}$$

where:

$$\begin{aligned}
 A = & CC(CT_2 - CT_1) + (CSYSB \times DISC \times CC + 8760 \times CEB_1) (NLL_2 - NLL_1) + (COE \times I) \\
 & + (CCAPF \times CC) (\sqrt{T_2^2 \times I_{O2}^2 - NLL_2^2} - \sqrt{T_1^2 \times I_{O1}^2 - NLL_1^2})
 \end{aligned}$$

$$\begin{aligned}
B = & (CSYSP \times DISC \times CC \times PRFS^2 + 8760 \times LSF \times CEP1) (LL1 - (\frac{T1}{T2})^2 \times LL2) \\
& + (PRFD^2 \times CCAPS \times CC) (\sqrt{T1^2 \times Z1^2 - LL1^2} - (\frac{T1}{T2})^2 \sqrt{T2^2 \times Z2^2 - LL2^2}) \\
& + (T1 \times PF \times LKW) (8760 \times LSF) (CCE1 - CE1) - PRFS^2 \times CSYSP \times DISC \times CC (REG1 - \frac{T1}{T2} \times REG2)
\end{aligned}$$

It should be noted that the load growth rate has no effect on the economic transformer changeout load. An example of the determination of the economic changeout load is shown below, using representative system, transformer, and load parameters. The system cost and load parameters are those developed in Tasks 2 and 3 of this project and the transformer characteristics are representative of 1979 (mid-loss) transformers, Type S, 7200/12470Y - 120/240 volts.

Example Data

CSYSB = \$744/kW	T1 = 25 kVA	T2 = 50 kVA
CSYSP = \$411/kW	CT1 = \$337	CT2 = \$510
CEB1 = \$0.035/kWh	NLL1 = 0.105 kW	NLL2 = 0.191 kW
CEP1 = \$0.0557/kWh	LL1 = 0.316 kW	LL2 = 0.524 kW
CCE1 = \$0.0472/kWh	I01 = 0.015 p.u.	I02 = 0.015 p.u.
CE1 = \$0.0216/kWh	Z1 = 0.018 p.u.	Z2 = 0.018 p.u.
COE = \$100	REG1 = 0.014 p.u.	REG2 = 0.014 p.u.
DISC = 0.75 p.u.	CCAPF = \$4.80/kVAR	CCAPS = \$9.24/kVAR
CC = 0.18 p.u.	LSF = 0.135 p.u.	PF = 0.90 p.u.
I = 0.10 p.u.	PRFS = 0.75 p.u.	PRFD = 0.843 p.u.
LKW = 0.75%		

Example

$$\begin{aligned}
A = & 0.18(510-337) + (744 \times 0.75 \times .18 + 8760 \times .035)(.191-.105) + (100 \times .10) \\
& + (4.80 \times .18) (\sqrt{50^2 \times .015^2 - .191^2} - \sqrt{25^2 \times .015^2 - .105^2})
\end{aligned}$$

$$A = \$31.14 + \$35.01 + \$10.00 + \$0.32 = \$76.47$$

(Investment Cost) (No-load loss-cost) (Changeout Cost) (Reactive No-load loss cost)

$$B = (411 \times 0.75 \times .18 \times .75^2 + 8760 \times .135 \times .0557) \left(.316 - \left(\frac{25}{50} \right)^2 \times .524 \right) \\ + (.843^2 \times 9.24 \times .18) \left(\sqrt{25^2 \times .018^2 - .316^2} - \left(\frac{25}{50} \right)^2 \sqrt{50^2 \times .018^2 - .524^2} \right) \\ + (25 \times .9 \times .75) \left[(8760 \times .135) (.0472 - .0216) - .75^2 \times 411 \times .75 \times .18 \right] \\ (.014 - \left(\frac{25}{50} \right) \times .014)$$

$$D = \$17.96 + \$0.16 + \$3.58 - \$3.69 = \$18.01$$

(Load loss Cost) (Reactive load loss cost) (Regulation energy cost) (Regulation demand savings)

$$P1 = \sqrt{\frac{A}{B}} = \sqrt{\frac{76.47}{18.01}} = 2.06 \text{ p.u.}$$

For the assumed parameters, the economic transformer changeout load (a 25 kVA unit changed out to a 50 kVA unit) is 206 percent of nameplate rating when all annual transformer costs are considered.

An EEI Task Force Report⁽¹³⁾ in 1963 was intended as a uniform method for the industry to use in transformer loss evaluations. This report was never officially published, primarily because the Task Force could not resolve the question of how to properly evaluate voltage regulation. There are several areas of controversy surrounding the evaluation of regulation. The EEI method used an approximate, although adequate, formula for the per unit voltage regulation (voltage drop) of the transformer. The EEI method, unlike others, also accounted for the savings resulting from system demand reduction. It is this factor that has created skepticism among the utilities, since it is possible to get a negative value for the cost of regulation.

It can also be seen in the above example that inclusion of the regulation demand savings results in a rather high value for the economic transformer changeout load (206 percent). Loading transformers to this level would indicate that the economic effect of transformer insulation aging should perhaps be considered. A procedure for calculating the present worth cost (or levelized annual cost) of transformer loss of life using formulas from the ANSI Loading Guide⁽¹⁴⁾ would need to be incorporated into the "economic transformer changeout load" equation. This additional complexity is beyond the scope of this study.

A new EEI Transformer Evaluation Task Force was organized in August, 1977. This task Force has concluded that the true cost of regulation is the cost of voltage regulating equipment itself; that is, voltage regulators, capacitors, and load tap changing (LTC) equipment.⁽¹⁵⁾ So there is reason to suggest that the regulation demand savings be eliminated in the determination of economic transformer changeout load. Neglecting this component in the above example, the economic changeout load becomes:

$$P1 = \sqrt{\frac{76.47}{21.70}} = 1.88 \text{ p.u.}$$

With an economic transformer changeout load of 188 percent of nameplate rating, transformer loss of life becomes less significant.

A final point of interest is the effect of reactive losses, both no-load and load, on the economic transformer changeout load. Neglecting both exciting current and $I^2 X$ losses, in addition to regulation demand savings, the economic changeout load is:

$$P1 = \sqrt{\frac{76.15}{21.54}} = 1.88 \text{ p.u.}$$

It is therefore concluded that neglecting the cost of reactive losses has little or no effect on the economic transformer changeout load.

It was indicated earlier that the final peak load can be either the economic transformer changeout load or the annual peak load at the end of the transformer's expected life. The proper choice depends on both the initial peak load and the peak load growth rate. Consider the following relationship:

$$IP (1 + GR)^{N-1} = FP$$

where GR is the levelized annual compound peak load growth rate and IP and FP are the initial and final annual peak loads, respectively. This relationship can be re-written in terms of the number of years (N) to transformer changeout, or the expected transformer life, as

$$N = \frac{\log_{10} (FP/IP)}{\log_{10} (GR + 1)} + 1$$

The initial peak load (IP) is based on the utility's loading policy and the annual peak load growth rate (GR) must be estimated. Assume for discussion purposes, that the initial peak loading policy is IP = 0.90 p.u. The normal expected life of a transformer will be assumed to be 30 years, and the result FP = 1.88 p.u. from the example derived for the economic transformer changeout load (neglecting regulation demand savings) will also be used. Three examples will illustrate the additional considerations required to determine the annual peak load for each year of evaluation.

Example 1. Assume the projected annual peak load growth rate is 1.5 percent per year. Then

$$N = \frac{\log_{10}(2.09)}{\log_{10}(1.015)} + 1 = 50.5 \text{ years}$$

The number of years to transformer changeout (50 years) is considerably longer than the normal expected life of the transformer (30 years). For this case, an evaluation of 30 years would be used and the final peak load (FP) at the end of the period would be:

$$P(30) = IP (1 + GR)^{N-1} = 0.9(1.015)^{29} = 1.39 \text{ p.u.}$$

Example 2.

Assume the projected annual peak load growth rate is 2.5 percent per year. Then

$$N = \frac{\log_{10}(2.09)}{\log_{10}(1.025)} + 1 = 30.8 \text{ years}$$

For this case, the number of years to changeout and expected transformer life are essentially the same, and the final peak load at the end of the period (30 years) would be:

$$P(30) = 0.9(1.025)^{29} = 1.84 \text{ p.u.}$$

Example 3.

Assume the projected annual peak load growth rate is 4 percent per year. Then

$$N = \frac{\log_{10}(2.09)}{\log_{10}(1.04)} + 1 = 19.8 \text{ years}$$

The number of years to transformer changeout (20 years) is considerably shorter than the expected transformer life. For this case, the transformer would be changed out at the end of 20 years with an annual peak load of

$$P(20) = 0.9 (1.04)^{19} = 1.90 \text{ p.u.}$$

This transformer would then be assumed to be re-installed at another location in the year 20 with an additional peak load of $IP = 0.9$ p.u. The load on this transformer would grow to a final peak load in year 30 of

$$P(30) = 0.9(1.04)^{(30-20)-1} = (1.04)^9 = 1.42 \text{ p.u.}$$

The number of years to reach the transformer changeout load as a function of annual compound peak load growth rate is shown in Figure 3-3.5 for various ratios of final peak load to initial peak load (FP/IP).

TRANSFORMER LOADING POLICY

The load on distribution transformers changes over the life of the unit, and is dependent on the rate of load growth. The "equivalent annual peak load" expression in the transformer loss evaluation technique selected in Task 1 requires an initial transformer annual peak load (IP) and a levelized annual compound peak load growth rate (GR).

Peak Load Growth Rate

Prior to the 1973 oil crisis, the annual peak load growth rate, on a national basis, was about 7 percent per year. The most recent Electrical World forecast ⁽⁶⁾ estimates the future peak load growth rate (1980-1995) at about 5 percent annually. Individual utility system peak load growth rates have varied considerably from the national figure, with some utilities experiencing no growth (or even negative growth), to others with peak load growth rates in excess of 10 percent annually. Distribution transformer peak load growth rate probably bears no relation-

ship to system load growth rates. The two primary factors causing transformer peak load growth are 1) the addition of customers on a transformer and 2) the addition of loads by a customer.

With no published data available, three values of transformer levelized annual compound peak load growth rate are assumed for this project.

$$GR = 0.02, 0.04, 0.06 \text{ p.u.}$$

Initial and Final Peak Load

The final transformer peak load can be either the economic transformer changeout load or the annual peak load at the end of the transformer's expected life. The proper choice depends on both the initial peak load and the peak load growth rate. The 1978 industry survey of 71 utilities indicates a range of initial peak (IP) and final peak (FP) values being used:

$$IP = 0.60 - 1.00 \text{ p.u.}$$

$$FP = 1.25 - 2.00 \text{ p.u.}$$

The "economic transformer changeout load" equation previously developed was used to examine the economic loading range of alternative transformer sizes (25, 37.5 and 50 kVA). Regulation demand savings was not included in the changeout equation. The first situation examined was for the case where the initial transformer is changed out to a transformer two ratings higher (for example, a 25-kVA unit changed out to a 50-kVA unit, eliminating the 37.5 kVA rating). Table 3-3.3 shows the initial and final peak loads for the two base-load cost scenarios and three load growth rates. The initial peak load for the 25 kVA

transformer is the economic changeout load for a 10 kVA unit and the final peak load for the 25 kVA unit is the 25 kVA unit's economic changeout load. This final peak load then becomes the initial peak load for the 50 kVA rating. Similarly, the initial peak load for the 37.5 kVA unit is the economic changeout load of the 15 kVA unit. Using alternate transformer sizes, the first portion of Table 3-3.3 shows the following economic loading ranges:

<u>Transformer Rating</u>	<u>Initial Peak</u>	<u>Final Peak</u>
25 kVA	0.73 - 0.80 p.u..	1.68 - 1.88 p.u.
37.5 kVA	0.77 - 0.87 p.u.	1.80 - 1.98 p.u.
50 kVA	0.84 - 0.94 p.u.	1.81 - 2.01 p.u.

It should be noted that the economic loading ranges are dependent on the particular transformer loss level selected, which in this case was that used in the "Economic Transformer Changeout Load" section.

The second situation examined was for the case where the initial transformer is changed out to a transformer of the next higher rating (for example, a 25-kVA unit changed out to a 37.5 kVA unit). The second portion of Table 3-3.3 shows the initial and final peak loads for alternative cost scenarios and load growth rates. In this case, the initial peak load for the 25 kVA transformer is the economic changeout load for a 15 kVA unit and the final peak load for the 25 kVA unit is the 25 kVA unit economic changeout load. This final peak load then becomes the initial peak load for the 37.5 kVA unit. Using consecutive transformer sizes, the second portion of Table 3-3.3 shows the following economic loading ranges.

<u>Transformer Rating</u>	<u>Initial Peak</u>	<u>Final Peak</u>
25 kVA	0.98 - 1.07 p.u.	1.69 - 1.88 p.u.
37.5 kVA	1.13 - 1.25 p.u.	1.37 - 1.48 p.u.
50 kVA	1.03 - 1.11 p.u.	1.80 - 1.97 p.u.

It can be seen that the changeout of transformers to the next higher rating results in a narrower economic loading range than when the changeout is to a transformer two ratings higher. In particular, it should be noted that the economic loading range of a 37.5 kVA transformer is extremely narrow when the changeout is to a 50 kVA unit; for example, from 1.25 to 1.48 p.u. for the oil-fired base-load cost scenario. This is consistent with previous studies ^(11,16) which concluded changeout of transformers to units two ratings higher provides the best economic choice and may result in elimination of intermediate ratings from future purchases.

It is recommended that subsequent tasks of this project consider only the situation where a transformer is changed out to a unit two ratings higher. For the particular transformer loss level selected, this results in the following loading policies:

<u>Cost Scenario</u>	<u>Transformer Rating</u>	<u>Initial Peak</u>	<u>Final Peak</u>
Oil	25 kVA	0.80 p.u.	1.88 p.u.
Nuclear	25	0.73	1.68
Oil	37.5	0.87	1.98
Nuclear	37.5	0.77	1.80
Oil	50	0.94	2.01
Nuclear	50	0.84	1.81

Equivalent Annual Peak Load

The loading policies resulting from the economic changeout load equation were used to determine the equivalent annual peak loads, PEQE and PEQ0, with and without energy cost inflation, respectively. Table 3-3.3 shows these equivalent annual peak loads as a function of transformer rating, cost scenario and load growth rate. It can be seen that,

since transformer changeout to the next higher rating results in a narrower economic loading range, the time to changeout is short compared to the case of changeout to a transformer two ratings higher. In some cases the equivalent annual peak load is not shown since two or more changeouts are required in the 30 year period. The loss evaluation equation developed in this project restricted the number of changeouts to one during the evaluation period.

The effect of the variability of the equivalent annual peak loads on the cost of losses is of interest. Table 3-3.4 shows the resultant no-load and load loss costs, in \$/kW. It can be seen that the high energy cost of the oil-fired base-load units results in a substantially higher no-load loss cost (\$4281/kW) than for the nuclear case (\$1763/kW). The load loss costs vary by 14 percent for the 25- and 37.5 kVA ratings as the load growth rate changes from two-to four percent. Increasing the growth rate to six percent reduces the load loss cost due to the earlier changeout date. Only minor variations in load loss cost occur for the 50 kVA rating.

SUMMARY OF TRANSFORMER LOAD CHARACTERISTICS

Representative distribution transformer load characteristics have been selected for use in subsequent tasks. These load characteristics are shown in Table 3-3.5. Since the economic transformer loading range is dependent on the transformer loss level selected, it is necessary to include both the economic changeout load equation and transformer loss evaluation equation in the transformer design optimization.

IMPACT OF LOAD MANAGEMENT

Load management is the systems concept of altering the real or apparent pattern of electricity use in order to 1) improve system efficiency, 2) shift fuel dependency from limited to more abundant energy resources, 3) reduce reserve requirements for generation and transmission capacity, and 4) improve reliability of service to essential loads.⁽¹⁷⁾ Several alternatives are available for achieving load management, including:

1. Direct control of customer loads
2. Voluntary control of customer loads
3. Customer energy storage
4. Utility energy storage
5. Utility interconnections

Utility energy storage and dispersed generation, such as batteries, fuel cells, solar and wind, would be expected to be applied at a level on the power system no lower than the distribution substation. Therefore, utility energy storage and transmission interconnections can be dismissed with regard to any impact on distribution transformer load characteristics and loss evaluation.

Direct Load Control

The major customer loads presently being considered for control by utilities are electric water heaters and central air conditioners. Detroit Edison⁽¹⁸⁾ has controlled 203,000 water heater customers, representing 200 MW of load, since 1968. Buckeye Power⁽¹⁹⁾ is controlling over 10,000 water heaters. Arkansas Power and Light⁽²⁰⁾ and Pacific Gas and Electric⁽²¹⁾ have both performed extensive experiments with control of central air conditioners.

The two primary purposes of direct load control are to reduce system demand and reduce the consumption of high-cost fuels. If load control does reduce the use of oil-fired peaking units with their associated high fuel costs, one possible effect on transformer loss evaluation might be a slight reduction in the energy cost component of load losses.

The total energy requirements of the water heaters and air conditioners should be essentially the same, whether controlled or not. The energy consumption will be deferred at the time of control, but the average distribution transformer load should remain the same.

Consideration of the effect of water heater and air conditioner control on the transformer peak load is more complex. The peak power requirement of a quick-recovery water heater is about 4.5 kW, with an average diversified demand of about 1 kW per water heater. The peak power requirement for central air conditioning is approximately 1.5 kW/ton, while the average diversified demand is a function of the ambient temperature. For example, with an average air conditioner unit size of 3.5 ton capacity (42,000 BTUH), the peak non-coincident demand is 3.5 tons x 1.5 kW/ton = 5.25 kW demand. Field tests⁽²¹⁾ resulted in the following air conditioning diversified demands for various outdoor temperatures.

Ambient Temperatures

Diversified Demand

85° F	1.75 kW
95° F	2.80 kW
105° F	4.20 kW

Results of load control systems in use have indicated that water heaters can be controlled for a duration of two hours with few cold water complaints⁽¹⁹⁾ and air conditioners can be controlled 15 minutes

out of each hour with little customer discomfort⁽²⁰⁾. Assuming that load control would be implemented at the time the system peak is being approached, the effect of load control on distribution transformer peak loads is dependent on the time of the transformer peak relative to the time of system peak. These relative times must be considered for three different situations.

1. Transformer peak occurs significantly prior to the system peak. Since the customer loads on the transformer are not shut off until after the transformer peak has occurred, the original peak will not be affected. When the controlled loads are allowed to turn on again, the transformer load depends on the number of loads returned to service simultaneously at their non-coincident demand value. If the saturation of controlled loads on the transformer is extremely high, the possibility of approaching, or exceeding, the original transformer peak load exists.
2. Transformer peak occurs just prior to, or at the time of, system peak. In this case, the customer loads are shut off at the time of the transformer peak. It seems certain that the time of transformer peak will change, but the magnitude of the new peak is dependent on the transformer load at the time the loads are returned to service and the number of loads returned simultaneously.
3. Transformer peak occurs after the system peak. If the controlled loads are returned to service at the time the transformer peak load would have occurred without control, it is very probable a higher trans-

former peak will be established. This is due to the fact that the controlled loads may all be running at their non-coincident demand values rather than their diversified demands.

The most significant effect of load control on the distribution transformer peak loads is at the time of system peak. With load control, the transformer peak load will always be lower at the time of system peak than it would have been without load control. The effect of this is to decrease the system peak responsibility factor (PRFS), which is the ratio of the transformer load at the time of system peak to the actual transformer peak load. So while it appears that the time of the transformer peak load may change, and the magnitude of the transformer peak load could increase, the resulting effect on the demand cost of load losses will be compensated for by the decrease in system peak responsibility factor.

In the future, utilities may control other loads such as commercial air conditioning, irrigation pumping, and residential space heating, with or without storage heating. In addition, future electric loads such as electric vehicles may require direct load control. The effect of controlling these loads on transformer load characteristics is not known. However, the present control of water heaters and central air conditioners appears to have a variable, but minimal, effect on transformer load characteristics and loss evaluations.

Voluntary Control of Loads

Voluntary control of customer loads has basically taken two forms; conservation and alternative rate designs, principally peak-load pricing. The main result of conservation has been a slight decrease in energy consumption. DOE (originally FEA) has funded 16 field projects on electric

utility rate designs since 1975, with major emphasis on several forms of time-of-day rates⁽²²⁾.

In general, the preliminary results indicate that T-O-D rate customers reduce kWh consumption during on-peak periods, compared to control customers on traditional declining block rates. The test projects also showed that T-O-D rates generally reduce residential diversified demands at the time of system monthly and annual peak demands. The effective reduction in demand coincident with system peak ranged from 15 to 70 percent on the day of system peak. If these results should continue in the long-term, the effect of T-O-D rates on transformer load characteristics would be similar to direct load control. However, those analyzing these results caution that the projects yield estimates only of short-run price elasticities, and may under-estimate long-run response, when appliance and capital-stock substitution may be expected to have a different impact on energy usage patterns.

Customer Energy Storage

Customer energy storage devices include storage heating and cooling which are located beyond the meter on the customer's premises. Theoretical studies⁽²³⁾ indicate thermal storage (both heating and cooling) can significantly increase the residential loads (by a factor of 4) between midnight and 7:00 A.M. Although thermal storage generally reduced substation peak loads, it appears there would be a detrimental effect on distribution transformer loading, creating high night-time peaks for extended periods. The experience in Europe⁽²⁴⁾, where a high saturation of residential storage heating exists, indicates increased distribution system costs and energy losses will result.

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LOAD
COINCIDENCE
FACTOR
(CF)

1.0

0.8

0.6

0.4

0.2

0.0

5

10

15

20

NUMBER OF CUSTOMERS (N)

Northeast
Committee

Houston L&P

Arkansas P&L

Union Electric

SMUD

(W) URD Handbook

FIG. 3-3.1

LOAD
COINCIDENCE
FACTOR
(CF)

1.0

0.8

0.6

0.4

0.2

0.0

$$CF = 0.5 \left(1 + \frac{5}{2N+3} \right)$$

REF: V. H. BROWNING, "DISTRIBUTION SYSTEM MANAGEMENT PROGRAM",
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NUMBER OF CUSTOMERS (N)

FIG. 3-3.2

FIGURE 3-3.3. WINTER PEAK DAY LOAD CYCLE

TOTAL ANNUAL TRANSFORMER
COST, DOLLARS

TRANSFORMER PEAK LOAD

FIG. 3-3.4 Determination of Economic Changeout Load

NUMBER OF YEARS (N) TO
REACH CHANGEOUT LOAD

ANNUAL PEAK LOAD GROWTH RATE (GR), PER UNIT

FIG. 3-3.5

SIGNATURE

TABLE 3-3.1.
TRANSFORMER LOAD CHARACTERISTICS

No. of Customers (N)	Coincidence Factor (CF)	Average Max. Diversified Demand/Customer ($\bar{D}$)	Cumulative Max. Diversified Demand (D)	Load Factor (LDF)	Loss Factor (LSF)	Peak Responsibility Factor (PRFD)
1	1.000 p.u.	5.472 kW	5.472 kW	0.190p.u.	0.059 p.u.	0.500 p.u.
2	0.857	4.690	9.38	0.222	0.075	0.583
4	0.727	3.978	15.91	0.261	0.097	0.688
6	0.667	3.650	21.90	0.285	0.112	0.750 (1)
8	0.632	3.458	27.67	0.301	0.122	0.791
10	0.609	3.332	33.32	0.312	0.130	0.821
12	0.593	3.245	38.94	0.320	0.135	0.843 (2)
16	0.571	3.125	49.99	0.333	0.144	0.876
20	0.558	3.053	61.07	0.341	0.150	0.896
25	0.547	2.993	74.83	0.347	0.154	0.914
30	0.540	2.955	88.65	0.352	0.158	0.926
35	0.534	2.922	102.27	0.356	0.161	0.936
40	0.530	2.900	116.01	0.358	0.163	0.943
45	0.527	2.884	129.77	0.361	0.165	0.949
50	0.524	2.867	143.37	0.363	0.166	0.954
100	0.512	2.802	280.17	0.371	0.173	0.977
200	0.506	2.769	553.77	0.375	0.176	0.988
500	0.502	2.747	1373.47	0.378	0.178	0.996
1000	0.501	2.741	2741.47	0.379	0.179	0.998
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
m	0.500	2.736	.	0.380	0.180	1.000

Notes: (1) The possible range of load characteristics for 25- and 50-kVA transformers.
(2) Load characteristics for 12 customers selected for loss evaluation.

TABLE 3-3.2

NOMENCLATURE FOR ECONOMIC TRANSFORMER CHANGEOUT LOAD

CSYSB	system investment cost per unit of base load, \$/kW
CSYSP	system investment cost per unit of peak load, \$/kW
CEB1	incremental energy cost for base load (first year value), \$/kWh
CEP1	incremental energy cost for peak generation (first year value), \$/kWh
CCE1	average sale price of incremental energy (first year value), \$/kWh
CE1	average incremental energy cost (first year value), \$/kWh
COE	transformer changeout expense, \$
CC	levelized annual carrying charge rate, p.u.
DISC	discount factor for system investment, p.u.
I	rate of return (weighted cost of capital), p.u.
CCAPF	installed cost of fixed capacitors, \$/kVAR
CCAPS	installed cost of switched capacitors, \$/kVAR
LSF	transformer annual loss factor, p.u.
P1	transformer (in use) annual peak load, p.u.
P2	transformer (replacement) annual peak load, p.u.
PRFS	peak responsibility factor (system) p.u.
PRFD	peak responsibility factor (distribution system), p.u.
PF	load power factor, p.u.
8760	number of hours per year
LKW	change in kW load for 1 percent change in voltage, percent
T1	transformer (in use) nameplate rating, kVA
CT1	transformer cost to utility, \$
NLL1	transformer no-load loss, kW
LL1	transformer load loss, kW
I01	transformer exciting current, p.u.
Z1	transformer impedance, p.u.
REG1	transformer regulation at rated load, p.u.
T2	transformer (replacement) nameplate rating, kVA
CT2	transformer cost to utility, \$
NLL2	transformer no-load loss, kW
LL2	transformer load loss, kW
I02	transformer exciting current, p.u.
Z2	transformer impedance, p.u.
REG2	transformer regulation at rated load, p.u.

TABLE 3-3.3
RESULTANT TRANSFORMER LOADING POLICIES

<u>Initial Transformer Size</u>	<u>Replacement Transformer Size</u>	<u>Base-Load Cost Scenario</u>	<u>Growth Rate</u>	<u>Changeout Year</u>	<u>Initial Peak</u>	<u>Final Peak</u>	<u>PEQO</u>	<u>PEQE</u>
25 kVA	50 kVA	Oil	2%	+30	0.80 p.u.	1.88 p.u.	0.96 p.u.	1.55 p.u.
25	50	Oil	4	22	0.80	1.88	1.09	1.64
25	50	Oil	6	15	0.80	1.88	1.15	1.55
25	50	Nuclear	2	+30	0.73	1.68	0.88	1.42
25	50	Nuclear	4	22	0.73	1.68	1.00	1.50
25	50	Nuclear	6	15	0.73	1.68	1.05	1.42
37.5	75	Oil	2	+30	0.87	1.98	1.04	1.69
37.5	75	Oil	4	22	0.87	1.98	1.19	1.78
37.5	75	Oil	6	15	0.87	1.98	1.25	1.69
37.5	75	Nuclear	2	+30	0.77	1.80	0.93	1.51
37.5	75	Nuclear	4	22	0.77	1.80	1.06	1.59
37.5	75	Nuclear	6	15	0.77	1.80	1.12	1.51
50	100	Oil	2	+30	0.94	2.01	1.13	1.83
50	100	Oil	4	20	0.94	2.01	1.25	1.80
50	100	Oil	6	14*	0.94	2.01	1.34	1.78
50	100	Nuclear	2	+30	0.84	1.81	1.01	1.64
50	100	Nuclear	4	20	0.84	1.81	1.13	1.61
50	100	Nuclear	6	14*	0.84	1.81	1.20	1.60

* PEQO and PEQE are slightly in error when the first changeout occurs after 14 years, since a second changeout is necessary in year 29.

TABLE 3-3.3 (Continued)
RESULTANT TRANSFORMER LOADING POLICIES

<u>Initial Transformer Size</u>	<u>Replacement Transformer Size</u>	<u>Base-Load Cost Scenario</u>	<u>Growth Rate</u>	<u>Changeout Year</u>	<u>Initial Peak</u>	<u>Final Peak</u>	<u>PEQO</u>	<u>PEQE</u>
25 kVA	37.5 kVA	Oil	2%	29	1.07 p.u.	1.88 p.u.	1.28 p.u.	2.04 p.u.
25	37.5	Oil	4	15	1.07	1.88	1.35	1.78
25	37.5	Oil	6	10*	1.07	1.88	-	-
25	37.5	Nuclear	2	28	0.98	1.69	1.17	1.84
25	37.5	Nuclear	4	15	0.98	1.69	1.23	1.60
25	37.5	Nuclear	6	10*	0.98	1.69	-	-
37.5	50	Oil	2	9*	1.25	1.48	-	-
37.5	50	Oil	4	5*	1.25	1.48	-	-
37.5	50	Oil	6	3*	1.25	1.48	-	-
37.5	50	Nuclear	2	11*	1.13	1.37	-	-
37.5	50	Nuclear	4	6*	1.13	1.37	-	-
37.5	50	Nuclear	6	4*	1.13	1.37	-	-
50	75	Oil	2	29	1.11	1.97	1.33	2.12
50	75	Oil	4	15	1.11	1.97	1.40	1.84
50	75	Oil	6	10*	1.11	1.97	-	-
50	75	Nuclear	2	29	1.03	1.80	1.23	1.96
50	75	Nuclear	4	15	1.03	1.80	1.30	1.71
50	75	Nuclear	6	10*	1.03	1.80	-	-

* PEQO and PEQE are not shown since two or more changeouts are required.

3-3-42

TABLE 3-3.4
RESULTANT NO-LOAD AND LOAD LOSS COSTS (\$/kW)

<u>Initial Transformer Size</u>	<u>Replacement Transformer Size</u>	<u>Base-Load Cost Scenario</u>	<u>Growth Rate</u>	<u>No-Load Loss Cost</u>	<u>Load Loss Cost</u>
25 kVA	50 kVA	Oil	2%	\$4281/kW	\$1042/kW
25	50	Oil	4	4281	1188
25	50	Oil	6	4281	1109
25	50	Nuclear	2	1763	868
25	50	Nuclear	4	1763	990
25	50	Nuclear	6	1763	924
37.5	75	Oil	2	4281	1233
37.5	75	Oil	4	4281	1405
37.5	75	Oil	6	4281	1313
37.5	75	Nuclear	2	1763	983
37.5	75	Nuclear	4	1763	1122
37.5	75	Nuclear	6	1763	1047
50	100	Oil	2	4281	1445
50	100	Oil	4	4281	1457
50	100	Oil	6	4281	1470
50	100	Nuclear	2	1763	1164
50	100	Nuclear	4	1763	1173
50	100	Nuclear	6	1763	1184

TABLE 3-3.5
SUMMARY OF DISTRIBUTION TRANSFORMER LOAD CHARACTERISTICS

LSF	Transformer annual loss factor	0.135 p.u.
PRFD	Peak responsibility factor (distribution system)	0.843 p.u.
PRFS	Peak responsibility factor (system)	0.75 p.u.
PF	Load power factor	0.90 p.u.
LKW	Change in kW load for 1 percent voltage change	0.75 %
GR	Levelized annual compound peak load growth rate	0.02, 0.04, 0.06 p.u

NOTE 1: The parameters for the transformer loading policy are established by the economic changeout load equation:

IP	Initial transformer annual peak load, p.u.
FP	Final transformer annual peak load, p.u.

NOTE 2: The following parameters are a function of the initial and final peak load and the load growth rate:

NC	Time to transformer changeout, years
PEQO	Transformer equivalent annual peak load (no inflation), p.u.
PEQE	Transformer equivalent annual peak load (energy cost inflation), p.u.

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While the general trend of price inflation is 6.0%, there is one major problem that may cause short periods of abrupt changes in price. This problem is that transformers are manufactured from materials whose prices are very energy sensitive. Any change in the supply or price of energy can cause a step change in the price of transformers. After the transitional period has passed, the price inflation rate of transformers should return to the average 6.0% rate.

Generating the Cost/Performance Data

To generate the optimum cost data for each distribution transformer rating with every set of no-load and load losses was virtually an impossible task to perform within the time frame of this project. The investigation was limited to the high activity kVA ratings in the industry. Ten through 50 kVA, 95 kV BIL were selected for this purpose. These ratings yielded adequate information for this project.

The performance range (bounds of no-load and load loss) was established by utilizing the information generated in Tasks 1, 2, and 3. Even with these kVA ratings and the performance range, it was not possible to generate the optimum cost for each combination of losses.

The optimum costs of each kVA rating for the strategically selected various sets of losses were determined. The next problem was to enlarge the cost tables so that the cost data for any intermediate sets of losses could be determined by interpolation. To solve this problem, two techniques were used: (i) graphical technique and (ii) regression analysis.

(i) Graphical technique: Actual cost points obtained from the optimization program were plotted on the graph paper. Smooth curves were drawn, and the intermediate values were determined from these curves.

(ii) Regression analysis: Regression analysis was performed using the optimized cost data. The cost data were reduced to a set of regression equations (one for each kVA rating. They describe

the transformer cost as a function of no-load loss and load loss or simply the product of losses. The costs of the transformer for the intermediate losses were determined. The regression equation is in the form of a hyperbolic function. For very low losses the function is discontinuous. However, the function represents the region of interest very well.

Indexing

Once the minimum cost of transformers (cost of the transformer to the user) was determined for each significant set of performance characteristics, the problem then became how to express this vast array of data in a meaningful format. To solve this problem, the cost arrays were enlarged and the cost data were reduced to cost indexes on a per unit cost basis using a reference transformer of each kVA that was given an index of 1. For single efficiency transformers, cost indexes obtained from the graphical method are presented in Tables 3-4.1A - 3-4.5A, and the data obtained from regression analysis are presented in Tables 3-4.1B - 3-4.5B. Similar approaches were taken for the multiple efficiency transformers selected in Task 5.

By using price indexes, transformer users can establish price differentials that are meaningful, no matter what the selling prices of distribution transformers are at any given time. Indexing also solves the problem of how to handle inflation. If the assumption is made that the marketplace will always force manufacturers to adapt to inflation, substitutions will be made to keep the overall price inflation of distribution transformers at approximately 6.0%, regardless of the performance of a particular transformer.

The use of indexing allows the minimization of total life cycle cost of a distribution transformer at any price level of interest. From the transformer cost index equation, the life cycle costing equation, and a set of correct current costs, the optimum distribution transformer can be selected.

Discussion of the Cost Tables

Any of the cost tables described above can be divided into three regions: the upper left hand corner, the lower right hand corner, and the middle region. The upper left hand corner is characterized by the very low loss area. Most of the designs were not feasible because of low loss level. Some designs were realized with Cu-conductors.

The lower right hand corner is characterized by the high loss area. In some cases the losses were not realized because of constraints on the flux density in the core, current density in the conductor, and the insulation clearances. The designs were realized with aluminum conductors.

The middle region is characterized by mid-range losses, which is the region of current industry practice. The designs were realized with aluminum conductors.

Graphical vs. Regression Equation Approach

In the graphical method, actual optimized cost indexes are retained for the purpose of bookkeeping. The graphical method gives more accurate results, but the data may be difficult to use in a computer program. The regression equations yield fairly accurate results and are very convenient to use in any computer program which requires transformer cost/performance relationships.

Recommendation

Considering convenience and accuracy, the following tables are recommended for use in any task of this project requiring cost/performance indexes.

Transformers

Tables

single efficiency 10 kVA

3-4.1A

single efficiency 15-50 kVAs

3-4.2B - 3-4.5B

Limited Ability to Produce and Change

In a perfect economy with ideal factories, a utility could calculate the optimum transformer for its system, order it, and be assured of the lowest operating cost. But manufacturers today are limited in their ability to produce an infinite variety of designs. The manufacturer must choose a loss level or a range of loss levels which he can produce at a competitive price level and limit his offerings to these designs. This limited performance range allows the manufacturer to take advantage of economies of scale and reduce the cost of manufacturing.

To achieve these economies, the manufacturer must commit his resources to these standard designs and give up the ability to change the design to meet each customer's particular design requirement. The conclusion reached by using the theoretical optimum design does not recognize these limits. But by using the most common costs in the evaluated transformer life cycle costs, the manufacturer should be able to produce a design that is reasonably competitive and satisfies most customers' needs.

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7. The Kagan Dixon Wire Corporation, 33 Wood Avenue, South Islin, New Jersey 08830. Price List, April 1, 1979.
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10. 1972 Census of Manufactures - U.S. Department of Commerce, Washington, D.C. 20233. January, 1974.
11. Producer Prices and Price Indexes - Department of Labor, Washington, D.C. 20212. December 1978.

TABLE 3-4.1A
(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 10 KVA

LL\NL	20	30	40	50	60	70	80	90	100	110	120
60	*****	*****	*****	*****	*****	*****	*****	*****	1.873	1.779	1.745
80	*****	*****	*****	*****	1.975	1.818	1.701	1.544	1.466	1.447	1.427
100	*****	*****	*****	1.857	1.617	1.457	1.378	1.325	1.308	1.308	1.308
120	*****	*****	1.799	1.564	1.388	1.290	1.232	1.193	1.153	1.153	1.153
140	*****	*****	1.549	1.359	1.275	1.202	1.153	1.095	1.075	1.075	1.075
160	*****	1.740	1.408	1.251	1.173	1.114	1.075	1.046	1.017	1.017	1.017
180	*****	1.623	1.310	1.173	1.095	1.056	1.036	1.007	0.987	0.987	0.987
200	*****	1.505	1.241	1.127	1.056	1.036	0.997	0.987	0.978	0.987	0.987
220	*****	1.388	1.173	1.075	1.017	0.997	0.968	0.958	0.948	0.948	0.948
240	*****	1.310	1.124	1.046	1.000	0.963	0.948	0.938	0.934	0.934	0.934
260	*****	1.251	1.095	1.033	0.993	0.963	0.948	0.938	0.934	0.934	0.934
280	*****	1.202	1.056	1.021	0.985	0.963	0.948	0.938	0.934	0.934	0.934
300	1.877	1.153	1.036	1.008	0.978	0.963	0.948	0.938	0.934	0.934	0.934
320	1.720	1.114	1.017	0.995	0.978	0.963	0.948	0.938	0.934	0.934	0.934
340	1.603	1.085	1.007	0.982	0.971	0.963	0.948	0.938	0.934	0.934	0.934
360	1.487	1.065	1.002	0.972	0.966	0.963	0.948	0.938	0.934	0.934	0.934
380	1.408	1.056	0.987	0.967	0.967	0.963	0.948	0.938	0.934	0.934	0.934
400	1.329	1.046	0.984	0.964	0.964	0.963	0.948	0.938	0.934	0.934	0.934
420	1.261	1.036	0.982	0.960	0.960	0.963	0.948	0.938	0.934	0.934	0.934
440	1.202	1.026	0.980	0.956	0.956	0.963	0.948	0.938	0.934	0.934	0.934
460	1.147	1.022	0.978	0.953	0.953	0.963	0.948	0.938	0.934	0.934	0.934

TABLE 3-4.1B
(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 10 KVA

$$Y = NL * LL / (-2735.9932 + 1.190002441 * NL + LL)$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL\NL	20	30	40	50	60	70	80	90	100	110	120
60	*****	*****	*****	*****	*****	1.857	1.613	1.463	1.362	1.290	1.235
80	*****	*****	*****	1.976	1.613	1.426	1.311	1.235	1.179	1.138	1.105
100	*****	*****	1.976	1.556	1.362	1.251	1.179	1.129	1.091	1.062	1.039
120	*****	*****	1.613	1.362	1.235	1.157	1.105	1.068	1.039	1.018	1.000
140	*****	1.857	1.426	1.251	1.157	1.098	1.057	1.028	1.005	0.988	0.974
160	*****	1.613	1.311	1.179	1.105	1.057	1.024	1.000	0.981	0.967	0.955
180	*****	1.463	1.235	1.129	1.068	1.028	1.000	0.979	0.963	0.951	0.940
200	1.976	1.362	1.179	1.091	1.039	1.005	0.981	0.963	0.949	0.938	0.929
220	1.760	1.290	1.138	1.062	1.018	0.988	0.967	0.951	0.938	0.929	0.920
240	1.613	1.235	1.105	1.039	1.000	0.974	0.955	0.940	0.929	0.920	0.913
260	1.506	1.192	1.079	1.021	0.986	0.962	0.945	0.932	0.922	0.914	0.907
280	1.426	1.157	1.057	1.005	0.974	0.952	0.936	0.925	0.916	0.908	0.902
300	1.362	1.129	1.039	0.992	0.963	0.944	0.929	0.919	0.910	0.903	0.898
320	1.311	1.105	1.024	0.981	0.955	0.936	0.923	0.913	0.905	0.899	0.894
340	1.270	1.085	1.011	0.972	0.947	0.930	0.918	0.909	0.901	0.895	0.891
360	1.235	1.068	1.000	0.963	0.940	0.925	0.913	0.905	0.898	0.892	0.888
380	1.205	1.053	0.990	0.956	0.935	0.920	0.909	0.901	0.894	0.889	0.885
400	1.179	1.039	0.981	0.949	0.929	0.916	0.905	0.898	0.892	0.887	0.883
420	1.157	1.028	0.974	0.944	0.925	0.912	0.902	0.895	0.889	0.884	0.881
440	1.138	1.018	0.967	0.938	0.920	0.908	0.899	0.892	0.887	0.882	0.879
460	1.120	1.008	0.960	0.934	0.917	0.905	0.896	0.890	0.885	0.880	0.877

TABLE 3-4.2A
(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 15 KVA

LL\NL	30	40	50	60	70	80	90	100	110	120	130
60	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
80	*****	*****	*****	*****	*****	*****	*****	*****	*****	1.962	1.834
100	*****	*****	*****	*****	*****	*****	*****	1.870	1.738	1.643	1.547
120	*****	*****	*****	*****	1.914	1.738	1.722	1.627	1.531	1.459	1.388
140	*****	*****	*****	*****	1.671	1.515	1.419	1.356	1.310	1.276	1.268
160	*****	*****	*****	1.659	1.499	1.356	1.325	1.292	1.260	1.204	1.148
180	*****	*****	1.730	1.483	1.356	1.260	1.228	1.196	1.164	1.132	1.100
200	*****	*****	1.575	1.368	1.261	1.204	1.164	1.132	1.120	1.077	1.036
220	*****	1.882	1.451	1.268	1.180	1.124	1.100	1.077	1.053	1.037	1.021
240	*****	1.707	1.372	1.204	1.116	1.069	1.053	1.037	1.021	1.013	1.005
260	*****	1.579	1.300	1.148	1.069	1.037	1.021	1.005	0.989	1.782	0.981
280	*****	1.459	1.244	1.116	1.045	0.997	0.989	0.981	0.973	0.973	0.973
300	1.914	1.372	1.196	1.093	1.013	0.973	0.967	0.962	0.957	0.953	0.949
320	1.786	1.303	1.136	1.053	1.000	0.965	0.941	0.939	0.938	0.939	0.941
340	1.691	1.236	1.118	1.045	0.998	0.967	0.945	0.943	0.939	0.940	0.941
360	1.611	1.188	1.100	1.037	0.997	0.970	0.949	0.945	0.941	0.942	0.943
380	1.563	1.140	1.082	1.029	0.995	0.974	0.953	0.947	0.943	0.944	0.946
400	1.499	1.124	1.065	1.021	0.994	0.976	0.957	0.951	0.945	0.947	0.948
420	1.467	1.110	1.046	1.013	0.993	0.979	0.961	0.954	0.947	0.949	0.951
440	1.434	1.102	1.029	1.005	0.992	0.982	0.965	0.956	0.948	0.951	0.954
460	1.404	1.100	1.031	1.008	0.995	0.985	0.969	0.959	0.950	0.953	0.956
480	1.356	1.099	1.033	1.012	0.999	0.988	0.973	0.963	0.951	0.955	0.958
500	1.308	1.098	1.036	1.016	1.003	0.991	0.977	0.965	0.951	0.957	0.962
520	1.276	1.096	1.039	1.020	1.007	0.994	0.981	0.968	0.955	0.960	0.965
540	1.260	1.093	1.041	1.024	1.011	0.998	0.985	0.970	0.958	0.962	0.972
560	1.244	1.094	1.045	1.028	1.015	1.001	0.989	0.974	0.958	0.964	0.970
580	1.202	1.093	1.047	1.032	1.019	1.004	0.993	0.977	0.959	0.967	0.978

TABLE 3-4.2B
(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 15 KVA

$$Y = NL * LL / (-5186.7539 + 1.231547356 * NL * LL)$$

Y = TRANSFORMER COST; NL = NO LOAD LOSS; LL = LOAD LOSS

LL \ NL	30	40	50	60	70	80	90	100	110	120	130
60	*****	*****	*****	*****	*****	*****	*****	*****	*****	1.956	1.765
80	*****	*****	*****	*****	*****	*****	1.956	1.715	1.957	1.447	1.365
100	*****	*****	*****	*****	*****	1.715	1.526	1.403	1.316	1.251	1.201
120	*****	*****	*****	1.956	1.628	1.447	1.331	1.251	1.192	1.148	1.112
140	*****	*****	*****	1.628	1.424	1.301	1.220	1.161	1.118	1.084	1.056
160	*****	*****	1.715	1.447	1.301	1.210	1.148	1.102	1.067	1.040	1.018
180	*****	1.956	1.526	1.331	1.220	1.148	1.097	1.060	1.031	1.009	0.990
200	*****	1.715	1.403	1.251	1.161	1.102	1.060	1.029	1.004	0.985	0.969
220	*****	1.557	1.316	1.192	1.118	1.067	1.031	1.004	0.983	0.966	0.952
240	1.956	1.447	1.251	1.148	1.084	1.040	1.009	0.985	0.966	0.951	0.939
260	1.765	1.365	1.201	1.112	1.056	1.018	0.990	0.969	0.952	0.939	0.928
280	1.628	1.301	1.161	1.084	1.034	1.000	0.975	0.956	0.941	0.928	0.918
300	1.526	1.251	1.129	1.060	1.016	0.985	0.962	0.945	0.931	0.920	0.910
320	1.447	1.210	1.102	1.040	1.000	0.972	0.951	0.935	0.922	0.912	0.903
340	1.383	1.176	1.079	1.023	0.987	0.961	0.942	0.927	0.915	0.905	0.898
360	1.331	1.148	1.060	1.009	0.975	0.951	0.933	0.920	0.909	0.900	0.892
380	1.288	1.123	1.043	0.996	0.965	0.943	0.926	0.913	0.903	0.895	0.888
400	1.251	1.102	1.029	0.985	0.956	0.935	0.920	0.908	0.898	0.890	0.884
420	1.220	1.084	1.016	0.975	0.948	0.928	0.914	0.902	0.893	0.886	0.880
440	1.192	1.067	1.004	0.966	0.941	0.922	0.909	0.898	0.889	0.882	0.877
460	1.169	1.053	0.994	0.958	0.934	0.917	0.904	0.894	0.886	0.879	0.874
480	1.148	1.040	0.985	0.951	0.928	0.912	0.900	0.890	0.882	0.876	0.871
500	1.129	1.029	0.976	0.945	0.923	0.908	0.896	0.887	0.879	0.873	0.868
520	1.112	1.018	0.969	0.939	0.913	0.903	0.892	0.884	0.877	0.871	0.866
540	1.097	1.009	0.962	0.933	0.914	0.900	0.889	0.881	0.874	0.868	0.864
560	1.084	1.000	0.956	0.928	0.910	0.896	0.886	0.878	0.872	0.866	0.862
580	1.071	0.992	0.950	0.924	0.906	0.893	0.883	0.876	0.869	0.864	0.860

TABLE 3-4.3A

(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 25 KVA

LL\NL	50	60	70	80	90	100	110	120	130	140	150
160	*****	*****	*****	*****	*****	1.890	1.757	1.645	1.563	1.481	1.426
180	*****	*****	*****	*****	1.844	1.701	1.588	1.491	1.384	1.338	1.316
200	*****	*****	*****	1.869	1.670	1.553	1.461	1.369	1.302	1.241	1.221
220	*****	*****	*****	1.706	1.522	1.430	1.348	1.267	1.216	1.159	1.144
240	*****	*****	1.839	1.583	1.395	1.328	1.246	1.185	1.148	1.103	1.080
260	*****	1.995	1.696	1.471	1.302	1.231	1.170	1.118	1.088	1.047	1.037
280	*****	1.839	1.578	1.379	1.226	1.159	1.098	1.062	1.037	1.006	0.996
300	*****	1.696	1.471	1.297	1.159	1.098	1.047	1.016	0.996	0.970	0.960
320	*****	1.583	1.389	1.226	1.128	1.042	0.991	0.970	0.960	0.950	0.953
340	1.879	1.491	1.302	1.164	1.057	1.006	0.965	0.945	0.935	0.924	0.909
360	1.726	1.389	1.231	1.113	1.016	0.970	0.955	0.919	0.914	0.909	0.889
380	1.601	1.336	1.180	1.073	1.000	0.950	0.930	0.919	0.909	0.904	0.860
400	1.532	1.267	1.124	1.037	0.975	0.919	0.919	0.889	0.878	0.878	0.853
420	1.450	1.216	1.088	1.006	0.955	0.909	0.873	0.878	0.868	0.868	0.848
440	1.389	1.175	1.047	0.981	0.940	0.894	0.868	0.868	0.858	0.858	0.848
460	1.338	1.134	1.016	0.965	0.930	0.884	0.855	0.855	0.853	0.855	0.843
480	1.297	1.103	0.996	0.950	0.914	0.878	0.853	0.853	0.848	0.848	0.843
500	1.291	1.075	0.981	0.935	0.905	0.878	0.858	0.853	0.848	0.843	0.842
520	1.216	1.042	0.960	0.924	0.894	0.868	0.853	0.853	0.848	0.843	0.843
540	1.185	0.991	0.945	0.914	0.889	0.868	0.853	0.853	0.848	0.838	0.843
560	1.144	0.981	0.935	0.904	0.884	0.863	0.853	0.853	0.848	0.843	0.843
580	1.134	0.975	0.930	0.899	0.884	0.863	0.853	0.853	0.848	0.843	0.843
600	1.114	0.983	0.924	0.899	0.893	0.863	0.858	0.853	0.848	0.843	0.842

TABLE 3-4.3B

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 25 KVA

$$Y = NL + LL/L - 13400.4961 + 1.391827583 * NL + LL$$

$$Y = \text{TRANSFORMER COST}, NL = \text{NO LOAD LOSS}, LL = \text{LOAD LOSS}$$

LL\NL	50	60	70	80	90	100	110	120	130	140	150
160	*****	*****	*****	*****	*****	1.804	1.586	1.441	1.338	1.260	1.200
180	*****	*****	*****	*****	1.771	1.545	1.399	1.296	1.221	1.163	1.117
200	*****	*****	*****	1.804	1.545	1.385	1.278	1.200	1.141	1.095	1.058
220	*****	*****	1.917	1.586	1.399	1.278	1.193	1.131	1.083	1.045	1.014
240	*****	*****	1.683	1.441	1.296	1.200	1.131	1.079	1.039	1.007	0.981
260	*****	1.877	1.525	1.338	1.221	1.141	1.083	1.039	1.005	0.977	0.954
280	*****	1.683	1.412	1.260	1.163	1.095	1.045	1.007	0.977	0.952	0.932
300	*****	1.545	1.327	1.200	1.117	1.058	1.014	0.981	0.954	0.932	0.914
320	1.804	1.441	1.260	1.152	1.079	1.028	0.989	0.959	0.935	0.915	0.899
340	1.657	1.361	1.207	1.112	1.048	1.002	0.968	0.940	0.919	0.901	0.886
360	1.545	1.296	1.163	1.079	1.022	0.981	0.949	0.925	0.905	0.888	0.874
380	1.457	1.244	1.126	1.052	1.000	0.962	0.933	0.911	0.892	0.877	0.865
400	1.385	1.200	1.095	1.028	0.981	0.946	0.920	0.899	0.882	0.868	0.856
420	1.327	1.163	1.068	1.007	0.964	0.932	0.908	0.888	0.872	0.859	0.848
440	1.278	1.131	1.045	0.989	0.949	0.920	0.897	0.879	0.864	0.852	0.841
460	1.236	1.103	1.025	0.973	0.936	0.909	0.887	0.870	0.856	0.845	0.835
480	1.200	1.079	1.007	0.959	0.925	0.899	0.879	0.863	0.850	0.839	0.829
500	1.168	1.058	0.991	0.946	0.914	0.890	0.871	0.856	0.843	0.833	0.824
520	1.141	1.039	0.977	0.939	0.905	0.882	0.864	0.850	0.838	0.828	0.820
540	1.117	1.022	0.964	0.925	0.896	0.874	0.857	0.844	0.833	0.823	0.815
560	1.095	1.007	0.952	0.915	0.888	0.868	0.852	0.839	0.828	0.819	0.811
580	1.076	0.993	0.942	0.907	0.881	0.861	0.846	0.834	0.824	0.815	0.808
600	1.058	0.981	0.932	0.899	0.874	0.856	0.841	0.829	0.820	0.811	0.805

TABLE 3-4.4A
(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 37.5 KVA

LL\NL	70	80	90	100	110	120	130	140	150	160	170	180	190	200
260	*****	*****	*****	*****	*****	1.913	1.735	1.650	1.594	1.483	1.419	1.368	1.323	1.308
280	*****	*****	*****	*****	1.953	1.722	1.620	1.530	1.443	1.411	1.363	1.307	1.279	1.251
300	*****	*****	*****	1.967	1.804	1.580	1.523	1.429	1.355	1.315	1.275	1.259	1.232	1.204
320	*****	*****	*****	1.835	1.762	1.487	1.439	1.345	1.275	1.248	1.230	1.212	1.140	1.148
340	*****	*****	1.901	1.726	1.576	1.411	1.355	1.275	1.216	1.188	1.176	1.164	1.136	1.108
360	*****	*****	1.782	1.626	1.481	1.343	1.287	1.220	1.164	1.140	1.134	1.128	1.098	1.068
380	*****	1.929	1.684	1.534	1.397	1.285	1.226	1.180	1.116	1.100	1.098	1.096	1.066	1.036
400	*****	1.825	1.594	1.459	1.331	1.228	1.149	1.116	1.076	1.052	1.036	1.020	1.016	1.012
420	*****	1.721	1.521	1.389	1.281	1.180	1.130	1.108	1.044	1.028	1.020	1.012	1.000	0.988
440	1.881	1.631	1.445	1.327	1.232	1.136	1.094	1.076	1.020	1.008	1.006	1.004	0.988	0.972
460	1.754	1.552	1.377	1.275	1.184	1.098	1.062	1.052	0.996	0.988	0.988	0.988	0.969	0.949
480	1.650	1.487	1.312	1.224	1.138	1.068	1.034	1.028	0.980	0.972	0.971	0.969	0.955	0.941
500	1.586	1.428	1.255	1.176	1.100	1.031	1.014	1.010	0.972	0.957	0.955	0.953	0.935	0.925
520	1.495	1.375	1.203	1.132	1.068	1.020	1.000	0.972	0.961	0.957	0.941	0.945	0.929	0.909
540	1.451	1.330	1.166	1.032	1.038	1.004	0.974	0.972	0.949	0.937	0.935	0.933	0.921	0.909
560	1.403	1.289	1.134	1.050	1.018	0.988	0.959	0.965	0.933	0.925	0.925	0.925	0.915	0.901
580	1.373	1.251	1.110	1.016	0.996	0.972	0.947	0.953	0.925	0.909	0.915	0.921	0.907	0.893
600	1.339	1.216	1.084	1.016	0.984	0.961	0.939	0.941	0.925	0.909	0.913	0.917	0.905	0.893
620	1.307	1.186	1.064	1.000	0.972	0.955	0.933	0.937	0.917	0.906	0.905	0.905	0.899	0.893
640	1.283	1.091	1.042	0.988	0.963	0.945	0.931	0.929	0.906	0.903	0.904	0.905	0.899	0.893
660	1.266	1.132	1.038	0.974	0.957	0.941	0.929	0.916	0.909	0.901	0.897	0.893	0.893	0.893
680	1.234	1.108	1.016	0.969	0.956	0.940	0.925	0.921	0.901	0.898	0.895	0.893	0.891	0.889
700	1.204	1.086	1.004	0.963	0.955	0.935	0.925	0.921	0.899	0.893	0.894	0.893	0.891	0.889
720	1.180	1.068	0.998	0.959	0.949	0.929	0.925	0.921	0.893	0.893	0.893	0.893	0.889	0.885
740	1.156	1.053	0.992	0.957	0.945	0.928	0.925	0.921	0.893	0.893	0.894	0.893	0.891	0.889
760	1.132	1.040	0.992	0.957	0.941	0.927	0.925	0.921	0.893	0.893	0.894	0.893	0.893	0.893
780	1.116	1.032	0.992	0.957	0.941	0.925	0.925	0.921	0.893	0.893	0.893	0.893	0.893	0.893
800	1.094	1.020	0.982	0.957	0.941	0.925	0.925	0.892	0.893	0.893	0.893	0.886	0.893	0.897

TABLE 3-4.4B
(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 37.5 KVA

$$Y = NL * LL / (-24281.4063 + 1.359191895 * NL + LL)$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	70	80	90	100	110	120	130	140	150	160	170	180	190	200
260	*****	*****	*****	*****	1.960	1.721	1.561	1.445	1.358	1.289	1.235	1.190	1.153	1.121
280	*****	*****	*****	*****	1.752	1.571	1.445	1.352	1.280	1.224	1.178	1.140	1.108	1.080
300	*****	*****	*****	1.819	1.604	1.460	1.358	1.280	1.220	1.172	1.132	1.099	1.072	1.048
320	*****	*****	1.938	1.666	1.494	1.376	1.289	1.224	1.172	1.130	1.095	1.067	1.042	1.021
340	*****	*****	1.768	1.550	1.409	1.309	1.235	1.178	1.132	1.095	1.065	1.039	1.017	0.998
360	*****	1.938	1.640	1.460	1.340	1.255	1.190	1.140	1.099	1.067	1.039	1.016	0.996	0.979
380	*****	1.784	1.540	1.388	1.285	1.210	1.153	1.108	1.072	1.042	1.017	0.996	0.978	0.962
400	*****	1.666	1.460	1.330	1.239	1.172	1.121	1.080	1.048	1.021	0.998	0.979	0.962	0.947
420	1.875	1.571	1.395	1.280	1.200	1.140	1.094	1.057	1.027	1.002	0.981	0.963	0.948	0.934
440	1.752	1.494	1.340	1.239	1.163	1.112	1.070	1.036	1.009	0.986	0.967	0.950	0.936	0.923
460	1.653	1.430	1.294	1.203	1.137	1.088	1.049	1.018	0.993	0.972	0.954	0.938	0.925	0.913
480	1.571	1.376	1.255	1.172	1.112	1.067	1.031	1.002	0.979	0.959	0.942	0.928	0.915	0.904
500	1.503	1.330	1.220	1.145	1.090	1.048	1.015	0.988	0.966	0.947	0.932	0.918	0.906	0.896
520	1.445	1.289	1.190	1.121	1.070	1.031	1.000	0.975	0.954	0.937	0.922	0.909	0.898	0.888
540	1.395	1.255	1.163	1.099	1.052	1.016	0.987	0.963	0.944	0.928	0.914	0.901	0.891	0.882
560	1.352	1.224	1.140	1.080	1.036	1.002	0.975	0.953	0.934	0.919	0.906	0.894	0.884	0.875
580	1.314	1.196	1.119	1.063	1.022	0.990	0.964	0.943	0.926	0.911	0.899	0.888	0.878	0.870
600	1.280	1.172	1.099	1.048	1.009	0.979	0.954	0.934	0.918	0.904	0.892	0.882	0.872	0.864
620	1.250	1.150	1.082	1.034	0.997	0.968	0.945	0.926	0.911	0.897	0.886	0.876	0.867	0.860
640	1.224	1.130	1.067	1.021	0.986	0.959	0.937	0.919	0.904	0.891	0.880	0.871	0.862	0.855
660	1.200	1.112	1.052	1.009	0.976	0.950	0.929	0.912	0.898	0.886	0.875	0.866	0.858	0.851
680	1.178	1.095	1.039	0.998	0.967	0.942	0.922	0.906	0.892	0.880	0.870	0.861	0.854	0.847
700	1.158	1.080	1.027	0.988	0.958	0.934	0.915	0.900	0.887	0.875	0.866	0.857	0.850	0.843
720	1.140	1.067	1.016	0.979	0.950	0.928	0.909	0.894	0.882	0.871	0.861	0.853	0.846	0.840
740	1.123	1.054	1.005	0.970	0.943	0.921	0.904	0.889	0.877	0.866	0.858	0.850	0.843	0.837
760	1.108	1.042	0.996	0.962	0.936	0.915	0.898	0.884	0.872	0.862	0.854	0.846	0.840	0.834
780	1.094	1.031	0.987	0.954	0.929	0.909	0.893	0.880	0.868	0.859	0.850	0.843	0.837	0.831
800	1.080	1.021	0.979	0.947	0.923	0.904	0.888	0.875	0.864	0.855	0.847	0.840	0.834	0.828

TABLE 3-4.5A
(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 50 KVA

LL\NL	90	100	110	120	130	140	150	160	170	180	190	200	210	220
400	*****	*****	*****	1.843	1.690	1.571	1.478	1.401	1.342	1.315	1.274	1.256	1.240	1.215
420	*****	*****	1.953	1.758	1.613	1.498	1.427	1.342	1.294	1.274	1.240	1.208	1.189	1.175
440	*****	*****	1.868	1.681	1.546	1.444	1.376	1.298	1.257	1.240	1.206	1.182	1.155	1.141
460	*****	*****	1.793	1.613	1.486	1.393	1.325	1.257	1.223	1.197	1.172	1.151	1.129	1.121
480	*****	1.945	1.722	1.552	1.430	1.342	1.274	1.219	1.189	1.168	1.145	1.121	1.101	1.089
500	*****	1.860	1.654	1.503	1.384	1.299	1.235	1.189	1.162	1.138	1.121	1.095	1.078	1.068
520	*****	1.778	1.579	1.440	1.332	1.260	1.199	1.155	1.124	1.104	1.087	1.070	1.056	1.043
540	1.945	1.705	1.512	1.418	1.287	1.223	1.168	1.129	1.101	1.080	1.067	1.048	1.036	1.021
560	1.868	1.630	1.447	1.338	1.247	1.189	1.141	1.107	1.080	1.060	1.080	1.029	1.019	1.002
580	1.792	1.571	1.393	1.294	1.209	1.163	1.121	1.084	1.063	1.043	1.029	1.007	1.002	0.987
600	1.724	1.512	1.342	1.257	1.180	1.148	1.097	1.067	1.046	1.028	1.016	0.999	0.993	0.970
620	1.664	1.469	1.296	1.214	1.148	1.111	1.082	1.046	1.026	1.012	1.002	1.000	0.993	0.975
640	1.596	1.410	1.267	1.179	1.121	1.084	1.056	1.029	1.019	1.002	0.988	0.968	0.968	0.949
660	1.537	1.367	1.233	1.151	1.095	1.061	1.043	1.016	1.012	0.988	0.978	0.956	0.960	0.938
680	1.486	1.325	1.202	1.124	1.073	1.043	1.029	0.999	1.002	0.982	0.968	0.951	0.951	0.934
700	1.444	1.291	1.175	1.104	1.056	1.028	1.019	0.985	0.994	0.971	0.960	0.941	0.944	0.932
720	1.393	1.257	1.155	1.084	1.039	1.016	1.005	0.978	0.985	0.968	0.951	0.934	0.938	0.929
740	1.358	1.231	1.140	1.087	1.053	1.026	1.000	0.988	0.978	0.961	0.958	0.951	0.938	0.930
760	1.308	1.196	1.111	1.053	1.022	1.002	0.985	0.968	0.968	0.954	0.943	0.931	0.931	0.917
780	1.277	1.172	1.097	1.043	1.012	0.994	0.975	0.961	0.968	0.951	0.938	0.927	0.921	0.917
800	1.248	1.167	1.078	1.033	1.005	0.982	0.968	0.958	0.965	0.951	0.934	0.924	0.917	0.917
820	1.223	1.138	1.063	1.026	1.002	0.971	0.966	0.954	0.960	0.948	0.934	0.921	0.910	0.910
840	1.206	1.121	1.046	1.022	0.999	0.968	0.965	0.951	0.954	0.948	0.934	0.921	0.909	0.917
860	1.197	1.104	1.053	1.019	0.994	0.975	0.966	0.951	0.954	0.946	0.927	0.921	0.919	0.919

TABLE 3-4.5B
(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
SINGLE EFFICIENCY 50 KVA

$$Y = NL * LL / 1 - 36678.1367 + 1.295791626 * NL * LL$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	90	100	110	120	130	140	150	160	170	180	190	200	210	220
400	*****	*****	*****	1.881	1.694	1.560	1.461	1.384	1.322	1.272	1.230	1.194	1.164	1.138
420	*****	*****	1.992	1.760	1.602	1.488	1.401	1.333	1.279	1.234	1.196	1.164	1.136	1.113
440	*****	*****	1.859	1.664	1.528	1.428	1.351	1.291	1.242	1.201	1.167	1.138	1.113	1.091
460	*****	*****	1.752	1.584	1.465	1.377	1.309	1.254	1.210	1.173	1.141	1.115	1.092	1.071
480	*****	1.881	1.664	1.517	1.412	1.333	1.272	1.222	1.182	1.148	1.119	1.094	1.073	1.054
500	*****	1.779	1.590	1.461	1.367	1.296	1.240	1.194	1.157	1.126	1.099	1.076	1.057	1.039
520	1.953	1.694	1.528	1.412	1.328	1.263	1.211	1.170	1.135	1.106	1.082	1.060	1.042	1.025
540	1.848	1.622	1.474	1.370	1.293	1.234	1.186	1.148	1.116	1.089	1.066	1.046	1.028	1.013
560	1.760	1.560	1.428	1.333	1.263	1.208	1.164	1.128	1.098	1.073	1.051	1.033	1.016	1.002
580	1.686	1.507	1.387	1.301	1.236	1.185	1.144	1.110	1.082	1.059	1.038	1.021	1.005	0.992
600	1.622	1.461	1.351	1.272	1.211	1.164	1.126	1.094	1.068	1.046	1.027	1.010	0.995	0.982
620	1.566	1.420	1.319	1.246	1.189	1.145	1.109	1.080	1.055	1.034	1.016	1.000	0.986	0.974
640	1.517	1.384	1.291	1.222	1.170	1.128	1.094	1.067	1.043	1.023	1.006	0.991	0.978	0.966
660	1.474	1.351	1.265	1.201	1.152	1.113	1.081	1.054	1.032	1.013	0.997	0.982	0.970	0.959
680	1.436	1.322	1.242	1.182	1.135	1.098	1.068	1.043	1.022	1.004	0.988	0.975	0.963	0.952
700	1.401	1.296	1.220	1.164	1.120	1.085	1.057	1.033	1.013	0.995	0.980	0.967	0.956	0.946
720	1.370	1.272	1.201	1.148	1.106	1.073	1.046	1.023	1.004	0.987	0.973	0.961	0.949	0.940
740	1.342	1.250	1.183	1.133	1.093	1.062	1.036	1.014	0.996	0.980	0.966	0.954	0.944	0.934
760	1.317	1.230	1.167	1.119	1.082	1.051	1.027	1.006	0.988	0.973	0.960	0.948	0.938	0.929
780	1.293	1.211	1.152	1.106	1.071	1.042	1.018	0.998	0.981	0.967	0.954	0.943	0.933	0.924
800	1.272	1.194	1.138	1.094	1.060	1.033	1.010	0.991	0.975	0.961	0.948	0.938	0.928	0.920
820	1.252	1.179	1.125	1.083	1.051	1.024	1.002	0.984	0.968	0.955	0.943	0.933	0.924	0.915
840	1.234	1.164	1.113	1.073	1.042	1.016	0.995	0.978	0.963	0.949	0.938	0.928	0.919	0.911
860	1.217	1.150	1.101	1.063	1.033	1.009	0.989	0.972	0.957	0.944	0.933	0.924	0.915	0.907

3.5 TASK 5 - DEFINE CHARACTERISTICS OF MULTIPLE EFFICIENCY TRANSFORMATION PACKAGE

INTRODUCTION

The load on a distribution transformer is very cyclic in nature and, as a result, the transformer only operates at its maximum efficiency for very short periods of time. The cycle varies simultaneously on a daily and yearly cycle, with the peak load only existing for three or four hours per day. Sizing the transformer so that its capacity is adequate to handle the peak loads has little effect on maximizing the efficiency of the transformer.

The purpose of this task is to determine if the total cost of a distribution transformer can be decreased by using a multiple efficiency transformer (MEX). The MEX could be designed so that, when the peak loads occur, the transformer would be switched to its high capacity mode. This mode would necessarily have high losses while, for the majority of the time, the transformer would operate in a low capacity mode which, by design, would have much lower losses.

Load Duration Curve

The savings that can be achieved with a multiple efficiency transformer are dependent on the load duration curve which defines the percent of the year that the transformer load exceeds a given value. From this curve and the transformer characteristics, the switching point can be defined. Once the load, switching point, and operating characteristics are defined, a good estimate of the potential savings can be made.

The load duration curve that will be used for this analysis was developed from data collected by Westinghouse in 1971. The transformer was a 37½ kVA unit connected to six all electric homes located in Coral Ridge, Florida. The unit was instrumented with a recording watt meter,

and the 15-minute integrated demand was recorded for the entire year. This data was key punched into computer cards, and a program was written to generate a load duration curve. The output from this program can be found in Tables 3-5.1 - 3-5.5 of this report. The column labeled *count* is the transformer load as a percent of $37\frac{1}{2}$ kVA.

The output load duration curve was statistically analyzed and found to have a log normal distribution. The results were then plotted on log normal probability paper. These graphs can be found in Figures 3-5.1 - 3-5.5 of this report. The load duration curves were developed for the entire year and for each of the four seasons. A complete treatment of log normal distribution can be found in most basic statistics books if further detail is desired.

Table 3-5.1

Load Duration Data for Year 1971

LINE	LOAD-DURATION	LINE-LOAD-DUR	LINE	LOAD-DURATION	LINE-LOAD-DUR	LINE	LOAD-DURATION	LINE-LOAD-DUR
1	.00	.00	63	46.25	7414.00	129	.25	8756.00
2	.00	.00	64	61.50	7475.50	130	.25	8756.25
3	.00	.00	65	51.25	7526.75	131	.00	8756.25
4	.00	.00	66	56.00	7532.75	132	.50	8756.75
5	.00	.00	67	55.00	7637.75	133	.25	8757.00
6	.00	.00	68	46.00	7683.75	134	.25	8757.25
7	1.00	1.00	69	55.00	7738.75	135	.50	8757.75
8	16.00	23.00	70	50.25	7793.00	136	1.00	8758.75
9	17.50	40.50	71	45.50	7814.50	137	.75	8759.50
10	22.00	62.50	72	41.25	7882.75	138	.25	8759.75
11	31.00	99.50	73	41.50	7929.25	139	.25	8760.00
12	55.25	158.75	74	31.75	7968.00			
13	100.00	266.75	75	41.00	8009.00			
14	144.25	511.00	76	44.25	8053.25			
15	180.00	591.00	77	39.50	8092.75			
16	158.50	707.50	78	35.50	8128.25			
17	252.25	1011.75	79	37.25	8165.50			
18	212.00	1224.75	80	31.50	8197.00			
19	228.25	1453.00	81	37.25	8229.25			
20	218.50	1671.50	82	33.00	8262.25			
21	190.50	1852.00	83	29.75	8292.00			
22	224.25	2076.25	84	28.50	8320.50			
23	226.25	2302.50	85	28.50	8339.00			
24	232.25	2534.75	86	26.00	8365.00			
25	215.00	2749.75	87	25.75	8390.75			
26	192.75	2942.50	88	24.75	8419.50			
27	198.50	3141.00	89	20.25	8443.75			
28	191.25	3332.25	90	23.25	8467.00			
29	182.25	3514.50	91	14.75	8486.75			
30	168.25	3682.75	92	22.75	8509.50			
31	134.25	3817.00	93	16.25	8525.75			
32	171.00	3593.00	94	16.00	8543.75			
33	174.50	4168.50	95	14.75	8558.50			
34	167.75	4336.25	96	15.50	8574.00			
35	153.25	4489.50	97	15.50	8589.50			
36	163.25	4652.75	98	13.25	8602.75			
37	165.25	4818.00	99	12.50	8615.25			
38	151.25	4969.25	100	15.00	8630.25			
39	150.75	5120.00	101	9.50	8639.75			
40	144.50	5264.50	102	10.75	8650.50			
41	144.25	5408.75	103	11.00	8661.50			
42	58.25	5507.00	104	11.25	8672.75			
43	135.75	5646.75	105	6.25	8679.00			
44	131.00	5777.75	106	7.50	8685.50			
45	126.50	5904.25	107	7.25	8692.75			
46	112.50	6017.75	108	3.75	8700.50			
47	111.50	6131.25	109	5.50	8706.00			
48	111.75	6249.00	110	6.25	8712.25			
49	103.50	6352.50	111	8.00	8720.25			
50	56.00	6448.50	112	6.00	8726.25			
51	97.75	6546.25	113	3.50	8729.75			
52	54.75	6641.00	114	2.25	8733.00			
53	62.75	6703.75	115	2.50	8735.50			
54	91.25	6795.00	116	2.00	8737.50			
55	19.75	6874.75	117	2.25	8739.75			
56	77.50	6952.25	118	2.00	8741.75			
57	77.00	7029.25	119	2.00	8743.75			
58	72.50	7101.75	120	2.25	8746.00			
59	62.75	7164.50	121	1.50	8747.50			
60	61.50	7224.00	122	1.75	8749.25			
61	70.25	7298.25	123	1.25	8750.50			
62	65.50	7367.75	124	1.75	8752.25			
			125	1.50	8753.75			
			126	1.00	8754.75			
			127	.50	8755.25			
			128	.50	8755.75			

KMF = 133.025.85 LARGEST LOAD = 52.12

and Factor .29

Table 3-5.2

Load Duration Data for Fall 1971

COUNT	LOAD-DURATION	CUM-LOAD-DURATION			
1	.00	.00	63	12.25	1806.75
2	.00	.00	64	23.00	1829.75
3	.00	.00	65	12.75	1842.50
4	.00	.00	66	18.25	1860.75
5	.00	.00	67	17.50	1877.25
6	.00	.00	68	14.75	1892.00
7	.00	.00	69	18.50	1910.50
8	.00	.00	70	17.00	1927.50
9	.00	.00	71	15.25	1942.75
10	.00	.00	72	14.25	1957.00
11	.00	.00	73	15.25	1972.25
12	.00	.00	74	11.50	1983.75
13	1.25	1.25	75	11.50	1995.25
14	7.75	9.00	76	16.25	2011.50
15	32.00	41.00	77	12.00	2023.50
16	48.50	89.50	78	5.25	2032.75
17	56.25	145.75	79	5.75	2042.50
18	37.50	183.25	80	9.50	2052.00
19	39.50	222.75	81	10.25	2062.25
20	39.25	262.00	82	10.50	2072.75
21	38.00	290.00	83	1.00	2079.75
22	51.50	349.50	84	8.50	2088.25
23	47.00	391.50	85	4.50	2092.75
24	46.25	437.75	86	5.25	2098.00
25	44.25	482.00	87	1.00	2105.00
26	35.25	521.25	88	7.25	2112.25
27	45.50	566.75	89	6.75	2119.00
28	38.50	605.25	90	6.00	2125.00
29	37.50	642.75	91	7.00	2132.00
30	36.75	682.50	92	5.00	2137.00
31	36.00	718.50	93	3.75	2140.75
32	45.75	764.25	94	4.00	2144.75
33	43.75	808.00	95	3.25	2148.00
34	50.00	858.00	96	2.25	2150.25
35	41.00	905.00	97	3.00	2153.25
36	40.75	946.75	98	2.00	2155.25
37	49.25	996.00	99	3.25	2158.50
38	42.00	1039.00	100	3.50	2162.00
39	49.25	1088.25	101	2.25	2164.25
40	42.25	1130.50	102	1.75	2165.50
41	46.00	1176.50	103	2.00	2167.50
42	25.25	1205.75	104	4.25	2171.75
43	49.25	1255.00	105	.75	2172.50
44	42.00	1297.00	106	1.00	2173.50
45	38.00	1335.00	107	2.00	2175.50
46	37.75	1372.75	108	1.25	2176.75
47	35.00	1407.75	109	.50	2177.25
48	32.00	1439.75	110	1.00	2178.25
49	37.50	1473.25	111	1.50	2179.75
50	30.25	1503.50	112	.00	2179.75
51	30.75	1534.25	113	.50	2180.25
52	27.75	1562.00	114	.25	2180.50
53	19.00	1581.00	115	.50	2181.00
54	29.00	1610.00	116	.25	2181.25
55	23.25	1633.25	117	.00	2181.25
56	29.75	1663.00	118	.25	2181.50
57	24.25	1687.25	119	.50	2182.00
58	25.75	1713.00	120	.50	2182.50
59	15.25	1728.25	121	.00	2182.50
60	20.00	1748.25	122	.25	2182.75
61	25.00	1773.25	123	.25	2183.00
	21.25	1794.50	124	.50	2183.50
			125	.25	2183.75
			126	.00	2183.75
			127	.00	2183.75
			128	.25	2184.00

Table 3-5.3

Load Duration Data for Winter 1971

COUNT	LOAD-DURATION	CUM-LOAD-DURATION			
1	.00	.00	63	5.75	2009.00
2	.00	.00	64	1.00	2096.00
3	.00	.00	65	1.00	2103.00
4	.00	.00	66	5.50	2108.50
5	.00	.00	67	5.25	2113.75
6	.00	.00	68	5.00	2118.75
7	4.25	4.25	69	4.25	2123.00
8	8.25	12.50	70	4.25	2127.25
9	11.25	23.75	71	3.75	2131.00
10	16.00	39.75	72	5.00	2136.00
11	22.00	61.75	73	2.50	2138.50
12	30.25	92.00	74	4.25	2142.75
13	51.75	143.75	75	1.00	2143.75
14	76.50	220.25	76	2.00	2145.75
15	73.75	294.00	77	1.75	2147.50
16	71.75	365.75	78	1.50	2149.00
17	76.00	441.75	79	1.75	2150.75
18	67.75	511.50	80	1.75	2152.50
19	75.25	586.75	81	1.25	2153.75
20	66.75	653.50	82	.75	2154.50
21	55.75	709.25	83	1.00	2155.50
22	61.50	770.75	84	.50	2156.00
23	67.50	838.25	85	.25	2156.25
24	75.25	913.50	86	.00	2156.25
25	64.00	977.50	87	.75	2157.00
26	59.75	1037.25	88	.50	2157.50
27	55.25	1096.50	89	.25	2157.75
28	65.50	1162.00	90	.00	2157.75
29	55.50	1221.50	91	.50	2158.25
30	52.25	1273.75	92	.00	2158.25
31	40.00	1313.75	93	.25	2158.50
32	52.00	1365.75	94	.25	2158.75
33	52.00	1417.75	95	.00	2158.75
34	44.50	1462.25	96	.25	2159.00
35	38.25	1500.50	97	.00	2159.00
36	45.75	1546.25	98	.00	2159.00
37	41.50	1587.75	99	.00	2159.00
38	36.00	1625.75	100	.25	2159.25
39	36.25	1662.00	101	.25	2159.50
40	33.75	1695.75	102	.00	2159.50
41	30.00	1725.75	103	.00	2159.50
42	20.25	1746.00	104	.00	2159.50
43	30.00	1776.00	105	.00	2159.50
44	25.75	1801.75	106	.00	2159.50
45	29.00	1830.75	107	.00	2159.50
46	20.75	1851.50	108	.00	2159.50
47	21.75	1873.25	109	.00	2159.50
48	26.00	1901.25	110	.00	2159.50
49	19.50	1920.75	111	.25	2159.75
50	16.50	1937.25	112	.00	2159.75
51	15.75	1957.00	113	.00	2159.75
52	19.00	1976.00	114	.00	2159.75
53	10.75	1986.75	115	.25	2160.00
54	15.75	2002.50			
55	13.00	2015.50			
56	5.50	2025.00			
57	12.50	2037.50			
58	10.50	2048.00			
59	6.75	2056.75			
60	6.50	2065.25			
61	7.25	2072.50			
62	10.75	2083.25			

KWP = 24.083.CI LARGEST LOAD = 43.12

Load Factor = .21

Table 3-5.4

Load Duration Data for Spring 1971

COUNT	LOAD-DURATION	CUM-LOAD-DURATION			
1	.00	.00	63	4.75	2110.25
2	.00	.00	64	6.25	2116.50
3	.00	.00	65	8.00	2122.50
4	.00	.00	66	6.75	2129.25
5	.00	.00	67	7.00	2136.25
6	.00	.00	68	4.00	2140.25
7	2.75	2.75	69	5.00	2145.25
8	7.75	10.50	70	4.50	2149.75
9	6.25	16.75	71	4.25	2154.00
10	5.50	22.25	72	2.50	2156.50
11	13.75	36.00	73	4.00	2160.50
12	25.00	61.00	74	4.00	2164.50
13	46.50	107.50	75	4.00	2169.50
14	52.00	159.50	76	3.00	2171.50
15	42.00	221.50	77	1.75	2173.25
16	45.00	286.50	78	2.00	2175.25
17	70.50	357.00	79	3.00	2178.25
18	82.50	440.50	80	1.75	2180.00
19	95.75	531.25	81	2.50	2182.50
20	88.25	617.50	82	1.50	2184.00
21	68.75	681.25	83	2.25	2186.25
22	83.25	764.50	84	1.25	2187.50
23	86.25	850.75	85	1.50	2189.00
24	81.00	931.75	86	2.00	2191.00
25	77.50	1009.25	87	1.50	2192.50
26	62.50	1071.75	88	1.50	2194.00
27	61.00	1138.75	89	2.00	2196.00
28	58.00	1196.75	90	2.00	2198.00
29	57.25	1254.00	91	1.00	2199.00
30	46.00	1303.00	92	1.00	2200.00
31	36.25	1339.25	93	.25	2200.25
32	45.25	1388.50	94	1.25	2201.50
33	45.25	1437.75	95	.75	2202.25
34	43.75	1481.50	96	.00	2202.25
35	38.50	1520.00	97	.75	2203.00
36	44.50	1564.50	98	.25	2203.25
37	38.00	1602.50	99	.25	2203.50
38	42.00	1644.50	100	.50	2204.00
39	34.00	1678.50	101	.25	2204.25
40	34.75	1713.25	102	.50	2204.75
41	32.00	1745.25	103	.75	2205.50
42	25.25	1770.50	104	.00	2205.50
43	30.75	1801.25	105	.25	2205.75
44	28.50	1829.75	106	.00	2205.75
45	24.00	1851.75	107	.50	2206.25
46	23.00	1876.75	108	.25	2206.50
47	22.00	1898.75	109	.25	2206.75
48	22.00	1920.75	110	.00	2206.75
49	21.25	1942.00	111	.25	2207.00
50	20.50	1962.50	112	.00	2207.00
51	18.50	1981.00	113	.25	2207.25
52	14.75	1995.75	114	.00	2207.25
53	12.00	2007.75	115	.25	2207.50
54	14.50	2022.25	116	.25	2207.75
55	11.75	2034.00	117	.00	2207.75
56	13.75	2047.75	118	.00	2207.75
57	5.00	2056.75	119	.25	2208.00
58	5.25	2064.00			
59	12.00	2078.00			
60	8.75	2086.75			
61	8.75	2095.50			
62	5.00	2105.50			

KMF = 20,100.07 LARGEST LOAD = 46.62

LOAD CAPACITY = 2.1

Table 3-5.5

Load Duration Data for Summer 1971

COUNT	LOAD-DURATION	CUM-LOAD-DURATION						
1	.00	.00	63	21.50	1400.00	129	.25	2204.00
2	.00	.00	64	25.25	1433.25	130	.25	2204.25
3	.00	.00	65	25.50	1450.75	131	.00	2204.25
4	.00	.00	66	25.50	1484.25	132	.50	2204.75
5	.00	.00	67	26.25	1510.50	133	.25	2205.00
6	.00	.00	68	27.25	1532.75	134	.25	2205.25
7	.00	.00	69	27.25	1560.00	135	.50	2205.75
8	.00	.00	70	24.50	1584.50	136	1.00	2206.75
9	.00	.00	71	22.25	1606.75	137	.75	2207.50
10	.50	.50	72	26.50	1633.25	138	.25	2207.75
11	1.25	1.75	73	24.75	1658.00	139	.25	2208.00
12	4.00	5.75	74	19.00	1677.00			
13	6.50	12.25	75	24.50	1701.50			
14	8.00	20.25	76	21.00	1724.50			
15	12.25	32.50	77	24.00	1748.50			
16	11.25	45.75	78	22.75	1771.25			
17	19.50	65.25	79	22.75	1794.00			
18	24.25	89.50	80	18.50	1812.50			
19	22.75	112.25	81	18.25	1830.75			
20	26.25	138.50	82	20.25	1851.00			
21	25.00	163.50	83	19.50	1870.50			
22	28.00	191.50	84	18.25	1888.75			
23	30.50	222.00	85	12.25	1901.00			
24	29.75	251.75	86	18.75	1919.75			
25	29.25	281.00	87	16.50	1936.25			
26	31.25	312.25	88	15.50	1951.75			
27	26.75	339.00	89	19.25	1971.00			
28	29.25	368.25	90	15.25	1986.25			
29	28.00	396.25	91	11.25	1997.50			
30	27.25	423.50	92	16.75	2014.25			
31	22.00	445.50	93	12.00	2026.25			
32	30.00	475.50	94	12.50	2038.75			
33	29.50	505.00	95	10.75	2049.50			
34	29.50	534.50	96	13.00	2062.50			
35	29.50	564.00	97	11.75	2074.25			
36	31.25	595.25	98	11.00	2085.25			
37	36.50	631.75	99	9.00	2094.25			
38	28.25	660.00	100	10.75	2105.00			
39	31.25	691.25	101	6.75	2111.75			
40	31.75	723.00	102	9.00	2120.75			
41	36.25	761.25	103	8.25	2129.00			
42	21.50	784.75	104	7.00	2136.00			
43	29.75	814.50	105	5.25	2141.25			
44	31.75	849.25	106	5.50	2146.75			
45	35.50	884.75	107	4.75	2151.50			
46	32.00	916.75	108	6.25	2157.75			
47	32.75	949.50	109	4.75	2162.50			
48	37.75	987.25	110	5.25	2167.75			
49	29.25	1016.50	111	6.00	2173.75			
50	28.75	1045.25	112	6.00	2179.75			
51	28.75	1074.00	113	2.75	2182.50			
52	31.25	1107.25	114	3.00	2185.50			
53	21.00	1128.25	115	1.50	2187.00			
54	32.00	1160.25	116	1.50	2188.50			
55	31.75	1192.00	117	2.25	2190.75			
56	24.50	1216.50	118	1.75	2192.50			
57	31.25	1247.75	119	1.25	2193.75			
58	27.00	1274.75	120	1.75	2195.50			
59	26.75	1301.50	121	1.50	2197.00			
60	26.25	1327.75	122	1.50	2198.50			
61	29.25	1357.00	123	1.00	2199.50			
62	27.50	1384.50	124	1.25	2200.75			
			125	1.25	2202.00			
			126	1.00	2203.00			
			127	.50	2203.50			
			128	.25	2203.75			

KWH = 46,173.26 LARGEST LOAD = 52.12

LOAD FACTOR = .40

Figure 3-5.1

Figure 3-5.2

Figure 3-5.3

Figure 3-5.4

Figure 3-5.5

Standard Load Duration Curve

The real benefit of the log normal plot of the load duration curve becomes apparent when the curve is standardized on the base of the peak transformer load being called the 100% load. This establishes one point on the curve (.01% of time, 100% load), and a second point can be established from the load factor. The 50% of time load should exactly equal the percent load factor. After these two points have been plotted on log normal cumulative probability, a straight line can be drawn connecting these two points. This line then describes the percent of time that the load is at or below any load as a percent of peak load (see Figure 3-5.6).

