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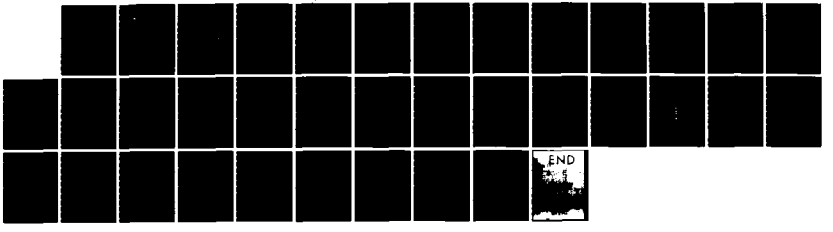

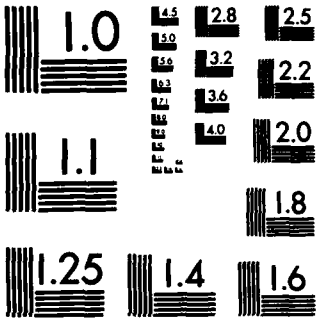

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NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

Sponsored by
NAVY ENERGY & NATURAL RESOURCES
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NAVAL FACILITIES ENGINEERING COMMAND

STATISTICAL ANALYSIS OF NAVAL ACTIVITY ELECTRICAL CONSUMPTION

June 1984

An Investigation Conducted by:
VSE CORPORATION
1200 Paseo Camarillo
Camarillo, CA 93010

N00123-82-D-0149

METRIC CONVERSION FACTORS

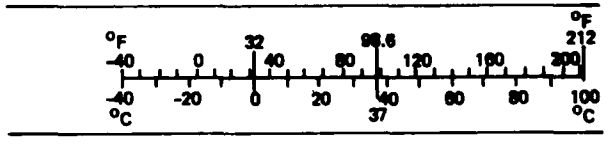
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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20 ABSTRACT (Continue on reverse side if necessary and identify by block number) The electrical consumptions of Naval shore facilities for 1983 were regressed with current square footage areas for ten different facility types. The data used was from the FACSO NFA/MAGIC and DEIS II data bases. The annual electrical consumption was found to vary from 2.4 kilowatt-hours per square foot for storage facilities to 34 kilowatt-hours per square foot for production facilities.		

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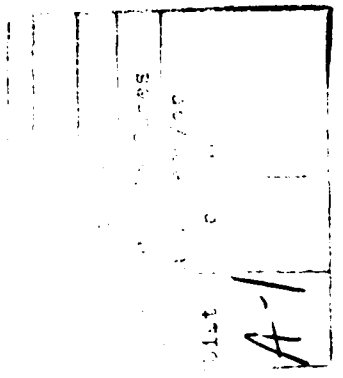

1.0 INTRODUCTION

1.1 Objectives

The year 1975 was selected as a baseline from which the Navy established goals regarding reduction in electrical consumption. Between 1975 and 1983, electrical consumption for the Navy, as a whole, rose 12.7 percent. The objective of this analysis is to identify possible explanations for this increase.

A second objective of this study is to estimate electrical consumption factors for different facility types for both 1975 and 1983. These factors will indicate the electrical consumption per square foot area of the various facility classifications.

1.2 Scope

The scope of this work involves the use of statistical regression techniques to determine the statistical linear function relating electrical consumption to the price of electricity and the change in activity square footage between 1975 and 1983. This function is then used to help explain the increase in electrical consumption from the baseline year to the present. The data used in this analysis were taken from the fourth quarter 1983 DEIS II reports and data base.

To develop electrical consumption factors, the total activity electrical consumptions for 1975 and 1983 were regressed with the current square foot areas of nine different facility types. The family housing electrical consumption factor was calculated separately. The data were collected from the FACSO NFA/MAGIC data bases and the DEIS II data base. Both the NFA/MAGIC and DEIS II data used in this analysis were from the fourth quarter of 1983.

The family housing electrical consumption factor was developed from a single linear regression of the DEIS II housing consumptions with their respective square footage areas.