Daily Peak

After the load duration curve has been established, the next question to answer on the operating characteristics of the multiple efficiency transformer (MEX) is the frequency with which switching will occur. To eliminate the problem of switching for any short-time transient, a 5-minute integrated load will be used for switching. To determine how many days a year the MEX might switch modes (low capacity to high capacity), the Coral Springs data was analyzed for the 15-minute daily peak load.

This analysis shows that the MEX would switch on 12% of the days if the switching point were 80% of the peak. If the switching point were 50% of the peak, the MEX would switch modes 58% of the days. The detailed data are found on Tables 3-5.7 - 3-5.11. The conclusion from this analysis is that the switch for the MEX must be designed for daily operation to achieve the reliability necessary for this type of switch.

MEX kVA Ratios

When a single efficiency transformer is sized, three factors are considered: the present average and peak load, the load growth rate, and the number of years between changeouts. Knowing these factors and

Table 3-5.6

1971

15 Minute Peak Daily Load for 1971

MAXIMUM 15 MINUTE LOAD	DAYS WITH THIS LOAD	DAYS AT THIS LOAD OR LESS
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	1	1
13	3	4
14	3	7
15	2	9
16	1	10
17	13	23
18	11	34
19	11	45
20	17	62
21	9	71
22	16	87
23	10	97
24	25	122
25	19	141
26	12	153
27	12	165
28	13	178
29	18	196
30	10	206
31	17	223
32	18	241
33	3	244
34	9	253
35	3	256
36	7	263
37	3	266
38	15	281
39	15	296
40	7	303
41	8	311
42	11	322
43	7	329
44	4	333
45	6	339
46	4	343
47	8	351
48	4	355
49	0	355
50	2	357
51	6	363
52	2	365

Table 3-5.7

WINTER

15 Minute Peak Daily Load for Winter 1971

MAXIMUM 15 MINUTE LOAD	DAYS WITH THIS LOAD	DAYS AT THIS LOAD OR LESS
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	1	1
13	2	2
14	0	3
15	2	5
16	1	6
17	3	9
18	6	15
19	8	23
20	8	31
21	7	38
22	9	47
23	3	50
24	6	56
25	6	62
26	2	64
27	4	68
28	1	69
29	7	76
30	5	81
31	2	83
32	1	84
33	2	86
34	1	87
35	0	87
36	0	87
37	0	87
38	2	89
39	0	89
40	0	89
41	0	89
42	0	89
43	1	90
44	0	90
45	0	90
46	0	90
47	0	90
48	0	90
49	0	90
50	0	90
51	0	90
52	0	90

Table 3-5.8

SPRING

15 Minute Peak Daily Load for Spring 1971

MAXIMUM 15 MINUTE LOAD	DAYS WITH THIS LOAD	DAYS AT THIS LOAD OR LESS
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	1	1
14	3	4
15	0	4
16	0	4
17	10	14
18	5	19
19	3	22
20	8	30
21	2	32
22	6	38
23	7	45
24	10	55
25	4	59
26	6	65
27	4	69
28	5	74
29	3	77
30	0	77
31	3	80
32	4	84
33	0	84
34	1	85
35	0	85
36	2	87
37	0	87
38	0	87
39	2	89
40	1	90
41	0	90
42	0	90
43	0	90
44	1	91
45	1	92
46	0	92
47	0	92
48	0	92
49	0	92
50	0	92
51	0	92
52	0	92

Table 3-5.9

SUMMER

15 Minute Peak Daily Load for Summer 1971

MAXIMUM 15 MINUTE LOAD	DAYS WITH THIS LOAD	DAYS AT THIS LOAD OR LESS
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	1	1
23	0	1
24	0	1
25	0	1
26	1	2
27	0	2
28	1	3
29	3	6
30	3	9
31	2	11
32	8	19
33	0	19
34	2	21
35	1	22
36	2	24
37	2	26
38	11	37
39	8	45
40	2	47
41	6	53
42	7	60
43	4	64
44	3	67
45	3	70
46	3	73
47	6	79
48	3	82
49	0	82
50	2	84
51	6	90
52	2	92

AUTUMN

15 Minute Peak Daily Load for Fall 1971

MAXIMUM 15 MINUTE LOAD	DAYS WITH THIS LOAD	DAYS AT THIS LOAD OR LESS
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	1	1
21	0	1
22	0	1
23	0	1
24	9	10
25	9	19
26	3	22
27	4	26
28	6	32
29	5	37
30	2	39
31	10	49
32	5	54
33	1	55
34	5	60
35	2	62
36	3	65
37	1	66
38	2	68
39	5	73
40	4	77
41	2	79
42	4	83
43	2	85
44	0	85
45	2	87
46	1	88
47	2	90
48	1	91
49	0	91
50	0	91
51	0	91
52	0	91

the cost components of the system, the economical size transformer for a particular installation can be selected. Selecting the kVA sizes for an MEX adds some new dimensions to the problem of matching the transformer to the load. The size of each of the transformer ratings must be selected and the switching point set to maximize the savings.

The lower kVA rating selected no longer is affected by the number of years to changeout as it was in selecting the single kVA transformer, because the changeout life is determined by the higher kVA rating. A key factor in selecting the lower kVA rating for the MEX is to select a unit that will be used 80 - 90% of the time initially, so that the savings achieved by the MEX transformer justifies the cost. A key factor in selecting the large kVA rating is the time to changeout. The MEX can be sized based on the initial peak load and the growth rate.

The ratio of kVAs achievable may be restricted by the final transformer design configuration selected. If the MEX is built on one core with windings that can be put in series or parallel to increase the ampacity, the ratio of capacity is limited to 2 to 1 because of practical design considerations, but the no-load loss in the low capacity mode would be much lower than a normal transformer of half the kVA. If the MEX is constructed of two magnetically independent coils, almost any capacity ratio is possible, limited only by the operating economics. If the two core/coil design is chosen, the coils could both be put in the same tank or in separate tanks.

Selecting the Switching Point

Selecting the switching point involves finding the value of load at which the total losses in the low kVA mode become greater than those of the high kVA mode. The equation for the switching point in per unit of the high kVA mode is:

$$SK = \sqrt{\frac{NLLH - NLLL}{(TH/TL)^2 \times LLL - LLH}}$$

These terms are defined in Table 3-5.17.

For the MEX with a 2:1 kVA ratio, the following relationships are assumed.

$$NLLH = 2 \times NLLL$$

$$LLL = LLH$$

In this case the equation for the switching point is:

$$SK = \sqrt{\frac{NLLH}{6 \times LLH}}$$

If cost parameters were considered in selecting the switching load, and different costs in dollars/kWh were assigned to load and no-load losses, the calculated value of the switching load would be higher. Use of this higher switching kVA may yield lower operating costs, according to the loss evaluation equations. However, cost parameters should not be considered when calculating the switching load.

This apparent paradox is explained by the fact that loss evaluation equations assume that base load generation supplies no-load losses and that peak load generation supplies load losses of the high kVA mode. Higher cost parameters are associated with peak load than base load generation, and therefore no-load losses are seemingly less important.

However, at a given value of load on a transformer, the system does not distinguish load losses from no-load losses. Therefore the switching load should be selected in such a way that the total losses on the transformer are minimized at any given time, and the cost parameters should not be considered when selecting the switching point.

The effect of voltage regulation in the low mode is greater than that in the high mode because of higher winding impedance. If the energy cost of regulation were considered in the equations, the calculated value of the switching load would be slightly lower. However, this slight change in SK would have a negligible effect on the loss evaluation.

Table 3-5.11 summarizes the switching points for a single core/coil MEX, and Table 3-5.12 shows switching points for the two-transformer MEX.

TABLE 3-5.11

SWITCHING POINT FOR SINGLE CORE/COIL MEX
(2:1 kVA RATIO)

kVA Rating	NLLH	LLH	Switching Load
5 x 10	.062	.148	2.64
7.5 x 15	.073	.210	3.61
12.5 x 25	.105	.316	5.88
18.75 x 37.5	.163	.430	9.43
25 x 50	.191	.524	12.3

Table 3-5.12
Switching Point For 2 Transformer MEX

INPUT DATA

XFMR SIZE	ASSUMED PRICE	NO LOAD LOSS	LOAD LOSS
5.	243.	.062	0.037
10.	243.	.062	0.148
15.	269.	.073	0.210
25.	337.	.105	0.316
37.	436.	.163	0.430
50.	510.	.191	0.524
75.	746.	.275	0.776
100.	867.	.346	1.004

ECONOMIC TRANSFORMER CHANGEOUT LOAD IN KVA

ORIGINAL XFMR	NEW TRANSFORMER						
	10 KVA	15 KVA	25 KVA	37 KVA	50 KVA	75 KVA	100 KVA
5 KVA	0.0	4.49	6.64	9.31	10.08	12.60	14.35
10		4.49	6.64	9.31	10.08	12.60	14.35
15			8.65	12.06	12.77	15.94	18.10
25				17.40	17.05	21.50	24.39
37					16.37	25.22	29.26
50						34.24	37.68
75							43.48

Design Alternatives for MEX

There are many configurations which could be used to achieve the implementation of the MEX transformer concept. This program will consider the five configurations that are the most practical based on today's transformer technology. The following is a brief description of each design and an evaluation of the benefits of and problems with each.

1. Shell Form

This design would consist of one core/coil assembly. The core would be a conventional wound core with two loops, as with standard shell form construction. The coil would be progressively wound with two sets of high voltage and low voltage windings, each with ampacity of one-half the maximum rated kVA. The number of turns in each set would be the same as would be expected in a single efficiency transformer of the maximum kVA rating. The transformer would contain a switch that could change the winding connections from series to parallel under load at the proper switching load.

The problem with this design is that progressively wound coils are located in very close proximity to each other and would require major insulation between each of the six coils adequate for the BIL test voltage for the insulation class (see Figure 3-5.7). Switching this design without causing a temporary service interruption--or, at the very least, a light flicker--is a difficult problem.

2. Core Form

This design would consist of one core/coil assembly. The core would be a conventional wound core with one core loop, as with standard core form construction. The two coils would each be wound with high voltage and low voltage coils which could be connected in series or parallel. Each coil would have an ampacity of one-half the maximum kVA. The number of turns in each coil would be the same as would be expected in total in both coils of

WESTINGHOUSE ELECTRIC CORPORATION

HIGH CAPACITY CONNECTIONS

HV 1-3, 2-4

LV A-E, C-G, B-F, D-H

LOW CAPACITY CONNECTIONS

HV 1, 2-3, 4

LV A, B-E, F, G, H-C, D

WESTINGHOUSE ELECTRIC CORPORATION

CORE FORM MEX

HIGH CAPACITY CONNECTIONS

HV 1-3, 2-4

LV A-E, C-G, B-F, D-H

LOW CAPACITY CONNECTIONS

HV 1, 2-3, 4

LV A, B-E, F, G, H-C, D

a single efficiency transformer. The transformer would contain a switch that could change the coils from series connection to parallel under load at the proper switching load.

By having two separate coils, the need for extra major insulation between high voltage coils is eliminated (see Figure 3-5.8). Switching this design without causing a temporary service interruption--or, at the very least, a light flicker--is a difficult problem.

3. Two Core/Coil Assemblies

This configuration would consist of two complete core/coil assemblies in one transformer tank with a switch in the tank that could switch from one core/coil assembly to the other. Each core/coil would be of different kVA ampacity and each would be used independently.

This design would allow flickerless switching by using a make-before-break switching plan which would parallel the coils before deenergizing the coil that is being switched out. The problem with this design is that it would be much more costly than a single core/coil design, the tank would be larger, and the unit would be heavier.

4. Two Transformer Unit

This configuration would consist of two complete transformers mounted at the same location, with a switch located adjacent to the transformers in a separate enclosure. The design would allow users complete freedom in selecting the kVA ratings of the two units selected. It would reduce the cost of changeout due to load growth or transformer failure.

This design would reduce the cost of developing the MEX, since all components are presently available except the switch. But the design would have the highest first cost to the user because of the redundancy required. The design would allow flickerless switching by using a make-before-break switching plan which would parallel the two transformers before deenergizing the unit that is being switched out.

5. The Secondary Network

This concept calls for the use of a primary and a secondary network, which results in all transformers on the system being in parallel. If a logic switch is added to the primary and secondary network protectors, it would allow all transformers to be switched in and out of the network as the load increases or decreases. In theory, if the load is closely monitored, the switching logic could keep all transformers operating at maximum efficiency. The major drawback of this system is the high initial cost and the operating complexity.

Design Specifications

1. The Switch

The switch that is used for the MEX must be able to break and make primary and secondary load current at rated voltages as any switch would. It must be able to close in on a faulted transformer and be able to sustain all fault currents that are due to external faults without damage. The device must pass all dielectric tests required of the transformer, which will restrict the use of solid state electronic devices. The switch must not contaminate the transformer oil in any way.

The switch must use five-minute integrated demand load to eliminate the problem of continuous switching. The switch must be able to change modes without service interruption and a minimum of light flicker. The switch must either withstand, suppress, or absorb the transient energy due to magnetization and inrush current.

The reliability of this switch must be greater than the reliability of the transformer. Based on this criterion, the switch must be able to change mode up to five times per day for 30 years without damage. The switch must be designed so that, if it does fail, it will switch to and remain in the high capacity position.

If the switch is designed for either the two core/coil assemblies in one tank or the two transformer concept, it must be able to detect a failed transformer and switch to the remaining good unit until a repair or replacement is made. This means that the switch will have to break fault current to change modes during a fault.

2. The Multiple Efficiency Transformer

The basic design specifications of the MEX would have to be the same as a standard transformer. Those items that are not affected by the MEX concept will not be addressed here. These specifications will only consider the single core/coil assembly MEX design. The transformer design for the other configurations is trivial, since it would be the same as a standard distribution transformer connected together through a switch.

The MEX must pass all dielectric tests in either capacity mode with the same margin of protection and coordination characteristics. The MEX must meet its rated no-load loss in both the series and parallel setting as closely as commercially practical. This is especially true of the low kVA setting, since the key to the economics of the MEX is the loss savings in the low capacity setting.

The ampacity ratio between the two settings should be 2 to 1. The temperature rise should be 65°C in either setting. The turns ratio of all windings to be connected in parallel must be 1. The winding must be able to withstand temporary short circuits that may occur during switching from series to parallel. The impedance must be less than 4% to prevent regulation problems in either setting. The use of tap changers is expensive but possible if the system requires it. Dual voltage designs are impractical because of the number of connections required and the insulation clearances.

SUMMARY

BIL: standard for voltage class
Temperature rise: 65°C OA
%IZ: less than 4%
Insulation: fully or graded
Connection: see Figures 3-5.7 - 3-5.8

While all of the configurations discussed have merit, the design optimization will be done on the core form MEX (see Figure 3-5.7) because of the inherent advantage of the insulation clearance between coils resulting in reduced major insulation requirements between high-voltage coils.

Evaluating Savings

It is appropriate to take a first look at the annual energy savings that can be achieved by use of the MEX. The easiest way to evaluate this saving is by means of a graph. Figure 3-5.9 illustrates how a set of parametric graphs can be used to estimate the kilowatt/hours saved per year.

The cumulative load duration curve is plotted in quadrant I. This curve is based on a 52 kW peak load and a load factor of 30%. In quadrant II, the losses of the MEX are plotted as a function of load kVA. The MEX unit is a 37.5 kVA x 18.75 kVA. Where the two lines cross is the switching point that would be used if regulation was ignored. At loads less than 9.4 kVA, the MEX would be in the low capacity mode. Above 9.4 kVA it would be in the high capacity mode.

Quadrant III is used to convert losses to loss saved and transfer the data. Quadrant IV is a graph of losses saved vs. hours at that load level. The integral or the area under the curve in quadrant IV represents the kWh saved per year--in this case 94 kWh.

Figure 3-5.9
MEX Loss Savings

FIG. 3-5.9

MEX LOSS EVALUATION

For the single efficiency transformer loss evaluation, a geometric progression was formulated to account for load growth, inflation, and the rate of return. The formula for the sum of this geometric series was then used to evaluate the losses. However, this simplification is not possible for the MEX, since the percent time in each mode changes annually due to load growth.

Therefore equations were developed to find the operating costs for a given year. The present worth values of these costs are summed over a 30-year period to get the present worth of the operating costs. The levelized annual cost of the losses is found by dividing the present worth of the operating costs by the uniform annual series present worth factor. The levelized annual cost of transformer investment for the MEX is evaluated in the same manner as that for the single efficiency transformer.

The load duration curve is used to evaluate the losses of the multiple efficiency transformer. The cumulative load duration curve is assumed to have log normal distribution and can be plotted as described on pages 3.5-13 and 3.5-14. If the switching kVA is known, the percent time in the high kVA mode can be determined. It is simply the amount of time that the load is above the switching kVA. The percent time in the low kVA mode is the amount of time that the load is below the switching kVA. Switching loads for different units are shown on Tables 3-5.11 and 3-5.12.

Loss Factor Evaluation

Since the MEX is essentially two transformers that operate at different loads, a separate loss factor is associated with each mode. The loss factor for each kVA mode can be approximated from the load duration curve. The loss factor (LSFH) for the high kVA mode is the loss factor of that portion of the load duration curve for which the load is above the switching kVA. Similarly, the loss factor (LSFL) for the low kVA mode is the loss factor of that part of the curve for which the load is below the switching kVA. Definitions of terms can be found on Table 3-5.14.

$$LSFH = \frac{1}{HH} \int_0^{HH} L^2(t) dt$$

$$LSFL = \frac{1}{SK(Y)^2 \times HL} \int_{HH}^1 L^2(t) dt$$

The integrals for loss factors can be approximated numerically from the load duration curve. The loss factor can be plotted as a function of percent time in the high (or low) kVA mode. Loss factors versus percent time are plotted for load duration curves with annual load factors of 10%, 20%, and 30% in Figures 3-5.10 and 3-5.11.

Load Growth

This analysis assumes that annual load growth will not affect the shape of the load duration curve and therefore will not change the overall loss factor. However, the switching load will decrease in percent of peak load due to load growth. Therefore the percent time in the high kVA mode will increase annually. The individual loss factors associated with each kVA mode will also change annually due to load growth.

Because of these variations, the losses of the multiple efficiency transformer must be evaluated on an annual cost basis before converting to a total levelized annual cost. Under the assumptions of constant annual load growth and fixed shape of the load duration curve, the switching kVA for year Y is:

$$SK(Y) = \frac{SK(1)}{(1 + GR)^{Y-1}}$$

where SK is in per unit of peak load. The peak load for year Y is:

$$P(Y) = P(1) \times (1 + GR)^{(Y-1)}$$

LOSS FACTOR CURVES FOR LOW KVA MODE

Figure 3-5.10

LOSS FACTOR CURVES FOR HIGH KVA MODE

Figure 3-5.11

The percent time in each kVA mode is determined from the load duration curve after calculating the switching kVA in per unit of peak load. The loss factors of each kVA mode can be determined from the plots in Figures 3-5.10 and 3-5.11.

Cost Parameters

The present worth of the cost parameters for year Y can be found using the following equations

$$CEP(Y) = CEP1 \left[\frac{(1 + IRP)^{Y-1}}{(1 + I)^Y} \right]$$

$$CEB(Y) = CEB1 \left[\frac{(1 + IRB)^{Y-1}}{(1 + I)^Y} \right]$$

$$CCE(Y) - CE(Y) = (CCE1 - CE1) \left[\frac{(1 + IRP)^{Y-1}}{(1 + I)^Y} \right]$$

$$CSYSB(Y) = CSYSB1 \left[\frac{1}{1 + I} \right]^Y$$

$$CSYSP(Y) = CSYSP1 \left[\frac{1}{1 + I} \right]^Y$$

Annual Load Loss Costs for MEX

1. Energy Component.

The energy component of the annual load loss cost depends on the loss factors associated with each mode and the amount of time in each mode. These values will change each year due to load growth as discussed previously. The cost parameters (CEB) and CEP) are functions of inflation and the rate of return. The annual peak load increases each year by the percent growth

rate. The switching kVA (SK) in this equation is expressed in kVA and is constant. It is not to be confused with the switching kVA in per unit of the peak load which is used to evaluate the loss factors. For definitions of terms, refer to Table 3-5.14.

$$LLCE(Y) = 8760 \times [CEP(Y) \times LSFH(Y) \times HH(Y) \times LLH \times P^2(Y) + CEB(Y) \times HL(Y) \times LLL \times (SK/TL)^2]$$

$$HL(Y) = 1 \times HH(Y)$$

2. Demand Component.

The demand component of annual load loss cost depends upon which mode the transformer is in at the time of system peak. If $PRFS \times P \geq SK$, then the transformer is in the high mode at the time of system peak and load losses for the high mode (LLH) should be used. Conversely if $PRFS \times P < SK$, then load losses for the low mode (LLL) should be used.

$$PRFS \times P(Y) \geq SK: \quad LLCD(Y) = CSYSP(Y) \times DISC \times CC \times PRFS^2 \times P^2(Y) \times LLH$$

$$PRFS \times P(Y) < SK: \quad LLCE(Y) = CSYSP(Y) \times DISC \times CC \times PRFS^2 \times P^2(Y) \times (TH/TL)^2 \times LLL$$

The system investment cost per unit of base load (CSYSP) is a function of the first year value (CSYSP1) and the rate of return.

Annual No-Load Loss Costs for MEX

1. Energy Component.

The energy component of the annual no-load loss cost depends on the amount of time the MEX spends in each mode for a given year.

$$NLCE(Y) = CEB(Y) \times 8760 \times [HH(Y) \times NLLH + HL(Y) \times NLLL]$$

2. Demand Component.

The demand component of the no-load loss cost, like that of the load loss cost, depends on which mode the transformer is in at the time of system peak. If $PRFS \times P(Y) \geq SK$, then the transformer is in the high mode at the time of system peak and the no-load losses of the high kVA mode should be used. If $PRFS \times P(Y) < SK$, the no-load losses for the low kVA mode should be used. The system investment cost per unit of base load is a function of the first year value (CSYSB1) and the rate of return.

$$PRFS \times P(Y) \geq SK: NLCD(Y) = CSYSB(Y) \times DISC \times CC \times NLLH$$

$$PRFS \times P(Y) < SK: NLCD(Y) = CSYSB(Y) \times DISC \times CC \times NLLL$$

Annual Energy Cost of Regulation

The energy cost of regulation is the lost revenue due to the reduction in energy minus the utility's cost of this energy. Therefore the reduction in energy is multiplied by the average sale price of incremental energy (CCE) minus the average incremental energy cost (CE). These cost parameters are functions of inflation and the rate of return. The reduction in energy due to regulation occurs in both modes and, as in the energy component of load losses, separate loss factors are used for each mode.

$$RGCE(Y) = [CCE(Y) - CE(Y)] \times LKW \times PF \times 8760 \times [TH \times REGH \times LSFH(Y) \times HH(Y) \\ \times P^2(Y) + TL \times REGL \times HL(Y) \times LSFL(Y) \times (SK/TL)^2]$$

Total Levelized Annual Cost (TLAC)

The above equations give the annual costs of operating the MEX. To determine the levelized annual cost, the present worths of costs for each year must be summed and then divided by the uniform series present worth factor. The levelized annual cost of the transformer investment (TIC) is the transformer cost (CT) times the carrying charge rate (CC). This cost is added to the levelized annual cost of operating the MEX to get the total levelized annual cost (TLAC).

$$TIC = CT \times CC$$

$$TLAC = TIC + \sum_{Y=1}^N [LLCE(Y) + LLCD(Y) + NLCE(Y) + NLCD(Y) + RGCE(Y)] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

COMPARISON OF MULTIPLE EFFICIENCY VERSUS SINGLE EFFICIENCY

In the comparison of multiple efficiency versus single efficiency, it is assumed that the characteristics of the MEX in the high mode are equivalent to those of the single efficiency transformer. This includes the no-load losses, load losses, kVA rating, and impedance. A 2:1 kVA rating is assumed for the MEX, and the no-load loss in the high mode is assumed to be twice that of the low mode. Load loss of the high and low modes are assumed to be equal.

Demand Components

The demand components of the loss evaluation for the MEX depend upon which mode the transformer is in at the time of system peak. If the peak responsibility factor is .75 per unit, and the peak load of the transformer is .75 per unit, then the switching kVA must be higher than .56 per unit of the high kVA rating in order for the low mode to be energized at system peak.

The switching kVA depends on the load loss and the no-load loss (see p. 3.5-20). The ratio of no-load to load loss would have to be unrealistically low in order for the switching kVA to be as high as .56 per unit of the high mode. Therefore it is unlikely that the MEX will be in the low kVA mode at the time of system peak, especially as load growth increases the peak load. As a result, it is doubtful that the MEX will affect the demand components.

Energy Components

The load loss in kilowatt hours will be higher for the MEX than for the single efficiency transformer because of the higher winding resistance of the low kVA mode. However, the cost of these losses will be less, because the load losses of the low kVA mode are assumed to be supplied by base load generation. The reason for this assumption is that, during the time when the transformer is in the low mode, it is most likely that only base load, and not peak load, is being generated.

The energy cost of regulation will be higher for the MEX than for the single efficiency transformers. This is due to the higher winding impedance of the low kVA mode. However, this does not have much effect on the TLAC since the cost of regulation is so small.

The most important savings of the MEX arise because of the lower no-load losses of the low kVA mode. The savings depend on the amount of time that the transformer is in the low mode. The more time the transformer spends in the low kVA mode, the greater the savings. These savings are indirectly affected by the overall load factor and the load growth, because these parameters determine the percent of time in the low kVA mode. For a given peak load, the lower the load factor, the greater the percent time in the low mode. A high load growth rate will diminish the percent time in the low kVA mode over the years. However, if the transformer is changed out at the proper time, the total percent time in the low kVA mode can be increased.

Table 3-5.13 shows an example of energy costs for a 50/25 kVA MEX and a 50 kVA single efficiency transformer. The costs tabulated are present worth values for the given year. Only the energy components are tabulated, since the demand components are the same in both cases. Three cases are considered to show the considerable dependence of the savings on the load factor.

For each value of load factor, all values are added for the MEX and for the single efficiency transformer. Then the difference between those values was tabulated at the bottom of the page. This number represents the present worth of the savings. To find the levelized savings, this value must be divided by the uniform annual series present worth factor. Tables for total levelized annual costs for the single efficiency transformer and for the MEX are included in Tasks 6 and 7 respectively.

TABLE 3-5.13

COMPARISON OF ENERGY COST COMPONENTS OF
SINGLE AND MULTIPLE EFFICIENCY TRANSFORMERS

MULTIPLE EFFICIENCY TRANSFORMER									
N	30 PERCENT LDF			20 PERCENT LDF			10 PERCENT LDF		
	LLC	NLC	REGC	LLC	NLC	REGC	LLC	NLC	REGC
1	22.70	49.44	7.72	17.83	37.67	4.81	8.57	31.20	2.04
2	22.69	49.02	7.85	18.08	37.49	4.94	8.99	30.85	2.16
4	24.29	39.03	6.99	18.48	37.09	5.21	9.11	29.89	2.22
6	23.13	47.83	8.66	18.31	37.20	5.39	9.60	29.23	2.39
8	23.59	47.19	9.14	18.21	37.24	5.55	9.65	28.31	2.45
10	24.68	46.03	9.78	18.74	36.73	5.47	9.97	27.67	2.57
12	25.79	44.89	10.42	18.30	36.67	6.04	10.30	27.03	2.73
14	27.29	43.77	11.21	18.36	36.55	6.31	10.76	26.62	2.92
16	29.18	42.45	12.10	18.92	36.39	6.78	10.90	25.99	3.04
18	31.15	40.96	12.98	19.47	35.76	7.18	11.08	25.37	3.15
20	33.32	39.52	13.94	19.69	35.13	7.45	11.48	25.15	3.38
22	35.69	38.13	14.98	20.79	34.49	8.07	11.81	24.91	3.58
24	38.28	36.79	16.11	21.66	33.84	8.59	11.82	24.46	3.67
26	41.25	35.31	17.36	22.71	33.02	9.14	12.25	24.19	3.92
28	44.46	33.90	18.71	23.77	32.03	9.66	12.60	23.73	4.15
30	47.92	32.54	20.17	25.03	31.24	10.30	12.95	23.43	4.38

SINGLE EFFICIENCY TRANSFORMER									
N	30 PERCENT LDF			20 PERCENT LDF			10 PERCENT LDF		
	LLC	NLC	REGC	LLC	NLC	REGC	LLC	NLC	REGC
1	16.18	58.86	6.81	8.37	58.86	3.52	3.11	58.86	1.31
2	16.80	57.67	7.07	8.69	57.67	3.66	3.23	57.67	1.36
4	18.10	55.36	7.62	9.37	55.36	3.94	3.48	55.36	1.46
6	19.51	53.14	8.21	10.09	53.14	4.25	3.75	53.14	1.58
8	21.03	51.01	8.85	10.88	51.01	4.58	4.04	51.01	1.70
10	22.66	48.97	9.54	11.72	48.97	4.93	4.35	48.97	1.83
12	24.43	47.01	10.28	12.64	47.01	5.32	4.69	47.01	1.97
14	26.32	45.13	11.08	13.62	45.13	5.73	5.05	45.13	2.13
16	28.37	43.32	11.94	14.68	43.32	6.18	5.45	43.32	2.29
18	30.58	41.58	12.87	15.82	41.58	6.66	5.87	41.58	2.47
20	32.95	39.92	13.87	17.05	39.92	7.18	6.33	39.92	2.66
22	35.52	38.32	14.95	18.37	38.32	7.73	6.82	38.32	2.87
24	38.28	36.79	16.11	19.80	36.79	8.33	7.35	36.79	3.09
26	41.25	35.31	17.36	21.34	35.31	8.98	7.92	35.31	3.33
28	44.46	33.90	18.71	23.00	33.90	9.68	8.54	33.90	3.59
30	47.92	32.54	20.17	24.79	32.54	10.43	9.20	32.54	3.87

PRESENT WORTH VALUE OF ENERGY COMPONENT SAVINGS

30 PERCENT LDF	20 PERCENT LDF	10 PERCENT LDF
SAVINGS = 36.55	SAVINGS = 128.87	SAVINGS = 393.79

TABLE 3-5.14

DEFINITION OF TERMS INTRODUCED IN TASK 5

LSFL	loss factor for low kVA mode
LSFH	loss factor for high kVA mode
HH	time in high kVA mode in per unit of 8760 hours
HL	time in low kVA mode in per unit of 8760 hours
SK	switching kVA of MEX
SK(Y)	switching kVA of MEX in per unit of peak load for year Y
P(Y)	peak load in per unit of high kVA transformer rating for year Y
REGH	per unit regulation of MEX in high kVA mode
REGL	per unit regulation of MEX in low kVA mode
LLH	load loss of high kVA mode
LLL	load loss of low kVA mode
NLLH	no-load loss of high kVA mode
NLLL	no-load loss of low kVA mode
TH	kVA rating of high mode
TL	kVA rating of low mode
IRP	rate of inflation for peak energy cost
IRB	rate of inflation for base energy cost
CSYSBI	system investment cost per unit of base load (first year value)
CSYSP1	system investment cost per unit of peak load (first year value)
LLCE(Y)	energy component of load loss cost for year Y
LLCD(Y)	demand component of load loss cost for year Y
NLCE(Y)	energy component of no-load loss cost for year Y
NLCD(Y)	demand component of no-load loss cost for year Y

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3.6 TASK 6 - MINIMIZE LIFE CYCLE COST BASED ON SINGLE EFFICIENCY CHARACTERISTIC TRANSFORMER DESIGN

INTRODUCTION

The purpose of this task is to determine what level of transformer losses yields the minimum total levelized annual cost. Results from Task 4 show that the minimum initial cost of a transformer is in the high loss region of the matrix. However, the minimum operating costs of a transformer are obviously in the low loss design. In this task, the two are added together and the minimum falls between the two extremes.

The results are arranged in tabular form to show the total levelized annual costs for different sets of load losses and no-load losses. This task also contains the listing for a computer program which can be used to calculate the total levelized annual cost for individual transformers.

Initial Transformer Cost

In Task 4, normalized tables of transformer costs versus load loss and no-load loss were produced. The values in these tables were then multiplied by a reference cost or index to get an assumed transformer cost. Several indexes were used for each kVA rating. The value of the index used can be found at the top of each table of total levelized annual costs.

Total Levelized Annual Costs

A computer program based on the equations in Task 1 was developed to calculate the total levelized annual cost of owning and operating a transformer. The equations used are summarized in Table 3-6.1. This program can readily be used for evaluating individual transformers.

Three scenarios in the calculations are possible. The first and second scenarios are for oil-fired and nuclear-base load generation respectively, and the third is for individual case studies.

The listing for this program is shown in Table 3-6.2. Table 3-6.3 lists the nomenclature used in the loss evaluation. The input and output formats are included in Tables 3-6.4 and 3-6.5 respectively. An example of output is included in Table 3-6.6.

The formatting of the computer program was then altered to evaluate entire arrays of transformers with different values of load loss and no-load loss. Results from Task 4 were used to find the initial transformer cost as a function of losses. These costs were added to the operating costs of the transformer to get the total levelized annual cost.

As in Task 4, the results are represented in tables as a function of load loss and no-load loss. Values of no-load loss are printed horizontally across the top of the table, and values of load loss are printed down the left hand side. Table 3-6.7 shows the input data used, and Table 3-6.8 shows total levelized annual costs for different transformer characteristics. Both oil-fired and nuclear-fired base load generation (scenarios 1 and 2 respectively) are considered.

A summary of optimum transformer characteristics is found in Table 3-6.9. The table lists the load losses, no-load losses, and the total levelized annual costs of the optimum designs for different kVA ratings and indexes. These tables show optimum designs based on the input data shown in Table 3-6.7 and the initial transformer costs developed in Task 4. However, these cost parameters and loading parameters may vary from one utility to another. Use of different input data will result in different costs and different optimum designs.

TABLE 3-6.1

SUMMARY OF DISTRIBUTION TRANSFORMER LOSS EVALUATION TECHNIQUE

$$\begin{aligned}
\text{TLAC} &= \text{CT} \times \text{CC} && \text{(investment cost)} \\
&+ (\text{CSYSB} \times \text{DISC} \times \text{CC} + 8760 \times \text{CEBL}) \times \text{NLL} && \text{(no-load loss cost)} \\
&+ \text{CCAPF} \times \text{CC} \times \sqrt{\text{T}^2 \times \text{IO}^2 - \text{NLL}^2} && \text{(reactive no-load loss cost)} \\
&+ \left[\text{CSYSP} \times \text{DISC} \times \text{CC} \times \text{PRFS}^2 \times \text{LL} \right. && \text{(load loss demand cost)} \\
&\quad \left. + \text{CCAPS} \times \text{CC} \times \text{PRFD}^2 \times \sqrt{\text{T}^2 \times \text{Z}^2 - \text{LL}^2} \right] \times \text{PEQO}^2 && \text{(reactive load loss cost)} \\
&+ \left[8760 \times \text{LSF} \times \text{CEP1} \times \text{LL} \right. && \text{(load loss energy cost)} \\
&\quad \left. + \text{T} \times \text{PF} \times 8760 \times \text{REG} \times \text{LKW} \times \text{LSF} \times (\text{CCE1} - \text{CE1}) \right] \times \text{PEQE}^2 && \text{(regulation energy cost)}
\end{aligned}$$

where:

$$\text{PEQO}^2 = \left[\frac{\text{IP}^2}{(1+\text{GR})^2 - (1+\text{I})} \right] \left[\frac{(1+\text{GR})^{2\text{NC}} - (1+\text{I})^{\text{NC}}}{(1+\text{I})^{\text{NC}}} + \frac{(1+\text{GR})^{2(\text{N}-\text{NC})} - (1+\text{I})^{\text{N}-\text{NC}}}{(1+\text{I})^{\text{N}}} \right] \left[\frac{\text{I}(1+\text{I})^{\text{N}}}{(1+\text{I})^{\text{N}} - 1} \right]$$

$$\text{PEQE}^2 = \left[\frac{\text{IP}^2 (1+\text{IRP})^{\text{NC}}}{(1+\text{IRP})(1+\text{GR})^2 - (1+\text{I})} \right] \left[\frac{(1+\text{IRP})^{\text{NC}} (1+\text{GR})^{2\text{NC}} - (1+\text{I})^{\text{NC}}}{(1+\text{I})^{\text{NC}} (1+\text{IRP})^{\text{NC}}} + \frac{(1+\text{IRP})^{\text{N}-\text{NC}} (1+\text{GR})^{2(\text{N}-\text{NC})} - (1+\text{I})^{\text{N}-\text{NC}}}{(1+\text{I})^{\text{N}}} \right] \left[\frac{\text{I}(1+\text{I})^{\text{N}}}{(1+\text{I})^{\text{N}} - 1} \right]$$

$$\text{CEBL} = \text{CEBF1} \left[\frac{(1+\text{IRBF})^{\text{N}} - (1+\text{I})^{\text{N}}}{(1+\text{IRBF}) - (1+\text{I})} \right] \left[\frac{\text{I}}{(1+\text{I})^{\text{N}} - 1} \right] + \text{CEBOM1} \left[\frac{(1+\text{IRBOM})^{\text{N}} - (1+\text{I})^{\text{N}}}{(1+\text{IRBOM}) - (1+\text{I})} \right] \left[\frac{\text{I}}{(1+\text{I})^{\text{N}} - 1} \right]$$

$$\approx \text{CEB1} \left[\frac{(1+\text{IRB})^{\text{N}} - (1+\text{I})^{\text{N}}}{(1+\text{IRB}) - (1+\text{I})} \right] \left[\frac{\text{I}}{(1+\text{I})^{\text{N}} - 1} \right]$$

* Refer to Table 3-1.1 for nomenclature for loss evaluation technique.

TABLE 3-0.4
PROGRAM LISTING

```

C   TOTAL LEVELIZED ANNUAL TRANSFORMER COST
REAL MLL,IO,LL,LSF,LKW,IP,I,II,N,NC,IRP,IRPI,IRB,IRBI,IRBF,IRBF1,
C   IRBOM,IRBOM1,MLC,LLC,NRC,LRC
C   J=1 OIL-FIRED BASE-LOAD GENERATION
C   J=2 NUCLEAR BASE-LOAD GENERATION
C   J=3 INDIVIDUAL CASE-STUDY
C   K = NUMBER OF TRANSFORMERS
C   DIMENSION F(5),T(100),CT(100),MLL(100),LL(100),IO(100),Z(100),
C   REG(100),TLAC(100)
C   INPUT SECTION
READ(5,210) K
DO 80 L=1,K
READ(5,170) (F(M),M=1,5)
READ(5,210) J
READ(5,90) IP,GR,N,NC
GO TO (10,10,50),J
10 CSYSP=411.
CEP1=0.0557
IRP=0.07641
DISC=0.75
CC=0.18
I=0.1
CCAPF=4.8
CCAPS=9.24
CCE1=0.0472
CE1=0.0216
GO TO (20,30),J
20 CSYSB=744.
CEB1=0.035
IRB=0.07775
GO TO 40
30 CSYSB=1102.
CEB1=0.0085
IRB=0.07527
40 IRB1=IRB+1.
II=I+1.
CEB1=CEB1+((IRB1+N-1)*N)/(IRB1-11)*((1/(11*N-1.))
50 READ(5,100) T(L),CT(L),NLL(L),LL(L),IC(L),Z(L),REG(L)
READ(5,110) LSF,PRFS,PRFD,PF,LKW
GO TO (70,70,60),J
60 READ(5,100) CSYSO,CSYSP,CEP1,CCE1,CE1,CEBF1,CEBOM1
READ(5,120) IRP,IRBF,IRBOM,CCAPF,CCAPS,CC,DISC,I
IRBF1=IRBF+1.
IRBOM1=IRBOM+1.
II=I+1.
C   CALCULATION SECTION
CEBLF=CEBF1+((IRBF1+N-1)*N)/(IRBF1-11)*((1/(11*N-1.))
CEBLOM=CEBOM1+((IRBOM1+N-1)*N)/(IRBOM1-11)*((1/(11*N-1.))
CEBL=CEBLF+CEBLOM
70 GRI=GR+1.
IRP1=IRP+1.
PEQQA=(IP**2/(GRI**2-11))*((1+11*N/(11*N-1.))
PEQOB=(GRI**2*(2*NC)-11*NC)/11*NC
PEQOC=(GRI**2*(2*(N-NC))-11*(N-NC))/11*N
PEQO2=PEQQA*(PEQOB+PEQOC)
PEQO=SQRT(PEQO2)
PEQEA=(IP**2/(IRP1*GRI**2-11))*((1+11*N/(11*N-1.))
PEQEB=(IRP1*NC*(GRI**2*NC)-11*NC)/11*NC

```

TABLE 3-6.2 (Continued)

```

PEQEC=(IRP1**((N-NC)*GR1**((2*(N-NC))-1)**((N-NC)))/11**N
PEQE2=PEQEA*(PEQEB+PEQEC)
PEQE=SQRT(PEQE2)
B=8760.
TIC=CT(L)*CC
NLC=(CSYSB*DISC*CC+B*CEBL)*NLL(L)
LLC=(PEQ02*PRFS**2*CSYSP*DISC*CC+PEQE2*B*LSF*CEP1)*LL(L)
NRC=CCAPF*CC*SQRT(T(L)**2+10(L)**2-NLL(L)**2)
LRC=CCAPS*CC*PEQ02*PRFD**2*SQRT(T(L)**2+Z(L)**2-LL(L)**2)
RGC=T(L)*PEQE2*PF*B*REG(L)*LKW*LSF*(CCE1-CE1)
TLAC(L)=TIC+NLC+LLC+NRC+LRC+RGC
IF (L.EQ.1) GO TO 71
WRITE(6,260) L
GO TO 72
71 WRITE(6,270) L
72 GO TO (73,74,75),J
73 WRITE(6,130)
GO TO 76
74 WRITE(6,140)
GO TO 76
75 WRITE(6,150)
76 WRITE(6,180) IF(M),M=1,5)
WRITE(6,250) CSYSB,CSYSP,CEP1,CEB1,CEBF1,CEBQ1,CCE1,CE1,CC,DISC
WRITE(6,240) IRP,IRB,IRBF,IRBQ1,1,CCAPF,CCAPS
WRITE(6,230) LSF,PEQ0,PEQE,1P,6R,PRFS,PRFD,PF,LKW
WRITE(6,230) N,NC,T(L),CT(L),NLL(L),LL(L),10(L),Z(L),REG(L)
WRITE(6,220) TIC,NLC,LLC,NRC,LRC,RGC
80 CONTINUE
WRITE(6,160)
WRITE(6,190)
DO 85 L=1,K
WRITE(6,200) L,T(L),CT(L),NLL(L),LL(L),10(L),Z(L),REG(L),TLAC(L)
85 CONTINUE
90 FORMAT(4E10.4)
100 FORMAT(7E10.4)
110 FORMAT(5E10.4)
120 FORMAT(8E10.4)
130 FORMAT('0',44X,'OIL-FIRED BASE-LOAD GENERATION')
140 FORMAT('0',45X,'NUCLEAR BASE-LOAD GENERATION')
150 FORMAT('0',49X,'INDIVIDUAL CASE-STUDY')
160 FORMAT('1',28X,'TOTAL LEVELIZED ANNUAL TRANSFORMER COST')
170 FORMAT(5A4)
180 FORMAT('0',49X,5A4)
190 FORMAT('0',3X,'CASE',5X,'KVA',8X,'CT',10X,'NLL',8X,'LL',9X,'10',
C      10X,'Z',9X,'REG',6X,'TLAC')
200 FORMAT(4X,13,2X,8(F9.4,2X))
210 FORMAT(13)
220 FORMAT(' ',6(E10.4,2X))
230 FORMAT(' ',9(E10.4,2X))
240 FORMAT(' ',7(E10.4,2X))
250 FORMAT('0',10(E10.4,2X))
260 FORMAT('0','INPUTS CASE ',13)
270 FORMAT('1','INPUTS CASE ',13)
STOP
END

```

TABLE 3-6.3

NOMENCLATURE FOR DISTRIBUTION TRANSFORMER LOSS EVALUATION TECHNIQUE

CSYSB	system investment cost per unit of base load, \$/kW
CSYSP	system investment cost per unit of peak load, \$/kW
CEB1	incremental energy cost for base load (first year value), \$/kWh
CEP1	incremental energy cost for peak generation (first year value), \$/kWh
CEBL	incremental energy cost for base load (levelized value), \$/kWh
CEPL	incremental energy cost for peak generation (levelized value), \$/kWh
CCE1	average sale price of incremental energy (first year value), \$/kWh
CE1	average incremental energy cost (first year value), \$/kWh
CEBF1	fuel cost component of CEB1 (first year value), \$/kWh
CEBOM1	O&M cost component of CEB1 (first year value), \$/kWh
IRB	inflation rate for base load energy cost, p.u.
IRP	inflation rate for peak energy cost, p.u.
IRBF	inflation rate for fuel cost component of CEB1, p.u.
IRBOM	inflation rate for O&M cost component of CEB1, p.u.
CC	levelized annual carrying charge rate, p.u.
DISC	discount factor for system investment, p.u.
I	rate of return (weighted cost of capital), p.u.
CCAPF	installed cost of fixed capacitors, \$/kVAR
CCAPS	installed cost of switched capacitors, \$/kVAR
LSF	transformer annual loss factor, p.u.
PEQO	transformer equivalent annual peak load (no inflation), p.u.
PEQE	transformer equivalent annual peak load (energy cost inflation), p.u.
IP	initial transformer annual peak load, p.u.
FP	final transformer annual peak load, p.u.
GR	levelized annual compound peak load growth rate, p.u.
PRFS	peak responsibility factor (system), p.u.
PRFD	peak responsibility factor (distribution system), p.u.
PF	load power factor, p.u.
8760	number of hours per year
LKW	change in kW load for 1 percent change in voltage, percent
N	evaluation period, years
NC	time to transformer changeout, years
T	transformer nameplate rating, kVA
CT	transformer cost to utility, \$
NLL	transformer no-load loss, kW
LL	transformer load loss at rated load, kW
IO	transformer exciting current, p.u.
Z	transformer impedance, p.u.
REG	transformer regulation at rated load, p.u.
TLAC	total levelized annual transformer cost, \$/year
TIC	levelized annual cost of transformer investment, \$/year
NLC	levelized annual no-load loss cost, \$/year
LLC	levelized annual load loss cost, \$/year
NRC	levelized annual reactive no-load loss cost, \$/year
LRC	levelized annual reactive load loss cost, \$/year
RGC(E)	levelized annual energy cost of regulation, \$/year

TABLE 3-6.5

OUTPUT FORMAT

1	2	3	4	5	6	7	8	9	10
CSYSB	CSYSP	CEP1	CEB1	CEBF1	CEBOM1	CCE1	CEL	CC	DISC

11	12	13	14	15	16	17
IRP	IRB	IRBF	IRBOM	I	CCAPF	CCAPS

18	19	20	21	22	23	24	25	26
LSF	PEQO	PEQE	IP	GR	PRFS	PRFD	PF	LKW

27	28	29	30	31	32	33	34	35
N	NC	T	CT	NLL	LL	IO	Z	REG

36	37	38	39	40	41
TIC	NLC	LLC	NRC	LRC	RGC

TABLE 3.6- 6

OUTPUT EXAMPLE

INPUTS CASE 1

OIL-FIRED BASE-LOAD GENERATION

WESTINGHOUSE

0.7440E 03	0.4110E 03	0.5570E-01	0.3500E-01	0.0	0.0	0.4720E-01	0.2160E-01	0.1800E 00	0.7500E 00
0.7641E-01	0.7775E-01	0.0	0.0	0.1000E 00	0.4800E 01	0.9240E 01			
0.1350E 00	0.1002E 01	0.1438E 01	0.7500E 00	0.4000E-01	0.7500E 00	0.8430E 00	0.9000E 00	0.7500E 00	
0.3000E 02	0.2000E 02	0.2500E 02	0.3370E 03	0.1050E 00	0.3160E 00	0.1500E-01	0.1800E-01	0.1400E-01	
0.6066E 02	0.8089E 02	0.5292E 02	0.3110E 00	0.3800E 00	0.1478E 02				

INPUTS CASE 2

OIL-FIRED BASE-LOAD GENERATION

WESTINGHOUSE

0.7440E 03	0.4110E 03	0.5570E-01	0.3500E-01	0.0	0.0	0.4720E-01	0.2160E-01	0.1800E 00	0.7500E 00
0.7641E-01	0.7775E-01	0.0	0.0	0.1000E 00	0.4800E 01	0.9240E 01			
0.1350E 00	0.1135E 01	0.1629E 01	0.8500E 00	0.4000E-01	0.7500E 00	0.8430E 00	0.9000E 00	0.7500E 00	
0.3000E 02	0.2000E 02	0.5000E 02	0.5100E 03	0.1910E 00	0.5240E 00	0.1500E-01	0.1800E-01	0.1400E-01	
0.9100E 02	0.1471E 03	0.1127E 03	0.6266E 00	0.1115E 01	0.3798E 02				

INPUTS CASE 3

NUCLEAR BASE-LOAD GENERATION

WESTINGHOUSE

0.1102E 04	0.4110E 03	0.5570E-01	0.8500E-02	0.0	0.0	0.4720E-01	0.2160E-01	0.1800E 00	0.7500E 00
0.7641E-01	0.7527E-01	0.0	0.0	0.1000E 00	0.4800E 01	0.9240E 01			
0.1350E 00	0.1002E 01	0.1438E 01	0.7500E 00	0.4000E-01	0.7500E 00	0.8430E 00	0.9000E 00	0.7500E 00	
0.3000E 02	0.2000E 02	0.2500E 02	0.3370E 03	0.1050E 00	0.3160E 00	0.1500E-01	0.1800E-01	0.1400E-01	
0.6066E 02	0.3334E 02	0.5292E 02	0.3110E 00	0.3800E 00	0.1478E 02				

INPUTS CASE 4

NUCLEAR BASE-LOAD GENERATION

WESTINGHOUSE

0.1102E 04	0.4110E 03	0.5570E-01	0.8500E-02	0.0	0.0	0.4720E-01	0.2160E-01	0.1800E 00	0.7500E 00
0.7641E-01	0.7527E-01	0.0	0.0	0.1000E 00	0.4800E 01	0.9240E 01			
0.1350E 00	0.1135E 01	0.1629E 01	0.8500E 00	0.4000E-01	0.7500E 00	0.8430E 00	0.9000E 00	0.7500E 00	
0.3000E 02	0.2000E 02	0.5000E 02	0.5100E 03	0.1910E 00	0.5240E 00	0.1500E-01	0.1800E-01	0.1400E-01	
0.9100E 02	0.6064E 02	0.1127E 03	0.6266E 00	0.1115E 01	0.3798E 02				

TOTAL LEVELIZED ANNUAL TRANSFORMER COST

CASE	KVA	CT	NLL	LL	IO	Z	REG	TLAC
1	25.0000	337.0000	0.1050	0.3160	0.0150	0.0180	0.0140	209.9457
2	50.0000	510.0000	0.1910	0.5240	0.0150	0.0180	0.0140	391.3787
3	25.0000	337.0000	0.1050	0.3160	0.0150	0.0180	0.0140	162.3961
4	50.0000	510.0000	0.1910	0.5240	0.0150	0.0180	0.0140	304.8838

TABLE 3-6.7

INPUT DATA

CSYSB	*744	PF	0.9
CSYSP	411	LKW	0.75
CEP1	0 .0557	N	30
CEB1	*0.035	NC	30
LSF	0.135	T	Variable
IP	0.75	CT	Variable
CCE1	0.0472	NLL	Variable
CE1	0.0216	LL	Variable
CC	0.18	IO	0.015
DISC	0.75	Z	0.018
IRP	0.07641	REG	0.014
IRB	0.0775	GR	0.03
I	0.10	PRFS	0.75
CCAPF	4.80	PRFD	0.843
CCAPS	9.24		

*Values above are for scenario 1. For scenario 2, CSYSB = 1182 and CEB1 is .0085.

TABLES 3-6.8
TOTAL LEVELIZED ANNUAL COSTS
FOR SINGLE EFFICIENCY CHARACTERISTIC
TRANSFORMER DESIGN
SCENARIO 1
OIL FIRED BASE LOAD GENERATION

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			228.10	155.67	160.08	154.38	154.48	156.47	159.93	164.58	171.16
.080			165.25	141.28	136.94	139.58	143.47	146.10	151.27	158.33	165.39
.100		178.31	136.51	129.96	129.87	132.38	137.54	143.50	150.65	158.35	166.04
.120		137.45	124.88	124.98	126.98	131.51	137.31	143.74	150.17	157.86	165.56
.140		128.53	121.32	122.84	127.82	133.18	139.29	145.09	152.15	159.85	167.54
.160		124.31	121.24	123.88	129.04	134.84	141.27	148.02	154.77	162.46	170.16
.180		125.03	122.55	125.86	131.03	137.46	144.52	151.27	158.33	166.03	173.72
.200		125.74	124.89	128.89	134.28	141.34	147.77	155.16	162.54	170.55	178.24
.220		126.46	127.19	131.73	137.53	144.59	151.34	158.72	166.10	173.80	181.49
.240	163.31	128.44	130.13	135.29	141.51	148.00	155.23	162.61	170.14	177.84	185.53
.260	156.93	131.06	133.69	139.40	145.80	152.52	159.74	167.12	174.66	182.36	190.05
.280	153.85	133.99	136.95	143.51	150.07	157.04	164.26	171.64	179.18	186.87	194.57
.300	152.66	136.93	140.83	147.61	154.36	161.55	168.78	176.16	183.70	191.39	199.08
.320	152.11	140.18	144.71	151.72	158.85	166.07	173.29	180.68	188.21	195.91	203.60
.340	152.83	143.75	148.91	155.82	163.14	170.59	177.81	185.19	192.73	200.43	208.12
.360	153.58	147.60	153.27	159.99	167.50	175.11	182.33	189.71	197.25	204.94	212.64
.380	155.53	151.83	157.31	164.35	172.05	179.62	186.85	194.23	201.77	209.46	217.15
.400	157.51	156.03	161.74	168.77	176.47	184.14	191.36	198.74	206.28	213.98	221.67
.420	159.81	160.23	166.19	173.16	180.86	188.66	195.88	203.26	210.80	218.50	226.19
.440	162.43	164.43	170.64	177.55	185.25	193.17	200.40	207.78	215.32	223.01	230.71
.460	165.14	168.79	175.07	181.98	189.68	197.69	204.92	212.30	219.83	227.53	235.22

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			247.55	166.22	170.26	163.07	162.32	163.69	166.67	170.98	177.45
.080			177.22	149.73	144.05	146.12	149.60	151.66	156.55	163.54	170.53
.100		192.08	144.78	136.65	135.69	137.62	142.50	149.26	155.36	163.06	170.75
.120		146.17	131.35	130.61	131.97	136.15	141.74	148.03	154.32	162.01	169.71
.140		135.77	126.90	127.73	132.41	137.50	143.44	149.03	156.02	163.72	171.41
.160		130.57	126.31	128.38	133.27	138.85	145.14	151.79	158.43	166.12	173.82
.180		130.87	127.31	130.08	134.97	141.26	148.25	154.90	161.89	169.58	177.28
.200		131.16	129.36	132.95	138.08	145.07	151.36	158.71	166.05	174.10	181.79
.220		131.46	131.42	135.60	141.19	148.18	154.83	162.17	169.52	177.21	184.90
.240	172.75	133.16	134.17	139.06	145.11	151.47	158.64	165.98	173.51	181.20	188.89
.260	165.16	135.57	137.64	143.12	149.38	155.99	163.16	170.50	178.02	185.72	193.41
.280	161.24	138.32	140.75	147.18	153.61	160.50	167.67	175.02	182.54	190.23	197.93
.300	159.42	141.08	144.56	151.24	157.88	165.02	172.19	179.54	187.06	194.75	202.45
.320	158.31	144.19	148.37	155.30	162.37	169.54	176.71	184.05	191.57	199.27	206.96
.340	158.60	147.65	152.54	159.36	166.64	174.05	181.23	188.57	196.09	203.79	211.48
.360	158.93	151.43	156.88	163.49	170.98	178.57	185.74	193.09	200.61	208.30	216.00
.380	160.60	155.63	160.87	167.83	175.53	183.09	190.26	197.61	205.13	212.82	220.51
.400	162.30	159.80	165.28	172.24	179.94	187.61	194.78	202.12	209.64	217.34	225.03
.420	164.35	163.96	169.73	176.62	184.32	192.12	199.29	206.64	214.16	221.86	229.55
.440	166.76	168.13	174.17	181.00	188.70	196.64	203.81	211.16	218.68	226.37	234.07
.460	169.27	172.47	178.59	185.41	193.11	201.16	208.33	215.67	223.20	230.89	238.58

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			267.00	176.76	180.44	171.76	170.17	170.90	173.41	177.39	183.73
.080			189.18	158.17	151.16	152.67	155.72	157.22	161.82	168.75	175.66
.100		205.85	153.05	143.33	141.51	142.86	147.46	153.03	160.07	167.77	175.46
.120		154.90	137.83	136.24	136.97	140.80	146.17	152.32	158.47	166.17	173.86
.140		143.00	132.47	132.63	137.00	141.83	147.60	152.97	159.89	167.59	175.28
.160		136.84	131.38	132.89	137.49	142.87	149.02	155.55	162.09	169.78	177.48
.180		136.71	132.02	134.31	138.91	145.06	151.98	158.52	165.44	173.14	180.83
.200		136.58	133.83	137.00	141.88	148.80	154.95	162.26	169.57	177.66	185.35
.220		136.45	135.64	139.47	144.85	151.77	158.31	165.62	172.93	180.62	188.32
.240	182.20	137.87	138.22	142.83	148.71	154.93	162.05	169.36	176.87	184.56	192.25
.260	173.40	140.07	141.58	146.84	152.95	159.45	166.57	173.88	181.38	189.08	196.77
.280	168.63	142.65	144.55	150.85	157.16	163.97	171.09	178.40	185.90	193.60	201.29
.300	166.18	145.23	148.29	154.87	161.41	168.49	175.60	182.91	190.42	198.11	205.81
.320	164.50	148.20	152.03	158.98	165.89	173.00	180.12	187.43	194.94	202.63	210.32
.340	164.37	151.56	156.16	162.90	170.13	177.52	184.64	191.95	199.45	207.15	214.84
.360	164.28	155.26	160.49	166.99	174.46	182.04	189.16	196.47	203.97	211.66	219.36
.380	165.66	159.43	164.42	171.31	179.01	186.56	193.67	200.98	208.49	216.18	223.88
.400	167.08	163.56	168.82	175.71	183.41	191.07	198.19	205.50	213.00	220.70	228.39
.420	168.89	167.69	173.26	180.07	187.77	195.59	202.71	210.02	217.52	225.22	232.91
.440	171.09	171.82	177.70	184.44	192.14	200.11	207.23	214.54	222.04	229.73	237.43
.460	173.40	176.15	182.10	188.84	196.54	204.62	211.74	219.05	226.56	234.25	241.94

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			286.45	187.31	190.62	180.46	178.32	178.12	180.15	183.79	190.01
.080			201.14	166.62	156.27	159.21	161.84	162.79	167.10	173.95	180.80
.100		219.62	161.32	150.02	147.33	148.11	152.43	157.80	164.78	172.47	180.17
.120		163.63	144.30	141.87	141.97	145.44	150.61	156.62	162.62	170.32	178.01
.140		150.24	138.05	137.52	141.59	146.16	151.75	156.91	163.76	171.46	179.15
.160		143.10	136.45	137.39	141.71	146.88	152.89	159.32	165.75	173.44	181.14
.180		142.55	136.74	138.53	142.85	148.86	155.71	162.15	169.00	176.69	184.39
.200		142.00	138.30	141.06	145.68	152.53	158.54	165.82	173.09	181.21	188.90
.220		141.45	139.86	143.34	148.51	155.36	161.79	169.07	176.34	184.04	191.73
.240	191.64	142.59	142.27	146.59	152.31	158.40	165.47	172.74	180.23	187.92	195.62
.260	181.63	144.57	145.52	150.56	156.53	162.92	169.98	177.26	184.74	192.44	200.13
.280	176.02	146.98	148.35	154.53	160.71	167.44	174.50	181.78	189.26	196.96	204.65
.300	172.93	149.39	152.02	158.50	164.93	171.95	179.32	186.29	193.78	201.47	209.17
.320	170.69	152.21	155.69	162.46	169.40	176.47	183.54	190.81	198.30	205.99	213.68
.340	170.14	155.46	159.79	166.43	173.63	180.99	188.05	195.33	202.81	210.51	218.20
.360	169.64	159.09	164.09	170.49	177.93	185.50	192.57	199.85	207.33	215.03	222.72
.380	170.73	163.23	167.98	174.79	182.49	190.02	197.09	204.36	211.85	219.54	227.24
.400	171.87	167.33	172.37	179.18	185.88	194.54	201.60	208.88	216.36	224.06	231.75
.420	173.43	171.42	176.80	183.53	191.23	199.06	206.12	213.40	220.88	228.58	236.27
.440	175.42	175.52	181.23	187.88	195.58	203.57	210.64	217.91	225.40	233.09	240.79
.460	177.53	179.82	185.62	192.27	199.97	208.09	215.16	222.43	229.92	237.61	245.30

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					287.42	246.45	231.55	224.71	221.88	219.76	220.26
.080					198.70	199.14	199.57	200.00	200.43	202.96	205.49
.100					181.26	183.63	186.16	188.37	190.74	194.56	198.39
.120					171.56	172.16	179.21	183.04	186.86	191.65	196.44
.140		244.50	190.39	172.26	166.23	167.63	171.46	176.57	182.43	188.74	196.05
.160		202.71	170.36	162.56	163.80	165.69	172.16	178.51	184.91	190.35	195.79
.180		185.27	162.61	159.97	162.51	166.33	172.74	179.15	185.56	191.96	198.37
.200	250.87	176.25	160.50	159.81	163.18	168.59	174.67	181.08	188.26	194.22	200.27
.220	210.50	169.75	160.02	160.29	164.44	169.88	176.61	183.34	190.07	197.12	204.17
.240	197.57	167.17	161.30	162.22	166.37	172.13	179.19	186.24	193.29	200.67	208.04
.260	189.82	166.52	162.91	164.48	168.95	175.36	182.41	189.47	196.52	203.65	211.59
.280	184.65	166.19	165.17	167.70	172.50	178.26	185.64	193.01	200.39	208.09	215.79
.300	181.41	167.15	167.75	171.25	175.72	181.81	189.28	196.76	204.26	211.80	219.34
.320	180.76	168.89	169.84	174.16	179.72	186.00	192.74	200.37	208.00	215.77	223.53
.340	181.40	170.70	173.62	178.35	184.14	190.62	197.41	205.02	212.59	220.32	228.05
.360	182.69	173.28	177.43	182.54	188.63	195.26	202.09	209.63	217.17	224.90	232.66
.380	185.27	175.86	181.20	186.74	193.08	199.91	206.77	214.24	221.75	229.51	237.28
.400	187.20	179.73	185.01	190.93	197.57	204.53	211.45	218.89	226.36	234.13	241.89
.420	190.43	183.66	188.78	195.13	202.02	209.17	216.13	223.54	230.95	238.74	246.54
.440	193.59	187.86	192.59	199.32	206.51	213.82	220.81	228.15	235.53	243.32	251.15
.460	196.38	192.31	197.20	203.97	211.15	218.43	225.49	232.80	240.11	247.94	255.76
.480	199.46	196.76	201.82	208.65	215.83	223.08	230.16	237.44	244.69	252.55	260.41
.500	202.04	201.25	206.43	213.32	220.51	227.73	234.84	242.06	247.98	257.13	265.02
.520	205.27	205.70	211.08	218.00	225.19	232.37	239.52	246.71	253.86	261.78	269.67
.540	209.14	210.06	215.69	222.68	229.87	237.02	244.20	251.32	258.44	266.36	274.48
.560	213.01	214.64	220.34	227.36	234.55	241.66	248.88	255.97	263.02	270.98	278.93
.580	215.81	219.12	224.95	232.04	239.22	246.31	253.56	260.61	267.60	275.59	283.74

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					310.42	264.04	246.62	238.17	234.17	230.96	230.65
.080					211.33	210.96	210.59	210.21	209.84	211.79	213.75
.100					191.45	193.23	195.19	196.79	198.56	201.96	205.35
.120					180.18	179.98	186.96	190.36	193.75	198.22	202.69
.140		263.40	202.31	181.30	173.75	174.45	177.85	182.67	188.33	194.48	201.75
.160		216.35	179.55	170.03	170.55	171.79	178.13	184.32	190.58	195.77	200.96
.180		196.46	170.43	166.65	163.61	172.00	178.27	184.53	190.79	197.06	203.32
.200	269.71	185.94	167.59	165.96	163.86	174.01	179.91	186.18	193.30	199.06	204.93
.220	224.35	178.22	166.55	165.99	169.75	174.94	181.56	188.18	194.81	201.79	208.77
.240	209.49	174.85	167.48	167.64	171.39	176.94	183.92	190.91	197.89	205.23	212.57
.260	200.37	173.62	168.76	169.65	173.76	180.02	187.01	193.99	200.97	244.37	216.01
.280	194.12	172.76	170.77	172.73	177.20	182.75	190.09	197.43	204.77	212.47	220.17
.300	190.03	173.33	173.13	176.17	180.28	186.19	193.64	201.08	208.57	216.09	223.61
.320	188.80	174.76	174.96	178.89	184.22	190.35	196.97	204.60	212.22	219.99	227.76
.340	189.01	176.26	178.65	183.05	188.63	194.97	201.67	209.26	216.81	224.55	232.28
.360	189.94	178.62	182.38	187.21	193.12	199.63	206.36	213.88	221.40	229.14	236.91
.380	192.30	180.99	186.07	191.37	197.56	204.29	211.06	218.51	225.99	233.76	241.53
.400	193.95	184.79	189.80	195.53	202.04	208.92	215.76	223.17	230.62	238.39	246.16
.420	197.03	188.66	193.49	199.68	206.49	213.58	220.45	227.83	235.21	243.01	250.82
.440	200.04	192.82	197.22	203.84	210.97	218.24	225.15	232.45	239.79	247.60	255.44
.460	203.20	197.26	201.84	208.50	215.63	222.86	229.85	237.12	244.38	252.23	260.07
.480	205.56	201.71	206.47	213.20	220.33	227.52	234.54	241.78	248.97	256.85	264.73
.500	207.93	206.19	211.09	217.90	225.02	232.19	239.24	246.40	252.13	261.44	269.35
.520	211.01	210.63	215.75	222.59	229.72	236.85	243.94	251.06	258.15	266.10	274.01
.540	214.81	214.97	220.38	227.29	234.42	241.51	248.63	255.69	262.74	270.69	278.85
.560	218.61	219.56	225.04	231.99	239.11	246.17	253.33	260.35	267.33	275.31	283.30
.580	221.22	224.04	229.66	236.68	243.81	250.83	258.03	265.01	271.92	279.94	288.14

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					333.41	281.62	261.69	251.63	246.46	242.16	241.05
.080					223.96	222.78	221.50	220.42	219.24	220.62	222.00
.100					201.64	202.83	204.21	205.20	206.39	209.35	212.31
.120					188.79	187.80	194.72	197.68	200.64	204.79	208.93
.140		282.19	214.22	190.34	181.27	181.27	184.23	188.77	194.22	200.22	207.45
.160		229.98	188.74	177.49	177.30	177.89	184.09	190.13	196.25	201.19	206.12
.180		207.66	178.25	173.32	174.71	177.67	183.79	189.91	196.03	202.15	208.27
.200	288.55	195.63	174.68	172.12	174.53	179.43	185.15	191.27	198.34	203.91	209.59
.220	238.20	186.69	173.08	171.70	175.06	180.00	186.51	193.03	199.54	206.45	213.36
.240	221.40	182.52	173.65	173.06	176.42	181.75	188.66	195.57	202.48	209.78	217.09
.260	210.92	180.73	174.61	174.81	178.57	184.69	191.60	198.51	205.42	212.39	220.42
.280	203.59	179.32	176.37	177.75	181.90	187.23	194.54	201.84	209.15	216.85	224.54
.300	198.64	179.50	178.52	181.09	184.84	190.57	197.99	205.41	212.87	220.38	227.88
.320	196.84	180.62	180.07	183.63	188.72	194.69	201.20	208.82	216.44	224.22	232.00
.340	196.62	181.82	183.68	187.75	193.12	199.32	205.92	213.50	221.04	228.78	236.52
.360	197.19	183.97	187.33	191.87	197.60	204.00	210.63	218.14	225.64	233.37	241.15
.380	199.34	186.12	190.94	196.00	202.04	208.67	215.35	222.77	230.23	238.01	245.79
.400	200.70	189.85	194.59	200.12	206.52	213.31	220.06	227.45	234.87	242.65	250.42
.420	203.64	193.65	198.20	204.24	210.96	217.98	224.78	232.12	239.46	247.28	255.10
.440	206.50	197.78	201.85	208.36	215.43	222.66	229.49	236.76	244.06	251.88	259.73
.460	209.51	202.21	206.48	213.04	220.11	227.30	234.21	241.43	248.66	256.51	264.37
.480	211.66	206.65	211.12	217.75	224.82	231.97	238.92	246.11	253.25	261.15	269.04
.500	213.81	211.13	215.75	222.47	229.54	236.65	243.64	250.74	256.27	265.75	273.68
.520	216.75	215.57	220.43	227.18	234.25	241.32	248.35	255.42	262.45	270.42	278.35
.540	220.48	219.89	225.06	231.90	238.97	246.00	253.06	260.05	267.04	275.02	283.23
.560	224.20	224.49	229.74	236.51	243.68	250.67	257.78	264.73	271.64	279.65	287.67
.580	226.63	228.96	234.38	241.33	248.40	255.35	262.49	269.40	276.23	284.29	292.54

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					356.40	239.20	276.76	265.08	258.74	253.35	251.45
.080					236.60	234.61	232.62	230.63	228.64	229.45	230.26
.100					211.83	212.43	213.24	213.62	214.21	216.74	219.27
.120					197.40	195.63	202.47	205.00	207.53	211.35	215.18
.140		300.98	226.13	199.38	188.78	188.09	190.62	194.87	200.12	205.97	213.15
.160		243.62	197.92	184.95	184.04	183.99	190.06	195.95	201.92	206.61	211.29
.180		218.85	186.08	180.00	180.81	183.34	189.32	195.30	201.27	207.25	213.22
.200	307.39	205.33	181.77	178.27	180.20	184.85	190.39	196.37	203.38	208.75	214.25
.220	252.05	195.16	179.61	177.41	180.37	185.06	191.46	197.87	204.28	211.12	217.95
.240	233.32	190.20	179.82	178.48	181.44	186.56	193.40	200.24	207.07	214.34	221.61
.260	221.47	187.83	180.46	179.98	183.38	189.35	196.19	203.03	209.87	260.41	224.83
.280	213.07	185.89	181.96	182.78	186.60	191.72	198.99	206.26	213.52	221.22	228.92
.300	207.25	185.67	183.90	186.00	189.40	194.94	202.34	209.74	217.18	224.66	232.15
.320	204.88	186.48	185.19	188.37	193.22	199.03	205.44	213.05	220.66	228.45	236.23
.340	204.23	187.38	188.71	192.45	197.61	203.68	210.17	217.74	225.27	233.01	240.75
.360	204.44	189.32	192.28	196.54	202.09	208.37	214.90	222.39	229.87	237.61	245.40
.380	206.37	191.25	195.81	200.63	206.52	213.06	219.64	227.03	234.47	242.26	250.04
.400	207.44	194.91	199.38	204.71	210.99	217.70	224.37	231.72	239.12	246.91	254.69
.420	210.24	198.65	202.91	208.80	215.42	222.39	229.10	236.41	243.72	251.55	259.38
.440	212.95	202.74	206.48	212.89	219.90	227.08	233.83	241.06	248.33	256.16	264.03
.460	215.83	207.17	211.12	217.57	224.59	231.73	238.57	245.75	252.93	260.80	268.67
.480	217.76	211.60	215.77	222.31	229.32	236.42	243.30	250.44	257.53	265.45	273.36
.500	219.70	216.07	220.42	227.04	234.05	241.11	248.03	255.08	260.42	270.05	278.01
.520	222.49	220.50	225.10	231.77	238.78	245.80	252.76	259.77	266.74	274.74	282.70
.540	226.15	224.81	229.75	236.51	243.52	250.49	257.50	264.42	271.34	279.34	287.60
.560	229.80	229.41	234.44	241.24	248.25	255.18	262.23	269.11	275.95	283.99	292.03
.580	232.04	233.88	235.09	245.97	252.98	259.86	266.96	273.80	280.55	288.64	296.94

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			262.45	238.30	230.56	228.42	229.55	231.69	235.37	239.00	244.00
.180			241.18	226.89	222.96	223.59	225.73	228.62	231.01	236.44	243.05
.200		259.74	230.53	221.04	218.89	220.77	223.92	227.07	231.49	236.15	242.84
.220		241.51	224.94	217.47	216.07	219.22	222.88	226.53	231.71	236.63	243.57
.240		231.36	220.86	215.92	214.29	218.68	222.34	227.01	232.89	238.36	244.92
.260	289.94	225.44	218.33	214.88	214.23	218.40	223.06	228.24	234.42	240.10	247.29
.280	258.98	222.19	217.03	214.84	214.96	219.37	224.04	229.97	236.41	242.59	249.79
.300	245.55	219.63	216.21	215.32	216.19	220.86	226.03	232.22	238.90	245.34	252.54
.320	235.89	218.59	216.63	216.29	219.14	222.59	227.77	234.46	241.65	248.85	256.70
.340	230.06	218.55	216.90	217.78	220.17	225.34	231.02	237.71	244.91	252.10	259.04
.360	227.00	218.01	217.83	219.77	222.66	228.09	235.03	240.96	248.41	255.86	262.55
.380	225.32	219.90	219.87	222.26	226.37	231.60	238.29	245.48	252.68	260.12	265.62
.400	226.42	220.98	221.60	225.01	229.68	234.60	242.30	248.48	255.68	263.38	269.81
.420	226.90	222.97	224.35	228.01	233.18	238.61	244.54	252.49	259.69	267.39	274.08
.440	228.38	225.46	226.85	231.26	236.94	242.37	248.80	256.50	263.70	271.40	278.59
.460	230.37	227.96	229.85	235.02	240.95	246.38	252.69	260.39	267.96	275.79	282.86
.480	232.86	230.96	233.35	238.78	244.71	250.64	257.08	264.78	272.23	279.93	287.38
.500	237.08	234.06	237.11	242.54	248.77	255.16	261.85	269.30	276.75	284.19	291.87
.520	237.85	236.96	240.62	246.55	252.73	259.17	266.11	273.82	281.26	288.71	296.41
.540	240.85	238.95	244.38	250.56	257.00	263.69	270.63	278.33	285.78	292.97	300.93
.560	243.35	242.96	248.39	254.57	261.26	267.95	275.15	282.85	290.30	297.74	305.44
.580	247.36	247.23	252.65	258.84	265.78	272.47	279.67	287.37	294.81	302.25	309.96
.600	250.89	252.10	256.92	263.35	270.78	276.99	284.44	291.88	299.33	306.78	314.45

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			276.15	249.10	239.95	236.93	237.46	239.09	242.41	245.67	250.41
.180			252.54	236.25	231.26	231.24	232.87	235.33	237.24	242.46	248.97
.200		273.07	240.51	229.46	226.40	227.76	230.50	233.23	237.35	241.74	248.33
.220		252.77	233.99	225.15	222.92	225.66	228.95	232.23	237.18	241.84	248.72
.240	372.50	241.29	229.13	223.05	220.57	224.66	227.95	232.34	238.05	243.33	249.79
.260	305.48	234.42	225.93	221.50	220.10	223.94	228.33	233.27	239.32	244.81	251.96
.280	271.30	230.47	224.10	221.05	220.48	224.59	228.98	234.75	241.08	247.12	254.27
.300	256.24	227.26	222.83	221.15	221.41	225.80	230.74	236.79	243.39	249.71	256.86
.320	245.28	225.71	222.93	221.81	224.22	227.28	232.23	238.82	245.97	253.12	260.99
.340	238.52	225.26	222.76	223.02	224.93	229.87	235.36	241.96	249.11	256.26	263.13
.360	234.76	224.26	223.42	224.78	227.24	232.46	239.33	245.10	252.53	259.95	266.55
.380	232.53	225.91	225.18	227.09	230.87	235.87	242.47	249.62	256.77	264.19	269.49
.400	233.32	226.68	226.66	229.67	234.07	238.73	246.43	252.48	259.63	267.33	273.65
.420	233.42	228.44	229.25	232.54	237.48	242.70	248.47	256.45	263.59	271.29	277.89
.440	234.53	230.75	231.56	235.67	241.17	246.39	252.71	260.41	267.56	275.26	282.41
.460	236.39	233.06	234.42	239.36	245.14	250.35	256.54	264.24	271.80	279.64	286.65
.480	238.70	235.92	237.83	243.05	248.83	254.60	260.92	268.62	276.04	283.74	291.17
.500	242.89	238.90	241.52	246.74	252.85	259.11	265.71	273.14	280.56	287.98	295.66
.520	243.32	241.65	244.94	250.71	256.76	263.08	269.95	277.65	285.08	292.50	300.20
.540	246.19	243.41	248.63	254.68	261.00	267.60	274.47	282.17	289.59	296.74	304.72
.560	248.50	247.37	252.59	258.64	265.24	271.84	278.99	286.69	294.11	301.54	309.24
.580	252.46	251.62	256.84	262.88	269.76	276.35	283.50	291.20	298.63	306.05	313.75
.600	255.90	256.52	261.08	267.40	274.80	280.87	288.30	295.72	303.15	310.57	318.24

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			289.85	259.90	249.35	245.43	245.36	246.49	249.44	252.33	256.83
.180			263.85	245.60	239.56	238.89	240.02	242.04	243.47	248.48	254.90
.200		286.40	250.48	237.87	233.92	234.75	237.07	239.39	243.21	247.32	253.83
.220		264.03	243.05	232.82	229.77	232.09	235.01	237.93	242.65	247.06	253.86
.240	394.01	251.22	237.41	230.17	226.85	230.63	233.55	237.67	243.22	248.29	254.65
.260	321.02	243.39	233.56	228.11	225.96	229.47	233.59	238.30	244.21	249.52	256.62
.280	283.62	238.74	231.20	227.25	225.99	229.81	233.92	239.53	245.74	251.65	258.75
.300	266.93	234.89	229.45	226.99	226.62	230.74	235.45	241.36	247.87	254.07	261.18
.320	254.68	232.84	229.18	227.32	229.29	231.97	236.68	243.19	250.29	257.40	265.28
.340	246.98	231.97	228.62	228.26	229.68	234.40	239.71	246.21	253.32	260.42	267.22
.360	242.53	230.52	228.96	229.79	231.81	236.82	243.63	249.24	256.64	264.04	270.55
.380	239.73	231.93	230.49	231.91	235.37	240.15	246.65	253.75	260.86	268.26	273.36
.400	240.21	232.38	231.72	234.34	238.46	242.87	250.57	256.48	263.58	271.28	277.49
.420	239.95	233.91	234.14	237.06	241.78	246.79	252.40	260.40	267.50	275.20	281.71
.440	240.88	236.04	236.27	240.09	245.40	250.41	256.62	264.32	271.42	279.12	286.22
.460	242.41	238.16	238.99	243.71	249.32	254.33	260.39	268.09	275.64	283.49	290.44
.480	244.54	240.89	242.32	247.33	252.94	258.55	264.76	272.46	279.86	287.56	294.96
.500	248.70	243.73	245.94	250.95	256.92	263.07	269.57	276.97	284.38	291.78	299.45
.520	248.79	246.34	249.26	254.87	260.78	266.99	273.79	281.49	288.89	296.29	303.99
.540	251.52	247.87	252.88	258.79	265.00	271.50	278.31	286.01	293.41	300.51	308.51
.560	253.65	251.79	256.80	262.71	269.22	275.72	282.82	290.53	297.93	305.33	313.03
.580	257.56	256.01	261.02	266.93	273.73	280.24	287.34	295.04	302.44	309.85	317.55
.600	260.92	260.94	265.24	271.44	278.82	284.76	292.16	299.56	306.96	314.36	322.03

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			303.55	270.71	258.75	253.93	253.27	253.89	256.48	259.00	263.25
.180			275.24	254.95	247.85	246.55	247.17	248.76	249.70	254.50	260.82
.200		299.73	260.46	246.28	241.43	241.73	243.64	245.55	249.07	252.91	259.32
.220		275.29	252.10	240.50	236.62	238.53	241.08	243.63	248.12	252.28	259.01
.240	415.51	261.14	245.68	237.29	233.12	236.61	239.16	243.00	248.39	253.25	259.51
.260	336.56	252.37	241.19	234.73	231.82	235.01	238.85	243.34	249.11	254.23	261.29
.280	295.94	247.01	238.31	233.46	231.51	235.03	238.87	244.31	250.41	256.18	263.23
.300	277.61	242.52	236.07	232.83	231.84	235.68	240.17	245.94	252.35	258.44	265.50
.320	264.08	239.96	235.43	232.84	234.36	236.66	241.14	247.56	254.61	261.67	269.56
.340	255.44	238.69	234.48	233.50	234.44	238.92	244.05	250.47	257.52	264.58	271.31
.360	250.30	236.77	234.49	234.00	236.38	241.19	247.93	253.37	260.75	268.13	274.54
.380	246.94	237.94	235.79	236.74	239.87	244.42	250.83	257.89	264.95	272.33	277.23
.400	247.11	238.08	236.77	239.00	242.84	247.01	254.71	260.48	267.53	275.24	281.33
.420	246.48	239.38	239.04	241.59	246.08	250.88	256.33	264.35	271.41	279.11	285.52
.440	247.13	241.32	240.98	244.50	249.63	254.43	260.52	268.23	275.28	282.98	290.04
.460	248.43	243.27	243.57	248.05	253.50	258.31	264.24	271.94	279.48	287.34	294.23
.480	250.38	245.85	246.80	251.60	257.05	262.50	268.59	276.29	283.67	291.37	298.75
.500	254.51	248.57	250.35	255.16	260.99	267.02	273.43	280.81	288.19	295.57	303.24
.520	254.26	251.03	253.58	259.03	264.80	270.89	277.63	285.33	292.71	300.09	307.79
.540	256.85	252.33	257.13	262.90	269.00	275.41	282.15	289.85	297.22	304.28	312.30
.560	258.79	256.20	261.01	266.78	273.19	279.61	286.66	294.36	301.74	309.12	316.82
.580	262.67	260.39	265.20	270.97	277.71	284.12	291.18	298.88	306.26	313.64	321.34
.600	265.93	265.36	269.40	275.49	282.84	288.64	296.02	303.40	310.78	318.16	325.82

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			330.94	292.31	277.54	270.94	269.08	268.69	270.55	272.33	276.09
.180			297.95	273.66	264.45	261.85	261.46	262.18	262.16	266.55	272.67
.200		326.39	280.40	263.10	256.46	255.71	256.79	257.87	260.79	264.08	270.31
.220		297.81	270.21	255.85	250.32	251.40	253.21	255.03	259.06	262.71	269.31
.240	458.52	281.00	262.23	251.54	245.68	248.56	250.38	253.67	258.72	263.18	269.23
.260	367.65	270.33	256.45	247.97	243.54	246.09	249.38	253.40	258.90	263.66	270.62
.280	320.58	263.56	252.51	245.87	242.54	245.46	248.75	253.87	259.74	265.23	272.20
.300	298.99	257.78	249.30	244.50	242.28	245.56	249.59	255.08	261.31	267.17	274.14
.320	282.87	254.21	247.94	243.87	244.51	246.04	250.06	256.29	263.26	270.22	278.14
.340	272.35	252.11	246.20	243.98	243.96	247.98	252.74	258.97	265.93	272.90	279.50
.360	265.84	249.27	245.57	244.82	245.53	249.92	256.52	261.65	268.98	276.31	282.54
.380	261.35	249.96	246.41	246.39	248.87	252.97	259.20	266.17	273.13	280.46	284.96
.400	260.90	249.48	246.88	248.34	251.62	255.28	262.98	268.48	275.44	283.14	289.00
.420	259.53	250.32	248.83	250.65	254.67	259.06	264.19	272.26	279.22	286.92	293.15
.440	259.64	251.89	250.40	253.32	258.08	262.48	268.34	276.04	283.00	290.70	297.67
.460	260.48	253.47	252.71	256.74	261.87	266.26	271.94	279.64	287.15	295.04	301.82
.480	262.05	255.78	255.76	260.15	265.28	270.41	276.27	283.97	291.30	299.00	306.34
.500	266.13	258.24	259.17	263.57	269.14	274.93	281.15	288.49	295.82	303.15	310.82
.520	265.20	260.40	262.22	267.35	272.84	278.71	285.30	293.01	300.34	307.67	315.37
.540	267.51	261.24	265.64	271.13	276.99	283.22	289.82	297.52	304.85	311.82	319.89
.560	269.09	265.02	269.42	274.91	281.14	287.37	294.34	302.04	309.37	316.70	324.40
.580	272.87	269.17	273.57	279.06	285.66	291.89	298.86	306.56	313.89	321.22	328.92
.600	275.95	274.21	277.72	283.58	290.88	296.41	303.74	311.07	318.41	325.74	333.40