1.3 Report Format

Three chapters follow this introduction. Chapter 2 describes the concepts of multiple and simple linear regression which are both used in the analysis of the electrical consumption data. An explanation of Mallow's C_p Criterion is also presented in Chapter 2. Chapter 3 discusses the different analyses performed and the results of each. Chapter 4 highlights the conclusions and makes recommendations regarding further study.

2.0 STATISTICAL REGRESSION TECHNIQUES

2.1 Simple Linear Regression

Simple linear regression is a statistical tool which utilizes the relation between two quantitative variables so that one variable can be predicted from the other. A statistical relation is unlike a functional relation in that it is not perfect. In most cases, the observations do not fall directly on the line; there is scatter. The regression line depicts the manner in which the dependent variable tends to vary with the independent variable in a systematic fashion.

In the simple linear regression model, there is one independent variable and the function is linear. The model is shown in equation 1.

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \tag{1}$$

where: Y_i is the value of the response variable in the ith trial,

β_0 and β_1 are parameters,

X_i is the value of the independent variable in the ith trial, and

ε_i is a random error term.

In most cases, the values of β_0 and β_1 are not known and must be estimated from sample data. The least squares estimates of β_0 and β_1 (b_0 and b_1) are shown in equations 2 and 3.

$$b_1 = \frac{\sum_{i=1}^{N} (X_i - \overline{X})(Y_i - \overline{Y})}{\sum_{i=1}^{N} (X_i - \overline{X})^2} \tag{2}$$

$$b_0 = \overline{Y} - b_1 \overline{X} \tag{3}$$

where: $\overline{X}$ is the average of the X_i values,

$\overline{Y}$ is the average of the Y_i values, and

N is the number of sample data points.

The expected value of the dependent variable for a given independent variable can be predicted using equation 4.

$$\hat{Y} = b_0 + b_1 X \tag{4}$$

where: $\hat{Y}$ is the predicted value of the independent variable,

X is the desired dependent variable value, and

b_0 and b_1 are the estimates of Y intercept and slope, respectively.

In many cases, the regression line is known to go through the origin. The model then becomes:

$$Y_i = \beta_1 X_i + \varepsilon_i \tag{5}$$

The least squares estimator for β_1 (b_1) is shown in equation 6.

$$b_1 = \frac{\sum_{i=1}^{N} X_i Y_i}{\sum_{i=1}^{N} X_i^2} \tag{6}$$

To measure the closeness of the relationship between X and Y, the coefficient of correlation, R, is calculated. The value of R falls between -1 and 1. The closer the absolute value of R lies to 1, the greater is said to be the degree of association between X and Y. For a simple linear regression, the coefficient of correlation is calculated as shown in equation 7.

$$R = \frac{\sum_{i=1}^{N} (X_i - \bar{X})(Y_i - \bar{Y})}{\left[\sum_{i=1}^{N} (X_i - \bar{X})^2 \sum_{i=1}^{N} (Y_i - \bar{Y})^2\right]^{\frac{1}{2}}} \tag{7}$$

2.2 Multiple Linear Regression

In a multiple linear regression model, there are numerous independent variables and the function is linear as shown in equation 8.

$$Y_i = \beta_0 + \beta_1 X_{i_1} + \beta_2 X_{i_2} + \ldots + \beta_{p-1} X_{i,p-1} + \varepsilon_i \tag{8}$$

In nearly all cases, the least squares estimates of the parameters β_0, β_1, ..., β_{p-1} are calculated using commercial computer software packages such as BMDP and SPSS. Matrix inversion is required in the solution which necessitates tremendous amounts of computation. For a more detailed discussion of multiple linear regression models, the reader is referred to reference 1.

Once the least squared estimates of β_0, β_1, ..., β_{p-1} have been calculated, the dependent variable, Y, can be estimated for given levels of the independent variables, using equation 9.

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_{p-1} X_{p-1} \tag{9}$$

The coefficient of correlation, R, indicates the reduction of the total variation in Y associated with the use of the set of X variables. When all observations fall in the fitted response surface, R assumes a value of 1. The coefficient of correlation for a multiple linear regression is calculated most efficiently through the use of a standard multiple regression software package. The equation for R-multiple is shown below:

$$R = \frac{\sum_{i=1}^{N} (\hat{Y}_i - \bar{\hat{Y}})(Y_i - \bar{Y})}{\left[\sum_{i=1}^{N} (\hat{Y}_i - \bar{\hat{Y}})^2 \sum_{i=1}^{N} (Y_i - \bar{Y})^2\right]^{\frac{1}{2}}} \tag{10}$$

where: $\bar{\hat{Y}}$ is the average of the predicted values $\hat{Y}_i$ and

$\hat{Y}_i$ is the predicted value for given values of X_{i_1}, X_{i_2}, ..., X_{ip-1}.

2.3 Mallow's C_p Criterion

A large absolute value of R does not necessarily imply that the fitted model is a useful one. Observations may have been taken at only a few levels of

the independent variables. Despite a large magnitude of R, the fitted model may not be useful because predictions would require extrapolations outside the region of observations. For any data set, adding more independent variables will increase the value of R. However, an independent variable may not be fundamental to the problem, or it may effectively duplicate another variable. The problem becomes how to shorten the list of independent variables to achieve the "best" set of independent variables.

The Mallow's C_p Criterion is concerned with the total squared error of the N fitted observations. The error, E_i, is equal to the observed minus the predicted value as shown in equation 11.

$$E_i = Y_i - \hat{Y}_i \tag{11}$$

where: $\hat{Y}_i = b_0 + b_1 X_i$

The C_p Criterion has a component which includes the sum of the error terms squared and a component with the number of independent variables (p) included in the model. The objective is to find a set of independent variables which produces a minimum C_p. All possible subsets are tested; the set of best independent variables is defined as that which produces the smallest C_p. Equation 12 shows the calculation for C_p.

$$C_p = \frac{SSE_p}{MSE_F} - (N - 2p) \tag{12}$$

where: F is the maximum number of independent variables,

SSE_p is the sum of the error terms squared for the model with p independent variables, and

MSE_F is the mean square error for the full model (all possible independent variables included) $MSE_F = SSE_F/(N - F)$.

2.4 Correlation in the Independent Variables

The coefficient of correlation, R, serves as an indication of the degree of relationship between the dependent and independent variables. It can also be used to provide information about the degree of relationship between two independent variables, X_j and X_k. The correlation coefficient for two independent variables is depicted as R_{jk} and calculated as shown in the following equation:

$$R_{jk} = \frac{\sum_{i=1}^{N} (X_{ji} - \bar{X}_j)(X_{ki} - \bar{X}_k)}{\left[\sum_{i=1}^{N} (X_{ji} - \bar{X}_j)^2 \sum_{i=1}^{N} (X_{ki} - \bar{X}_k)^2\right]^{\frac{1}{2}}} \qquad (\cdot\cdot)$$

A magnitude of R_{jk} close to unity indicates a high degree of correlation be w . the two variables.

3.0 ANALYSIS OF DATA

3.1 Description of Analyses

As mentioned in Chapter 1, the electrical consumption Navy-wide rose approximately 12.7 percent between the baseline year and the fourth quarter of 1983. To explain this relationship, several statistical analyses were performed. Each analysis will be presented in this chapter with its corresponding results. The development of the electrical consumption factors will be presented first, followed by the analysis of the change in consumption between 1975 and 1983.

3.2 Electrical Consumption Factors

The electrical consumption at any naval activity is directly related to the type, number, and size of its facilities. Data are available in the DEIS II quarterly reports that give the annual electrical consumption (in MBtus) and square foot area for each naval activity for both the current and baseline year. The activities are identified by DEIS II Unit Identification Codes (UICs); family housing activities begin with the letter D, and all the facility types are included under a UIC beginning with the letter N. For example, the DEIS II UICs for the Naval Air Station in Corpus Christi, Texas, are D00216 and N00216 for the family housing facilities and all other naval shore facilities, respectively.