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	432.17	435.87	360.96	339.37	328.13	321.48	316.36	317.95	318.76	321.30	324.40	328.46	332.92	339.53
.280	436.68	444.39	343.79	326.52	321.17	312.23	312.61	313.85	315.24	320.65	324.90	328.59	334.28	339.97
.300	441.20	352.51	330.34	318.99	314.92	306.56	310.10	311.05	313.45	318.28	323.11	329.66	335.35	341.04
.320	445.72	339.24	321.11	314.03	316.43	304.33	308.59	309.54	312.22	317.92	324.33	330.73	333.27	341.54
.340	450.23	333.42	315.58	310.66	307.60	303.39	307.08	309.04	312.44	318.13	324.97	331.81	337.50	343.19
.360	355.49	324.31	311.49	308.00	305.23	303.03	306.72	309.54	313.22	319.20	326.47	333.74	339.29	344.84
.380	344.51	318.93	308.98	305.92	303.72	303.39	306.79	311.19	314.30	320.85	328.41	335.96	341.51	347.06
.400	336.23	315.98	307.94	304.99	303.50	303.74	305.82	311.11	315.94	321.92	328.48	335.03	342.44	349.80
.420	327.15	313.01	306.25	304.48	304.43	304.82	308.93	315.06	318.17	324.72	331.85	338.97	345.81	352.65
.440	321.33	310.98	305.31	304.55	305.36	306.18	310.87	317.28	320.96	327.80	335.36	342.92	349.47	356.02
.460	316.67	309.88	304.95	305.34	306.44	307.97	313.09	320.07	323.76	330.88	338.58	346.29	352.55	358.82
.480	313.72	309.66	304.76	306.12	307.66	310.31	315.60	322.87	327.13	334.25	341.81	349.37	356.06	362.76
.500	313.65	309.93	305.23	307.23	309.45	312.18	318.68	326.09	331.07	337.62	345.18	352.74	359.15	366.13
.520	311.67	310.66	305.96	308.56	311.67	315.93	322.16	327.89	334.73	342.14	348.69	356.68	363.29	369.50
.540	312.93	311.96	307.81	310.21	314.03	319.30	324.84	332.40	338.38	345.22	352.78	360.34	367.18	374.02
.560	314.00	313.52	310.03	312.43	316.97	322.66	328.21	336.35	341.75	348.88	356.58	364.28	371.26	377.96
.580	316.36	315.31	312.83	315.22	320.05	326.03	331.87	340.00	345.70	352.25	360.38	368.51	375.21	381.90
.600	318.44	317.31	315.48	318.30	323.71	329.69	335.81	343.66	350.21	356.77	364.75	372.74	379.58	386.42
.620	320.66	319.61	318.56	321.67	327.37	333.78	339.90	347.89	354.16	361.08	368.73	376.40	383.67	390.94
.640	323.46	317.30	321.50	325.33	331.17	337.58	344.27	351.83	357.93	365.40	373.16	380.91	388.18	395.45
.660	326.74	324.77	325.70	328.84	335.25	341.81	348.68	355.40	362.62	369.74	377.16	384.57	392.27	399.97
.680	328.91	327.57	328.67	332.93	339.74	346.30	352.88	360.29	366.56	374.06	381.56	389.09	396.65	404.20
.700	331.27	330.51	332.33	337.02	344.14	350.41	357.40	364.81	370.93	378.20	385.96	393.61	401.16	408.72
.720	334.07	333.73	336.41	341.25	348.23	354.50	361.91	369.33	375.02	382.72	390.42	398.12	405.54	412.95
.740	336.86	337.13	340.50	345.65	352.46	358.99	366.43	373.84	379.54	387.27	395.03	402.64	410.20	417.75
.760	339.66	340.76	344.99	350.14	356.72	363.39	370.95	378.36	384.05	391.78	399.51	407.16	414.86	422.56
.780	343.03	344.70	349.48	354.66	361.21	367.76	375.46	382.88	388.57	396.27	404.00	411.67	419.38	427.08
.800	345.94	348.36	353.31	359.17	365.73	372.28	380.01	385.36	393.09	400.79	408.49	415.73	423.87	431.88

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.150	.170	.180	.190	.200
.260	460.86	468.56	381.00	356.47	343.34	335.26	328.85	329.83	329.95	331.97	334.62	338.31	342.45	348.95
.280	465.38	473.08	361.65	341.89	335.23	324.62	324.27	324.87	325.63	330.81	334.72	338.00	343.49	348.98
.300	469.89	371.57	346.41	333.15	327.91	317.93	321.06	321.34	323.20	327.75	332.29	338.73	344.22	349.71
.320	474.41	356.51	335.80	327.25	329.11	315.03	318.95	319.23	321.41	326.90	333.18	339.46	341.48	349.81
.340	478.93	349.67	329.27	323.09	318.95	313.55	316.83	318.22	321.19	326.68	333.43	340.19	345.68	351.17
.360	374.26	339.19	324.32	319.71	315.89	312.70	315.99	318.32	321.60	327.41	334.64	341.86	347.20	352.53
.380	361.73	332.81	321.10	316.97	313.78	312.64	315.61	319.68	322.33	328.77	336.31	343.86	349.19	354.52
.400	352.17	329.13	318.52	315.49	313.09	312.58	314.10	319.15	323.69	329.50	335.94	342.38	349.76	357.08
.420	341.72	325.40	317.20	314.48	313.66	313.31	317.07	323.03	325.68	332.12	339.19	346.26	353.02	359.77
.440	334.88	322.72	315.72	314.11	314.23	314.36	318.74	325.03	328.31	335.06	342.60	350.15	356.59	363.02
.460	329.29	321.05	314.87	314.52	314.96	315.88	320.74	327.65	330.93	338.00	345.70	353.40	359.52	365.65
.480	325.60	320.36	314.21	314.43	315.85	317.99	323.04	330.27	334.19	341.26	348.80	356.34	362.94	369.53
.500	325.07	320.21	314.27	315.69	317.37	319.61	325.98	333.37	338.07	344.51	352.05	359.60	365.88	372.79
.520	322.39	320.56	314.62	316.71	319.36	323.27	329.36	334.89	341.64	349.03	355.47	363.48	369.98	376.04
.540	323.37	321.54	316.21	318.07	321.51	326.53	331.86	339.40	345.21	351.97	359.51	367.05	373.81	380.56
.560	324.10	322.81	318.20	320.06	324.29	329.78	335.12	343.29	348.47	355.54	363.24	370.94	377.85	384.45
.580	326.25	324.32	320.82	322.68	327.23	333.04	338.69	346.86	352.35	358.79	366.97	375.14	381.74	388.33
.600	328.08	326.06	323.29	325.62	330.80	336.61	342.57	350.43	356.87	363.31	371.32	379.34	386.09	392.85
.620	330.08	328.15	326.23	328.88	334.37	340.65	346.62	354.63	360.76	367.60	375.24	382.91	390.14	397.37
.640	332.70	325.16	329.01	332.45	338.10	344.38	350.98	358.52	364.45	371.90	379.66	387.43	394.66	401.88
.660	335.86	332.92	333.18	335.86	342.14	348.58	355.37	361.99	369.16	376.23	383.61	391.00	398.70	406.40
.680	337.79	335.55	335.99	339.90	346.63	353.07	359.54	366.92	373.04	380.53	388.00	395.52	403.06	410.60
.700	339.94	338.33	339.56	343.95	351.02	357.14	364.05	371.44	377.40	384.63	392.40	400.03	407.58	415.12
.720	342.56	341.43	343.60	348.15	355.06	361.18	368.57	375.96	381.45	389.15	396.85	404.55	411.94	419.32
.740	345.18	344.71	347.65	352.54	359.26	365.67	373.09	380.47	385.97	393.70	401.46	409.07	416.61	424.15
.760	347.81	348.25	352.13	357.03	363.50	370.06	377.61	384.99	390.48	398.22	405.95	413.59	421.29	428.99
.780	351.06	352.14	356.62	361.54	367.98	374.42	382.12	389.51	395.00	402.70	410.43	418.10	425.80	433.50
.800	353.81	355.71	360.38	366.06	372.50	378.94	386.67	391.78	399.52	407.22	414.92	422.11	430.32	438.34

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	489.55	497.26	401.03	373.57	358.55	349.03	341.34	341.71	341.14	342.65	344.84	348.16	351.97	358.36
.280	494.07	501.77	379.51	357.26	349.29	337.02	335.94	335.89	336.02	340.96	344.53	347.41	352.70	357.99
.300	498.59	390.62	362.47	347.31	340.89	329.31	332.02	331.63	332.96	337.22	341.47	347.80	353.09	358.38
.320	503.11	373.79	350.50	340.46	341.80	325.74	329.31	328.91	330.59	335.88	342.03	348.18	349.68	358.07
.340	507.62	365.91	342.96	335.51	330.30	323.71	326.59	327.41	329.94	335.23	341.90	348.57	353.86	359.15
.360	393.03	354.07	337.15	331.42	326.55	322.37	325.25	327.10	329.98	335.62	342.80	349.99	355.10	350.22
.380	378.95	346.70	333.23	328.02	323.84	321.90	324.43	328.18	330.37	336.69	344.22	351.75	356.87	361.98
.400	368.11	342.27	330.00	325.99	322.67	321.42	322.37	327.18	331.44	337.08	343.40	349.72	357.08	364.37
.420	356.30	337.80	328.14	324.48	322.89	321.81	325.20	331.01	333.20	339.53	346.54	353.55	360.22	366.89
.440	348.42	334.46	326.12	323.66	323.10	322.54	326.62	332.77	335.65	342.32	349.85	357.38	363.70	370.03
.460	341.92	332.23	324.78	323.70	323.48	323.78	328.38	335.23	338.11	345.12	352.82	360.52	366.50	372.48
.480	337.48	331.07	323.65	323.74	324.04	325.68	330.49	337.68	341.24	348.26	355.79	363.31	369.81	376.30
.500	336.49	330.49	323.31	324.16	325.29	327.03	333.29	340.64	345.07	351.40	358.93	366.45	372.61	379.44
.520	333.16	330.46	323.28	324.86	327.05	330.62	336.56	341.89	348.56	355.91	362.24	370.28	376.67	382.58
.540	333.82	331.12	324.50	325.93	328.98	333.76	338.88	346.41	352.04	358.71	366.24	373.77	380.43	387.10
.560	334.20	332.09	326.36	327.69	331.61	336.90	342.02	350.24	355.18	362.19	369.89	377.60	384.44	390.93
.580	336.14	333.34	328.81	330.14	334.40	340.04	345.50	353.72	359.01	365.33	373.55	381.77	388.26	394.76
.600	337.73	334.82	331.09	332.94	337.89	343.52	349.33	357.20	363.53	369.85	377.90	385.94	392.61	399.28
.620	339.49	336.69	333.89	336.08	341.37	347.52	353.33	361.38	367.36	374.13	381.76	389.43	396.61	403.79
.640	341.94	333.01	336.51	339.56	345.03	351.18	357.68	365.21	370.98	378.40	386.17	393.94	401.13	408.31
.660	344.98	341.07	340.65	342.88	349.03	355.35	362.06	368.59	375.70	382.71	390.07	397.43	405.13	412.83
.680	346.67	343.52	343.31	346.88	353.51	359.84	366.19	373.55	379.53	386.99	394.45	401.94	409.47	417.00
.700	348.60	346.15	346.79	350.88	357.89	363.87	370.71	378.07	383.88	391.06	398.83	406.46	413.99	421.52
.720	351.06	349.12	350.79	355.05	361.89	367.87	375.23	382.59	387.88	395.58	403.28	410.98	418.33	425.69
.740	353.51	352.29	354.79	359.43	366.06	372.35	379.75	387.10	392.39	400.13	407.90	415.50	423.02	430.55
.760	355.96	355.74	359.28	363.91	370.27	376.73	384.26	391.62	396.91	404.65	412.38	420.01	427.71	435.41
.780	359.10	359.57	363.76	368.43	374.75	381.08	388.78	396.14	401.43	409.13	416.86	424.53	432.23	439.93
.800	361.69	363.05	367.45	372.95	379.27	385.60	393.33	398.21	405.95	413.65	421.35	428.50	436.75	444.79

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.150	.170	.180	.190	.200
.260	518.25	525.95	421.00	390.68	373.76	362.81	353.83	353.59	352.33	353.32	355.05	358.02	361.50	357.78
.280	522.76	530.47	397.33	372.62	363.35	349.42	347.60	346.91	346.41	351.12	354.35	356.82	361.91	357.00
.300	527.28	405.67	378.54	361.47	353.88	340.69	342.98	341.92	342.72	346.69	350.66	356.87	361.95	367.04
.320	531.80	391.06	365.15	353.68	354.48	336.44	339.67	338.60	339.77	344.86	350.88	356.91	357.89	366.34
.340	536.32	382.15	356.65	347.94	341.65	333.87	336.35	336.59	338.69	343.78	350.37	356.95	362.04	357.12
.360	411.79	368.95	349.93	343.13	337.21	332.04	334.52	335.88	338.36	343.82	350.97	358.11	363.01	367.91
.380	396.17	360.59	345.35	339.06	333.90	331.15	333.26	336.67	338.40	344.61	352.13	359.64	364.54	369.44
.400	384.04	355.41	341.48	336.49	332.26	330.26	330.65	335.22	339.19	344.65	350.86	357.07	364.40	371.65
.420	370.88	350.19	339.09	334.48	332.11	330.30	333.34	338.99	340.72	346.93	353.89	360.84	367.42	374.00
.440	361.97	346.20	336.52	333.22	331.97	330.71	334.50	340.52	343.00	349.58	357.10	364.61	370.82	377.03
.460	354.55	343.41	334.70	332.89	332.01	331.69	336.03	342.80	345.28	352.23	359.94	367.64	373.47	379.31
.480	349.36	341.77	333.10	332.55	332.23	333.37	337.94	345.08	348.30	355.26	362.77	370.29	376.68	383.08
.500	347.91	340.77	332.35	332.63	333.21	334.45	340.59	347.92	352.08	358.28	365.80	373.31	379.33	386.10
.520	343.92	340.36	331.95	333.01	334.74	337.97	343.76	348.89	355.47	362.80	369.01	377.08	383.37	389.13
.540	344.26	340.70	332.99	333.79	336.46	340.99	345.89	353.41	358.87	365.45	372.97	380.48	387.06	393.64
.560	344.30	341.37	334.53	335.33	338.92	344.02	348.92	357.18	361.90	368.85	376.55	384.25	391.02	397.42
.580	346.02	342.35	336.81	337.61	341.58	347.04	352.32	360.58	365.67	371.88	380.14	388.40	394.79	401.19
.600	347.37	343.58	338.90	340.26	344.97	350.44	356.09	363.98	370.19	376.39	384.47	392.54	399.12	405.70
.620	348.90	345.23	341.55	343.28	348.37	354.40	360.05	368.12	373.96	380.65	388.28	395.94	403.08	410.22
.640	351.18	340.86	344.01	346.68	351.96	357.98	364.38	371.89	377.50	384.91	392.68	400.46	407.60	414.74
.660	354.09	349.22	348.12	349.89	355.92	362.12	368.74	375.18	382.24	389.29	396.53	403.85	411.56	419.26
.680	355.55	351.50	350.62	353.85	360.40	366.60	372.85	380.18	386.02	393.45	400.90	408.37	415.89	423.40
.700	357.27	353.97	354.02	357.81	364.76	370.60	377.37	384.70	390.35	397.49	405.26	412.89	420.40	427.92
.720	359.55	356.81	357.98	361.95	368.72	374.56	381.89	389.21	394.30	402.01	409.71	417.41	424.73	432.06
.740	361.83	359.87	361.94	366.32	372.87	379.04	386.40	393.73	398.82	406.55	414.34	421.92	429.44	436.95
.760	364.11	363.23	366.42	370.80	377.05	383.41	390.92	398.25	403.34	411.03	418.82	426.44	434.14	441.84
.780	367.13	367.00	370.90	375.32	381.53	387.74	395.44	402.77	407.86	415.56	423.30	430.96	438.66	446.36
.800	369.56	370.40	374.52	379.83	386.04	392.25	399.99	404.63	412.37	420.07	427.78	434.88	443.18	451.25

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	416.90	380.30	366.18	359.11	355.90	354.87	357.18	358.46	362.57	368.73	373.86	379.13	385.41	392.09
.420	406.91	377.11	364.27	357.85	355.28	355.28	357.85	359.64	364.26	370.68	375.81	381.72	387.36	394.04
.440	396.40	374.19	363.14	357.23	355.31	355.95	358.51	361.08	366.21	371.99	377.76	383.92	389.96	397.01
.460	389.36	371.38	362.27	357.13	355.59	356.61	359.18	362.77	368.16	374.32	380.23	386.13	392.29	399.09
.480	385.10	369.48	361.65	357.92	356.64	357.92	360.77	364.98	370.62	376.53	382.95	388.72	395.14	402.04
.500	379.78	367.84	360.52	357.69	357.17	359.48	362.56	366.93	372.32	378.48	384.89	391.31	397.99	404.66
.520	377.23	366.83	359.90	360.54	358.35	361.18	364.77	369.52	375.04	381.20	387.87	394.16	400.96	407.51
.540	375.97	365.70	359.54	359.02	359.79	363.13	367.23	372.37	378.01	384.17	393.42	397.27	404.20	410.61
.560	374.71	365.72	359.94	360.20	361.48	365.72	370.21	375.09	381.25	387.41	394.08	400.11	407.43	413.97
.580	374.09	365.75	360.61	361.89	363.82	369.08	372.93	378.32	384.48	390.77	397.57	403.99	411.23	417.21
.600	374.12	367.05	361.66	363.20	365.89	370.77	376.26	381.30	387.46	394.13	401.06	408.61	415.74	422.11
.620	373.50	367.08	363.99	365.02	368.36	373.23	378.88	384.53	391.46	397.88	404.55	410.71	418.41	424.70
.640	373.52	368.38	365.94	367.48	370.95	376.08	382.37	388.02	395.46	401.37	408.30	414.33	422.29	428.32
.660	374.19	369.69	368.15	369.95	373.80	379.19	385.86	391.25	399.21	405.37	412.04	418.46	426.16	432.58
.680	375.49	371.64	370.61	372.92	377.03	382.55	389.61	394.74	403.09	409.12	415.92	422.21	430.17	436.97
.700	376.16	373.59	373.59	375.90	380.26	386.17	393.10	398.75	406.96	413.38	419.80	426.21	434.17	441.23
.720	378.08	376.18	377.00	380.67	385.81	391.45	397.23	404.03	410.96	417.38	424.83	432.01	438.69	445.85
.740	378.77	378.00	379.29	382.62	389.01	394.17	400.59	407.01	414.71	421.39	428.19	434.99	442.69	449.37
.760	380.98	380.72	382.78	386.37	391.76	398.05	404.34	411.01	419.23	425.65	432.32	439.25	446.44	453.88
.780	383.32	384.85	385.88	390.12	395.76	401.67	408.34	415.27	423.49	430.16	436.58	443.51	450.70	458.37
.800	385.91	387.19	389.24	394.12	400.02	405.41	412.73	419.53	427.62	434.42	441.10	447.77	454.70	462.40
.820	389.14	390.42	392.48	398.38	404.28	409.68	417.12	423.79	431.75	438.94	445.62	452.29	459.09	467.43
.840	392.96	393.66	397.48	402.64	408.42	414.71	421.74	428.31	436.24	443.33	449.62	456.81	464.41	472.11

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	437.26	396.44	380.24	371.77	367.52	365.66	367.45	368.12	371.89	377.90	382.79	387.82	393.97	400.55
.420	424.90	392.52	377.72	369.96	366.41	365.68	367.75	368.98	373.31	379.61	384.50	390.23	395.68	402.25
.440	413.55	388.88	376.05	368.85	366.01	365.97	368.05	370.13	375.02	380.61	386.20	392.21	398.09	405.08
.460	405.81	385.39	374.67	368.31	365.88	366.27	368.35	371.55	376.72	382.73	388.47	394.20	400.21	406.93
.480	400.71	382.87	373.56	368.74	366.60	367.27	369.66	373.54	378.99	384.72	391.02	396.61	402.90	409.73
.500	394.45	380.64	371.89	368.06	366.76	368.56	371.20	375.24	380.41	386.43	392.72	399.02	405.59	412.17
.520	391.23	379.11	370.78	370.75	367.62	369.98	373.18	377.65	382.96	388.97	395.55	401.71	408.42	414.86
.540	389.42	377.44	369.95	368.66	368.76	371.68	375.45	380.34	385.79	391.80	401.19	404.68	411.53	417.83
.560	387.61	377.03	369.97	369.52	370.19	374.09	378.28	382.89	388.90	394.92	401.49	407.36	414.64	421.08
.580	386.51	376.63	370.27	370.94	372.31	377.34	380.83	386.00	392.01	398.17	404.88	411.18	418.37	424.19
.600	386.10	377.63	370.99	371.94	374.16	378.77	384.05	388.83	394.84	401.42	408.28	415.81	422.89	429.13
.620	384.99	377.23	373.12	373.51	376.43	381.04	386.49	391.94	398.80	405.09	411.67	417.68	425.38	431.54
.640	384.59	378.23	374.82	375.77	378.83	383.72	389.88	395.33	402.75	408.48	415.34	421.21	429.20	435.07
.660	384.89	379.23	376.81	378.04	381.52	386.69	393.27	398.44	406.42	412.44	419.02	425.31	433.01	439.31
.680	385.89	380.93	379.07	380.87	384.64	389.95	396.95	401.83	410.24	416.11	422.83	428.98	436.97	443.68
.700	386.19	382.64	381.90	383.70	387.75	393.48	400.34	405.79	414.05	420.35	426.64	432.94	440.92	447.92
.720	387.86	385.05	385.21	388.50	393.39	398.84	404.43	411.15	418.01	424.30	431.72	438.86	445.44	452.55
.740	388.19	386.61	387.28	390.20	395.37	401.39	407.68	413.98	421.68	428.26	434.97	441.69	449.39	455.97
.760	390.18	389.16	390.67	393.88	399.05	405.20	411.36	417.93	426.20	432.49	439.07	445.93	453.07	460.49
.780	392.30	393.26	393.65	397.55	403.00	408.74	415.31	422.17	430.43	437.91	443.31	450.16	457.30	464.98
.800	394.71	395.38	396.90	401.51	407.24	412.41	419.69	426.41	434.53	441.25	447.82	454.40	461.26	468.96
.820	397.82	398.49	400.01	405.74	411.47	416.65	424.07	430.64	438.63	445.76	452.34	458.92	465.63	474.04
.840	401.58	401.60	405.06	409.98	415.57	421.72	428.70	435.16	443.11	450.14	456.30	463.43	471.02	478.72

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	457.62	412.58	354.30	384.43	379.14	376.44	377.73	377.78	381.21	387.07	391.72	396.51	402.53	409.01
.420	443.79	407.93	391.18	382.06	377.54	376.07	377.66	378.33	382.36	388.53	393.18	398.74	403.99	410.47
.440	431.49	403.58	388.97	380.47	376.71	376.00	377.59	379.18	383.82	389.23	394.64	400.50	406.22	413.16
.460	422.25	399.39	387.07	379.48	376.18	375.93	377.52	380.33	385.28	391.15	396.71	402.27	408.14	414.77
.480	416.32	396.26	385.47	379.57	376.57	376.63	378.55	382.10	387.35	392.91	399.09	404.50	410.67	417.42
.500	409.13	393.44	383.26	378.43	376.35	377.63	379.83	383.56	388.51	394.37	400.55	406.72	413.20	419.68
.520	405.24	391.39	381.66	380.96	376.89	378.78	381.59	385.78	390.88	396.75	403.23	409.25	415.88	422.21
.540	402.87	389.18	380.37	378.29	377.74	380.24	383.67	388.31	393.57	399.43	408.97	412.09	418.87	425.04
.560	400.51	388.35	380.00	378.83	378.89	382.47	386.35	390.69	396.56	402.42	408.90	414.62	421.86	428.18
.580	398.92	387.51	379.93	379.99	380.81	385.61	388.73	393.68	399.54	405.56	412.20	418.37	425.52	431.17
.600	398.08	388.21	380.32	380.69	382.43	386.77	391.84	396.36	402.23	408.71	415.49	423.01	430.04	436.15
.620	396.49	387.38	382.24	381.99	384.50	389.84	394.09	399.35	406.13	412.31	418.78	424.65	432.35	438.37
.640	395.65	388.07	383.70	384.06	386.72	391.37	397.39	402.64	410.04	415.60	422.39	428.10	436.11	441.82
.660	395.59	388.77	385.46	386.14	389.25	394.20	400.68	405.63	413.64	419.51	425.99	432.16	439.86	446.03
.680	396.28	390.23	387.54	388.82	392.24	397.34	404.28	408.93	417.39	423.11	429.74	435.76	443.77	450.40
.700	396.21	391.69	390.22	391.50	395.23	400.79	407.58	412.83	421.15	427.32	433.49	439.66	447.67	454.61
.720	397.64	393.91	393.42	396.32	400.97	406.23	411.64	418.27	425.05	431.22	438.62	445.71	452.19	459.25
.740	397.61	395.22	395.28	397.78	402.74	409.60	414.78	420.95	428.65	435.13	441.76	448.39	456.09	462.57
.760	399.37	397.60	398.57	401.39	406.34	412.36	418.38	424.86	433.17	439.34	445.82	452.60	459.69	467.09
.780	401.29	401.66	401.41	404.99	410.24	415.80	422.28	429.07	437.38	443.86	450.03	456.82	463.91	471.58
.800	403.51	403.57	404.55	408.89	414.45	419.40	426.65	433.28	441.44	448.07	454.55	461.03	467.81	475.51
.820	406.50	406.56	407.54	413.10	418.66	423.62	431.01	437.49	445.50	452.59	459.07	465.54	472.18	480.64
.840	410.20	409.55	412.64	417.31	422.72	428.74	435.65	442.01	449.98	456.95	462.97	470.06	477.64	485.34

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	477.98	428.73	408.36	397.08	390.75	387.23	388.00	387.44	390.52	396.24	400.64	405.21	411.09	417.47
.420	462.68	423.34	404.63	394.17	388.67	386.46	387.56	387.67	391.41	397.46	401.86	407.25	412.31	418.69
.440	449.04	418.28	401.88	392.08	387.41	386.03	387.13	388.22	392.62	397.85	403.08	408.80	414.35	421.23
.460	438.70	413.39	399.46	390.66	386.48	385.59	386.69	389.11	393.84	399.56	404.95	410.34	416.06	422.61
.480	431.93	409.65	397.38	390.39	386.54	385.98	387.44	390.66	395.72	401.11	407.16	412.38	418.43	425.11
.500	423.80	406.24	394.63	388.80	385.93	386.70	388.46	391.87	396.60	402.32	408.37	414.42	420.80	427.18
.520	419.24	403.66	392.55	391.17	386.16	387.59	390.01	393.91	398.81	404.53	410.91	416.79	423.34	429.56
.540	416.33	400.92	390.79	387.93	386.72	388.80	391.88	396.28	401.34	407.06	416.75	419.50	426.21	432.26
.560	413.41	399.66	390.02	388.15	387.60	390.85	394.42	398.49	404.21	409.93	416.31	421.87	429.07	435.29
.580	411.33	398.40	389.55	389.04	389.31	393.88	396.63	401.36	407.08	412.96	419.51	425.56	432.67	438.15
.600	410.07	398.79	389.65	389.43	390.69	394.76	399.62	403.89	409.61	415.99	422.71	430.21	437.18	443.17
.620	407.98	397.53	391.36	390.48	392.57	396.64	401.70	406.76	413.47	419.52	425.90	431.62	439.32	445.21
.640	406.72	397.92	392.58	392.35	394.61	399.01	404.90	409.96	417.33	422.72	429.43	434.98	443.02	448.57
.660	406.29	398.31	394.12	394.23	396.98	401.71	408.09	412.82	420.85	426.57	432.96	439.01	446.71	452.76
.680	406.68	399.52	396.00	396.77	399.85	404.74	411.62	416.02	424.55	430.10	436.65	442.53	450.56	457.11
.700	406.24	400.74	398.53	399.30	402.71	408.10	414.82	419.88	428.24	434.29	440.34	446.39	454.42	461.30
.720	407.42	402.78	401.63	404.15	408.55	413.61	418.84	425.38	432.09	438.15	445.52	452.56	458.94	465.95
.740	407.02	403.83	403.28	405.37	410.10	415.82	421.87	427.92	435.62	442.00	448.55	455.09	462.79	469.18
.760	408.57	406.03	406.47	408.89	413.62	419.51	425.40	431.78	440.14	446.19	452.57	459.28	466.32	473.69
.780	410.28	410.06	409.17	412.42	417.48	422.87	429.25	435.96	444.33	450.71	456.76	463.47	470.51	478.18
.800	412.32	411.77	412.21	416.28	421.67	425.40	433.60	440.15	448.35	454.89	461.27	467.66	474.37	482.07
.820	415.19	414.63	415.07	420.46	425.85	430.59	437.96	444.34	452.37	459.41	465.79	472.17	478.72	487.24
.840	418.81	417.50	420.22	424.65	429.88	435.76	442.61	448.86	456.85	463.76	469.65	476.69	484.26	491.96

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

	.09C	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	508.52	452.94	429.46	416.07	408.18	403.41	403.40	401.94	404.50	410.00	414.03	418.25	423.93	430.17
.420	491.02	446.45	424.80	412.33	405.36	402.05	402.42	401.68	404.98	410.85	414.88	420.02	424.78	431.02
.440	475.36	440.33	421.25	409.51	403.45	401.07	401.43	401.80	405.83	410.78	415.73	421.23	426.55	433.33
.460	463.37	434.39	418.06	407.42	401.92	400.08	400.45	402.28	406.68	412.18	417.31	422.45	427.95	434.36
.480	455.34	429.74	415.24	406.62	401.48	400.01	400.78	403.50	408.26	413.40	419.26	424.21	430.08	436.64
.500	445.81	425.45	411.69	404.35	400.32	400.31	401.41	404.34	408.74	414.24	420.11	425.98	432.21	438.45
.520	440.24	422.08	408.87	406.48	400.06	400.80	402.63	406.11	410.69	416.19	422.43	428.11	434.53	440.58
.540	436.50	418.53	406.42	402.38	400.18	401.64	404.21	408.24	413.01	418.51	428.41	430.61	437.21	443.08
.560	432.77	416.62	405.07	402.13	400.66	403.41	406.53	410.19	415.69	421.19	427.43	432.74	439.89	445.95
.580	429.95	414.72	404.03	402.61	402.06	406.28	408.48	412.88	418.38	424.06	430.48	436.34	443.39	449.63
.600	428.04	414.65	403.65	402.54	403.09	406.76	411.31	415.19	420.69	426.93	433.53	441.01	447.90	453.70
.620	425.22	412.75	405.04	403.21	404.67	408.34	413.11	417.87	424.48	430.34	436.58	442.08	449.78	455.46
.640	423.32	412.68	405.89	404.79	406.44	410.47	416.16	420.92	428.26	433.39	439.99	445.31	453.38	458.69
.660	422.34	412.61	407.11	406.37	408.57	412.97	419.21	423.61	431.68	437.18	443.41	449.28	456.98	462.85
.680	422.27	413.46	408.69	408.69	411.26	415.84	422.62	426.66	435.28	440.59	447.01	452.69	460.76	467.18
.700	421.28	414.31	411.01	411.01	413.94	419.07	425.67	430.44	438.88	444.74	450.61	456.48	464.55	471.33
.720	422.09	416.08	413.95	415.89	419.92	424.69	429.64	436.06	442.66	448.53	455.86	462.83	469.06	475.99
.740	421.15	416.74	415.27	416.74	421.14	426.64	432.51	438.38	446.08	452.31	458.73	465.15	472.85	479.08
.760	422.36	418.69	418.32	420.16	424.56	430.24	435.92	442.16	450.59	456.46	462.70	469.30	476.26	483.60
.780	423.76	422.66	420.82	423.57	428.34	433.47	439.71	446.31	454.74	460.98	466.85	473.45	480.41	488.08
.800	425.53	424.06	423.69	427.36	432.49	436.89	444.04	450.46	458.71	465.13	471.36	477.60	484.20	491.90
.820	428.21	426.74	426.37	431.51	436.64	441.04	448.38	454.61	462.68	469.65	475.88	482.11	488.53	497.15
.840	431.74	429.42	431.59	435.66	440.61	446.29	453.04	459.13	467.16	473.98	479.66	486.63	494.19	501.89

SCENARIO 2

NUCLEAR FIRED BASE LOAD GENERATION

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			209.98	133.03	132.91	122.68	118.25	115.72	114.64	114.77	116.82
.080			147.14	118.64	109.77	107.88	107.25	105.35	105.98	108.52	111.05
.100		164.73	118.40	107.32	102.70	100.68	101.31	102.74	105.37	108.54	111.70
.120		123.86	106.76	102.33	99.81	99.81	101.08	102.98	104.88	108.05	111.21
.140		114.95	103.20	100.20	100.65	101.48	103.06	104.33	106.87	110.03	113.20
.160		110.72	103.13	101.23	101.87	103.14	105.05	107.26	109.48	112.65	115.81
.180		111.44	104.48	103.22	103.86	105.76	108.30	110.52	113.05	116.22	119.38
.200		112.16	106.78	106.25	107.11	109.64	111.55	114.40	117.25	120.73	123.90
.220		112.87	109.08	109.08	110.36	112.89	115.11	117.97	120.82	123.98	127.15
.240	154.25	114.86	112.01	112.65	114.34	116.30	119.00	121.85	124.86	128.03	131.19
.260	147.87	117.48	115.58	116.76	118.63	120.82	123.51	126.37	129.38	132.54	135.71
.280	144.79	120.41	118.83	120.86	122.89	125.34	128.03	130.88	133.89	137.06	140.23
.300	143.61	123.34	122.71	124.97	127.19	129.85	132.55	135.40	138.41	141.58	144.74
.320	143.06	126.59	126.60	129.07	131.68	134.37	137.07	139.92	142.93	146.09	149.26
.340	143.77	130.16	130.80	133.18	135.97	138.89	141.58	144.44	147.45	150.61	153.78
.360	144.52	134.01	135.16	137.35	140.33	143.41	146.10	148.95	151.96	155.13	158.29
.380	146.47	138.24	139.20	141.71	144.88	147.92	150.62	153.47	156.48	159.65	162.81
.400	148.46	142.44	143.62	146.13	149.30	152.44	155.14	157.99	161.00	164.16	167.33
.420	150.76	146.65	148.08	150.52	153.69	156.96	159.65	162.51	165.51	168.68	171.85
.440	153.37	150.85	152.53	154.91	158.08	161.48	164.17	167.02	170.03	173.20	176.36
.460	156.09	155.20	156.95	159.33	162.50	165.99	168.69	171.54	174.55	177.72	180.88

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			229.43	143.57	143.09	131.37	126.10	122.93	121.38	121.17	123.10
.080			159.10	127.08	116.88	114.42	113.37	110.91	111.26	113.72	116.18
.100		178.50	126.67	114.00	108.52	105.92	106.27	107.51	110.08	113.24	116.41
.120		132.59	113.24	107.96	104.80	104.45	105.51	107.27	109.03	112.20	115.37
.140		122.18	108.78	105.09	105.24	105.80	107.21	108.27	110.74	113.90	117.07
.160		116.99	108.20	105.74	106.09	107.15	108.92	111.03	113.14	116.31	119.47
.180		117.28	109.19	107.44	107.80	109.56	112.03	114.14	116.60	119.77	122.93
.200		117.58	111.25	110.30	110.91	113.37	115.14	117.95	120.77	124.29	127.45
.220		117.87	113.30	112.96	114.02	116.48	118.60	121.41	124.23	127.40	130.56
.240	163.70	119.57	116.06	116.42	117.94	119.77	122.41	125.23	128.22	131.39	134.55
.260	156.11	121.98	119.52	120.48	122.21	124.29	126.93	129.75	132.74	135.90	139.07
.280	152.18	124.74	122.63	124.54	126.44	128.80	131.45	134.26	137.25	140.42	143.59
.300	150.36	127.49	126.45	128.60	130.71	133.32	135.96	138.78	141.77	144.94	148.10
.320	149.25	130.60	130.26	132.66	135.19	137.84	140.48	143.30	146.29	149.46	152.62
.340	149.54	134.07	134.42	136.72	139.47	142.36	145.00	147.81	150.81	153.97	157.14
.360	149.87	137.84	138.77	140.85	143.81	146.87	149.51	152.33	155.32	158.49	161.65
.380	151.54	142.04	142.75	145.19	148.36	151.39	154.03	156.85	159.84	163.01	166.17
.400	153.24	146.21	147.17	149.60	152.77	155.91	158.55	161.37	164.36	167.52	170.69
.420	155.30	150.38	151.61	153.98	157.15	160.42	163.07	165.88	168.88	172.04	175.21
.440	157.70	154.54	156.06	158.35	161.52	164.94	167.58	170.40	173.39	176.56	179.72
.460	160.21	158.88	160.47	162.76	165.94	169.46	172.10	174.92	177.91	181.08	184.24

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			248.88	154.12	153.27	140.06	133.94	130.14	128.13	127.53	129.39
.080			171.07	135.53	123.99	120.97	119.49	116.47	116.54	118.93	121.32
.100		192.27	134.94	120.69	114.34	111.16	111.24	112.28	114.79	117.95	121.12
.120		141.31	119.71	113.60	109.80	109.10	109.95	111.57	113.19	116.35	119.52
.140		129.42	114.36	109.98	109.83	110.13	111.37	112.21	114.61	117.77	120.94
.160		123.25	113.26	110.24	110.32	111.17	112.79	114.80	116.80	119.97	123.13
.180		123.12	113.91	111.66	111.74	113.36	115.76	117.76	120.16	123.32	126.49
.200		123.00	115.72	114.36	114.71	117.10	118.73	121.51	124.29	127.84	131.01
.220		122.87	117.53	116.83	117.68	120.07	122.08	124.86	127.64	130.81	133.98
.240	173.14	124.29	120.11	120.18	121.54	123.24	125.82	128.61	131.58	134.75	137.91
.260	164.34	126.48	123.46	124.20	125.78	127.75	130.34	133.12	136.10	139.26	142.43
.280	159.57	129.07	126.43	128.21	129.99	132.27	134.86	137.64	140.62	143.78	146.95
.300	157.12	131.65	130.18	132.22	134.24	136.79	139.38	142.16	145.13	148.30	151.46
.320	155.44	134.62	133.92	136.24	138.71	141.30	143.89	146.68	149.65	152.82	155.98
.340	155.31	137.97	138.05	140.25	142.96	145.82	148.41	151.19	154.17	157.33	160.50
.360	155.23	141.58	142.37	144.34	147.28	150.34	152.93	155.71	158.68	161.85	165.02
.380	156.61	145.85	146.31	148.67	151.84	154.86	157.45	160.23	163.20	166.37	169.53
.400	158.03	149.98	150.71	153.07	156.24	159.37	161.96	164.74	167.72	170.89	174.05
.420	159.84	154.11	155.15	157.43	160.60	163.89	166.48	169.26	172.24	175.40	178.57
.440	162.03	158.24	159.59	161.79	164.97	168.41	171.00	173.78	176.75	179.92	183.08
.460	164.34	162.56	163.99	166.20	169.37	172.92	175.51	178.30	181.27	184.44	187.60

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060			268.33	164.67	163.45	148.76	141.79	137.36	134.87	133.98	135.67
.080			183.03	143.97	131.10	127.51	125.62	122.03	121.82	124.14	126.46
.100		206.04	143.21	127.38	120.16	116.41	116.20	117.04	119.49	122.66	125.83
.120		150.04	126.19	119.23	114.80	113.74	114.38	115.86	117.34	120.51	123.67
.140		136.65	119.94	114.88	114.41	114.46	115.52	116.15	118.48	121.64	124.81
.160		129.52	118.33	114.75	114.54	115.18	116.66	118.56	120.46	123.63	126.79
.180		128.97	118.63	115.89	115.68	117.16	119.49	121.39	123.71	126.88	130.04
.200		128.42	120.19	118.42	118.51	120.83	122.31	125.06	127.81	131.40	134.56
.220		127.87	121.75	120.70	121.34	123.66	125.57	128.31	131.06	134.22	137.39
.240	182.59	129.00	124.15	123.95	125.14	126.70	129.24	131.98	134.94	138.11	141.27
.260	172.58	130.99	127.40	127.92	129.36	131.22	133.76	136.50	139.46	142.63	145.79
.280	166.96	133.39	130.23	131.88	133.54	135.74	138.27	141.02	143.98	147.14	150.31
.300	163.88	135.80	133.91	135.85	137.76	140.25	142.79	145.54	148.49	151.66	154.82
.320	161.64	138.63	137.58	139.82	142.23	144.77	147.31	150.05	153.01	156.18	159.34
.340	161.09	141.88	141.67	143.79	146.45	149.29	151.82	154.57	157.53	160.69	163.86
.360	160.58	145.51	145.98	147.84	150.76	153.80	156.34	159.09	162.05	165.21	168.38
.380	161.67	149.65	149.86	152.15	155.32	158.32	160.86	163.61	166.56	169.73	172.89
.400	162.81	153.74	154.25	156.54	159.71	162.84	165.38	168.12	171.08	174.25	177.41
.420	164.38	157.84	158.69	160.89	164.06	167.36	169.89	172.64	175.60	178.76	181.93
.440	166.36	161.93	163.12	165.24	168.41	171.87	174.41	177.16	180.11	183.28	186.45
.460	168.47	166.24	167.51	169.63	172.80	176.39	178.93	181.67	184.63	187.80	190.96

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					255.72	210.23	190.79	179.43	172.07	165.42	161.39
.080					167.00	162.91	153.81	154.72	150.62	148.62	146.62
.100					149.56	147.40	145.40	143.08	140.93	140.22	139.51
.120					139.86	135.93	138.46	137.75	137.05	137.31	137.57
.140					134.53	131.40	130.70	131.29	132.62	134.40	137.18
.160		184.50	147.72	135.39	132.10	129.46	131.41	133.22	135.10	136.01	136.92
.180		167.15	139.97	132.80	130.81	130.10	131.98	133.86	135.74	137.62	139.50
.200	237.29	158.14	137.86	132.64	131.48	132.36	133.92	135.80	138.45	139.88	141.40
.220	196.91	151.84	137.37	133.12	132.74	133.65	135.85	138.05	140.25	142.78	145.30
.240	183.99	149.05	138.66	135.05	134.67	135.91	138.43	140.96	143.48	146.33	149.17
.260	176.23	148.40	140.21	137.31	137.25	139.13	141.66	144.18	146.71	148.01	152.72
.280	171.06	148.07	142.53	140.53	140.80	142.03	144.88	147.73	150.58	153.75	156.92
.300	167.83	149.04	145.11	144.08	144.02	145.58	148.53	151.47	154.45	157.46	160.46
.320	167.18	150.78	147.20	146.98	148.02	149.78	151.98	155.08	158.19	161.42	164.66
.340	167.82	152.58	150.98	151.18	152.45	154.39	156.66	159.73	162.77	165.97	169.18
.360	169.11	155.16	154.78	155.37	156.93	159.04	161.34	164.35	167.35	170.56	173.79
.380	171.69	157.74	158.56	159.57	161.38	163.68	166.01	168.96	171.94	175.17	178.40
.400	173.62	161.61	162.36	163.76	165.87	168.30	170.69	173.61	176.55	179.78	183.02
.420	176.84	165.55	166.14	167.96	170.32	172.94	175.37	178.25	181.13	184.40	187.66
.440	180.01	169.74	169.95	172.15	174.81	177.59	180.05	182.87	185.71	188.98	192.28
.460	183.30	174.20	174.56	176.80	179.45	182.20	184.73	187.51	190.30	193.59	196.89
.480	185.87	178.65	179.17	181.47	184.13	186.85	189.41	192.16	194.88	198.21	201.54
.500	188.45	183.13	183.79	186.15	188.81	191.50	194.09	196.77	198.17	202.79	206.15
.520	191.68	187.59	188.43	190.83	193.49	196.14	198.77	201.42	204.04	207.44	210.80
.540	195.55	191.94	193.05	195.51	198.17	200.79	203.44	206.03	208.62	212.02	215.61
.560	199.42	196.52	197.70	200.19	202.85	205.44	208.12	210.68	213.21	216.63	220.06
.580	202.23	201.01	202.31	204.87	207.52	210.08	212.80	215.33	217.79	221.25	224.87

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					278.72	227.81	205.86	192.88	184.36	176.62	171.78
.080					179.63	174.73	169.93	164.93	160.02	157.45	154.88
.100					159.75	157.00	154.43	151.50	148.75	147.61	146.48
.120					148.48	143.75	146.21	145.07	143.94	143.88	143.82
.140		245.28	179.65	154.13	142.05	138.22	137.09	137.39	138.51	140.14	142.88
.160		198.23	156.91	142.86	138.85	135.56	137.37	139.03	140.77	141.43	142.09
.180		178.35	147.79	139.48	136.91	135.77	137.51	139.25	140.98	142.72	144.45
.200	256.13	167.83	144.95	138.79	137.16	137.78	139.16	140.89	143.49	144.72	146.06
.220	210.76	160.11	143.90	138.82	138.05	138.71	140.80	142.90	144.99	147.44	149.90
.240	195.90	156.73	144.83	140.47	139.69	140.71	143.17	145.62	148.07	150.88	153.70
.260	186.78	155.51	146.12	142.48	142.06	143.80	146.25	148.70	151.16	190.03	157.14
.280	180.53	154.64	148.13	145.56	145.50	146.52	149.33	152.14	154.96	158.12	161.29
.300	176.44	155.21	150.49	149.00	148.58	149.96	152.88	155.80	158.75	161.75	164.73
.320	175.22	156.64	152.32	151.72	152.52	154.12	156.21	159.31	162.41	165.65	168.89
.340	175.43	158.15	156.01	155.88	156.93	158.74	160.91	163.97	167.00	170.21	173.41
.360	176.36	160.51	159.74	160.04	161.42	163.40	165.61	168.60	171.59	174.79	178.04
.380	178.72	162.87	163.43	164.20	165.86	168.06	170.30	173.22	176.18	179.42	182.66
.400	180.37	166.67	167.16	168.35	170.34	172.69	175.00	177.88	180.80	184.04	187.29
.420	183.45	170.54	170.85	172.51	174.79	177.35	179.70	182.54	185.39	188.67	191.95
.440	186.46	174.70	174.57	176.67	179.27	182.01	184.39	187.17	189.98	193.26	196.57
.460	189.61	179.15	179.20	181.33	183.93	186.64	189.09	191.83	194.57	197.88	201.20
.480	191.98	183.59	183.82	186.03	188.63	191.30	193.79	196.49	199.16	202.51	205.86
.500	194.34	188.08	188.45	190.73	193.32	195.96	198.48	201.12	202.31	207.10	210.48
.520	197.42	192.52	193.11	195.42	198.02	200.62	203.18	205.78	208.34	211.76	215.14
.540	201.22	196.86	197.74	200.12	202.72	205.28	207.88	210.40	212.93	216.35	219.98
.560	205.02	201.45	202.40	204.82	207.41	209.94	212.57	215.06	217.51	220.97	224.43
.580	207.64	205.93	207.02	209.51	212.11	214.60	217.27	219.72	222.10	225.60	229.27

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					301.71	245.39	220.93	206.34	196.64	187.81	182.18
.080					192.26	186.56	180.85	175.13	169.42	166.28	163.13
.100					169.94	166.60	163.45	159.91	156.57	155.01	153.44
.120					157.09	151.58	153.96	152.39	150.83	150.44	150.06
.140		264.07	191.58	163.17	149.57	145.04	143.48	143.49	144.41	145.88	148.58
.160		211.87	166.09	150.32	145.60	141.66	143.34	144.85	146.44	146.85	147.25
.180		189.54	155.61	146.15	143.01	141.44	143.04	144.63	146.22	147.81	149.40
.200	274.97	177.52	152.04	144.95	142.83	143.20	144.40	145.99	148.53	149.53	150.72
.220	274.61	168.58	150.44	144.53	143.36	143.77	145.76	147.74	149.73	152.11	154.49
.240	207.82	164.41	151.01	145.89	144.72	145.52	147.90	150.29	152.67	155.44	158.22
.260	197.33	162.61	151.97	147.64	146.87	148.46	150.84	153.22	155.61	158.05	161.55
.280	190.01	161.21	153.72	150.58	150.20	151.00	153.78	156.56	159.33	162.53	165.67
.300	185.05	161.38	155.87	153.91	153.14	154.34	157.23	160.13	163.06	166.03	169.01
.320	183.25	162.51	157.43	156.46	157.02	158.46	160.45	163.54	166.63	169.88	173.13
.340	183.03	163.71	161.04	160.58	161.42	163.10	165.16	168.21	171.23	174.44	177.64
.360	183.60	165.86	164.69	164.70	165.90	167.77	169.88	172.85	175.82	179.03	182.28
.380	185.75	168.01	168.30	168.83	170.34	172.45	174.59	177.49	180.42	183.67	186.92
.400	187.11	171.73	171.95	172.95	174.82	177.08	179.31	182.16	185.05	188.30	191.55
.420	190.05	175.54	175.56	177.07	179.26	181.76	184.02	186.84	189.65	192.94	196.23
.440	192.91	179.66	179.20	181.19	183.73	186.43	188.73	191.47	194.25	197.54	200.86
.460	195.93	184.10	183.84	185.87	188.41	191.07	193.45	196.15	198.84	202.17	205.50
.480	198.08	188.54	188.48	190.58	193.12	195.74	198.16	200.82	203.44	206.81	210.17
.500	200.22	193.02	193.11	195.30	197.84	200.42	202.88	205.46	208.46	211.40	214.81
.520	203.16	197.46	197.79	200.01	202.55	205.09	207.59	210.13	212.63	216.08	219.48
.540	206.89	201.77	202.42	204.73	207.27	209.77	212.31	214.77	217.23	220.67	224.36
.560	210.62	206.37	207.10	209.44	211.98	214.44	217.02	219.44	221.82	225.31	228.80
.580	213.04	210.85	211.73	214.16	216.70	219.12	221.74	224.12	226.42	229.95	233.67

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060					324.70	262.98	236.00	219.80	208.93	199.01	192.58
.080					204.90	198.38	191.86	185.34	178.83	175.11	171.38
.100					180.13	176.20	172.48	168.33	164.40	162.40	160.40
.120					165.70	159.40	161.71	159.71	157.72	157.01	156.30
.140		282.87	203.49	172.21	157.08	151.86	149.86	149.59	150.31	151.62	154.28
.160		225.50	175.28	157.78	152.34	147.76	149.30	150.66	152.11	152.27	152.42
.180		200.74	163.43	152.83	149.11	147.11	148.56	150.01	151.46	152.91	154.35
.200	293.81	187.21	159.12	151.10	148.50	148.62	149.64	151.08	153.57	154.41	155.38
.220	238.47	177.05	156.97	150.23	143.67	148.83	150.71	152.59	154.47	156.77	159.08
.240	219.73	172.09	157.18	151.31	149.74	150.33	152.64	154.95	157.26	160.00	162.74
.260	207.88	169.72	157.82	152.81	151.68	153.13	155.44	157.75	160.05	206.07	165.96
.280	199.48	167.78	159.32	155.60	154.90	155.49	158.23	160.97	163.71	166.88	170.05
.300	193.66	167.56	161.26	158.83	157.70	158.72	161.59	164.45	167.37	170.32	173.28
.320	191.29	168.37	162.54	161.19	161.52	162.80	164.58	167.77	170.85	174.11	177.36
.340	190.64	169.27	166.07	165.28	165.91	167.45	169.41	172.46	175.45	178.67	181.88
.360	190.85	171.20	169.64	169.37	170.39	172.14	174.15	177.10	180.06	183.27	186.53
.380	192.79	173.14	173.17	173.45	174.82	176.83	178.88	181.75	184.66	187.92	191.17
.400	193.86	176.79	176.74	177.54	179.29	181.47	183.61	186.44	189.31	192.56	195.82
.420	196.65	180.53	180.26	181.63	183.72	186.16	188.34	191.13	193.91	197.21	200.51
.440	199.36	184.62	183.83	185.71	188.20	190.85	193.08	195.77	198.51	201.81	205.15
.460	202.24	189.05	188.48	190.40	192.89	195.50	197.81	200.46	203.12	206.46	209.80
.480	204.18	193.48	193.13	195.14	197.62	200.19	202.54	205.15	207.72	211.11	214.49
.500	206.11	197.96	197.77	199.87	202.35	204.88	207.27	209.80	210.60	215.71	219.14
.520	208.90	202.39	202.46	204.60	207.08	209.57	212.01	214.49	216.93	220.40	223.83
.540	212.56	206.69	207.11	209.33	211.82	214.26	216.74	219.14	221.53	225.00	228.73
.560	216.22	211.29	211.80	214.07	216.55	218.95	221.47	223.83	226.13	229.65	233.16
.580	218.45	215.77	216.44	218.80	221.28	223.64	226.20	228.51	230.74	234.30	238.07

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			230.75	202.07	189.80	183.14	179.74	177.35	176.50	175.60	176.07
.180			209.48	190.66	182.21	178.30	175.91	174.28	172.14	173.04	175.12
.200		232.57	198.83	184.82	178.13	175.49	174.11	172.73	172.62	172.75	174.91
.220		214.33	193.24	181.24	175.31	173.94	173.06	172.19	172.84	173.23	175.64
.240	328.35	204.19	189.16	179.69	173.54	173.40	172.53	172.66	174.02	174.96	177.00
.260	267.29	198.26	186.60	178.65	173.48	173.11	173.25	173.89	175.55	176.70	179.36
.280	236.34	195.02	185.30	178.61	174.20	174.09	174.23	175.63	177.54	179.19	181.86
.300	222.91	192.46	184.51	179.09	175.43	175.57	176.22	177.87	180.03	181.94	184.61
.320	213.24	191.41	184.98	180.06	178.38	177.31	177.95	180.11	182.78	185.45	188.77
.340	207.42	191.38	185.20	181.55	179.41	180.06	181.21	183.37	186.03	188.70	191.11
.360	204.35	190.84	186.18	183.54	181.91	182.80	185.22	186.62	189.54	192.46	194.62
.380	202.68	192.73	188.17	186.03	185.62	186.31	188.47	191.14	193.80	196.72	197.70
.400	203.78	193.81	189.90	188.78	188.92	189.31	192.48	194.14	196.81	199.98	201.88
.420	204.25	195.80	192.65	191.78	192.43	193.32	194.73	198.15	200.82	203.99	206.15
.440	205.74	198.29	195.15	195.03	196.18	197.08	198.99	202.16	204.83	208.00	210.67
.460	207.73	200.79	198.15	198.79	200.20	201.09	202.88	206.05	209.09	212.39	214.93
.480	210.22	203.79	201.65	202.55	203.95	205.36	207.27	210.44	213.36	216.53	219.45
.500	214.44	206.89	205.41	206.31	208.02	209.87	212.04	214.96	217.87	220.79	223.94
.520	215.21	209.79	208.92	210.32	211.98	213.89	216.30	219.47	222.39	225.31	228.48
.540	218.21	211.78	212.68	214.33	216.24	218.40	220.82	223.99	226.91	229.58	233.00
.560	220.71	215.79	216.69	218.35	220.51	222.67	225.34	228.51	231.43	234.35	237.52
.580	224.72	220.05	220.95	222.61	225.02	227.19	229.85	233.02	235.94	238.86	242.03
.600	228.25	224.93	225.22	227.13	230.02	231.70	234.62	237.54	240.46	243.38	246.53

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			244.45	212.87	195.20	191.64	187.64	184.75	183.53	182.27	182.49
.180			220.84	200.02	190.50	185.95	183.06	180.99	178.37	179.06	181.05
.200		245.90	208.81	193.23	185.64	182.47	180.68	178.89	178.48	178.34	180.41
.220		225.60	202.29	188.92	182.16	180.37	179.13	177.89	178.31	178.44	180.79
.240	349.86	214.12	197.43	186.82	179.81	179.37	178.13	178.00	179.18	179.93	181.86
.260	282.84	207.24	194.23	185.27	179.34	178.65	178.51	178.93	180.44	181.41	184.03
.280	248.66	203.29	192.40	184.82	179.72	179.31	179.17	180.41	182.20	183.72	186.34
.300	233.60	200.09	191.13	184.92	180.65	180.51	180.93	182.45	184.52	186.31	188.93
.320	222.64	198.54	191.23	185.58	183.46	182.00	182.41	184.48	187.10	189.72	193.06
.340	215.88	198.09	191.06	186.79	184.17	184.58	185.55	187.62	190.24	192.86	195.20
.360	212.12	197.09	191.72	188.55	186.48	187.17	189.52	190.76	193.65	196.55	198.62
.380	209.98	198.74	193.48	190.86	190.12	190.59	192.65	195.28	197.90	200.79	201.56
.400	210.68	199.51	194.96	193.45	193.31	193.45	196.62	198.14	200.76	203.93	205.72
.420	210.78	201.27	197.55	196.31	196.72	197.41	198.66	202.10	204.72	207.90	209.96
.440	211.99	203.58	199.86	199.45	200.41	201.10	202.90	206.07	208.69	211.86	214.48
.460	213.75	205.89	202.72	203.14	204.38	205.07	206.72	209.90	212.93	216.24	218.72
.480	216.06	208.75	206.13	206.83	203.07	209.31	211.10	214.28	217.17	220.34	223.24
.500	220.25	211.73	209.82	210.52	212.09	213.83	215.90	218.79	221.69	224.59	227.73
.520	220.68	214.48	213.24	214.48	215.00	217.79	220.14	223.31	226.21	229.10	232.27
.540	223.54	216.24	216.93	218.45	220.24	222.31	224.66	227.83	230.72	233.34	236.79
.560	225.85	220.20	220.89	222.41	224.48	226.55	229.17	232.35	235.24	238.14	241.31
.580	229.82	224.44	225.14	226.65	229.00	231.07	233.69	236.86	239.76	242.65	245.83
.600	233.26	229.35	229.38	231.17	234.04	235.59	238.48	241.38	244.28	247.17	250.32

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			258.15	223.68	208.59	200.14	195.55	192.15	190.57	188.93	188.91
.180			232.19	209.37	198.80	193.61	190.21	187.70	184.60	185.08	186.97
.200		259.23	218.78	201.64	193.16	189.46	187.25	185.05	184.34	183.92	185.90
.220		236.86	211.35	196.59	189.01	186.81	185.20	183.59	183.78	183.66	185.94
.240	371.36	224.05	205.71	193.94	186.09	185.35	183.74	183.33	184.35	184.89	186.72
.260	298.38	216.22	201.86	191.89	185.20	184.19	183.78	183.96	185.34	186.12	188.70
.280	260.98	211.57	199.50	191.03	185.23	184.52	184.11	185.19	186.87	188.25	190.82
.300	244.28	207.72	197.75	190.76	185.87	185.46	185.64	187.02	189.00	190.67	193.25
.320	232.04	205.66	197.48	191.10	188.53	186.69	186.87	188.85	191.42	194.00	197.35
.340	224.34	204.80	196.92	192.03	188.93	189.11	189.89	191.87	194.45	197.02	199.30
.360	219.89	203.34	197.26	193.56	191.05	191.54	193.81	194.90	197.77	200.64	202.62
.380	217.09	204.75	198.79	195.68	194.62	194.86	196.84	199.41	201.99	204.86	205.43
.400	217.57	205.21	200.02	198.11	197.70	197.58	200.76	202.14	204.71	207.88	209.56
.420	217.31	206.74	202.44	200.84	201.02	201.50	202.59	206.06	208.63	211.80	213.78
.440	218.24	208.87	204.57	203.86	204.64	205.13	206.80	209.98	212.55	215.72	218.30
.460	219.77	210.99	207.29	207.48	208.56	209.05	210.57	213.75	216.77	220.09	222.51
.480	221.90	213.72	210.62	211.10	212.18	213.26	214.94	218.11	220.99	224.16	227.03
.500	226.06	216.56	214.24	214.72	216.16	217.78	219.76	222.63	225.50	228.38	231.52
.520	226.15	219.17	217.56	218.64	220.02	221.70	223.98	227.15	230.02	232.90	236.07
.540	228.88	220.70	221.18	222.56	224.24	226.22	228.49	231.67	234.54	237.11	240.58
.560	231.00	224.52	225.10	226.48	228.46	230.44	233.01	236.18	239.06	241.93	245.10
.580	234.92	228.33	229.32	230.70	232.98	234.95	237.53	240.70	243.57	246.45	249.62
.600	238.27	233.77	233.54	235.22	238.06	239.47	242.34	245.22	248.09	250.96	254.11

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			271.35	234.48	217.99	208.65	203.46	199.55	197.60	195.60	195.32
.180			243.54	218.72	207.10	201.26	197.35	194.41	190.83	191.10	192.89
.200		272.56	228.76	210.05	200.67	196.45	193.83	191.21	190.20	189.51	191.39
.220		248.12	220.40	204.27	195.86	193.24	191.27	189.29	189.24	188.88	191.08
.240	192.87	233.97	213.98	201.07	192.37	191.32	189.35	188.66	189.51	189.86	191.58
.260	313.92	225.20	209.49	198.50	191.06	189.73	189.04	188.99	190.24	190.83	193.36
.280	273.30	219.84	206.51	197.23	190.75	189.74	189.05	189.97	191.54	192.78	195.30
.300	254.97	215.35	204.37	196.60	191.09	190.40	190.35	191.59	193.48	195.04	197.57
.320	241.44	212.79	203.74	196.61	193.61	191.37	191.33	193.21	195.74	198.27	201.64
.340	232.79	211.51	202.78	197.27	193.68	193.64	194.24	196.12	198.65	201.18	203.39
.360	227.66	209.60	202.80	198.57	195.63	195.90	198.11	199.03	201.88	204.73	206.62
.380	224.29	210.77	204.09	200.51	199.12	199.13	201.02	203.55	206.08	208.93	209.30
.400	224.47	210.91	205.07	202.78	202.09	201.72	204.89	206.14	208.66	211.84	213.40
.420	223.84	212.21	207.34	205.36	205.32	205.60	206.52	210.01	212.54	215.71	217.59
.440	224.49	214.15	209.28	208.27	208.87	209.15	210.71	213.88	216.41	219.58	222.11
.460	225.79	216.09	211.87	211.82	212.74	213.02	214.42	217.60	220.61	223.94	226.31
.480	227.73	218.68	215.10	215.38	216.30	217.22	218.78	221.95	224.80	227.97	230.82
.500	231.87	221.40	218.65	218.93	220.23	221.73	223.62	226.47	229.32	232.17	235.31
.520	231.62	223.85	221.88	222.80	224.04	225.61	227.81	230.99	233.84	236.69	239.86
.540	234.21	225.15	225.43	226.67	228.24	230.12	232.33	235.50	238.35	240.88	244.38
.560	236.15	229.03	229.31	230.55	232.43	234.32	236.85	240.02	242.87	245.72	248.89
.580	240.02	233.22	233.50	234.74	236.95	238.84	241.37	244.54	247.39	250.24	253.41
.600	243.29	238.19	237.70	239.26	242.08	243.35	246.21	249.06	251.91	254.76	257.90

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160			299.24	256.08	236.79	225.66	219.27	214.35	211.67	208.93	208.16
.180			266.25	237.43	223.69	216.57	211.65	207.83	203.28	203.15	204.74
.200		299.22	248.71	226.87	215.71	210.42	206.97	203.53	201.92	200.68	202.38
.220		270.64	238.51	219.62	209.56	206.11	203.40	200.69	200.18	199.31	201.38
.240	435.88	253.83	230.53	215.32	204.92	203.27	200.56	199.32	199.85	199.78	201.30
.260	345.01	243.16	224.75	211.74	202.78	200.81	199.57	199.06	200.03	200.26	202.69
.280	297.93	236.39	220.81	209.64	201.78	200.17	198.93	199.53	200.87	201.83	204.27
.300	276.34	230.61	217.60	208.27	201.52	200.28	199.77	200.74	202.44	203.77	206.21
.320	260.23	227.04	216.24	207.64	203.76	200.75	200.25	201.95	204.38	206.82	210.21
.340	249.71	224.94	214.50	207.75	203.20	202.69	202.93	204.63	207.06	209.50	211.57
.360	243.19	222.10	213.87	208.59	204.77	204.64	206.71	207.31	210.11	212.91	214.61
.380	238.70	222.79	214.71	210.16	208.12	207.68	209.39	211.82	214.26	217.06	217.04
.400	238.26	222.31	215.19	212.11	210.87	210.00	213.17	214.13	216.57	219.74	221.07
.420	236.89	223.15	217.13	214.42	213.91	213.78	214.38	217.92	220.35	223.52	225.22
.440	236.99	224.72	218.70	217.10	217.33	217.19	218.53	221.70	224.13	227.31	229.74
.460	237.83	226.30	221.01	220.51	221.11	220.97	222.12	225.30	228.28	231.64	233.89
.480	239.41	228.61	224.05	223.92	224.52	225.12	226.46	229.63	232.43	235.60	238.41
.500	243.49	231.07	227.48	227.34	228.38	229.64	231.34	234.15	236.95	239.75	242.89
.520	242.56	233.23	230.52	231.12	232.09	233.42	235.49	238.66	241.47	244.27	247.44
.540	244.87	234.07	233.94	234.90	236.24	237.94	240.01	243.18	245.98	248.42	251.96
.560	246.45	237.85	237.72	238.68	240.39	242.09	244.53	247.70	250.50	253.31	256.48
.580	250.23	242.00	241.87	242.83	244.90	246.61	249.04	252.22	255.02	257.82	260.99
.600	253.31	247.04	246.02	247.35	250.12	251.12	253.93	256.73	259.54	262.34	265.48

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	400.47	403.64	320.21	294.08	278.32	267.14	257.49	254.55	250.83	248.84	247.42	246.95	246.88	248.96
.280	404.98	408.16	303.03	281.24	271.35	257.88	253.74	250.45	247.31	248.19	247.92	247.07	248.24	249.40
.300	409.50	316.28	289.58	273.70	265.11	252.21	251.23	247.65	245.52	245.82	246.12	248.15	249.31	250.47
.320	414.02	303.01	280.35	268.75	266.61	249.99	249.72	246.15	244.30	245.46	247.34	249.22	247.23	250.97
.340	418.54	297.19	274.83	265.38	257.79	249.05	248.21	245.64	244.51	245.67	247.98	250.30	251.46	252.62
.360	323.79	288.08	270.74	262.72	255.42	248.69	247.85	246.14	245.30	246.75	249.49	252.23	253.25	254.27
.380	312.81	282.70	268.22	260.64	253.91	249.05	247.92	247.79	246.37	248.39	251.42	254.45	255.47	256.49
.400	304.53	279.75	266.28	259.70	253.69	249.40	246.95	247.71	248.02	249.47	251.49	253.52	256.40	259.23
.420	295.45	276.78	265.49	259.20	254.62	250.48	250.06	251.66	250.24	252.26	254.86	257.46	259.77	262.08
.440	289.63	274.76	264.56	259.26	255.55	251.84	252.00	253.88	253.03	255.35	258.37	261.40	263.43	265.45
.460	284.97	273.65	264.20	260.05	255.62	253.63	254.22	256.67	255.83	258.43	261.60	264.77	266.51	268.25
.480	282.02	273.43	264.01	260.84	257.84	255.96	256.73	259.47	259.20	261.80	264.83	267.85	270.02	272.19
.500	281.95	273.70	264.48	261.94	259.63	257.84	259.81	262.70	263.14	265.17	268.20	271.22	273.10	275.56
.520	279.92	274.43	265.21	263.27	261.85	261.58	263.29	264.49	266.80	269.68	271.71	275.17	277.25	278.93
.540	281.23	275.73	267.06	264.92	264.22	264.95	265.97	269.00	270.45	272.77	275.80	278.82	281.13	283.45
.560	282.30	277.29	269.28	267.14	267.16	268.32	269.34	272.95	273.82	276.42	279.59	282.77	285.22	287.39
.580	284.66	279.09	272.07	269.94	270.24	271.69	273.00	276.60	277.77	279.79	283.39	287.00	289.16	291.33
.600	286.74	281.08	274.72	273.02	273.90	275.35	276.94	280.26	282.28	284.31	287.77	291.23	293.54	295.85
.620	288.96	283.39	277.81	276.39	277.55	279.44	281.03	284.49	286.23	288.63	291.74	294.88	297.63	300.37
.640	291.76	281.07	280.75	280.05	281.35	283.24	285.40	288.43	290.00	292.94	296.17	299.40	302.14	304.88
.660	295.04	288.55	284.95	283.56	285.44	287.47	289.81	292.00	294.69	297.29	300.17	303.06	306.23	309.40
.680	297.21	291.34	287.92	287.64	289.93	291.95	294.01	296.89	298.63	301.60	304.57	307.57	310.60	313.63
.700	299.57	294.28	291.57	291.73	294.33	296.07	298.52	301.41	303.01	305.75	308.98	312.09	315.12	318.15
.720	302.37	297.51	295.66	295.56	298.42	300.16	303.04	305.93	307.09	310.26	313.44	316.61	319.49	322.38
.740	305.16	300.90	299.74	300.36	302.65	304.64	307.56	310.45	311.61	314.81	318.04	321.13	324.16	327.18
.760	307.96	304.53	304.23	304.85	306.91	309.05	312.08	314.96	316.13	319.33	322.53	325.64	328.82	331.99
.780	311.33	308.48	308.72	309.37	311.40	313.42	316.59	319.48	320.64	323.82	327.02	330.16	333.33	336.50
.800	314.24	312.13	312.55	313.89	315.91	317.94	321.14	321.96	325.16	328.33	331.51	334.22	337.85	341.31

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	429.16	432.33	340.24	311.18	293.52	280.91	269.98	266.43	262.02	259.51	257.64	256.80	256.40	258.38
.280	433.68	436.85	320.89	296.60	285.42	270.28	265.40	261.47	257.70	258.35	257.73	256.49	257.45	259.41
.300	438.19	335.34	305.65	287.86	278.09	263.59	262.19	257.94	255.27	255.29	255.31	257.22	258.18	259.14
.320	442.71	320.28	295.05	281.96	279.30	260.69	260.08	255.83	253.48	254.44	256.19	257.95	255.44	259.24
.340	447.23	313.44	288.52	277.80	269.14	259.21	257.96	254.82	253.26	254.22	256.45	258.67	259.64	260.60
.360	342.56	302.96	283.56	274.43	266.08	258.36	257.11	254.92	253.67	254.95	257.65	260.35	261.16	261.96
.380	330.03	296.59	280.35	271.68	263.97	258.30	256.74	256.28	254.40	256.31	259.33	262.34	263.15	263.95
.400	320.47	292.90	277.76	270.20	263.28	258.24	255.23	255.75	255.76	257.04	258.95	260.86	263.72	266.51
.420	310.02	289.18	276.44	269.20	263.85	258.97	258.20	259.63	257.76	259.67	262.21	264.75	266.97	269.20
.440	303.18	286.50	274.96	268.82	264.42	260.02	259.87	261.63	260.38	262.61	265.62	268.63	270.54	272.45
.460	297.59	284.83	274.11	269.23	265.15	261.53	261.87	264.25	263.00	265.54	268.72	271.89	273.48	275.08
.480	293.90	284.13	273.45	269.65	266.03	263.65	264.17	266.87	266.26	268.80	271.81	274.83	276.90	278.96
.500	293.37	283.98	273.52	270.41	267.55	265.27	267.11	269.97	270.14	272.05	275.07	278.08	279.83	282.22
.520	290.69	284.33	273.87	271.42	269.55	268.93	270.49	271.49	273.71	276.57	278.48	281.97	283.94	285.47
.540	291.67	285.31	275.45	272.78	271.69	272.18	272.99	276.01	277.28	279.51	282.52	285.54	287.76	289.99
.560	292.40	286.58	277.44	274.77	274.48	275.44	276.25	279.89	280.54	283.08	286.25	289.42	291.81	293.87
.580	294.55	288.10	280.06	277.40	277.41	278.69	279.82	283.46	284.42	286.33	289.98	293.63	295.69	297.76
.600	296.38	289.84	282.53	280.34	280.99	282.26	283.70	287.03	288.94	290.85	294.34	297.83	300.05	302.28
.620	298.38	291.92	285.47	283.59	284.56	286.31	287.75	291.23	292.83	295.15	298.26	301.40	304.10	306.79
.640	301.00	288.93	288.25	287.16	288.28	290.04	292.10	295.12	296.52	299.44	302.68	305.92	308.61	311.31
.660	304.16	296.70	292.42	290.57	292.33	294.24	296.50	298.59	301.23	303.77	306.63	309.49	312.66	315.83
.680	306.09	299.32	295.23	294.62	296.81	298.72	300.67	303.52	305.12	308.07	311.02	314.00	317.02	320.03
.700	308.24	302.10	298.80	298.66	301.20	302.80	305.18	308.04	309.48	312.18	315.41	318.52	321.53	324.55
.720	310.86	305.20	302.85	302.86	305.25	306.84	309.70	312.56	313.52	316.69	319.87	323.04	325.89	328.75
.740	313.48	308.48	306.89	307.25	309.45	311.33	314.22	317.07	318.04	321.24	324.48	327.55	330.57	333.58
.760	316.11	312.02	311.38	311.74	313.68	315.72	318.73	321.59	322.55	325.76	328.96	332.07	335.24	338.42
.780	319.36	315.91	315.86	316.26	318.17	320.08	323.25	326.11	327.07	330.24	333.45	336.59	339.76	342.93
.800	322.11	319.48	319.62	320.77	322.69	324.60	327.80	328.39	331.59	334.76	337.93	340.60	344.28	347.77

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	457.85	461.03	360.27	328.29	308.73	294.69	282.47	278.31	273.22	270.19	267.85	266.65	265.93	267.79
.280	462.37	465.54	338.76	311.97	299.48	282.68	277.07	272.49	268.09	268.51	267.55	265.90	266.66	267.42
.300	466.89	354.39	321.72	302.03	291.08	274.97	273.15	268.23	265.03	264.76	264.49	266.28	267.05	267.81
.320	471.41	337.56	309.74	295.18	291.98	271.39	270.44	265.52	262.66	263.42	265.05	266.67	263.64	267.50
.340	475.92	329.68	302.20	290.23	280.49	269.37	267.72	264.01	262.01	262.78	264.91	267.05	267.82	268.58
.360	361.33	317.84	296.39	286.13	276.74	268.03	266.38	263.70	262.05	263.16	265.82	268.47	269.06	259.65
.380	347.25	310.48	292.47	282.73	274.02	267.56	265.56	264.78	262.44	264.23	267.23	270.23	270.82	271.41
.400	336.41	306.04	289.24	280.71	272.86	267.08	263.50	263.78	263.51	264.62	266.41	268.21	271.04	273.80
.420	324.60	301.57	287.39	279.20	273.07	267.46	266.33	267.61	265.28	267.07	269.55	272.04	274.18	276.31
.440	316.72	298.24	285.36	278.38	273.29	268.19	267.75	269.37	267.73	269.87	272.87	275.87	277.66	279.45
.460	310.22	296.00	284.02	278.42	273.67	269.44	269.51	271.83	270.18	272.66	275.83	279.01	280.46	281.91
.480	305.78	294.84	282.89	278.46	274.23	271.34	271.62	274.28	273.32	275.80	278.80	281.80	283.77	285.73
.500	304.79	294.26	282.56	278.88	275.47	272.69	274.42	277.24	277.15	278.94	281.94	284.94	286.56	288.87
.520	301.46	294.23	282.53	279.57	277.24	276.28	277.69	278.49	280.63	283.46	285.25	288.77	290.63	292.01
.540	302.12	294.89	283.84	280.65	279.17	279.42	280.01	283.01	284.11	286.25	289.25	292.25	294.39	296.53
.560	302.50	295.86	285.61	282.41	261.79	282.56	283.15	286.84	287.25	289.74	292.91	296.08	298.39	300.36
.580	304.44	297.11	288.06	284.86	284.59	285.70	286.63	290.32	291.08	292.88	296.57	300.25	302.22	304.19
.600	306.03	298.59	290.34	287.65	288.07	289.18	290.46	293.80	295.60	297.39	300.91	304.43	306.57	308.71
.620	307.79	300.46	293.13	290.79	291.56	293.18	294.46	297.98	299.43	301.67	304.77	307.91	310.57	313.22
.640	310.24	296.78	295.75	294.28	295.21	296.84	298.80	301.81	303.05	305.95	309.19	312.43	315.08	317.74
.660	313.28	304.85	299.89	297.59	299.21	301.01	303.18	305.19	307.77	310.26	313.09	315.91	319.09	322.26
.680	314.97	307.30	302.55	301.59	303.70	305.49	307.32	310.15	311.60	314.53	317.47	320.43	323.43	326.43
.700	316.90	309.92	306.03	305.59	308.08	309.53	311.84	314.67	315.95	318.60	321.84	324.95	327.95	330.95
.720	319.36	312.89	310.04	309.76	312.08	313.53	316.36	319.19	319.95	323.12	326.29	329.47	332.29	335.12
.740	321.81	316.06	314.04	314.14	316.25	318.01	320.87	323.70	324.47	327.67	330.91	333.98	336.98	339.98
.760	324.26	319.51	318.52	318.63	320.46	322.39	325.39	328.22	328.98	332.19	335.40	338.50	341.67	344.84
.780	327.40	323.34	323.00	323.14	324.94	326.74	329.91	332.74	333.50	336.67	339.88	343.02	346.19	349.36
.800	329.99	326.82	326.69	327.66	329.46	331.25	334.46	334.81	338.02	341.19	344.36	346.98	350.71	354.22

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260	486.55	489.72	380.31	345.39	323.94	308.46	294.96	290.19	284.41	280.86	278.07	276.50	275.46	277.21
.280	491.06	494.24	356.62	327.34	313.54	295.07	288.73	283.51	278.48	278.67	277.36	275.31	275.87	276.43
.300	495.58	373.45	337.78	316.19	304.07	286.35	284.11	278.52	274.79	274.23	273.67	275.35	275.91	276.47
.320	500.10	354.83	324.43	308.39	304.67	282.10	280.79	275.20	271.84	272.41	273.90	275.39	271.85	275.77
.340	504.62	345.92	315.89	302.65	291.84	279.53	277.48	273.19	270.77	271.33	273.38	275.43	275.99	276.55
.360	380.09	332.72	309.22	297.84	287.40	277.70	275.65	272.48	270.43	271.37	273.98	276.59	276.97	277.34
.380	364.47	324.37	304.60	293.78	284.08	276.81	274.39	273.27	270.47	272.15	275.14	278.13	278.50	278.87
.400	352.34	319.18	300.72	291.21	282.44	275.92	271.78	271.82	271.26	272.19	273.88	275.56	278.35	281.08
.420	339.18	313.96	298.33	289.20	282.30	275.96	274.47	275.59	272.79	274.47	276.90	279.33	281.38	283.43
.440	330.27	309.97	295.76	287.93	282.15	276.37	275.63	277.12	275.07	277.13	280.11	283.10	284.78	286.46
.460	322.85	307.18	293.94	287.60	282.19	277.35	277.16	279.40	277.35	279.78	282.95	286.12	287.43	298.74
.480	317.66	305.54	292.34	287.27	282.42	279.03	279.07	281.68	280.38	282.80	285.79	288.77	290.64	292.51
.500	316.21	304.54	291.60	287.35	283.39	280.11	281.72	284.52	284.15	285.83	288.81	291.80	293.29	295.53
.520	312.22	304.13	291.19	287.72	284.93	283.62	284.89	285.49	287.55	290.35	292.03	295.57	297.32	298.56
.540	312.56	304.47	292.24	288.51	286.65	286.65	287.02	290.01	290.94	293.00	295.98	298.97	301.02	303.07
.560	312.60	305.14	293.77	290.04	289.11	289.67	290.05	293.78	293.97	296.40	299.57	302.74	304.98	306.85
.580	314.32	306.12	296.05	292.32	291.76	292.70	293.45	297.18	297.74	299.42	303.15	306.88	308.75	310.62
.600	315.67	307.35	298.14	294.97	295.16	296.10	297.22	300.58	302.26	303.94	307.48	311.03	313.08	315.13
.620	317.20	309.00	300.79	298.00	298.56	300.05	301.17	304.72	306.03	308.19	311.29	314.43	317.04	319.65
.640	319.48	304.64	303.26	301.40	302.14	303.64	305.51	308.49	309.58	312.45	315.70	318.94	321.56	324.17
.660	322.39	313.00	307.36	304.61	306.10	307.78	309.87	311.78	314.32	316.74	319.54	322.34	325.51	328.69
.680	323.85	315.27	309.87	308.56	310.58	312.26	313.98	316.78	318.09	321.00	323.91	326.86	329.84	332.83
.700	325.57	317.74	313.27	312.52	314.95	316.26	318.50	321.30	322.42	325.03	328.28	331.38	334.36	337.35
.720	327.85	320.58	317.22	316.67	318.91	320.22	323.01	325.82	326.38	329.55	332.72	335.89	338.69	341.49
.740	330.13	323.64	321.18	321.03	323.05	324.69	327.53	330.33	330.89	334.10	337.35	340.41	343.40	346.38
.760	332.41	327.00	325.66	325.51	327.23	329.06	332.05	334.85	335.41	338.62	341.83	344.93	348.10	351.27
.780	335.43	330.77	330.14	330.03	331.71	333.39	336.57	339.37	339.93	343.10	346.31	349.45	352.62	355.79
.800	337.86	334.17	333.76	334.55	336.23	337.91	341.12	341.24	344.45	347.62	350.79	353.37	357.13	350.68

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	376.14	335.02	316.36	304.77	297.03	291.47	289.25	286.01	285.59	287.22	287.82	288.56	290.32	292.46
.420	365.25	331.83	314.46	303.51	295.41	291.88	289.92	287.19	287.28	289.17	289.77	291.15	292.27	294.41
.440	355.64	328.90	313.33	302.89	296.44	292.55	290.58	288.62	289.23	290.47	291.72	293.35	294.86	297.39
.460	348.60	326.10	312.45	302.79	296.72	293.21	291.25	290.31	291.18	292.81	294.18	295.56	297.19	299.46
.480	344.34	324.20	311.33	303.58	297.77	294.52	292.84	292.52	293.64	295.01	296.90	298.15	300.04	302.42
.500	339.02	322.55	310.70	303.35	298.30	296.08	294.64	294.47	295.33	296.96	298.85	300.74	302.89	305.03
.520	336.48	321.55	310.08	306.20	299.48	297.78	296.84	297.06	298.05	299.68	301.83	303.59	305.86	307.88
.540	335.22	320.41	309.72	304.68	300.92	299.73	299.30	299.91	301.03	302.66	307.37	306.69	309.10	310.99
.560	333.96	320.44	310.13	305.86	302.61	302.32	302.28	302.63	304.26	305.89	308.04	309.54	312.33	314.35
.580	333.34	320.46	310.80	307.55	304.94	305.68	305.00	305.86	307.49	309.25	311.53	313.42	316.13	317.58
.600	333.36	321.77	311.85	308.86	307.02	307.37	308.34	308.84	310.47	312.62	315.02	318.04	320.65	322.48
.620	332.74	321.79	314.18	310.68	309.49	309.83	310.95	312.07	314.47	316.36	318.51	320.14	323.31	325.07
.640	332.76	323.10	316.13	313.14	312.08	312.68	314.44	315.56	318.48	319.85	322.26	323.76	327.19	328.69
.660	333.43	324.41	318.34	315.60	314.92	315.79	317.93	318.80	322.23	323.86	326.00	327.89	331.06	332.95
.680	334.74	326.36	320.80	318.58	318.16	319.15	321.68	322.29	326.10	327.60	329.88	331.64	335.07	337.34
.700	335.40	328.31	323.78	321.56	321.39	322.77	325.17	326.29	329.98	331.86	333.75	335.64	339.07	341.60
.720	337.33	330.90	327.19	326.33	326.94	328.05	329.30	331.58	333.98	335.87	338.78	341.44	343.59	346.22
.740	338.02	332.72	329.47	328.28	329.14	330.77	332.66	334.55	337.73	339.87	342.15	344.42	347.59	349.74
.760	340.22	335.44	332.96	332.03	332.89	334.65	336.41	338.56	342.24	344.13	346.28	348.68	351.34	354.26
.780	342.56	339.57	336.07	335.77	336.89	338.27	340.41	342.82	346.50	348.65	350.54	352.94	355.60	358.75
.800	345.15	341.90	339.43	339.78	341.15	342.02	344.80	347.08	350.64	352.91	355.06	357.20	359.60	362.78
.820	348.38	345.14	342.66	344.04	345.41	346.28	349.19	351.34	354.77	357.43	359.57	361.72	363.99	367.81
.840	352.21	348.37	347.67	348.30	349.55	351.31	353.81	355.86	359.26	361.82	363.58	366.24	369.31	372.48

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	396.50	351.16	330.43	317.43	308.65	302.26	299.53	295.67	294.90	296.39	296.75	297.25	298.88	300.92
.420	384.14	347.24	327.91	315.62	307.54	302.28	299.82	296.53	296.33	298.09	298.45	299.66	300.58	302.63
.440	373.19	343.60	326.24	314.51	307.14	302.57	300.12	297.67	298.03	299.09	300.16	301.64	302.99	305.46
.460	365.05	340.10	324.95	313.96	307.01	302.87	300.42	299.09	299.74	301.22	302.43	303.63	305.11	307.30
.480	359.95	337.59	323.74	314.40	307.73	303.87	301.73	301.08	302.00	303.21	304.97	306.04	307.80	310.10
.500	353.70	335.35	322.07	313.72	307.89	305.16	303.27	302.78	303.43	304.91	306.68	308.45	310.49	312.54
.520	350.48	333.82	320.97	316.41	308.75	306.58	305.25	305.19	305.98	307.46	309.51	311.13	313.32	315.23
.540	348.67	332.15	320.14	314.31	309.89	308.29	307.52	307.88	308.80	310.29	315.15	314.10	316.43	318.20
.560	346.86	331.75	320.16	315.17	311.32	310.69	310.35	310.43	311.92	313.40	315.45	316.79	319.54	321.45
.580	345.75	331.34	320.46	316.60	313.44	313.94	312.90	313.54	315.03	316.65	318.84	320.61	323.27	324.56
.600	345.34	332.35	321.88	317.60	315.29	315.37	316.12	316.37	317.86	319.90	322.23	325.24	327.79	329.50
.620	344.24	331.94	323.30	319.16	317.56	317.64	318.56	319.48	321.81	323.58	325.63	327.11	330.28	331.91
.640	343.83	332.94	325.51	321.43	319.96	320.32	321.95	322.87	325.77	325.97	329.30	330.64	334.10	335.44
.660	344.13	333.94	326.59	323.70	322.65	323.30	325.34	325.99	329.44	330.93	332.97	334.74	337.91	339.68
.680	345.13	335.65	329.26	326.53	325.76	326.55	329.02	329.38	333.25	334.50	336.79	338.41	341.87	344.05
.700	345.43	337.35	332.09	329.36	328.88	330.08	332.41	333.33	337.07	338.33	340.60	342.37	345.82	348.29
.720	347.11	339.76	335.40	334.16	334.52	335.44	336.50	338.69	341.02	342.79	345.68	348.29	350.34	352.92
.740	347.43	341.33	337.47	335.86	336.50	337.99	339.76	341.52	344.70	346.74	348.93	351.12	354.29	356.34
.760	349.42	343.87	340.86	339.53	340.18	341.80	343.43	345.48	349.21	350.98	353.03	355.36	357.97	360.86
.780	351.55	347.97	343.83	343.21	344.13	345.34	347.38	349.71	353.45	355.50	357.26	359.59	362.20	365.35
.800	353.95	350.10	347.08	347.16	348.37	349.01	351.76	353.95	357.55	359.73	361.78	363.83	366.16	369.33
.820	357.06	353.21	350.19	351.40	352.60	353.25	356.14	358.19	361.64	364.25	366.30	368.35	370.53	374.41
.840	360.82	356.32	355.25	355.64	356.70	358.33	360.77	362.70	366.13	368.63	370.25	372.86	375.92	379.10

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	416.86	367.30	344.49	330.08	320.26	313.04	309.80	305.33	304.22	305.56	305.68	305.94	307.44	309.38
.420	403.03	362.64	341.36	327.72	318.67	312.67	309.73	305.87	305.38	307.02	307.14	308.17	308.90	310.84
.440	390.74	358.30	339.15	326.13	317.83	312.60	309.66	306.72	306.84	307.72	308.60	309.93	311.12	313.53
.460	381.50	354.10	337.25	325.14	317.31	312.53	309.59	307.87	308.30	309.63	310.67	311.70	313.04	315.14
.480	375.56	350.98	335.65	325.22	317.70	313.23	310.62	309.64	310.37	311.40	313.04	313.92	315.57	317.79
.500	368.37	348.16	333.45	324.09	317.48	314.23	311.90	311.10	311.52	312.86	314.50	316.15	318.10	320.05
.520	364.48	346.10	331.85	326.62	318.02	315.39	313.67	313.32	313.90	315.24	317.19	318.68	320.78	322.58
.540	362.12	343.89	330.56	323.95	318.87	316.85	315.74	315.85	316.58	317.92	322.93	321.52	323.77	325.41
.560	359.76	343.06	330.18	324.49	320.02	319.07	318.42	318.23	319.57	320.91	322.86	324.05	326.76	328.56
.580	358.16	342.23	330.12	325.65	321.94	322.21	320.80	321.22	322.56	324.05	326.15	327.80	330.42	331.54
.600	357.33	342.92	330.51	326.34	323.56	323.37	323.91	323.90	325.24	327.19	329.45	332.44	334.94	336.52
.620	355.73	342.09	332.42	327.65	325.63	325.44	326.17	326.89	329.15	330.79	332.74	334.08	337.25	338.74
.640	354.90	342.79	333.39	329.72	327.85	327.97	329.46	330.19	333.05	334.09	336.34	337.53	341.01	342.19
.660	354.83	343.48	335.65	331.79	330.38	330.80	332.75	333.18	336.65	337.99	339.94	341.59	344.76	346.40
.680	355.53	344.94	337.72	334.48	333.37	333.94	336.35	336.47	340.41	341.59	343.70	345.19	348.67	350.77
.700	355.46	346.40	340.41	337.16	336.36	337.39	339.65	340.38	344.16	345.80	347.45	349.09	352.57	354.98
.720	356.89	348.63	343.61	341.98	342.10	342.83	343.71	345.81	348.07	349.71	352.58	355.14	357.09	359.62
.740	356.85	349.93	345.47	343.44	343.86	345.20	346.85	348.49	351.67	353.62	355.72	357.82	360.99	362.94
.760	358.61	352.31	348.76	347.04	347.47	348.96	350.45	352.40	356.18	357.83	359.78	362.03	364.59	367.46
.780	360.53	356.37	351.60	350.64	351.37	352.40	354.35	356.61	360.40	362.35	363.99	366.25	368.81	371.95
.800	362.76	358.29	354.74	354.55	355.58	356.00	358.72	360.82	364.45	366.56	368.51	370.46	372.71	375.88
.820	365.75	361.28	357.73	358.76	359.79	360.22	363.08	365.03	368.51	371.07	373.02	374.97	377.08	381.01
.840	369.44	354.27	362.32	362.97	363.85	365.34	367.72	369.55	373.00	375.44	376.93	379.49	382.54	385.71

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	437.22	383.44	358.55	342.74	331.88	323.83	320.07	314.99	313.54	314.73	314.60	314.64	315.99	317.85
.420	421.93	378.05	354.81	339.83	329.80	323.06	319.63	315.21	314.42	315.95	315.82	316.68	317.21	319.06
.440	408.29	372.99	352.07	337.74	328.53	322.63	319.20	315.77	315.64	316.34	317.03	318.22	319.25	321.60
.460	397.95	368.10	349.65	336.32	327.60	322.19	318.76	316.65	316.86	318.05	318.91	319.77	320.96	322.98
.480	391.17	364.37	347.56	336.05	327.66	322.58	319.52	318.20	318.73	319.59	321.12	321.81	323.33	325.48
.500	383.04	360.96	344.82	334.46	327.06	323.30	320.53	319.42	319.62	320.81	322.33	323.85	325.70	327.56
.520	378.48	358.38	342.73	336.83	327.29	324.19	322.08	321.46	321.82	323.01	324.87	326.22	328.24	329.93
.540	375.57	355.63	340.98	333.59	327.84	325.40	323.96	323.83	324.36	325.55	330.71	328.93	331.11	332.63
.560	372.66	354.37	340.21	333.81	328.73	327.45	326.49	326.03	327.23	328.42	330.27	331.30	333.97	335.66
.580	370.57	353.11	339.78	334.70	330.44	330.48	328.70	328.90	330.09	331.45	333.47	334.99	337.57	338.53
.600	369.31	353.50	339.84	335.09	331.82	331.36	331.70	331.44	332.63	334.48	336.66	339.64	342.08	343.54
.620	367.23	352.24	341.55	336.14	333.70	333.24	333.77	334.30	336.49	338.01	339.86	341.05	344.22	345.58
.640	365.96	352.63	342.76	338.01	335.74	335.61	336.97	337.50	340.34	341.20	343.39	344.41	347.92	348.94
.660	365.53	353.02	344.31	339.89	338.11	338.31	340.16	340.37	343.87	345.06	346.91	348.44	351.61	353.13
.680	365.92	354.24	346.18	342.42	340.98	341.34	343.69	343.56	347.56	348.59	350.61	351.96	355.46	357.48
.700	365.48	355.45	348.72	344.96	343.84	344.70	346.89	347.42	351.25	352.77	354.30	355.82	359.32	361.67
.720	366.67	357.49	351.82	349.81	349.68	350.21	350.91	352.93	355.11	356.63	359.47	361.99	363.84	366.32
.740	366.26	358.54	353.46	351.02	351.23	352.42	353.94	355.46	358.64	360.49	362.51	364.52	367.70	369.55
.760	367.81	360.75	356.66	354.55	354.75	356.11	357.47	359.32	363.15	364.68	366.53	368.71	371.22	374.06
.780	369.52	364.77	359.36	358.08	358.61	359.47	361.32	363.51	367.34	369.19	370.72	372.90	375.41	378.55
.800	371.56	366.48	362.39	361.93	362.80	363.00	365.68	367.69	371.36	373.38	375.23	377.08	379.27	382.44
.820	374.43	369.35	365.26	366.12	366.98	367.19	370.03	371.88	375.39	377.90	379.75	381.60	383.62	387.62
.840	378.05	372.22	370.40	370.31	371.01	372.36	374.68	376.40	379.87	382.25	383.61	386.12	389.16	392.33

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400	467.76	407.65	379.64	361.72	349.31	340.01	335.48	329.48	327.52	328.49	327.99	327.68	328.83	330.54
.420	457.27	401.16	374.99	357.99	346.49	338.65	334.49	329.23	328.00	329.34	328.84	329.45	329.68	331.39
.440	434.61	395.04	371.44	355.17	344.58	337.67	333.51	329.34	328.85	329.27	329.69	330.66	331.45	333.70
.460	422.62	389.10	368.25	353.08	343.05	336.68	332.52	329.82	329.70	330.67	331.27	331.88	332.85	334.74
.480	414.59	384.45	365.43	352.28	342.61	336.62	332.85	331.04	331.28	331.88	333.22	333.64	334.98	337.02
.500	405.05	380.16	361.88	350.01	341.44	336.91	333.48	331.89	331.76	332.73	334.07	335.41	337.11	338.82
.520	399.48	376.79	359.06	352.14	341.19	337.40	334.70	333.65	333.71	334.68	336.39	337.54	339.43	340.95
.540	395.75	373.24	356.60	348.04	341.31	338.24	336.28	335.79	336.03	337.00	342.37	340.04	342.11	343.45
.560	392.01	371.34	355.25	347.79	341.79	340.01	338.60	337.74	338.71	339.68	341.39	342.17	344.80	346.32
.580	389.19	369.44	354.27	348.27	343.19	342.88	340.55	340.42	341.39	342.55	344.44	345.77	348.29	349.00
.600	387.29	369.37	353.83	348.20	344.22	343.36	343.38	342.74	343.71	345.41	347.49	350.44	352.80	354.07
.620	384.47	367.46	355.23	348.87	345.80	344.94	345.18	345.42	347.49	348.83	350.53	351.51	354.68	355.83
.640	382.56	367.40	356.08	350.45	347.57	347.07	348.23	348.47	351.27	351.88	353.95	354.74	358.28	359.07
.660	381.58	367.33	357.29	352.03	349.70	349.57	351.28	351.15	354.69	355.66	357.37	358.71	361.88	363.22
.680	381.51	368.18	358.88	354.35	352.39	352.44	354.70	354.20	358.29	359.08	360.97	362.12	365.66	367.55
.700	380.53	369.03	361.19	356.66	355.07	355.67	357.75	357.98	361.89	363.23	364.57	365.91	369.45	371.70
.720	381.34	370.79	364.13	361.55	361.05	361.29	361.71	363.60	365.68	367.01	369.82	372.26	373.96	376.37
.740	380.39	371.46	365.46	362.40	362.27	363.24	364.58	365.92	369.09	370.80	372.69	374.57	377.75	379.45
.760	381.60	373.41	368.51	365.81	365.69	366.84	368.00	369.70	373.61	374.95	376.65	378.73	381.16	383.97
.780	383.00	377.37	371.01	369.23	369.47	370.07	371.78	373.85	377.76	379.46	380.80	382.88	385.31	388.45
.800	384.77	378.77	373.88	373.01	373.62	373.49	376.11	378.00	381.73	383.62	385.32	387.03	389.10	392.27
.820	387.45	381.45	376.56	377.16	377.77	377.64	380.45	382.15	385.69	388.13	389.84	391.54	393.43	397.52
.840	390.98	384.14	381.77	381.31	381.74	382.89	385.11	386.67	390.17	392.47	393.62	396.06	399.09	402.26

TABLE 3-6.9

SUMMARY OF OPTIMUM DESIGNS
(SINGLE EFFICIENCY)

SCENARIO 1

KVA	INDEX	NLL	LL	TLAC
10	180	.040	.160	121.24
10	200	.040	.160	126.31
10	220	.040	.160	131.38
10	240	.040	.160	136.45
15	225	.060	.200	159.81
15	250	.060	.200	165.96
15	275	.060	.200	172.12
15	300	.060	.220	177.41
25	275	.090	.260	214.23
25	300	.090	.260	220.10
25	325	.090	.260	225.96
25	350	.090	.280	231.51
25	400	.090	.300	242.28
37.5	400	.120	.360	303.03
37.5	440	.120	.400	312.58
37.5	480	.120	.400	321.42
37.5	520	.120	.400	330.26
50	420	.140	.400	354.87
50	460	.140	.400	365.66
50	500	.140	.460	375.93
50	540	.140	.460	385.59
50	600	.140	.480	400.01

TABLE 3-6.9
(CONTINUED)
SUMMARY OF OPTIMUM DESIGNS
(SINGLE EFFICIENCY)
SCENARIO 2

KVA	INDEX	NLL	LL	TLAC
10	180	.070	.120	99.81
10	200	.070	.120	104.45
10	220	.070	.120	109.10
10	240	.070	.120	113.74
15	225	.080	.160	129.46
15	250	.080	.160	135.56
15	275	.080	.180	141.44
15	300	.080	.180	147.11
25	275	.130	.180	172.14
25	300	.120	.220	177.89
25	325	.120	.240	183.33
25	350	.120	.240	188.66
25	400	.110	.280	198.93
37.5	400	.150	.320	244.30
37.5	440	.150	.340	253.26
37.5	480	.150	.340	262.01
37.5	520	.150	.360	270.43
50	420	.160	.400	286.01
50	460	.170	.400	294.90
50	500	.170	.400	304.22
50	540	.170	.400	313.54
50	600	.170	.400	327.52

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3.7 TASK 7 - MINIMIZE LIFE CYCLE COST BASED ON MULTIPLE EFFICIENCY CHARACTERISTIC TRANSFORMER DESIGN

INTRODUCTION

The purpose of this task is to determine what level of transformer losses yields the minimum total levelized annual cost of a multiple efficiency transformer (MEX). As in Task 6, initial costs were added to operating costs for different values of losses to find the optimum design. This task contains numerous tables of total levelized annual cost associated with the MEX for different losses, load factors, kVA ratings, cost indexes, and scenarios.

Initial Transformer Cost

Matrices of initial costs for the MEX were developed in the same manner as those for the single efficiency design in Task 4. Table 3-7.3 shows the normalized initial costs used in the evaluation. The costs are based on a core form design with a 2:1 kVA ratio. The losses shown are for the high kVA mode. The graphical data rather than the regression equation data was used for more accurate results. Values greater than two per unit were not printed.

These normalized values were multiplied by an index number to get an assumed transformer cost. Values for indexes used are shown in tables of the total levelized annual cost in Table 3-7.4. The cost of the switch used to change modes of the MEX is not included because the design of the switch is beyond the scope of this project.

Total Levelized Annual Cost

A computer program based on the equations in Task 5 was developed to calculate the total levelized annual cost of owning and operating a multiple efficiency transformer. The program makes year-by-year calculations of the present worth of operating costs for the MEX. These costs

are summed and then divided by the uniform annual series present worth factor. This value is added to the levelized value of the initial cost to get the total levelized annual cost. The costs are based on a 2:1 kVA ratio.

Two scenarios are available in the calculations. One is for oil-fired and the other is for nuclear-fired base load generation. Three different load factors (10%, 20%, and 30%) are considered in the evaluation. Also, as in Task 6, different cost indexes are used for the initial transformer costs (see Table 3-7.4).

It is interesting to note that the optimum value of losses changed little if any when the cost indexes were increased. This means that the initial cost of the transformer does not have a significant effect on the minimum cost design. Designs that were considered unfeasible were not printed out.

Table 3-7.1 is a listing of the computer program used to evaluate the MEX. Because of the excessive amount of input data needed for this program, an input example is not included. Table 3-7.2 is a list of parameters used to calculate the total levelized annual cost. Table 3-7.5 summarizes the loss characteristics and the total levelized annual costs of the minimum cost designs from the data in Table 3-7.4.

This table shows optimum designs based on the input data shown in Table 3-7.2 and the initial transformer costs in Table 3-7.3. However, these cost parameters and loading parameters may vary from one utility to another. Use of different input data will result in different costs and different optimum designs.

Comparison of Multiple and Single Efficiency Designs

The results show that the multiple efficiency design excluding the switch has a lower total levelized annual cost than the single efficiency design. In order to compare the two, tables using the same index number,

load factor, and scenario must be compared. The evaluation for the single efficiency design uses a 30% load factor in each case, while the MEX is evaluated for three different load factors. Table 3-7.6 shows the levelized annual savings of the MEX. An intermediate index number was used in each case in the comparison.

TABLE 3-7.1

```

C *****
C   TOTAL LEVELIZED ANNUAL TRANSFORMER COST
C *****
      REAL LSFL(16,3),LSFH(16,3),CEP(16),G(16),HH(16),HL,
&     LLL(400),LLH(400),XIND(9),FIRST(30,30),NLLH(400),NLLL(400),
&     CT(400),TLAC(400),IXI,RGC(400),NLC(400),LLC(400),LKW,LP8,IP,
&     TLA(400),IRP,IRB,L(16,3),CCAP(400)
      RI=.1
      IRP=.07641
C   INPUT SECTION
      DO 1 I1=1,14
1     READ(5,2) HH(I1),((L(I1,JS),LSFH(I1,JS),LSFL(I1,JS)),JS=1,3)
      IP=.75
      PRFS=.75
      LKW=.75
      PF=.9
      READ(5,211) J
      READ(5,119) CEP I,GI
      DISC=0.75
      CC=C.18
      CEE1=.0256
      CCAPS=9.24
      PRFD=.843
      CSYSP=411.
      REGL=.014
      REGH=.014
      DC=DISC*CC
      CDCPR=CSYSP*DISC*CC*(PRFS**2)
      LP8=LKW*PF*8760.
      GO TO (10,20),J
10    CEBI = .035
      IRB=.07775
      CSYSB=744.
      GO TO 9
20    CEBI = .0085
      IRB=.07527
      CSYSB=1182.
9     READ(5,210) K,T,NZE
      IF (K.EQ.0) GO TO 999
      TH=T
      TL=T/2.
      READ(5,105) STLL,STNL,NL,NN
      READ(5,277) REFCOS,(XIND(JP),JP=1,NZE)
      DO 15 M=1,NL
      READ(5,107) (FIRST(M,IN),IN=1,NN)
      DO 15 IN=1,NN
      NOT = (M-1)*NN+IN
15    CT(NOT)=2*FIRST(M,IN)/REFCOS
16    DO 25 M=1,NL
      DO 25 LM=1,NN
      LLH((M-1)*NN+LM)=((M-1)*20+STLL)/1000.
25    NLLH((M-1)*NN+LM)=((LM-1)*10+STNL)/1000.
      DO 25 INST=1,K
      NLLL(INST)=NLLH(INST)/2.

```


TABLE 3-7.1 (Continued)

```

35 LLL(INST)=LLH(INST)
45 DO 65 IX=1,3
   DO 598 IMPOS=1,400
      RGC(IMPOS)=0.
      NLC(IMPOS)=0.
598 LLC(IMPOS)=0.
   DO 63 IRST=1,K
   55 DO 64 IRS=1,16
      IF(IRS.NE.1)GO TO 57
      YEAR=1.
      GO TO 59
   57 YEAR=IRS*2-2
   59 P=IP*(1.03** (YEAR-1.))
      SKPU = SQRT(NLLH(IRST)/LLH(IRST)/6.)
      SK = SKPU*TH
      SKY = SKPU/P
      ILK = 0
   80 ILK = ILK+1
      IF(SKY.GT.L(ILK,IX))GO TO 81
      IF(ILK.LT.14)GO TO 80
   81 HH1 = (SKY-L(ILK-1,IX))*(HH(ILK-1)-HH(ILK))/(L(ILK-1,IX)-L(ILK,IX)
      C )+HH(ILK-1)
      HL=1.-HH1
      ILK1=0
   82 ILK1=ILK1+1
      IF(HH1.LT.HH(ILK1))GO TO 83
      IF(ILK1.LT.14)GO TO 82
   83 LSFH1 = (HH1-HH(ILK1))*(LSFH(ILK1-1,IX)-LSFH(ILK1,IX))/(HH(ILK1-1)
      & -HH(ILK1))+LSFH(ILK1,IX)
      LSFL1 = (HH1-HH(ILK1))*(LSFL(ILK1-1,IX)-LSFL(ILK1,IX))/(HH(ILK1-1)
      & -HH(ILK1))+LSFL(ILK1,IX)
      IF((P*PRFS).LT.SK) GO TO 61
      CHN=NLLH(IRST)
      CHL=LLH(IRST)
      GO TO 62
   61 CHN=NLLL(IRST)
      CHL=((TH/TL)**2)*LLL(IRST)
   62 GA=GI*((1.+IRP)** (YEAR-1.))
      CEPA=CEPI*((1.+IRP)** (YEAR-1.))
      CEB=CEBI*((1.+IRB)** (YEAR-1.))
      CEE=CEE1*((1.+IRP)** (YEAR-1))
      LLC(IRST) = (CSYSP*DISC*CC*PRFS**2*P**2*CHL+DISC*CC*NLLH(IRST)*
      & CSYSB)/(1+RI)**YEAR+LLC(IRST)
      NLC(IRST) = NLC(IRST)+(CEB*8760*(NLLL(IRST)*HL+LSFL1*HL*LLL(IRST)
      & *(SK/TL)**2+NLLH(IRST)*HH1) + CEPA *8760*LSFH1*HH1*P**2*
      & LLH(IRST))/(RI+1)**YEAR
      RGC(IRST) = CEE*LK**PF*8760*REGH*(TH*LSFH1*P**2 + TL*HL*LSFL1*
      & (SK/TL)**2)/(1+RI)**YEAR +RGC(IRST)
      CCAP(IRST)=CCAP(IRST)+CCAPS*CC*(PRFD**2*LLH(IRST)+NLLH(IRST)
      & )/((1+RI)**YEAR)
      TLA(IRST)=(NLC(IRST)+LLC(IRST)+CCAP(IRST)+RGC(IRST))*30./16.
   64 CONTINUE
   63 CONTINUE
   DO 66 NZ=1,NZE
   DO 72 NST=1,K
   72 TLAC NST)=CT(IRST)*XIND(NZ)*CC+ TLA(IRST)*(RI*(RI+1.))**30)/(((1.+
      & R)**30.)-1.)
      WRITE(6,271)XIND(NZ)

```

TABLE 3-7.1 (Continued)

```

WRITE(6,272)T
IXI=IX/10.
WRITE(6,300)IXI
WRITE(6,273)(NLLH(IN),IN=1,NN)
WRITE(6,274)
DO 275 IN=1,NL
275 WRITE(6,276)LLL(IN>NN),(TLAC(NIN+(IN-1)*NN),NIN=1,NN)
66 CONTINUE
65 CONTINUE
85 CONTINUE
GO TO 9
105 FORMAT(2F10.4,2I10)
211 FORMAT(I3)
277 FORMAT(9F5.1)
276 FORMAT(IX,F4.3,IX,14(IX,F8.2))
274 FORMAT(' ')
273 FORMAT('0',9X,13(F4.3,5X),F4.3)
301 FORMAT('0','TIC=',F6.2,' RGC=',F6.2,' NLC=',F6.2,' LLC=',
& F6.2,' TLAC=',F6.2,' LLH=',F4.3,' LLL=',F4.3,' NLLH=
& F4.3,' NLLL=',F4.3)
2 FORMAT(F5.4,3(F6.5,F7.6,F6.5))
119 FORMAT(2F10.4)
272 FORMAT('0',56X,F4.1,' KVA TRANSFORMER')
300 FORMAT('0',57X,'LOAD FACTOR = ',F3.2)
305 FORMAT(' ','RGC=',F6.2,' LLC=',F6.2,' NLC=',F6.2)
271 FORMAT('1',50X,'TABLE GENERATED USING INDEX',F5.0)
107 FORMAT(F6.1,13F5.1)
90 FORMAT(4E10.4)
100 FORMAT(7E10.4)
110 FORMAT(5E10.4)
120 FORMAT(8E10.4)
210 FORMAT(I10,F10.4,I10)
999 STOP
END

```

TABLE 3-7.2

INPUT DATA

CSYSB	*744	IP	0.75
CSYSP	411	GR	0.04
CEP1	0.0557	PRFS	0.75
CEB	*0.035	PRFD	0.843
CCE1	0.0472	PF	0.9
CE1	0.0216	LKW	0.75
CC	0.18	N	30
DISC	0.75	NC	30
IRP	0.07641	T	Variable
IRB	0.0775	CT	Variable
I	0.10	NLL	Variable
CCAPS	4.80	LL	Variable
REG	0.014	LSF	Variable

*Values above are for scenario 1. For scenario 2,
 CSYSB = 1182 and CEB1 = .0085

TABLES 3-7.3

MEX COST/PERFORMANCE INDEX

(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 10 KVA

LL\NL	20	30	40	50	60	70	80	90	100	110	120
60	*****	*****	*****	*****	*****	*****	*****	1.994	1.873	1.803	1.767
80	*****	*****	*****	*****	*****	1.943	1.844	1.733	1.640	1.603	1.584
100	*****	*****	*****	*****	1.813	1.636	1.598	1.481	1.445	1.435	1.426
120	*****	*****	*****	1.788	1.533	1.415	1.398	1.389	1.314	1.305	1.305
140	*****	1.976	1.719	1.514	1.361	1.267	1.256	1.235	1.202	1.202	1.202
160	*****	1.741	1.445	1.297	1.214	1.167	1.151	1.145	1.152	1.145	1.145
180	*****	1.538	1.417	1.212	1.113	1.100	1.090	1.081	1.072	1.072	1.072
200	*****	1.463	1.267	1.146	1.062	1.053	1.044	1.034	1.025	1.025	1.025
220	*****	1.379	1.207	1.095	1.021	1.021	1.021	1.021	1.016	1.016	1.016
240	*****	1.316	1.156	1.055	1.000	1.000	1.000	1.000	1.000	1.000	1.000
260	*****	1.230	1.109	1.031	0.987	0.985	0.985	0.984	0.979	0.979	0.979
280	*****	1.169	1.072	1.007	0.983	0.982	0.981	0.980	0.979	0.979	0.979
300	*****	1.128	1.044	1.006	0.979	0.979	0.979	0.979	0.979	0.979	0.979
320	1.789	1.100	1.025	0.997	0.979	0.979	0.979	0.979	0.979	0.979	0.979
340	1.631	1.081	1.007	0.996	0.979	0.979	0.979	0.979	0.979	0.979	0.979
360	1.370	1.058	0.988	0.988	0.978	0.978	0.978	0.978	0.978	0.978	0.978
380	1.291	1.054	0.988	0.979	0.978	0.978	0.978	0.978	0.969	0.969	0.969
400	1.240	1.054	0.988	0.979	0.978	0.978	0.978	0.978	0.969	0.969	0.969
420	1.202	1.054	0.988	0.979	0.978	0.978	0.978	0.978	0.969	0.969	0.969
440	1.193	1.054	0.988	0.978	0.978	0.978	0.978	0.978	0.969	0.969	0.969
460	1.186	1.062	0.979	0.978	0.978	0.978	0.978	0.978	0.969	0.969	0.969

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 10 KVA

$$Y = NL * LL / (-2475.1157 + 1.171879768 * NL + LL)$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	20	30	40	50	60	70	80	90	100	110	120
60	*****	*****	*****	*****	*****	1.717	1.524	1.401	1.317	1.255	1.208
80	*****	*****	*****	1.808	1.524	1.370	1.274	1.208	1.159	1.123	1.094
100	*****	*****	1.808	1.477	1.317	1.222	1.159	1.115	1.082	1.056	1.036
120	*****	*****	1.524	1.317	1.208	1.140	1.094	1.061	1.036	1.016	1.000
140	*****	1.717	1.370	1.222	1.140	1.088	1.052	1.025	1.005	0.989	0.976
160	*****	1.524	1.274	1.159	1.094	1.052	1.022	1.000	0.983	0.970	0.959
180	*****	1.401	1.208	1.115	1.061	1.025	1.000	0.981	0.967	0.955	0.946
200	1.808	1.317	1.159	1.082	1.036	1.005	0.983	0.967	0.954	0.944	0.936
220	1.641	1.255	1.123	1.056	1.016	0.989	0.970	0.955	0.944	0.935	0.928
240	1.524	1.208	1.094	1.036	1.000	0.976	0.959	0.946	0.936	0.928	0.921
260	1.437	1.170	1.071	1.019	0.987	0.965	0.950	0.938	0.929	0.921	0.915
280	1.370	1.140	1.052	1.005	0.976	0.956	0.942	0.931	0.923	0.916	0.911
300	1.317	1.115	1.036	0.993	0.967	0.949	0.936	0.926	0.918	0.912	0.907
320	1.274	1.094	1.022	0.983	0.959	0.942	0.930	0.921	0.914	0.908	0.903
340	1.238	1.076	1.010	0.974	0.952	0.936	0.925	0.917	0.910	0.904	0.900
360	1.208	1.061	1.000	0.967	0.946	0.931	0.921	0.913	0.907	0.901	0.897
380	1.182	1.047	0.991	0.960	0.940	0.927	0.917	0.909	0.904	0.899	0.895
400	1.159	1.036	0.983	0.954	0.936	0.923	0.914	0.907	0.901	0.896	0.893
420	1.140	1.025	0.976	0.949	0.931	0.919	0.911	0.904	0.899	0.894	0.891
440	1.123	1.016	0.970	0.944	0.928	0.916	0.908	0.901	0.896	0.892	0.889
460	1.108	1.008	0.964	0.943	0.924	0.913	0.905	0.899	0.894	0.891	0.887

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 15 KVA

$$Y = NL * LL / 1 - 5436.0078 + 1.242678642 * NL * (LL)$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	30	40	50	60	70	80	90	100	110	120	130
60	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1.832
80	*****	*****	*****	*****	*****	*****	*****	1.776	1.600	1.478	1.389
100	*****	*****	*****	*****	*****	1.776	1.566	1.430	1.336	1.266	1.213
120	*****	*****	*****	*****	1.679	1.478	1.353	1.266	1.204	1.156	1.118
140	*****	*****	*****	1.679	1.454	1.320	1.233	1.170	1.124	1.088	1.059
160	*****	*****	1.776	1.478	1.320	1.223	1.156	1.108	1.071	1.042	1.019
180	*****	*****	1.566	1.353	1.233	1.196	1.102	1.063	1.033	1.009	0.990
200	*****	1.776	1.430	1.266	1.170	1.108	1.063	1.030	1.004	0.984	0.967
220	*****	1.600	1.336	1.204	1.124	1.071	1.033	1.004	0.982	0.965	0.950
240	*****	1.478	1.266	1.155	1.088	1.042	1.009	0.984	0.965	0.949	0.936
260	1.832	1.389	1.213	1.113	1.059	1.019	0.990	0.967	0.950	0.936	0.924
280	1.679	1.320	1.170	1.088	1.036	1.000	0.974	0.954	0.938	0.925	0.915
300	1.566	1.266	1.136	1.069	1.016	0.984	0.960	0.942	0.928	0.916	0.906
320	1.478	1.223	1.108	1.042	1.000	0.971	0.949	0.932	0.919	0.908	0.899
340	1.409	1.186	1.084	1.024	0.986	0.959	0.939	0.924	0.911	0.901	0.893
360	1.353	1.156	1.063	1.009	0.974	0.949	0.930	0.916	0.905	0.895	0.888
380	1.306	1.130	1.045	0.994	0.963	0.940	0.923	0.909	0.899	0.890	0.883
400	1.266	1.108	1.030	0.984	0.954	0.932	0.916	0.904	0.894	0.885	0.879
420	1.233	1.088	1.016	0.974	0.945	0.925	0.910	0.898	0.889	0.881	0.875
440	1.204	1.071	1.004	0.965	0.938	0.919	0.905	0.894	0.885	0.877	0.871
460	1.178	1.056	0.994	0.956	0.931	0.913	0.900	0.889	0.881	0.874	0.868
480	1.156	1.042	0.984	0.949	0.925	0.908	0.895	0.885	0.877	0.871	0.865
500	1.136	1.030	0.975	0.942	0.920	0.904	0.891	0.882	0.874	0.868	0.863
520	1.118	1.019	0.967	0.936	0.915	0.899	0.888	0.879	0.871	0.865	0.860
540	1.102	1.009	0.960	0.930	0.910	0.895	0.884	0.876	0.869	0.863	0.858
560	1.088	1.000	0.954	0.925	0.906	0.892	0.881	0.873	0.866	0.861	0.856
580	1.075	0.992	0.948	0.920	0.902	0.888	0.878	0.870	0.864	0.859	0.854

(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 25 KVA

LL\NL	50	60	70	80	90	100	110	120	130	140	150
160	*****	*****	*****	*****	*****	*****	*****	*****	1.544	*****	1.418
180	*****	*****	*****	*****	*****	*****	*****	*****	1.396	*****	1.297
200	*****	*****	*****	*****	1.722	1.559	1.444	1.360	1.297	1.243	1.211
220	*****	*****	*****	*****	1.536	1.419	1.333	1.265	1.211	1.161	1.125
240	*****	*****	*****	*****	1.402	1.295	1.229	1.179	1.141	1.107	1.081
260	*****	1.900	*****	*****	1.306	1.238	1.179	1.130	1.085	1.046	1.012
280	*****	1.740	*****	*****	1.229	1.161	1.109	1.066	1.033	0.996	0.967
300	*****	1.645	1.441	1.263	1.159	1.098	1.053	1.017	0.985	0.958	0.935
320	*****	1.554	1.367	1.225	1.127	1.071	1.026	0.994	0.959	0.926	0.901
340	1.898	1.462	1.286	1.152	1.066	1.019	0.981	0.950	0.922	0.900	0.888
360	1.758	1.392	1.243	1.121	1.030	0.981	0.945	0.919	0.901	0.884	0.877
380	1.650	1.326	1.194	1.085	1.000	0.949	0.920	0.894	0.878	0.876	0.874
400	1.586	1.301	1.152	1.048	0.978	0.935	0.908	0.888	0.877	0.874	0.872
420	1.518	1.207	1.094	1.008	0.958	0.926	0.903	0.886	0.877	0.874	0.872
440	1.469	1.157	1.048	0.985	0.944	0.917	0.896	0.882	0.877	*****	*****
460	1.412	1.121	1.026	0.972	0.935	0.908	0.889	0.881	0.877	*****	*****
480	1.367	1.089	1.008	0.958	0.924	0.904	0.888	0.881	0.877	*****	*****
500	1.317	1.064	0.985	0.944	0.919	0.899	0.887	0.880	0.880	*****	*****
520	1.281	1.039	0.976	0.938	0.913	0.895	0.886	0.877	*****	*****	*****
540	1.238	1.035	0.972	0.931	0.904	0.890	0.881	0.877	*****	*****	*****
560	1.207	1.035	0.967	0.929	0.899	0.886	0.881	0.877	*****	*****	*****
580	1.175	1.030	0.962	0.926	0.895	0.881	0.881	0.877	*****	*****	*****
600	1.139	1.034	0.959	0.924	0.897	0.883	0.881	0.877	*****	*****	*****

THE 1960 TRANSFORMER COST/PERFORMANCE INDEX

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 25 KVA

$$Y = NL * LL / (-12930.9961 + 1.378100395 * NL * LL)$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	50	60	70	80	90	100	110	120	130	140	150
160	*****	*****	*****	*****	*****	1.755	1.554	1.419	1.322	1.249	1.191
180	*****	*****	*****	*****	1.724	1.516	1.379	1.283	1.211	1.156	1.112
200	*****	*****	*****	1.755	1.516	1.367	1.265	1.191	1.135	1.091	1.056
220	*****	*****	1.857	1.554	1.379	1.265	1.185	1.126	1.080	1.044	1.014
240	*****	*****	1.644	1.419	1.283	1.191	1.126	1.076	1.038	1.007	0.981
260	*****	1.821	1.498	1.322	1.211	1.135	1.080	1.038	1.004	0.978	0.956
280	*****	1.644	1.392	1.249	1.156	1.091	1.044	1.007	0.978	0.954	0.934
300	1.938	1.516	1.312	1.191	1.112	1.056	1.014	0.981	0.956	0.934	0.917
320	1.755	1.419	1.249	1.145	1.076	1.027	0.989	0.960	0.937	0.918	0.902
340	1.620	1.344	1.198	1.108	1.047	1.002	0.969	0.942	0.921	0.904	0.889
360	1.516	1.283	1.156	1.076	1.021	0.981	0.951	0.927	0.908	0.892	0.878
380	1.434	1.233	1.121	1.050	1.000	0.964	0.936	0.914	0.896	0.881	0.869
400	1.367	1.191	1.091	1.027	0.981	0.948	0.922	0.902	0.885	0.872	0.860
420	1.312	1.156	1.066	1.007	0.965	0.934	0.911	0.892	0.876	0.863	0.853
440	1.265	1.126	1.044	0.989	0.951	0.922	0.900	0.882	0.868	0.856	0.846
460	1.226	1.099	1.024	0.974	0.938	0.912	0.891	0.874	0.861	0.849	0.840
480	1.191	1.076	1.007	0.960	0.927	0.902	0.882	0.867	0.854	0.843	0.834
500	1.162	1.056	0.991	0.948	0.917	0.893	0.875	0.860	0.848	0.838	0.829
520	1.135	1.038	0.978	0.937	0.908	0.885	0.868	0.854	0.843	0.833	0.825
540	1.112	1.021	0.965	0.927	0.899	0.878	0.862	0.849	0.838	0.828	0.821
560	1.091	1.007	0.954	0.918	0.892	0.872	0.856	0.843	0.833	0.824	0.817
580	1.073	0.994	0.944	0.910	0.885	0.866	0.851	0.839	0.829	0.820	0.813
600	1.056	0.981	0.934	0.902	0.878	0.860	0.846	0.834	0.825	0.817	0.810

(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 37.5 KVA

LL\HL	70	80	90	100	110	120	130	140	150	160	170	180	190	200
260	*****	*****	*****	*****	*****	1.052	1.703	1.595	1.515	1.446	1.386	1.343	1.305	1.279
280	*****	*****	*****	*****	*****	1.758	1.560	1.460	1.418	1.340	1.312	1.269	1.237	1.205
300	*****	*****	*****	1.847	1.709	1.563	1.460	1.379	1.343	1.283	1.255	1.223	1.198	1.141
320	*****	*****	1.886	1.684	1.570	1.482	1.407	1.305	1.276	1.223	1.223	1.170	1.145	1.097
340	*****	*****	1.720	1.567	1.450	1.358	1.293	1.230	1.212	1.177	1.152	1.127	1.106	1.056
360	*****	*****	1.652	1.446	1.347	1.280	1.234	1.184	1.163	1.131	1.120	1.095	1.074	1.021
380	*****	*****	1.556	1.382	1.287	1.219	1.170	1.131	1.113	1.099	1.081	1.053	1.032	0.993
400	*****	1.737	1.553	1.343	1.235	1.170	1.127	1.095	1.074	1.053	1.035	1.021	1.000	0.984
420	*****	1.657	1.421	1.312	1.223	1.152	1.102	1.063	1.046	1.028	1.017	0.996	0.985	0.959
440	1.882	1.569	1.354	1.276	1.198	1.127	1.074	1.042	1.021	1.010	0.993	0.975	0.959	0.939
460	1.772	1.499	1.312	1.237	1.170	1.117	1.053	1.021	1.000	0.993	0.975	0.957	0.945	0.929
480	1.702	1.430	1.262	1.209	1.141	1.099	1.032	1.010	0.982	0.971	0.955	0.936	0.936	0.925
500	1.624	1.365	1.223	1.172	1.124	1.088	1.021	0.996	0.968	0.954	0.941	0.925	0.929	0.922
520	1.545	1.305	1.192	1.141	1.106	1.078	1.000	0.984	0.957	0.943	0.929	0.921	0.921	0.921
540	1.499	1.266	1.152	1.120	1.088	1.056	0.993	0.971	0.950	0.939	0.925	0.915	0.911	0.907
560	1.443	1.223	1.124	1.099	1.063	1.037	0.987	0.961	0.943	0.932	0.922	0.904	0.900	0.897
580	1.400	1.191	1.095	1.071	1.042	1.021	0.978	0.954	0.939	0.929	0.915	0.897	0.897	0.893
600	1.351	1.152	1.074	1.049	1.028	0.996	0.975	0.946	0.936	0.925	0.911	0.911	0.893	0.890
620	1.319	1.124	1.055	1.028	1.010	0.985	0.970	0.943	0.932	0.920	0.904	0.890	0.886	0.886
640	1.278	1.099	1.039	1.016	0.996	0.980	0.964	0.939	0.929	0.915	0.900	0.886	0.886	0.886
660	1.254	1.085	1.028	1.005	0.984	0.968	0.962	0.941	0.925	0.911	0.897	0.889	0.889	0.889
680	1.223	1.060	1.010	0.993	0.971	0.957	0.954	0.932	0.922	0.907	0.897	0.886	0.886	0.886
700	1.198	1.035	1.003	0.982	0.961	0.946	0.946	0.925	0.918	0.904	0.897	0.886	0.886	0.886
720	1.173	1.021	0.996	0.971	0.954	0.939	0.936	0.918	0.913	0.900	0.893	0.886	0.886	0.886
740	1.145	1.010	0.989	0.961	0.946	0.936	0.932	0.915	0.907	0.897	0.893	0.886	0.886	0.886
760	1.125	1.000	0.975	0.954	0.939	0.932	0.929	0.911	0.904	0.897	0.893	0.886	0.886	0.886
780	1.106	0.993	0.968	0.948	0.936	0.929	0.922	0.911	0.904	0.893	0.893	0.886	0.886	0.886
800	1.091	0.985	0.963	0.945	0.934	0.925	0.919	0.911	0.904	0.900	0.894	0.886	0.886	0.886

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 37.5 KVA

$$Y = NL * LL / I - 16091.2695 + 1.238037109 * NL * LL$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL \ NL	70	80	90	100	110	120	130	140	150	160	170	180	190	200
260	*****	*****	1.817	1.615	1.481	1.384	1.312	1.256	1.211	1.175	1.144	1.118	1.096	1.077
280	*****	1.924	1.668	1.578	1.397	1.317	1.256	1.208	1.170	1.138	1.111	1.088	1.069	1.052
300	*****	1.762	1.557	1.425	1.333	1.264	1.211	1.170	1.136	1.108	1.084	1.064	1.046	1.031
320	1.924	1.641	1.472	1.350	1.281	1.221	1.175	1.138	1.108	1.083	1.061	1.043	1.027	1.014
340	1.780	1.547	1.404	1.308	1.238	1.185	1.144	1.111	1.084	1.061	1.042	1.026	1.011	0.999
360	1.668	1.472	1.349	1.254	1.202	1.155	1.118	1.088	1.064	1.043	1.026	1.010	0.997	0.986
380	1.580	1.411	1.303	1.228	1.172	1.130	1.096	1.069	1.046	1.027	1.011	0.997	0.985	0.974
400	1.508	1.360	1.264	1.197	1.146	1.108	1.077	1.052	1.031	1.014	0.999	0.986	0.974	0.964
420	1.448	1.317	1.231	1.170	1.124	1.088	1.060	1.037	1.018	1.001	0.987	0.975	0.965	0.956
440	1.397	1.281	1.202	1.146	1.104	1.071	1.045	1.024	1.006	0.991	0.978	0.966	0.956	0.948
460	1.354	1.249	1.177	1.126	1.087	1.056	1.032	1.012	0.995	0.981	0.969	0.958	0.949	0.941
480	1.317	1.221	1.155	1.108	1.071	1.043	1.020	1.001	0.986	0.972	0.961	0.951	0.942	0.934
500	1.285	1.197	1.136	1.091	1.058	1.031	1.010	0.992	0.977	0.964	0.954	0.944	0.936	0.928
520	1.256	1.175	1.118	1.077	1.045	1.020	1.000	0.983	0.969	0.957	0.947	0.938	0.930	0.923
540	1.231	1.155	1.103	1.064	1.034	1.010	0.991	0.975	0.962	0.951	0.941	0.932	0.925	0.918
560	1.208	1.138	1.088	1.052	1.024	1.001	0.983	0.968	0.956	0.945	0.935	0.927	0.920	0.914
580	1.188	1.122	1.076	1.041	1.014	0.993	0.976	0.962	0.950	0.939	0.930	0.923	0.916	0.910
600	1.170	1.108	1.064	1.031	1.006	0.986	0.969	0.956	0.944	0.934	0.926	0.918	0.912	0.906
620	1.153	1.095	1.053	1.022	0.998	0.979	0.963	0.950	0.939	0.930	0.921	0.914	0.908	0.902
640	1.138	1.083	1.043	1.014	0.991	0.972	0.957	0.945	0.934	0.925	0.917	0.910	0.904	0.899
660	1.124	1.071	1.034	1.006	0.984	0.966	0.952	0.940	0.930	0.921	0.914	0.907	0.901	0.896
680	1.111	1.061	1.026	0.999	0.978	0.961	0.947	0.935	0.926	0.917	0.910	0.904	0.898	0.893
700	1.099	1.052	1.018	0.992	0.972	0.956	0.942	0.931	0.922	0.914	0.907	0.901	0.895	0.890
720	1.088	1.043	1.010	0.936	0.966	0.951	0.938	0.927	0.918	0.910	0.904	0.898	0.893	0.888
740	1.078	1.035	1.004	0.980	0.961	0.946	0.934	0.924	0.915	0.907	0.901	0.895	0.890	0.885
760	1.069	1.027	0.997	0.974	0.956	0.942	0.930	0.920	0.912	0.904	0.898	0.893	0.888	0.883
780	1.060	1.020	0.991	0.969	0.952	0.938	0.926	0.917	0.909	0.902	0.896	0.890	0.885	0.881
800	1.052	1.014	0.986	0.964	0.948	0.934	0.923	0.914	0.906	0.899	0.893	0.888	0.883	0.879

(OPTIMUM & GRAPHICAL DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 50 KVA

LL\NL	90	100	110	120	130	140	150	160	170	180	190	200	210	220
400	*****	*****	*****	1.814	1.658	1.561	1.487	1.424	1.367	1.321	1.283	1.254	1.227	1.214
420	*****	*****	1.911	1.711	1.589	1.499	1.402	1.355	1.314	1.277	1.239	1.202	1.186	1.165
440	*****	*****	1.826	1.636	1.502	1.411	1.356	1.305	1.268	1.236	1.210	1.186	1.165	1.149
460	*****	*****	1.720	1.564	1.483	1.399	1.299	1.257	1.227	1.202	1.172	1.143	1.121	1.099
480	*****	*****	1.645	1.505	1.436	1.342	1.260	1.219	1.193	1.174	1.146	1.118	1.096	1.077
500	*****	1.814	1.651	1.505	1.386	1.299	1.241	1.196	1.165	1.137	1.116	1.101	1.080	1.071
520	1.892	1.742	1.517	1.421	1.350	1.274	1.186	1.161	1.140	1.108	1.094	1.074	1.063	1.046
540	1.801	1.630	1.458	1.367	1.313	1.243	1.161	1.133	1.115	1.086	1.077	1.062	1.046	1.030
560	1.727	1.561	1.417	1.336	1.283	1.211	1.141	1.099	1.086	1.074	1.062	1.046	1.030	1.018
580	1.664	1.499	1.367	1.302	1.255	1.177	1.121	1.091	1.071	1.058	1.046	1.030	1.021	1.012
600	1.623	1.449	1.327	1.268	1.224	1.149	1.102	1.077	1.055	1.029	1.021	1.015	1.008	1.002
620	1.588	1.411	1.296	1.252	1.196	1.124	1.090	1.065	1.043	1.024	1.012	1.000	0.996	0.993
640	1.514	1.367	1.261	1.214	1.174	1.105	1.071	1.046	1.030	1.005	0.996	0.988	0.988	0.988
660	1.467	1.336	1.233	1.179	1.155	1.086	1.055	1.030	1.015	0.996	0.987	0.980	0.980	0.980
680	1.442	1.305	1.202	1.161	1.130	1.068	1.043	1.018	1.002	0.983	0.977	0.974	0.974	0.974
700	1.405	1.271	1.180	1.133	1.103	1.058	1.030	1.002	0.993	0.977	0.974	0.971	0.971	0.971
720	1.374	1.249	1.168	1.118	1.083	1.043	1.014	0.996	0.983	0.971	0.968	0.965	0.965	0.965
740	1.353	1.227	1.157	1.099	1.058	1.030	1.011	0.990	0.977	0.966	0.962	0.961	0.960	0.960
760	1.328	1.197	1.127	1.077	1.043	1.018	0.993	0.983	0.971	0.962	0.958	0.955	0.955	0.955
780	1.302	1.180	1.115	1.068	1.033	1.005	0.987	0.977	0.968	0.958	0.955	0.952	0.952	0.952
800	1.271	1.165	1.099	1.062	1.024	0.999	0.977	0.971	0.962	0.955	0.952	0.949	0.949	0.949
820	1.249	1.149	1.086	1.049	1.018	0.993	0.974	0.965	0.958	0.952	0.949	0.946	0.946	0.946
840	1.232	1.130	1.079	1.040	1.008	0.987	0.971	0.962	0.955	0.949	0.946	0.946	0.946	0.946
860	1.218	1.115	1.069	1.030	1.002	0.983	0.970	0.958	0.954	0.948	0.947	0.947	0.946	0.948

(REGRESSION EQUATION DATA)

TRANSFORMER COST/PERFORMANCE INDEX
MULTIPLE EFFICIENCY 50 KVA

$$Y = NL * (LL / (-35039.2031 + 1.282573700 * NL * LL))$$

Y = TRANSFORMER COST, NL = NO LOAD LOSS, LL = LOAD LOSS

LL\NL	90	100	110	120	130	140	150	160	170	180	190	200	210	220
400	*****	*****	*****	1.810	1.643	1.522	1.431	1.360	1.303	1.256	1.217	1.184	1.155	1.131
420	*****	*****	1.908	1.703	1.560	1.456	1.377	1.314	1.263	1.221	1.186	1.155	1.130	1.107
440	*****	*****	1.790	1.616	1.493	1.401	1.330	1.274	1.228	1.190	1.158	1.131	1.107	1.086
460	*****	1.920	1.695	1.544	1.435	1.354	1.291	1.240	1.198	1.164	1.134	1.109	1.087	1.068
480	*****	1.810	1.616	1.483	1.387	1.314	1.256	1.210	1.172	1.140	1.113	1.090	1.070	1.052
500	1.984	1.719	1.549	1.431	1.345	1.279	1.226	1.184	1.149	1.120	1.094	1.073	1.054	1.037
520	1.873	1.643	1.493	1.387	1.308	1.248	1.200	1.161	1.128	1.101	1.078	1.057	1.040	1.024
540	1.781	1.578	1.444	1.348	1.276	1.221	1.176	1.140	1.110	1.084	1.063	1.044	1.027	1.013
560	1.703	1.522	1.401	1.314	1.248	1.197	1.155	1.122	1.093	1.070	1.049	1.031	1.016	1.002
580	1.636	1.474	1.364	1.283	1.223	1.175	1.137	1.105	1.079	1.056	1.037	1.020	1.005	0.992
600	1.578	1.431	1.330	1.256	1.200	1.155	1.120	1.090	1.065	1.044	1.025	1.010	0.996	0.983
620	1.528	1.394	1.301	1.232	1.179	1.138	1.104	1.076	1.052	1.032	1.015	1.000	0.987	0.975
640	1.483	1.360	1.274	1.210	1.161	1.122	1.090	1.063	1.041	1.022	1.006	0.991	0.979	0.967
660	1.444	1.330	1.250	1.190	1.144	1.107	1.077	1.052	1.031	1.013	0.997	0.983	0.971	0.960
680	1.408	1.303	1.228	1.172	1.128	1.093	1.065	1.041	1.021	1.004	0.989	0.976	0.964	0.954
700	1.377	1.279	1.208	1.155	1.114	1.081	1.054	1.031	1.012	0.996	0.981	0.969	0.958	0.948
720	1.348	1.256	1.190	1.140	1.101	1.070	1.044	1.022	1.004	0.988	0.974	0.962	0.952	0.942
740	1.322	1.236	1.174	1.126	1.089	1.059	1.034	1.014	0.996	0.981	0.968	0.956	0.946	0.937
760	1.298	1.217	1.158	1.113	1.078	1.049	1.025	1.006	0.989	0.974	0.962	0.951	0.941	0.932
780	1.276	1.200	1.144	1.101	1.067	1.040	1.017	0.998	0.982	0.968	0.956	0.945	0.936	0.927
800	1.256	1.184	1.131	1.090	1.057	1.031	1.010	0.991	0.976	0.962	0.951	0.940	0.931	0.923
820	1.238	1.169	1.118	1.079	1.048	1.023	1.002	0.985	0.970	0.957	0.945	0.936	0.927	0.919
840	1.221	1.155	1.107	1.070	1.040	1.016	0.996	0.979	0.964	0.952	0.941	0.931	0.923	0.915
860	1.205	1.143	1.096	1.060	1.032	1.009	0.989	0.973	0.959	0.947	0.936	0.927	0.919	0.911

TABLES 3.7-4

TOTAL LEVELIZED ANNUAL COSTS FOR MULTIPLE EFFICIENCY
CHARACTERISTIC TRANSFORMER DESIGN

SCENARIO 1

OIL FIRED BASE LOAD GENERATION

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					120.51	115.91	113.71	113.03	113.56	115.76	119.05
.080					113.77	105.48	106.54	107.38	108.80	112.03	115.88
.100					99.66	90.28	101.44	102.04	105.28	109.41	113.55
.120	417.35	109.26	102.34	97.46	93.72	94.08	97.89	101.96	103.92	108.02	112.45
.140	207.25	97.66	93.79	91.55	90.94	92.28	96.26	99.92	103.22	107.60	111.99
.160	152.93	92.93	87.80	87.44	89.15	91.98	95.82	99.98	104.54	108.69	113.06
.180	144.60	89.20	89.80	87.59	88.97	92.75	96.82	100.87	104.92	109.27	113.62
.200	136.43	89.64	87.85	88.39	90.09	94.18	98.26	102.32	106.37	110.73	115.07
.220	129.56	89.74	88.75	89.63	91.65	96.05	100.44	104.82	109.03	113.39	117.74
.240	125.18	90.50	89.95	91.22	93.90	98.32	102.71	107.10	111.48	115.84	120.19
.260	118.65	90.50	91.29	93.31	96.38	100.78	105.16	109.52	113.73	118.10	122.46
.280	113.34	91.16	92.92	95.39	99.15	103.58	107.96	112.33	116.66	121.04	125.42
.300	112.73	91.71	94.83	98.21	101.91	106.36	110.79	115.20	119.60	123.98	128.36
.320	105.56	93.49	97.03	100.79	104.75	109.25	113.71	118.12	122.52	126.92	131.31
.340	102.74	94.34	99.21	103.60	107.61	112.14	116.62	121.04	125.45	129.85	134.24
.360	94.86	96.18	101.39	106.16	110.43	114.98	119.48	123.93	128.34	132.75	137.15
.380	94.49	97.18	102.89	108.57	113.28	117.85	122.37	126.84	130.99	135.40	139.80
.400	92.96	99.69	105.58	111.47	116.13	120.70	125.24	129.73	133.90	138.32	142.73
.420	93.83	100.44	108.26	114.26	118.96	123.56	128.11	132.62	136.82	141.24	145.65
.440	93.17	102.85	109.36	117.31	121.78	126.41	130.97	135.50	139.71	144.15	148.57
.460	94.92	103.48	111.65	119.78	124.59	129.26	133.83	138.37	142.60	147.07	151.49

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					130.00	124.40	121.46	120.21	120.31	122.25	125.41
.080					122.19	112.49	113.18	113.62	114.70	117.80	121.58
.100					106.18	104.17	107.20	107.37	110.49	114.58	118.68
.120	460.80	117.98	109.81	103.89	99.25	99.17	102.92	106.96	108.65	112.72	117.15
.140	227.04	104.78	99.98	97.00	95.84	96.84	100.78	104.36	107.55	111.93	116.32
.160	166.38	99.19	93.00	92.11	93.52	96.18	99.96	104.11	108.69	112.82	117.19
.180	156.81	94.74	94.90	91.95	93.00	96.71	100.74	104.76	108.78	113.12	117.48
.200	147.50	94.90	92.41	92.52	93.91	97.97	102.01	106.04	110.06	114.42	118.76
.220	139.66	94.71	93.10	93.58	95.32	99.73	104.12	108.50	112.69	117.05	121.40
.240	134.51	95.23	94.11	95.02	97.50	101.92	106.31	110.70	115.08	119.44	123.79
.260	127.07	94.93	95.28	97.02	99.94	104.33	108.71	113.07	117.25	121.63	125.98
.280	121.03	95.36	96.77	99.01	102.69	107.11	111.49	115.86	120.18	124.57	128.94
.300	120.08	95.77	98.59	101.83	105.44	109.89	114.31	118.73	123.12	127.51	131.89
.320	112.00	97.45	100.72	104.38	108.27	112.78	117.23	121.64	126.05	130.44	134.83
.340	108.61	98.23	102.84	107.19	111.13	115.66	120.14	124.56	128.98	133.37	137.76
.360	99.79	99.99	104.94	109.72	113.95	118.50	123.00	127.45	131.86	136.27	140.67
.380	99.13	100.97	106.44	112.19	116.80	121.37	125.89	130.36	134.48	138.89	143.29
.400	97.42	103.48	109.13	114.99	119.65	124.22	128.76	133.25	137.39	141.81	146.22
.420	98.16	104.24	111.82	117.78	122.48	127.08	131.63	136.14	140.30	144.73	149.14
.440	97.46	106.65	112.91	120.53	125.30	129.93	134.49	139.02	143.20	147.64	152.06
.460	99.19	107.31	115.18	123.30	128.11	132.78	137.35	141.89	146.09	150.56	154.98

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					139.50	132.89	129.21	127.39	127.05	128.75	131.78
.080					130.61	119.50	119.82	119.86	120.61	123.57	127.29
.100					112.71	110.05	112.95	112.70	115.69	119.75	123.81
.120	504.26	126.71	117.27	110.33	104.79	104.27	107.96	111.95	113.39	117.42	121.85
.140	246.84	111.89	106.17	102.45	100.74	101.40	105.31	108.81	111.88	116.26	120.65
.160	179.82	105.46	98.20	96.78	97.89	100.38	104.11	108.23	112.84	116.94	121.31
.180	169.03	100.27	100.00	96.31	97.02	100.67	104.67	108.65	112.63	116.98	121.34
.200	158.57	100.17	96.97	96.64	97.74	101.76	105.77	109.77	113.76	118.11	122.45
.220	149.76	99.68	97.44	97.52	99.00	103.40	107.79	112.17	116.35	120.70	125.06
.240	143.83	99.97	98.27	98.82	101.10	105.52	109.91	114.30	118.68	123.04	127.39
.260	135.49	99.36	99.27	100.73	103.49	107.88	112.25	116.61	120.77	125.15	129.51
.280	128.71	99.55	100.63	102.63	106.23	110.65	115.03	119.39	123.71	128.09	132.47
.300	127.43	99.83	102.34	105.45	108.96	113.41	117.84	122.25	126.64	131.03	135.41
.320	118.44	101.41	104.43	107.97	111.79	116.30	120.75	125.17	129.57	133.97	138.35
.340	114.48	102.12	106.46	110.78	114.65	119.18	123.66	128.09	132.50	136.90	141.28
.360	104.72	103.79	108.50	113.27	117.47	122.02	126.52	130.96	135.38	139.79	144.19
.380	103.78	104.77	110.00	115.72	120.32	124.89	129.41	133.88	137.97	142.38	146.78
.400	101.88	107.27	112.69	118.52	123.17	127.74	132.28	136.77	140.88	145.30	149.71
.420	102.49	108.03	115.37	121.31	126.00	130.60	135.15	139.66	143.79	148.22	152.63
.440	101.76	110.44	116.47	124.05	128.82	133.45	138.01	142.54	146.69	151.13	155.55
.460	103.46	111.13	118.75	126.82	131.63	136.30	140.87	145.41	149.58	154.04	158.47

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					148.99	141.38	136.96	134.57	133.79	135.24	138.14
.080					139.03	126.51	126.46	126.10	126.51	129.34	132.99
.100					119.24	115.94	118.71	118.03	120.89	124.91	128.94
.120	547.71	135.43	124.74	116.76	110.33	109.36	112.99	116.95	118.12	122.11	126.54
.140	266.63	119.00	112.36	107.90	105.64	105.97	109.83	113.25	116.20	120.58	124.98
.160	193.27	111.73	103.40	101.45	102.26	104.58	108.25	112.35	116.98	121.06	125.43
.180	181.24	105.81	105.10	100.67	101.05	104.63	108.59	112.55	116.49	120.84	125.20
.200	169.64	105.44	101.54	100.77	101.56	105.55	109.53	113.49	117.45	121.80	126.14
.220	159.86	104.64	101.79	101.46	102.67	107.07	111.46	115.85	120.00	124.36	128.71
.240	153.16	104.71	102.43	102.62	104.70	109.12	113.51	117.90	122.28	126.64	130.99
.260	143.91	103.79	103.27	104.44	107.04	111.43	115.80	120.15	124.30	128.67	133.03
.280	136.39	103.74	104.49	106.26	109.77	114.19	118.56	122.92	127.23	131.61	135.99
.300	134.78	103.89	106.10	109.07	112.49	116.93	121.36	125.77	130.17	134.55	138.93
.320	124.89	105.37	108.10	111.56	115.32	119.82	124.27	128.69	133.09	137.49	141.88
.340	120.35	106.01	110.08	114.36	118.18	122.71	127.18	131.61	136.02	140.42	144.81
.360	109.65	107.60	112.05	116.83	120.99	125.54	130.04	134.48	138.90	143.31	147.71
.380	108.43	108.56	113.56	119.24	123.84	128.40	132.93	137.39	141.46	145.87	150.27
.400	106.34	111.07	116.24	122.04	126.69	131.26	135.80	140.29	144.37	148.79	153.20
.420	106.81	111.83	118.93	124.83	129.52	134.11	138.67	143.18	147.28	151.71	156.12
.440	106.05	114.24	120.03	127.57	132.34	136.97	141.53	146.06	150.18	154.62	159.04
.460	107.73	114.96	122.22	130.34	135.15	139.82	144.39	148.93	153.07	157.53	161.96

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					122.21	117.42	115.06	114.24	114.64	116.73	119.92
.080					116.41	107.95	108.81	109.45	110.70	113.78	117.49
.100					103.15	101.66	104.67	105.08	108.12	112.04	116.00
.120	420.20	112.91	106.41	101.67	97.98	98.29	102.00	105.93	107.73	111.64	115.85
.140	210.17	101.59	98.30	96.37	95.88	97.24	101.18	104.75	107.93	112.15	116.36
.160	155.89	97.06	92.68	92.76	94.70	97.63	101.50	105.62	110.10	114.13	118.36
.180	147.58	93.47	94.95	93.33	95.06	99.04	103.18	107.26	111.26	115.53	119.78
.200	139.40	93.99	93.23	94.48	96.64	101.03	105.27	109.40	113.47	117.78	122.05
.220	132.51	94.15	94.32	96.01	98.62	103.40	108.04	112.54	116.82	121.19	125.50
.240	128.10	94.94	95.65	97.84	101.21	106.10	110.84	115.44	119.91	124.34	128.71
.260	121.51	94.97	97.07	100.14	103.98	108.97	113.76	118.41	122.79	127.25	131.67
.280	116.16	95.63	98.76	102.38	107.01	112.10	116.98	121.72	126.30	130.84	135.29
.300	115.49	96.17	100.72	105.33	109.99	115.19	120.21	125.03	129.76	134.36	138.87
.320	108.25	97.93	102.95	108.00	113.02	118.34	123.45	128.37	133.16	137.84	142.42
.340	105.36	98.75	105.16	110.88	116.03	121.45	126.66	131.68	136.52	141.27	145.92
.360	97.41	100.55	107.34	113.49	118.98	124.51	129.78	134.89	139.82	144.63	149.33
.380	96.98	101.51	108.84	116.04	121.92	127.55	132.91	138.10	142.84	147.70	152.47
.400	95.38	103.96	111.52	118.88	124.84	130.55	136.01	141.26	146.09	151.03	155.84
.420	96.19	104.66	114.19	121.69	127.72	133.53	139.08	144.40	149.30	154.31	159.18
.440	95.46	107.02	115.26	124.46	130.60	136.47	142.11	147.51	152.46	157.55	162.51
.460	97.15	107.59	117.52	127.23	133.45	139.40	145.11	150.59	155.61	160.77	165.78

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					131.70	125.91	122.81	121.42	121.38	123.22	126.28
.080					124.84	114.96	115.45	115.69	116.60	119.55	123.19
.100					109.67	107.55	110.43	110.41	113.32	117.21	121.14
.120	463.65	121.64	113.87	108.11	103.51	103.38	107.03	110.92	112.46	116.33	120.55
.140	229.57	108.70	104.49	101.82	100.77	101.81	105.70	109.20	112.26	116.48	120.69
.160	169.34	103.33	97.88	97.43	99.07	101.83	105.64	109.74	114.24	118.25	122.48
.180	159.79	99.01	100.05	97.69	99.09	103.00	107.11	111.15	115.12	119.39	123.64
.200	150.47	99.26	97.80	98.61	100.47	104.83	109.02	113.12	117.16	121.47	125.74
.220	142.61	99.12	98.66	99.95	102.29	107.08	111.72	116.22	120.48	124.85	129.16
.240	137.42	99.68	99.81	101.64	104.81	109.70	114.44	119.04	123.51	127.94	132.31
.250	129.93	99.40	101.06	103.85	107.54	112.52	117.30	121.95	126.32	130.78	135.20
.280	123.84	99.83	102.62	106.01	110.55	115.64	120.51	125.25	129.82	134.36	138.81
.300	122.84	100.23	104.48	108.95	113.51	118.71	123.73	128.56	133.28	137.89	142.40
.320	114.69	101.89	106.65	111.59	116.54	121.86	126.97	131.89	136.68	141.36	145.94
.340	111.23	102.64	108.79	114.47	119.55	124.98	130.18	135.20	140.04	144.79	149.44
.350	102.34	104.36	110.90	117.04	122.50	128.03	133.30	138.41	143.34	148.15	152.85
.380	101.62	105.30	112.40	119.57	125.44	131.07	136.43	141.62	146.33	151.19	155.96
.400	99.84	107.76	115.08	122.40	128.36	134.07	139.53	144.78	149.58	154.52	159.33
.420	100.52	108.46	117.74	125.22	131.24	137.05	142.60	147.92	152.79	157.80	162.67
.440	99.76	110.81	118.81	127.98	134.12	139.99	145.62	151.03	155.95	161.04	166.00
.460	101.42	111.41	121.04	130.75	136.97	142.92	148.63	154.11	159.10	164.26	169.27

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LCAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060	19.61	24.08	28.35	32.57	141.19	134.40	130.56	128.60	128.13	129.71	132.64
.080	22.94	27.68	32.10	36.39	133.26	121.97	122.09	121.93	122.51	125.32	128.90
.100	26.08	31.11	35.72	40.13	116.20	113.44	116.18	115.74	118.52	122.38	126.27
.120	507.11	130.36	121.34	114.54	109.05	108.47	112.06	115.92	117.19	121.03	125.24
.140	249.76	115.82	110.68	107.27	105.67	106.37	110.22	113.64	116.59	120.81	125.02
.160	182.79	109.60	103.08	102.10	103.45	106.03	109.78	113.86	118.39	122.38	126.60
.180	172.01	104.55	105.15	102.05	103.12	106.96	111.03	115.04	118.97	123.25	127.50
.200	161.55	104.52	102.36	102.74	104.29	108.62	112.78	116.85	120.85	125.16	129.43
.220	152.71	104.08	103.01	103.89	105.96	110.75	115.39	119.89	124.14	129.51	132.82
.240	146.75	104.42	103.97	105.44	108.41	113.30	118.04	122.64	127.11	131.54	135.91
.260	138.36	103.83	105.06	107.56	111.09	116.07	120.85	125.50	129.84	134.30	138.72
.280	131.52	104.02	106.47	109.63	114.09	119.18	124.05	128.78	133.35	137.88	142.33
.300	130.18	104.29	108.24	112.57	117.04	122.23	127.25	132.08	136.80	141.41	145.92
.320	121.13	105.85	110.34	115.18	120.07	125.38	130.50	135.42	140.21	144.89	149.47
.340	117.10	106.53	112.41	118.05	123.08	128.50	133.70	138.72	143.57	148.31	152.96
.360	107.28	108.17	114.46	120.60	126.02	131.55	136.82	141.93	146.86	151.66	156.37
.380	106.27	109.10	115.96	123.09	128.96	134.59	139.95	145.14	149.82	154.68	159.45
.400	104.31	111.55	118.63	125.93	131.88	137.59	143.05	148.30	153.06	158.01	162.82
.420	104.85	112.25	121.30	128.74	134.76	140.57	146.12	151.44	156.28	161.29	166.16
.440	104.05	114.61	122.37	131.49	137.64	143.51	149.14	154.55	159.44	164.53	169.49
.460	105.69	115.24	124.57	134.27	140.49	146.43	152.15	157.63	162.59	167.75	172.76

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					150.69	142.89	138.32	135.78	134.87	136.20	139.00
.080					141.68	128.98	128.73	128.17	128.41	131.09	134.60
.100					122.73	119.32	121.93	121.07	123.72	127.54	131.40
.120	550.56	139.08	128.80	120.98	114.58	113.56	117.10	120.92	121.92	125.73	129.94
.140	269.56	122.93	116.87	112.72	110.57	110.93	114.75	118.09	120.92	125.13	129.35
.160	196.74	115.86	108.28	106.77	107.82	110.23	113.93	117.99	122.54	126.50	130.73
.180	184.22	110.08	110.25	106.41	107.14	110.92	114.96	118.93	122.83	127.10	131.36
.200	172.62	109.79	106.92	106.86	108.12	112.41	116.54	120.57	124.54	128.85	133.12
.220	162.81	109.05	107.35	107.84	109.64	114.42	119.06	123.57	127.79	132.16	136.47
.240	156.07	109.15	108.13	109.24	112.01	116.90	121.64	126.24	130.71	135.14	139.51
.260	146.78	108.26	109.05	111.28	114.64	119.62	124.40	129.04	133.36	137.82	142.24
.280	139.21	108.21	110.33	113.25	117.62	122.71	127.58	132.30	136.87	141.41	145.85
.300	137.53	108.35	111.99	116.19	120.57	125.75	130.77	135.60	140.32	144.93	149.44
.320	127.57	109.81	114.03	118.77	123.59	128.90	134.02	138.94	143.73	148.41	152.99
.340	122.97	110.42	116.03	121.64	126.60	132.02	137.23	142.24	147.09	151.84	156.49
.360	112.21	111.97	118.01	124.16	129.54	135.07	140.34	145.45	150.38	155.18	159.89
.380	110.92	112.89	119.51	126.61	132.48	138.11	143.47	148.66	153.31	158.17	162.94
.400	108.77	115.35	122.19	129.45	135.40	141.11	146.57	151.82	156.55	161.50	166.31
.420	109.17	116.05	124.86	132.26	138.28	144.09	149.64	154.96	159.77	164.78	169.65
.440	108.35	118.40	125.93	135.01	141.15	147.03	152.66	158.07	162.93	168.02	172.98
.460	109.96	119.06	128.09	137.79	144.01	149.95	155.67	161.15	166.08	171.24	176.25

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					126.07	121.14	118.59	117.54	117.71	119.57	122.53
.080					121.57	113.18	113.95	114.48	115.54	118.41	121.89
.100					109.16	108.01	111.20	111.62	114.55	118.36	122.14
.120	421.97	113.19	111.02	107.38	104.51	105.40	109.51	113.66	115.57	119.47	123.56
.140	211.69	104.66	102.84	102.16	102.69	104.87	109.41	113.42	116.87	121.25	125.52
.160	157.18	99.92	97.05	98.51	101.63	105.54	110.21	114.95	119.89	124.24	128.67
.180	148.68	95.14	94.13	98.97	101.99	107.10	112.20	117.06	121.67	126.44	131.05
.200	140.35	95.39	97.20	99.95	103.49	109.14	114.47	119.52	124.36	129.27	134.08
.220	133.33	95.30	98.06	101.28	105.33	111.47	117.30	122.86	128.03	133.17	138.09
.240	128.81	95.87	99.20	102.90	107.77	114.06	120.08	125.83	131.33	136.63	141.77
.260	122.13	96.70	100.56	104.99	110.34	116.77	122.93	128.82	134.32	139.78	145.05
.280	116.70	97.20	101.79	107.01	113.16	119.76	126.05	132.09	137.88	143.51	148.91
.300	115.96	97.59	103.51	109.77	115.94	122.63	129.10	135.31	141.30	147.09	152.68
.320	108.66	99.21	105.53	112.18	118.73	125.60	132.20	138.55	144.67	150.56	156.28
.340	105.72	99.91	107.54	114.79	121.56	128.49	135.19	141.66	147.91	153.95	159.83
.360	97.73	101.61	109.54	117.15	124.31	131.35	138.14	144.73	151.10	157.21	163.19
.380	97.26	102.48	110.88	119.47	126.99	134.15	141.04	147.72	153.93	160.20	166.29
.400	95.64	104.85	113.41	122.09	129.63	136.98	143.94	150.71	157.02	163.38	169.54
.420	96.42	105.47	115.94	124.71	132.27	139.75	146.77	153.62	160.01	166.49	172.78
.440	95.68	107.76	116.89	127.29	134.90	142.44	149.59	156.53	163.00	169.58	175.94
.460	97.35	108.26	119.54	129.89	137.52	145.08	152.43	159.42	165.95	172.57	179.05

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					135.56	129.63	126.34	124.72	124.45	126.06	128.89
.080					129.99	120.19	120.59	120.72	121.45	124.18	127.59
.100					115.69	113.90	116.95	116.95	119.75	123.53	127.28
.120	465.43	124.92	118.49	113.82	110.04	110.50	114.55	118.66	120.30	124.16	128.26
.140	231.48	111.78	109.03	107.61	107.58	109.43	113.93	117.87	121.20	125.58	129.84
.160	170.63	106.19	102.25	103.18	106.00	109.74	114.35	119.07	124.04	128.36	132.79
.180	160.89	101.68	104.23	103.33	106.02	111.06	116.13	120.95	125.53	130.30	134.91
.200	151.42	101.65	101.76	104.07	107.32	112.93	118.23	123.24	128.05	132.96	137.77
.220	143.43	101.27	102.41	105.22	109.01	115.14	120.97	126.53	131.68	136.83	141.75
.240	138.13	101.61	103.36	106.70	111.37	117.66	123.68	129.43	134.93	140.23	145.37
.260	130.55	101.13	104.35	108.70	113.89	120.32	126.47	132.37	137.84	143.30	148.57
.280	124.38	101.39	105.65	110.53	116.69	123.29	129.58	135.62	141.41	147.03	152.43
.300	123.31	101.65	107.27	113.40	119.46	126.15	132.62	138.83	144.82	150.61	156.20
.320	115.11	103.17	109.22	115.77	122.26	129.12	135.72	142.07	148.19	154.08	159.80
.340	111.59	103.81	111.16	118.38	125.08	132.01	138.72	145.19	151.43	157.47	163.35
.360	102.67	105.42	113.10	120.71	127.83	134.87	141.66	148.25	154.62	160.73	166.71
.380	101.91	106.27	114.43	123.00	130.51	137.67	144.56	151.24	157.41	163.69	169.78
.400	100.10	108.64	116.96	125.62	133.15	140.50	147.46	154.23	160.51	166.87	173.03
.420	100.75	109.27	119.49	128.23	135.79	143.27	150.29	157.14	163.50	169.98	176.27
.440	99.97	111.55	120.44	130.81	138.42	145.96	153.11	160.05	166.49	173.07	179.43
.460	101.62	112.09	122.56	133.41	141.04	148.60	155.95	162.94	169.44	176.06	182.54

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					145.05	138.12	134.09	131.90	131.20	132.55	135.25
.080					138.41	127.20	127.23	126.96	127.35	129.95	133.30
.100					122.21	119.79	122.71	122.28	124.95	128.69	132.41
.120	508.88	133.64	125.95	120.25	115.58	115.59	119.58	123.66	125.03	128.86	132.96
.140	251.28	118.89	115.22	113.06	112.48	113.99	118.45	122.31	125.53	129.91	134.17
.160	184.07	112.45	107.45	107.85	110.38	113.94	118.49	123.19	128.19	132.49	136.91
.180	173.10	107.21	109.33	107.69	110.04	115.02	120.05	124.84	129.39	134.16	138.77
.200	162.49	106.92	106.33	108.20	111.14	116.73	121.98	126.96	131.74	136.66	141.46
.220	153.53	106.23	106.75	109.16	112.68	118.81	124.65	130.21	135.34	140.49	145.40
.240	147.45	106.34	107.52	110.49	114.97	121.26	127.28	133.03	138.53	142.83	148.97
.260	138.97	105.56	108.34	112.41	117.45	123.87	130.02	135.91	141.36	146.82	152.10
.280	132.06	105.58	109.50	114.26	120.23	126.83	133.12	139.15	144.93	150.56	155.95
.300	130.66	105.71	111.02	117.02	122.99	129.68	136.14	142.35	148.35	154.13	159.73
.320	121.55	107.13	112.91	119.36	125.78	132.65	139.24	145.59	151.71	157.60	163.33
.340	117.46	107.70	114.73	121.96	128.60	135.54	142.24	148.71	154.95	160.99	166.87
.360	107.60	109.23	116.65	124.26	131.35	138.39	145.18	151.77	158.14	164.25	170.23
.380	106.56	110.06	117.99	126.52	134.03	141.19	148.08	154.76	160.90	167.17	173.27
.400	104.56	112.43	120.52	129.14	136.67	144.51	150.98	157.75	164.00	170.36	176.52
.420	105.08	113.06	123.05	131.75	139.31	146.79	153.81	160.66	166.99	173.47	179.76
.440	104.27	115.35	124.00	134.33	141.94	149.47	156.63	163.57	169.98	176.56	182.92
.460	105.89	115.91	126.08	136.93	144.56	152.12	159.46	166.46	172.93	179.55	186.03

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060					154.54	146.61	141.84	139.08	137.94	139.05	141.61
.080					146.83	134.21	133.87	133.20	133.26	135.72	139.00
.100					128.74	125.67	128.46	127.61	130.15	133.86	137.54
.120	552.34	142.36	133.42	126.69	121.12	120.68	124.61	128.66	129.76	133.56	137.66
.140	271.07	126.00	121.41	118.51	117.38	118.56	122.98	126.76	129.86	134.23	138.50
.160	197.52	118.72	112.65	112.52	114.75	118.14	122.64	127.32	132.34	136.61	141.04
.180	185.32	112.75	114.43	112.05	114.07	118.98	123.98	128.73	133.25	138.02	142.63
.200	173.56	112.19	110.89	112.33	114.96	120.52	125.74	130.69	135.43	140.35	145.15
.220	163.63	111.20	111.10	113.11	116.35	122.49	128.32	133.88	139.00	144.14	149.06
.240	156.78	111.08	111.68	114.29	118.57	124.86	130.88	136.63	142.13	147.43	152.57
.260	147.39	109.99	112.34	116.12	121.00	127.42	133.57	139.45	144.88	150.34	155.62
.280	139.75	109.78	113.36	117.88	123.77	130.37	136.65	142.68	148.45	154.08	159.48
.300	138.00	109.77	114.78	120.64	126.52	133.20	139.67	145.88	151.87	157.66	163.25
.320	127.99	111.09	116.60	122.95	129.30	136.17	142.77	149.11	155.23	161.13	166.85
.340	123.34	111.59	118.41	125.55	132.12	139.06	145.76	152.23	158.47	164.52	170.40
.360	112.53	113.03	120.21	127.82	134.87	141.90	148.70	155.29	161.66	167.77	173.75
.380	111.20	113.86	121.54	130.04	137.55	144.71	151.60	158.28	164.39	170.66	176.76
.400	109.03	116.23	124.08	132.66	140.19	147.53	154.50	161.27	167.49	173.85	180.01
.420	109.41	116.86	126.61	135.28	142.83	150.30	157.33	164.18	170.48	176.96	183.25
.440	108.56	119.14	127.56	137.85	145.46	152.99	160.15	167.09	173.47	180.05	186.41
.460	110.16	119.74	129.61	140.45	148.08	155.64	162.98	169.98	176.42	183.04	189.52

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											178.95
.080											142.28
.100											135.20
.120					124.90	123.76	123.34	123.92	125.55	127.87	130.41
.140					119.13	118.27	118.58	119.82	121.97	124.73	128.15
.160					116.18	115.74	117.27	118.80	121.19	124.71	128.24
.180					113.21	114.47	115.70	117.80	121.30	125.09	128.91
.200	285.76	153.32	121.43	114.40	112.31	113.22	115.50	118.70	122.18	126.47	130.79
.220	196.96	133.92	116.10	111.77	112.03	114.33	116.29	119.52	123.31	127.53	131.30
.240	170.32	128.88	114.25	113.64	111.85	114.56	117.26	120.79	124.30	128.38	132.45
.260	156.33	124.41	114.03	113.45	112.80	115.80	118.78	122.32	126.42	130.47	134.56
.280	150.65	124.14	114.63	114.51	113.74	117.31	121.01	124.41	128.66	132.61	137.22
.300	144.95	122.17	114.95	115.83	116.06	118.83	122.67	126.79	131.14	135.27	139.64
.320	142.94	120.74	115.58	115.88	118.05	120.84	125.08	129.20	133.60	137.99	142.37
.340	140.58	121.56	117.83	118.15	119.05	123.24	127.38	131.51	135.91	140.30	144.69
.360	138.24	121.52	119.53	119.62	121.63	125.57	130.02	134.43	138.84	143.24	147.62
.380	138.14	121.19	122.03	121.91	124.22	128.46	132.93	137.35	141.76	146.16	150.56
.400	137.48	122.25	122.29	123.91	127.08	131.33	135.82	140.27	144.68	149.10	153.49
.420	137.38	123.87	124.27	126.46	129.84	134.40	138.91	143.38	147.80	152.10	156.50
.440	139.02	125.49	126.43								
.460	139.13	127.38	128.97								
.480	139.30	129.83	131.74								
.500	138.89	132.55	134.49								
.520	141.02	135.00	137.25								
.540	142.30	137.71	139.99								
.560	143.99	140.14	142.87								
.580	144.89	142.91	145.46								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											191.47
.080											150.43
.100											142.24
.120					133.42	131.67	130.71	130.87	132.20	134.28	136.61
.140					126.68	125.23	125.10	125.99	127.90	130.47	133.78
.160					123.07	122.10	123.31	124.53	126.70	130.13	133.57
.180					119.44	120.36	121.24	123.08	126.49	130.22	133.99
.200	312.82	165.15	129.23	120.93	118.11	118.64	120.69	123.76	127.15	131.43	135.75
.220	213.84	143.28	123.20	117.68	117.48	119.55	121.24	124.35	128.07	132.27	135.99
.240	183.92	137.37	120.61	119.43	116.96	119.48	121.99	125.43	128.84	132.88	136.93
.260	168.08	132.08	120.04	118.89	117.69	120.53	123.36	126.80	130.87	134.88	138.95
.280	161.46	131.47	120.40	119.75	118.41	121.89	125.50	128.80	133.02	136.93	141.57
.300	154.82	128.96	120.43	120.90	120.66	123.24	127.03	131.11	135.46	139.56	143.93
.320	152.28	127.07	120.81	120.64	122.55	125.15	129.38	133.47	137.87	142.25	146.63
.340	149.35	127.67	122.99	122.84	123.34	127.50	131.61	135.71	140.11	144.49	148.89
.360	146.44	127.31	124.57	124.16	125.89	129.76	134.21	138.63	143.04	147.43	151.82
.380	146.04	126.63	127.04	126.39	128.45	132.65	137.12	141.55	145.96	150.36	154.76
.400	145.00	127.51	127.02	128.30	131.30	135.53	140.02	144.46	148.88	153.29	157.69
.420	144.58	129.01	128.90	130.81	134.06	138.62	143.13	147.59	152.02	156.30	160.71
.440	146.10	130.50	130.99	133.32	136.70	141.26	145.79	150.27	154.71	159.13	163.54
.460	145.92	132.30	133.52								
.480	145.81	134.71	136.28								
.500	145.06	137.44	139.03								
.520	147.13	139.85	141.79								
.540	148.25	142.57	144.53								
.560	149.83	144.96	147.42								
.580	150.53	147.74	150.01								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											203.99
.080											158.57
.100											149.29
.120					141.94	139.58	138.09	137.82	138.85	140.69	142.81
.140					134.23	132.20	131.62	132.16	133.82	136.22	139.42
.160					129.95	128.45	129.36	130.26	132.21	135.55	138.89
.180					125.67	126.25	126.78	128.37	131.69	135.35	139.06
.200	339.88	176.99	137.02	127.45	123.92	124.07	125.88	128.82	132.11	136.38	140.70
.220	230.72	152.64	130.11	123.59	122.92	124.77	126.19	129.17	132.83	137.02	140.67
.240	197.53	145.85	126.97	125.23	122.06	124.40	126.72	130.06	133.39	137.39	141.40
.260	179.82	139.75	126.05	124.34	122.57	125.26	127.93	131.28	135.31	139.29	143.33
.280	172.26	138.80	126.16	125.00	123.08	126.46	130.00	133.18	137.39	141.25	145.92
.300	164.68	135.76	125.91	125.98	125.26	127.66	131.38	135.43	139.78	143.85	148.22
.320	161.61	133.39	126.04	125.40	127.05	129.47	133.68	137.73	142.13	146.52	150.90
.340	158.12	133.77	128.16	127.54	127.63	131.76	135.84	139.91	144.30	148.69	153.08
.360	154.65	133.10	129.61	128.70	130.15	133.96	138.41	142.82	147.23	151.63	156.01
.380	153.93	132.08	132.04	130.87	132.67	136.85	141.32	145.75	150.16	154.55	158.95
.400	152.51	132.77	131.74	132.68	135.53	139.72	144.21	148.66	153.08	157.49	161.88
.420	151.78	134.15	133.54	135.17	138.28	142.84	147.35	151.81	156.24	160.51	164.91
.440	153.18	135.51	135.56	137.65	140.89	145.46	149.98	154.47	158.91	163.33	167.74
.460	152.72	137.21	138.06								
.480	152.32	139.60	140.82								
.500	151.23	142.32	143.57								
.520	153.23	144.70	146.32								
.540	154.20	147.42	149.07								
.560	155.67	149.79	151.96								
.580	156.18	152.57	154.55								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											216.51
.080											166.71
.100											156.34
.120					150.46	147.48	145.46	144.77	145.49	147.10	149.01
.140					141.77	139.17	138.14	138.33	139.75	141.96	145.05
.160					136.84	134.81	135.40	135.99	137.72	140.96	144.21
.180					131.90	132.13	132.32	133.66	136.88	140.49	144.13
.200	366.94	188.83	144.82	133.98	129.73	129.49	131.07	133.89	137.07	141.34	145.65
.220	247.60	162.01	137.01	129.49	128.37	129.98	131.13	133.99	137.59	141.76	145.35
.240	211.14	154.34	133.33	131.02	127.17	129.31	131.44	134.70	137.93	141.90	145.88
.260	191.56	147.42	132.06	129.79	127.46	129.99	132.50	135.76	139.76	143.70	147.72
.280	183.06	146.12	131.92	130.24	127.74	131.03	134.49	137.56	141.76	145.57	150.27
.300	174.55	142.56	131.39	131.05	129.86	132.07	135.73	139.75	144.10	148.14	152.51
.320	170.95	139.72	131.28	130.16	131.55	133.78	137.97	142.00	146.40	150.78	155.16
.340	166.88	139.88	133.33	132.23	131.92	136.02	140.07	144.10	148.50	152.89	157.28
.360	162.85	138.90	134.65	133.24	134.41	138.16	142.61	147.02	151.43	155.83	160.21
.380	161.82	137.53	137.05	135.35	136.90	141.05	145.52	149.94	154.35	158.75	163.15
.400	160.03	138.03	136.47	137.07	139.76	143.92	148.41	152.86	157.27	161.68	166.08
.420	158.98	139.28	138.17	139.52	142.50	147.05	151.56	156.03	160.45	164.72	169.12
.440	160.27	140.52	140.12	141.97	145.09	149.65	154.18	158.66	163.11	167.52	171.94
.460	159.51	142.13	142.60								
.480	158.84	144.48	145.36								
.500	157.40	147.21	148.12								
.520	159.34	149.56	150.87								
.540	160.15	152.27	153.61								
.560	161.51	154.61	156.54								
.580	161.82	157.40	159.09								