The NFA/MAGIC data base, maintained by FACSO, contains information for each individual naval facility. Software was developed to extract the facility square foot areas for the UICs contained within the following states:

- Alabama
- Arizona
- California
- Connecticut
- Delaware
- District of Columbia
- Florida
- Georgia
- Louisiana
- Maryland
- Massachusetts
- Mississippi
- New Jersey
- New Mexico
- New York
- North Carolina
- Oregon
- Rhode Island
- South Carolina
- Texas
- Virginia
- Washington

This software is described in detail in reference 2. The facility types and their respective Category Code/Nomenclatures (CCNs) selected for this analysis are shown below:

Group Number	Facility Description	Prime Use CCNs
1	Port Facilities	11100-16999
2	Training	17000-19999
3	Maintenance	20000-21999
4	Production	22000-29999
5	Laboratories	30000-39999
6	Storage	40000-49999
7	Medical	50000-54999
8	Dispensaries	55000-59999
9	Administration	60000-69999
10	Troop Housing	72100-72999
11	Community	73000-79999
12	Utilities	80000-89999

Family housing facilities, CCNs 70000 through 72099, will be covered in a separate analysis because of their special classification in the DEIS II data base. The 22 states listed above contain 228 naval activities. The current facility square footage areas for each activity are shown with the total base electrical consumptions for 1983 and 1975 in Appendix A. The DEIS II data base also contains a measure of the square footage area for temporary buildings such as construction trailers which use electricity but are not contained in the NFA/MAGIC data base. The square foot areas for the temporary structures are also shown in Appendix A. To determine the electrical consumption factors for each facility type, the following model was hypothesized.

$$ELE_i = \beta_0 * SQFTOT_i + \beta_1 * SQFT1_i + \beta_2 * SQFT2_i + \beta_3 * SQFT3_i + \beta_4 SQFT4_i + \beta_5 * SQFT5_i + \beta_6 * SQFT6_i + \beta_7 * SQFT7_i + \beta_8 * SQFT8_i + \beta_9 * SQFT9_i + \beta_{10} * SQFT10_i + \beta_{11} * SQFT11_i + \beta_{12} * SQFT12_i + \varepsilon_i \quad (14)$$

where: ELE_i is the electrical consumption in MBtus for activity i minus the family housing consumption for either 1983 or 1975;

$SQFTOT_i$ is the temporary facility square footage area for activity i;

$SQFT1_i$ is the port facility square footage area for activity i;

$SQFT2_i$ is the training square footage area for activity i;

$SQFT3_i$ is the maintenance square footage area for activity i;

$SQFT4_i$ is the production square footage area for activity i;

$SQFT5_i$ is the laboratories square footage area for activity i;

$SQFT6_i$ is the storage square footage area for activity i;

$SQFT7_i$ is the medical square footage area for activity i;

$SQFT8_i$ is the dispensary square footage area for activity i;

$SQFT9_i$ is the administration square footage area for activity i;

$SQFT10_i$ is the troop housing square footage area for activity i;

$SQFT11_i$ is the community square footage area for activity i;

$SQFT12_i$ is the utility square footage area for activity i; and

ε_i is an error term.

To determine the least squares estimates of the coefficients $\beta_0, \beta_1, \ldots, \beta_{12}$, a computerized version of Mallow's C_p technique was used. The software is documented in reference 2. The "best" set results of the C_p analysis for 1983 and 1975 are contained in Table 1.

Table 1. Regression Results for Mallow's C_p Analysis

Facility Type	Variable Name	Regression Coefficient, b[MBtu/ft^2]	
		Baseline Year, 1975*	Current Year, 1983
Temporary	SQFTOT	0.140227	0.256889
Training	SQFT2	0.0878216	0.186324
Maintenance	SQFT3	0.288121	0.377864
Production	SQFT4	0.483617	0.387691
Laboratories	SQFT5	0.304718	0.336881
Storage	SQFT6	0.0250001	0.0339457
Medical	SQFT7	0.162382	0.361043
Administration	SQFT9	0.153715	0.211236
Troop Housing	SQFT10	0.186402	0.150921
Correlation Coefficient, R		0.95228	0.94370

*The current square footage areas were used for this analysis because the 1975 areas were not available.

The 1975 electrical consumptions, when regressed with the 1983 facility square footage data, should result in lower factors because less electrical consumption is spread over a larger activity square footage. For this reason, these figures should be used cautiously.