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											179.73
.080											143.76
.100											137.50
.120					129.11	127.87	127.31	127.72	129.17	131.27	133.61
.140					124.10	123.18	123.42	124.53	126.52	129.10	132.33
.160					121.83	121.42	122.90	124.35	126.62	130.00	133.37
.180					119.49	120.84	122.09	124.13	127.56	131.25	134.95
.200	290.12	158.70	127.52	120.95	119.17	120.23	122.58	125.80	129.23	133.45	137.68
.220	201.37	139.48	122.68	118.73	119.38	121.93	124.01	127.31	131.12	135.29	139.00
.240	174.76	134.58	120.57	120.95	119.64	122.69	125.59	129.23	132.81	135.89	140.92
.260	160.80	130.19	120.86	121.05	120.99	124.40	127.67	131.39	135.57	139.58	143.79
.280	155.12	129.98	121.63	122.36	122.27	126.33	130.39	134.05	138.45	142.47	147.14
.300	149.41	128.06	122.07	123.91	124.88	128.24	132.50	136.94	141.52	145.76	150.22
.320	147.38	126.67	122.79	124.15	127.13	130.58	135.33	139.84	144.52	149.10	153.59
.340	144.99	127.51	125.10	126.57	128.36	133.28	138.02	142.58	147.33	151.98	156.53
.360	142.61	127.48	126.85	128.17	131.16	135.87	140.98	145.91	150.72	155.43	160.04
.380	142.47	127.14	129.40	130.55	133.92	139.00	144.19	149.21	154.06	158.83	163.51
.400	141.76	123.20	129.70	132.62	136.93	142.10	147.35	152.45	157.39	162.20	166.94
.420	141.60	129.80	131.70	135.22	139.82	145.37	150.69	155.86	160.87	165.63	170.42
.440	143.18	131.39	133.87	137.81	142.56	148.20	153.60	158.83	163.92	168.87	173.69
.460	143.23	133.25	136.42								
.480	143.33	135.66	139.18								
.500	142.86	138.34	141.93								
.520	144.92	140.73	144.66								
.540	146.13	143.40	147.38								
.560	147.76	145.77	150.23								
.580	148.59	148.48	152.79								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											192.25
.080											151.90
.100											144.55
.120					137.63	135.78	134.68	134.67	135.81	137.68	139.81
.140					131.65	130.15	129.94	130.70	132.44	134.84	137.96
.160					128.72	127.77	128.94	130.08	132.13	135.42	138.70
.180					125.72	126.73	127.63	129.42	132.76	136.38	140.02
.200	317.18	170.54	135.32	127.48	124.97	125.65	127.77	130.86	134.20	138.41	142.64
.220	218.25	148.85	129.58	124.64	124.83	127.15	128.96	132.14	135.88	140.03	143.68
.240	188.37	143.07	127.23	126.74	124.75	127.60	130.32	133.86	137.35	141.40	145.40
.260	172.54	137.86	126.87	126.49	125.88	129.13	132.25	135.87	140.02	144.09	148.17
.280	165.92	137.31	127.39	127.60	126.94	130.90	134.89	138.44	142.82	146.80	151.49
.300	159.28	134.86	127.55	128.98	129.48	132.65	136.86	141.26	145.84	150.07	154.51
.320	156.72	133.00	128.02	128.91	131.63	134.90	139.63	144.11	148.79	153.37	157.85
.340	153.76	133.62	130.27	131.27	132.65	137.54	142.25	146.78	151.52	156.17	160.73
.360	150.81	133.27	131.90	132.71	135.42	140.07	145.18	150.11	154.91	159.62	164.24
.380	150.36	132.59	134.41	135.03	138.15	143.20	148.39	153.40	158.26	163.03	167.71
.400	149.27	133.46	134.43	137.00	141.15	146.30	151.55	156.64	161.59	166.40	171.13
.420	148.80	134.94	136.34	139.58	144.04	149.59	154.91	160.08	165.09	169.83	174.62
.440	150.26	136.40	138.44	142.14	146.76	152.39	157.79	163.02	168.11	173.07	177.89
.460	150.03	138.16	140.96								
.480	149.84	140.54	143.72								
.500	149.03	143.22	146.47								
.520	151.03	145.58	149.20								
.540	152.08	148.25	151.92								
.560	153.60	150.59	154.79								
.580	154.24	153.31	157.33								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											204.77
.080											160.04
.100											151.59
.120					146.14	143.68	142.06	141.62	142.46	144.09	146.01
.140					139.19	137.12	136.46	136.87	138.37	140.59	143.60
.160					135.60	134.13	134.99	135.81	137.64	140.84	144.02
.180					131.96	132.61	133.17	134.71	137.95	141.52	145.10
.200	344.24	182.38	143.11	134.01	130.78	131.07	132.96	135.92	139.16	143.37	147.59
.220	235.13	158.21	136.49	130.55	130.28	132.37	133.91	136.96	140.64	144.78	148.36
.240	201.68	151.55	133.59	132.54	129.85	132.52	135.05	138.50	141.89	145.91	149.88
.260	184.29	145.53	132.88	131.94	130.76	133.85	136.82	140.35	144.46	148.50	152.56
.280	176.73	144.64	133.15	132.85	131.60	135.48	139.38	142.82	147.19	151.12	155.84
.300	169.14	141.65	133.03	134.06	134.08	137.07	141.21	145.59	150.16	154.36	158.81
.320	166.05	139.32	133.25	133.67	136.13	139.21	143.93	148.37	153.05	157.63	162.12
.340	162.52	139.72	135.44	135.96	136.94	141.80	146.47	150.97	155.72	160.37	164.92
.360	159.02	139.06	136.94	137.25	139.68	144.27	149.37	154.31	159.11	163.82	168.43
.380	158.25	138.04	139.42	139.50	142.38	147.39	152.58	157.60	162.46	167.23	171.91
.400	156.79	138.72	139.15	141.39	145.38	150.50	155.74	160.84	165.79	170.60	175.33
.420	156.00	140.07	140.97	143.93	148.25	153.81	159.12	164.30	169.31	174.04	178.83
.440	157.35	141.41	143.00	146.46	150.95	156.59	161.99	167.22	172.31	177.26	182.08
.460	156.82	143.03	145.50								
.480	156.35	145.43	148.26								
.500	155.20	148.11	151.01								
.520	157.13	150.44	153.74								
.540	158.03	153.11	156.46								
.560	159.44	155.42	159.34								
.580	159.88	158.14	161.97								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											217.29
.080											168.18
.100											158.64
.120					154.66	151.59	149.43	148.57	149.10	150.50	152.21
.140					146.74	144.09	142.98	143.05	144.29	146.33	149.23
.160					142.49	140.49	141.03	141.54	143.16	146.26	149.34
.180					138.19	138.50	138.71	140.00	143.15	146.65	150.17
.200	371.30	194.21	150.91	140.53	136.58	136.49	138.15	140.98	144.12	148.32	152.54
.220	252.01	167.57	143.39	136.46	135.72	137.58	138.85	141.78	145.40	149.52	153.05
.240	215.58	160.04	139.95	138.33	134.96	137.44	139.78	143.13	146.43	150.42	154.36
.260	196.03	153.20	138.90	137.39	135.65	138.58	141.39	144.82	148.91	152.92	156.94
.280	187.53	151.97	138.92	138.09	136.27	140.05	143.88	147.20	151.55	155.44	160.19
.300	179.01	148.45	138.51	139.13	138.68	141.48	145.56	149.91	154.48	158.65	163.10
.320	175.39	145.65	138.49	138.43	140.63	143.53	148.22	152.64	157.32	161.90	166.38
.340	171.29	145.83	140.60	140.66	141.23	146.06	150.70	155.17	159.92	164.57	169.12
.360	167.22	144.86	141.98	141.79	143.94	148.46	153.57	158.50	163.31	168.01	172.63
.380	166.15	143.49	144.43	143.98	146.60	151.59	156.78	161.80	166.65	171.42	176.10
.400	164.31	143.98	143.88	145.77	149.61	154.69	159.94	165.04	169.98	174.79	179.53
.420	163.21	145.21	145.60	148.28	152.47	158.02	163.34	168.52	173.53	178.24	183.04
.440	164.43	146.42	147.57	150.78	155.15	160.79	166.19	171.42	176.51	181.46	186.28
.460	163.62	148.00	150.04								
.480	162.87	150.31	152.81								
.500	161.37	152.99	155.55								
.520	163.24	155.29	158.28								
.540	163.98	157.96	161.00								
.560	165.28	160.24	163.90								
.580	165.52	162.97	166.41								

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											182.11
.080											147.94
.100											143.45
.120					136.23	135.38	135.04	135.56	137.00	138.98	141.21
.140					131.72	131.41	132.09	133.47	135.62	138.25	141.44
.160					129.74	130.13	132.23	134.15	136.73	140.31	143.83
.180	46.32	157.40	59.71	65.76	127.56	129.86	131.89	134.55	138.47	142.52	146.47
.200	292.51	162.67	132.98	127.80	127.27	129.44	132.70	136.69	140.73	145.48	150.11
.220	203.52	143.23	127.95	125.45	127.44	131.19	134.32	138.52	143.10	147.87	152.13
.240	176.69	138.13	125.93	127.51	127.60	131.92	135.99	140.65	145.10	149.96	154.59
.260	162.53	133.47	125.70	127.40	128.79	133.57	138.09	142.91	148.09	153.06	157.94
.280	156.68	133.01	126.26	128.51	129.92	135.40	140.77	145.64	151.12	156.09	161.61
.300	150.83	130.85	126.52	129.86	132.33	137.13	142.78	148.49	154.25	159.59	164.94
.320	148.66	129.24	126.97	129.87	134.40	139.33	145.51	151.35	157.24	162.96	168.50
.340	146.15	129.88	129.01	132.10	135.40	141.82	148.01	153.97	160.01	165.89	171.52
.360	143.67	129.67	130.52	133.50	138.00	144.23	150.82	157.19	163.30	169.28	175.09
.380	143.44	129.17	132.83	135.62	140.52	147.13	153.81	160.29	166.56	172.65	178.53
.400	142.64	130.08	132.92	137.41	143.35	150.03	156.80	163.38	169.75	175.90	181.93
.420	142.41	131.55	134.71	139.77	146.03	153.06	159.91	166.57	173.05	179.23	185.34
.440	143.92	133.02	136.70	142.12	148.53	155.68	162.62	169.37	175.94	182.30	188.50
.460	143.91	134.76	139.08								
.480	143.95	137.07	141.68								
.500	143.43	139.66	144.28								
.520	145.44	141.96	146.88								
.540	146.61	144.55	149.47								
.560	148.20	146.85	152.21								
.580	149.01	149.49	154.66								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											194.63
.080											156.08
.100											150.50
.120					144.74	143.29	142.41	142.51	143.64	145.39	147.41
.140					139.27	138.38	138.61	139.64	141.55	143.99	147.07
.160					136.63	136.48	138.27	139.88	142.24	145.73	149.15
.180					133.79	135.75	137.43	139.84	143.67	147.66	151.54
.200	319.57	174.51	140.78	134.33	133.08	134.86	137.89	141.75	145.69	150.43	155.06
.220	220.40	152.59	134.85	131.36	132.89	136.41	139.27	143.34	147.86	152.62	156.82
.240	190.30	146.62	132.29	133.30	132.71	136.84	140.72	145.28	149.64	154.47	159.07
.260	174.28	141.15	131.72	132.85	133.68	138.30	142.66	147.39	152.54	157.47	162.33
.280	167.49	140.34	132.02	133.75	134.59	139.97	145.26	150.02	155.49	160.42	165.96
.300	160.69	137.64	132.00	134.93	136.93	141.55	147.13	152.81	158.57	163.88	169.23
.320	158.00	135.57	132.20	134.63	138.90	143.64	149.80	155.61	161.50	167.23	172.77
.340	154.92	135.99	134.18	136.79	139.69	146.08	152.23	158.16	164.21	170.08	175.72
.360	151.87	135.47	135.56	138.04	142.26	148.43	155.02	161.38	167.50	173.48	179.29
.380	151.33	134.62	137.84	140.10	144.75	151.33	158.01	164.48	170.76	176.85	182.73
.400	150.16	135.34	137.64	141.80	147.58	154.23	161.00	167.58	173.94	180.10	186.13
.420	149.61	136.69	139.35	144.12	150.25	157.28	164.13	170.79	177.27	183.44	189.55
.440	151.00	138.03	141.27	146.44	152.72	159.88	166.82	173.56	180.14	186.50	192.70
.460	150.70	139.63	143.62								
.480	150.46	141.96	146.23								
.500	149.60	144.55	148.83								
.520	151.55	146.82	151.42								
.540	152.56	149.40	154.02								
.560	154.05	151.67	156.77								
.580	154.65	154.32	159.20								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											207.15
.080											164.22
.100											157.55
.120					153.26	151.20	149.79	149.46	150.29	151.80	153.61
.140					146.82	145.35	145.13	145.82	147.47	149.74	152.71
.160					143.52	142.84	144.32	145.61	147.75	151.15	154.48
.180					140.02	141.63	142.97	145.13	148.86	152.79	156.62
.200	346.63	186.34	148.58	140.85	138.89	140.28	143.08	146.81	150.66	155.39	160.01
.220	237.28	161.95	141.76	137.27	138.34	141.62	144.22	148.16	152.62	157.36	161.50
.240	203.90	155.11	138.64	139.10	137.81	141.76	145.45	149.92	154.18	158.98	163.55
.260	186.02	149.82	137.73	138.30	138.56	143.02	147.23	151.87	156.98	161.88	166.71
.280	178.29	147.67	137.78	139.00	139.26	144.55	149.75	154.40	159.86	164.74	170.31
.300	170.56	144.44	137.48	140.01	141.53	145.96	151.48	157.13	162.88	168.17	173.52
.320	167.33	141.89	137.43	139.39	143.40	147.96	154.10	159.88	165.77	171.49	177.03
.340	163.69	142.09	139.35	141.49	143.98	150.34	156.46	162.36	168.40	174.28	179.91
.360	160.08	141.26	140.60	142.58	146.52	152.63	159.21	165.58	171.70	177.67	183.48
.380	159.22	140.07	142.85	144.57	148.98	155.52	162.21	168.68	174.95	181.04	186.92
.400	157.67	140.61	142.37	146.18	151.80	158.43	165.19	171.77	178.14	184.29	190.32
.420	156.81	141.82	143.98	148.48	154.47	161.50	168.35	175.01	181.48	187.64	193.75
.440	158.09	143.04	145.84	150.76	156.92	164.07	171.01	177.76	184.33	190.70	196.89
.460	157.50	144.60	148.16								
.480	156.98	146.84	150.77								
.500	155.77	149.43	153.77								
.520	157.66	151.67	155.96								
.540	158.51	154.26	158.56								
.560	159.89	156.50	161.12								
.580	160.29	159.15	163.74								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											219.67
.080											172.36
.100											164.59
.120					151.78	159.10	157.16	156.42	156.93	158.21	159.81
.140					154.36	152.32	151.65	151.99	153.40	155.48	158.34
.160					150.41	149.20	150.36	151.34	153.27	156.57	159.80
.180					146.25	147.52	148.51	150.42	154.06	157.92	161.69
.200	373.69	198.18	156.38	147.38	144.69	145.70	148.27	151.87	155.62	160.35	164.97
.220	254.16	171.32	148.66	143.18	143.79	146.84	149.17	152.98	157.38	162.11	166.18
.240	217.51	163.59	145.00	144.89	142.92	146.67	150.17	154.55	158.72	163.48	168.03
.260	197.76	156.49	143.74	143.75	143.45	147.75	151.80	156.35	161.43	166.29	171.10
.280	189.10	155.00	143.54	144.24	143.92	149.12	154.25	158.79	164.23	169.06	174.66
.300	180.42	151.23	142.96	145.08	146.13	150.38	155.84	161.45	167.20	172.46	177.81
.320	173.67	148.22	142.66	144.15	147.90	152.27	158.40	164.14	170.03	175.76	181.30
.340	172.46	148.20	144.52	146.18	148.27	154.59	160.69	166.55	172.60	178.48	184.11
.360	168.28	147.05	145.64	147.12	150.78	156.82	163.41	169.78	175.89	181.87	187.68
.380	167.11	145.52	147.86	149.05	153.20	159.72	166.40	172.88	179.15	185.24	191.12
.400	165.19	145.87	147.09	150.57	156.03	162.62	169.39	175.97	182.34	188.49	194.52
.420	164.02	146.96	148.62	152.83	158.69	165.72	172.57	179.23	185.70	191.85	197.96
.440	165.17	148.05	150.40	155.08	161.12	168.27	175.21	181.95	188.53	194.89	201.09
.460	164.29	149.51	152.71								
.480	163.49	151.73	155.31								
.500	161.94	154.32	157.91								
.520	163.76	156.53	160.50								
.540	164.46	159.11	163.10								
.560	165.73	161.32	165.88								
.580	165.94	163.98	168.28								

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											159.35
.180											156.22
.200					154.02	150.33	148.98	149.18	150.40	152.08	154.89
.220					147.81	146.36	146.46	147.46	149.12	151.00	153.58
.240					144.11	143.19	144.26	146.17	148.65	151.29	154.34
.260					142.28	143.31	144.78	146.67	148.79	151.24	153.90
.280	200.34	153.41	71.75	76.17	141.41	142.44	144.25	146.50	149.18	151.74	154.65
.300	186.42	151.59	146.01	141.60	140.87	142.25	144.39	146.98	149.79	152.81	156.04
.320	174.40	149.99	145.21	142.62	142.18	143.83	145.99	148.79	151.44	154.20	157.31
.340	165.27	148.26	144.07	141.95	142.12	144.19	146.73	149.55	152.55	155.83	159.61
.360	161.16	147.65	144.82	142.27	143.25	145.20	147.87	150.97	154.48	157.99	162.01
.380	158.65	147.24	145.27	144.37	144.66	145.58	149.52	152.66	156.23	160.53	164.84
.400	158.28	148.88	146.07	145.46	146.43	148.80	151.88	155.28	159.12	163.39	167.67
.420	157.71	147.01	146.01	146.32	148.37	151.27	154.55	158.09	162.05	166.33	170.60
.440	158.03	147.37	146.63	148.06	150.57	153.71	157.08	160.81			
.460	158.01	148.39	148.36	150.24	153.00	155.16	159.68	163.68			
.480	158.53	149.62	150.30	152.43	155.31	158.82	162.51	166.60			
.500	158.83	151.16	152.01	154.61	157.92	161.47	165.36	169.49			
.520	159.79	152.74	154.38	157.13	160.46	164.11	168.18	172.21			
.540	160.41	155.29	156.96	159.63	162.87	166.76	170.83	175.10			
.560	161.58	158.06	159.54	162.35	165.50	169.39	173.70	177.99			
.580	162.75	160.60	162.11	165.06	168.13	172.02	176.57	180.87			
.600	163.72	163.53	164.13	167.74	171.06	174.99	179.44	183.74			

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.150											165.74
.130											162.05
.200					161.77	157.34	155.47	155.30	156.24	157.67	160.34
.220					154.72	152.74	152.46	153.15	154.57	156.23	158.64
.240					150.42	149.01	149.78	151.48	153.78	156.27	159.20
.260					148.16	148.88	150.08	151.76	153.67	155.95	158.46
.280					146.94	147.67	149.24	151.30	153.83	156.23	159.00
.300	197.40	158.99	152.50	147.29	146.09	147.19	149.13	151.56	154.22	157.12	160.25
.320	184.02	156.98	151.36	148.13	147.25	148.65	150.61	153.26	155.76	158.37	161.36
.340	173.81	154.84	149.86	147.13	146.92	148.77	151.14	153.82	156.70	159.88	163.61
.360	169.07	153.91	150.41	148.32	147.89	149.61	152.12	155.10	158.54	161.97	165.96
.380	166.08	153.20	150.64	149.25	149.16	150.85	153.65	156.69	160.18	164.47	168.77
.400	155.41	154.73	151.25	150.18	150.88	153.01	155.96	159.28	163.06	167.33	171.60
.420	154.54	152.44	150.93	150.85	152.68	155.43	158.61	162.07	165.99	170.27	174.53
.440	154.64	152.58	151.35	152.49	154.82	157.84	161.11	164.78			
.460	164.36	153.43	152.98	154.61	157.21	160.24	163.68	167.64			
.480	164.69	154.52	154.84	156.74	159.46	162.89	166.51	170.56			
.500	164.76	155.95	156.44	158.86	162.06	165.52	169.35	173.45			
.520	165.56	157.41	158.77	161.35	164.57	168.14	172.17	176.15			
.540	165.98	159.95	161.33	163.82	166.94	170.76	174.80	179.04			
.560	167.01	162.72	163.89	166.53	169.54	173.38	177.67	181.93			
.580	168.04	165.23	166.44	169.23	172.16	175.99	180.54	184.81			
.600	168.84	168.18	169.05	171.90	175.10	178.96	183.40	187.69			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											172.12
.180											167.89
.200					169.52	164.36	161.97	161.42	162.07	163.25	165.79
.220					161.64	159.13	158.46	158.85	160.02	161.45	163.71
.240					156.73	154.84	155.31	156.79	158.92	161.25	164.07
.260					154.03	154.45	155.39	156.84	158.55	160.66	163.01
.280					152.47	152.89	154.24	156.10	158.48	160.71	163.35
.300	208.38	165.40	158.98	152.97	151.30	152.13	153.87	156.14	158.66	161.43	164.46
.320	193.65	163.98	157.51	153.64	152.32	153.47	155.22	157.73	160.07	162.53	165.42
.340	182.35	161.42	155.64	152.32	151.72	153.36	155.56	158.10	160.85	163.93	167.60
.360	176.98	160.17	156.00	153.36	152.52	154.03	156.38	159.24	162.59	165.95	169.90
.380	173.50	159.17	156.01	154.13	153.66	155.13	157.79	160.71	164.13	168.41	172.71
.400	172.55	160.59	156.44	154.89	155.29	157.22	160.05	163.27	167.01	171.26	175.52
.420	171.38	157.87	155.85	155.38	156.99	159.60	162.68	166.06	169.94	174.20	178.45
.440	171.25	157.78	156.06	156.92	159.07	161.97	165.14	168.74			
.460	170.72	153.48	157.59	158.99	161.41	164.33	167.69	171.61			
.480	170.84	159.43	159.37	161.05	163.62	166.95	170.50	174.52			
.500	170.68	160.74	160.88	163.11	166.19	169.56	173.34	177.41			
.520	171.32	162.09	163.16	165.57	168.68	172.17	176.15	180.10			
.540	171.55	164.60	165.71	168.01	171.00	174.77	178.76	182.99			
.560	172.44	167.37	168.24	170.70	173.59	177.36	181.63	185.88			
.580	173.33	169.87	170.77	173.40	176.18	179.95	184.50	188.76			
.600	173.97	172.83	173.37	176.05	179.13	182.94	187.37	191.63			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											178.50
.180											173.73
.200					177.27	171.37	168.47	167.54	167.91	168.86	171.24
.220					168.55	165.51	164.46	164.54	165.46	166.68	168.77
.240					163.04	160.67	160.84	162.09	164.06	166.23	168.93
.250					159.91	160.02	160.70	161.93	163.43	165.37	167.57
.280					158.00	158.12	159.23	160.90	163.12	165.19	167.70
.300	219.36	173.80	165.47	158.65	156.52	157.07	158.61	160.71	163.09	165.74	168.67
.320	203.28	170.97	163.67	159.15	157.39	158.29	159.84	162.20	164.39	166.70	169.47
.340	190.89	168.00	161.43	157.50	156.52	157.94	159.98	162.37	165.00	167.98	171.60
.350	184.89	166.44	161.59	158.40	157.16	158.44	160.63	163.38	166.65	169.93	173.85
.380	180.93	165.13	161.38	159.01	158.16	159.40	161.93	164.73	168.08	172.35	176.64
.400	179.69	166.44	161.62	159.61	159.69	161.43	164.14	167.27	170.95	175.20	179.45
.420	178.21	163.30	160.77	159.92	161.30	163.77	166.74	170.05	173.88	178.14	182.38
.440	177.86	162.99	160.78	161.36	163.32	166.10	169.17	172.71			
.460	177.07	163.52	162.21	163.36	165.62	168.42	171.69	175.57			
.480	176.99	164.33	163.90	165.36	167.78	171.02	174.50	178.48			
.500	176.61	165.52	165.31	167.36	170.33	173.61	177.33	181.37			
.520	177.09	166.77	167.56	169.79	172.78	176.19	180.14	184.04			
.540	177.12	169.26	170.08	172.20	175.07	178.78	182.73	186.93			
.560	177.87	172.03	172.59	174.88	177.64	181.35	185.60	189.82			
.580	178.62	174.50	175.10	177.57	180.21	183.92	188.47	192.70			
.600	179.10	177.49	177.68	180.21	183.16	186.91	191.33	195.58			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											191.27
.180											185.40
.200					192.76	185.40	181.46	179.79	179.58	180.04	182.13
.220					182.38	178.28	176.45	175.93	176.36	177.13	178.90
.240					175.66	172.32	171.90	172.71	174.33	176.20	178.66
.260					171.66	171.17	171.31	172.09	173.19	174.78	176.68
.280					169.06	168.57	169.21	170.50	172.41	174.16	176.40
.300	241.32	188.60	178.44	170.02	166.95	166.95	168.08	169.86	171.96	174.36	177.09
.320	222.54	184.96	175.97	170.17	167.52	167.93	169.07	171.15	173.02	175.04	177.58
.340	207.97	181.15	173.00	167.87	166.12	167.11	168.81	170.92	173.29	176.08	179.59
.360	200.71	178.96	172.77	168.49	166.43	167.26	169.14	171.65	174.76	177.88	181.74
.380	195.78	177.07	172.13	168.78	167.16	167.94	170.21	172.78	175.98	180.23	184.51
.400	193.96	178.16	171.99	169.05	168.49	169.85	172.31	175.26	178.84	183.07	187.29
.420	191.87	174.15	170.62	168.99	169.92	172.11	174.87	178.02	181.77	186.01	190.22
.440	191.07	173.40	170.22	170.22	171.82	174.35	177.23	180.64	184.70	125.98	130.37
.460	189.78	173.60	171.44	172.10	174.04	176.59	179.69	183.50	187.62	128.91	133.30
.480	189.29	174.13	172.97	173.98	176.10	179.15	182.49	186.41	190.54	131.83	136.23
.500	188.47	175.10	174.17	175.86	178.60	181.70	185.32	189.29	193.68	134.75	139.16
.520	188.62	176.12	176.34	178.22	181.00	184.25	188.11	191.93	133.25	137.67	142.08
.540	188.27	178.57	178.82	180.57	183.20	186.79	190.66	194.82	136.16	140.59	145.00
.560	188.73	181.34	181.30	183.24	185.73	189.32	193.53	197.71	139.06	143.50	147.92
.580	189.19	183.78	183.76	185.90	188.26	191.85	196.40	200.59	141.96	146.41	150.84
.600	189.35	186.79	186.32	188.52	191.23	194.86	199.26	203.47	144.85	149.32	153.75

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											164.10
.180											161.92
.200					161.10	157.42	156.03	156.16	157.29	158.84	161.50
.220					155.53	154.15	154.27	155.22	156.81	158.62	161.07
.240					152.44	151.62	152.76	154.69	157.12	159.70	162.66
.260					151.17	152.38	153.93	155.89	158.01	160.43	163.03
.280					150.79	152.08	154.05	156.37	159.11	161.68	164.54
.300	153.54	159.67	154.83	151.02	150.70	152.40	154.78	157.50	160.37	163.44	166.68
.320	151.60	158.26	154.29	152.36	152.43	154.47	156.91	159.90	162.67	165.50	168.65
.340	172.55	156.69	153.38	151.99	152.76	155.25	158.14	161.23	164.40	167.77	171.63
.360	168.49	156.20	154.34	153.58	154.21	156.69	159.74	163.16	166.90	170.57	174.66
.380	166.03	155.87	154.97	154.92	155.93	158.43	161.82	165.33	169.19	173.69	178.14
.400	165.68	157.58	155.92	156.23	158.01	160.98	164.59	168.39	172.57	177.11	181.56
.420	165.14	155.77	155.98	157.29	160.14	163.75	167.62	171.62	175.96	180.55	185.06
.440	165.48	156.18	156.69	159.19	162.58	166.47	170.48	174.74	179.32	184.68	189.36
.460	165.46	157.25	158.50	161.52	165.22	169.17	173.39	177.97	182.65	187.66	192.78
.480	165.98	158.52	160.50	163.82	167.71	172.06	176.49	181.21	185.97	190.74	195.55
.500	166.26	160.08	162.26	166.10	170.48	174.93	179.59	184.41	189.40	194.40	199.40
.520	167.21	161.67	164.68	168.69	173.17	177.78	182.65	187.40	192.09	196.89	201.69
.540	167.80	164.23	167.30	171.26	175.69	180.60	185.53	190.55	195.31	200.32	205.32
.560	168.94	167.00	169.91	174.03	178.41	183.38	188.62	193.69	198.49	203.56	208.56
.580	170.08	169.53	172.50	176.79	181.12	186.15	191.68	196.80	201.64	206.78	211.78
.600	171.30	172.45	175.15	179.52	184.12	189.23	194.71	199.90	204.78	209.96	215.02

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											170.49
.180											167.76
.200					168.85	164.44	162.52	162.28	163.13	164.44	166.95
.220					162.44	160.53	160.26	160.91	162.26	163.84	166.13
.240					158.75	157.45	158.29	159.99	162.26	164.68	167.53
.260					157.04	157.95	159.24	160.97	162.89	165.14	167.58
.280					156.32	157.31	159.04	161.17	163.75	166.16	168.89
.300	204.52	167.07	161.32	156.70	155.92	157.34	159.51	162.07	164.81	167.75	170.89
.320	191.23	165.25	160.44	157.87	157.50	159.29	161.53	164.37	166.98	169.67	172.71
.340	181.09	163.26	159.17	157.13	157.56	159.84	162.56	165.50	168.54	171.82	175.62
.360	176.40	162.46	159.94	158.62	158.85	161.10	164.00	167.29	170.96	174.54	178.61
.380	173.45	161.84	160.34	159.80	160.43	162.71	165.95	169.36	173.13	177.63	182.07
.400	172.82	163.44	161.10	160.95	162.41	165.19	168.67	172.39	176.51	181.04	185.49
.420	171.98	161.20	160.91	161.82	164.46	167.92	171.69	175.60	179.91	184.49	188.99
.440	172.08	161.39	161.41	163.62	166.83	170.59	174.51	178.71			
.460	171.81	162.29	163.11	165.89	169.43	173.25	177.39	181.94			
.480	172.13	163.42	165.03	168.14	171.87	176.13	180.48	185.18			
.500	172.19	164.87	166.69	170.35	174.62	178.98	183.58	188.37			
.520	172.97	166.35	169.07	172.91	177.27	181.81	186.64	191.35			
.540	173.37	168.88	171.67	175.45	179.76	184.60	189.50	194.50			
.560	174.37	171.65	174.26	178.21	182.46	187.37	192.59	197.64			
.580	175.37	174.16	176.84	180.96	185.14	190.12	195.65	200.75			
.600	176.13	177.10	179.47	183.68	188.16	193.21	198.67	203.84			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											176.87
.180											173.59
.200					176.60	171.45	169.02	168.40	168.96	170.03	172.40
.220					169.36	166.92	166.26	166.61	167.71	169.07	171.19
.240					165.06	163.28	163.82	165.30	167.39	169.66	172.39
.260					162.92	163.52	164.54	166.06	167.77	169.84	172.14
.280					161.85	162.53	164.03	165.97	168.40	170.64	173.25
.300	215.50	174.48	167.81	162.38	161.13	162.29	164.25	166.65	169.24	172.06	175.10
.320	200.86	172.25	166.60	163.38	162.57	164.11	166.14	168.85	171.30	173.83	176.76
.340	189.63	169.84	164.95	162.36	162.36	164.43	166.98	169.78	172.69	175.87	179.62
.360	184.31	168.72	165.53	163.67	163.49	165.51	168.25	171.43	175.01	178.52	182.55
.380	180.88	167.80	165.71	164.68	164.93	166.98	170.09	173.38	177.08	181.57	186.01
.400	179.96	169.30	166.29	165.67	166.81	169.40	172.76	176.38	180.46	184.98	189.41
.420	178.81	166.63	165.83	166.36	168.77	172.09	175.75	179.59	183.85	188.42	192.91
.440	179.69	166.59	166.12	168.06	171.08	174.72	178.54	182.68			
.460	178.16	167.33	167.73	170.27	173.64	177.34	181.39	185.90			
.480	178.28	168.32	169.57	172.45	176.03	180.19	184.48	189.14			
.500	178.12	169.65	171.12	174.60	178.75	183.03	187.58	192.34			
.520	178.73	171.02	173.46	177.13	181.38	185.83	190.62	195.29			
.540	178.95	173.54	176.05	179.64	183.82	188.61	193.46	198.44			
.560	179.80	176.31	178.51	182.39	186.50	191.35	196.55	201.58			
.580	180.65	178.80	181.17	185.13	189.17	194.08	199.61	204.69			
.600	181.26	181.75	183.78	187.83	192.19	197.19	202.64	207.79			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											183.25
.180											179.43
.200					184.35	178.47	175.52	174.53	174.80	175.62	177.85
.220					176.27	173.30	172.26	172.30	173.16	174.29	176.26
.240					171.37	169.10	169.34	170.61	172.53	174.64	177.26
.260					168.80	169.09	169.85	171.14	172.65	174.55	176.69
.280					167.38	167.76	169.02	170.77	173.05	175.13	177.60
.300	226.48	181.88	174.29	168.07	166.35	167.23	168.99	171.22	173.67	176.38	179.31
.320	210.49	179.24	172.75	168.89	167.64	168.92	170.76	173.32	175.61	178.00	180.82
.340	198.17	176.42	170.74	167.55	167.16	169.01	171.39	174.05	176.84	179.92	183.61
.360	192.22	174.99	171.12	168.71	168.12	169.92	172.51	175.56	179.07	182.50	186.50
.380	188.30	173.77	171.09	169.56	169.43	171.25	174.23	177.41	181.03	185.51	189.94
.400	187.10	175.15	171.47	170.38	171.22	173.61	176.85	180.38	184.40	188.91	193.34
.420	185.64	172.06	170.75	170.89	173.08	176.26	179.82	183.57	187.80	192.36	196.84
.440	185.30	171.80	170.84	172.49	175.33	178.85	182.57	186.65			
.460	184.52	172.38	172.34	174.64	177.85	181.43	185.39	189.86			
.480	184.43	173.22	174.10	176.76	180.19	184.26	188.48	193.10			
.500	184.04	174.44	175.56	178.85	182.89	187.07	191.57	196.30			
.520	184.50	175.70	177.85	181.35	185.49	189.86	194.61	199.24			
.540	184.52	178.20	180.42	183.83	187.89	192.61	197.43	202.39			
.560	185.23	180.97	182.97	186.57	190.55	195.34	200.52	205.53			
.580	185.94	183.44	185.50	189.30	193.20	198.05	203.58	208.64			
.600	186.38	186.41	188.10	191.99	196.23	201.16	206.60	211.73			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											196.02
.180											191.10
.200					199.84	192.50	188.51	186.77	186.47	186.80	188.75
.220					190.10	186.07	184.26	183.69	184.06	184.75	186.38
.240					183.99	180.76	180.40	181.22	182.80	184.61	186.98
.260					180.55	180.23	180.47	181.31	182.41	183.97	185.80
.280					178.45	178.21	179.01	180.36	182.34	184.10	186.30
.300	248.44	196.68	187.27	179.43	176.78	177.11	178.47	180.37	182.54	185.00	187.73
.320	229.75	193.23	185.05	179.92	177.77	178.56	179.99	182.26	184.24	186.34	188.93
.340	215.25	189.58	182.31	177.92	176.75	178.18	180.23	182.60	185.14	188.01	191.61
.360	208.04	187.51	182.30	178.79	177.39	178.75	181.01	183.84	187.18	190.45	194.39
.380	203.16	185.70	181.83	179.32	178.43	179.80	182.51	185.45	188.93	193.39	197.81
.400	201.37	186.86	181.84	179.82	180.02	182.03	185.02	188.37	192.29	196.78	201.19
.420	199.31	182.92	180.59	179.96	181.70	184.59	187.95	191.54	195.69	200.22	204.68
.440	198.52	182.21	180.28	181.36	183.83	187.11	190.63	194.58			
.460	197.23	182.46	181.58	183.38	186.27	189.60	193.40	197.79			
.480	196.74	183.02	183.17	185.38	188.50	192.39	196.47	201.03			
.500	195.90	184.01	184.42	187.35	191.16	195.17	199.55	204.22			
.520	196.03	185.05	186.64	189.79	193.70	197.91	202.58	207.13			
.540	195.66	187.51	189.16	192.21	196.03	200.62	205.36	210.28			
.560	196.09	190.28	191.67	194.92	198.64	203.31	208.45	213.42			
.580	196.51	192.71	194.16	197.64	201.25	205.98	211.51	216.53			
.600	196.64	195.71	196.74	200.30	204.29	209.11	214.53	219.62			

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											174.50
.180											173.68
.200					171.22	163.31	167.52	168.19	169.72	171.54	174.39
.220					165.84	165.35	166.24	167.80	169.94	172.20	174.94
.240					162.84	163.04	165.05	167.75	170.79	173.94	177.36
.260					161.58	163.90	166.45	169.26	172.17	175.19	178.37
.280					161.16	163.66	166.72	169.99	173.57	176.92	180.39
.300	147.98	165.62	162.28	159.91	160.97	163.95	167.50	171.30	175.09	179.00	183.02
.320	185.78	163.97	161.56	161.11	162.60	165.97	169.63	173.76	177.58	181.32	185.30
.340	176.46	162.21	160.42	160.53	162.75	166.64	170.83	175.14	179.39	183.30	188.56
.360	172.15	161.53	161.08	161.94	164.05	167.96	172.33	177.01	181.95	185.70	191.80
.380	169.46	160.94	161.57	163.05	165.55	169.52	174.31	179.15	184.20	189.38	195.42
.400	168.90	162.38	162.34	164.16	167.46	171.92	176.94	182.09	187.56	193.33	198.89
.420	168.16	160.32	162.20	164.98	169.37	174.46	179.80	185.22	190.88	195.71	202.44
.440	168.31	160.48	162.55	166.68	171.60	177.01	182.51	188.18			
.460	168.12	161.32	164.18	168.84	174.05	179.51	185.19	191.24			
.480	168.48	162.37	165.92	170.93	176.28	182.17	188.12	194.33			
.500	168.62	163.73	167.44	172.95	178.85	184.85	191.05	197.30			
.520	169.43	165.14	169.62	175.26	181.38	187.47	193.85	200.12			
.540	169.90	167.52	172.02	177.57	183.68	190.05	196.54	203.10			
.560	170.92	170.12	174.41	180.09	186.16	192.64	199.43	205.99			
.580	171.95	172.50	176.80	182.61	188.58	195.25	202.23	208.90			
.600	172.77	175.28	179.26	185.10	191.31	198.12	205.05	211.80			

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											180.88
.180											179.52
.200					178.97	175.33	174.02	174.31	175.55	177.13	179.84
.220					172.76	171.73	172.24	173.50	175.39	177.43	180.00
.240					169.15	168.87	170.58	173.06	175.93	178.92	182.23
.260					167.46	169.47	171.76	174.35	177.05	179.90	182.93
.280					166.69	168.89	171.71	174.79	178.22	181.41	184.75
.300	208.96	173.02	168.77	165.59	166.19	168.89	172.24	175.88	179.52	183.31	187.23
.320	195.41	170.97	167.71	166.62	167.67	170.79	174.24	178.23	181.90	185.49	189.35
.340	185.00	168.79	166.21	165.71	167.55	171.22	175.24	179.41	183.53	187.84	192.56
.360	180.06	167.79	166.77	166.98	168.69	172.37	176.59	181.15	186.01	190.67	195.74
.380	176.88	166.91	166.94	167.93	170.05	173.79	178.45	183.17	188.15	193.82	199.36
.400	176.04	168.23	167.52	168.88	171.86	176.13	181.03	186.08	191.50	197.26	202.81
.420	174.99	165.75	167.12	169.51	173.68	178.63	183.86	189.21	194.83	200.65	206.36
.440	174.92	165.65	167.37	171.11	175.85	181.13	186.54	192.14			
.460	174.47	166.36	168.79	173.21	178.25	183.59	189.19	195.21			
.480	174.63	167.27	170.46	175.24	180.44	186.24	192.11	198.30			
.500	174.55	168.52	171.87	177.20	182.99	188.89	195.04	201.26			
.520	175.19	169.81	174.01	179.48	185.49	191.50	197.84	204.07			
.540	175.47	172.18	176.39	181.76	187.75	194.06	200.50	207.04			
.560	176.35	174.78	178.76	184.27	190.21	196.62	203.39	209.94			
.580	177.24	177.14	181.13	186.78	192.61	199.22	206.19	212.84			
.600	177.90	179.93	183.57	189.26	195.35	202.09	209.01	215.74			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											187.26
.180											185.35
.200					186.72	182.34	180.52	180.43	181.39	182.73	185.29
.220					179.67	178.12	178.24	179.19	180.84	182.65	185.06
.240					175.46	174.70	176.11	178.37	181.07	183.90	187.09
.260					173.33	175.04	177.07	179.43	181.93	184.61	187.48
.280					172.22	174.12	176.70	179.59	182.86	185.89	189.10
.300	219.54	180.42	175.25	171.28	171.41	173.83	176.97	180.45	183.96	187.62	191.44
.320	205.04	177.96	173.86	172.13	172.74	175.61	178.86	182.70	186.21	189.66	193.41
.340	193.54	175.37	171.99	170.90	172.34	175.81	179.66	183.69	187.68	191.89	196.55
.360	187.97	174.05	172.37	172.03	173.32	176.79	180.84	185.28	190.06	194.65	199.69
.380	184.31	172.87	172.31	172.81	174.55	178.06	182.59	187.20	192.10	197.76	203.29
.400	183.17	174.09	172.71	173.60	176.27	180.33	185.11	190.08	195.45	201.20	206.74
.420	181.82	171.17	172.04	174.05	177.99	182.80	187.93	193.19	198.77	204.58	210.29
.440	181.53	170.89	172.09	175.54	180.10	185.26	190.57	196.11			
.460	180.83	171.40	173.41	177.59	182.46	187.68	193.19	199.17			
.480	180.78	172.17	174.99	179.55	184.60	190.30	196.11	202.26			
.500	180.48	173.31	176.30	181.45	187.13	192.94	199.03	205.22			
.520	180.96	174.49	178.40	183.70	189.60	195.52	201.82	208.01			
.540	181.04	176.83	180.76	185.95	191.82	198.06	204.47	210.99			
.560	181.78	179.44	183.11	188.45	194.26	200.61	207.36	213.88			
.580	182.52	181.77	185.46	190.94	196.64	203.18	210.16	216.79			
.600	183.02	184.58	187.89	193.41	199.38	206.07	212.98	219.69			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											193.65
.180											191.19
.200					194.46	189.36	187.01	186.55	187.22	188.32	190.74
.220					186.58	184.50	184.24	184.89	186.29	187.88	190.13
.240					181.77	180.52	181.63	183.67	186.20	188.88	191.95
.260					179.21	180.61	182.37	184.52	186.81	189.31	192.04
.280					177.76	179.34	181.70	184.39	187.51	190.37	193.45
.300	233.92	187.83	181.74	176.96	176.62	178.77	181.71	185.03	188.39	191.93	195.64
.320	214.67	184.96	180.01	177.64	177.81	180.43	183.47	187.18	190.53	193.83	197.46
.340	202.08	181.94	177.78	176.08	177.14	180.40	184.08	187.96	191.83	195.94	200.55
.360	195.88	180.31	177.96	177.07	177.96	181.20	185.09	189.42	194.12	198.63	203.63
.380	191.73	178.84	177.68	177.69	179.05	182.33	186.73	191.22	196.05	201.70	207.23
.400	190.31	179.95	177.89	178.31	180.67	184.54	189.20	194.07	199.39	205.13	210.66
.420	188.65	176.60	176.96	178.58	182.30	186.97	191.99	197.18	202.72	208.52	214.21
.440	188.13	176.10	176.81	179.98	184.35	189.39	194.60	200.08			
.460	187.18	176.45	178.03	181.96	186.67	191.77	197.19	203.13			
.480	186.93	177.07	179.53	183.86	188.76	194.37	200.10	206.22			
.500	186.40	178.09	180.73	185.70	191.26	196.99	203.02	209.18			
.520	186.72	179.17	182.79	187.92	193.70	199.55	205.81	211.96			
.540	186.61	181.49	185.13	190.13	195.88	202.07	208.43	214.93			
.560	187.21	184.09	187.46	192.63	198.30	204.60	211.32	217.83			
.580	187.81	186.41	189.79	195.11	200.66	207.15	214.12	220.73			
.600	188.15	189.24	192.21	197.57	203.42	210.04	216.94	223.63			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											206.41
.180											202.86
.200					209.96	203.39	200.01	198.79	198.90	199.50	201.64
.220					200.41	197.27	196.24	196.27	197.19	198.33	200.25
.240					194.39	192.18	192.69	194.29	196.48	198.85	201.68
.260					190.96	191.76	192.99	194.68	196.57	198.73	201.15
.280					188.82	189.79	191.68	193.98	196.80	199.34	202.15
.300	252.88	202.63	194.71	188.33	187.05	188.66	191.19	194.18	197.25	200.55	204.06
.320	233.92	198.95	192.31	188.66	187.95	190.07	192.71	196.12	199.16	202.16	205.57
.340	219.16	195.10	189.35	186.45	186.74	189.57	192.91	196.51	200.13	204.04	208.54
.360	211.70	192.84	189.14	187.16	187.23	190.02	193.60	197.69	202.23	206.58	211.52
.380	206.59	190.77	188.43	187.45	188.05	190.88	195.00	199.27	203.95	209.58	215.09
.400	204.59	191.66	188.26	187.75	189.47	192.96	197.38	202.07	207.28	213.00	218.51
.420	202.32	187.46	186.81	187.65	190.92	195.30	200.12	205.15	210.61	216.39	222.06
.440	201.35	186.51	186.24	188.84	192.85	197.65	202.66	208.01			
.460	199.89	186.53	187.26	190.70	195.09	199.94	205.20	211.06			
.480	199.24	186.87	188.60	192.48	197.07	202.50	208.10	214.15			
.500	198.26	187.67	189.60	194.20	199.53	205.08	211.00	217.11			
.520	198.25	188.52	191.58	196.36	201.92	207.60	213.78	219.85			
.540	197.75	190.80	193.87	198.51	204.02	210.08	216.37	222.82			
.560	198.07	193.41	196.17	200.58	206.39	212.57	219.26	225.72			
.580	198.38	195.68	198.46	203.45	208.71	215.08	222.05	228.62			
.600	198.40	198.54	200.84	205.88	211.49	217.99	224.87	231.52			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

3.7-59

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						224.11	217.74	214.31	212.91	212.28	212.30	213.55	215.16	217.67
.280						220.31	210.37	207.58	208.87	207.59	209.90	211.18	213.26	215.31
.300						209.21	206.18	204.67	206.47	206.49	208.78	210.84	213.39	213.68
.320						206.29	205.31	202.27	204.59	205.11	209.46	209.97	212.54	213.44
.340						200.28	200.00	199.86	202.95	204.76	207.32	209.89	212.70	213.47
.360						197.61	198.67	199.49	202.33	204.39	207.99	210.55	213.38	213.89
.380						196.19	197.02	198.60	201.70	205.06	208.13	210.46	213.27	214.82
.400	245.64	218.63	209.90	199.23	195.86	195.56	196.86	198.98	201.84	204.68	207.78	211.11	213.95	217.19
.420	237.62	215.75	203.29	199.85	197.89	197.20	198.03	199.62	202.72	205.84	209.45	212.29	215.88	219.33
.440	230.76	212.24	201.32	200.19	199.02	198.33	198.92	201.01	203.88	207.50	210.61	213.71	216.93	219.88
.460	225.20	210.11	201.13	200.27	199.89	200.48	200.30	202.41	205.28	209.16	212.27	215.37	218.86	222.07
.480	222.93	207.99	200.43	201.12	200.74	202.12	201.69	204.57	206.92	210.56	213.79	216.78	221.16	224.77
.500	220.14	206.12	200.48	201.31	202.36	204.27	203.84	206.46	208.84	212.21	215.72	218.95	223.59	227.45
.520	217.32	204.64	201.09	202.01	203.97	206.40	205.25	208.50	210.99	214.38	217.75	221.61	225.99	230.38
.540	216.83	204.67	201.08	203.34	205.57	207.76	207.63	210.52	213.40	217.05	220.42	224.06	228.18	232.32
.560	215.55	204.44	201.89	204.67	206.65	209.25	210.15	212.67	215.81	219.46	223.10	226.22	230.36	234.48
.580	215.28	204.96	202.71	205.48	207.99	210.98	212.40	215.07	218.47	222.12	225.51	228.63	233.03	237.17
.600	214.49	204.97	204.02	206.81	209.84	212.07	215.03	217.46	221.13	224.79	228.17	232.59	235.70	239.85
.620	214.57	205.73	205.45	208.13	211.42	214.17	217.54	220.10	223.79	227.32	230.58	233.97	238.13	242.52
.640	214.81	206.74	207.13	210.09	213.25	216.66	220.03	222.73	226.44	229.85	233.25	236.64	241.05	245.44
.660	215.86	208.52	209.18	212.17	215.21	218.62	222.77	225.75	229.08	232.51	235.91	239.76	244.15	248.61
.680	216.38	209.52	210.71	214.11	217.17	220.71	225.01	227.99	231.71	235.16	238.82	242.48	246.88	251.30
.700	217.34	210.51	213.01	216.17	219.26	222.80	227.36	230.35	234.35	237.80	241.74	245.39	249.81	254.22
.720	218.31	212.26	215.30	218.24	221.60	225.15	229.45	232.71	236.85	240.43	244.39	248.31	252.73	257.13
.740	219.02	214.27	217.58	220.29	223.93	227.74	232.05	235.33	239.34	243.07	247.28	251.22	255.64	260.06
.760	220.35	216.27	219.35	222.58	226.25	230.34	234.65	237.94	241.95	245.96	250.18	254.13	258.56	262.98
.780	221.69	218.51	221.61	225.00	228.82	232.94	237.00	240.79	244.82	248.58	253.06	257.02	261.47	265.89
.800	223.33	220.76	224.03	227.55	231.51	235.53	239.64	243.65	247.69	251.91	256.03			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						237.45	230.01	225.80	223.82	222.70	222.28	223.22	224.55	226.88
.280						232.97	221.60	218.09	219.08	217.24	219.35	220.32	222.16	223.99
.300						220.47	216.70	214.60	216.14	215.73	217.82	219.64	222.02	221.89
.320						216.96	215.44	211.66	213.78	213.91	218.27	218.40	220.78	221.34
.340						210.06	209.31	208.72	211.67	213.23	215.61	218.01	220.66	221.08
.360						206.82	207.56	208.01	210.71	212.53	216.06	218.44	221.11	221.24
.380						204.97	205.44	206.74	209.71	212.97	215.92	218.04	220.70	221.97
.400	261.30	231.13	221.08	208.91	204.76	203.98	204.97	206.86	209.57	212.26	215.23	218.46	221.15	224.28
.420	252.19	227.69	213.53	209.29	206.70	205.49	205.97	207.28	210.25	213.24	216.77	219.46	222.97	225.23
.440	243.81	223.53	211.07	209.38	207.64	206.45	206.65	208.52	211.23	214.77	217.75	220.73	223.83	226.64
.460	237.96	220.91	210.57	209.18	208.31	208.52	207.88	209.77	212.47	216.30	219.28	222.26	225.66	228.76
.480	235.18	218.29	209.51	209.82	208.96	210.03	209.12	211.84	213.99	217.56	220.67	223.52	227.89	231.44
.500	231.83	215.95	209.28	209.75	210.45	212.10	211.19	213.64	215.81	219.08	222.49	225.61	230.28	234.09
.520	228.44	214.03	209.67	210.23	211.94	214.16	212.45	215.58	217.88	221.17	224.44	228.24	232.62	237.01
.540	227.63	213.78	209.38	211.41	213.41	215.37	214.77	217.51	220.24	223.81	227.08	230.64	234.74	238.85
.560	225.94	213.24	209.98	212.58	214.31	216.71	217.25	219.58	222.60	226.17	229.74	232.72	236.84	240.94
.580	225.36	213.54	210.59	213.19	215.50	218.33	219.44	221.94	225.24	228.81	232.10	235.09	239.49	243.60
.600	224.21	213.26	211.75	214.36	217.24	219.24	222.05	224.28	227.87	231.45	234.73	239.15	242.13	246.26
.620	224.46	213.82	213.04	215.53	218.69	221.27	224.52	226.89	230.50	233.94	237.09	240.38	244.51	248.90
.640	224.01	214.66	214.60	217.40	220.42	223.71	226.97	229.50	233.12	236.43	239.73	243.02	247.43	251.82
.660	224.89	216.33	216.58	219.41	222.29	225.59	229.70	232.53	235.74	239.07	242.37	246.17	250.55	255.01
.680	225.18	217.15	217.95	221.26	224.16	227.61	231.87	234.70	238.35	241.69	245.28	248.86	253.27	257.68
.700	225.97	217.96	220.23	223.24	226.18	229.62	234.18	237.02	240.96	244.30	248.19	251.77	256.19	260.60
.720	226.76	219.61	222.47	225.23	228.46	231.91	236.19	239.32	243.42	246.92	250.82	254.69	259.11	263.52
.740	227.26	221.54	224.70	227.20	230.74	234.48	238.77	241.91	245.87	249.53	253.71	257.60	262.02	266.44
.760	228.46	223.46	226.36	229.45	233.01	237.06	241.34	244.50	248.46	252.41	256.61	260.51	264.94	269.36
.780	229.65	225.66	228.58	231.83	235.56	239.63	243.63	247.35	251.33	255.01	259.50	263.41	267.85	272.27
.800	231.18	227.85	230.96	234.35	238.24	242.19	246.26	250.21	254.20	258.39	262.47			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						250.78	242.27	237.29	234.73	233.11	232.26	232.89	233.94	236.09
.280						245.53	232.83	228.61	229.29	226.89	228.79	229.46	231.07	232.67
.300						231.72	227.21	224.53	225.82	224.97	226.85	228.45	230.65	230.11
.320						227.62	225.57	221.05	222.97	222.72	227.08	226.82	229.02	229.24
.340						219.83	218.62	217.58	220.40	221.71	223.91	226.12	228.62	228.68
.360						216.04	216.44	216.54	219.08	220.67	224.12	226.32	228.84	228.59
.380						213.75	213.87	214.88	217.73	220.88	223.70	225.62	228.13	229.12
.400	276.96	243.64	232.26	218.58	213.65	212.40	213.09	214.75	217.30	219.84	222.69	225.81	228.34	231.37
.420	266.76	239.62	223.76	218.73	215.50	213.79	213.90	214.93	217.78	220.64	224.10	226.63	230.07	232.14
.440	257.37	234.82	220.82	218.57	216.27	214.56	214.38	216.02	218.58	222.04	224.90	227.75	230.73	233.40
.460	250.72	231.71	220.02	218.09	216.73	216.56	215.46	217.12	219.67	223.45	226.30	229.15	232.46	235.44
.480	247.43	228.59	218.60	218.52	217.18	217.95	216.55	219.12	221.06	224.55	227.55	230.26	234.63	238.10
.500	243.52	225.77	218.09	218.18	218.54	219.94	218.54	220.81	222.78	225.94	229.27	232.27	236.97	240.73
.520	239.57	223.42	218.25	218.45	219.90	221.92	219.65	222.66	224.77	227.95	231.12	234.87	239.76	243.64
.540	238.43	222.89	217.67	219.48	221.24	222.97	221.92	224.51	227.08	230.58	233.74	237.23	241.30	245.38
.560	236.32	222.05	213.07	220.50	221.97	224.18	224.36	226.50	229.39	232.88	236.37	239.23	243.33	247.40
.580	235.44	222.12	213.48	220.90	223.00	225.68	226.49	228.80	232.00	235.49	238.68	241.55	245.95	250.03
.600	233.94	221.56	219.49	221.92	224.64	226.41	229.07	231.09	234.61	238.11	241.29	245.71	248.56	252.66
.620	233.96	221.91	220.63	222.93	225.97	228.36	231.50	233.68	237.21	240.56	243.60	246.79	250.89	255.28
.640	233.21	222.57	222.08	224.71	227.59	230.77	233.91	236.26	239.81	243.02	246.22	249.40	253.82	258.20
.660	233.92	224.14	223.98	226.64	229.38	232.56	236.63	239.31	242.40	245.63	248.82	252.57	256.95	261.42
.680	233.99	224.78	225.26	228.41	231.15	234.50	238.74	241.42	244.98	248.23	251.74	255.24	259.65	264.07
.700	234.60	225.41	227.45	230.31	233.09	236.43	240.99	243.68	247.57	250.81	254.65	258.15	262.57	266.98
.720	235.21	226.96	229.64	232.22	235.33	238.67	242.93	245.93	249.99	253.40	257.25	261.07	265.49	269.90
.740	235.50	228.82	231.82	234.12	237.56	241.22	245.48	248.50	252.40	255.98	260.15	263.98	268.41	272.82
.760	236.56	230.66	233.38	236.32	239.77	243.77	248.03	251.05	254.97	258.87	263.04	266.89	271.32	275.74
.780	237.62	232.81	235.55	238.66	242.30	246.31	250.27	253.91	257.84	261.44	265.93	269.79	274.23	278.66
.800	239.04	234.95	237.90	241.15	244.97	248.85	252.87	256.77	260.71	264.86	268.91			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						264.12	254.54	248.77	245.64	243.52	242.24	242.55	243.33	245.29
.280						258.29	244.06	239.12	239.50	236.53	238.23	238.60	239.98	241.35
.300						242.98	237.73	234.46	235.49	234.21	235.89	237.25	239.27	238.33
.320						238.29	235.70	230.44	232.15	231.52	235.88	235.24	237.27	237.14
.340						229.61	227.93	226.43	229.13	230.18	232.20	234.24	236.59	236.29
.360						225.25	225.32	225.06	227.45	228.82	232.19	234.21	236.58	235.94
.380						222.53	222.29	223.02	225.74	228.79	231.49	233.20	235.55	236.26
.400	292.62	256.15	243.45	228.25	222.55	220.82	221.20	222.64	225.04	227.42	230.14	233.16	235.54	238.46
.420	281.34	251.55	234.00	228.18	224.31	222.08	221.84	222.59	225.31	228.04	231.42	233.81	237.16	239.04
.440	270.92	246.12	230.57	227.75	224.90	222.68	222.12	223.52	225.93	229.32	232.05	234.76	237.64	240.17
.460	263.48	242.50	229.46	227.00	225.16	224.60	223.04	224.47	226.87	230.59	233.32	236.05	239.26	242.13
.480	259.68	238.89	227.63	227.23	225.40	225.86	223.97	226.39	228.13	231.54	234.43	237.00	241.37	244.76
.500	255.21	235.60	226.89	226.62	226.63	227.77	225.89	227.98	229.74	232.81	236.05	238.93	243.66	247.36
.520	250.70	232.82	226.83	226.67	227.86	229.68	226.85	229.75	231.67	234.74	237.81	241.51	245.89	250.28
.540	249.22	232.00	225.97	227.54	229.08	230.58	229.07	231.50	233.92	237.34	240.40	243.81	247.86	251.92
.560	246.71	230.85	226.16	228.41	229.63	231.65	231.47	233.42	236.18	239.59	243.01	245.74	249.81	253.85
.580	245.52	230.69	226.37	228.61	230.51	233.03	233.53	235.67	238.76	242.18	245.27	248.01	252.40	256.46
.600	243.66	229.85	227.22	229.47	232.04	233.58	236.09	237.91	241.34	244.77	247.85	252.27	255.00	259.07
.620	243.45	230.00	228.23	230.33	233.24	235.46	238.48	240.47	243.93	247.19	250.11	253.19	257.27	261.66
.640	242.41	230.48	229.56	232.03	234.77	237.83	240.86	243.02	246.50	249.60	252.70	255.78	260.20	264.58
.660	242.95	231.95	231.39	233.88	236.46	239.53	243.56	246.08	249.06	252.19	255.28	258.97	263.34	267.82
.680	242.79	232.41	232.54	235.55	238.15	241.39	245.60	248.13	251.62	254.76	258.20	261.62	266.03	270.45
.700	243.22	232.87	234.63	237.38	240.01	243.25	247.80	250.34	254.18	257.32	261.11	264.54	268.95	273.36
.720	243.66	234.31	236.81	239.22	242.20	245.44	249.67	252.54	256.56	259.88	263.68	267.45	271.87	276.28
.740	243.75	236.09	238.94	241.04	244.37	247.95	252.19	255.08	258.94	262.44	266.58	270.36	274.79	279.21
.760	244.66	237.86	240.40	243.18	246.54	250.48	254.71	257.61	261.48	265.33	269.47	273.27	277.70	282.12
.780	245.58	239.95	242.52	245.49	249.03	253.00	256.90	260.47	264.35	267.87	272.36	276.17	280.61	285.04
.800	246.89	242.04	244.83	247.95	251.69	255.51	259.49	263.33	267.22	271.34	275.35			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						233.33	226.97	223.50	222.03	221.33	221.24	222.37	223.84	226.19
.280						230.17	220.30	217.51	218.77	217.43	219.66	220.86	222.87	224.74
.300						219.72	216.77	215.31	217.11	217.10	219.33	221.31	223.79	223.95
.320						217.40	216.53	213.57	215.93	216.46	220.78	221.23	223.72	224.54
.340						211.96	211.85	211.80	214.96	216.81	219.38	221.92	224.67	225.37
.360						209.80	211.10	212.06	214.99	217.12	220.76	223.32	226.12	226.57
.380						208.87	209.97	211.76	215.00	218.43	221.58	223.93	226.75	228.27
.400	255.49	229.40	221.42	211.41	208.57	208.66	210.31	212.69	215.73	218.69	221.87	225.27	228.13	231.39
.420	247.59	226.73	215.07	212.33	210.96	210.72	211.94	213.84	217.18	220.46	224.17	227.09	230.75	233.22
.440	240.32	223.37	213.33	212.94	212.42	212.27	213.26	215.71	218.86	222.70	225.96	229.15	232.44	235.46
.460	235.33	221.39	213.35	213.28	213.59	214.78	215.06	217.57	220.76	224.90	228.20	231.45	235.01	238.30
.480	233.13	219.39	212.83	214.36	214.72	216.74	216.85	220.15	222.88	226.81	230.29	233.45	237.96	241.64
.500	230.39	217.61	213.04	214.77	216.59	219.20	219.35	222.46	225.23	228.94	232.73	236.19	240.99	244.97
.520	227.62	216.20	213.79	215.68	218.44	221.60	221.09	224.88	227.80	231.57	235.26	239.38	243.97	248.51
.540	227.17	216.30	213.90	217.18	220.27	223.22	223.77	227.25	230.62	234.67	238.41	242.34	246.72	251.04
.560	225.92	216.12	214.81	218.66	221.57	224.95	226.57	229.72	233.42	237.49	241.53	244.98	249.40	253.76
.580	225.68	216.70	215.70	219.62	223.10	226.91	229.08	232.44	236.42	240.57	244.37	247.87	252.58	256.98
.600	224.91	216.75	217.08	221.05	225.11	228.22	231.97	235.11	239.40	243.61	247.44	252.25	255.72	260.16
.620	225.39	217.55	218.56	222.46	226.84	230.53	234.70	238.00	242.37	246.49	250.26	254.06	258.60	263.32
.640	225.23	218.60	220.29	224.51	228.81	233.20	237.42	240.90	245.30	249.34	253.30	257.14	261.95	266.72
.660	226.29	220.40	222.40	226.66	230.88	235.32	240.38	244.15	248.21	252.31	256.29	260.67	265.47	270.32
.680	226.80	221.42	223.98	228.66	232.93	237.56	242.81	246.62	251.10	255.25	259.53	263.75	268.62	273.44
.700	227.75	222.42	226.31	230.78	235.10	239.79	245.33	249.20	253.98	258.15	262.76	267.00	271.94	276.77
.720	228.70	224.18	228.63	232.89	237.52	242.24	247.58	251.77	256.71	261.04	265.70	270.24	275.22	280.10
.740	229.38	226.18	230.94	234.99	239.91	244.93	250.33	254.57	259.42	263.93	268.86	273.46	278.47	283.42
.760	230.70	228.18	232.73	237.33	242.29	247.61	253.06	257.34	262.26	267.04	272.01	276.66	281.70	286.69
.780	232.00	230.42	235.01	239.79	244.91	250.28	255.52	260.35	265.32	269.90	275.15	279.82	284.95	289.94
.800	233.61	232.65	237.44	242.37	247.65	252.94	258.26	263.35	268.37	273.45	278.36			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						246.66	239.23	234.99	232.94	231.74	231.22	232.03	233.23	235.40
.280						242.83	231.53	228.03	228.98	227.08	229.10	229.99	231.71	233.41
.300						230.98	227.28	225.24	226.79	226.33	228.37	230.11	232.41	232.17
.320						229.07	226.66	222.96	225.12	225.27	229.59	229.66	231.97	232.44
.340						221.74	221.16	220.66	223.69	225.29	227.68	230.03	232.63	232.98
.360						219.01	219.98	220.59	223.36	225.27	228.82	231.21	233.85	233.92
.380						217.65	218.39	219.90	223.01	226.34	229.37	231.51	234.18	235.42
.400	271.15	241.91	232.61	221.09	217.47	217.09	218.42	220.58	223.46	226.27	229.32	232.62	235.33	238.47
.420	262.16	238.66	225.31	221.78	219.77	219.02	219.88	221.50	224.71	227.86	231.50	234.26	237.84	240.13
.440	253.87	234.66	223.08	222.13	221.04	220.38	220.99	223.22	226.21	229.97	233.11	236.17	239.35	242.22
.460	248.10	232.19	222.80	222.19	222.02	222.82	222.64	224.92	227.95	232.05	235.22	238.34	241.81	244.99
.480	245.38	229.69	221.92	223.06	222.94	224.65	224.28	227.42	229.95	233.81	237.17	240.19	244.70	248.30
.500	242.08	227.44	221.85	223.21	224.58	227.03	226.70	229.63	232.19	235.81	239.51	242.85	247.68	251.61
.520	238.74	225.59	222.37	223.90	226.41	229.36	228.29	231.96	234.69	238.36	241.95	246.02	250.60	255.14
.540	237.97	225.41	222.20	225.25	228.11	230.82	230.92	234.24	237.46	241.44	245.07	248.92	253.28	257.57
.560	236.31	224.92	222.90	226.58	229.23	232.42	233.67	236.64	240.21	244.20	248.17	251.49	255.89	260.22
.580	235.76	225.27	223.58	227.32	230.60	234.27	236.12	239.30	243.18	247.26	250.95	254.33	259.03	263.41
.600	234.63	225.05	224.81	228.61	232.51	235.40	238.99	241.92	246.14	250.27	254.00	258.81	262.16	266.57
.620	234.89	225.64	226.16	229.87	234.11	237.63	241.68	244.79	249.09	253.11	256.77	260.47	264.98	269.70
.640	234.44	226.51	227.77	231.82	235.98	240.26	244.37	247.66	251.99	255.93	259.78	263.52	268.33	273.10
.660	235.32	228.21	229.80	233.90	237.96	242.29	247.31	250.93	254.87	258.87	262.75	267.07	271.87	276.72
.680	235.60	229.05	231.26	235.81	239.93	244.45	249.67	253.33	257.73	261.78	265.99	270.13	275.00	279.82
.700	236.38	229.87	233.53	237.85	242.02	246.60	252.15	255.87	260.59	264.66	269.22	273.38	278.32	283.15
.720	237.15	231.53	235.80	239.88	244.38	249.01	254.32	258.38	263.28	267.53	272.13	276.62	281.60	286.48
.740	237.63	233.46	238.06	241.91	246.73	251.67	257.04	261.16	265.96	270.39	275.29	279.84	284.85	289.80
.760	238.80	235.38	239.75	244.20	249.05	254.33	259.75	263.90	268.76	273.50	278.44	283.04	288.08	293.07
.780	239.96	237.56	241.98	246.62	251.65	256.97	262.15	266.91	271.83	276.33	281.59	286.20	291.31	296.32
.800	241.46	239.74	244.37	249.17	254.38	259.60	264.87	269.91	274.88	279.93	284.80			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.250						260.00	251.50	246.47	243.85	242.15	241.20	241.70	242.62	244.60
.280						255.49	242.76	238.54	239.19	236.72	238.54	239.13	240.61	242.09
.300						242.24	237.80	235.16	236.46	235.57	237.40	238.92	241.04	240.38
.320						238.74	236.79	232.35	234.31	234.07	238.39	238.08	240.21	240.34
.340						231.51	230.46	229.51	232.42	233.76	235.97	238.15	240.60	240.58
.350						228.22	228.86	229.11	231.73	233.41	236.89	239.10	241.58	241.27
.380						226.43	226.82	228.04	231.03	234.25	237.15	239.09	241.61	242.56
.400	286.81	254.41	243.79	230.76	226.36	225.51	226.54	228.46	231.20	233.86	236.77	239.97	242.53	245.56
.420	276.74	250.59	235.54	231.22	228.57	227.31	227.82	229.15	232.24	235.26	238.82	241.43	244.94	247.03
.440	267.43	245.96	232.83	231.32	229.67	228.50	228.73	230.72	233.56	237.24	240.25	243.18	246.25	248.98
.460	260.86	242.99	232.24	231.10	230.44	230.85	230.22	232.27	235.15	239.20	242.24	245.23	248.61	251.68
.480	257.63	239.99	231.00	231.76	231.16	232.56	231.71	234.70	237.02	240.80	244.05	246.93	251.44	254.97
.500	253.77	237.26	230.65	231.64	232.77	234.87	234.05	236.80	239.16	242.68	246.28	249.51	254.37	258.25
.520	249.87	234.99	230.95	232.11	234.37	237.12	235.49	239.05	241.58	245.15	248.64	252.65	257.24	261.77
.540	248.77	234.52	230.49	233.31	235.94	238.43	238.07	241.24	244.30	248.20	251.73	255.51	259.84	264.10
.550	246.70	233.73	230.99	234.49	236.89	239.88	240.78	243.56	247.00	250.92	254.80	258.00	262.37	266.68
.580	245.84	233.85	231.47	235.03	238.11	241.52	243.17	246.17	249.95	253.94	257.54	260.78	265.49	269.84
.600	244.35	233.34	232.55	236.16	239.91	242.57	246.01	248.74	252.88	256.94	260.56	265.37	268.59	272.97
.620	244.38	233.74	233.75	237.27	241.39	244.72	248.66	251.58	255.80	259.73	263.28	266.88	271.36	276.08
.640	243.64	234.42	235.25	239.13	243.15	247.31	251.31	254.42	258.68	262.51	266.26	269.90	274.71	279.48
.650	244.35	236.02	237.20	241.13	245.05	249.26	254.24	257.70	261.53	265.43	269.21	273.47	278.26	283.12
.630	244.41	236.68	238.53	242.96	246.92	251.35	256.54	260.04	264.37	268.31	272.45	276.51	281.38	286.20
.700	245.00	237.32	240.76	244.92	248.94	253.41	258.96	262.53	267.20	271.17	275.67	279.76	284.70	289.53
.720	245.59	238.88	242.98	246.88	251.25	255.77	261.06	264.99	269.85	274.01	278.56	283.00	287.98	292.86
.740	245.87	240.73	245.18	248.82	253.54	258.41	263.75	267.74	272.49	276.84	281.72	286.22	291.23	296.18
.760	246.90	242.58	246.77	251.07	255.81	261.04	266.43	270.46	275.27	279.96	284.87	289.42	294.46	299.45
.780	247.93	244.71	248.95	253.45	258.39	263.66	268.79	273.47	278.34	282.76	288.02	292.58	297.69	302.70
.800	249.31	246.84	251.30	255.97	261.10	266.26	271.49	276.47	281.38	286.41	291.24			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						273.33	263.76	257.96	254.77	252.57	251.18	251.37	252.01	253.81
.280						268.15	253.99	249.06	249.39	246.37	247.99	248.27	249.52	250.77
.300						253.49	248.31	245.09	246.13	244.81	246.44	247.72	249.67	248.60
.320						249.41	246.93	241.74	243.50	242.88	247.20	246.50	248.46	248.24
.340						241.29	239.77	238.37	241.15	242.23	244.27	246.27	248.56	248.19
.360						237.44	237.74	237.63	240.10	241.55	244.95	246.98	249.32	248.62
.380						235.21	235.24	236.18	239.04	242.16	244.93	246.67	249.04	249.71
.400	302.47	266.92	254.98	240.43	235.26	233.93	234.65	236.35	238.93	241.44	244.22	247.32	249.72	252.65
.420	291.31	262.52	245.78	240.66	237.38	235.61	235.76	236.81	239.77	242.67	246.15	248.61	252.03	253.93
.440	280.98	257.25	242.58	240.51	238.30	236.62	236.46	238.23	240.91	244.52	247.40	250.20	253.15	255.75
.460	273.62	253.78	241.68	240.00	238.86	238.89	237.80	239.62	242.35	246.34	249.26	252.12	255.41	258.37
.480	269.88	250.28	240.09	240.47	239.37	240.48	239.13	241.97	244.09	247.75	250.93	253.67	258.17	261.63
.500	265.46	247.09	239.46	240.08	240.86	242.70	241.40	243.97	246.13	249.54	253.06	256.17	261.06	264.88
.520	260.99	244.38	239.53	240.33	242.33	244.88	242.69	246.13	248.47	251.94	255.32	259.28	263.87	268.41
.540	259.56	243.63	238.79	241.38	243.78	246.04	245.21	248.23	251.14	254.96	258.39	262.09	266.40	270.64
.560	257.08	242.54	239.08	242.40	244.54	247.35	247.89	250.47	253.79	257.63	261.44	264.51	268.85	273.13
.580	255.92	242.42	239.36	242.74	245.61	248.97	250.21	253.03	256.71	260.63	264.12	267.24	271.95	276.27
.600	254.08	241.64	240.28	243.72	247.31	249.74	253.03	255.55	259.62	263.60	267.12	271.93	275.02	279.38
.620	253.88	241.83	241.34	244.67	248.66	251.82	255.64	258.37	262.51	265.35	269.79	273.28	277.74	282.46
.640	252.84	242.34	242.13	246.44	250.32	254.37	258.25	261.19	265.36	269.10	272.75	276.28	281.10	285.86
.660	253.38	243.83	244.60	248.37	252.13	256.23	261.17	264.48	268.19	271.95	275.67	279.87	284.66	289.53
.680	253.21	244.31	245.60	250.10	253.91	258.24	263.41	266.76	271.01	274.85	278.90	282.89	287.76	292.58
.700	253.63	244.78	247.58	251.99	255.85	260.23	265.78	269.19	273.81	277.67	282.13	286.14	291.08	295.91
.720	254.04	246.23	250.15	253.87	258.11	262.53	267.80	271.60	276.42	280.49	284.99	289.38	294.36	299.24
.740	254.11	248.00	252.30	255.74	260.35	265.15	270.47	274.33	279.03	283.30	288.15	292.61	297.61	302.56
.760	255.01	249.77	253.79	257.93	262.58	267.75	273.12	277.02	281.78	286.42	291.30	295.80	300.85	305.83
.780	255.89	251.86	255.91	260.27	265.12	270.34	275.42	280.03	284.85	289.19	294.45	298.97	304.07	309.08
.800	257.17	253.94	258.23	262.77	267.83	272.93	278.10	283.03	287.89	292.88	297.67			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						246.70	241.12	238.26	237.38	237.13	237.42	238.82	240.51	243.03
.280						243.79	234.76	232.76	234.62	233.89	236.58	238.19	240.43	242.62
.300						233.53	231.48	230.86	233.45	234.04	236.90	239.35	242.27	242.73
.320						231.26	231.44	229.39	232.58	233.88	238.82	239.90	242.87	244.14
.340						225.87	226.84	227.83	231.90	234.55	237.89	241.04	244.42	245.62
.360						223.65	226.14	228.19	232.12	235.17	239.58	242.92	246.33	247.40
.380						222.68	224.99	227.94	232.28	236.66	240.73	243.84	247.44	249.57
.400	261.91	237.33	230.88	222.35	220.93	222.36	225.30	228.91	233.05	237.10	241.20	245.50	249.13	253.16
.420	253.81	234.42	224.29	223.04	223.14	224.33	226.87	230.00	234.56	238.92	243.69	247.52	252.07	255.31
.440	246.29	230.85	222.35	223.48	224.44	225.70	228.07	231.84	236.19	241.21	245.55	249.77	253.97	257.86
.460	241.02	228.71	222.18	223.62	225.39	228.05	229.77	233.57	238.06	243.42	247.86	252.19	256.75	260.93
.480	238.55	226.49	221.40	224.47	226.35	229.86	231.37	236.07	240.14	245.28	250.00	254.24	259.85	264.48
.500	235.57	224.47	221.41	224.69	228.04	232.08	233.72	238.27	242.35	247.38	252.37	257.03	262.91	267.98
.520	232.55	222.77	222.01	225.36	229.64	234.32	235.30	240.48	244.83	249.91	254.87	260.21	265.95	271.56
.540	231.89	222.61	221.90	226.64	231.28	235.76	237.76	242.71	247.53	252.90	257.98	263.12	268.74	274.15
.560	230.42	222.18	222.56	227.92	232.38	237.25	240.37	245.03	250.11	255.63	260.96	265.73	271.35	276.93
.580	229.57	222.51	223.16	228.72	233.65	239.01	242.71	247.51	252.97	258.56	263.71	268.54	274.50	280.11
.600	229.01	222.33	224.27	229.93	235.45	240.12	245.38	250.00	255.80	261.40	266.69	272.80	277.60	283.25
.620	229.32	222.91	225.50	231.11	236.99	242.21	247.89	252.72	258.55	264.13	269.33	274.52	280.36	286.37
.640	228.99	223.74	226.99	232.86	238.79	244.62	250.41	255.43	261.28	266.83	272.18	277.49	283.61	289.73
.660	229.38	225.33	228.85	234.74	240.65	246.55	253.17	258.42	264.01	269.58	275.03	280.82	287.03	293.17
.680	230.24	226.16	230.20	236.49	242.47	248.61	255.35	260.70	266.73	272.31	278.12	283.72	290.07	296.21
.700	231.05	226.98	232.31	238.35	244.35	250.66	257.65	263.08	269.35	275.05	281.12	286.83	293.17	299.44
.720	231.86	228.57	234.42	240.22	246.48	252.90	259.70	265.45	271.87	277.76	283.85	289.91	296.29	302.65
.740	232.41	230.41	236.52	242.08	248.61	255.36	262.28	267.97	274.40	280.42	286.85	292.42	299.39	305.73
.760	233.61	232.24	238.11	244.19	250.74	257.76	264.82	270.54	277.03	283.30	289.82	295.90	302.48	308.85
.780	234.80	234.33	240.21	246.43	253.12	260.14	267.06	273.35	279.85	285.96	292.76	298.90	305.49	311.95
.800	236.29	236.42	242.47	248.79	255.62	262.53	269.58	276.19	282.65	289.31	295.70			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						260.04	253.39	249.75	248.29	247.55	247.40	248.49	249.91	252.23
.280						256.45	245.99	243.27	244.83	243.53	246.03	247.33	249.33	251.30
.300						244.79	242.00	240.79	243.12	243.28	245.94	248.15	250.90	250.95
.320						241.93	241.58	238.78	241.76	242.69	247.62	248.32	251.11	252.04
.340						235.65	236.15	236.68	240.63	243.02	246.19	249.16	252.38	253.23
.360						232.87	235.03	236.72	240.49	243.31	247.64	250.81	254.06	254.75
.380						231.46	233.41	236.09	240.30	244.57	248.51	251.42	254.87	256.72
.400	277.57	249.84	242.06	232.02	229.82	230.78	233.41	236.80	240.79	244.68	248.65	252.85	256.33	260.25
.420	268.38	246.35	234.53	232.49	231.94	232.62	234.80	237.66	242.09	246.32	251.02	254.69	259.16	262.21
.440	259.84	242.15	232.10	232.67	233.07	233.82	235.80	239.34	243.54	248.48	252.69	256.79	260.87	264.63
.460	253.78	239.51	231.62	232.53	233.82	236.08	237.35	240.92	245.26	250.57	254.88	259.08	263.55	267.62
.480	250.80	236.79	230.49	233.17	234.57	237.77	238.79	243.34	247.21	252.28	256.87	260.98	266.59	271.15
.500	247.26	234.29	230.22	233.12	236.14	239.92	241.07	245.44	249.31	254.25	259.15	263.69	269.60	274.62
.520	243.68	232.17	230.59	233.58	237.60	242.08	242.50	247.56	251.72	256.70	261.56	266.84	272.58	278.19
.540	242.68	231.72	230.19	234.70	239.11	243.37	244.90	249.70	254.37	259.67	264.64	269.70	275.30	280.69
.560	240.81	230.98	230.65	235.83	240.04	244.72	247.48	251.94	256.90	262.34	267.59	272.24	277.84	283.39
.580	240.05	231.09	231.05	236.42	241.15	246.36	249.75	254.38	259.74	265.25	270.30	275.00	280.95	286.54
.600	238.74	230.62	232.00	237.49	242.85	247.29	252.40	256.81	262.54	268.06	273.25	279.36	284.04	289.66
.620	238.82	231.00	233.10	238.51	244.26	249.31	254.87	259.51	265.26	270.75	275.84	280.93	286.74	292.75
.640	238.19	231.55	234.47	240.18	245.97	251.68	257.35	262.19	267.97	273.42	278.66	283.87	289.99	296.11
.660	238.91	233.14	236.25	241.98	247.73	253.52	260.10	265.20	270.68	276.14	281.49	287.22	293.43	299.57
.680	239.05	233.79	237.47	243.63	249.46	255.50	262.21	267.41	273.37	278.85	284.58	290.10	296.45	302.59
.700	239.68	234.44	239.53	245.42	251.27	257.48	264.46	269.75	275.96	281.56	287.58	293.21	299.55	305.82
.720	240.31	235.92	241.59	247.21	253.35	259.66	266.43	272.06	278.44	284.25	290.28	296.29	302.67	309.03
.740	240.66	237.58	243.64	249.00	255.43	262.10	268.99	274.55	280.93	286.88	293.28	299.30	305.77	312.11
.760	241.71	239.44	245.13	251.06	257.50	264.47	271.51	277.10	283.54	289.76	296.25	302.28	308.86	315.23
.780	242.76	241.48	247.18	253.26	259.86	266.83	273.70	279.91	286.36	292.39	299.19	305.28	311.87	318.33
.800	244.14	243.52	249.40	255.60	262.34	269.19	276.20	282.75	289.16	295.79	302.14			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						273.37	265.65	261.23	259.20	257.96	257.38	258.16	259.30	261.44
.280						269.11	257.22	253.79	255.04	253.18	255.47	256.47	258.24	259.98
.300						256.04	252.51	250.72	252.79	252.52	254.97	256.96	259.52	259.17
.320						252.60	251.71	248.18	250.95	251.49	256.43	256.74	259.36	259.94
.340						245.43	245.45	245.54	249.35	251.49	254.48	257.27	260.34	260.83
.360						242.08	243.91	245.24	248.86	251.45	255.71	258.70	261.79	262.10
.380						240.24	241.84	244.23	248.31	252.48	256.29	259.00	262.30	263.87
.400	293.23	262.34	253.24	241.69	238.72	239.21	241.53	244.68	248.52	252.26	256.10	260.20	263.52	267.34
.420	282.95	258.28	244.76	241.93	240.75	240.92	242.74	245.32	249.62	253.72	258.34	261.86	266.26	269.12
.440	273.39	253.44	241.85	241.86	241.70	241.93	243.54	246.85	250.89	255.76	259.84	263.81	267.78	271.39
.460	266.54	250.30	241.07	241.44	242.24	244.12	244.93	248.27	252.45	257.72	261.90	265.97	270.35	274.31
.480	263.05	247.09	239.57	241.87	242.79	245.68	246.22	250.62	254.28	259.27	263.75	267.72	273.33	277.81
.500	258.95	244.12	239.02	241.56	244.23	247.75	248.42	252.62	256.28	261.11	265.92	270.35	276.29	281.26
.520	254.81	241.56	239.17	241.80	245.57	249.84	249.70	254.65	258.61	263.49	268.25	273.48	279.22	284.82
.540	253.48	240.83	238.49	242.77	246.95	250.97	252.05	256.69	261.21	266.43	271.30	276.29	281.86	287.22
.560	251.20	239.79	238.74	243.74	247.69	252.18	254.59	258.86	263.69	269.06	274.23	278.74	284.32	289.85
.580	250.14	239.66	238.93	244.13	248.65	253.71	256.80	261.25	266.50	271.94	276.88	281.46	287.41	292.97
.600	248.46	238.92	239.74	245.04	250.25	254.47	259.42	263.63	269.28	274.72	279.80	285.91	290.47	296.06
.620	248.31	239.09	240.69	245.91	251.54	256.41	261.85	266.30	271.97	277.38	282.35	287.33	293.12	299.13
.640	247.40	239.57	241.94	247.49	253.14	258.74	264.30	268.96	274.66	280.00	285.15	290.25	296.37	302.49
.660	247.94	240.95	243.65	249.21	254.82	260.49	267.03	271.97	277.34	282.70	287.95	293.62	299.83	305.98
.680	247.85	241.42	244.75	250.78	256.46	262.39	269.08	274.12	280.00	285.38	291.03	296.48	302.83	308.97
.700	248.31	241.89	246.76	252.49	258.19	264.29	271.27	276.41	282.57	288.06	294.04	299.59	305.93	312.20
.720	248.76	243.27	248.76	254.20	260.22	266.43	273.17	278.67	285.02	290.73	296.72	302.68	309.05	315.41
.740	248.90	244.96	250.76	255.91	262.24	268.84	275.70	281.14	287.46	293.33	299.71	305.69	312.15	318.49
.760	249.81	246.64	252.15	257.92	264.27	271.18	278.20	283.66	290.05	296.21	302.68	308.66	315.24	321.61
.780	250.72	248.63	254.15	260.09	266.59	273.52	280.33	286.47	292.87	298.82	305.62	311.66	318.25	324.72
.800	252.00	250.61	256.33	262.40	269.07	275.85	282.81	289.31	295.67	302.27	308.58			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						286.71	277.92	272.72	270.11	268.37	257.36	267.82	268.69	270.65
.280						281.77	268.45	264.30	265.25	262.83	254.91	265.61	267.15	268.66
.300						267.30	263.03	260.65	262.47	261.76	264.01	265.76	268.15	267.39
.320						263.27	261.84	257.57	260.14	260.30	265.23	265.17	267.60	267.84
.340						255.20	254.76	254.40	258.08	259.97	262.78	265.39	268.31	268.44
.360						251.29	252.79	253.77	257.23	259.59	263.77	266.58	269.53	269.45
.380						249.02	250.26	252.37	256.32	260.40	264.08	266.58	269.73	271.01
.400	308.89	274.85	264.43	251.27	247.61	247.63	249.64	252.57	256.25	259.84	263.56	267.55	270.72	274.43
.420	297.53	270.21	255.00	251.37	249.56	249.21	250.68	252.97	257.15	261.12	265.67	269.04	273.35	276.02
.440	286.94	264.74	251.60	251.05	250.32	250.05	251.27	254.35	258.24	263.03	266.99	270.83	274.68	278.15
.460	279.30	261.10	250.51	250.34	250.66	252.16	252.51	255.62	259.65	264.86	268.92	272.86	277.15	280.99
.480	275.30	257.39	248.66	250.58	251.00	253.59	253.65	257.89	261.35	266.26	270.63	274.46	280.07	284.47
.500	270.64	253.95	247.83	249.99	252.32	255.59	255.77	259.79	263.25	267.98	272.70	277.01	282.98	287.89
.520	265.93	250.95	247.75	250.02	253.53	257.59	256.90	261.73	265.51	270.28	274.93	280.11	285.85	291.46
.540	264.27	249.94	246.78	250.33	254.78	258.58	259.20	263.69	268.06	273.19	277.97	282.87	288.42	293.76
.560	261.58	248.60	246.83	251.05	255.35	259.65	261.70	265.78	270.48	275.77	280.86	285.25	290.80	296.30
.580	260.22	248.24	246.82	251.34	256.16	261.06	263.84	268.11	273.26	278.62	283.47	287.91	293.87	299.40
.600	258.18	247.21	247.47	252.60	257.65	261.64	266.44	270.44	276.02	281.39	286.36	292.47	296.90	302.47
.620	257.81	247.18	248.28	253.32	258.81	263.50	268.83	273.09	278.69	284.00	288.86	293.74	299.50	305.51
.640	256.60	247.48	249.42	254.30	260.31	265.80	271.24	275.72	281.34	286.59	291.63	296.63	302.75	308.87
.660	256.97	248.76	251.05	256.35	261.90	267.45	273.96	278.75	284.00	289.26	294.41	300.02	306.23	312.38
.680	256.66	249.05	252.02	257.92	263.45	269.29	275.94	280.83	286.64	291.91	297.49	302.87	309.21	315.35
.700	256.93	249.34	253.93	259.56	265.10	271.10	278.09	283.07	289.18	294.57	300.50	305.97	312.31	318.58
.720	257.21	250.62	255.93	261.20	267.08	273.19	279.91	285.28	291.59	297.21	303.15	309.06	315.43	321.79
.740	257.15	252.23	257.86	262.83	269.06	275.58	282.41	287.72	294.00	299.79	306.14	312.07	318.53	324.87
.760	257.92	253.84	259.17	264.79	271.03	277.89	284.88	290.22	296.55	302.67	309.11	315.04	321.62	327.99
.780	258.68	255.77	261.12	266.91	273.33	280.20	286.97	293.03	299.38	305.25	312.06	318.04	324.63	331.10
.800	259.85	257.71	263.26	269.20	275.79	282.51	289.43	295.87	302.17	308.75	315.02			