In the case of this regression, the resulting factors are overall on the high side because certain facilities were removed from the regression due to correlations with other facilities. For example, SQFT1 (port facilities) were highly correlated with storage facilities. Similarly, dispensaries (SQFT8) were strongly related to the medical facilities. Community (SQFT11) and utility (SQFT12) facilities were excluded due to a correlation with troop housing. Combining the correlated facilities gives the following facility classifications:

Variable Name	Facility Description	Prime Use CCNs
SQFTOT	Temporary Structures	--
SQFT1	Port Facilities and Storage	11100-16999, 40000-49999
SQFT2	Training	17000-19999
SQFT3	Maintenance	20000-21999
SQFT4	Production	22000-29999
SQFT5	Laboratories	30000-39999
SQFT6	Medical and Dispensaries	50000-59999
SQFT7	Administration	60000-69999
SQFT8	Troop Housing, Community and Utilities	72100-89999

Employing Mallow's C_p Multiple Linear Regression techniques to the new classifications yields the results shown in Table 2.

Table 2. Mallow's C_p Results for New Facility Classifications

Facility Type	Variable Name	Regression Coefficient, b[MBtu/ft^2]	
		Baseline Year, 1975*	Current Year, 1983
Temporary Structures	SQFTOT	0.11557	0.233444
Port Facilities and Storage	SQFT1	0.01909	0.0279635
Training	SQFT2	0.11307	0.201617
Maintenance	SQFT3	0.28415	0.373056
Production	SQFT4	0.48714	0.391705
Laboratories	SQFT5	0.30210	0.334136
Medical and Dispensaries	SQFT6	0.11959	0.297953
Administration	SQFT7	0.11529	0.174109
Troop Housing, Community and Utilities	SQFT8	0.11151	0.0943252
Correlation Coefficient, R		0.95180	0.94322

*As in the last analysis, these values were determined using the current square footage data.

These current year coefficients, when multiplied by the square footage areas will provide an estimate of the yearly base consumption in units of MBtus as shown in equation 15.

$$\hat{ELE} = 0.233444SQFTOT + 0.0279635SQFT1 + 0.201617SQFT2 + 0.373056SQFT3 + 0.391705SQFT4 + 0.334136SQFT5 + 0.297953SQFT6 + 0.174109SQFT7 + 0.0943252SQFT8 \quad (15)$$

To determine the electrical consumption factors for the family housing facilities, the DEIS II UIC data for the family housing activities were used. A simple linear regression analysis was performed on the data for both the baseline and present year. Electrical consumption in MBtus was regressed with the total square footage area for the housing activities. The data used in the analysis are listed in Appendix B. The following model was selected.

$$ELE_i = \beta_9 * SQFT9_i + \varepsilon_i \quad (16)$$

where: $SQFT9_i$ is the total family housing square footage at activity i,

ELE_i is the total electrical consumption in MBtus for activity i, and

ε_i is a random error term.

Utilizing regression software, the family housing electrical consumption factors shown in Table 3 were developed.

Table 3. Family Housing Electrical Consumption Factors

Year	Family Housing Electrical Consumption Factor, b_9 [MBtu/ft^2]	Correlation Coefficient
1975	0.122017	0.88609
1983	0.109837	0.90817

The per square foot electrical consumption appears to have decreased by 10 percent from 1975 to 1983.

3.3 Regression Analysis of Electrical Consumption Changes

To explain the average increase in electrical consumption from 1975 to 1983, the change in consumption was regressed with the following two factors:

(1) DIFF, change in activity square footage from 1975 to 1983

(2) COST, unit cost of electricity in units of $/KWHr.

Because the overall base consumption is highly related to facility square footage, the change in square footage should reflect a change in consumption. Similarly, the unit cost of electricity can be used to predict a change in electrical consumption. The unit cost of electricity is important in the decision of whether to fund energy savings alternatives. In locations where the cost of electricity is high, energy savings projects can be economically justified. Therefore, the electrical consumption should decrease in the high cost areas because energy savings programs can be justified and implemented. The change in electrical consumption can be expressed in the following ways:

(1) DELE, change in consumption from 1975 to 1983 [MBtu]

(2) PER, percent change in consumption from 1975 to 1983 [%]

(3) ESQFT, change in consumption from 1975 to 1983 per 1983 square footage area [MBtu/ft^2].