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			262.98	248.46	241.05	238.13	236.92	236.51	236.63	237.44	238.98	241.15	243.43	246.77
.420			254.29	243.59	238.79	236.34	233.41	234.26	235.57	237.11	238.63	240.16	243.32	246.03
.440			250.80	240.85	235.11	232.66	232.88	233.42	234.97	236.99	239.35	241.93	244.65	247.81
.460			245.71	238.34	236.61	234.65	231.49	232.69	234.84	237.33	239.47	241.59	244.29	247.01
.480			242.95	236.77	235.99	233.32	231.46	232.80	235.17	238.15	240.40	242.66	245.36	248.31
.500			246.24	239.68	235.13	232.93	233.01	233.95	235.99	238.29	241.10	244.37	247.14	250.76
.520	258.31	251.53	239.05	236.20	235.33	233.97	231.77	234.29	237.03	239.06	242.38	245.24	248.79	251.86
.540	254.32	245.90	237.44	235.08	235.41	234.53	232.80	235.09	238.07	240.35	244.02	247.23	250.43	253.63
.560	251.51	243.56	237.24	235.61	236.07	235.08	234.19	235.41	238.88	242.33	245.78	248.98	252.19	255.62
.580	249.64	241.70	236.34	235.90	236.84	235.40	235.57	237.74	240.62	244.07	247.53	250.74	254.41	258.10
.600	249.42	240.78	236.13	236.18	237.37	236.17	237.07	239.60	242.36	244.77	248.56	252.50	256.40	260.32
.620	249.54	240.79	236.63	237.86	238.13	237.18	239.08	241.57	244.34	247.33	250.79	254.31	258.40	262.54
.640	246.82	240.35	236.89	237.90	239.35	238.65	240.53	243.07	246.31	248.83	252.54	256.34	260.74	265.13
.660	246.10	240.83	237.62	238.05	240.81	240.13	242.24	244.80	248.05	251.05	254.75	258.69	263.08	267.48
.680	247.02	241.31	238.11	239.61	241.79	241.59	244.18	246.76	250.02	253.02	256.95	261.14	265.54	269.93
.700	246.99	241.54	239.31	240.34	242.77	243.75	246.13	248.48	252.22	255.46	259.65	263.82	268.23	272.62
.720	247.43	242.71	241.22	242.01	243.97	245.44	259.87	250.90	254.42	257.91	262.09	266.26	270.68	275.08
.740	248.64	243.88	243.25	243.44	244.94	247.37	250.45	253.32	256.84	260.46	264.53	268.88	273.24	277.66
.760	249.59	244.45	243.82	244.65	246.62	249.29	251.93	255.73	259.26	263.02	267.21	271.40	275.81	280.22
.780	250.36	245.95	245.70	246.79	248.76	251.20	254.32	258.14	261.92	265.68	269.89	274.08	278.50	282.90
.800	250.78	247.57	247.34	249.16	250.90	253.58	256.48	260.54	264.33	268.34	272.56	276.75	281.18	285.59
.820	251.90	249.18	249.21	251.05	253.29	255.97	259.11	262.93	266.98	270.99	275.22	279.43	283.85	288.27
.840	253.37	250.55	251.43	253.17	255.44	258.35	261.73	265.57	269.61	273.64	277.98	282.34	286.77	291.19
.860	255.12	252.16	253.52	255.29	257.81	260.96	264.49	268.20	272.37	276.41	280.86	285.29	289.68	294.27

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			277.64	261.52	252.99	249.37	247.63	246.76	246.48	246.95	248.22	250.19	252.27	255.50
.420			268.04	255.91	250.23	247.13	243.50	244.02	245.03	246.30	247.55	248.82	251.87	254.41
.440			263.95	252.63	245.92	242.82	242.64	242.81	244.10	245.89	248.06	250.47	253.03	256.08
.460			258.10	249.60	247.29	244.72	240.84	241.74	243.67	245.59	247.91	249.81	252.36	254.92
.480			254.79	247.60	246.33	242.99	240.53	241.58	243.76	246.80	248.65	250.70	253.25	256.06
.500			258.12	250.51	245.11	242.28	241.95	242.56	244.38	246.48	249.14	252.30	254.92	258.47
.520	271.93	264.07	249.98	246.43	245.05	243.14	240.31	242.65	245.23	247.04	250.26	252.97	256.44	259.39
.540	267.29	257.63	247.94	244.93	244.87	243.47	241.16	243.25	246.09	248.17	251.77	254.87	257.96	261.05
.560	263.94	254.80	247.45	245.24	245.31	243.80	242.41	243.33	246.70	250.06	253.42	256.51	259.61	262.95
.580	261.63	252.49	246.18	245.27	245.88	243.87	243.64	245.60	248.33	251.70	255.06	258.16	261.76	265.38
.600	261.11	251.21	245.69	245.30	246.18	244.45	245.00	247.36	249.96	252.17	255.92	259.80	263.66	267.53
.620	260.97	250.95	245.96	246.88	246.74	245.27	246.93	249.24	251.84	254.70	258.08	261.51	265.57	269.69
.640	257.72	250.19	245.97	246.65	247.81	246.61	248.24	250.60	253.73	256.87	259.71	263.45	267.85	272.25
.660	256.66	250.46	246.49	246.53	249.13	247.95	249.84	252.22	255.35	258.22	261.85	265.75	270.13	274.54
.680	257.40	250.71	246.76	247.97	249.93	249.28	251.69	254.09	257.23	260.10	263.99	268.15	272.55	276.94
.700	257.11	250.69	247.31	248.50	250.73	251.37	253.55	255.69	259.37	262.50	266.66	270.81	275.22	279.61
.720	257.32	251.71	249.52	250.06	251.77	252.95	268.32	258.07	261.50	264.90	269.06	273.21	277.62	282.03
.740	258.38	252.71	251.58	251.35	252.56	254.79	257.73	260.44	263.88	267.42	271.46	275.80	280.15	284.57
.760	259.15	253.07	251.53	252.40	254.13	256.62	259.07	262.81	266.25	269.94	274.11	278.28	282.68	287.10
.780	259.73	254.45	253.73	254.48	256.20	258.44	261.43	265.17	268.88	272.58	276.77	280.93	285.35	289.76
.800	259.92	255.95	255.26	256.80	258.28	260.78	263.52	267.53	271.26	275.21	279.42	283.59	288.01	292.42
.820	260.89	257.46	257.04	258.60	260.62	263.11	266.12	269.88	273.88	277.34	282.06	286.24	290.67	295.09
.840	262.24	258.69	259.20	260.65	262.70	265.45	268.72	272.49	276.49	280.48	284.69	289.15	293.58	298.00
.860	263.89	260.18	261.22	262.71	265.02	268.04	271.47	275.10	279.24	283.23	287.68	292.10	296.49	301.10

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			292.71	274.58	264.93	260.60	258.34	257.01	256.33	256.46	257.46	259.22	261.10	264.24
.420			291.80	268.23	261.67	257.92	253.59	253.77	254.49	255.49	256.47	257.47	260.41	262.80
.440			277.10	264.41	256.74	252.98	252.41	252.21	253.22	254.79	256.77	259.01	261.41	264.35
.460			270.49	260.86	257.97	254.79	250.19	250.79	252.51	254.64	256.35	258.04	260.43	262.83
.480			266.64	258.44	256.67	252.65	249.60	250.35	252.35	255.05	256.90	258.75	261.14	263.82
.500			270.01	261.35	255.09	251.64	250.88	251.17	252.76	254.67	257.18	260.23	262.70	266.18
.520	285.56	276.62	260.90	256.66	254.78	252.31	248.85	251.01	253.44	255.02	258.14	260.70	264.09	266.93
.540	280.26	269.37	258.44	254.78	254.32	252.42	249.52	251.41	254.12	255.99	259.53	262.51	265.49	268.46
.560	276.37	266.04	257.65	254.86	254.55	252.52	250.62	251.24	254.52	257.79	261.07	264.04	267.03	270.28
.580	273.61	263.28	256.03	254.65	254.91	252.35	251.71	253.45	256.04	259.32	262.59	265.58	269.12	272.66
.600	272.80	261.64	255.24	254.43	254.99	252.72	252.94	255.11	257.55	259.58	263.27	267.11	270.93	274.75
.620	272.40	261.12	255.29	255.89	255.35	253.36	254.78	256.90	259.35	262.08	265.36	268.71	272.75	276.84
.640	268.62	260.04	255.05	255.39	256.26	254.57	255.95	258.13	261.15	263.31	266.88	270.57	274.97	279.36
.660	267.23	260.08	255.37	255.02	257.44	255.77	257.43	259.64	262.66	265.39	268.95	272.80	277.19	281.60
.680	267.79	260.10	255.41	256.33	258.07	256.96	259.20	261.42	264.45	267.18	271.03	275.16	279.56	283.96
.700	267.22	259.84	256.31	256.66	258.63	258.99	260.97	262.91	266.52	269.53	273.67	277.80	282.21	286.60
.720	267.21	260.70	258.03	258.10	259.57	260.46	276.78	265.24	268.58	271.89	276.03	280.15	284.57	288.98
.740	268.12	261.55	259.91	259.27	260.13	262.20	265.01	267.57	270.91	274.38	278.38	282.72	287.07	291.48
.760	268.72	261.69	260.05	260.16	261.63	263.94	266.22	269.89	273.25	276.87	281.01	285.16	289.56	293.98
.780	269.11	262.94	261.75	262.17	263.64	265.68	268.53	272.21	275.85	279.48	283.65	287.79	292.21	296.61
.800	269.07	264.34	263.17	264.45	265.65	267.97	270.56	274.52	278.18	282.09	286.27	290.42	294.84	299.25
.820	269.88	265.73	264.86	266.16	267.95	270.26	273.14	276.82	280.78	284.70	288.89	293.05	297.48	301.90
.840	271.10	266.83	266.96	268.14	269.95	272.55	275.71	279.41	283.37	287.31	291.50	295.96	300.39	304.81
.860	272.66	268.21	268.92	270.12	272.24	275.12	278.45	282.00	286.10	290.05	294.50	298.92	303.30	307.92

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			267.57	267.64	276.86	271.84	269.04	267.26	266.17	265.97	266.70	268.25	269.94	272.98
.420			295.56	280.55	273.12	268.71	263.69	263.53	263.96	264.69	265.40	266.12	268.95	271.18
.440			290.25	276.18	267.55	263.14	262.17	261.60	262.35	263.69	265.48	267.56	269.80	272.62
.460			282.87	272.12	268.64	264.86	259.54	259.84	261.34	263.29	264.79	266.27	268.50	270.74
.480			278.48	269.27	267.01	262.32	258.67	259.13	260.93	263.51	265.15	266.80	269.03	271.57
.500			281.89	272.18	265.08	260.99	259.82	259.78	261.15	262.85	265.21	268.16	270.48	273.89
.520	299.18	289.16	271.82	266.89	264.50	261.49	257.40	259.37	261.64	263.00	266.02	268.44	271.75	274.46
.540	293.23	281.10	268.93	264.62	263.77	261.37	257.88	259.57	262.14	263.81	267.28	270.16	273.02	275.88
.560	288.80	277.28	267.86	264.48	263.79	261.24	258.84	259.15	262.35	265.52	268.71	271.57	274.45	277.61
.580	285.59	274.07	265.87	264.02	263.95	260.82	259.78	261.31	263.75	266.94	270.12	272.99	276.47	279.95
.600	284.49	272.07	264.79	263.55	263.81	260.99	260.87	262.87	265.15	266.99	270.62	274.41	278.19	281.97
.620	283.83	271.28	264.61	264.91	263.96	261.46	262.63	264.57	266.86	269.45	272.64	275.91	279.92	283.99
.640	279.52	269.89	264.13	264.13	264.71	262.52	263.66	265.66	268.57	270.54	274.05	277.68	282.08	286.48
.660	277.79	269.70	264.25	263.50	265.76	263.60	265.03	267.06	269.96	272.56	276.06	279.86	284.25	288.65
.680	278.18	269.50	264.07	264.69	266.20	264.65	266.71	268.75	271.66	274.26	278.06	282.18	286.58	290.97
.700	277.34	268.99	264.80	264.81	266.64	266.61	268.39	270.12	273.67	276.57	280.69	284.79	289.21	293.59
.720	277.10	269.69	266.44	266.15	267.37	267.96	285.23	272.41	275.66	278.88	283.00	287.10	291.52	295.92
.740	277.86	270.38	268.24	267.18	267.80	269.62	272.29	274.69	277.95	281.34	285.30	289.63	293.98	298.40
.760	278.28	270.31	268.16	267.91	269.14	271.27	273.37	276.97	280.24	283.79	287.91	292.03	296.44	300.85
.780	278.48	271.44	269.78	269.86	271.08	272.91	275.63	279.24	282.82	286.38	290.52	294.64	299.06	303.47
.800	278.22	272.72	271.08	272.09	273.02	275.16	277.59	281.51	285.11	288.97	293.13	297.25	301.63	306.09
.820	278.87	274.00	272.68	273.71	275.27	277.41	280.15	283.77	287.68	291.55	295.72	299.86	304.29	308.71
.840	279.97	274.97	274.73	275.63	277.22	279.66	282.70	286.34	290.25	294.15	298.31	302.77	307.20	311.62
.860	281.43	276.23	276.62	277.54	279.45	282.20	285.44	288.90	292.97	296.88	301.32	305.73	310.11	314.75

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			329.86	307.23	294.77	288.70	285.10	282.63	280.94	280.23	280.56	281.80	283.19	286.08
.420			316.19	299.02	290.28	284.90	278.83	278.16	278.15	278.48	278.78	279.11	281.76	283.76
.440			309.97	293.85	283.77	278.38	276.81	275.70	276.04	277.04	278.54	280.37	282.38	285.03
.460			301.45	289.02	284.66	279.97	273.57	273.41	274.59	276.28	277.45	278.61	280.61	282.61
.480			296.25	285.52	282.52	276.82	272.28	272.30	273.81	276.18	277.52	278.87	280.87	283.20
.500			299.72	288.44	280.05	275.01	273.23	272.70	273.72	275.13	277.27	280.05	282.14	285.45
.520	319.61	307.97	288.21	282.23	279.08	275.24	270.21	271.92	273.95	274.97	277.84	280.04	283.23	285.75
.540	312.69	298.70	284.68	279.39	277.95	274.79	270.43	271.81	274.18	275.55	278.91	281.62	284.32	287.01
.560	307.45	294.14	283.17	278.91	277.65	274.33	271.16	271.02	274.08	277.12	280.17	282.87	285.57	288.60
.580	303.56	290.25	280.64	278.08	277.50	273.53	271.89	273.09	275.32	278.37	281.41	284.12	287.49	290.87
.600	302.02	287.71	279.12	277.24	277.02	273.40	272.78	274.50	276.55	278.10	281.64	285.37	289.08	292.79
.620	300.97	286.52	278.61	278.43	276.88	273.60	274.41	276.07	278.12	280.51	283.57	286.71	290.67	294.71
.640	295.98	284.65	277.75	277.25	277.39	274.46	275.22	276.96	279.69	281.40	284.81	288.35	292.76	297.15
.660	293.64	284.13	277.57	276.23	278.24	275.33	276.43	278.18	280.92	283.32	286.71	290.45	294.84	299.24
.680	293.75	283.59	277.05	277.24	278.41	276.18	277.97	279.74	282.49	284.89	288.62	292.70	297.10	301.49
.700	292.51	282.71	277.55	277.05	278.58	278.04	279.51	280.95	284.39	287.12	291.21	295.28	299.69	304.08
.720	291.94	283.18	279.05	278.22	279.07	279.23	297.91	283.17	286.28	289.36	293.45	297.52	301.94	306.34
.740	292.47	283.63	280.74	279.05	279.23	280.75	283.21	285.38	288.50	291.77	295.69	300.01	304.35	308.76
.760	292.63	283.24	280.34	279.55	280.40	282.26	284.09	287.60	290.72	294.17	298.27	302.35	306.76	311.17
.780	292.54	284.19	281.81	281.39	282.24	283.77	286.29	289.80	293.27	296.73	300.84	304.93	309.35	313.75
.800	291.95	285.30	282.95	283.55	284.08	285.95	288.15	291.99	295.49	299.29	303.41	307.50	311.93	316.34
.820	292.36	286.41	284.42	285.04	286.27	288.13	290.67	294.19	298.03	301.84	305.97	310.08	314.50	318.92
.840	293.27	287.17	286.38	286.85	288.11	290.31	293.19	296.72	300.57	304.40	308.53	312.99	317.42	321.84
.860	294.59	288.27	288.17	288.67	290.28	292.82	295.91	299.25	303.27	307.11	311.55	315.96	320.33	324.99

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			275.69	261.57	254.50	251.84	250.82	250.52	250.72	251.61	253.17	255.35	257.59	260.87
.420			267.36	257.12	252.71	250.56	247.87	248.88	250.29	251.91	253.50	255.05	258.23	260.90
.440			264.20	254.78	249.46	247.36	247.86	248.62	250.32	252.43	254.86	257.51	260.25	263.42
.460			255.42	252.63	251.37	249.80	246.97	248.44	250.78	253.41	255.62	257.82	260.58	263.32
.480			256.92	251.38	251.15	248.90	247.42	249.05	251.67	254.82	257.20	259.53	262.31	265.31
.500			260.47	254.61	250.64	248.93	249.39	250.69	253.01	255.53	258.50	261.89	264.73	268.43
.520	271.02	265.20	253.52	251.40	251.17	250.35	248.58	251.48	254.54	256.84	260.36	263.37	267.01	270.17
.540	267.14	259.74	252.14	250.54	251.56	251.26	250.02	252.71	256.06	258.63	262.55	265.95	269.29	272.57
.560	264.42	257.56	252.16	251.32	252.49	252.13	251.80	253.45	257.31	261.09	264.83	268.26	271.64	275.21
.580	262.63	255.83	251.44	251.83	253.52	252.76	253.52	256.19	259.48	263.31	267.07	270.55	274.44	278.28
.600	262.48	255.02	251.40	252.33	254.30	253.82	255.34	258.43	261.62	264.43	268.59	272.81	276.98	281.08
.620	262.65	255.13	252.05	254.23	255.30	255.08	257.67	260.74	264.01	267.42	271.26	275.11	279.48	283.86
.640	259.99	254.76	252.44	254.44	256.75	256.82	259.39	262.56	266.36	269.33	273.44	277.61	282.32	286.98
.660	259.31	255.32	253.29	254.75	258.42	258.52	261.37	264.61	268.43	271.95	276.07	280.39	285.13	289.82
.680	260.29	255.86	253.87	256.45	259.59	260.22	263.57	266.85	270.73	274.29	278.69	283.27	288.05	292.76
.700	260.29	256.14	255.16	257.32	260.74	262.60	265.76	268.83	273.24	277.07	281.77	286.36	291.17	295.93
.720	260.77	257.37	257.13	259.11	262.10	264.50	279.73	271.51	275.73	279.83	284.58	289.23	294.04	298.83
.740	262.00	258.58	259.24	260.63	263.22	266.61	270.54	274.18	278.42	282.71	287.36	292.23	297.01	301.83
.760	262.97	259.20	259.86	261.92	265.02	268.69	272.23	276.82	281.09	285.55	290.36	295.10	300.00	304.82
.780	263.76	260.74	261.79	264.14	267.28	270.76	274.83	279.46	284.01	288.48	293.35	298.12	303.07	307.91
.800	264.18	262.39	263.48	266.58	269.52	273.29	277.16	282.08	286.66	291.39	296.31	301.12	306.10	311.01
.820	265.30	264.03	265.40	268.52	271.99	275.80	279.95	284.68	289.53	294.30	299.24	304.11	309.11	314.07
.840	266.77	265.42	267.66	270.70	274.21	278.29	282.72	287.51	292.40	297.20	302.16	307.31	312.35	317.34
.860	268.52	267.04	269.79	272.86	276.65	281.00	285.62	290.31	295.36	300.19	305.40	310.53	315.58	320.75

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			290.55	274.63	266.44	263.08	261.52	260.77	260.57	261.11	262.40	264.38	266.43	269.61
.420			281.12	269.44	264.15	261.35	257.96	258.64	259.76	261.10	262.42	263.71	266.77	269.28
.440			277.35	266.56	260.27	257.52	257.63	258.01	259.45	261.33	263.57	266.05	268.63	271.69
.460			271.81	263.89	262.05	259.87	256.32	257.49	259.61	262.06	264.06	266.05	268.65	271.23
.480			268.77	262.22	261.49	258.57	256.49	257.83	260.26	263.27	265.45	267.57	270.20	273.06
.500			272.36	265.44	260.62	258.28	258.33	259.30	261.39	263.72	266.54	269.82	272.51	276.14
.520	284.64	277.74	264.45	261.63	260.89	259.53	257.12	259.84	262.75	264.82	268.24	271.10	274.67	277.70
.540	280.11	271.47	262.64	260.39	261.01	260.20	258.39	260.87	264.08	266.45	270.31	273.59	276.82	279.99
.560	276.85	268.80	262.37	260.94	261.73	260.86	260.01	261.36	265.13	268.83	272.47	275.79	279.06	282.54
.580	274.61	266.62	261.29	261.21	262.56	261.24	261.59	264.05	267.19	270.93	274.60	277.97	281.79	285.56
.600	274.17	265.45	260.95	261.46	263.12	262.09	263.28	266.18	269.22	271.84	275.94	280.11	284.24	288.30
.620	274.08	265.29	261.38	263.24	263.91	263.18	265.52	268.40	271.52	274.79	278.55	282.31	286.55	291.01
.640	270.89	264.61	261.52	263.19	265.20	264.77	267.10	270.09	273.78	276.57	280.61	284.73	289.43	294.09
.660	269.88	264.94	262.17	263.23	266.74	266.35	268.97	272.03	275.74	279.12	283.17	287.45	292.19	296.88
.680	270.67	265.26	262.53	264.82	267.73	267.90	271.08	274.18	277.94	281.37	285.73	290.28	295.06	299.78
.700	270.41	265.29	263.65	265.48	268.70	270.22	273.18	276.05	280.39	284.10	288.79	293.35	298.16	302.92
.720	270.66	266.36	265.54	267.15	269.90	272.01	284.18	278.68	282.81	286.82	291.55	296.17	300.99	305.78
.740	271.74	267.42	267.57	268.55	270.84	274.03	277.82	281.30	285.45	289.66	294.28	299.15	303.93	308.75
.760	272.54	267.82	267.97	269.67	272.53	276.02	279.38	283.90	288.08	292.47	297.26	301.98	306.88	311.70
.780	273.13	269.23	269.82	271.82	274.72	278.00	281.93	286.49	290.97	295.38	300.23	304.97	309.93	314.76
.800	273.33	270.77	271.40	274.22	276.89	280.48	284.20	289.07	293.58	298.27	303.17	307.95	312.94	317.84
.820	274.30	272.30	273.22	276.08	279.31	282.95	286.96	291.63	296.43	301.16	306.08	310.92	315.92	320.88
.840	275.64	273.56	275.43	278.18	281.47	285.40	289.71	294.43	299.27	304.03	308.97	314.12	319.16	324.15
.860	277.29	275.06	277.49	280.28	283.87	288.08	292.60	297.21	302.23	307.02	312.22	317.35	322.39	327.57

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			305.41	287.69	278.38	274.32	272.23	271.02	270.41	270.62	271.64	273.41	275.26	278.34
.420			294.87	281.76	275.59	272.14	268.05	268.39	269.22	270.29	271.34	272.36	275.31	277.67
.440			290.50	278.34	271.08	267.68	267.39	267.41	268.58	270.23	272.29	274.59	277.02	279.96
.460			284.19	275.15	272.72	269.94	265.67	266.54	268.44	270.72	272.50	274.29	276.72	279.14
.480			280.62	273.05	271.83	268.23	265.56	266.60	268.85	271.72	273.70	275.62	278.09	280.82
.500			284.24	276.28	270.61	267.63	267.27	267.91	269.77	271.91	274.58	277.75	280.29	283.85
.520	298.26	290.28	275.37	271.86	270.61	268.70	265.66	268.21	270.95	272.80	276.12	278.83	282.32	285.23
.540	293.08	283.21	273.14	270.23	270.46	269.15	266.75	269.03	272.11	274.27	278.06	281.23	284.35	287.41
.560	289.28	280.04	272.57	270.56	270.97	269.58	268.23	269.27	272.95	276.56	280.11	283.32	286.48	289.87
.580	286.60	277.41	271.14	270.58	271.59	269.71	269.66	271.91	274.90	278.55	282.13	285.39	289.14	292.84
.600	285.86	275.88	270.51	270.59	271.93	270.36	271.21	273.94	276.82	279.24	283.29	287.42	291.50	295.51
.620	285.52	275.45	270.71	272.26	272.52	271.27	273.37	276.07	279.03	282.16	285.83	289.51	293.82	298.16
.640	281.79	274.46	270.61	271.93	273.65	272.73	274.81	277.62	281.20	283.81	287.78	291.84	296.54	301.20
.660	280.44	274.56	271.05	271.72	275.05	274.17	276.56	279.44	283.04	286.29	290.27	294.51	299.25	303.94
.680	281.06	274.65	271.18	273.18	275.97	275.59	278.59	281.51	285.16	288.45	292.76	297.30	302.08	306.79
.700	280.53	274.44	272.15	273.64	276.66	277.84	280.60	283.26	287.54	291.14	295.80	300.35	305.15	309.91
.720	280.55	275.35	273.95	275.20	277.70	279.52	296.64	285.85	289.89	293.81	298.52	303.12	307.94	312.73
.740	281.48	276.25	275.90	276.46	278.46	281.45	285.10	288.43	292.49	296.62	301.20	306.07	310.84	315.66
.760	282.10	276.44	276.09	277.43	280.04	283.35	286.53	290.98	295.08	299.40	304.16	308.86	313.76	318.57
.780	282.50	277.73	277.84	279.51	282.16	285.24	289.03	293.53	297.94	302.28	307.11	311.83	316.78	321.62
.800	282.48	279.16	279.31	281.86	284.27	287.67	291.23	296.06	300.51	305.15	310.02	314.78	319.77	324.67
.820	283.29	280.57	281.05	283.63	286.64	290.10	293.97	298.58	303.33	308.02	312.91	317.73	322.74	327.69
.840	284.51	281.69	283.20	285.67	288.73	292.50	296.70	301.36	306.15	310.87	315.78	320.93	325.97	330.96
.860	286.06	283.09	285.19	287.70	291.08	295.16	299.59	304.11	309.10	313.84	319.04	324.16	329.20	334.40

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			320.28	300.75	290.31	285.56	282.94	281.27	280.26	280.13	280.88	282.44	284.10	287.08
.420			308.63	294.07	287.03	282.93	278.15	278.15	278.68	279.49	280.27	281.02	283.95	286.05
.440			303.65	290.12	281.89	277.84	277.15	276.81	277.70	279.13	281.00	283.14	285.40	288.24
.460			296.58	285.41	283.40	280.01	275.02	275.58	277.28	279.37	280.94	282.50	284.79	287.06
.480			292.46	283.89	282.17	277.90	274.63	275.38	277.43	280.18	281.95	283.67	285.98	288.57
.500			296.13	287.11	280.59	276.98	276.21	276.52	278.16	280.09	282.61	285.68	288.06	291.55
.520	311.38	302.83	286.30	282.09	280.34	277.87	274.21	276.57	279.16	280.78	284.00	286.57	289.98	292.76
.540	306.05	294.94	283.63	280.08	279.92	278.09	275.11	277.19	280.13	282.10	285.82	288.87	291.39	294.83
.560	301.71	291.27	282.78	280.18	280.21	278.30	276.44	277.19	280.78	284.29	287.75	290.85	293.90	297.19
.580	298.58	288.20	280.98	279.95	280.63	278.19	277.73	279.76	282.61	286.17	289.66	292.81	296.49	300.13
.600	297.55	286.31	280.06	279.71	280.74	278.64	279.15	281.69	284.42	286.65	290.64	294.73	298.76	302.73
.620	296.95	285.61	280.04	281.27	281.13	279.36	281.22	283.73	286.54	289.54	293.11	296.71	300.99	305.31
.640	292.69	284.30	279.69	280.68	282.10	280.69	282.52	285.15	288.61	291.05	294.95	298.96	303.56	308.32
.660	291.01	284.19	279.93	280.20	283.37	281.99	284.16	286.86	290.35	293.46	297.38	301.57	306.30	311.00
.680	291.44	284.05	279.83	281.54	284.01	283.28	286.10	288.84	292.37	295.53	299.80	304.31	309.09	313.80
.700	290.64	283.59	280.65	281.80	284.61	285.46	288.02	290.48	294.69	298.18	302.81	307.34	312.15	316.90
.720	290.44	284.34	282.35	283.25	285.50	287.02	305.09	293.02	296.97	300.81	305.48	310.06	314.88	319.67
.740	291.22	285.08	284.23	294.37	286.08	288.87	292.38	295.56	299.53	303.58	308.13	312.99	317.75	322.57
.760	291.67	285.06	284.20	285.18	287.55	290.68	293.67	298.06	302.07	306.32	311.06	315.74	320.53	325.45
.780	291.88	286.23	285.87	287.20	289.60	292.47	296.14	300.56	304.91	309.18	313.99	318.68	323.64	328.48
.800	291.63	287.54	287.22	289.50	291.64	294.87	298.27	303.05	307.43	312.03	316.88	321.62	326.60	331.51
.820	292.28	288.84	288.87	291.18	293.97	297.24	300.99	305.52	310.23	314.87	319.74	324.54	329.55	334.51
.840	293.38	289.83	290.96	293.15	295.99	299.60	303.69	308.28	313.03	317.70	322.59	327.75	332.78	337.77
.860	294.83	291.11	292.89	295.12	298.30	302.24	306.57	311.01	315.97	320.66	325.86	330.98	336.01	341.23

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			342.57	320.34	308.22	302.42	299.00	296.65	295.03	294.39	294.74	295.99	297.35	300.19
.420			329.27	312.55	304.19	299.12	293.29	292.78	292.88	293.28	293.66	294.00	296.66	298.63
.440			323.37	307.79	298.11	293.08	291.80	290.90	291.39	292.48	294.06	295.95	297.98	300.64
.460			315.16	303.31	299.42	295.12	289.05	289.15	290.53	292.36	293.60	294.84	296.90	298.92
.480			310.23	300.14	297.69	292.40	288.24	288.55	290.31	292.85	294.33	295.74	297.82	300.21
.500			315.95	303.36	295.56	291.01	289.61	289.43	290.74	292.37	294.67	297.57	299.73	303.12
.520	332.32	321.64	302.68	297.43	294.92	291.63	287.02	289.11	291.46	292.75	295.82	298.17	301.46	304.06
.540	325.51	312.54	299.38	294.85	294.10	291.51	287.65	289.43	292.17	293.83	297.45	300.34	303.18	305.95
.560	320.36	308.13	298.08	294.61	294.07	291.38	288.77	289.06	292.51	295.89	299.22	302.15	305.02	308.19
.580	316.55	304.38	295.75	294.01	294.18	290.90	289.83	291.55	294.17	297.60	300.96	303.93	307.51	311.05
.600	315.08	301.96	294.39	293.40	293.96	291.04	291.05	293.33	295.81	297.76	301.66	305.68	309.65	313.55
.620	314.09	300.86	294.03	294.79	294.04	291.50	292.99	295.23	297.80	300.60	304.04	307.51	311.75	316.03
.640	309.05	299.07	293.31	293.79	294.78	292.62	294.09	296.45	299.74	301.90	305.71	309.63	314.33	318.99
.660	306.86	298.62	293.24	292.93	295.85	293.73	295.56	297.99	301.31	304.22	308.03	312.16	316.89	321.58
.680	307.02	298.14	292.82	294.08	296.21	294.81	297.36	299.83	303.20	306.15	310.35	314.83	319.61	324.32
.700	305.81	297.31	293.39	294.04	296.55	296.90	299.14	301.30	305.41	308.73	313.33	317.82	322.63	327.39
.720	305.27	297.83	294.97	295.32	297.20	298.29	317.77	303.78	307.59	311.29	315.94	320.48	325.30	330.09
.740	305.83	298.33	296.73	296.24	297.51	299.99	303.30	306.24	310.08	314.01	318.51	323.36	328.12	332.94
.760	306.01	297.99	296.37	296.82	298.81	301.67	304.40	308.68	312.55	316.70	321.41	326.06	330.95	335.77
.780	305.94	298.97	297.90	298.73	300.77	303.33	306.79	311.12	315.36	319.53	324.30	328.97	333.92	338.76
.800	305.35	300.12	299.09	300.97	302.70	305.66	308.82	313.54	317.81	322.34	327.17	331.87	336.85	341.76
.820	305.77	301.25	300.60	302.51	304.96	307.97	311.51	315.94	320.59	325.16	330.00	334.76	339.76	344.72
.840	306.68	302.04	302.61	304.38	306.88	310.26	314.18	318.66	323.35	327.95	332.81	337.96	343.00	347.99
.860	307.99	303.15	304.44	306.25	309.12	312.87	317.04	321.36	326.27	330.89	336.09	341.20	346.23	351.47

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			288.04	275.27	269.49	268.06	268.14	268.93	270.05	271.84	274.16	277.12	279.98	283.86
.420			279.53	270.72	267.63	266.73	265.25	267.34	269.81	272.34	274.82	277.14	281.09	284.38
.440			276.23	268.22	264.25	263.49	265.19	267.13	269.91	273.05	276.39	279.92	283.42	287.37
.460			271.22	265.90	266.03	265.81	264.27	266.96	270.43	274.15	277.36	280.45	284.08	287.58
.480			268.55	264.50	265.67	264.82	264.68	267.52	271.38	275.61	279.09	282.37	286.05	289.89
.500			271.93	267.49	265.01	264.74	266.51	269.12	272.64	276.38	280.43	284.90	288.67	293.28
.520	279.23	274.88	264.72	264.12	265.33	265.96	265.61	269.82	274.15	277.67	282.35	286.42	291.14	295.21
.540	275.14	269.19	263.15	263.08	265.54	266.71	266.94	270.95	275.63	279.41	284.58	289.06	293.49	297.80
.560	272.17	266.81	262.97	263.62	266.30	267.44	268.49	271.59	276.74	281.84	286.78	291.43	295.89	300.56
.580	270.10	264.93	261.99	263.93	267.15	267.84	270.07	274.18	278.82	283.98	288.99	293.68	298.74	303.66
.600	269.67	263.90	261.74	264.23	267.72	268.71	271.74	276.22	280.87	284.97	290.47	295.90	301.30	306.53
.620	269.59	263.78	262.20	265.91	268.48	269.80	273.84	278.38	283.08	287.88	293.02	298.16	303.74	309.36
.640	266.68	263.12	262.43	265.87	269.74	271.35	275.37	280.05	285.24	289.68	295.10	300.62	306.55	312.41
.660	265.77	263.40	263.06	265.97	271.21	272.80	277.18	281.88	287.17	292.10	297.63	303.24	309.32	315.22
.680	266.50	263.68	263.41	267.50	272.13	274.29	279.21	283.92	289.31	294.27	300.14	306.04	312.14	318.13
.700	266.29	263.72	264.40	268.15	273.05	276.48	281.14	285.73	291.61	296.90	303.00	309.04	315.14	321.25
.720	266.55	264.70	266.10	269.76	274.22	278.18	294.90	288.23	293.88	299.51	305.65	311.78	317.93	324.01
.740	267.53	265.67	267.94	271.07	275.16	280.01	285.51	290.67	296.41	302.17	308.28	314.54	320.80	326.92
.760	268.36	266.05	268.31	272.06	276.75	281.89	287.00	293.08	298.91	304.79	311.13	317.27	323.63	329.81
.780	268.96	267.38	270.00	274.00	278.83	283.76	289.36	295.52	301.61	307.55	313.91	320.14	326.47	332.79
.800	269.21	268.81	271.45	276.16	280.84	286.13	291.44	297.94	304.00	310.29	316.64	322.98	329.36	335.71
.820	270.16	270.25	273.13	277.86	283.02	288.45	294.03	300.35	306.68	313.03	319.41	325.76	332.22	338.57
.840	271.46	271.45	275.16	279.79	284.96	290.73	296.60	302.90	309.35	315.65	322.15	328.73	335.31	341.69
.860	273.05	272.88	277.08	281.71	287.13	293.22	299.36	305.47	312.12	318.43	325.22	331.78	338.33	344.95

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			302.91	288.33	281.43	279.30	278.84	279.18	279.90	281.35	283.40	286.16	288.82	292.60
.420			293.29	283.04	279.07	277.52	275.34	277.09	279.27	281.53	283.74	285.80	289.63	292.76
.440			289.38	280.00	275.08	273.65	274.96	276.53	279.04	281.96	285.10	288.46	291.81	295.65
.460			283.61	277.16	276.76	275.88	273.62	276.01	279.26	282.81	285.80	288.68	292.15	295.49
.480			280.40	275.34	276.01	274.49	273.75	276.30	279.96	284.06	287.34	290.42	293.94	297.64
.500			283.81	278.33	274.99	274.09	275.45	277.73	281.03	284.56	288.46	292.83	296.45	300.99
.520	292.85	287.43	275.64	274.35	275.10	275.13	274.15	278.18	282.36	285.65	290.22	294.15	298.79	302.74
.540	289.11	280.93	273.65	272.93	274.99	275.56	275.30	279.11	283.65	287.23	292.33	296.71	301.02	305.22
.560	284.60	278.05	273.17	273.24	275.54	276.16	276.71	279.50	284.56	289.51	294.42	298.96	303.31	307.89
.580	282.08	275.72	271.83	273.30	276.19	276.31	276.14	282.04	286.53	291.60	296.52	301.10	306.09	310.95
.600	281.36	274.33	271.30	273.36	276.53	276.98	279.68	283.97	288.47	292.38	297.82	303.20	308.56	313.74
.620	281.02	273.94	271.53	274.92	277.09	277.90	281.69	286.05	290.59	295.25	300.30	305.36	310.91	316.51
.640	277.58	272.97	271.51	274.61	278.19	279.30	283.08	287.58	292.66	296.92	302.27	307.74	313.66	319.52
.660	276.33	273.02	271.94	274.46	279.53	280.62	284.78	289.29	294.48	299.27	304.74	310.30	316.38	322.28
.680	276.89	273.08	272.06	275.86	280.27	281.98	286.71	291.25	296.53	301.35	307.18	313.05	319.15	325.14
.700	276.41	272.87	272.90	276.35	281.01	284.10	288.55	292.95	298.76	303.94	310.02	316.03	322.13	328.24
.720	276.44	273.69	274.51	277.81	282.02	285.68	303.35	295.40	300.97	306.50	312.62	318.72	324.87	330.96
.740	277.32	274.51	276.27	278.98	282.78	287.43	292.79	297.79	303.44	309.12	315.21	321.46	327.71	333.83
.760	277.92	274.67	276.43	279.82	284.30	289.22	294.15	300.16	305.90	311.72	318.03	324.15	330.51	336.69
.780	278.33	275.87	278.02	281.68	286.27	291.00	296.46	302.55	308.58	314.45	320.78	326.99	333.33	339.65
.800	278.36	277.20	279.36	283.81	288.22	293.32	298.48	304.93	310.92	317.17	323.50	329.82	336.19	342.55
.820	279.15	278.52	280.95	285.41	290.35	295.60	301.04	307.30	313.58	319.88	326.24	332.57	339.04	345.38
.840	280.33	279.58	282.93	287.27	292.22	297.83	303.59	309.82	316.23	322.48	328.96	335.54	342.12	348.50
.860	281.82	280.90	284.77	289.12	294.34	300.30	306.34	312.37	318.99	325.25	332.04	338.60	345.14	351.78

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			317.77	301.39	293.37	290.54	289.55	289.43	289.74	290.85	292.64	295.19	297.65	301.34
.420			307.05	295.36	290.51	288.31	285.43	286.85	288.74	290.72	292.67	294.45	298.18	301.15
.440			302.53	291.77	285.89	283.81	284.72	285.92	288.16	290.86	293.81	297.00	300.19	303.92
.460			295.99	288.42	287.43	285.95	282.97	285.06	288.10	291.46	294.24	296.90	300.22	303.41
.480			292.24	286.17	286.35	284.15	282.82	285.08	288.55	292.51	295.59	298.46	301.83	305.40
.500			295.69	289.16	284.97	283.44	284.39	286.34	289.41	292.75	296.50	300.76	304.23	308.69
.520	306.47	299.97	286.57	284.58	284.83	284.30	282.69	286.55	290.56	293.63	298.10	301.88	306.44	310.27
.540	301.08	292.66	284.14	282.77	284.45	284.61	283.66	287.27	291.68	295.05	300.09	304.35	308.55	312.64
.560	297.04	289.29	283.38	282.86	284.78	284.88	284.92	287.41	292.38	297.30	302.06	306.49	310.73	315.21
.580	294.06	286.51	281.68	282.67	285.22	284.79	286.21	289.90	294.24	299.22	304.05	308.52	313.44	318.23
.600	293.05	284.76	280.85	282.48	285.34	285.26	287.61	291.73	296.07	299.79	305.17	310.51	315.82	320.96
.620	292.46	284.10	280.86	283.94	285.70	285.99	289.54	293.72	298.10	302.62	307.59	312.56	318.08	323.66
.640	288.48	282.81	280.59	283.36	286.64	287.26	290.79	295.11	300.08	304.16	309.44	314.05	320.78	326.64
.660	286.90	282.64	280.82	282.95	287.84	288.44	292.37	296.71	301.78	306.44	311.84	317.36	323.44	329.34
.680	287.27	282.47	280.72	284.23	288.41	289.67	294.22	298.58	303.74	308.43	314.21	320.07	326.17	332.15
.700	286.52	282.02	281.40	284.51	288.97	291.72	295.97	300.16	305.91	310.97	317.03	323.02	329.12	335.23
.720	286.33	282.68	282.92	285.86	289.82	293.19	311.80	302.57	308.05	313.49	319.59	325.67	331.82	337.90
.740	287.06	283.34	284.60	286.89	290.41	294.84	300.07	304.92	310.48	316.08	322.13	328.38	334.62	340.74
.760	287.48	283.29	284.54	287.57	291.80	296.55	301.30	307.24	312.89	318.64	324.93	331.03	337.39	343.57
.780	287.71	284.37	286.05	289.37	293.71	298.23	303.56	309.59	315.55	321.35	327.66	333.85	340.18	346.51
.800	287.51	285.58	287.27	291.45	295.59	300.52	305.52	311.92	317.85	324.05	330.36	336.65	343.03	349.38
.820	288.14	286.79	288.77	292.96	297.68	302.75	308.06	314.25	320.48	326.74	333.07	339.39	345.85	352.19
.840	289.20	287.72	290.70	294.76	299.48	304.93	310.58	316.74	323.11	329.32	335.77	342.35	348.93	355.31
.860	290.59	288.93	292.47	296.54	301.56	307.38	313.33	319.28	325.86	332.08	338.86	345.41	351.95	358.61

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			332.63	314.45	305.30	301.78	300.26	299.68	299.59	300.36	301.88	304.22	306.49	310.07
.420			320.81	307.68	301.95	299.10	295.52	296.60	298.20	299.92	301.59	303.10	306.72	309.53
.440			315.67	303.55	296.70	293.97	294.48	295.32	297.29	299.76	302.52	305.54	308.58	312.19
.460			308.38	299.68	298.11	296.02	292.33	294.10	296.93	300.11	302.68	305.13	308.29	311.32
.480			304.09	297.01	296.69	293.82	291.89	293.85	297.14	300.96	303.84	306.51	309.72	313.15
.500			307.58	300.00	294.95	292.79	293.33	294.95	297.80	300.94	304.53	308.69	312.01	316.40
.520	320.10	312.51	297.49	294.80	294.55	293.47	291.24	294.91	298.77	301.61	305.98	309.61	314.10	317.80
.540	314.05	304.39	294.64	292.62	293.90	293.55	292.02	295.43	299.70	302.88	307.84	311.99	316.08	320.05
.560	309.47	300.53	293.58	292.48	294.01	293.61	293.14	295.33	300.20	305.04	309.70	314.02	318.15	322.54
.580	306.04	297.30	291.53	292.05	294.26	293.26	294.28	297.75	301.95	306.84	311.58	315.93	320.79	325.51
.600	304.74	295.20	290.40	291.61	294.15	293.53	295.55	299.48	303.66	307.19	312.52	317.82	323.09	328.18
.620	303.89	294.26	290.19	292.95	294.31	294.08	297.39	301.38	305.61	309.99	314.87	319.76	325.25	330.80
.640	299.39	292.66	289.68	292.10	295.09	295.22	298.50	302.64	307.50	311.40	316.61	321.97	327.89	333.75
.660	297.46	292.27	289.69	291.43	296.16	296.26	299.97	304.13	309.09	313.61	318.94	324.42	330.49	336.40
.680	297.66	291.87	289.37	292.59	296.54	297.36	301.73	305.90	310.96	315.51	321.25	327.08	333.18	339.17
.700	296.64	291.17	289.90	292.67	296.93	299.34	303.39	307.38	313.05	318.01	324.04	330.01	336.11	342.23
.720	296.22	291.67	291.32	293.91	297.62	300.70	320.25	309.74	315.13	320.48	326.55	332.62	338.76	344.85
.740	296.80	292.17	292.93	294.80	298.03	302.26	307.35	312.04	317.51	323.04	329.05	335.30	341.53	347.65
.760	297.05	291.92	292.66	295.33	299.31	303.87	308.45	314.32	319.88	325.56	331.83	337.90	344.26	350.45
.780	297.08	292.87	294.07	297.06	301.15	305.47	310.67	316.62	322.52	328.26	334.54	340.70	347.04	353.36
.800	296.66	293.97	295.18	299.09	302.96	307.71	312.55	318.91	324.77	330.93	337.21	343.48	349.86	356.22
.820	297.14	295.06	296.60	300.52	305.01	309.89	315.07	321.19	327.38	333.60	339.91	346.20	352.66	359.00
.840	298.07	295.86	298.46	302.24	306.74	312.04	317.57	323.67	329.98	335.15	342.58	349.17	355.74	362.12
.860	299.36	296.95	300.17	303.96	308.77	314.46	320.31	326.18	332.72	338.90	345.68	352.23	358.76	365.43

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			354.93	334.04	323.21	318.64	316.32	315.06	314.36	314.63	315.74	317.77	319.74	323.18
.420			341.44	326.16	319.12	315.28	310.66	311.24	312.40	313.71	314.98	316.09	319.53	322.11
.440			335.40	321.22	312.92	309.21	309.12	309.41	310.98	313.11	315.59	318.36	321.15	324.60
.460			326.96	316.58	314.13	311.12	306.35	307.68	310.18	313.10	315.34	317.47	320.39	323.19
.480			321.86	313.26	312.20	308.32	305.49	307.02	310.02	313.64	316.22	318.58	321.55	324.79
.500			325.41	316.25	309.92	306.82	306.73	307.87	310.38	313.22	316.59	320.58	323.67	327.96
.520	340.53	331.33	313.88	310.15	309.13	307.23	304.05	307.45	311.08	313.58	317.80	321.21	325.58	329.10
.540	333.50	322.00	310.39	307.39	308.08	306.97	304.57	307.67	311.74	314.61	319.48	323.46	327.37	331.18
.560	328.11	317.39	308.89	306.91	307.87	306.69	305.46	307.20	311.94	316.64	321.17	325.31	329.28	333.53
.580	324.01	313.48	306.29	306.11	307.82	305.98	306.39	309.54	313.52	318.28	322.88	327.06	331.82	336.44
.600	322.27	310.84	304.73	305.30	307.37	305.94	307.45	311.11	315.06	318.30	323.55	328.77	333.98	339.00
.620	321.03	309.50	304.18	306.47	307.22	306.22	309.17	312.88	316.87	321.05	325.80	330.56	336.01	341.53
.640	315.74	307.43	303.30	305.22	307.77	307.16	310.07	313.94	318.62	322.25	327.36	332.64	338.56	344.42
.660	313.31	306.70	303.01	304.16	308.64	308.00	311.37	315.26	320.05	324.37	329.60	335.01	341.08	346.98
.680	313.24	305.96	302.35	305.13	308.75	308.89	312.99	316.90	321.78	326.13	331.80	337.60	343.70	349.69
.700	311.81	304.89	302.64	304.91	308.86	310.77	314.52	318.20	323.78	328.56	334.56	340.50	346.60	352.71
.720	311.06	305.16	303.94	305.98	309.32	311.96	332.93	320.50	325.75	330.97	337.01	343.03	349.18	355.27
.740	311.41	305.43	305.43	306.67	309.46	313.39	318.27	322.73	328.07	333.47	339.44	345.67	351.90	358.02
.760	311.40	304.85	304.83	306.96	310.57	314.87	319.17	324.94	330.37	335.95	342.18	348.22	354.58	360.76
.780	311.14	305.61	306.11	308.59	312.31	316.33	321.32	327.18	332.97	338.61	344.86	350.99	357.32	363.65
.800	310.38	306.54	307.05	310.56	314.02	318.50	323.11	329.40	335.16	341.25	347.50	353.73	360.11	366.47
.820	310.62	307.47	308.33	311.85	316.00	320.62	325.59	331.61	337.73	343.88	350.16	356.41	362.87	369.22
.840	311.37	308.06	310.11	313.47	317.63	322.69	328.06	334.05	340.30	346.40	352.80	359.38	365.96	372.34
.860	312.52	308.59	311.72	315.09	319.60	325.08	330.78	336.53	343.02	349.13	355.91	362.45	368.98	375.67

SCENARIO 2

NUCLEAR FIRED BASE LOAD GENERATION

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.44	108.36	101.84	97.70	95.08	93.67	93.91	95.25
.080				23.10	101.38	91.19	90.34	89.26	88.74	90.04	91.95
.100				25.77	86.98	83.73	85.02	83.71	85.04	87.24	89.44
.120	412.07	101.95	93.13	86.35	80.74	79.24	81.19	93.37	83.45	85.65	88.15
.140	201.72	90.11	84.31	80.16	77.67	77.14	79.26	81.05	82.49	84.98	87.48
.160	147.22	85.15	78.06	75.79	75.60	76.55	78.52	80.82	83.52	85.00	88.29
.180	138.73	81.21	79.81	75.67	75.15	77.04	79.22	81.41	83.59	86.08	88.56
.200	130.42	81.43	77.62	76.21	75.99	78.19	80.38	82.56	84.75	87.24	89.72
.220	123.43	81.35	78.31	77.20	77.29	79.79	82.29	84.78	87.12	89.60	92.09
.240	118.93	81.93	79.29	78.56	79.29	81.79	84.28	86.78	89.27	91.76	94.24
.260	112.28	81.78	80.42	80.42	81.52	83.99	86.46	88.92	91.24	93.73	96.21
.280	106.87	82.29	81.85	82.28	84.05	86.53	89.00	91.46	93.93	96.39	98.88
.300	106.16	82.70	83.58	84.89	86.57	89.06	91.56	94.06	96.55	99.05	101.54
.320	98.89	84.34	85.61	87.26	89.19	91.71	94.22	96.72	99.22	101.71	104.21
.340	95.97	85.07	87.63	89.37	91.83	94.36	96.87	99.38	101.83	104.37	106.87
.360	88.01	86.79	89.65	92.23	94.44	96.98	99.49	102.00	104.50	107.00	109.50
.380	87.56	87.68	91.00	94.56	97.09	99.62	102.15	104.66	106.89	109.39	111.89
.400	85.96	90.07	93.56	97.19	99.73	102.26	104.79	107.31	109.55	112.05	114.55
.420	86.76	90.73	94.11	99.92	102.36	104.91	107.44	109.96	112.20	114.70	117.20
.440	86.04	93.04	97.08	102.42	105.00	107.55	110.08	112.61	114.85	117.36	119.86
.460	87.73	93.57	99.25	105.04	107.63	110.19	112.72	115.25	117.50	120.02	122.52

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.44	117.85	110.33	105.45	102.26	100.41	100.41	101.61
.080				23.10	109.80	98.21	96.98	95.50	94.65	95.81	97.65
.100				25.77	93.51	89.62	90.77	89.04	90.24	92.41	94.58
.120	455.47	110.67	100.59	92.78	86.28	84.34	86.22	88.37	88.18	90.35	92.85
.140	221.51	97.22	90.50	85.62	82.57	81.70	83.79	85.50	86.81	89.31	91.80
.160	160.67	91.41	83.26	80.46	79.97	80.75	82.66	84.95	87.67	89.92	92.41
.180	150.95	86.74	84.91	80.03	79.17	81.00	83.15	85.30	87.45	89.94	92.42
.200	141.49	86.70	82.19	80.34	79.82	81.98	84.14	86.29	88.44	90.93	93.41
.220	133.52	86.32	82.65	81.15	80.97	83.46	85.96	88.45	90.77	93.26	95.75
.240	128.25	86.67	83.45	82.35	82.89	85.39	87.88	90.38	92.87	95.36	97.84
.260	120.70	86.21	84.41	84.13	85.07	87.54	90.00	92.47	94.76	97.25	99.74
.280	114.55	86.43	85.71	85.90	87.59	90.06	92.53	94.99	97.42	99.91	102.40
.300	113.50	86.75	87.34	88.51	90.10	92.58	95.09	97.59	100.08	102.57	105.07
.320	105.33	83.30	89.30	90.85	92.71	95.23	97.74	100.24	102.74	105.24	107.73
.340	101.84	88.96	91.25	93.46	95.36	97.88	100.40	102.90	105.40	107.90	110.39
.360	92.94	90.60	93.21	95.79	97.96	100.49	103.01	105.52	108.02	110.52	113.02
.380	92.21	91.47	94.56	98.09	100.61	103.14	105.66	108.18	110.38	112.88	115.37
.400	90.42	93.87	97.11	100.72	103.25	105.78	108.31	110.83	113.03	115.53	118.04
.420	91.09	94.52	99.66	103.34	105.88	108.43	110.96	113.48	115.69	118.19	120.69
.440	90.33	96.83	100.64	105.93	108.52	111.07	113.60	116.13	118.34	120.85	123.35
.460	92.00	97.40	102.78	108.56	111.15	113.71	116.24	118.77	120.99	123.50	126.01

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.44	127.35	118.82	113.20	109.44	107.15	106.90	107.97
.080				23.10	118.22	105.22	103.62	101.74	100.55	101.58	103.36
.100				25.77	100.03	95.51	96.53	94.37	95.44	97.57	99.71
.120	498.93	119.40	108.06	99.22	91.82	89.43	91.25	93.37	92.91	95.04	97.55
.140	241.31	104.34	96.69	91.07	87.47	86.27	88.31	89.95	91.14	93.64	96.13
.160	174.11	97.68	88.46	85.13	84.34	84.95	86.81	89.07	91.81	94.04	96.53
.180	163.16	92.28	90.01	84.39	83.20	84.95	87.07	89.19	91.31	93.79	96.28
.200	152.56	91.97	86.75	84.47	83.64	85.77	87.89	90.01	92.13	94.62	97.10
.220	143.62	91.28	87.00	85.09	84.64	87.14	89.63	92.13	94.43	96.92	99.40
.240	137.57	91.40	87.61	86.15	86.49	88.99	91.48	93.98	96.47	98.96	101.44
.260	129.12	90.63	88.41	87.84	88.62	91.09	93.55	96.01	98.28	100.77	103.26
.280	122.23	90.67	89.57	89.52	91.13	93.60	96.06	98.52	100.94	103.44	105.93
.300	120.85	90.82	91.09	92.13	93.63	96.11	98.61	101.11	103.60	106.10	108.59
.320	111.77	92.26	92.99	94.44	96.23	98.76	101.26	103.76	106.26	108.76	111.25
.340	107.72	92.85	94.88	97.04	98.88	101.41	103.92	106.42	108.92	111.42	113.91
.360	97.87	94.41	96.76	99.35	101.48	104.01	106.53	109.04	111.54	114.04	116.54
.380	96.85	95.27	98.12	101.61	104.13	106.66	109.18	111.70	113.87	116.37	118.86
.400	94.98	97.66	100.67	104.24	106.77	109.30	111.83	114.35	116.52	119.02	121.52
.420	95.42	98.32	103.22	106.87	109.40	111.94	114.48	117.00	119.18	121.68	124.18
.440	94.63	100.63	104.19	109.45	112.04	114.59	117.12	119.65	121.83	124.34	126.84
.460	96.27	101.22	106.30	112.08	114.67	117.23	119.76	122.29	124.48	126.99	129.50

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.44	136.84	127.30	120.95	116.62	113.90	113.39	114.33
.080				23.10	126.64	112.23	110.26	107.98	106.46	107.35	109.06
.100				25.77	106.56	101.40	102.28	99.70	100.64	102.74	104.84
.120	542.38	128.12	115.52	105.65	97.35	94.52	96.28	98.37	97.65	99.74	102.24
.140	261.10	111.45	102.88	96.52	92.37	90.83	92.83	94.39	95.47	97.96	100.46
.160	187.56	103.95	93.66	89.80	88.71	89.15	90.95	93.19	95.96	98.17	100.66
.180	175.37	97.82	95.11	88.75	87.22	88.91	91.00	93.08	95.17	97.65	100.14
.200	163.64	97.24	91.31	88.59	87.47	89.56	91.65	93.74	95.82	98.31	100.79
.220	153.72	96.25	91.34	89.03	88.31	90.81	93.31	95.80	98.09	100.57	103.06
.240	146.90	96.14	91.77	89.95	90.09	92.59	95.08	97.58	100.07	102.56	105.04
.260	137.54	95.06	92.40	91.55	92.18	94.64	97.10	99.55	101.80	104.30	106.78
.280	129.92	94.87	93.43	93.15	94.67	97.13	99.59	102.05	104.46	106.96	109.45
.300	128.20	94.88	94.85	95.75	97.15	99.63	102.13	104.63	107.13	109.62	112.11
.320	118.21	96.22	96.68	98.03	99.76	102.28	104.79	107.29	109.79	112.28	114.78
.340	113.59	96.75	98.50	100.63	102.40	104.93	107.44	109.95	112.44	114.94	117.44
.360	102.81	98.21	100.32	102.90	105.00	107.53	110.05	112.56	115.06	117.56	120.06
.380	101.50	99.06	101.67	105.13	107.65	110.18	112.70	115.22	117.36	119.86	122.35
.400	99.35	101.46	104.23	107.76	110.29	112.82	115.35	117.87	120.01	122.51	125.01
.420	99.75	102.11	106.78	110.39	112.92	115.46	118.00	120.52	122.67	125.17	127.67
.440	98.92	104.42	107.75	112.97	115.56	118.11	120.64	123.17	125.32	127.83	130.33
.460	100.54	105.05	109.82	115.60	118.19	120.75	123.28	125.81	127.97	130.48	132.99

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.88	108.76	102.19	98.02	95.36	93.91	94.14	95.45
.080				23.74	101.99	91.77	90.87	89.73	89.18	90.44	92.32
.100				26.59	87.80	84.52	85.77	84.42	85.69	87.85	90.01
.120	412.69	102.81	94.08	87.33	81.74	80.22	82.14	84.30	84.33	86.49	88.94
.140	202.41	91.03	35.37	81.29	78.83	78.30	80.41	82.18	83.58	86.03	88.49
.160	147.92	86.12	79.20	77.03	76.89	77.86	79.84	82.13	84.81	87.06	89.52
.180	139.44	82.21	31.02	77.01	76.57	78.51	80.71	82.90	85.07	87.54	90.00
.200	131.12	82.46	78.89	77.64	77.53	79.79	82.02	84.22	86.40	88.88	91.35
.220	124.12	82.39	79.62	78.70	78.93	81.51	84.06	86.58	88.93	91.42	93.90
.240	119.62	82.98	80.63	80.11	81.00	83.61	86.18	88.72	91.24	93.74	96.23
.260	112.95	82.83	31.78	82.02	83.30	85.91	88.47	91.00	93.35	95.86	98.36
.280	107.53	83.34	83.23	83.92	85.89	88.53	91.11	93.66	96.15	98.68	101.18
.300	106.81	83.75	84.97	86.57	88.47	91.13	93.77	96.37	98.94	101.48	104.00
.320	99.53	85.39	37.00	88.96	91.13	93.84	96.51	99.12	101.71	104.27	106.81
.340	96.59	86.11	39.03	91.58	93.82	96.55	99.23	101.87	104.47	107.05	109.60
.360	88.62	87.83	91.06	93.96	96.46	99.22	101.92	104.58	107.19	109.78	112.35
.380	88.15	88.70	92.41	96.30	99.12	101.90	104.62	107.30	109.67	112.27	114.85
.400	86.53	91.09	94.96	98.94	101.78	104.58	107.32	110.02	112.40	115.03	117.62
.420	87.32	91.73	97.51	101.58	104.43	107.25	110.02	112.73	115.13	117.77	120.37
.440	86.58	94.03	98.48	104.17	107.08	109.92	112.70	115.43	117.85	120.50	123.13
.460	88.26	94.54	100.64	106.80	109.72	112.58	115.38	118.13	120.56	123.23	125.87

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.88	118.25	110.68	105.77	102.54	100.66	100.63	101.81
.080				23.74	110.42	98.78	97.51	95.97	95.09	96.22	98.02
.100				26.59	94.32	90.41	91.52	89.75	90.89	93.01	95.14
.120	456.14	111.53	101.54	93.77	87.27	85.32	87.17	89.30	89.07	91.18	93.64
.140	222.20	98.15	91.56	86.74	83.72	82.86	84.93	86.62	87.91	90.36	92.82
.160	161.37	92.39	84.40	81.70	81.27	82.07	83.99	86.26	88.96	91.18	93.64
.180	151.65	87.75	86.12	81.38	80.60	82.46	84.63	86.79	88.93	91.39	93.86
.200	142.20	87.73	83.45	81.77	81.35	83.58	85.77	87.94	90.10	92.57	95.04
.220	134.22	87.36	83.96	82.64	82.60	85.19	87.74	90.26	92.59	95.08	97.55
.240	128.94	87.72	84.79	83.91	84.60	87.21	89.78	92.32	94.84	97.34	99.83
.260	121.38	87.26	85.78	85.74	86.85	89.46	92.02	94.55	96.88	99.39	101.89
.280	115.22	87.54	87.09	87.55	89.43	92.06	94.64	97.19	99.67	102.20	104.71
.300	114.16	87.81	88.73	90.19	92.00	94.65	97.29	99.89	102.46	105.00	107.52
.320	105.97	89.35	90.70	92.55	94.66	97.37	100.03	102.64	105.23	107.79	110.33
.340	102.47	90.01	92.66	95.17	97.34	100.07	102.75	105.39	107.99	110.57	113.12
.360	93.55	91.63	94.61	97.52	99.98	102.74	105.43	108.09	110.71	113.30	115.87
.380	92.80	92.50	95.97	99.83	102.64	105.42	108.14	110.82	113.16	115.76	118.34
.400	91.00	94.88	98.52	102.46	105.30	108.10	110.84	113.54	115.89	118.51	121.11
.420	91.65	95.52	101.07	105.10	107.95	110.77	113.54	116.25	118.62	121.26	123.86
.440	90.88	97.82	102.03	107.69	110.60	113.44	116.22	118.95	121.34	123.99	126.62
.460	92.53	98.37	104.17	110.32	113.24	116.10	118.90	121.65	124.05	126.72	129.36

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.88	127.74	119.17	113.52	109.72	107.40	107.12	108.17
.080				23.74	118.84	105.79	104.15	102.21	100.99	101.99	103.73
.100				26.59	100.85	96.30	97.27	95.08	96.09	98.18	100.28
.120	499.60	120.26	109.01	100.20	92.81	90.41	92.21	94.29	93.80	95.88	98.33
.140	242.00	105.26	97.75	92.19	88.62	87.42	89.45	91.07	92.24	94.69	97.14
.160	174.81	98.65	89.60	86.37	85.64	86.27	88.13	90.38	93.11	95.31	97.76
.180	163.86	93.29	91.22	85.74	84.62	86.42	88.56	90.68	92.79	95.25	97.71
.200	153.27	92.99	89.02	85.89	85.18	87.37	89.53	91.67	93.79	96.26	98.73
.220	144.32	92.32	88.31	86.59	86.27	88.86	91.41	93.93	96.25	98.74	101.21
.240	138.26	92.45	88.95	87.71	88.20	90.81	93.38	95.92	98.44	100.94	103.43
.260	129.80	91.69	89.77	89.45	90.41	93.01	95.56	98.09	100.40	102.91	105.41
.280	122.90	91.73	90.95	91.17	92.97	95.60	98.17	100.72	103.20	105.72	108.23
.300	121.51	91.87	92.48	93.81	95.53	98.18	100.82	103.41	105.98	108.52	111.05
.320	112.41	93.31	94.39	96.14	98.18	100.89	103.55	106.17	108.75	111.31	113.85
.340	108.34	93.90	95.28	98.76	100.86	103.59	106.28	108.92	111.51	114.09	116.64
.360	98.48	95.44	98.17	101.07	103.50	106.26	108.95	111.61	114.23	116.82	119.39
.380	97.45	96.29	99.53	103.35	106.16	108.94	111.66	114.34	116.65	119.25	121.83
.400	95.46	98.68	102.08	105.99	108.82	111.62	114.36	117.06	119.38	122.00	124.60
.420	95.98	99.32	104.62	108.62	111.47	114.29	117.06	119.77	122.11	124.75	127.35
.440	95.17	101.62	105.59	111.21	114.12	116.96	119.74	122.47	124.83	127.48	130.11
.460	96.80	102.19	107.69	113.84	116.76	119.62	122.42	125.17	127.54	130.21	132.85

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				20.88	137.23	127.65	121.27	116.90	114.15	113.61	114.53
.080				23.74	127.26	112.80	110.79	108.45	106.90	107.76	109.43
.100				26.59	107.37	102.18	103.03	100.41	101.29	103.35	105.41
.120	543.05	128.98	116.47	106.64	98.34	95.50	97.24	99.29	98.53	100.58	103.03
.140	261.79	112.37	103.94	97.65	93.52	91.99	93.98	95.52	96.56	99.02	101.47
.160	188.26	104.92	94.80	91.04	90.01	90.47	92.27	94.50	97.25	99.43	101.89
.180	176.07	98.82	96.32	90.10	88.65	90.38	92.49	94.57	96.64	99.11	101.57
.200	164.34	98.26	92.58	90.02	89.00	91.16	93.29	95.39	97.48	99.95	102.42
.220	154.42	97.29	92.65	90.53	89.95	92.53	95.08	97.60	99.90	102.39	104.87
.240	147.59	97.19	93.11	91.51	91.80	94.41	96.98	99.52	102.04	104.54	107.03
.260	138.22	96.12	93.76	93.16	93.96	96.56	99.11	101.63	103.92	106.43	108.93
.280	130.58	95.92	94.80	94.79	96.51	99.13	101.71	104.25	106.72	109.25	111.75
.300	128.85	95.53	96.24	97.43	99.05	101.70	104.34	106.93	109.50	112.05	114.57
.320	118.85	97.27	98.08	99.73	101.70	104.41	107.07	109.69	112.28	114.84	117.37
.340	114.21	97.79	99.90	102.34	104.38	107.12	109.80	112.44	115.04	117.61	120.17
.360	103.41	99.25	101.73	104.63	107.02	109.77	112.47	115.13	117.75	120.34	122.91
.380	102.09	100.09	103.08	106.87	109.68	112.46	115.18	117.86	120.14	122.74	125.32
.400	99.92	102.47	105.63	109.51	112.34	115.14	117.88	120.58	122.87	125.49	128.08
.420	100.31	103.11	108.18	112.14	114.99	117.81	120.58	123.29	125.60	128.24	130.84
.440	99.47	105.41	109.15	114.73	117.64	120.48	123.26	125.99	128.32	130.97	133.60
.460	101.07	106.02	111.21	117.36	120.28	123.14	125.94	128.69	131.03	133.70	136.34

TABLE GENERATED USING INDEX 180.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				21.79	109.65	103.05	98.83	96.12	94.62	94.79	96.05
.080				24.89	103.20	92.98	92.06	90.90	90.30	91.52	93.34
.100				27.87	89.21	86.00	87.29	85.94	87.19	89.32	91.44
.120	413.11	103.59	95.17	88.68	83.27	81.89	83.90	86.10	86.16	88.31	90.73
.140	202.77	91.76	86.44	82.66	80.43	80.09	82.34	84.21	85.67	88.16	90.62
.160	148.23	86.80	80.24	78.40	78.53	79.73	81.89	84.32	87.11	89.43	91.92
.180	139.70	82.85	82.01	78.35	78.21	80.41	82.83	85.20	87.51	90.09	92.63
.200	131.35	83.03	79.84	78.94	79.15	81.71	84.19	86.60	88.96	91.58	94.16
.220	124.32	82.91	80.51	79.96	80.52	83.42	86.25	89.01	91.57	94.24	96.85
.240	119.79	83.44	81.43	81.32	82.56	85.50	88.37	91.18	93.93	96.63	99.30
.260	113.10	83.25	82.57	83.18	84.81	87.76	90.64	93.47	96.08	98.82	101.51
.280	107.66	83.72	83.95	85.03	87.36	90.34	93.26	96.11	98.89	101.67	104.39
.300	106.92	84.09	85.64	87.63	89.89	92.90	95.88	98.80	101.67	104.48	107.26
.320	99.63	85.70	87.62	89.96	92.50	95.57	98.58	101.53	104.43	107.27	110.08
.340	96.68	86.39	88.60	92.52	95.13	98.23	101.26	104.24	107.17	110.05	112.89
.360	88.69	88.08	91.53	94.84	97.73	100.85	103.90	106.91	109.87	112.77	115.63
.380	88.22	88.94	92.90	97.12	100.33	103.48	106.56	109.59	112.30	115.23	118.12
.400	86.60	91.30	95.42	99.71	102.93	106.12	109.21	112.27	115.00	117.96	120.86
.420	87.38	91.92	97.93	102.30	105.52	108.74	111.85	114.92	117.68	120.66	123.60
.440	86.63	94.20	98.87	104.85	108.11	111.34	114.49	117.58	120.35	123.36	126.32
.460	88.30	94.71	101.01	107.44	110.69	113.94	117.13	120.23	123.02	125.04	129.02

TABLE GENERATED USING INDEX 200.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				21.79	119.15	111.54	106.58	103.30	101.37	101.28	102.41
.080				24.89	111.62	100.00	98.70	97.14	96.21	97.29	99.04
.100				27.87	95.73	91.89	93.04	91.27	92.39	94.48	96.57
.120	456.57	112.31	102.63	95.12	88.81	86.98	88.93	91.10	90.89	93.01	95.43
.140	222.56	98.88	92.63	88.11	85.33	84.65	86.86	88.65	90.00	92.49	94.95
.160	161.67	93.07	85.44	83.07	82.90	83.93	86.03	88.45	91.25	93.55	96.05
.180	151.91	88.39	87.11	82.71	82.24	84.37	86.76	89.09	91.37	93.95	96.49
.200	142.42	88.30	84.40	83.07	82.98	85.50	87.94	90.32	92.65	95.27	97.86
.220	134.42	87.87	84.85	83.90	84.19	87.09	89.92	92.69	95.23	97.89	100.51
.240	129.11	88.18	85.64	85.11	86.16	89.10	91.97	94.78	97.53	100.23	102.90
.260	121.52	87.68	86.56	86.89	88.37	91.31	94.19	97.01	99.60	102.34	105.04
.280	115.35	87.91	87.81	88.65	90.90	93.88	96.79	99.64	102.41	105.19	107.92
.300	114.27	88.15	89.39	91.25	93.42	96.42	99.40	102.32	105.19	108.01	110.78
.320	106.07	89.66	91.31	93.55	96.02	99.10	102.11	105.06	107.95	110.80	113.60
.340	102.55	90.29	93.23	96.11	98.66	101.75	104.78	107.76	110.69	113.57	116.41
.360	93.63	91.89	95.14	98.39	101.25	104.37	107.42	110.43	113.39	116.28	119.15
.380	92.87	92.73	96.46	100.65	103.85	107.00	110.08	113.11	115.79	118.72	121.61
.400	91.06	95.09	98.97	103.23	106.45	109.63	112.73	115.79	118.49	121.45	124.35
.420	91.71	95.72	101.49	105.82	109.04	112.26	115.37	118.44	121.17	124.15	127.09
.440	90.93	98.00	102.42	108.37	111.63	114.86	118.01	121.10	123.84	126.85	129.80
.460	92.58	98.53	104.53	110.96	114.21	117.46	120.65	123.75	126.51	129.53	132.51

TABLE GENERATED USING INDEX 220.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				21.79	128.64	120.03	114.33	110.48	108.11	107.78	108.77
.080				24.89	120.04	107.01	105.34	103.38	102.11	103.06	104.74
.100				27.87	102.26	97.78	98.80	96.60	97.59	99.65	101.70
.120	500.02	121.03	110.10	101.55	94.34	92.08	93.97	96.10	95.62	97.70	100.13
.140	242.36	105.99	98.82	93.56	90.23	89.22	91.38	93.10	94.33	96.82	99.28
.160	175.12	99.34	93.64	87.74	87.27	88.13	90.18	92.57	95.40	97.67	100.17
.180	164.12	93.92	82.21	87.07	86.26	88.33	90.69	92.99	95.23	97.81	100.35
.200	153.49	93.57	83.96	87.19	86.80	89.29	91.70	94.05	96.35	98.96	101.55
.220	144.52	92.84	89.20	87.84	87.87	90.77	93.60	96.36	98.88	101.55	104.16
.240	138.43	92.91	89.80	88.91	89.76	92.70	95.57	98.38	101.13	103.83	106.50
.260	129.95	92.10	90.55	90.60	91.92	94.86	97.74	100.55	103.12	105.86	108.56
.280	123.03	92.11	91.67	92.27	94.43	97.42	100.33	103.17	105.93	108.72	111.44
.300	121.62	92.21	93.15	94.87	96.94	99.95	102.93	105.84	108.71	111.53	114.30
.320	112.51	93.62	95.00	97.14	99.54	102.62	105.63	108.58	111.48	114.32	117.12
.340	108.42	94.18	96.85	99.69	102.18	105.27	108.31	111.29	114.21	117.09	119.93
.360	98.56	95.70	98.70	101.95	104.77	107.89	110.94	113.95	116.91	119.80	122.67
.380	97.52	96.53	100.01	104.17	107.37	110.52	113.60	116.63	119.28	122.21	125.10
.400	95.52	98.89	102.53	106.76	109.96	113.15	116.25	119.30	121.98	124.93	127.84
.420	96.04	99.51	105.04	109.34	112.56	115.78	118.89	121.96	124.66	127.64	130.58
.440	95.77	101.79	105.98	111.89	115.15	118.38	121.53	124.62	127.33	130.34	133.29
.460	96.85	102.36	108.05	114.47	117.73	120.98	124.17	127.27	130.00	133.02	136.00

TABLE GENERATED USING INDEX 240.