To explain the change in consumption, the following regression analyses were performed.

(1) DELE vs. COST

(2) PER vs. COST

(3) ESQFT vs. COST

(4) DELE vs. DIFF

(5) DELE vs. DIFF and COST.

The results are presented in Table 4.

Table 4. Prediction Models for Change in Electrical Consumption

Dependent Variable	Regression Relation	Correlation Coefficient, R
DELE	$50356 - 0.42530*10^6$ COST	0.1296
PER	17.779 - 132.88 COST	0.1047
ESQFT	0.04898 - 0.55615 COST	0.1111
DELE	14483 + 0.11290 DIFF	0.3690
DELE	$41612 - 0.42186*10^6$ COST + 0.11279 DIFF	0.3907

In all cases, the change in electrical consumption between 1975 and 1983 was inversely proportioned to the unit cost of electricity (COST) and directly proportional to the change in square footage area (DIFF). Although the correlation coefficients are fairly small, a slight relationship is present in each case. The models which include the change in square foot area are generally better than the models which include only cost as the independent variable.

Utilizing the fifth model, the estimated unit cost of electricity at which energy savings alternatives were justified is calculated by inserting the average change in square foot area from 1975 to 1983 (75563.38 ft^2) and setting the change in electrical consumption to zero.

$$DELE = 41612.44556 - 0.42186 * 10^6 \text{ COST} + 0.11279 \text{ DIFF}$$

$$0 = 41612.44556 - 0.42186 * 10^6 \text{ COST} + (0.11279)(75563.38)$$

$$\text{COST} = 0.119 \text{ \$/KWHr}$$

For an activity with average growth, the estimated cost for justification of energy savings alternatives was 0.119 $/KWHr.

4.0 SUMMARY AND CONCLUSIONS

4.1 Significant Results

A model which predicts the total annual base consumption was developed. The following electrical consumption factors for 1983 were calculated.

Production	0.391705 MBtu/ft^2	33.768 KWHr/ft^2
Maintenance	0.373056 MBtu/ft^2	32.610 KWHr/ft^2
Laboratories	0.334136 MBtu/ft^2	28.805 KWHr/ft^2
Medical/Dispensaries	0.297953 MBtu/ft^2	25.685 KWHr/ft^2
Temporary Structures	0.233444 MBtu/ft^2	20.124 KWHr/ft^2
Training	0.201617 MBtu/ft^2	17.381 KWHr/ft^2
Administration	0.174109 MBtu/ft^2	15.009 KWHr/ft^2
Family Housing	0.109837 MBtu/ft^2	9.469 KWHr/ft^2
Troop Housing/Community/ Utilities	0.0943252 MBtu/ft^2	8.131 KWHr/ft^2
Port Facilities/Storage	0.0279635 MBtu/ft^2	2.411 KWHr/ft^2

The storage facilities consumption factor is an order of magnitude lower than the other facilities. Production facilities use the most electricity per square foot, closely followed by maintenance, laboratory, and medical facilities.

Table 5 shows the average area for each facility type for the 228 activities included in the analysis. The percent of the total area for each of these classifications is also shown. The family housing facilities contribute the most to the square footage area. Port facilities and storage, troop housing, and maintenance facilities are also area intensive.

Using the total facility areas and the electrical consumption factors for 1983, Table 6 was developed. Several significant results should be noted.

Table 5. Average Area Per Activity for 228 Activities

Facility Type	Average Area Per Base (ft^2)	Percent of Total
Temporary Structures	48,283	3.17
Port Facilities and Storage	289,342	18.98
Training	95,249	6.25
Maintenance	245,907	16.13
Production	41,303	2.71
Laboratories	74,838	4.91
Medical and Dispensaries	48,118	3.16
Administration	103,592	6.80
Troop Houaing, Community, and Utilities	279,955	18.36
Family Housing	297,829	19.54