10.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.020	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120
.060				21.79	138.13	128.52	122.08	117.66	114.85	114.27	115.13
.080				24.89	128.46	114.02	111.98	109.62	108.02	108.83	110.45
.100				27.87	108.78	103.67	104.55	101.93	102.79	104.82	106.83
.120	543.48	129.75	117.56	107.99	99.88	97.17	99.00	101.10	100.36	102.40	104.83
.140	262.15	113.10	105.01	99.02	95.13	93.78	95.91	97.55	98.65	101.14	103.61
.160	188.57	105.60	95.84	92.41	91.65	92.33	94.32	96.69	99.55	101.80	104.29
.180	176.34	99.46	97.31	91.44	90.29	92.29	94.61	96.88	99.09	101.67	104.21
.200	164.56	98.83	93.52	91.32	90.63	93.08	95.46	97.77	100.04	102.65	105.24
.220	154.62	97.80	93.54	91.78	91.54	94.44	97.27	100.04	102.54	105.21	107.82
.240	147.76	97.65	93.96	92.71	93.36	96.30	99.17	101.98	104.73	107.43	110.10
.260	138.37	96.53	94.55	94.31	95.47	98.41	101.28	104.09	106.64	109.38	112.08
.280	130.71	96.30	95.53	95.90	97.97	100.95	103.86	106.70	109.46	112.24	114.96
.300	128.97	96.27	96.91	98.49	100.47	103.47	106.45	109.37	112.23	115.05	117.83
.320	118.95	97.58	98.69	100.73	103.07	106.14	109.15	112.10	115.00	117.84	120.65
.340	114.30	98.67	100.47	103.28	105.70	108.79	111.83	114.81	117.74	120.62	123.46
.360	103.49	99.50	102.25	105.51	108.29	111.40	114.46	117.47	120.43	123.32	126.19
.380	102.16	100.32	103.57	107.69	110.89	114.04	117.12	120.15	122.77	125.70	128.59
.400	99.98	102.68	106.08	110.28	113.48	116.67	119.77	122.82	125.47	128.42	131.33
.420	100.36	103.31	108.60	112.87	116.08	119.30	122.41	125.48	128.15	131.13	134.07
.440	99.52	105.59	109.54	115.41	118.66	121.90	125.05	128.14	130.82	133.83	136.78
.460	101.12	106.18	111.58	117.99	121.25	124.49	127.69	130.79	133.49	136.51	139.49

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											153.19
.080											116.40
.100											109.16
.120					110.07	107.06	104.76	103.45	103.18	103.57	104.19
.140					104.00	101.27	99.72	99.08	99.35	100.21	101.72
.160					100.75	98.44	98.11	97.77	98.29	99.94	101.58
.180					97.49	96.88	96.24	96.47	98.11	100.03	101.99
.200	277.56	143.09	109.25	100.31	96.32	95.34	95.75	97.08	98.69	101.12	103.58
.220	188.57	123.47	103.87	97.41	95.77	96.18	96.24	97.60	99.53	101.87	103.79
.240	161.75	118.22	101.59	99.02	95.32	96.13	96.93	98.58	100.22	102.43	104.63
.260	147.61	113.54	101.13	98.58	96.01	97.10	98.19	99.83	102.04	104.22	106.45
.280	141.78	113.08	101.52	99.40	96.69	98.35	100.14	101.65	104.00	106.07	108.81
.300	135.94	110.92	101.63	100.50	98.76	99.60	101.53	103.75	106.21	108.45	110.94
.320	133.80	109.32	102.64	100.12	100.50	101.35	103.68	105.90	108.39	110.89	113.38
.340	131.31	109.99	104.09	102.37	101.27	103.50	105.72	107.94	110.43	112.93	115.42
.360	128.85	109.78	105.60	103.64	103.63	105.59	108.09	110.59	113.09	115.59	118.08
.380	128.64	109.30	107.52	105.71	105.99	108.24	110.75	113.25	115.75	118.25	120.74
.400	127.87	110.23	108.02	107.51	108.64	110.88	113.40	115.91	118.41	120.91	123.40
.420	127.66	111.72	109.83	109.86	111.19	113.73	116.25	118.76	121.26	123.65	126.15
.440	129.20	113.21	111.83	112.22	113.64	116.17	118.70	121.22	123.72	126.22	128.72
.460	129.22	114.98	114.23								
.480	129.29	117.31	116.85								
.500	128.79	119.92	119.47								
.520	130.83	122.25	122.09								
.540	132.03	124.86	124.70								
.560	133.64	127.19	127.46								
.580	134.47	129.86	129.93								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											165.71
.080											124.55
.100											116.21
.120					118.58	114.96	112.13	110.40	109.83	109.98	110.39
.140					111.54	108.24	106.24	105.26	105.28	105.96	107.36
.160					107.63	104.80	104.15	103.51	103.80	105.35	106.91
.180					103.72	102.77	101.78	101.76	103.30	105.17	107.06
.200	304.62	154.93	117.05	106.83	102.12	100.77	100.94	102.14	103.66	106.08	108.53
.220	205.45	132.84	110.77	103.32	101.21	101.39	101.19	102.43	104.29	106.62	108.48
.240	175.36	126.71	107.94	104.82	100.43	101.05	101.66	103.21	104.76	106.94	109.11
.260	159.35	121.21	107.15	104.03	100.89	101.83	102.76	104.31	106.49	108.63	110.84
.280	152.58	120.40	107.29	104.64	101.36	102.92	104.63	106.03	108.37	110.39	113.16
.300	145.81	117.71	107.11	105.57	103.36	104.01	105.88	108.07	110.53	112.74	115.23
.320	143.13	115.65	107.28	105.08	105.00	105.67	107.98	110.16	112.66	115.15	117.64
.340	140.08	116.08	109.26	107.07	105.56	107.76	109.95	112.13	114.63	117.12	119.62
.360	137.05	115.57	110.64	108.18	107.89	109.78	112.29	114.79	117.29	119.79	122.28
.380	136.54	114.75	112.93	110.19	110.22	112.43	114.95	117.45	119.95	122.44	124.94
.400	135.39	115.49	112.74	111.89	112.86	115.08	117.60	120.10	122.60	125.10	127.60
.420	134.87	116.86	114.46	114.22	115.41	117.94	120.47	122.98	125.48	127.86	130.35
.440	136.28	118.22	116.40	116.54	117.84	120.37	122.90	125.41	127.92	130.42	132.92
.460	136.01	119.90	118.77								
.480	135.80	122.20	121.39								
.500	134.96	124.81	124.01								
.520	136.94	127.11	126.63								
.540	137.98	129.72	129.25								
.560	139.48	132.01	132.02								
.580	140.11	134.68	134.48								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											178.23
.080											132.69
.100											123.26
.120					127.10	122.87	119.51	117.35	116.47	116.39	116.59
.140					119.09	115.20	112.76	111.43	111.20	111.70	112.99
.160					114.52	111.15	110.20	109.24	109.31	110.77	112.23
.180					109.95	108.65	107.32	107.05	108.50	110.30	112.13
.200	331.68	166.77	124.34	113.36	107.93	106.19	106.13	107.20	108.62	111.03	113.49
.220	222.33	142.20	117.68	109.23	106.66	106.61	106.14	107.25	109.05	111.36	113.16
.240	188.56	135.20	114.30	110.61	105.53	105.96	106.39	107.85	109.30	111.45	113.59
.260	171.09	128.88	113.66	109.48	105.78	106.56	107.33	108.79	110.94	113.04	115.22
.280	163.38	127.73	113.05	109.89	106.02	107.49	109.13	110.42	112.74	114.71	117.51
.300	155.67	124.51	112.59	110.64	107.96	108.43	110.24	112.39	114.85	117.03	119.52
.320	152.47	121.97	112.51	109.84	109.50	109.98	112.27	114.43	116.92	119.42	121.91
.340	148.85	122.19	114.43	111.76	109.85	112.02	114.17	116.33	118.83	121.32	123.81
.360	145.26	121.37	115.68	112.72	112.15	113.98	116.49	118.99	121.49	123.98	126.48
.380	144.43	120.20	117.94	114.57	114.45	116.63	119.14	121.64	124.14	126.64	129.14
.400	142.90	120.75	117.47	116.28	117.09	119.28	121.79	124.30	126.80	129.30	131.80
.420	142.07	121.99	119.10	118.57	119.63	122.16	124.68	127.20	129.70	132.06	134.56
.440	143.37	123.23	120.96	120.36	122.03	124.57	127.09	129.61	132.11	134.62	137.12
.460	142.81	124.81	123.31								
.480	142.31	127.08	125.53								
.500	141.13	129.69	128.55								
.520	143.04	131.96	131.17								
.540	143.93	134.57	133.79								
.560	145.32	136.84	136.57								
.580	145.75	139.51	139.02								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											190.75
.080											140.83
.100											130.30
.120					135.62	130.78	126.88	124.30	123.12	122.80	122.79
.140					126.64	122.17	119.28	117.60	117.12	117.44	118.63
.160					121.41	117.51	116.24	114.97	114.82	116.19	117.55
.180					116.19	114.54	112.86	112.34	113.69	115.43	117.20
.200	358.74	178.60	132.64	119.88	113.74	111.61	111.31	112.26	113.58	115.99	118.44
.220	239.21	151.56	124.58	115.14	112.11	111.83	111.09	112.07	113.81	116.11	117.84
.240	202.57	143.68	120.66	116.40	110.64	110.88	111.12	112.48	113.84	115.95	118.07
.260	182.84	136.56	119.17	114.93	110.67	111.28	111.90	113.27	115.38	117.46	119.61
.280	174.19	135.06	118.81	115.13	110.69	112.06	113.62	114.80	117.11	119.03	121.86
.300	165.53	131.31	118.07	115.71	112.56	112.84	114.59	116.71	119.17	121.32	123.81
.320	161.80	128.30	117.74	114.60	114.00	114.30	116.57	118.69	121.19	123.68	126.17
.340	157.61	128.30	119.59	116.46	114.14	116.27	118.40	120.53	123.02	125.52	128.01
.360	153.46	127.16	120.73	117.26	116.41	118.17	120.68	123.18	125.68	128.18	130.67
.380	152.32	125.65	122.95	119.15	118.68	120.82	123.34	125.84	128.34	130.84	133.33
.400	150.42	126.01	122.19	120.66	121.32	123.47	125.99	128.50	131.00	133.50	135.99
.420	149.27	127.13	123.73	122.92	123.85	126.38	128.90	131.42	133.92	136.27	138.76
.440	150.45	128.24	125.53	125.18	126.23	128.76	131.29	133.80	136.31	138.81	141.31
.460	149.60	129.73	127.85								
.480	148.83	131.97	130.47								
.500	147.30	134.58	133.09								
.520	149.15	136.82	135.71								
.540	149.08	139.43	138.33								
.560	151.16	141.66	141.13								
.580	151.39	144.34	143.56								

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											153.37
.080											116.74
.100											109.70
.120					111.04	108.01	105.68	104.33	104.02	104.36	104.93
.140					105.16	102.41	100.85	100.18	100.41	101.22	102.69
.160					102.06	99.76	99.42	99.07	99.55	101.16	102.77
.180					99.96	98.37	97.73	97.95	99.57	101.47	103.39
.200	278.59	144.36	110.68	101.84	97.92	96.98	97.40	98.73	100.33	102.75	105.18
.220	189.61	124.78	105.37	99.04	97.49	97.95	98.05	99.42	101.35	103.68	105.59
.240	162.80	119.57	103.14	100.74	97.15	98.03	98.88	100.55	102.21	104.41	106.61
.260	148.66	114.90	102.74	100.36	97.93	99.11	100.26	101.95	104.18	106.37	108.60
.280	142.83	114.45	103.17	101.24	98.69	100.46	102.34	103.90	106.29	108.37	111.13
.300	137.00	112.31	103.31	102.39	100.83	101.80	103.84	106.12	108.64	110.91	113.41
.320	134.85	110.72	103.74	102.27	102.64	103.64	106.08	108.39	110.95	113.49	116.00
.340	132.35	111.38	105.81	104.36	103.45	105.86	108.21	110.53	113.11	115.66	118.19
.360	129.89	111.19	107.33	105.65	105.87	108.01	110.67	113.29	115.87	118.44	120.99
.380	129.67	110.71	109.66	107.75	108.28	110.71	113.39	116.03	118.63	121.21	123.77
.400	128.89	111.64	109.77	109.56	110.96	113.42	116.11	118.77	121.39	123.98	126.55
.420	128.66	113.12	111.58	111.93	113.54	116.31	119.02	121.69	124.33	126.82	129.41
.440	130.19	114.61	113.59	114.30	116.01	118.79	121.52	124.21	126.87	129.49	132.08
.460	130.19	116.37	115.99								
.480	130.24	118.69	118.61								
.500	129.73	121.29	121.23								
.520	131.76	123.61	123.84								
.540	132.94	126.21	126.45								
.560	134.54	128.53	129.20								
.580	135.35	131.18	131.67								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											165.89
.080											124.89
.100											116.74
.120					119.56	115.92	113.05	111.28	110.66	110.77	111.13
.140					112.70	109.38	107.37	106.35	106.33	106.97	108.33
.160					108.95	106.12	105.46	104.80	105.07	106.58	108.10
.180					105.19	104.25	103.27	103.24	104.76	106.60	108.46
.200	305.65	156.20	118.47	108.37	103.73	102.40	102.59	103.79	105.30	107.70	110.13
.220	206.49	134.15	112.27	104.95	102.94	103.17	103.00	104.25	106.11	108.43	110.27
.240	176.41	128.05	109.50	106.53	102.25	102.95	103.61	105.18	106.75	108.92	111.08
.260	160.41	122.57	108.75	105.81	102.82	103.84	104.84	106.43	108.63	110.78	112.99
.280	153.64	121.78	108.93	106.49	103.36	105.03	106.83	108.29	110.66	112.69	115.48
.300	146.86	119.10	108.79	107.47	105.43	106.22	108.19	110.44	112.96	115.20	117.70
.320	144.18	117.05	108.98	107.03	107.14	107.95	110.38	112.65	115.21	117.75	120.27
.340	141.12	117.49	110.97	109.05	107.75	110.11	112.44	114.73	117.30	119.86	122.39
.360	138.09	116.98	112.37	110.19	110.13	112.20	114.86	117.48	120.07	122.64	125.18
.380	137.56	116.16	114.67	112.23	112.50	114.91	117.59	120.23	122.83	125.41	127.97
.400	136.40	116.90	114.49	113.95	115.18	117.61	120.30	122.96	125.58	128.18	130.75
.420	135.87	118.26	116.22	116.28	117.76	120.53	123.23	125.91	128.55	131.03	133.61
.440	137.27	119.62	118.16	118.62	120.21	122.99	125.72	128.41	131.06	133.69	136.28
.460	136.98	121.29	120.53								
.480	136.76	123.58	123.15								
.500	135.90	126.18	125.77								
.520	137.86	128.47	128.38								
.540	138.89	131.07	130.99								
.560	140.38	133.35	133.76								
.580	140.99	136.01	136.21								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											178.41
.080											133.03
.100											123.79
.120					128.08	123.83	120.43	118.23	117.31	117.18	117.33
.140					120.25	116.35	113.89	112.52	112.26	112.71	113.96
.160					115.84	112.48	111.51	110.53	110.58	112.00	113.42
.180					111.42	110.14	108.81	108.52	109.96	111.73	113.53
.200	332.71	168.03	126.27	114.89	109.53	107.82	107.78	108.86	110.26	112.66	115.09
.220	223.37	143.51	119.18	110.36	108.38	108.39	107.94	109.07	110.87	113.17	114.95
.240	190.01	136.54	115.86	112.33	107.36	107.87	108.34	109.82	111.29	113.43	115.56
.260	172.15	130.25	114.77	111.26	107.70	108.57	109.41	110.91	113.07	115.19	117.37
.280	164.44	129.11	114.69	111.73	108.03	109.61	111.32	112.67	115.03	117.02	119.83
.300	156.72	125.90	114.27	112.54	110.03	110.63	112.54	114.77	117.28	119.49	121.99
.320	153.52	123.37	114.21	111.79	111.64	112.27	114.68	116.92	119.48	122.02	124.53
.340	149.89	123.59	116.14	113.75	112.04	114.37	116.67	118.92	121.50	124.05	126.58
.360	146.29	122.78	117.41	114.73	114.39	116.40	119.06	121.68	124.27	126.83	129.38
.380	145.45	121.61	119.68	116.70	116.73	119.11	121.79	124.42	127.03	129.61	132.17
.400	143.92	122.16	119.22	118.33	119.41	121.81	124.50	127.16	129.78	132.37	134.94
.420	143.07	123.40	120.85	120.64	121.98	124.74	127.45	130.13	132.77	135.23	137.82
.440	144.36	124.63	122.72	122.94	124.40	127.19	129.91	132.60	135.26	137.88	140.48
.460	143.78	126.20	125.07								
.480	143.27	128.46	127.69								
.500	142.07	131.06	130.31								
.520	143.97	133.32	132.92								
.540	144.84	135.92	135.54								
.560	146.22	138.17	138.32								
.580	146.63	140.83	140.75								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											190.93
.080											141.17
.100											130.83
.120					136.60	131.73	127.80	125.18	123.95	123.59	123.53
.140					127.80	123.32	120.41	118.70	118.18	118.45	119.59
.160					122.73	118.84	117.55	116.26	116.09	117.42	118.74
.180					117.66	116.03	114.35	113.81	115.15	116.86	118.61
.200	359.77	179.87	134.07	121.42	115.34	113.24	112.97	113.92	115.23	117.62	120.04
.220	240.25	152.87	126.08	116.77	113.83	113.60	112.89	113.89	115.63	117.91	119.63
.240	203.62	145.03	122.21	118.12	112.46	112.78	113.07	114.45	115.83	117.94	120.04
.260	183.89	137.92	120.78	116.71	112.59	113.30	113.98	115.39	117.52	119.61	121.76
.280	175.24	136.44	120.46	116.98	112.69	114.18	115.82	117.06	119.39	121.34	124.17
.300	166.59	132.69	119.75	117.61	114.63	115.05	116.89	119.09	121.59	123.78	126.28
.320	162.85	129.70	119.44	116.55	116.14	116.58	118.97	121.18	123.74	126.28	128.80
.340	158.66	129.70	121.31	118.44	116.33	118.63	120.90	123.12	125.69	128.25	130.78
.360	154.50	128.57	122.45	119.27	118.65	120.59	123.25	125.87	128.46	131.03	133.58
.380	153.34	127.06	124.69	121.18	120.96	123.30	125.98	128.62	131.22	133.80	136.36
.400	151.43	127.42	123.94	122.71	123.64	126.00	128.70	131.35	133.98	136.57	139.14
.420	150.27	128.53	125.49	124.99	126.20	128.96	131.67	134.35	136.98	139.44	142.02
.440	151.44	129.64	127.29	127.26	128.60	131.38	134.11	136.80	139.45	142.08	144.67
.460	150.57	131.12	129.61								
.480	149.78	133.35	132.23								
.500	148.24	135.95	134.85								
.520	150.08	138.17	137.46								
.540	150.79	140.77	140.08								
.560	152.06	142.99	142.87								
.580	152.27	145.66	145.29								

TABLE GENERATED USING INDEX 225.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											153.92
.080											117.71
.100											111.07
.120					112.71	109.77	107.48	106.16	105.84	106.15	106.69
.140					106.95	104.34	102.88	102.27	102.53	103.36	104.81
.160					103.93	101.81	101.61	101.36	101.92	103.57	105.21
.180					100.86	100.49	100.03	100.39	102.12	104.10	106.08
.200	279.16	145.30	111.98	103.46	99.84	99.15	99.78	101.29	103.03	105.56	108.09
.220	190.13	125.68	106.62	100.64	99.40	100.14	100.48	102.06	104.16	106.64	108.66
.240	163.26	120.41	104.35	102.30	99.04	100.22	101.34	103.24	105.10	107.48	109.82
.260	149.08	115.69	103.90	101.88	99.78	101.28	102.73	104.67	107.13	109.52	111.93
.280	143.21	115.18	104.27	102.71	100.51	102.61	104.79	106.64	109.28	111.58	114.53
.300	137.33	112.98	104.37	103.81	102.60	103.91	106.27	108.85	111.64	114.16	116.88
.320	135.15	111.34	104.74	103.63	104.37	105.71	108.50	111.11	113.96	116.76	119.52
.340	132.63	111.95	106.74	105.68	105.13	107.89	110.58	113.23	116.11	118.95	121.73
.360	130.14	111.72	108.23	106.92	107.50	110.00	113.00	115.96	118.86	121.72	124.54
.380	129.90	111.20	110.43	108.96	109.85	112.65	115.68	118.66	121.60	124.49	127.33
.400	129.10	112.09	110.53	110.71	112.49	115.31	118.36	121.36	124.32	127.22	130.10
.420	128.86	113.54	112.30	113.02	115.03	118.14	121.21	124.24	127.22	130.05	132.94
.440	130.37	115.00	114.27	115.32	117.43	120.58	123.67	126.72	129.72	132.68	135.59
.460	130.35	116.73	116.63								
.480	130.39	119.03	119.21								
.500	129.87	121.61	121.79								
.520	131.88	123.91	124.37								
.540	133.05	126.49	125.96								
.560	134.64	128.78	129.68								
.580	135.44	131.42	132.12								

TABLE GENERATED USING INDEX 250.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											166.44
.080											125.85
.100											118.12
.120					121.23	117.68	114.86	113.11	112.49	112.56	112.89
.140					114.49	111.31	109.40	108.44	108.45	109.10	110.45
.160					110.82	108.17	107.65	107.09	107.43	108.99	110.54
.180					107.10	106.38	105.57	105.68	107.32	109.24	111.15
.200	306.22	157.14	119.77	109.99	105.65	104.57	104.97	106.35	108.00	110.52	113.04
.220	207.00	135.04	113.53	106.55	104.84	105.36	105.43	106.88	108.92	111.38	113.35
.240	176.87	128.90	110.70	108.09	104.14	105.13	106.07	107.88	109.64	111.99	114.29
.260	160.82	123.36	109.91	107.32	104.67	106.01	107.30	109.15	111.58	113.93	116.32
.280	154.01	122.51	110.04	107.95	105.18	107.18	109.29	111.02	113.65	115.90	118.88
.300	147.23	119.77	109.85	108.89	107.20	108.33	110.62	113.18	115.96	118.45	121.17
.320	144.49	117.66	109.97	108.39	108.87	110.03	112.79	115.38	118.22	121.02	123.78
.340	141.40	118.06	111.91	110.37	109.42	112.14	114.81	117.42	120.30	123.14	125.93
.360	138.34	117.51	113.25	111.46	111.76	114.19	117.20	120.16	123.05	125.92	128.74
.380	137.79	116.65	115.49	113.44	114.08	116.85	119.88	122.86	125.79	128.68	131.52
.400	136.61	117.35	115.26	115.09	116.72	119.50	122.55	125.56	128.52	131.42	134.30
.420	136.06	118.68	116.94	117.37	119.25	122.36	125.43	128.46	131.44	134.25	137.15
.440	137.45	120.01	118.83	119.65	121.63	124.77	127.87	130.91	133.92	136.87	139.79
.460	137.15	121.65	121.17								
.480	136.91	123.92	123.75								
.500	136.04	126.50	126.33								
.520	137.99	128.76	128.92								
.540	139.00	131.34	131.50								
.560	140.48	133.61	134.23								
.580	141.09	136.25	136.66								

TABLE GENERATED USING INDEX 275.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											178.96
.080											133.99
.100											125.17
.120					129.75	125.58	122.23	120.06	119.13	118.97	119.09
.140					122.04	118.28	115.92	114.61	114.38	114.84	116.08
.160					117.71	114.53	113.70	112.82	112.94	114.41	115.86
.180					113.33	112.27	111.11	110.97	112.51	114.37	116.23
.200	333.28	168.98	127.57	116.52	111.45	110.00	110.16	111.42	112.96	115.48	118.00
.220	223.38	144.40	120.43	112.46	110.23	110.57	110.38	111.71	113.68	116.12	118.03
.240	190.47	137.39	117.06	113.88	109.25	110.05	110.79	112.51	114.18	116.50	118.77
.260	172.56	131.03	115.92	112.77	109.55	110.74	111.87	113.63	116.03	118.34	120.70
.280	164.81	129.83	115.80	113.20	109.84	111.76	113.78	115.41	118.02	120.23	123.23
.300	157.06	126.57	115.33	113.96	111.83	112.75	114.97	117.50	120.28	122.74	125.46
.320	153.82	123.99	115.21	113.15	113.37	114.35	117.09	119.64	122.49	125.29	128.05
.340	150.17	124.16	117.08	115.06	113.71	116.40	119.04	121.62	124.50	127.34	130.12
.360	146.55	123.30	118.29	116.00	116.02	118.39	121.40	124.35	127.25	130.11	132.94
.380	145.68	122.10	120.50	117.92	118.31	121.04	124.07	127.05	129.99	132.88	135.72
.400	144.13	122.61	119.99	119.48	120.94	123.70	126.75	129.76	132.71	135.62	138.49
.420	143.26	123.82	121.57	121.72	123.45	126.58	129.65	132.67	135.66	138.46	141.35
.440	144.53	125.02	123.40	123.97	125.83	128.97	132.06	135.11	138.12	141.07	143.99
.460	143.94	126.57	125.71								
.480	143.42	128.80	128.29								
.500	142.21	131.38	130.87								
.520	144.10	133.62	133.46								
.540	144.95	136.20	136.04								
.560	146.32	138.43	138.79								
.580	146.73	141.08	141.20								

TABLE GENERATED USING INDEX 300.

15.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.030	.040	.050	.060	.070	.080	.090	.100	.110	.120	.130
.060											191.48
.080											142.14
.100											132.21
.120					138.27	133.49	129.61	127.01	125.78	125.38	125.29
.140					129.59	125.25	122.44	120.79	120.30	120.59	121.71
.160					124.60	120.88	119.74	118.55	118.45	119.82	121.18
.180					119.56	118.15	116.65	116.26	117.71	119.50	121.30
.200	360.34	180.82	135.37	123.04	117.26	115.42	115.35	116.48	117.92	120.44	122.95
.220	240.76	153.77	127.34	118.37	115.74	115.79	115.32	116.53	118.44	120.87	122.71
.240	204.08	145.87	123.42	119.68	114.35	114.97	115.52	117.15	118.72	121.01	123.25
.260	184.31	138.70	121.93	118.22	114.44	115.47	116.44	118.11	120.47	122.76	125.08
.280	175.62	137.16	121.56	118.44	114.51	116.33	118.27	119.79	122.39	124.55	127.58
.300	166.93	133.36	120.81	119.03	116.40	117.16	119.33	121.82	124.60	127.03	129.75
.320	163.16	130.31	120.44	117.91	117.87	118.66	121.39	123.91	126.75	129.55	132.31
.340	158.94	130.27	122.24	119.76	118.00	120.66	123.27	125.82	128.70	131.54	134.32
.360	154.75	129.10	123.33	120.54	120.28	122.58	125.59	128.55	131.44	134.31	137.13
.380	153.58	127.54	125.51	122.39	122.53	125.24	128.27	131.25	134.18	137.07	139.92
.400	151.65	127.37	124.71	123.86	125.17	127.89	130.95	133.95	136.91	139.81	142.69
.420	150.47	128.95	126.21	126.08	127.68	130.80	133.87	136.89	139.87	142.66	145.56
.440	151.62	130.03	127.97	128.29	130.02	133.17	136.26	139.31	142.31	145.27	148.18
.460	150.74	131.48	130.25								
.480	149.93	133.69	132.83								
.500	148.38	136.27	135.41								
.520	150.20	138.47	138.00								
.540	150.90	141.05	140.58								
.560	152.16	143.25	143.35								
.580	152.37	145.91	145.74								

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											128.88
.180											125.51
.200					134.27	128.70	125.49	123.93	123.19	122.99	123.92
.220					127.76	124.44	122.67	121.80	121.60	121.63	122.33
.240					123.78	120.97	120.17	120.22	120.83	121.61	122.80
.260					121.68	120.82	120.40	120.43	120.68	121.26	122.07
.280					120.54	119.68	119.60	119.96	120.77	121.47	122.50
.300	173.09	136.26	128.71	122.38	119.73	119.21	119.46	120.17	121.09	122.24	123.60
.320	160.86	134.43	127.67	123.13	120.78	120.52	120.78	121.69	122.46	123.34	124.57
.340	151.53	132.49	126.29	122.21	120.46	120.61	121.25	122.18	123.29	124.68	126.59
.360	147.24	131.66	126.81	123.29	121.33	121.37	122.12	123.32	124.94	126.56	128.70
.380	144.55	131.04	127.04	124.15	122.48	122.48	123.50	124.75	126.42	128.82	131.25
.400	144.00	132.47	127.63	125.01	124.06	124.44	125.60	127.10	129.03	131.41	133.80
.420	143.27	130.41	127.36	125.64	125.71	126.65	128.01	129.64	131.69	134.08	136.46
.440	143.44	130.59	127.77	127.17	127.68	128.86	130.29	132.10			
.460	143.26	131.43	129.29	129.14	129.88	131.06	132.63	134.71			
.480	143.65	132.49	131.03	131.11	131.97	133.49	135.22	137.36			
.500	143.81	133.87	132.55	133.08	134.36	135.91	137.82	140.00			
.520	144.63	135.28	134.74	135.39	136.69	138.33	140.41	142.47			
.540	145.13	137.68	137.14	137.69	138.89	140.75	142.83	145.12			
.560	146.18	140.31	139.55	140.22	141.31	143.17	145.48	147.77			
.580	147.22	142.70	141.95	142.74	143.73	145.59	148.12	150.42			
.600	148.07	145.50	144.42	145.24	146.46	148.34	150.77	153.07			

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											135.26
.180											131.35
.200					142.02	135.72	131.98	129.95	129.02	128.58	129.37
.220					134.68	130.82	128.67	127.50	127.05	126.85	127.39
.240					130.09	126.80	125.70	125.53	125.97	126.60	127.67
.260					127.56	126.39	125.71	125.51	125.56	125.97	126.62
.280					126.07	124.90	124.59	124.76	125.42	125.95	126.85
.300	184.07	143.66	135.19	128.06	124.95	124.15	124.20	124.74	125.52	126.55	127.81
.320	170.49	141.42	133.82	128.64	125.85	125.34	125.40	126.16	126.77	127.50	128.63
.340	160.07	139.06	132.08	127.39	125.26	125.20	125.67	126.45	127.43	128.73	130.58
.360	155.15	137.92	132.40	128.33	125.96	125.78	126.37	127.46	129.00	130.54	132.64
.380	151.97	137.00	132.41	129.03	126.98	126.75	127.64	128.77	130.37	132.76	135.18
.400	151.14	138.33	132.81	129.73	128.46	128.65	129.69	131.09	132.98	135.35	137.72
.420	150.10	135.84	132.28	130.18	130.02	130.82	132.08	133.63	135.64	138.01	140.38
.440	150.04	135.79	132.48	131.60	131.93	132.98	134.32	136.06			
.460	149.62	136.47	133.91	133.51	134.09	135.15	136.63	138.67			
.480	149.80	137.39	135.57	135.42	136.13	137.55	139.21	141.33			
.500	149.73	138.65	136.98	137.33	138.50	139.95	141.81	143.96			
.520	150.40	139.96	139.13	139.61	140.80	142.36	144.39	146.42			
.540	150.70	142.34	141.52	141.88	142.96	144.76	146.79	149.07			
.560	151.60	144.96	143.90	144.40	145.35	147.16	149.44	151.72			
.580	152.51	147.24	146.29	146.91	147.75	149.55	152.09	154.37			
.600	153.20	150.15	148.74	149.40	150.49	152.32	154.73	157.01			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											141.65
.180											137.18
.200					149.76	142.73	138.48	136.07	134.86	134.18	134.82
.220					141.59	137.21	134.67	133.19	132.50	132.08	132.46
.240					136.40	132.63	131.23	130.84	131.10	131.58	132.53
.260					133.43	131.96	131.02	130.60	130.44	130.68	131.18
.280					131.60	130.13	129.58	129.56	130.07	130.44	131.21
.300	195.05	151.06	141.68	133.74	130.16	129.09	128.94	129.32	129.96	130.86	132.02
.320	180.12	148.42	139.97	134.15	130.92	130.16	130.01	130.63	131.09	131.67	132.68
.340	168.62	145.64	137.86	132.58	130.06	129.78	130.08	130.73	131.58	132.78	134.58
.360	163.06	144.19	133.00	133.38	130.60	130.19	130.63	131.59	133.05	134.52	136.59
.380	159.40	142.97	137.79	133.91	131.48	131.02	131.78	132.80	134.31	136.70	139.11
.400	158.27	144.18	138.00	134.45	132.87	132.86	133.78	135.09	136.92	139.28	141.65
.420	156.94	141.27	137.20	134.71	134.33	134.99	136.14	137.61	139.58	141.94	144.31
.440	156.65	141.00	137.20	136.03	136.18	137.11	138.35	140.03			
.460	155.97	141.51	133.52	137.88	138.30	139.23	140.64	142.64			
.480	155.95	142.29	140.10	139.73	140.28	141.62	143.21	145.29			
.500	155.66	143.44	141.42	141.58	142.64	144.00	145.81	147.92			
.520	156.16	144.64	143.52	143.83	144.91	146.38	148.38	150.36			
.540	156.27	147.00	145.89	146.07	147.02	148.76	150.76	153.01			
.560	157.03	149.62	148.25	148.58	149.40	151.14	153.41	155.66			
.580	157.80	151.98	150.82	151.08	151.78	153.52	156.05	158.31			
.600	158.32	154.81	153.06	153.55	154.52	156.29	158.70	160.96			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											148.03
.180											143.02
.200					157.51	149.75	144.98	142.19	140.70	139.77	140.27
.220					148.51	143.59	140.67	138.89	137.95	137.31	137.52
.240					142.71	138.46	136.76	136.14	136.24	136.56	137.39
.260					139.31	137.53	136.32	135.68	135.32	135.39	135.73
.280					137.13	135.35	134.57	134.36	134.71	134.92	135.56
.300	206.04	158.46	148.17	139.43	135.38	134.03	133.68	133.89	134.39	135.17	136.23
.320	189.75	155.41	146.12	139.66	135.98	134.98	134.63	135.10	135.40	135.84	136.74
.340	177.16	152.22	143.65	137.76	134.86	134.37	134.50	135.00	135.73	136.83	138.58
.360	170.97	150.45	143.59	138.42	135.23	134.60	134.88	135.73	137.11	138.49	140.53
.380	166.82	148.94	143.16	138.79	135.98	135.30	135.92	136.82	138.26	140.64	143.05
.400	165.41	150.04	143.18	139.16	137.27	137.07	137.86	139.08	140.87	143.22	145.57
.420	163.77	146.70	142.12	139.25	138.64	139.16	140.21	141.60	143.53	145.88	148.23
.440	163.26	146.20	141.92	140.47	140.43	141.24	142.38	144.00			
.460	162.33	146.56	143.14	142.26	142.51	143.32	144.64	146.60			
.480	162.10	147.19	144.64	144.04	144.44	145.69	147.20	149.25			
.500	161.59	148.23	145.85	145.83	146.77	148.05	149.80	151.88			
.520	161.93	149.32	147.91	148.05	149.02	150.41	152.36	154.31			
.540	161.84	151.65	150.26	150.26	151.09	152.77	154.73	156.96			
.560	162.46	154.28	152.60	152.75	153.45	155.13	157.37	159.61			
.580	163.09	156.61	154.95	155.25	155.81	157.49	160.02	162.26			
.600	163.45	159.46	157.37	157.71	158.56	160.27	162.66	164.90			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											160.80
.180											154.69
.200					173.01	163.78	157.97	154.44	152.37	150.95	151.17
.220					162.33	156.36	152.67	150.27	148.85	147.76	147.65
.240					155.33	150.11	147.82	146.76	146.51	146.52	147.12
.260					151.06	148.68	146.94	145.85	145.08	144.80	144.84
.280					148.19	145.81	144.56	143.96	144.01	143.89	144.26
.300	228.00	173.27	161.14	150.79	145.81	143.91	143.15	143.04	143.26	143.79	144.65
.320	209.00	169.40	158.42	150.68	146.12	144.62	143.86	144.05	144.03	144.18	144.85
.340	194.24	165.38	155.22	148.13	144.45	143.54	143.33	143.55	144.03	144.93	146.57
.360	186.79	162.98	154.77	148.51	144.51	143.43	143.39	144.00	145.22	146.45	148.42
.380	181.68	160.87	153.90	148.55	144.98	143.84	144.19	144.87	146.16	146.52	150.92
.400	179.69	161.75	153.55	148.60	146.07	145.49	146.04	147.07	148.76	151.09	153.42
.420	177.43	157.56	151.97	148.32	147.26	147.49	148.34	149.57	151.41	153.75	156.08
.440	176.48	156.61	151.35	149.33	148.93	149.50	150.44	151.93			
.460	175.04	156.64	152.37	151.00	150.93	151.50	152.64	154.52			
.480	174.40	156.99	153.71	152.67	152.76	153.82	155.19	157.18			
.500	173.44	157.80	154.71	154.33	155.04	156.14	157.78	159.80			
.520	173.46	158.67	156.70	156.49	157.23	158.46	160.33	162.20			
.540	172.98	160.97	159.00	158.64	159.22	160.78	162.66	164.85			
.560	173.32	163.59	161.31	161.11	161.54	163.10	165.30	167.50			
.580	173.66	165.89	163.61	163.58	163.86	165.42	167.95	170.15			
.600	173.70	168.76	166.01	166.02	166.63	168.22	170.59	172.79			

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											129.98
.180											126.83
.200					135.92	130.36	127.13	125.46	124.79	124.56	125.45
.220					129.57	126.25	124.49	123.61	123.40	123.40	124.07
.240					125.73	122.94	122.16	122.21	122.80	123.57	124.74
.260					123.76	122.94	122.54	122.58	122.83	123.40	124.19
.280					122.73	121.93	121.89	122.27	123.09	123.79	124.81
.300	174.77	138.16	130.78	124.58	122.03	121.58	121.89	122.62	123.56	124.72	126.09
.320	152.56	136.37	129.80	125.42	123.18	123.01	123.34	124.29	125.08	125.97	127.22
.340	153.25	134.47	128.48	124.56	122.95	123.20	123.92	124.91	126.05	127.47	129.39
.360	148.96	133.68	129.05	125.71	123.90	124.06	124.90	126.17	127.84	129.50	131.65
.380	146.29	133.07	129.32	126.63	125.13	125.26	126.39	127.71	129.45	131.90	134.35
.400	145.75	134.52	129.95	127.54	126.77	127.30	128.58	130.17	132.18	134.62	137.04
.420	145.03	132.48	129.71	128.22	128.47	129.58	131.08	132.81	134.95	137.40	139.84
.440	145.19	132.66	130.14	129.79	130.50	131.85	133.43	135.36			
.460	145.02	133.52	131.68	131.80	132.76	134.12	135.85	138.06			
.480	145.41	134.59	133.44	133.80	134.89	136.60	138.50	140.79			
.500	145.56	135.97	134.97	135.79	137.32	139.07	141.17	143.50			
.520	146.39	137.39	137.17	138.11	139.69	141.54	143.81	146.04			
.540	146.88	139.80	139.58	140.43	141.91	144.01	146.29	148.75			
.560	147.92	142.42	142.00	142.97	144.35	146.46	148.98	151.46			
.580	148.96	144.82	144.41	145.51	146.79	148.92	151.68	154.17			
.600	149.80	147.61	146.88	148.02	149.53	151.70	154.36	156.87			

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											136.36
.180											132.67
.200					143.67	137.37	133.63	131.58	130.63	130.16	130.90
.220					136.48	132.64	130.49	129.31	128.85	128.63	129.13
.240					132.04	128.77	127.69	127.51	127.94	128.55	129.60
.260					129.64	128.51	127.85	127.66	127.71	128.11	128.75
.280					128.26	127.16	126.88	127.07	127.74	128.27	129.16
.300	185.75	145.56	137.27	130.27	127.25	126.52	126.63	127.20	127.99	129.03	130.29
.320	172.19	143.37	135.95	130.93	128.25	127.83	127.95	128.76	129.39	130.14	131.27
.340	161.79	141.05	134.26	129.75	127.75	127.79	128.34	129.18	130.20	131.52	133.39
.360	156.87	139.94	134.64	130.76	128.53	128.47	129.16	130.31	131.90	133.48	135.60
.380	153.71	139.04	134.70	131.51	129.63	129.53	130.52	131.74	133.40	135.84	138.29
.400	152.89	140.38	135.13	132.26	131.17	131.51	132.67	134.16	136.12	138.56	140.97
.420	151.86	137.91	134.63	132.76	132.78	133.75	135.14	136.80	138.89	141.34	143.76
.440	151.80	137.87	134.85	134.22	134.75	135.98	137.46	139.33			
.460	151.38	138.56	136.29	136.17	136.96	138.20	139.85	142.02			
.480	151.56	139.49	137.97	138.11	139.04	140.66	142.49	144.76			
.500	151.49	140.76	139.40	140.04	141.46	143.12	145.16	147.46			
.520	152.15	142.07	141.56	142.33	143.79	145.57	147.79	149.99			
.540	152.45	144.45	143.96	144.62	145.98	148.01	150.25	152.70			
.560	153.35	147.08	146.35	147.15	148.40	150.45	152.95	155.41			
.580	154.25	149.45	148.74	149.68	150.81	152.88	155.64	158.11			
.600	154.92	152.26	151.20	152.18	153.57	155.67	158.32	160.81			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											142.75
.180											138.51
.200					151.42	144.39	140.12	137.70	136.46	135.75	136.35
.220					143.39	139.02	136.49	135.00	134.30	133.85	134.20
.240					138.35	134.60	133.22	132.82	133.08	133.54	134.47
.260					135.51	134.08	133.15	132.75	132.59	132.82	133.30
.280					133.80	132.38	131.87	131.87	132.38	132.75	133.51
.300	196.73	152.96	143.75	135.95	132.46	131.47	131.37	131.77	132.43	133.34	134.50
.320	181.82	150.36	142.10	136.44	133.32	132.65	132.57	133.23	133.71	134.31	135.33
.340	170.33	147.63	140.05	134.93	132.55	132.37	132.76	133.46	134.35	135.57	137.38
.360	164.78	146.20	140.24	135.80	133.17	132.88	133.41	134.44	135.96	137.45	139.54
.380	161.14	145.01	140.07	136.39	134.13	133.80	134.66	135.76	137.34	139.78	142.22
.400	160.02	146.24	140.32	136.98	135.57	135.72	136.76	138.16	140.07	142.49	144.89
.420	158.69	143.34	139.55	137.29	137.09	137.92	139.21	140.78	142.84	145.27	147.69
.440	158.41	143.08	139.57	138.65	139.00	140.11	141.49	143.30			
.460	157.73	143.60	140.91	140.54	141.17	142.29	143.85	145.99			
.480	157.71	144.39	142.51	142.42	143.20	144.73	146.49	148.72			
.500	157.42	145.55	143.83	144.29	145.59	147.17	149.15	151.42			
.520	157.92	146.75	145.95	146.55	147.90	149.60	151.78	153.93			
.540	158.02	149.11	148.33	148.81	150.04	152.02	154.22	156.64			
.560	158.78	151.73	150.70	151.33	152.44	154.44	156.91	159.35			
.580	159.53	154.09	153.07	153.85	154.84	156.85	159.61	162.06			
.600	160.05	156.92	155.52	156.33	157.60	159.65	162.29	164.76			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LCAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											149.13
.180											144.34
.200					159.16	151.40	146.62	143.82	142.30	141.34	141.80
.220					150.31	145.41	142.49	140.69	139.74	139.08	139.26
.240					144.66	140.43	138.74	138.13	138.21	138.52	139.33
.260					141.39	139.65	138.46	137.83	137.47	137.53	137.86
.280					139.33	137.61	136.86	136.66	137.03	137.24	137.86
.300	207.71	160.36	150.24	141.63	137.68	136.41	136.10	136.35	136.86	137.65	138.71
.320	191.45	157.36	148.25	141.95	138.39	137.47	137.19	137.70	138.02	138.48	139.38
.340	178.87	154.20	145.84	140.12	137.35	136.96	137.17	137.73	138.50	139.62	141.38
.360	172.69	152.46	145.83	140.84	137.81	137.29	137.66	138.58	140.01	141.43	143.48
.380	168.56	150.97	145.44	141.27	138.63	138.08	138.80	139.79	141.29	143.72	146.16
.400	167.16	152.09	145.50	141.70	139.98	139.93	140.84	142.15	144.01	146.43	148.82
.420	165.52	148.76	144.47	141.83	141.41	142.09	143.27	144.77	146.78	149.21	151.61
.440	165.02	148.28	144.29	143.09	143.25	144.23	145.52	147.27			
.460	164.09	148.65	145.53	144.91	145.38	146.38	147.85	149.95			
.480	163.86	149.29	147.04	146.73	147.36	148.80	150.49	152.68			
.500	163.35	150.33	148.27	148.54	149.73	151.21	153.14	155.39			
.520	163.68	151.42	150.34	150.77	152.01	153.62	155.76	157.88			
.540	163.59	153.77	152.70	153.00	154.11	156.03	158.18	160.59			
.560	164.21	156.39	155.05	155.51	156.49	158.42	160.88	163.30			
.580	164.82	158.72	157.40	158.01	158.87	160.81	163.57	166.00			
.600	165.18	161.57	159.83	160.49	161.64	163.63	166.25	168.70			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LCAD FACTOR = .20

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											161.90
.180											156.01
.200					174.66	165.44	159.61	156.06	153.97	152.52	152.70
.220					164.14	158.18	154.49	152.08	150.64	149.53	149.39
.240					157.28	152.08	149.80	148.74	148.49	148.48	149.06
.260					153.14	150.80	149.08	148.00	147.23	146.94	146.97
.280					150.39	148.06	146.85	146.26	146.32	146.20	146.57
.300	229.67	175.16	163.21	153.00	148.11	146.29	145.58	145.50	145.73	146.27	147.13
.320	210.70	171.35	160.56	152.97	148.53	147.11	146.42	146.64	146.65	146.82	147.49
.340	195.95	167.36	157.41	150.49	146.95	146.13	146.01	146.28	146.80	147.71	149.37
.360	188.51	164.99	157.01	150.93	147.08	146.12	146.17	146.85	148.13	149.39	151.37
.380	183.42	162.90	156.19	151.03	147.63	146.62	147.08	147.84	149.19	151.60	154.03
.400	181.43	163.81	155.87	151.13	148.78	148.35	149.02	150.14	151.90	154.30	156.67
.420	179.19	159.62	154.31	150.90	150.03	150.42	151.40	152.74	154.67	157.08	159.46
.440	178.24	158.69	153.72	151.95	151.75	152.49	153.58	155.20			
.460	176.80	158.73	154.76	153.66	153.80	154.55	155.86	157.88			
.480	176.16	159.09	156.11	155.35	155.68	156.93	158.48	160.61			
.500	175.20	159.91	157.13	157.04	158.00	159.31	161.12	163.31			
.520	175.21	160.78	159.13	159.21	160.22	161.68	163.73	165.76			
.540	174.73	163.08	161.44	161.38	162.24	164.04	166.11	168.48			
.560	175.06	165.70	163.76	163.87	164.58	166.39	168.81	171.19			
.580	175.39	168.00	166.07	166.35	166.92	168.74	171.50	173.89			
.600	175.43	170.87	168.47	168.80	169.71	171.58	174.19	176.59			

TABLE GENERATED USING INDEX 275.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											132.40
.180											129.58
.200					138.30	132.92	129.83	128.28	127.70	127.53	128.46
.220					132.00	128.89	127.31	126.57	126.48	126.58	127.31
.240					128.19	125.64	125.05	125.28	126.01	126.91	128.18
.260					126.22	125.66	125.49	125.73	126.16	126.87	127.79
.280					125.19	124.67	124.88	125.48	126.49	127.37	128.53
.300	175.83	139.57	132.55	126.69	124.47	124.31	124.90	125.88	127.03	128.38	129.92
.320	163.56	137.74	131.53	127.49	125.59	125.74	126.34	127.56	128.60	129.70	131.14
.340	154.18	135.79	130.16	126.59	125.32	125.90	126.92	128.20	129.59	131.25	133.38
.360	149.84	134.95	130.68	127.70	126.24	126.73	127.88	129.45	131.40	133.31	135.69
.380	147.11	134.28	130.90	128.57	127.41	127.89	129.35	130.99	133.00	135.72	138.43
.400	146.52	135.67	131.48	129.43	129.02	129.90	131.51	133.41	135.73	138.46	141.14
.420	145.75	133.56	131.19	130.06	130.67	132.13	133.97	136.04	138.48	141.23	143.94
.440	145.87	133.69	131.56	131.57	132.65	134.36	136.29	138.55			
.460	145.66	134.49	133.04	133.54	134.86	136.58	138.65	141.21			
.480	146.01	135.51	134.73	135.49	136.93	139.00	141.26	143.91			
.500	146.13	136.85	136.21	137.43	139.32	141.44	143.89	146.57			
.520	146.92	138.22	138.35	139.69	141.65	143.85	146.47	149.07			
.540	147.38	140.59	140.71	141.94	143.82	146.26	148.91	151.74			
.560	148.39	143.17	143.08	144.42	146.20	148.67	151.56	154.39			
.580	149.41	145.53	145.44	146.90	148.57	151.09	154.19	157.05			
.600	150.22	148.29	147.87	149.35	151.25	153.82	156.83	159.70			

TABLE GENERATED USING INDEX 300.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											138.78
.180											135.41
.200					146.05	139.93	136.32	134.40	133.53	133.12	133.91
.220					138.91	135.28	133.31	132.26	131.92	131.81	132.38
.240					134.50	131.46	130.58	130.59	131.15	131.89	133.05
.260					132.10	131.23	130.80	130.81	131.04	131.58	132.35
.280					130.72	129.89	129.87	130.28	131.14	131.85	132.88
.300	136.81	146.98	139.04	132.38	129.68	129.26	129.63	130.45	131.46	132.69	134.13
.320	173.19	144.73	137.68	133.01	130.66	130.56	130.96	132.03	132.91	133.87	135.19
.340	152.72	142.37	135.94	131.78	130.12	130.49	131.34	132.47	133.74	135.30	137.38
.360	157.75	141.21	136.27	132.74	130.87	131.14	132.14	133.58	135.46	137.28	139.63
.380	154.53	140.25	136.27	133.45	131.91	132.16	133.49	135.01	136.95	139.66	142.37
.400	153.65	141.53	136.66	134.15	133.42	134.11	135.60	137.41	139.67	142.39	145.06
.420	152.58	138.99	136.12	134.59	134.98	136.30	138.03	140.02	142.43	145.16	147.87
.440	152.48	138.90	136.28	136.01	136.90	138.49	140.32	142.52			
.460	152.01	139.53	137.65	137.91	139.07	140.66	142.66	145.17			
.480	152.16	140.41	139.27	139.80	141.09	143.07	145.26	147.87			
.500	152.06	141.63	140.64	141.68	143.45	145.48	147.88	150.53			
.520	152.69	142.90	142.74	143.90	145.75	147.88	150.46	153.01			
.540	152.95	145.24	145.08	146.13	147.88	150.27	152.87	155.68			
.560	153.82	147.82	147.43	148.60	150.25	152.66	155.52	158.34			
.580	154.69	150.16	149.77	151.07	152.60	155.05	158.16	160.99			
.600	155.35	152.94	152.18	153.51	155.29	157.80	160.79	163.65			

TABLE GENERATED USING INDEX 325.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											145.17
.180											141.25
.200					153.80	146.95	142.82	140.52	139.37	138.72	139.36
.220					145.83	141.66	139.31	137.95	137.37	137.03	137.44
.240					140.81	137.29	136.11	135.89	136.29	136.87	137.91
.260					137.97	136.80	136.11	135.89	135.92	136.28	136.90
.280					136.25	135.12	134.86	135.08	135.79	136.34	137.23
.300	197.79	154.38	145.52	138.06	134.90	134.20	134.37	135.03	135.89	137.00	138.34
.320	182.87	151.73	143.33	138.52	135.73	135.38	135.58	136.50	137.23	138.04	139.24
.340	171.27	148.94	141.73	136.96	134.92	135.07	135.76	136.75	137.89	139.35	141.37
.360	165.66	147.47	141.37	137.79	135.51	135.56	136.39	137.72	139.51	141.25	143.58
.380	161.96	146.22	141.54	138.33	136.41	136.44	137.62	139.03	140.90	143.60	146.30
.400	160.79	147.38	141.35	138.87	137.82	138.32	139.69	141.40	143.62	146.33	148.98
.420	159.41	144.42	141.34	139.13	139.29	140.47	142.10	144.01	146.37	149.10	151.79
.440	159.09	144.10	141.30	140.44	141.15	142.61	144.35	146.49			
.460	158.37	144.58	142.27	142.29	143.28	144.75	146.66	149.14			
.480	158.31	145.31	143.80	144.11	145.25	147.14	149.26	151.84			
.500	157.98	146.42	145.07	145.93	147.59	149.53	151.88	154.49			
.520	158.45	147.58	147.13	148.12	149.86	151.91	154.44	156.96			
.540	158.52	149.90	149.46	150.32	151.95	154.27	156.84	159.63			
.560	159.25	152.48	151.78	152.78	154.29	156.64	159.49	162.28			
.580	159.98	154.80	154.10	155.24	156.62	159.02	162.12	164.94			
.600	160.47	157.59	156.50	157.67	159.32	161.77	164.76	167.59			

TABLE GENERATED USING INDEX 350.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											151.55
.180											147.08
.200					161.55	153.96	149.32	146.64	145.21	144.31	144.81
.220					152.74	148.05	145.31	143.65	142.82	142.26	142.50
.240					147.12	143.12	141.64	141.20	141.42	141.86	142.77
.260					143.85	142.37	141.41	140.98	140.80	140.99	141.46
.280					141.78	140.35	139.85	139.87	140.43	140.82	141.59
.300	208.77	161.78	152.01	143.74	140.11	139.14	139.11	139.60	140.33	141.31	142.55
.320	192.44	158.72	149.98	144.03	140.80	140.20	140.19	140.97	141.54	142.21	143.30
.340	179.81	155.52	147.51	142.15	139.72	139.66	140.17	141.02	142.04	143.40	145.37
.360	173.57	153.74	147.46	142.83	140.14	139.97	140.65	141.86	143.57	145.24	147.52
.380	169.38	152.18	147.02	143.21	140.91	140.71	141.76	143.06	144.85	147.54	150.24
.400	167.93	153.24	147.03	143.59	142.22	142.53	143.77	145.40	147.56	150.26	152.91
.420	166.24	149.85	145.96	143.66	143.60	144.63	146.16	147.99	150.32	153.03	155.72
.440	165.70	149.31	145.71	144.87	145.40	146.74	148.38	150.45			
.460	164.72	149.62	146.88	146.66	147.49	148.84	150.66	153.10			
.480	164.46	150.22	148.34	148.43	149.40	151.21	153.25	155.80			
.500	163.91	151.21	149.50	150.18	151.73	153.58	155.87	158.45			
.520	164.22	152.26	151.52	152.34	153.97	155.93	158.43	160.90			
.540	164.09	154.55	153.83	154.51	156.02	158.28	160.80	163.57			
.560	164.68	157.14	156.13	156.96	158.34	160.63	163.46	166.23			
.580	165.27	159.44	158.43	159.40	160.65	162.99	166.09	168.88			
.600	165.60	162.25	160.82	161.82	163.36	165.75	168.72	171.54			

TABLE GENERATED USING INDEX 400.

25.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.050	.060	.070	.080	.090	.100	.110	.120	.130	.140	.150
.160											164.32
.180											158.76
.200					177.04	167.99	162.31	158.88	156.88	155.49	155.71
.220					166.57	160.82	157.30	155.04	153.72	152.71	152.63
.240					159.74	154.78	152.70	151.82	151.70	151.82	152.50
.260					155.60	153.52	152.03	151.15	150.56	150.41	150.57
.280					152.84	150.80	149.84	149.47	149.73	149.79	150.29
.300	230.73	176.58	164.98	155.11	150.55	149.02	148.59	148.76	149.19	149.93	150.97
.320	211.70	172.71	162.29	155.05	150.94	149.83	149.42	149.92	150.17	150.54	151.41
.340	196.89	168.68	159.08	152.52	149.32	148.83	149.01	149.57	150.33	151.49	153.36
.360	189.39	166.26	158.64	152.92	149.42	148.79	149.15	150.13	151.68	153.19	155.41
.380	184.24	164.12	157.76	152.97	149.91	149.25	150.04	151.11	152.74	155.43	158.10
.400	182.20	164.95	157.40	153.02	151.03	150.94	151.95	153.39	155.45	158.13	160.76
.420	179.91	160.71	155.30	152.73	152.22	152.97	154.29	155.96	158.21	160.90	163.57
.440	178.92	159.72	155.15	153.74	153.90	155.00	156.44	158.39			
.460	177.43	159.71	156.12	155.40	155.91	157.01	158.66	161.03			
.480	176.76	160.02	157.41	157.05	157.72	159.34	161.24	163.73			
.500	175.77	160.78	158.37	158.68	160.00	161.67	163.85	166.37			
.520	175.74	161.61	160.31	160.78	162.18	163.99	166.40	168.79			
.540	175.24	163.87	162.57	162.89	164.15	166.29	168.73	171.46			
.560	175.54	166.45	164.33	165.32	166.43	168.60	171.39	174.12			
.580	175.84	168.71	167.09	167.74	168.70	170.92	174.02	176.77			
.600	175.85	171.55	169.45	170.14	171.42	173.70	176.65	179.43			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						197.87	189.63	184.34	181.08	178.58	176.73	176.11	175.84	176.47
.280						193.77	181.96	177.30	176.73	173.59	174.04	173.46	173.66	173.84
.300						182.39	177.48	174.10	174.03	172.18	172.62	172.81	173.51	171.92
.320						179.19	176.32	171.41	171.85	170.51	173.00	171.65	172.35	171.39
.340						172.91	170.74	168.71	169.92	169.86	170.56	171.26	172.21	171.12
.360						169.96	169.14	168.06	169.02	169.21	170.93	171.63	172.58	171.24
.380						168.28	167.20	166.89	168.11	169.58	170.79	171.23	172.19	171.87
.400	227.20	198.13	187.48	174.87	169.59	167.37	166.77	167.00	167.96	168.92	170.14	171.60	172.56	173.95
.420	218.97	195.03	180.63	175.23	171.35	168.75	167.67	167.36	168.58	169.80	171.52	172.48	174.20	174.78
.440	211.40	191.35	178.43	175.33	172.22	169.62	168.29	168.49	169.45	171.18	172.40	173.62	174.96	176.04
.460	206.13	189.01	178.01	175.17	172.84	171.51	169.42	169.62	170.58	172.57	173.78	175.00	176.60	177.94
.480	203.66	186.68	177.09	175.78	173.45	172.89	170.54	171.51	171.96	173.70	175.04	176.13	178.62	180.35
.500	200.68	184.60	176.92	175.75	174.82	174.78	172.43	173.15	173.61	175.08	176.68	178.03	180.78	182.76
.520	197.68	182.90	177.32	176.23	176.20	176.67	173.58	174.91	175.50	176.97	178.45	180.41	182.90	185.40
.540	197.01	182.73	177.10	177.34	177.57	177.79	175.70	176.67	177.64	179.38	180.85	182.58	184.82	187.06
.560	195.56	182.31	177.70	178.45	178.43	179.03	177.97	178.57	179.79	181.52	183.26	184.48	186.72	188.95
.580	195.13	182.64	178.30	179.05	179.54	180.53	179.99	180.71	182.19	183.93	185.41	186.63	189.12	191.36
.600	194.18	182.47	179.41	180.16	181.17	181.39	182.38	182.85	184.59	186.33	187.81	190.31	191.53	193.77
.620	194.51	183.06	180.65	181.27	182.53	183.27	184.65	185.25	186.99	188.60	189.95	191.43	193.68	196.17
.640	194.19	183.90	182.13	183.02	184.15	185.54	186.91	187.64	189.39	190.88	192.36	193.83	196.34	198.83
.660	195.11	185.51	184.00	184.90	185.90	187.29	189.43	190.42	191.79	193.28	194.76	196.70	199.17	201.72
.680	195.48	186.35	185.36	186.64	187.65	189.17	191.44	192.43	194.18	195.68	197.41	199.15	201.65	204.15
.700	196.31	187.19	187.48	188.51	189.53	191.04	193.58	194.57	196.58	198.07	200.07	201.81	204.31	206.81
.720	197.14	188.79	189.60	190.38	191.66	193.17	195.45	196.70	198.85	200.47	202.47	204.46	206.96	209.46
.740	197.72	190.65	191.72	192.25	193.79	195.56	197.84	199.10	201.11	202.86	205.12	207.12	209.62	212.12
.760	198.93	192.50	193.32	194.37	195.91	197.95	200.23	201.48	203.50	205.51	207.77	209.77	212.28	214.78
.780	200.14	194.61	195.44	196.62	198.29	200.33	202.36	204.13	206.15	207.90	210.42	212.42	214.93	217.43
.800	201.66	196.72	197.70	198.99	200.80	202.72	204.80	206.77	208.79	211.01	213.15			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.150	.170	.180	.190	.200
.260						211.20	201.90	195.82	191.99	189.00	186.71	185.78	185.23	185.68
.280						206.43	193.19	187.82	186.94	183.24	183.48	182.60	182.56	182.52
.300						193.65	188.00	184.03	183.71	181.42	181.66	181.62	182.14	180.13
.320						189.86	186.45	180.80	181.04	179.32	181.80	180.07	180.59	179.29
.340						182.69	180.05	177.57	178.65	178.33	178.85	179.38	180.17	178.73
.360						179.17	178.02	176.58	177.39	177.35	179.00	179.51	180.32	178.59
.380						177.06	175.63	175.03	176.12	177.49	178.57	178.81	179.61	179.01
.400	242.86	210.69	198.66	184.55	178.48	175.79	174.89	174.88	175.69	176.50	177.59	178.95	179.76	181.03
.420	233.54	207.01	190.87	184.68	180.16	177.04	175.61	175.02	176.11	177.20	178.85	179.65	181.30	181.68
.440	224.95	202.64	188.18	184.52	180.85	177.74	176.02	175.99	176.81	178.46	179.55	180.63	181.86	182.80
.460	218.89	199.81	187.46	184.08	181.26	179.55	177.00	176.97	177.78	179.71	180.80	181.89	183.40	184.63
.480	215.51	196.98	186.17	184.45	181.67	180.80	177.97	178.78	179.03	180.69	181.92	182.87	185.36	187.01
.500	212.37	194.42	185.73	184.18	182.91	182.62	179.78	180.32	180.57	181.95	183.46	184.69	187.46	189.39
.520	208.80	192.29	185.90	184.44	184.16	184.43	180.78	181.99	182.39	183.76	185.14	187.04	189.53	192.03
.540	207.81	191.84	185.40	185.40	185.40	185.39	182.85	183.67	184.48	186.14	187.51	189.17	191.38	193.59
.560	205.95	191.11	185.79	186.36	186.08	186.50	185.08	185.48	186.58	188.24	189.89	190.99	193.20	195.41
.580	205.21	191.22	186.19	186.76	187.05	187.89	187.03	187.58	188.96	190.61	191.99	193.08	195.58	197.79
.600	203.90	190.76	187.15	187.72	188.57	188.57	189.40	189.67	191.33	192.99	194.37	196.87	197.96	200.17
.620	204.00	191.15	188.24	188.67	189.81	190.37	191.63	192.04	193.71	195.23	196.46	197.84	200.06	202.55
.640	203.40	191.81	189.61	190.34	191.33	192.59	193.86	194.41	196.08	197.46	198.84	200.21	202.72	205.21
.660	204.14	193.32	191.40	192.13	192.98	194.26	196.36	197.20	198.45	199.84	201.21	203.10	205.57	208.12
.680	204.29	193.98	192.63	193.79	194.64	196.06	198.31	199.15	200.82	202.21	203.87	205.53	208.03	210.53
.700	204.94	194.64	194.70	195.58	196.44	197.86	200.39	201.23	203.19	204.58	206.53	208.19	210.69	213.19
.720	205.59	196.14	196.77	197.38	198.52	199.94	202.19	203.31	205.42	206.95	208.90	210.84	213.34	215.84
.740	205.96	197.92	198.84	199.17	200.60	202.30	204.55	205.68	207.64	209.32	211.55	213.50	216.00	218.50
.760	207.04	199.70	200.34	201.24	202.68	204.66	206.91	208.04	210.01	211.97	214.20	216.15	218.66	221.16
.780	208.11	201.76	202.40	203.45	205.03	207.02	208.99	210.69	212.65	214.34	216.85	218.81	221.31	223.82
.800	209.51	203.81	204.63	205.80	207.53	209.38	211.41	213.33	215.30	217.49	219.59			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						224.54	214.16	207.31	202.90	199.41	196.69	195.44	194.63	194.88
.280						219.09	204.42	198.33	197.15	192.89	192.93	191.74	191.47	191.20
.300						204.91	198.51	193.96	193.38	190.66	190.69	190.42	190.76	188.35
.320						200.52	196.58	190.19	190.23	188.12	190.61	188.50	188.84	187.19
.340						192.46	189.35	186.43	187.38	186.81	187.15	187.49	188.14	186.33
.360						188.39	186.90	185.11	185.76	185.49	187.06	187.40	188.05	185.94
.380						185.84	184.05	183.17	184.13	185.40	186.36	186.40	187.04	186.16
.400	258.52	223.19	209.84	194.22	187.38	184.21	183.00	182.77	183.43	184.08	185.04	186.30	186.95	188.12
.420	248.11	218.95	201.10	194.12	188.96	185.34	183.55	182.68	183.64	184.60	186.17	186.83	188.39	188.59
.440	238.50	213.93	197.93	193.71	189.48	185.85	183.76	183.50	184.16	185.73	186.69	187.65	188.76	189.57
.460	231.65	210.60	196.90	192.99	189.68	187.59	184.58	184.32	184.98	186.86	187.82	188.78	190.20	191.31
.480	228.16	207.27	195.26	193.19	189.88	188.71	185.40	186.06	186.10	187.68	188.80	189.61	192.10	193.67
.500	224.06	204.25	194.53	192.62	191.00	190.45	187.14	187.49	187.54	188.81	190.24	191.35	194.15	196.03
.520	219.93	201.69	194.48	192.66	192.12	192.19	187.98	189.08	189.28	190.55	191.82	193.67	196.17	198.66
.540	218.61	200.96	193.69	193.47	193.24	193.00	190.00	190.66	191.32	192.91	194.17	195.75	197.94	200.13
.560	216.34	199.92	193.88	194.28	193.74	193.97	192.19	192.40	193.37	194.95	196.53	197.49	199.68	201.87
.580	215.29	199.80	194.08	194.47	194.55	195.24	194.08	194.44	195.72	197.30	198.58	199.54	202.04	204.23
.600	213.63	199.06	194.88	195.27	195.97	195.74	196.42	196.48	198.07	199.65	200.93	203.43	204.39	206.58
.620	213.49	199.24	195.83	196.08	197.08	197.47	198.61	198.83	200.42	201.85	202.97	204.24	206.44	208.93
.640	212.60	199.73	197.09	197.65	198.50	199.65	200.80	201.17	202.77	204.05	205.32	206.60	209.10	211.59
.660	213.17	201.13	198.81	199.37	200.07	201.22	203.29	203.98	205.11	206.40	207.67	209.50	211.97	214.53
.680	213.09	201.61	199.91	200.94	201.64	202.95	205.17	205.86	207.46	208.74	210.33	211.91	214.41	216.91
.700	213.57	202.09	201.92	202.65	203.36	204.67	207.20	207.89	209.80	211.09	212.98	214.57	217.07	219.57
.720	214.04	203.49	203.94	204.37	205.39	206.70	208.93	209.92	211.99	213.43	215.33	217.22	219.73	222.22
.740	214.21	205.19	205.96	206.08	207.42	209.04	211.27	212.27	214.18	215.78	217.98	219.88	222.38	224.88
.760	215.14	206.90	207.36	208.10	209.44	211.37	213.60	214.60	216.52	218.43	220.64	222.53	225.04	227.54
.780	216.07	208.90	209.37	210.27	211.77	213.71	215.63	217.25	219.16	220.77	223.29	225.19	227.69	230.20
.800	217.37	210.91	211.57	212.60	214.25	216.04	218.03	219.89	221.81	223.97	226.03			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .10

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						237.87	226.42	218.79	213.81	209.82	206.67	205.11	204.02	204.09
.280						231.75	215.65	208.85	207.35	202.54	202.37	200.87	200.38	199.88
.300						216.16	209.03	203.89	203.05	199.90	199.73	199.23	199.39	196.57
.320						211.19	206.72	199.58	199.42	196.93	199.41	196.92	197.08	195.09
.340						202.24	198.66	195.28	196.11	195.28	195.44	195.61	196.10	193.94
.360						197.60	195.78	193.63	194.13	193.63	195.13	195.29	195.78	193.29
.380						194.62	192.47	191.31	192.15	193.31	194.14	193.98	194.47	193.31
.400	274.18	235.70	221.03	203.89	196.27	192.64	191.12	190.66	191.16	191.66	192.49	193.65	194.15	195.21
.420	262.69	230.88	211.34	203.56	197.77	193.63	191.49	190.33	191.17	192.00	193.50	194.00	195.49	195.49
.440	252.06	225.23	207.68	202.90	198.10	193.97	191.49	191.00	191.51	193.00	193.84	194.67	195.67	196.33
.460	244.41	221.40	206.34	201.90	198.10	195.63	192.16	191.67	192.17	194.01	194.84	195.67	197.01	198.00
.480	240.41	217.57	204.34	201.85	198.10	196.63	192.82	193.33	193.17	194.68	195.68	196.35	198.84	200.34
.500	235.75	214.08	203.34	201.06	199.09	198.29	194.49	194.66	194.51	195.68	197.01	198.01	200.84	202.66
.520	231.05	211.08	203.06	200.88	200.09	199.94	195.18	196.16	196.17	197.34	198.51	200.31	202.80	205.30
.540	229.40	210.07	201.99	201.53	201.07	200.60	197.14	197.65	198.16	199.67	200.84	202.34	204.50	206.66
.560	226.72	208.72	201.97	202.15	201.40	201.43	199.30	199.32	200.16	201.66	203.17	204.00	206.17	208.33
.580	225.37	208.37	201.96	202.18	202.05	202.59	201.12	201.31	202.48	203.99	205.16	206.00	208.49	210.66
.600	223.35	207.35	202.61	202.82	203.37	202.91	203.44	203.30	204.81	206.31	207.48	209.99	210.82	212.99
.620	222.39	207.33	203.42	203.48	204.35	204.56	205.59	205.62	207.13	208.47	209.48	210.65	212.82	215.31
.640	221.80	207.64	204.57	204.96	205.57	206.71	207.74	207.94	209.45	210.63	211.80	212.98	215.48	217.97
.660	222.20	208.94	206.21	206.60	207.15	208.19	210.22	210.75	211.77	212.95	214.13	215.90	218.37	220.93
.680	221.90	209.24	207.18	208.08	208.63	209.84	212.04	212.57	214.09	215.28	216.79	218.29	220.79	223.29
.700	222.19	209.54	204.15	209.72	210.28	211.49	214.02	214.55	216.41	217.60	219.44	220.95	223.45	225.95
.720	222.49	210.84	211.11	211.36	212.26	213.46	215.67	216.54	218.56	219.92	221.76	223.60	226.11	228.60
.740	222.45	212.47	213.08	213.00	214.23	215.77	217.98	218.85	220.71	222.23	224.42	226.26	228.76	231.26
.760	223.24	214.09	214.38	214.97	216.20	218.09	220.29	221.16	223.03	224.88	227.07	228.92	231.42	233.92
.780	224.03	216.05	216.34	217.10	218.51	220.40	222.27	223.81	225.67	227.20	229.72	231.57	234.07	236.58
.800	225.22	218.01	218.50	219.40	220.98	222.70	224.64	226.45	228.32	230.44	232.47			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						200.02	191.78	186.48	183.20	180.69	178.81	178.16	177.86	178.45
.280						196.07	184.28	179.62	179.03	175.89	176.31	175.71	175.87	176.03
.300						184.85	179.95	176.58	176.52	174.65	175.08	175.25	175.93	174.30
.320						181.79	178.94	174.04	174.50	173.16	175.63	174.27	174.95	173.97
.340						175.65	173.51	171.50	172.73	172.67	173.37	174.06	175.00	173.89
.360						172.81	172.04	170.99	171.97	172.18	173.91	174.61	175.55	174.19
.380						171.25	170.23	169.97	171.21	172.70	173.93	174.38	175.33	175.00
.400	229.52	200.71	190.18	177.73	172.57	170.44	169.92	170.21	171.21	172.20	173.43	174.91	175.87	177.26
.420	221.31	197.66	183.40	178.16	174.42	171.92	170.93	170.69	171.96	173.22	174.96	175.94	177.67	178.25
.440	213.77	193.97	181.25	178.33	175.37	172.89	171.65	171.93	172.96	174.74	175.99	177.22	178.58	179.67
.460	208.52	191.67	180.89	178.23	176.05	174.86	172.87	173.17	174.21	176.25	177.51	178.76	180.37	181.73
.480	206.07	189.36	180.01	178.89	176.73	176.32	174.10	175.16	175.70	177.50	178.90	180.03	182.55	184.29
.500	203.10	187.30	179.88	178.91	178.17	178.28	176.07	176.89	177.44	179.00	180.66	182.06	184.84	186.85
.520	200.11	185.63	180.31	179.44	179.60	180.24	177.30	178.75	179.43	181.00	182.55	184.57	187.11	189.63
.540	199.45	185.47	180.12	180.60	181.02	181.42	179.49	180.60	181.68	183.51	185.06	186.86	189.16	191.44
.560	198.01	185.06	180.74	181.74	181.93	182.72	181.83	182.57	183.92	185.75	187.57	189.87	191.17	193.46
.580	197.58	185.43	181.36	182.38	183.10	184.28	183.90	184.79	186.40	188.25	189.82	191.13	193.70	196.00
.600	196.64	185.25	182.49	183.52	184.76	185.19	186.36	187.00	188.88	190.74	192.32	194.91	196.21	198.52
.620	196.97	185.85	183.74	184.65	186.16	187.12	188.68	189.45	191.36	193.10	194.57	196.14	198.47	201.04
.640	196.66	186.70	185.24	186.42	187.82	189.43	191.00	191.91	193.82	195.45	197.06	198.64	201.23	203.81
.660	197.57	188.31	187.12	188.31	189.59	191.22	193.57	194.75	196.28	197.92	199.54	201.60	204.17	206.80
.680	197.94	189.16	188.49	190.07	191.36	193.13	195.63	196.81	198.74	200.39	202.27	204.14	206.74	209.33
.700	198.77	190.00	190.62	191.96	193.26	195.04	197.80	199.00	201.19	202.85	205.00	206.87	209.49	212.09
.720	199.60	191.60	192.75	193.84	195.41	197.20	199.72	201.19	203.51	205.31	207.47	209.61	212.24	214.85
.740	200.17	193.46	194.87	195.72	197.56	199.61	202.14	203.62	205.83	207.76	210.19	212.34	214.97	217.60
.760	201.38	195.32	196.48	197.85	199.70	202.02	204.56	206.05	208.27	210.47	212.90	215.06	217.71	220.34
.780	202.58	197.43	198.60	200.11	202.09	204.42	206.72	208.73	210.97	212.92	215.61	217.78	220.44	223.07
.800	204.09	199.53	200.87	202.49	204.61	206.82	209.18	211.41	213.66	216.08	218.40			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						213.35	204.05	197.96	194.11	191.10	188.79	187.82	187.25	187.65
.280						208.73	195.51	190.13	189.24	185.53	185.75	184.85	184.78	184.71
.300						196.11	190.47	186.51	186.19	183.89	184.11	184.05	184.55	182.52
.320						192.45	189.07	183.44	183.69	181.96	184.44	182.70	183.20	181.87
.340						185.42	182.81	180.36	181.46	181.15	181.67	182.18	182.96	181.50
.360						182.03	180.92	179.52	180.34	180.32	181.97	182.49	183.29	181.54
.380						180.03	178.66	178.11	179.23	180.61	181.71	181.96	182.76	182.15
.400	245.18	213.22	201.37	187.40	181.46	178.86	178.04	178.09	178.94	179.78	180.88	182.26	183.07	184.34
.420	235.89	209.59	193.63	187.61	183.22	180.21	178.87	178.35	179.49	180.62	182.29	183.11	184.77	185.16
.440	227.32	205.26	191.00	187.51	183.99	181.00	179.38	179.44	180.31	182.01	183.13	184.24	185.48	186.44
.460	221.28	202.46	190.33	187.14	184.48	182.90	180.45	180.52	181.40	183.40	184.53	185.65	187.17	188.42
.480	218.32	199.66	189.09	187.60	184.95	184.23	181.52	182.43	182.77	184.49	185.78	186.77	189.29	190.95
.500	214.79	197.13	188.68	187.35	186.26	186.12	183.42	184.07	184.41	185.86	187.44	188.72	191.53	193.49
.520	211.23	195.02	188.89	187.66	187.56	188.00	184.50	185.84	186.33	187.79	189.23	191.20	193.74	196.27
.540	210.25	194.59	188.42	188.66	188.86	189.02	186.64	187.59	188.52	190.27	191.73	193.45	195.72	197.97
.560	208.40	193.87	188.84	189.66	189.59	190.19	188.94	189.48	190.71	192.46	194.21	195.38	197.66	199.92
.580	207.66	193.99	189.25	190.09	190.60	191.63	190.95	191.65	193.17	194.94	196.41	197.59	200.15	202.43
.600	206.36	193.54	190.22	191.07	192.16	192.37	193.38	193.81	195.62	197.41	198.88	201.47	202.64	204.93
.620	206.46	193.94	191.33	192.05	193.44	194.22	195.66	196.24	198.07	199.72	201.08	202.55	204.85	207.42
.640	205.86	194.61	192.72	193.73	194.99	196.49	197.95	198.68	200.51	202.03	203.54	205.02	207.61	210.19
.660	206.60	196.12	194.52	195.55	196.68	198.19	200.50	201.52	202.94	204.48	206.00	208.00	210.56	213.21
.680	206.75	196.79	195.76	197.22	198.36	200.02	202.49	203.52	205.37	206.92	208.73	210.52	213.12	215.72
.700	207.40	197.45	197.84	199.03	200.18	201.86	204.62	205.66	207.80	209.36	211.46	213.25	215.88	218.47
.720	208.05	198.95	199.92	200.83	202.28	203.96	206.46	207.80	210.09	211.79	213.90	215.99	218.62	221.23
.740	208.42	200.74	201.99	202.64	204.37	206.35	208.86	210.21	212.37	214.22	216.62	218.72	221.35	223.98
.760	209.48	202.52	203.50	204.72	206.46	208.73	211.25	212.61	214.78	216.93	219.33	221.44	224.09	226.72
.780	210.55	204.57	205.57	206.94	208.83	211.11	213.36	215.29	217.48	219.35	222.04	224.16	226.87	229.45
.800	211.95	206.63	207.80	209.29	211.33	213.49	215.80	217.97	220.16	222.55	224.83			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						226.69	216.31	209.45	205.02	201.51	198.77	197.49	196.64	196.86
.280						221.39	206.74	200.65	199.45	195.18	195.20	193.99	193.69	193.39
.300						207.36	200.98	196.44	195.86	193.13	193.15	192.86	193.18	190.74
.320						203.12	199.21	192.83	192.88	190.77	193.25	191.12	191.44	189.77
.340						195.20	192.12	189.21	190.19	189.62	189.96	190.29	190.93	189.11
.360						191.24	189.80	188.04	188.71	188.46	190.04	190.38	191.02	188.89
.380						188.81	187.08	186.25	187.24	188.52	189.49	189.54	190.19	189.29
.400	260.84	225.72	212.55	197.00	190.36	187.28	186.15	185.98	186.68	187.36	188.33	189.61	190.26	191.43
.420	250.46	221.53	203.87	197.05	192.03	188.51	186.81	186.00	187.02	188.02	189.61	190.28	191.86	192.06
.440	240.87	216.55	200.75	196.70	192.62	189.12	187.12	186.94	187.66	189.28	190.28	191.26	192.39	193.20
.460	234.04	213.26	199.78	196.05	192.90	190.94	188.04	187.87	188.60	190.54	191.55	192.54	193.98	195.10
.480	230.57	209.96	198.18	196.30	193.17	192.14	188.95	189.71	189.84	191.49	192.66	193.51	196.03	197.61
.500	226.48	206.96	197.49	195.79	194.35	193.96	190.77	191.24	191.38	192.73	194.22	195.38	198.22	200.12
.520	222.36	204.41	197.47	195.88	195.52	195.75	191.70	192.92	193.22	194.58	195.92	197.83	200.37	202.90
.540	221.05	203.70	196.71	196.73	196.69	196.63	193.79	194.59	195.36	197.03	198.39	200.03	202.28	204.50
.560	218.78	202.67	196.93	197.57	197.25	197.66	196.05	196.40	197.50	199.18	200.85	201.89	204.14	206.38
.580	217.74	202.56	197.14	197.79	198.10	198.98	197.99	198.52	199.93	201.63	202.99	204.04	206.61	208.86
.600	216.09	201.84	197.96	198.63	199.56	199.54	200.40	200.63	202.36	204.07	205.44	208.03	209.08	211.33
.620	215.96	202.03	198.92	199.45	200.71	201.31	202.64	203.03	204.78	206.34	207.58	208.95	211.23	213.80
.640	215.06	202.52	200.20	201.04	202.16	203.54	204.89	205.44	207.20	208.62	210.02	211.40	213.99	216.57
.660	215.63	203.93	201.92	202.78	203.76	205.15	207.43	208.30	209.60	211.04	212.45	214.40	216.96	219.61
.680	215.55	204.42	203.04	204.37	205.35	206.91	209.36	210.24	212.01	213.46	215.19	216.90	219.50	222.10
.700	216.03	204.90	205.06	206.10	207.09	208.67	211.43	212.32	214.41	215.87	217.92	219.64	222.26	224.85
.720	216.50	206.31	207.09	207.83	209.14	210.73	213.20	214.41	216.66	218.27	220.33	222.37	225.00	227.61
.740	216.66	208.01	209.11	209.55	211.18	213.09	215.57	216.79	218.90	220.68	223.05	225.10	227.74	230.36
.760	217.59	209.71	210.52	211.58	213.22	215.44	217.94	219.17	221.29	223.38	225.76	227.82	230.47	233.10
.780	218.51	211.72	212.53	213.76	215.57	217.80	219.99	221.85	223.98	225.78	228.48	230.54	233.20	235.84
.800	219.80	213.72	214.73	216.10	218.06	220.15	222.41	224.53	226.67	229.03	231.27			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .20

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						240.02	228.57	220.93	215.93	211.93	208.75	207.16	206.03	206.07
.280						234.05	217.97	211.17	209.66	204.83	204.64	203.12	202.60	202.07
.300						218.62	211.50	206.37	205.53	202.37	202.18	201.67	201.81	198.96
.320						213.79	209.34	202.22	202.06	199.57	202.05	199.54	199.69	197.67
.340						204.97	201.43	198.07	198.91	198.09	198.26	198.41	198.89	196.71
.360						200.45	198.69	196.57	197.09	196.60	198.10	198.27	198.75	196.24
.380						197.59	195.50	194.39	195.26	196.44	197.28	197.12	197.61	196.44
.400	276.50	238.23	223.74	206.75	199.25	195.71	194.26	193.87	194.41	194.94	195.78	196.96	197.46	198.52
.420	265.04	233.46	214.10	206.49	200.84	196.80	194.74	193.66	194.55	195.42	196.94	197.45	198.96	198.96
.440	254.43	227.85	210.50	205.89	201.25	197.24	194.85	194.44	195.01	196.56	197.43	198.28	199.29	199.97
.460	246.80	224.06	209.22	204.95	201.32	198.98	195.62	195.22	195.80	197.69	198.57	199.43	200.78	201.79
.480	242.82	220.26	207.26	205.00	201.38	200.06	196.38	196.98	196.91	198.48	199.54	200.24	202.76	204.27
.500	238.17	216.78	206.30	204.22	202.44	201.79	198.12	198.41	198.35	199.59	200.99	202.04	204.91	206.76
.520	233.48	213.80	206.05	204.10	203.49	203.51	198.90	200.00	200.11	201.37	202.61	204.47	207.01	209.53
.540	231.84	212.81	205.01	204.79	204.53	204.24	200.93	201.58	202.20	203.80	205.05	206.62	208.84	211.04
.560	229.17	211.48	205.02	205.48	204.91	205.12	203.15	203.32	204.29	205.89	207.48	208.40	210.62	212.84
.580	227.83	211.14	205.02	205.50	205.61	206.33	205.04	205.38	206.69	208.31	209.58	210.50	213.07	215.29
.600	225.81	210.13	205.69	206.18	206.96	206.71	207.42	207.44	209.09	210.73	212.00	214.59	215.51	217.74
.620	225.45	210.12	206.52	206.86	207.98	208.41	209.63	209.82	211.49	212.97	214.09	215.36	217.61	220.18
.640	224.26	210.44	207.67	208.36	209.33	210.60	211.83	212.20	213.88	215.20	216.51	217.78	220.37	222.95
.660	224.66	211.74	209.32	210.02	210.84	212.12	214.36	215.08	216.26	217.60	218.91	220.80	223.36	226.02
.680	224.36	212.05	210.31	211.51	212.34	213.80	216.23	216.95	218.65	219.99	221.64	223.28	225.88	228.48
.700	224.65	212.36	212.29	213.17	214.01	215.48	218.25	218.99	221.02	222.38	224.38	226.02	228.64	231.23
.720	224.95	213.66	214.26	214.82	216.01	217.49	219.93	221.02	223.23	224.76	226.77	228.75	231.38	233.99
.740	224.90	215.28	216.23	216.47	218.00	219.82	222.28	223.38	225.43	227.14	229.48	231.48	234.12	236.74
.760	225.69	216.91	217.54	218.45	219.99	222.15	224.62	225.73	227.80	229.84	232.19	234.20	236.85	239.48
.780	226.47	218.86	219.50	220.59	222.30	224.48	226.63	228.41	230.49	232.21	234.91	236.92	239.58	242.22
.800	227.65	220.82	221.66	222.90	224.78	226.81	229.03	231.09	233.18	235.51	237.71			

TABLE GENERATED USING INDEX 400.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						203.16	195.11	189.94	186.80	184.39	182.60	182.00	181.75	182.38
.280						199.28	187.68	183.20	182.76	179.75	180.28	179.77	180.00	180.21
.300						188.11	183.42	180.24	180.36	178.63	179.20	179.48	180.26	178.70
.320						185.06	182.46	177.77	178.42	177.25	179.87	178.65	179.44	178.56
.340						178.93	177.05	175.28	176.72	176.85	177.72	178.55	179.63	178.64
.360						176.09	175.60	174.80	176.01	176.43	178.34	179.21	180.30	179.08
.380						174.52	173.79	173.79	175.29	177.00	178.43	179.06	180.19	180.00
.400	231.05	202.60	192.43	180.33	175.50	173.68	173.47	174.04	175.30	176.54	177.98	179.67	180.81	182.38
.420	222.80	199.50	195.60	180.71	177.31	175.14	174.47	174.51	176.07	177.57	179.57	180.75	182.69	183.45
.440	215.19	195.75	193.40	180.83	178.22	176.07	175.16	175.75	177.06	179.11	180.61	182.09	183.65	184.95
.460	209.88	193.41	192.99	180.69	178.86	178.01	176.36	176.96	178.30	180.63	182.15	183.65	185.50	187.06
.480	207.36	191.06	192.05	181.30	179.50	179.44	177.54	178.93	179.79	181.87	183.56	184.94	187.72	189.68
.500	204.34	188.94	191.88	181.28	180.89	181.35	179.48	180.65	181.50	183.36	185.31	186.98	190.02	192.28
.520	201.29	187.20	192.27	181.75	182.26	183.26	180.68	182.46	183.47	185.34	187.19	189.49	192.30	195.07
.540	200.58	186.98	192.03	182.85	183.65	184.40	182.82	184.27	185.69	187.83	189.70	191.78	194.36	196.90
.560	199.09	186.51	192.60	183.95	184.51	185.65	185.11	186.20	187.88	190.05	192.18	193.78	196.37	198.94
.580	198.61	186.80	193.15	184.55	185.61	187.16	187.15	188.37	190.33	192.52	194.41	196.03	198.88	201.47
.600	197.62	186.58	194.21	185.64	187.22	188.03	189.55	190.54	192.78	194.97	196.89	199.78	201.39	203.98
.620	197.91	187.13	185.40	186.72	188.58	189.91	191.82	192.96	195.20	197.29	199.09	200.99	203.62	206.50
.640	197.56	187.93	186.84	188.42	190.20	192.15	194.10	195.37	197.62	199.60	201.54	203.47	206.36	209.26
.660	198.43	189.50	188.66	190.24	191.93	193.90	196.62	198.14	200.04	202.03	203.99	206.38	209.28	212.22
.680	198.77	190.29	189.98	191.94	193.64	195.77	198.62	200.16	202.46	204.45	206.69	208.88	211.83	214.73
.700	199.56	191.09	192.05	193.77	195.47	197.64	200.74	202.31	204.85	206.87	209.37	211.58	214.53	217.47
.720	200.36	192.66	194.13	195.59	197.55	199.75	202.61	204.45	207.12	209.29	211.79	214.28	217.24	220.20
.740	200.90	194.47	196.21	197.42	199.64	202.10	204.99	206.82	209.40	211.69	214.47	216.96	219.94	222.89
.760	202.08	196.29	197.77	199.49	201.72	204.44	207.37	209.20	211.80	214.34	217.14	219.64	222.64	225.60
.780	203.25	198.36	199.85	201.70	204.05	206.78	209.48	211.83	214.43	216.74	219.80	222.31	225.32	228.30
.800	204.74	200.44	202.07	204.03	206.51	209.12	211.89	214.47	217.06	219.86	222.52			

TABLE GENERATED USING INDEX 440.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						216.50	207.37	201.43	197.71	194.81	192.58	191.67	191.15	191.59
.280						211.94	198.91	193.72	192.96	189.39	189.72	188.91	188.90	188.89
.300						199.36	193.94	190.17	190.03	187.87	188.24	188.28	188.88	186.92
.320						195.73	192.59	187.16	187.60	186.06	188.67	187.08	187.69	186.46
.340						188.71	186.35	184.14	185.45	185.32	186.02	186.67	187.60	186.25
.360						185.30	184.48	183.33	184.38	184.57	186.40	187.10	188.03	186.43
.380						183.30	182.21	181.93	183.31	184.91	186.22	186.64	187.62	187.15
.400	246.71	215.11	203.62	190.00	184.39	182.11	181.58	181.93	183.03	184.12	185.43	187.02	188.01	189.46
.420	237.37	211.43	195.83	190.15	186.12	183.44	182.40	182.17	183.60	184.97	186.89	187.93	189.79	190.35
.440	228.75	207.04	193.15	190.02	186.85	184.19	182.89	183.25	184.41	186.38	187.76	189.11	190.56	191.71
.460	222.64	204.21	192.44	189.60	187.28	186.05	183.94	184.31	185.50	187.78	189.17	190.54	192.30	193.75
.480	219.61	201.36	191.13	190.01	187.71	187.35	184.97	186.21	186.86	188.86	190.44	191.68	194.45	196.34
.500	216.03	198.77	190.63	189.71	188.98	189.18	186.83	187.82	188.47	190.23	192.08	193.64	196.71	198.91
.520	212.41	196.59	190.85	189.97	190.23	191.02	187.88	189.54	190.36	192.13	193.88	196.12	198.93	201.71
.540	211.38	196.09	190.33	190.92	191.48	192.01	189.96	191.26	192.53	194.59	196.36	198.36	200.92	203.43
.560	209.47	195.31	190.69	191.86	192.17	193.12	192.22	193.12	194.67	196.76	198.81	200.29	202.85	205.40
.580	208.69	195.38	191.04	192.26	193.11	194.51	194.19	195.24	197.10	199.21	200.99	202.48	205.34	207.90
.600	207.35	194.88	191.94	193.19	194.63	195.20	196.57	197.35	199.51	201.63	203.45	206.34	207.83	210.39
.620	207.40	195.22	192.99	194.12	195.86	197.00	198.80	199.75	201.91	203.91	205.60	207.40	210.00	212.88
.640	206.76	195.84	194.32	195.73	197.37	199.21	201.04	202.13	204.31	206.19	208.02	209.85	212.74	215.64
.660	207.46	197.31	196.06	197.48	199.01	200.86	203.55	204.92	206.70	208.59	210.45	212.78	215.68	218.62
.680	207.57	197.93	197.25	199.09	200.64	202.66	205.48	206.88	209.09	210.98	213.15	215.26	218.21	221.11
.700	208.19	198.55	199.23	200.84	202.39	204.45	207.55	208.97	211.46	213.38	215.83	217.96	220.91	223.85
.720	208.81	200.01	201.33	202.58	204.42	206.51	209.35	211.06	213.70	215.77	218.22	220.66	223.62	226.58
.740	209.14	201.75	203.33	204.33	206.45	208.84	211.71	213.40	215.93	218.15	220.90	223.34	226.32	229.27
.760	210.18	203.49	204.79	206.36	208.48	211.15	214.06	215.76	218.30	220.80	223.57	226.02	229.02	231.98
.780	211.22	205.51	206.81	208.53	210.79	213.47	216.11	218.39	220.94	223.17	226.23	228.70	231.70	234.68
.800	212.59	207.53	209.00	210.83	213.24	215.78	218.50	221.03	223.57	226.33	228.96			

TABLE GENERATED USING INDEX 480.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						229.84	219.64	212.91	208.62	205.22	202.56	201.34	200.54	200.79
.280						224.60	210.14	204.23	203.17	199.04	199.16	198.04	197.81	197.57
.300						210.62	204.45	200.10	199.70	197.11	197.27	197.09	197.51	195.14
.320						206.40	202.72	196.56	196.79	194.86	197.48	195.50	195.93	194.36
.340						198.48	195.66	192.99	194.17	193.79	194.31	194.79	195.56	193.85
.360						194.52	193.36	191.85	192.75	192.71	194.47	194.99	195.77	193.78
.380						192.08	190.63	190.07	191.32	192.82	194.00	194.22	195.05	194.30
.400	262.37	227.61	214.80	199.68	193.29	190.53	189.70	189.81	190.77	191.70	192.89	194.37	195.20	196.55
.420	251.95	223.36	206.06	199.60	194.92	191.73	190.34	189.83	191.13	192.38	194.22	195.10	196.88	197.26
.440	242.30	218.34	202.90	199.21	195.48	192.31	190.63	190.76	191.76	193.66	194.90	196.12	197.46	198.48
.460	235.40	215.01	201.88	198.51	195.70	194.09	191.52	191.66	192.70	194.92	196.19	197.44	199.10	200.43
.480	231.86	211.65	200.22	198.71	195.93	195.26	192.40	193.48	193.93	195.86	197.31	198.42	201.19	203.00
.500	227.72	208.59	199.49	198.15	197.07	197.02	194.18	194.99	195.44	197.09	198.86	200.31	203.39	205.55
.520	223.54	205.98	199.43	198.19	198.19	198.78	195.08	196.62	197.26	198.92	200.56	202.76	205.57	208.34
.540	222.17	205.20	198.62	198.98	199.32	199.61	197.11	198.26	199.37	201.35	203.02	204.95	207.48	209.97
.560	219.86	204.12	198.78	199.78	199.82	200.58	199.33	200.04	201.46	203.48	205.45	206.80	209.33	211.85
.580	218.77	203.95	198.92	199.97	200.62	201.86	201.24	202.10	203.86	205.89	207.58	208.94	211.80	214.33
.600	217.07	203.17	199.68	200.75	202.03	202.37	203.59	204.17	206.25	208.29	210.00	212.90	214.26	216.80
.620	216.90	203.31	200.58	201.52	203.13	204.10	205.78	206.54	208.62	210.53	212.11	213.80	216.39	219.26
.640	215.96	203.75	201.80	203.04	204.54	206.27	207.98	208.90	211.00	212.77	214.51	216.23	219.12	222.02
.660	216.49	205.12	203.47	204.72	206.09	207.83	210.48	211.70	213.36	215.15	216.90	219.18	222.08	225.03
.680	216.38	205.56	204.52	206.24	207.63	209.55	212.35	213.59	215.73	217.52	219.60	221.64	224.59	227.49
.700	216.82	206.00	206.50	207.91	209.30	211.27	214.37	215.63	218.07	219.89	222.28	224.34	227.29	230.23
.720	217.26	207.36	208.47	209.58	211.29	213.27	216.09	217.67	220.27	222.25	224.65	227.04	230.00	232.96
.740	217.39	209.02	210.45	211.25	213.26	215.58	218.42	219.99	222.47	224.60	227.33	229.72	232.70	235.65
.760	218.28	210.69	211.81	213.22	215.24	217.87	220.74	222.32	224.81	227.25	230.00	232.40	235.40	238.36
.780	219.18	212.65	213.78	215.35	217.53	220.15	222.75	224.95	227.45	229.61	232.67	235.08	238.09	241.06
.800	220.44	214.63	215.94	217.63	219.96	222.44	225.12	227.59	230.08	232.81	235.40			

TABLE GENERATED USING INDEX 520.

37.5 KVA TRANSFORMER

LOAD FACTOR = .30

	.070	.080	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
.260						243.17	231.90	224.40	219.53	215.63	212.54	211.01	209.93	210.00
.280						237.26	221.37	214.75	213.38	208.69	208.61	207.18	206.72	206.25
.300						221.87	214.97	210.03	209.37	206.35	206.31	205.89	206.14	203.35
.320						217.06	212.86	205.95	205.98	203.67	206.29	203.92	204.17	202.26
.340						208.26	204.97	201.85	202.90	202.27	202.61	202.90	203.52	201.46
.360						203.73	202.24	200.38	201.13	200.85	202.53	202.87	203.50	201.13
.380						200.86	199.05	198.22	199.33	200.73	201.79	201.80	202.48	201.44
.400	278.03	240.12	225.98	209.35	202.18	198.95	197.81	197.70	198.50	199.28	200.34	201.72	202.40	203.64
.420	266.52	235.29	216.30	209.04	203.73	200.03	198.28	197.48	198.66	199.78	201.54	202.27	203.98	204.16
.440	255.85	229.63	212.65	208.40	204.10	200.42	198.36	198.26	199.11	200.93	202.05	203.14	204.36	205.24
.460	248.16	225.80	211.32	207.41	204.13	202.13	199.10	199.01	199.89	202.07	203.21	204.33	205.90	207.12
.480	244.12	221.95	209.31	207.41	204.15	203.17	199.82	200.76	201.00	202.85	204.19	205.15	207.93	209.66
.500	239.41	218.42	208.29	206.58	205.16	204.85	201.53	202.16	202.40	203.96	205.64	206.97	210.08	212.19
.520	234.66	215.37	208.01	206.40	206.15	206.54	202.28	203.70	204.15	205.71	207.25	209.39	212.20	214.97
.540	232.97	214.32	206.92	207.05	207.15	207.22	204.26	205.25	206.21	208.12	209.68	211.53	214.04	216.50
.560	230.25	212.93	206.87	207.69	207.48	208.05	206.44	206.95	208.25	210.19	212.08	213.31	215.81	218.31
.580	228.85	212.53	206.81	207.68	208.12	209.21	208.28	208.97	210.62	212.58	214.16	215.40	218.26	220.76
.600	226.79	211.47	207.41	208.30	209.43	209.54	210.61	210.98	212.99	214.95	216.56	219.46	220.69	223.20
.620	226.39	211.40	208.18	208.92	210.41	211.19	212.76	213.32	215.34	217.16	218.62	220.21	222.77	225.64
.640	225.16	211.67	209.27	210.35	211.72	213.33	214.92	215.66	217.68	219.36	220.99	222.61	225.51	228.40
.660	225.52	212.93	210.87	211.95	213.17	214.80	217.41	218.47	220.03	221.71	223.36	225.58	228.47	231.43
.680	225.18	213.19	211.80	213.38	214.62	216.44	219.21	220.30	222.37	224.05	226.06	228.02	230.97	233.87
.700	225.44	213.45	213.72	214.98	216.22	218.08	221.18	222.29	224.68	226.40	228.74	230.73	233.68	236.61
.720	225.70	214.71	215.65	216.57	218.15	220.04	222.82	224.28	226.84	228.74	231.08	233.42	236.38	239.34
.740	225.63	216.30	217.57	218.17	220.08	222.32	225.13	226.57	229.00	231.06	233.76	236.11	239.09	242.03
.760	226.39	217.88	218.83	220.09	222.01	224.58	227.43	228.88	231.32	233.71	236.43	238.78	241.78	244.74
.780	227.14	219.80	220.75	222.18	224.27	226.84	229.39	231.51	233.96	236.04	239.10	241.46	244.47	247.45
.800	228.30	221.72	222.87	224.44	226.69	229.10	231.73	234.15	236.59	239.29	241.84			

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			236.70	220.28	210.97	206.15	203.05	200.75	198.99	197.94	197.59	197.91	198.32	199.79
.420			227.75	215.14	208.44	204.09	199.26	198.22	197.64	197.30	196.95	196.61	197.91	198.75
.440			224.01	212.14	204.49	200.14	198.46	197.10	196.76	196.89	197.38	198.09	198.93	200.24
.460			218.66	209.36	205.73	201.85	196.80	196.10	196.36	196.96	197.21	197.46	198.29	199.13
.480			215.65	207.54	204.84	200.26	196.50	195.93	196.42	197.50	197.87	198.23	199.07	200.14
.500	241.72	228.53	218.70	210.19	203.72	199.61	197.77	196.82	196.96	197.37	198.29	199.67	200.56	202.31
.520	234.54	225.75	211.28	206.47	203.67	200.39	196.28	196.89	197.73	197.86	199.29	200.26	201.92	203.11
.540	230.34	219.89	209.44	205.11	203.49	200.68	197.04	197.42	198.50	198.87	200.66	201.97	203.29	204.60
.560	227.32	217.34	209.02	205.40	203.90	200.98	198.17	197.48	199.04	200.59	202.14	203.45	204.77	206.31
.580	225.24	215.27	207.89	205.45	204.43	201.04	199.29	199.55	200.51	202.07	203.62	204.93	206.72	208.51
.600	224.81	214.13	207.46	205.50	204.72	201.57	200.53	201.14	201.99	202.48	204.39	206.41	208.44	210.46
.620	224.74	213.94	207.74	206.97	205.24	202.33	202.29	202.86	203.70	204.79	206.34	207.96	210.15	212.41
.640	221.83	213.28	207.79	206.78	206.24	203.56	203.48	204.10	205.42	206.03	207.82	209.73	212.22	214.72
.660	220.92	213.56	208.31	206.71	207.47	204.80	204.95	205.57	206.89	207.98	209.77	211.80	214.29	216.79
.680	221.66	213.84	208.59	208.06	208.23	206.03	206.66	207.28	208.61	209.69	211.72	213.98	216.48	218.98
.700	221.46	213.88	209.58	208.57	208.98	207.97	208.36	208.75	210.55	211.88	214.14	216.40	218.90	221.40
.720	221.73	214.86	211.28	210.04	209.97	209.43	221.87	210.93	212.50	214.06	216.33	218.59	221.09	223.59
.740	222.78	215.84	213.11	211.26	210.73	211.14	212.22	213.11	214.68	216.36	218.51	220.94	223.39	225.89
.760	223.56	216.23	213.48	212.25	212.19	212.84	213.47	215.29	216.86	218.66	220.93	223.20	225.69	228.19
.780	224.18	217.56	215.18	214.19	214.12	214.54	215.65	217.46	219.27	221.08	223.35	225.62	228.12	230.62
.800	224.44	219.01	216.63	216.35	216.06	216.71	217.59	219.64	221.45	223.49	225.77	228.04	230.54	233.04
.820	225.42	220.46	218.32	218.05	218.23	218.88	219.99	221.81	223.86	225.91	228.19	230.46	232.96	235.46
.840	226.74	221.67	220.36	219.98	220.16	221.05	222.40	224.22	226.27	228.32	230.60	233.11	235.61	238.12
.860	228.35	223.12	222.28	221.90	222.33	223.45	224.95	226.63	228.80	230.85	233.35	235.81	238.27	240.94

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			251.57	233.34	222.91	217.39	213.75	211.00	208.84	207.44	206.83	206.94	207.15	208.52
.420			241.51	227.46	219.88	214.88	209.36	207.97	207.10	206.49	205.88	205.26	206.46	207.13
.440			237.16	223.91	215.30	210.30	208.22	206.50	205.89	205.80	206.09	206.64	207.32	208.51
.460			231.05	220.63	216.40	211.92	206.15	205.15	205.19	205.61	205.65	205.68	206.36	207.04
.480			227.50	218.37	215.18	209.93	205.57	204.71	205.01	205.95	206.12	206.28	206.96	207.90
.500	256.28	241.59	230.59	221.03	213.71	208.97	206.71	205.43	205.34	205.56	206.32	207.60	208.33	210.02
.520	248.17	238.29	222.20	216.70	213.39	209.56	204.82	205.25	205.93	205.84	207.17	207.99	209.57	210.64
.540	243.31	231.63	219.94	214.96	212.94	209.63	205.41	205.59	206.52	206.70	208.41	209.61	210.82	212.01
.560	239.75	228.58	219.22	215.02	213.14	209.70	206.38	205.39	206.86	208.32	209.78	210.98	212.19	213.64
.580	237.22	226.06	217.73	214.83	213.46	209.51	207.36	207.40	208.22	209.69	211.15	212.35	214.07	215.79
.600	236.50	224.56	217.01	214.63	213.53	209.84	208.47	208.90	209.59	209.89	211.74	213.72	215.70	217.67
.620	236.17	224.10	217.07	215.98	213.85	210.42	210.14	210.52	211.21	212.16	213.63	215.16	217.32	219.56
.640	232.73	223.13	216.87	215.53	214.69	211.52	211.19	211.63	212.84	213.27	214.99	216.84	219.34	221.83
.660	231.48	223.18	217.19	215.20	215.79	212.62	212.55	212.99	214.20	215.15	216.87	218.86	221.35	223.85
.680	232.05	223.23	217.24	216.42	216.36	213.72	214.17	214.61	215.82	216.77	218.75	221.00	223.49	225.99
.700	231.58	223.03	218.08	216.73	216.94	215.59	215.78	215.97	217.70	218.91	221.15	223.39	225.90	228.39
.720	231.62	223.85	219.68	218.08	217.77	216.94	230.32	218.10	219.58	221.05	223.29	225.53	228.03	230.53
.740	232.52	224.68	221.44	219.17	218.35	218.55	219.50	220.24	221.72	223.32	225.43	227.86	230.30	232.80
.760	233.13	224.85	221.60	220.01	219.70	220.16	220.62	222.37	223.85	225.59	227.83	230.07	232.57	235.07
.780	233.56	226.06	223.20	221.87	221.57	221.77	222.75	224.50	226.24	227.98	230.23	232.47	234.97	237.47
.800	233.59	227.40	224.54	224.00	223.43	223.90	224.62	226.63	228.38	230.37	232.63	234.87	237.37	239.87
.820	234.41	228.73	226.14	225.60	225.56	226.02	227.01	228.76	230.77	232.76	235.02	237.27	239.77	242.27
.840	235.61	229.81	228.13	227.46	227.42	228.15	229.39	231.15	233.15	235.16	237.41	239.92	242.43	244.93
.860	237.17	231.14	229.98	229.32	229.55	230.53	231.93	233.53	235.67	237.68	240.17	242.63	245.08	247.76

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			266.43	246.40	234.84	228.63	224.46	221.25	218.68	216.95	216.07	215.97	215.98	217.26
.420			255.26	239.78	231.32	225.67	219.45	217.73	216.57	215.69	214.80	213.92	215.00	215.52
.440			250.30	235.69	226.11	220.46	217.98	215.89	215.02	214.70	214.80	215.18	215.70	216.78
.460			243.44	231.89	227.08	221.99	215.50	214.20	214.02	214.27	214.09	213.91	214.43	214.95
.480			239.34	229.21	225.53	219.59	214.64	213.49	213.59	214.40	214.36	214.33	214.85	215.65
.500	270.84	254.65	242.47	231.86	223.69	218.32	215.65	214.04	213.73	213.75	214.36	215.53	216.11	217.73
.520	261.79	250.83	233.12	226.93	223.11	218.73	213.36	213.61	214.14	213.82	215.05	215.72	217.23	218.17
.540	256.28	243.36	230.43	224.80	222.39	218.57	213.77	213.74	214.55	214.52	216.17	217.26	218.35	219.43
.560	252.18	239.82	229.43	224.64	222.38	218.42	214.60	213.31	214.68	216.05	217.43	218.51	219.60	220.97
.580	249.20	236.85	227.58	224.20	222.50	217.99	215.43	215.26	215.93	217.31	218.68	219.77	221.42	223.07
.600	248.19	234.99	226.57	223.76	222.34	218.11	216.40	216.65	217.19	217.30	219.09	221.03	222.96	224.89
.620	247.60	234.26	226.40	225.00	222.46	218.51	217.99	218.19	218.72	219.53	220.91	222.36	224.50	226.71
.640	243.63	232.97	225.95	224.27	223.14	219.48	218.90	219.16	220.25	220.50	222.16	223.95	226.45	228.95
.660	242.05	232.80	226.07	223.68	224.10	220.44	220.15	220.41	221.51	222.32	223.98	225.91	228.41	230.91
.680	242.43	232.63	225.90	224.78	224.50	221.41	221.67	221.94	223.04	223.85	225.79	228.01	230.51	233.00
.700	241.69	232.18	226.57	224.89	224.90	223.21	223.20	223.18	224.85	225.95	228.17	230.39	232.89	235.38
.720	241.51	232.85	228.09	226.13	225.57	224.45	238.78	225.27	226.66	228.04	230.26	232.48	234.98	237.48
.740	242.26	233.51	229.77	227.09	225.97	225.97	226.78	227.36	228.75	230.28	232.36	234.77	237.22	239.72
.760	242.69	233.47	229.71	227.76	227.21	227.49	227.77	229.45	230.84	232.51	234.73	236.95	239.45	241.95
.780	242.93	234.56	231.23	229.56	229.01	229.01	229.85	231.54	233.21	234.88	237.11	239.33	241.83	244.33
.800	242.74	235.78	232.46	231.64	230.80	231.09	231.66	233.62	235.30	237.25	239.48	241.70	244.21	246.70
.820	243.40	237.01	233.97	233.15	232.89	233.17	234.02	235.70	237.67	239.62	241.85	244.08	246.58	249.08
.840	244.48	237.95	235.89	234.95	234.69	235.25	236.38	238.07	240.03	241.99	244.22	246.73	249.24	251.74
.860	245.89	239.17	237.68	236.74	236.76	237.61	238.91	240.43	242.54	244.50	246.99	249.44	251.89	254.59

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			281.29	259.46	246.78	239.86	235.17	231.50	228.53	226.46	225.31	225.00	224.82	226.00
.420			269.02	252.10	242.76	236.46	229.54	227.49	226.03	224.88	223.73	222.57	223.54	223.90
.440			263.45	247.47	236.92	230.62	227.74	225.29	224.14	223.63	223.51	223.72	224.09	225.05
.460			255.32	243.15	237.76	232.07	224.85	223.25	222.86	222.92	222.53	222.14	222.50	222.87
.480			251.19	240.04	235.87	229.26	223.71	222.27	222.18	222.85	222.61	222.38	222.74	223.41
.500	285.39	267.71	254.36	242.70	233.67	227.67	224.59	222.65	222.11	221.93	222.40	223.46	223.89	225.43
.520	275.41	263.38	244.05	237.16	232.83	227.90	221.90	221.97	222.34	221.80	222.93	223.45	224.88	225.71
.540	269.25	255.10	240.93	234.65	231.85	227.52	222.13	221.90	222.57	222.34	223.92	224.90	225.89	226.85
.560	264.61	251.06	239.53	234.26	231.62	227.14	222.82	221.22	222.50	223.79	225.07	226.04	227.02	228.30
.580	261.19	247.64	237.42	233.57	231.54	226.46	223.50	223.12	223.64	224.93	226.21	227.19	228.77	230.36
.600	259.88	245.42	236.12	232.88	231.15	226.38	224.34	224.41	224.78	224.71	226.44	228.33	230.22	232.10
.620	259.03	244.42	235.73	234.01	231.07	226.61	225.84	225.85	226.23	226.91	228.19	229.56	231.67	233.85
.640	254.53	242.82	235.03	233.01	231.59	227.44	226.61	226.69	227.67	227.74	229.33	231.07	233.57	236.06
.660	252.61	242.42	234.95	232.17	232.42	228.27	227.74	227.83	228.81	229.49	231.08	232.97	235.47	237.96
.680	252.82	242.03	234.55	233.14	232.64	229.09	229.18	229.27	230.25	230.93	232.83	235.02	237.52	240.02
.700	251.81	241.33	235.07	233.05	232.86	230.83	230.62	230.40	232.00	232.98	235.18	237.38	239.88	242.37
.720	251.40	241.84	236.50	234.18	233.37	231.96	247.23	232.44	233.74	235.03	237.23	239.43	241.93	244.43
.740	252.70	242.35	238.11	235.00	233.59	233.39	234.06	234.49	235.79	237.23	239.28	241.69	244.13	246.63
.760	252.26	242.09	237.83	235.52	234.71	234.82	234.92	236.53	237.83	239.43	241.63	243.83	246.33	248.83
.780	252.30	243.06	239.25	237.25	236.45	236.25	236.96	238.57	240.18	241.78	243.99	246.18	248.69	251.18
.800	251.89	244.17	240.37	239.28	238.18	238.29	238.69	240.61	242.22	244.13	246.34	248.54	251.04	253.54
.820	252.39	245.28	241.79	240.71	240.21	240.32	241.03	242.65	244.57	246.48	248.69	250.89	253.39	255.89
.840	253.34	246.09	243.66	242.43	241.95	242.36	243.37	244.99	246.91	248.82	251.03	253.54	256.05	258.55
.860	254.66	247.19	245.38	244.16	243.98	244.69	245.89	247.33	249.41	251.32	253.81	256.26	258.70	261.42

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .10

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			303.59	279.05	264.68	256.72	251.23	246.87	243.30	240.72	239.17	238.55	238.07	239.11
.420			289.66	270.58	259.92	252.64	244.58	242.12	240.23	238.67	237.11	235.55	236.35	236.48
.440			283.17	265.14	253.14	245.86	242.39	239.38	237.83	236.95	236.58	236.53	236.66	237.46
.460			274.40	260.04	253.78	247.17	238.88	236.82	236.11	235.91	235.19	234.48	234.61	234.74
.480			268.96	256.29	251.38	243.76	237.32	235.43	235.06	235.53	234.99	234.45	234.57	235.04
.500	307.23	287.30	272.18	258.95	248.64	241.70	237.99	235.56	234.69	234.21	234.45	235.36	235.56	237.00
.520	295.84	282.19	260.44	252.50	247.42	241.66	234.71	234.52	234.65	233.77	234.75	235.05	236.36	237.00
.540	288.71	272.70	256.68	249.42	246.03	240.94	234.57	234.14	234.61	234.07	235.56	236.36	237.17	237.98
.560	283.26	267.92	254.94	248.69	245.48	240.23	235.14	233.09	234.24	235.38	236.53	237.34	238.15	239.29
.580	279.16	263.82	252.19	247.63	245.09	239.17	235.61	234.90	235.21	236.36	237.51	238.32	239.80	241.28
.600	277.41	261.07	250.45	246.57	244.37	238.79	236.24	236.04	236.18	235.82	237.47	239.29	241.11	242.93
.620	276.17	259.65	249.72	247.53	243.99	238.75	237.61	237.35	237.49	237.97	239.12	240.36	242.42	244.58
.640	270.89	257.59	248.66	246.13	244.27	239.37	238.18	237.98	238.80	238.60	240.09	241.74	244.24	246.73
.660	268.46	256.86	248.26	244.90	244.90	240.00	239.14	238.95	239.77	240.25	241.73	243.56	246.05	248.55
.680	268.40	256.12	247.53	245.69	244.84	240.63	240.44	240.26	241.08	241.56	243.38	245.54	248.04	250.54
.700	266.98	255.05	247.82	245.29	244.79	242.26	241.75	241.22	242.72	243.54	245.70	247.86	250.36	252.86
.720	266.24	255.32	249.11	246.25	245.07	243.22	259.91	243.20	244.36	245.52	247.68	249.84	252.35	254.84
.740	266.61	255.60	250.60	246.87	245.02	244.52	244.98	245.18	246.34	247.67	249.67	252.07	254.50	257.00
.760	266.60	255.03	250.00	247.15	245.98	245.81	245.64	247.15	248.32	249.82	251.98	254.15	256.65	259.15
.780	266.36	255.80	251.29	248.78	247.61	247.11	247.61	249.13	250.63	252.13	254.30	256.47	258.97	261.47
.800	265.61	256.74	252.24	250.75	249.24	249.08	249.25	251.10	252.61	254.45	256.62	258.79	261.29	263.79
.820	265.88	257.69	253.52	252.04	251.21	251.04	251.55	253.07	254.92	256.76	258.94	261.11	263.61	266.11
.840	266.65	258.29	255.31	253.66	252.84	253.01	253.86	255.38	257.23	259.07	261.25	263.76	266.26	268.77
.860	267.82	259.23	256.93	255.28	254.80	255.31	256.37	257.69	259.71	261.55	264.04	266.48	268.92	271.66

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			239.68	223.35	214.12	209.35	206.30	204.02	202.28	201.24	200.90	201.21	201.62	203.07
.420			230.32	218.31	211.69	207.42	202.65	201.64	201.08	200.75	200.42	200.08	201.39	202.21
.440			227.15	215.40	207.85	203.58	201.96	200.66	200.35	200.53	201.00	201.73	202.57	203.87
.460			221.38	212.72	209.19	205.40	200.42	199.79	200.08	200.72	200.98	201.25	202.09	202.93
.480			218.33	210.97	208.40	203.91	200.24	199.74	200.28	201.43	201.79	202.17	203.03	204.11
.500	244.68	231.69	222.35	213.70	207.36	203.36	201.51	200.74	200.94	201.41	202.35	203.76	204.66	206.43
.520	237.54	228.96	214.68	210.04	207.38	204.23	200.21	200.91	201.83	202.02	203.50	204.49	206.18	207.39
.540	233.36	223.15	212.89	208.74	207.28	204.61	201.08	201.55	202.71	203.15	204.99	206.35	207.69	209.02
.560	230.36	220.64	212.52	209.09	207.76	204.98	202.30	201.71	203.35	204.98	206.60	207.96	209.31	210.89
.580	228.30	218.59	211.44	209.20	208.35	205.11	203.50	203.87	204.93	206.57	208.19	209.57	211.40	213.22
.600	227.89	217.49	211.05	209.30	208.70	205.71	204.82	205.56	206.51	207.09	209.08	211.17	213.25	215.31
.620	227.83	217.32	211.37	210.82	209.28	206.53	206.65	207.35	208.32	209.49	211.14	212.83	215.09	217.40
.640	224.93	216.68	211.45	210.67	210.33	207.83	207.91	208.67	210.12	210.83	212.72	214.71	217.27	219.83
.660	224.04	216.98	212.00	210.64	211.61	209.12	209.44	210.22	211.68	212.88	214.76	216.88	219.45	222.02
.680	224.79	217.27	212.30	212.02	212.41	210.41	211.21	212.00	213.46	214.68	216.81	219.17	221.75	224.32
.700	224.60	217.32	213.31	212.57	213.21	212.40	212.98	213.53	215.49	216.94	219.33	221.69	224.28	226.86
.720	224.88	218.32	215.03	214.06	214.24	213.92	226.54	215.77	217.50	219.20	221.60	223.97	226.56	229.15
.740	225.93	219.31	216.88	215.31	215.03	215.66	216.94	218.01	219.75	221.58	223.86	226.42	228.96	231.56
.760	226.72	219.71	217.27	216.32	216.53	217.40	218.25	220.24	221.99	223.95	226.36	228.76	231.37	233.96
.780	227.35	221.05	218.97	218.27	218.49	219.14	220.47	222.48	224.46	226.43	228.86	231.26	233.88	236.48
.800	227.61	222.51	220.44	220.46	220.44	221.34	222.45	224.70	226.70	228.91	231.34	233.75	236.38	239.00
.820	228.58	223.97	222.14	222.17	222.63	223.55	224.90	226.93	229.17	231.39	233.83	236.25	238.88	241.51
.840	229.91	225.18	224.19	224.11	224.59	225.74	227.34	229.38	231.63	233.86	236.30	238.97	241.62	244.25
.860	231.51	226.63	226.12	226.05	226.77	228.17	229.92	231.83	234.21	236.44	239.11	241.74	244.35	247.15

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			254.55	236.41	226.05	220.59	217.00	214.27	212.13	210.75	210.14	210.25	210.45	211.81
.420			244.57	230.63	223.14	218.21	212.74	211.39	210.54	209.95	209.35	208.74	209.93	210.60
.440			240.30	227.18	218.66	213.74	211.72	210.05	209.48	209.40	209.71	210.27	210.96	212.15
.460			234.27	223.98	219.86	215.47	209.77	208.84	208.92	209.37	209.42	209.47	210.16	210.85
.480			230.78	221.30	218.74	213.58	209.31	208.51	208.87	209.85	210.04	210.22	210.92	211.86
.500	259.23	244.75	233.93	224.53	217.34	212.71	210.55	209.35	209.32	209.59	210.39	211.69	212.44	214.14
.520	251.16	241.50	225.60	220.27	217.10	213.40	208.76	209.27	210.03	210.00	211.38	212.23	213.83	214.92
.540	246.33	234.88	223.39	218.59	216.73	213.55	209.44	209.71	210.74	210.97	212.75	213.99	215.22	216.44
.560	242.79	231.88	222.73	218.71	217.00	213.70	210.51	209.62	211.18	212.71	214.24	215.49	216.73	218.22
.580	240.28	229.38	221.28	218.57	217.38	213.59	211.57	211.73	212.64	214.19	215.72	216.99	218.75	220.51
.600	239.58	227.92	220.61	218.43	217.51	213.98	212.75	213.31	214.10	214.50	216.43	218.47	220.51	222.53
.620	239.26	227.48	220.70	219.83	217.89	214.63	214.50	215.02	215.83	216.87	218.42	220.03	222.26	224.54
.640	235.83	226.52	220.53	219.42	218.78	215.79	215.62	216.20	217.54	218.07	219.89	221.82	224.39	226.94
.660	234.60	226.60	220.88	219.13	219.93	216.94	217.04	217.64	218.98	220.05	221.87	223.94	226.51	229.08
.680	235.18	226.66	220.96	220.38	220.55	218.10	218.72	219.33	220.68	221.76	223.85	226.18	228.77	231.33
.700	234.72	226.47	221.81	220.73	221.17	220.02	220.40	220.75	222.64	223.98	226.34	228.68	231.27	233.85
.720	234.77	227.31	223.44	222.11	222.04	221.42	234.99	222.94	224.58	226.20	228.57	230.92	233.51	236.10
.740	235.67	228.15	225.21	223.22	222.65	223.08	224.22	225.14	226.78	228.54	230.79	233.33	235.87	238.47
.760	236.29	228.33	225.38	224.08	224.03	224.73	225.40	227.33	228.98	230.87	233.26	235.63	238.24	240.84
.780	236.72	229.55	227.00	225.96	225.93	226.38	227.57	229.51	231.43	233.33	235.73	238.11	240.74	243.33
.800	236.76	230.90	228.35	228.10	227.82	228.54	229.49	231.70	233.62	235.79	238.20	240.59	243.22	245.83
.820	237.58	232.24	229.96	229.72	229.96	230.69	231.91	233.87	236.07	238.24	240.66	243.06	245.69	248.32
.840	238.78	233.32	231.96	231.59	231.85	232.85	234.33	236.31	238.51	240.69	243.11	245.78	248.43	251.06
.860	240.29	234.66	233.82	233.47	233.99	235.25	236.91	238.73	241.08	243.27	245.93	248.55	251.16	253.98

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			269.41	249.47	237.99	231.83	227.71	224.52	221.97	220.26	219.38	219.28	219.28	220.55
.420			258.33	242.95	234.58	228.99	222.83	221.15	220.01	219.14	218.27	217.39	218.47	218.98
.440			253.45	238.96	229.47	223.90	221.49	219.45	218.60	218.30	218.42	218.81	219.34	220.42
.460			246.55	235.24	230.54	225.54	219.12	217.88	217.75	219.03	217.86	217.70	218.23	218.76
.480			242.53	232.64	229.08	223.24	218.38	217.29	217.45	213.30	218.29	218.27	218.81	219.62
.500	273.79	257.81	245.82	235.36	227.32	222.07	219.49	217.96	217.71	217.78	218.43	219.62	220.22	221.85
.520	264.78	254.05	236.52	230.50	226.83	222.57	217.30	217.64	218.24	217.98	219.26	219.96	221.49	222.45
.540	259.30	246.62	233.89	228.43	226.18	222.50	217.81	217.87	218.76	218.80	220.50	221.63	222.75	223.86
.560	255.22	243.12	232.93	228.33	226.23	222.42	218.73	217.53	219.00	220.45	221.88	223.02	224.15	225.55
.580	252.26	240.17	231.13	227.95	226.42	222.06	219.64	219.59	220.35	221.81	223.25	224.40	226.10	227.79
.600	251.27	238.35	230.16	227.55	226.32	222.25	220.69	221.07	221.70	221.90	223.78	225.78	227.77	229.74
.620	250.69	237.64	230.03	228.85	226.50	222.72	222.35	222.68	223.33	224.24	225.70	227.23	229.43	231.69
.640	246.74	236.37	229.62	228.16	227.23	223.75	223.33	223.73	224.96	225.31	227.06	228.94	231.50	234.06
.660	245.17	236.22	229.76	227.61	228.24	224.77	224.64	225.06	226.29	227.22	228.97	231.00	233.57	236.13
.680	245.56	236.06	229.61	228.75	228.69	225.78	226.23	226.65	227.90	228.84	230.88	233.20	235.78	238.35
.700	244.83	235.62	230.31	228.89	229.13	227.64	227.81	227.96	229.78	231.02	233.36	235.67	238.26	240.84
.720	244.66	236.30	231.84	230.16	229.84	228.93	243.44	230.11	231.66	233.19	235.54	237.86	240.46	243.04
.740	245.41	236.98	233.54	231.14	230.27	230.50	231.50	232.26	233.82	235.50	237.71	240.25	242.79	245.38
.760	245.85	236.95	233.50	231.83	231.54	232.06	232.55	234.41	235.97	237.80	240.16	242.51	245.12	247.72
.780	246.09	238.05	235.02	233.65	233.37	233.61	234.68	236.55	238.40	240.23	242.61	244.97	247.59	250.19
.800	245.91	239.28	236.26	235.74	235.19	235.73	236.52	238.69	240.54	242.67	245.06	247.42	250.05	252.66
.820	246.57	240.51	237.78	237.27	237.29	237.84	238.92	240.82	242.97	245.10	247.49	249.87	252.51	255.13
.840	247.64	241.46	239.72	239.08	239.11	239.95	241.32	243.23	245.39	247.53	249.92	252.60	255.24	257.87
.860	249.06	242.68	241.52	240.88	241.20	242.33	243.89	245.64	247.95	250.09	252.75	255.37	257.97	260.80

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			284.27	262.53	249.93	243.07	238.42	234.77	231.82	229.77	228.62	228.31	228.12	229.28
.420			272.09	255.27	246.02	239.78	232.92	230.90	229.47	228.34	227.20	226.05	227.01	227.37
.440			266.60	250.74	240.28	234.06	231.25	228.85	227.73	227.21	227.13	227.36	227.72	228.69
.460			259.04	246.50	241.22	235.61	228.47	226.93	226.59	226.68	226.31	225.93	226.30	226.67
.480			254.47	243.47	239.42	232.91	227.45	226.07	226.04	226.75	226.54	226.32	226.70	227.37
.500	288.35	270.88	257.70	246.20	237.30	231.42	228.42	226.57	226.09	225.97	226.46	227.55	228.00	229.56
.520	278.40	266.59	247.45	240.72	236.55	231.74	225.84	226.00	226.44	225.96	227.14	227.69	229.14	229.98
.540	272.27	258.35	244.39	238.28	235.64	231.45	226.17	226.03	226.79	226.62	228.26	229.28	230.28	231.28
.560	267.65	254.36	243.14	237.95	235.47	231.14	226.94	225.45	226.82	228.18	229.52	230.55	231.57	232.88
.580	264.25	250.96	240.98	237.32	235.45	230.54	227.71	227.44	228.06	229.43	230.78	231.82	233.45	235.07
.600	262.96	248.78	239.71	236.68	235.13	230.53	228.62	228.82	229.30	229.31	231.13	233.09	235.03	236.96
.620	262.12	247.80	239.36	237.86	235.11	230.81	230.20	230.35	230.84	231.61	232.99	234.43	236.60	238.84
.640	257.64	246.21	238.70	236.91	235.68	231.70	231.04	231.26	232.37	232.55	234.23	236.05	238.62	241.17
.660	255.73	245.84	238.64	236.10	236.56	232.59	232.24	232.47	233.59	234.39	236.07	238.06	240.63	243.19
.680	255.95	245.46	238.27	237.11	236.83	233.47	233.74	233.98	235.11	235.92	237.92	240.21	242.79	245.36
.700	254.95	244.77	238.80	237.05	237.08	235.26	235.23	235.18	236.93	238.05	240.37	242.66	245.25	247.83
.720	254.55	245.29	240.25	238.20	237.64	236.44	251.89	237.29	238.75	240.18	242.50	244.81	247.40	249.99
.740	255.15	245.81	241.87	239.05	237.89	237.92	238.79	239.39	240.85	242.45	244.63	247.17	249.70	252.29
.760	255.42	245.58	241.61	239.59	239.05	239.39	239.69	241.49	242.96	244.72	247.06	249.39	252.00	254.59
.780	255.47	246.55	243.05	241.34	240.81	240.85	241.78	243.58	245.37	247.13	249.49	251.82	254.45	257.04
.800	255.06	247.67	244.18	243.39	242.56	242.92	243.56	245.68	247.47	249.54	251.91	254.25	256.88	259.50
.820	255.56	248.78	245.61	244.83	244.62	244.99	245.94	247.77	249.87	251.95	254.33	256.68	259.32	261.94
.840	256.51	249.60	247.49	246.56	246.37	247.05	248.31	250.15	252.27	254.36	256.74	259.41	262.05	264.68
.860	257.33	250.71	249.22	248.30	248.42	249.41	250.87	252.54	254.81	256.91	259.57	262.18	264.78	267.63

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .20

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			306.57	282.12	267.83	259.93	254.48	250.15	246.59	244.03	242.48	241.86	241.37	242.39
.420			292.72	273.75	263.18	255.97	248.06	245.54	243.67	242.13	240.58	239.03	239.83	239.95
.440			286.32	268.41	256.50	249.30	245.89	242.94	241.42	240.56	240.20	240.17	240.30	241.10
.460			277.62	263.39	257.23	250.72	242.50	240.50	239.84	239.66	238.97	238.27	238.41	238.54
.480			272.24	259.72	254.93	247.41	241.06	239.24	238.92	239.43	238.92	238.39	238.53	239.01
.500	310.19	250.47	275.53	262.45	252.28	245.44	241.83	239.48	238.67	238.25	238.52	239.45	239.66	241.12
.520	298.84	285.41	263.84	256.07	251.13	245.50	238.65	238.54	238.75	237.93	238.95	239.29	240.62	241.27
.540	291.73	275.95	260.13	253.05	249.82	244.87	238.71	238.27	238.82	238.35	239.89	240.74	241.58	242.40
.560	286.30	271.22	258.45	252.38	249.33	244.23	239.27	237.31	238.55	239.78	240.99	241.85	242.70	243.87
.580	282.22	267.15	255.74	251.38	249.01	243.25	239.81	239.23	239.63	240.86	242.08	242.95	244.48	246.00
.600	280.49	264.42	254.04	250.37	248.35	242.93	240.53	240.46	240.70	240.42	242.15	244.04	245.92	247.78
.620	279.27	263.04	253.35	251.38	248.02	242.95	241.97	241.85	242.10	242.67	243.91	245.23	247.35	249.56
.640	273.99	260.98	252.32	250.02	248.36	243.64	242.61	242.56	243.50	243.40	244.99	246.72	249.29	251.84
.660	271.58	260.27	251.95	248.83	249.04	244.32	243.63	243.60	244.55	245.15	246.73	248.64	251.22	253.78
.680	271.53	259.55	251.25	249.65	249.03	245.00	245.00	244.97	245.94	246.54	248.47	250.73	253.31	255.88
.700	270.12	258.49	251.55	249.29	249.02	246.69	246.36	246.00	247.66	248.60	250.89	253.15	255.74	258.31
.720	269.39	258.78	252.86	250.28	249.34	247.70	264.57	248.04	249.37	250.66	252.96	255.23	257.82	260.41
.740	269.76	259.07	254.37	250.92	249.32	249.04	249.71	250.08	251.41	252.89	255.02	257.54	260.07	262.66
.760	269.76	258.51	253.78	251.22	250.31	250.38	250.42	252.11	253.45	255.11	257.42	259.71	262.32	264.91
.780	269.53	259.29	255.08	252.87	251.97	251.71	252.44	254.14	255.82	257.49	259.81	262.11	264.73	267.33
.800	268.78	260.24	256.04	254.85	253.62	253.71	254.11	256.16	257.85	259.86	262.20	264.50	267.14	269.75
.820	269.05	261.19	257.34	256.15	255.61	255.71	256.46	258.19	260.22	262.24	264.58	266.90	269.53	272.16
.840	269.81	261.80	259.14	257.79	257.26	257.71	258.80	260.54	262.58	264.61	266.95	269.62	272.27	274.90
.860	270.99	262.75	260.77	259.43	259.24	260.04	261.34	262.89	265.11	267.14	269.80	272.41	275.00	277.87

TABLE GENERATED USING INDEX 420.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			242.61	226.59	217.66	213.19	210.39	208.36	206.84	206.00	205.84	206.33	206.89	208.47
.420			233.71	221.54	215.23	211.24	206.75	205.99	205.68	205.57	205.44	205.28	206.76	207.73
.440			230.01	218.59	211.36	207.40	206.06	205.03	204.98	205.37	206.07	207.01	208.02	209.51
.460			224.69	215.87	212.67	209.19	204.51	204.17	204.72	205.61	206.11	206.58	207.62	208.64
.480			221.70	214.08	211.84	207.69	204.33	204.11	204.94	206.31	206.96	207.56	208.62	209.90
.500	246.67	234.06	224.77	216.76	210.77	207.11	205.67	205.10	205.58	206.33	207.53	209.19	210.31	212.29
.520	239.50	231.27	217.34	213.06	210.76	207.93	204.25	205.26	206.47	206.95	208.69	209.93	211.87	213.29
.540	235.27	225.41	215.52	211.73	210.60	208.28	205.09	205.87	207.35	208.07	210.20	211.81	213.40	214.97
.560	232.21	222.85	215.10	212.02	211.04	208.62	206.26	206.01	207.95	209.89	211.79	213.44	215.04	216.87
.580	230.09	220.77	213.95	212.08	211.59	208.70	207.43	208.14	209.52	211.47	213.38	215.04	217.14	219.22
.600	229.61	219.61	213.52	212.14	211.89	209.25	208.71	209.78	211.07	211.96	214.26	216.63	219.00	221.32
.620	229.49	219.38	213.80	213.60	212.42	210.04	210.50	211.54	212.84	214.34	216.29	218.29	220.82	223.42
.640	226.53	218.67	213.84	213.40	213.42	211.29	211.71	212.83	214.60	215.66	217.85	220.16	223.01	225.84
.660	225.58	218.91	214.33	213.32	214.66	212.52	213.20	214.32	216.13	217.66	219.88	222.29	225.18	228.03
.680	226.28	219.14	214.58	214.66	215.40	213.76	214.93	216.06	217.88	219.42	221.90	224.57	227.46	230.32
.700	226.04	219.13	215.52	215.17	216.15	215.71	216.64	217.55	219.85	221.65	224.37	227.06	229.96	232.85
.720	226.26	220.07	217.17	216.61	217.13	217.18	230.15	219.75	221.82	223.38	226.60	229.32	232.22	235.11
.740	227.27	221.01	218.96	217.80	217.88	218.86	220.51	221.94	224.02	226.21	228.83	231.71	234.60	237.50
.760	228.01	221.35	219.29	218.75	219.33	220.55	221.77	224.12	226.22	228.53	231.30	234.02	236.97	239.88
.780	228.59	222.64	220.93	220.63	221.24	222.24	223.93	226.30	228.65	230.97	233.74	236.48	239.43	242.38
.800	228.82	224.05	222.34	222.75	223.15	224.41	225.86	228.48	230.83	233.41	236.18	238.95	241.91	244.86
.820	229.75	225.46	223.99	224.40	225.27	226.57	228.26	230.66	233.25	235.84	238.62	241.39	244.37	247.32
.840	231.03	226.63	225.99	226.28	227.16	228.71	230.65	233.05	235.67	238.25	241.06	244.07	247.07	250.03
.860	232.60	228.03	227.87	228.16	229.28	231.09	233.20	235.45	238.20	240.79	243.82	246.79	249.75	252.90

TABLE GENERATED USING INDEX 460.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			257.48	239.65	229.60	224.43	221.09	218.61	216.68	215.51	215.08	215.37	215.71	217.21
.420			247.46	233.86	226.67	222.03	216.84	215.75	215.15	214.76	214.37	213.93	215.31	216.11
.440			243.16	230.37	222.17	217.56	215.82	214.43	214.10	214.27	214.78	215.55	216.41	217.78
.460			237.07	227.13	223.35	219.26	213.87	213.21	213.56	214.27	214.55	214.80	215.69	216.55
.480			233.55	224.92	222.18	217.35	213.40	212.88	213.52	214.76	215.21	215.61	216.51	217.65
.500	261.23	247.12	236.66	227.59	220.75	216.47	214.61	213.71	213.97	214.52	215.57	217.12	218.09	220.00
.520	253.12	243.81	228.27	223.29	220.48	217.10	212.79	213.62	214.67	214.93	216.57	217.67	219.52	220.82
.540	248.24	237.14	226.01	221.57	220.06	217.22	213.46	214.03	215.37	215.89	217.95	219.45	220.93	222.39
.560	244.64	234.09	225.30	221.64	220.28	217.34	214.47	213.92	215.78	217.62	219.43	220.97	222.46	224.20
.580	242.07	231.56	223.80	221.45	220.63	217.17	215.50	216.00	217.23	219.09	220.91	222.46	224.49	226.50
.600	241.30	230.04	223.07	221.26	220.70	217.52	216.65	217.54	218.67	219.37	221.61	223.94	226.26	228.54
.620	240.92	229.55	223.12	222.62	221.03	218.13	218.35	219.21	220.35	221.72	223.57	225.49	227.99	230.57
.640	237.43	228.52	222.92	222.14	221.87	219.25	219.42	220.36	222.02	222.90	225.02	227.27	230.12	232.96
.660	236.15	228.53	223.21	221.81	222.98	220.34	220.80	221.74	223.43	224.83	226.98	229.35	232.24	235.09
.680	236.67	228.53	223.24	223.02	223.54	221.45	222.44	223.38	225.10	226.50	228.94	231.58	234.47	237.34
.700	236.15	228.28	224.02	223.33	224.11	223.33	224.06	224.77	227.00	228.69	231.38	234.05	236.95	239.84
.720	236.15	229.06	225.58	224.66	224.93	224.68	238.60	226.92	228.90	230.87	233.57	236.27	239.17	242.06
.740	237.01	229.84	227.29	225.72	225.50	226.28	227.79	229.06	231.06	233.16	235.76	238.63	241.52	244.41
.760	237.58	229.97	227.40	226.50	226.84	227.88	228.92	231.20	233.22	235.45	238.20	240.90	243.85	246.76
.780	237.97	231.14	228.96	228.32	228.69	229.48	231.04	233.34	235.62	237.87	240.62	243.34	246.29	249.23
.800	237.96	232.43	230.26	230.39	230.52	231.60	232.89	235.48	237.75	240.28	243.03	245.78	248.74	251.69
.820	238.74	233.73	231.81	231.95	232.60	233.71	235.27	237.61	240.15	242.70	245.45	248.21	251.18	254.13
.840	239.90	234.76	233.75	233.77	234.42	235.82	237.64	239.98	242.55	245.08	247.87	250.88	253.88	256.84
.860	241.37	236.06	235.56	235.58	236.49	238.17	240.18	242.35	245.07	247.61	250.64	253.61	256.57	259.72

TABLE GENERATED USING INDEX 500.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			272.34	252.71	241.54	235.67	231.80	228.87	226.53	225.02	224.32	224.40	224.54	225.94
.420			261.22	246.18	238.11	232.82	226.94	225.50	224.61	223.96	223.29	222.59	223.85	224.50
.440			256.31	242.15	232.98	227.72	225.59	223.82	223.23	223.17	223.49	224.09	224.79	226.05
.460			249.46	238.39	234.03	229.34	223.22	222.26	222.39	222.92	222.99	223.03	223.76	224.47
.480			245.39	235.75	232.52	227.02	222.47	221.66	222.11	223.21	223.46	223.65	224.40	225.41
.500	275.79	260.18	248.54	238.43	230.73	225.82	223.54	222.32	222.35	222.70	223.60	225.05	225.86	227.70
.520	266.74	256.36	239.19	233.52	230.20	226.27	221.34	221.98	222.88	222.91	224.45	225.40	227.18	228.35
.540	261.21	248.87	236.51	231.42	229.51	226.17	221.82	222.19	223.40	223.71	225.71	227.09	228.46	229.81
.560	257.07	245.33	235.51	231.26	229.52	226.06	222.69	221.83	223.60	225.36	227.07	228.50	229.88	231.53
.580	254.05	242.35	233.64	230.83	229.66	225.55	223.57	223.85	224.94	226.71	228.44	229.87	231.84	233.78
.600	252.99	240.47	232.63	230.39	229.51	225.79	224.58	225.29	226.27	226.77	228.96	231.24	233.52	235.75
.620	252.35	239.71	232.45	231.63	229.64	226.22	226.20	226.87	227.86	229.09	230.86	232.69	235.16	237.72
.640	248.34	238.37	232.00	230.89	230.33	227.20	227.13	227.89	229.44	230.14	232.19	234.38	237.24	240.07
.660	246.71	238.15	232.09	230.29	231.29	228.16	228.40	229.16	230.74	232.00	234.08	236.41	239.30	242.14
.680	247.05	237.93	231.89	231.38	231.68	229.14	229.95	230.71	232.31	233.58	235.97	238.59	241.48	244.35
.700	246.27	237.43	232.52	231.49	232.06	230.95	231.47	231.98	234.15	235.73	238.39	241.05	243.94	246.83
.720	246.04	238.05	233.99	232.70	232.73	232.19	247.05	234.09	235.98	237.86	240.54	243.21	246.12	249.00
.740	246.75	238.68	235.62	233.63	233.12	233.69	235.07	236.19	238.10	240.12	242.68	245.54	248.43	251.32
.760	247.14	238.60	235.52	234.26	234.35	235.21	236.07	238.28	240.21	242.37	245.10	247.77	250.73	253.64
.780	247.34	239.64	236.98	236.01	236.13	236.72	238.14	240.37	242.59	244.77	247.50	250.20	253.15	256.09
.800	247.11	240.82	238.17	238.04	237.90	238.80	239.93	242.47	244.67	247.16	249.89	252.61	255.57	258.53
.820	247.73	242.00	239.63	239.50	239.93	240.86	242.28	244.56	247.05	249.55	252.29	255.02	257.99	260.94
.840	248.77	242.90	241.52	241.25	241.68	242.92	244.64	246.90	249.43	251.92	254.68	257.69	260.69	263.65
.860	250.14	244.08	243.26	243.00	243.71	245.25	247.17	249.25	251.94	254.43	257.46	260.42	263.38	266.55

TABLE GENERATED USING INDEX 540.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			287.20	265.77	253.47	246.91	242.51	239.12	236.37	234.53	233.56	233.43	233.38	234.68
.420			274.98	258.49	249.55	243.61	237.03	235.26	234.08	233.15	232.22	231.24	232.39	232.88
.440			269.45	253.93	243.79	237.88	235.35	233.22	232.35	232.07	232.20	232.63	233.18	234.32
.460			261.34	249.65	244.71	239.41	232.57	231.31	231.23	231.58	231.43	231.26	231.83	232.38
.480			257.24	246.59	242.86	236.68	231.54	230.44	230.70	231.66	231.71	231.70	232.29	233.16
.500	290.35	273.24	260.43	249.26	240.72	235.17	232.48	230.93	230.74	230.89	231.64	232.98	233.64	235.41
.520	280.36	268.90	250.12	243.75	239.93	235.44	229.88	230.34	231.08	230.89	232.33	233.13	234.83	235.88
.540	274.18	260.61	247.01	241.26	238.96	235.12	230.18	230.35	231.42	231.54	233.46	234.74	235.99	237.23
.560	269.51	256.56	245.72	240.88	238.76	234.78	230.91	229.75	231.42	233.09	234.72	236.03	237.30	238.86
.580	266.03	253.14	243.49	240.20	238.70	234.12	231.64	231.71	232.65	234.33	235.97	237.29	239.20	241.07
.600	264.68	250.90	242.18	239.52	238.33	234.07	232.52	233.05	233.86	234.18	236.31	238.55	240.78	242.97
.620	263.78	249.87	241.78	240.64	238.25	234.31	234.04	234.54	235.37	236.46	238.14	239.89	242.34	244.87
.640	259.24	248.21	241.08	239.63	238.78	235.16	234.84	235.42	236.86	237.37	239.36	241.50	244.35	247.19
.660	257.28	247.77	240.97	238.78	239.61	235.99	236.00	236.58	238.04	239.17	241.19	243.47	246.36	249.20
.680	257.44	247.33	240.54	239.75	239.82	236.82	237.46	238.04	239.53	240.66	243.01	245.61	248.50	251.36
.700	256.38	246.58	241.01	239.65	240.02	238.57	238.89	239.20	241.30	242.76	245.41	248.04	250.93	253.82
.720	255.93	247.05	242.39	240.75	240.53	239.70	255.51	241.26	243.06	244.85	247.51	250.16	253.06	255.95
.740	256.49	247.51	243.95	241.54	240.74	241.11	242.35	243.31	245.13	247.08	249.60	252.46	255.34	258.24
.760	256.71	247.22	243.63	242.01	241.86	242.53	243.21	245.36	247.20	249.30	252.00	254.65	257.61	260.52
.780	256.71	248.13	245.01	243.69	243.57	243.95	245.24	247.41	249.56	251.67	254.38	257.05	260.00	262.95
.800	256.26	249.20	246.08	245.68	245.27	245.99	246.96	249.46	251.60	254.04	256.75	259.45	262.41	265.36
.820	256.72	250.27	247.46	247.06	247.26	248.01	249.30	251.50	253.95	256.41	259.12	261.83	264.81	267.76
.840	257.64	251.04	249.29	248.74	248.94	250.02	251.63	253.82	256.31	258.75	261.49	264.50	267.50	270.46
.860	258.91	252.11	250.96	250.42	250.92	252.33	254.15	256.15	258.81	261.25	264.29	267.24	270.19	273.38

TABLE GENERATED USING INDEX 600.

50.0 KVA TRANSFORMER

LOAD FACTOR = .30

	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
.400			309.50	285.36	271.38	263.77	258.57	254.49	251.14	248.79	247.42	246.98	246.63	247.79
.420			295.61	276.97	266.72	259.79	252.17	249.89	248.27	246.94	245.60	244.23	245.20	245.46
.440			289.18	271.60	260.01	253.12	249.99	247.31	246.04	245.42	245.27	245.44	245.75	246.73
.460			280.42	266.55	260.72	254.51	246.59	244.88	244.48	244.56	244.09	243.60	243.94	244.25
.480			275.01	262.84	258.37	251.18	245.14	243.61	243.58	244.34	244.08	243.77	244.12	244.79
.500	312.18	292.83	278.25	265.52	255.69	249.19	245.89	243.85	243.31	243.17	243.69	244.88	245.31	246.97
.520	300.80	287.71	266.50	259.09	254.51	249.20	242.69	242.89	243.39	242.86	244.15	244.73	246.31	247.18
.540	293.64	278.21	262.75	256.03	253.14	248.54	242.72	242.59	243.46	243.27	245.10	246.20	247.29	248.35
.560	288.15	273.42	261.02	255.31	252.61	247.86	243.23	241.62	243.16	244.69	246.18	247.32	248.42	249.85
.580	284.00	269.32	258.26	254.26	252.25	246.83	243.75	243.50	244.21	245.76	247.27	248.42	250.22	251.99
.600	282.21	266.54	256.51	253.21	251.54	246.48	244.42	244.68	245.26	245.29	247.33	249.51	251.67	253.79
.620	280.93	265.11	255.78	254.17	251.16	246.45	245.82	246.04	246.63	247.52	249.06	250.69	253.09	255.59
.640	275.59	262.98	254.70	252.75	251.46	247.10	246.41	246.71	247.98	248.23	250.12	252.17	255.02	257.86
.660	273.12	262.20	254.29	251.51	252.09	247.72	247.39	247.71	249.00	249.93	251.84	254.06	256.94	259.79
.680	273.01	261.42	253.53	252.29	252.02	248.36	248.72	249.03	250.35	251.29	253.56	256.13	259.02	261.88
.700	271.56	260.30	253.76	251.89	251.96	250.00	250.02	250.02	252.02	253.31	255.93	258.52	261.42	264.31
.720	270.77	260.53	255.00	252.82	252.23	250.96	248.18	252.02	253.68	255.34	257.96	260.58	263.48	266.37
.740	271.10	260.76	256.45	253.41	252.17	252.24	253.27	254.00	255.69	257.51	259.99	262.84	265.71	268.60
.760	271.05	260.15	255.80	253.64	253.12	253.53	253.94	255.98	257.68	259.68	262.35	264.97	267.93	270.84
.780	270.77	260.88	257.05	255.23	254.73	254.81	255.90	257.96	260.01	262.02	264.69	267.34	270.29	273.23
.800	269.99	261.78	257.95	257.14	256.33	256.78	257.52	259.94	261.98	264.36	267.03	269.70	272.66	275.61
.820	270.21	262.68	259.19	258.39	258.25	258.73	259.82	261.92	264.30	266.69	269.37	272.04	275.02	277.97
.840	270.94	263.24	260.94	259.97	259.83	260.68	262.11	264.21	266.62	269.00	271.71	274.72	277.72	280.68
.860	272.07	264.14	262.51	261.54	261.75	262.95	264.62	266.51	269.11	271.49	274.52	277.46	280.40	283.62

TABLES 3-7.5

SUMMARY OF OPTIMUM DESIGNS (MEX)

SCENARIO 1

LDF= .10

KVA	INDEX	NLL	LL	TLAC
10	180	.050	.160	87.44
10	200	.050	.180	91.95
10	220	.050	.180	96.31
10	240	.050	.180	100.67
15	225	.060	.220	111.77
15	250	.070	.220	117.48
15	275	.070	.240	122.06
15	300	.070	.240	127.17
25	275	.090	.300	140.87
25	300	.090	.300	146.09
25	325	.090	.300	151.30
25	350	.090	.300	156.52
25	400	.090	.340	166.12
37.5	400	.120	.400	195.56
37.5	440	.120	.400	203.98
37.5	480	.120	.400	212.40
37.5	520	.120	.400	220.82
50	420	.150	.460	231.49
50	460	.150	.520	240.31
50	500	.150	.520	248.85
50	540	.150	.520	257.40
50	600	.150	.520	270.21

TABLES 3-7.5

SUMMARY OF OPTIMUM DESIGNS (MEX)

SCENARIO 1

LDF = .20

KVA	INDEX	NLL	LL	TLAC
10	180	.040	.160	92.68
10	200	.050	.160	97.43
10	220	.050	.160	102.10
10	240	.050	.180	106.41
15	225	.060	.220	118.73
15	250	.060	.220	124.64
15	275	.070	.220	130.28
15	300	.070	.220	135.72
25	275	.090	.300	150.70
25	300	.090	.300	155.92
25	325	.090	.300	161.13
25	350	.090	.300	166.35
25	400	.090	.300	176.78
37.5	400	.110	.400	208.57
37.5	440	.120	.400	217.09
37.5	480	.120	.400	225.51
37.5	520	.120	.400	233.93
50	420	.150	.460	246.97
50	460	.150	.460	256.32
50	500	.150	.480	265.56
50	540	.150	.480	274.63
50	600	.150	.480	288.24

TABLES 3-7.5
SUMMARY OF OPTIMUM DESIGNS (MEX)
SCENARIO 1
LDF = .30

KVA	INDEX	NLL	LL	TLAC
10	180	.030	.180	96.14
10	200	.030	.260	101.13
10	220	.030	.260	105.56
10	240	.030	.280	109.78
15	225	.060	.220	125.45
15	250	.060	.220	131.36
15	275	.060	.220	137.27
15	300	.060	.220	143.18
25	275	.080	.300	159.91
25	300	.080	.300	165.59
25	325	.080	.300	171.28
25	350	.080	.340	176.08
25	400	.080	.340	186.45
37.5	400	.090	.480	221.40
37.5	440	.090	.540	230.19
37.5	480	.090	.540	238.49
37.5	520	.090	.540	246.78
50	420	.110	.600	261.74
50	460	.110	.600	271.30
50	500	.110	.640	280.59
50	540	.110	.680	289.37
50	600	.110	.680	302.35

TABLES 3-7.5
SUMMARY OF OPTIMUM DESIGNS (MEX)
SCENARIO 2
LDF = .10

KVA	INDEX	NLL	LL	TLAC
10	180	.060	.180	75.15
10	200	.060	.180	79.17
10	220	.060	.180	83.20
10	240	.060	.180	87.22
15	225	.070	.240	95.32
15	250	.070	.240	100.43
15	275	.070	.240	105.53
15	300	.070	.240	110.64
25	275	.100	.300	119.21
25	300	.100	.300	125.20
25	325	.100	.300	129.09
25	350	.110	.300	133.68
25	400	.110	.300	143.15
37.5	400	.130	.400	166.77
37.5	440	.140	.400	174.88
37.5	480	.140	.420	182.68
37.5	520	.140	.420	190.33
50	420	.160	.480	195.93
50	460	.160	.480	204.71
50	500	.150	.520	213.36
50	540	.160	.560	221.22
50	600	.160	.560	233.09

TABLES 3-7.5
SUMMARY OF OPTIMUM DESIGNS (MEX)
SCENARIO 2
LDF = .20

KVA	INDEX	NLL	LL	TLAC
10	180	.060	.180	76.57
10	200	.060	.180	80.60
10	220	.060	.180	85.18
10	240	.060	.180	88.65
15	225	.080	.200	96.98
15	250	.080	.200	102.40
15	275	.070	.240	107.36
15	300	.070	.240	112.46
25	275	.100	.300	121.58
25	300	.100	.300	126.52
25	325	.110	.300	131.37
25	350	.110	.300	136.10
25	400	.120	.300	145.50
37.5	400	.130	.400	169.92
37.5	440	.130	.400	178.04
37.5	480	.140	.400	185.98
37.5	520	.140	.420	193.66
50	420	.160	.480	199.74
50	460	.160	.480	208.51
50	500	.160	.480	217.29
50	540	.160	.560	225.45
50	600	.160	.560	237.31

TABLES 3-7.5
SUMMARY OF OPTIMUM DESIGNS (MEX)
SCENARIO 2
LDF = .30

KVA	INDEX	NLL	LL	TLAC
10	180	.060	.180	78.21
10	200	.060	.180	82.24
10	220	.060	.180	86.26
10	240	.060	.180	90.29
15	225	.070	.240	99.04
15	250	.070	.240	104.14
15	275	.070	.240	109.25
15	300	.070	.240	114.35
25	275	.100	.300	124.31
25	300	.090	.340	130.12
25	325	.100	.300	134.20
25	350	.110	.300	139.11
25	400	.110	.300	148.59
37.5	400	.130	.400	173.47
37.5	440	.130	.400	181.58
37.5	480	.130	.400	189.70
37.5	520	.140	.420	197.48
50	420	.160	.480	204.11
50	460	.170	.480	213.52
50	500	.150	.520	221.34
50	540	.160	.560	229.75
50	600	.160	.560	241.62

TABLE 3-7.6
COMPARISON OF SINGLE EFFICIENCY VERSUS MULTIPLE EFFICIENCY
(OPTIMUM DESIGNS)

SCENARIO 1

KVA	INDEX	TOTAL LEVELIZED ANNUAL COST		
		SINGLE EFFICIENCY	MULTIPLE EFFICIENCY	SAVINGS
10	200	126.31	101.13	25.18
15	250	165.96	131.36	34.60
25	325	225.96	171.28	54.68
37.5	440	312.58	230.19	82.39
50	500	375.93	280.59	95.34

SCENARIO 2

10	200	104.45	82.24	22.21
15	250	135.56	104.14	31.42
25	325	183.33	134.20	49.13
37.5	440	253.26	181.58	71.68
50	500	304.22	221.34	82.88

3.8 TASK 8 - INTERPRETATION

INTRODUCTION

The purpose of this task is to summarize the results and conclusions of the previous tasks and provide recommendations for distribution transformer efficiency characteristics. In addition, recommendations for further investigation are provided.

The method derived for distribution transformer loss evaluation applies only to utilities with generation and transmission facilities. Further effort is required to derive a loss evaluation method applicable to utilities which purchase their total power requirements. For example, the system investment cost and discount factor used in the demand component of loss costs would not apply. Purchase power costs would be in the form of a monthly demand charge and energy charge. In addition, the demand charge may have a ratchet associated with it.

The system cost parameters developed in Task 2 are applicable only to investor-owned utilities with generation and transmission facilities. Properly inflated demand and energy charges are required to reflect purchase power costs. The components of the carrying charge rate for publicly-owned utilities would also be different because of differences in the cost of money and tax structure.

The transformer load characteristics developed in Task 3 pertain only to the residential load class. There is very limited published data on commercial and industrial load characteristics. Further effort is required to analyze a sufficient amount of commercial and industrial load data in order to develop the required load characteristics.

SUMMARY OF OPTIMUM EFFICIENCY DATA

The optimum designs of the single efficiency transformer are summarized in Table 3-6.9. It lists the designs with the lowest total levelized annual costs for the given kVA rating, index, and scenario based on the input data shown in Table 3-6.7. Use of other input data can result in different optimum designs.

The index number is a multiplier used to produce an assumed selling price. It is obtained by multiplying the index number by the appropriate number in the normalized matrix of transformer costs versus losses developed in Task 4. In scenario 1, cost parameters for oil-fired base load generation are used for input and, in scenario 2, nuclear-fired base load generation is assumed.

It can be seen from Table 3-6.9 that the losses of the optimum designs change little if any as the index number is changed. This means that changes in the initial transformer cost have little effect on the optimum design for a given set of input parameters. However, the losses of the optimum designs are different for the two scenarios.

The no-load losses for the optimum designs in scenario 1 are generally lower than those in scenario 2. The load losses in scenario 1 are generally higher. This is a reflection of the fact that the energy cost of nuclear-fired base load generation is cheaper than that of oil-fired base load generation.

The optimum designs of the multiple efficiency transformers (MEX) are summarized in Table 3-7.5. This table lists the designs with the lowest total levelized annual cost for different indexes, load factors, and scenarios. These optimum designs depend on the input parameters which are found in Table 3-7.2. The losses of the optimum designs changed little if any with changes in the index number which is proportional to an assumed selling price. Also, the optimum designs generally did not change much with changes in load factor.

However, in scenario 1, when the load factor was changed from 20% to 30%, the losses of the optimum designs changed seemingly in the wrong direction. As the load factor increased, the cost per kilowatt of load loss became higher, and therefore the load loss should have gone down if everything else had remained unchanged. Instead, the load losses of the optimum design increased. This is due to the fact that the switching load changes as a function of the losses (see p. 3.5-20). Because of lower energy costs for nuclear-fired base load generation, the no-load losses for the optimum designs are higher in scenario 2 than in scenario 1.

SUMMARIZE ECONOMIC/ENERGY BENEFIT OF MULTIPLE EFFICIENCY CHARACTERISTICS

Table 3-7.6 shows a comparison of multiple efficiency and single efficiency designs. The costs of the multiple efficiency designs do not include the cost of the switch used to change modes. However, the levelized savings indicate the price which can be justified for the switch. In each case, the optimum designs for the same scenario, load factor, and index number are compared. The loss levels in each comparison are not necessarily the same.

It can be seen from Table 3-7.6 that the savings in scenario 1 are greater than those in scenario 2. Since the main benefit of the MEX is lower iron losses at low loads, the greater the cost of iron losses, the greater the savings of the MEX. Also, the more time the MEX stays in the low kVA mode, the greater the savings.

The savings of the MEX are highly dependent on the load factor. At low load factors, the MEX remains in the low kVA mode at reduced iron losses for a greater percentage of time. The savings of the MEX also depend on load growth. A high load growth rate will diminish the percent time in the low kVA mode over the years. However, if the transformer is changed out at the proper time, the total percent time in the low kVA mode can be increased.

The demand components of the MEX loss evaluation depend on which mode the transformer is in at the time of system peak. The analysis on page 3.5-39 shows that it is most likely that the MEX will be in the high kVA mode at the time of system peak. Therefore the MEX should have no significant effect on the demand components of the operating cost.

Regulation of the MEX

Regulation is the percent voltage decrease at the output of a transformer as the load on the transformer increases from zero to full load. If it is assumed that the high kVA mode of the multiple efficiency transformer has the same characteristics as a single efficiency transformer of the same rating, the regulation will, of course, be the same.

The percent regulation of the low kVA mode would be approximately twice that of the single efficiency design. However this should not present a problem because the low kVA mode is only used at low loads.

For example, if the voltage drop of an MEX in the high mode is 1.4% at full load, and if the switching load is .5 per unit of the low kVA mode, the maximum voltage drop of the low kVA mode would be:

$$\text{voltage drop} = 1.4\% \times 2 \times .5 = 1.4\%$$

The switching loads for the optimum designs studied in Task 7 are generally between 40% and 50% of the low kVA rating. Therefore, if an acceptable value of voltage regulation in the high mode is achieved, the voltage drop in the low mode should pose no problem.

COMPILE CONCLUSIONS/RECOMMENDATIONS FOR DISTRIBUTION TRANSFORMER EFFICIENCY CHARACTERISTICS

Task 1 describes a method to calculate the total levelized annual cost (TLAC) of owning and operating a single efficiency distribution transformer.

The equations for the evaluation are summarized in Table 3-8.1. Cost parameters and load parameters are developed in Tasks 2 and 3 respectively. These parameters may vary from one utility to another. A listing for a computer program based on the equations developed in Task 1 is included in Task 6. It is recommended that this program be used to determine the total levelized annual cost of owning and operating a distribution transformer. This evaluation should aid in choosing between existing designs of different loss levels and initial costs.

For a given set of input parameters there is an optimum set of load and no-load losses which will minimize the total levelized annual cost of the transformer. This has been shown in Task 6. Table 3-6.7 shows the input data used, and Table 3-6.8 shows total levelized annual costs for different loss levels.

The values developed in Task 4 to obtain an initial transformer cost assume that the designs are produced in large quantities. Special designs could be significantly more costly. This additional cost would probably increase the total levelized annual cost above the cost of an existing design. Therefore it is recommended that the evaluation be used only in choosing between existing designs.

In Task 5, the equations developed in Task 1 were modified to evaluate the losses of the multiple efficiency transformer. These equations are summarized in Table 3-8.2. It is recommended that the method described in Task 5 be used to evaluate the losses of the multiple efficiency transformer. Although the multiple efficiency transformer does not exist now, the evaluation method described in Task 5 can be used to compare the MEX design to the single efficiency design to determine its feasibility.

A listing for the computer program used to evaluate the losses of the MEX is included in Task 7. Table 3-7.4 shows total levelized annual costs for the MEX as a function of load loss, no-load loss, index or assumed initial cost, load factor, and scenario. The values listed do not include the cost of the switch used to change modes of the MEX.

TABLE 3-8.1

SUMMARY OF DISTRIBUTION TRANSFORMER LOSS EVALUATION TECHNIQUE

TLAC = CT x CC	(investment cost)
+ (CSYSB x DISC x CC + 8760 x CEBL) x NLL	(no-load loss cost)
+ CCAPF x CC x $\sqrt{T^2 \times IO^2 - NLL^2}$	(reactive no-load loss cost)
+ $\left[CSYSP \times DISC \times CC \times PRFS^2 \times LL \right.$	(load loss demand cost)
$\left. + CCAPS \times CC \times PRFD^2 \times \sqrt{T^2 \times Z^2 - LL^2} \right] \times PEQO^2$	(reactive load loss cost)
+ $\left[8760 \times LSF \times CEP1 \times LL \right.$	(load loss energy cost)
$\left. + T \times PF \times 8760 \times REG \times LKW \times LSF \times (CCE1-CE1) \right] \times PEQE^2$	(regulation energy cost)

where:

$$PEQO^2 = \left[\frac{IP^2}{(1+GR)^2 - (1+I)} \right] \left[\frac{(1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC}} + \frac{(1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

$$PEQE^2 = \left[\frac{IP^2 (1+IRP)^{NC}}{(1+IRP)(1+GR)^2 - (1+I)} \right] \left[\frac{(1+IRP)^{NC} (1+GR)^{2NC} - (1+I)^{NC}}{(1+I)^{NC} (1+IRP)^{NC}} + \frac{(1+IRP)^{N-NC} (1+GR)^{2(N-NC)} - (1+I)^{N-NC}}{(1+I)^N} \right] \left[\frac{I(1+I)^N}{(1+I)^N - 1} \right]$$

$$CEBL = CEBF1 \left[\frac{(1+IRBF)^N - (1+I)^N}{(1+IRBF) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right] + CEBOM1 \left[\frac{(1+IRBOM)^N - (1+I)^N}{(1+IRBOM) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

$$\approx CEB1 \left[\frac{(1+IRB)^N - (1+I)^N}{(1+IRB) - (1+I)} \right] \left[\frac{I}{(1+I)^N - 1} \right]$$

* Refer to Table 3-1.1 for nomenclature for loss evaluation technique.

TABLE 3-8.2

SUMMARY OF MEX EVALUATION EQUATIONS

$$TIC = CC \times CT$$

investment cost

$$ANNUAL COSTS = 8760 \times [CEP(Y) \times LSFH(Y) \times HHH(Y) \times LLH \times P^2(Y) \\ + CEB(Y) \times HL(Y) \times LLL \times (SK/TL)^2]$$

load loss energy component LLCE(Y)

$$+ CSYSP(Y) \times DISC \times CC \times PRFS^2 \times P^2(Y)$$

load loss demand component
LLCD(Y)

$$+ CEB(Y) \times 8760 \times [HH(Y) \times NLLH \times HL(Y) \times NLLL]$$

no-load loss energy component
NLCE(Y)

$$+ CSYSB(Y) \times DISC \times CC \times NLLH$$

no-load loss demand component
NLCD(Y)

$$+ [CCE(Y) - CE(Y)] \times LKW \times PF \times 8760 \times [TH \times REGH \times LSFH(Y) \\ \times HH(Y) \times P^2(Y) + REGL \times HL(Y) \times LSFL(Y) \times (SK/TL)^2]$$

regulation energy component
RGCE(Y)

$$P(Y) = P1(1 + GR)^{Y-1}$$

$$CEP(Y) = CEP1 \left[\frac{(1 + IRP)^{Y-1}}{(1 + I)^Y} \right]$$

$$CEB(Y) = CEB1 \left[\frac{(1 + IRB)^{Y-1}}{(1 + I)^Y} \right]$$

$$CCE(Y) - CE(Y) = (CCE1 - CE1) \left[\frac{(1 + IRP)^{Y-1}}{(1 + I)^Y} \right]$$

$$CSYSB(Y) = CSYSB1 \left[\frac{1}{1 + I} \right]^Y$$

$$CSYSP(Y) = CSYSP1 \left[\frac{1}{1 + I} \right]^Y$$

$$TLAC = CC \times CT + \sum_{Y=1}^N \left[LLCE(Y) + LLCD(Y) + NLCE(Y) + NLCD(Y) + RGCE(Y) \right] \left[\frac{I(1 + I)^N}{(1 + I)^{N-1}} \right]$$

A summary of the optimum designs are included in Table 3-7.5. The total levelized annual costs and the losses of the optimum designs are, of course, functions of the input data. Table 3-7.2 shows the input data used.

Sensitivity Analysis

A sensitivity analysis was performed to find the change in total levelized annual cost (TLAC) due to changes in input variables. The reactive loss costs were not considered because these costs are small, and changes in these values would not have a significant effect on the TLAC.

A base case was established using a 25 kVA transformer. The loss levels used in the analysis are those of the optimum design based on the input parameters in Table 3-8.3. Definitions for these terms can be found in Table 3-1.1. Equations used in the calculations are shown in Table 3-8.1.

Once the base case TLAC was established, it was calculated again after increasing one input value by 10%. This was done for different input parameters while keeping all other input parameters at their base case value. The resulting changes in each component of the cost and the change in the TLAC were then tabulated. The percent change in the TLAC as a result of this 10% increase in a given input parameter was also tabulated. Only the cost components which changed from the base case value were recorded.

Many of the input parameters will cause a linear change in the TLAC. These are tabulated in Table 3-8.4. However, parameters such as GR, I, IRP, IRB, and LDF have a nonlinear effect. Therefore several values for these parameters were used to find the resulting change in TLAC. These are tabulated in Table 3-8.5.

The peak equivalent load (PEQE) will increase with increasing load growth rate if all other inputs are equal, but the number of years to change-out also have an effect. In this analysis, the transformer is assumed to be changed out in the year that the peak load becomes 180% of the transformer

TABLE 3-8.3

INPUT PARAMETERS FOR BASE CASE

CT	\$423.15
CSYSP	\$411/kW
CSYSB	\$744/kW
CEP1	\$.0557/kWh
CEB1	\$.035/kWh
CCE1-CE1	\$.0256/kWh
CC	.18 p.u.
DISC	.75 p.u.
PRFS	.75 p.u.
LSF	.135 p.u.
GR	.03 p.u.
I	.10 p.u.
IRP	.077 p.u.
IRB	.077 p.u.
NC	30 years
N	30 years
IP	.75 p.u.
REG	.014 p.u.
PF	.9 p.u.
LKW	.75 p.u.
LL	.260 kW
NLL	.090 kW
kVA	25 kVA

TABLE 3-8.4

CHANGES IN TLAC DUE TO A 10% INCREASE IN THE GIVEN PARAMETERS

LINEAR CHANGES

	TIC	NO-LOAD COST		LOAD LOSS COST		REGULATION		
		DEMAND	ENERGY	DEMAND	ENERGY	ENERGY	TLAC	% CHANGE IN TLAC
BASE CASE	76.17	9.04	60.15	8.20	50.52	21.10	225.18	-
Increase 10%								
CT	83.79						232.80	3.38%
CSYSB		9.94					226.08	.40
CSYSP				9.02			226.00	.36
CEB1			66.17				231.80	2.94
CEP1					55.57		230.23	2.24
CC	83.79	9.94		9.02			234.52	4.15
DISC		9.94		9.02			226.90	.76
PRFS ²				9.02			226.00	.36
LSF					55.57	23.21	232.34	3.18
*(PEQE) ²					55.57	23.21	232.34	3.18
*(PEQO) ²				9.02			226.00	.36
*CEBL			66.17				231.80	2.94
IP ²				9.02	55.57	23.21	233.16	3.54
REG						23.21	227.29	.94
PF						23.21	227.29	.94
LKW						23.21	227.29	.94
CCE1-CE1						23.21	227.29	.94

*Not an input but calculated from other input parameters

TABLE 3-8.5

CHANGES IN TLAC DUE TO CHANGES IN GIVEN PARAMETERS
(NONLINEAR CHANGES)

						NO-LOAD COST		LOAD LOSS COST		REGULATION	TLAC	% CHANGE
	(PEQE) ²	(PEQ0) ²	CEBL	NC	TIC +	DEMAND + ENERGY		+DEMAND + ENERGY		+ENERGY		
BASE CASE	2.95	1.01	.0763	30	76.17	9.04	60.15	8.20	50.52	21.10	225.18	-
GR (.03)												
0	1.21	.563						4.57	20.72	8.65	179.30	-20.30
.02	2.13	.813						6.60	36.48	15.23	203.67	-9.52
.04	2.80	1.08		23				8.77	47.95	20.03	222.11	-1.36
.06	2.98	1.17		15				9.50	51.03	21.31	227.21	.90
I (.10)												
.12	2.51	.949	.0704				55.50	7.70	42.98	17.95	209.34	-7.03
.08	3.49	1.08	.0838				66.06	8.78	59.77	24.96	244.78	8.70
.06	4.16	1.17	.0925				72.92	9.50	71.24	29.75	268.62	19.29
IRP, IRB (.077)												
.05	1.97		.0560				44.15		33.74	14.09	185.39	-17.67
.07	2.66		.0700				55.18		45.55	19.03	213.17	-5.33
.09	3.68		.0890				70.16		63.02	26.32	252.91	12.31
LDF(.32) LSF(.135)												
.20 .064									23.95	10.00	187.51	-16.73
.30 .121									45.28	18.90	217.74	-3.30
.40 .196									73.34	30.63	257.53	14.37

rating. Under this assumption, the peak equivalent load will decrease with increasing load growth when the number of years to changeout becomes less than 30 years.

The energy cost of regulation was included in this analysis. However, regulation need not be included in the total levelized annual cost when using the evaluation to compare transformer costs, since regulation does not vary significantly for different designs.

Life Cycle Energy

An analysis was done to determine the amount of energy that is required to produce the materials for distribution transformers. Generally, in order to manufacture a more efficient transformer, more materials must be used. To decrease load losses, more aluminum and/or copper must be used in the transformer windings. In order to decrease no-load losses, more iron in the core and/or more turns in the windings must be used.

These materials have a certain energy content--that is, energy is required to manufacture the materials. The purpose of this analysis is to determine whether the energy content of the extra materials used to produce a higher efficiency transformer is greater than the amount of energy saved in operating costs. The energy content of the principal materials used to manufacture transformers is found in Table 3-8.6. Table 3-8.7 shows the total energy content of the materials used to manufacture the respective transformers. The energy used to manufacture the transformers at the factory is included in this figure.

The table also shows the lifetime energy losses and the total amount of energy associated with the corresponding transformer. The lifetime energy losses are calculated using the following equation:

$$\text{lifetime energy loss} = [\text{NL} + \text{LL} \times \text{P}^2 \times \text{LSF}] \times 8760 \text{ hrs/year} \times 30 \text{ years}$$

A 10% loss factor and an average peak load (P) of 1.4 per unit was used in the equation.

TABLE 3-8.6

ENERGY CONTENT OF PRINCIPLE TRANSFORMER MATERIALS

<u>Material</u>	<u>Energy Content</u>	
Aluminum	2.24×10^8 BTU/TON	32.8 kWh/lb
Copper	9.32×10^7 BTU/TON	13.7 kWh/lb
Paper	1.97×10^7 BTU/TON	2.89 kWh/lb
*Steel	3.41×10^7 BTU/TON	5.00 kWh/lb
Oil	1.06×10^7 BTU/BBL	74.0 kWh/gal

*Estimate based on the energy content of steel cable.

Reference for this chart--

John J. Bzura

"An Energy Content Analysis of Electric Power Transmission Systems"

Arthur D. Little, Inc.

Acron Park

Cambridge, MA

February 15, 1979

Prepared for the U. S. Department of Energy
Contract EC-77-C-01-5043

TABLE 3-8.7

TOTAL ENERGY ASSOCIATED
WITH MANUFACTURING AND OPERATING DISTRIBUTION TRANSFORMERS

	LOAD LOSS kW	NO-LOAD LOSS kW	MATERIAL ENERGY CONTENT kWh	LIFETIME ENERGY OF LOSSES kWh	TOTAL ENERGY kWh
LOW LOSS UNITS					
10 kVA	.060	.050	4554	16230	20784
15 kVA	.100	.075	5127	24860	29987
25 kVA	.200	.060	4552	33854	38406
37.5 kVA	.400	.090	6531	44255	50786
50 kVA	.468	.146	10150	62474	72624
MEDIUM LOSS UNITS					
10 kVA	.177	.061	2307	25148	27455
15 kVA	.264	.081	3002	34885	37887
25 kVA	.376	.098	3617	45122	48739
37.5 kVA	.528	.142	5297	64514	69811
50 kVA	.685	.138	7642	71550	79192
HIGH LOSS UNITS					
10 kVA	.270	.088	1475	37034	38509
15 kVA	.420	.110	2142	50542	52684
25 kVA	.500	.150	3461	65174	68635
37.5 kVA	.660	.200	5120	86556	91676
50 kVA	.860	.220	6665	102114	108778

The analysis shows that less energy is associated with low loss designs, despite the fact that more energy is required to manufacture the low loss designs. Therefore, from a total energy standpoint, it is worth using the extra energy to manufacture a more efficient transformer.

RECOMMENDATIONS FOR FURTHER INVESTIGATION

Introduction

Recommendations for further investigation include thermal life evaluation, expanding evaluation to all transformers, determining the economics of changing out power transformers, continued evaluation of the MEX, load characteristic study, industrial and commercial load study, and public power loss evaluation. A brief discussion of these subjects follows.

Thermal Life Evaluation Based on Optimum Loading

This project dealt with an economic evaluation of transformer losses with an assumed lifetime of 30 years. However, the actual lifetime of a transformer depends on many factors, including loading and loss levels. A heavily loaded transformer will operate at higher temperatures which will cause a faster thermal degradation of the insulation. All other things being equal, a higher loss transformer will operate at higher temperatures than a low loss design.

Also, if two transformers have the same total losses but one has higher load losses and lower no-load losses, they may operate at different temperatures. The transformer with higher load losses would operate at higher temperatures when the transformer is heavily loaded. Therefore a transformer with high load losses may be subject to thermal degradation. Since these factors were not directly considered in the loss evaluation, it is recommended that a thermal life evaluation be conducted.

Expand the Analysis to All Power System Transformers

This project was restricted to the evaluation of distribution transformers rated at 50 kVA or less. These transformers are generally used to supply residential loads. The same evaluation equations can be applied to almost all transformers, including larger distribution transformers and substation transformers.

However, these transformers may experience significantly different load characteristics. For example, a much higher load factor would be expected for a larger transformer. In addition, the load growth rate and the peak responsibility factor should be higher for larger transformers. These are important factors which must be studied before attempting to evaluate the losses of transformers. Therefore it is recommended that appropriate input parameters be determined in order to evaluate the losses of all power system transformers. This recommendation applies to the multiple efficiency evaluation as well as the single efficiency evaluation.

Determine the Economics of Changing Out Old Power Transformers for More Efficient Units

Once the losses of power transformers can be evaluated, a study could be conducted to determine the feasibility of changing out old power transformers for more efficient units. Power transformers are generally very efficient, but the cost of the losses in these transformers could be significant.

Continued Evaluation of the MEX

In this project, equations were developed to evaluate the losses of the multiple efficiency transformer. The load characteristics and the cost parameters for the MEX should be the same as those for the single efficiency transformer. However, the combination of the peak load, the growth rate, and the loss factor sufficiently define the load characteristics for the single efficiency evaluation. In addition to these values, the shape of the load duration curve must be known in order to evaluate the losses of the MEX properly. The loss factor does not completely describe the shape of the curve.

In this project, the load duration curve was assumed to have log-normal distribution. This assumption was based on a limited amount of data from the field. Therefore it is recommended that the shape of the load duration curve be further investigated in order to evaluate the multiple efficiency transformer more accurately. To do this, the loads of many transformers must be monitored. Samples from different parts of the country and different types of residences should be monitored.

Load Growth Study

Although the peak load growth rate for individual utilities may be established, this probably has no relationship to peak load growth rate on individual distribution transformers. Little or no published data concerning distribution transformer growth rate is available. It can be seen from the sensitivity analysis that the growth rate is a very important factor in the loss evaluation. Therefore it is recommended that a study be conducted to determine the load growth characteristics of distribution transformers. Different factors that affect the load growth should also be determined.

Load Characteristics Study

The characteristics of transformer load cycles are a very important part of any loss evaluation. Important load characteristics are load factor, loss factor, and peak load growth rate. For the multiple efficiency transformer, the shape of the load duration curve is also important. In order to determine these variables more accurately, it is recommended that many distribution transformer loads be monitored. Samples from different parts of the country and different types of residences should be studied to see how different conditions affect each load parameter. Once this is done, a more accurate prediction of the value of these parameters for different types of loads may be possible.

Develop Load and Cost Parameters for Commercial and Industrial Load

Transformers supplying industrial and commercial loads may experience significantly different load cycles than those supplying residential loads. Therefore it is recommended that different types of commercial and industrial loads be monitored to determine the characteristics of these loads.

Determine the Proper Method of Transformer Evaluation for Public Power

This project dealt with transformer loss evaluation for investor-owned utilities. The cost structure for public-owned utilities may be different enough from private utilities to justify a study to develop a methodology for evaluating transformer losses for public utilities.

The key areas that require investigation are the load and loss factors of urban vs. rural systems, how to handle depreciation when it does not represent a tax savings, how to handle debt when the sources are low interest government guaranteed loans or municipal bonds, and how to establish the correct growth rate for public power systems' distribution transformers. A thorough study of public-owned utilities should answer these questions.

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