Table 6. Average Electrical Use Per Activity for 228 Activities

Facility Type	Rate of Use (MBtus/ft^2)	Average Activity Consumption (MBtus)	Percent of Total
Temporary Structures	0.233444	11,271	4.29
Port Facilities and Storage	0.0279635	8,091	3.08
Training	0.201617	19,204	7.30
Maintenance	0.373056	91,737	34.88
Production	0.391705	16,179	6.15
Laboratories	0.334136	25,006	9.51
Medical and Dispensaries	0.297953	14,337	5.45
Administration	0.174109	18,036	6.86
Troop Housing, Community, and Utilities	0.0943252	26,407	10.04
Family Housing	0.109837	32,713	12.44

- o Maintenance facilities consume almost 35% of the total electricity with only 16.13% of the total area.
- o Storage facilities, due to their low consumption factor, use only 3% of the total consumption while occupying 18.98% of the total area.
- o Both family and troop housing facilities use considerably less electricity proportionately than area.

Figures 1 and 2 graphically illustrate these results.

Similar coefficients were developed for the baseline electrical consumptions; however, current square footage measurements were used. This decreases the magnitude of the consumption factors, making them unrepresentative of the actual consumption factors.

The change in electrical consumption was regressed against the unit cost of electricity and the change in square foot area between 1975 and 1983. The consumption was found to vary inversely with cost and directly with change in area. A cost of 0.119 $/KWHr was estimated as the unit cost of electricity above which energy savings alternatives were economically justified.

Figure 3 uses a scatter diagram to best illustrate the unit cost of electricity versus the change in electrical consumption for each activity from 1975 to 1983. For 393 activities, the average cost of electricity was $0.0643/KWHr, and the average increase in electrical consumption was 23,000 MBtus over the period 1975 to 1983.

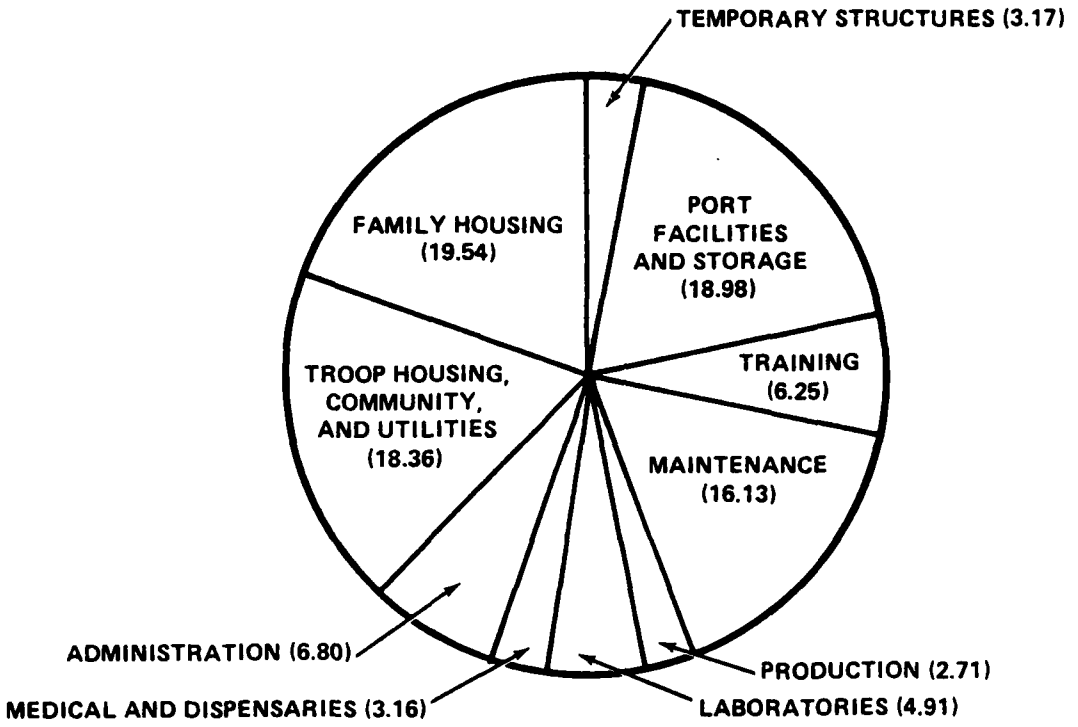

Figure 1. Mean Area Per Activity

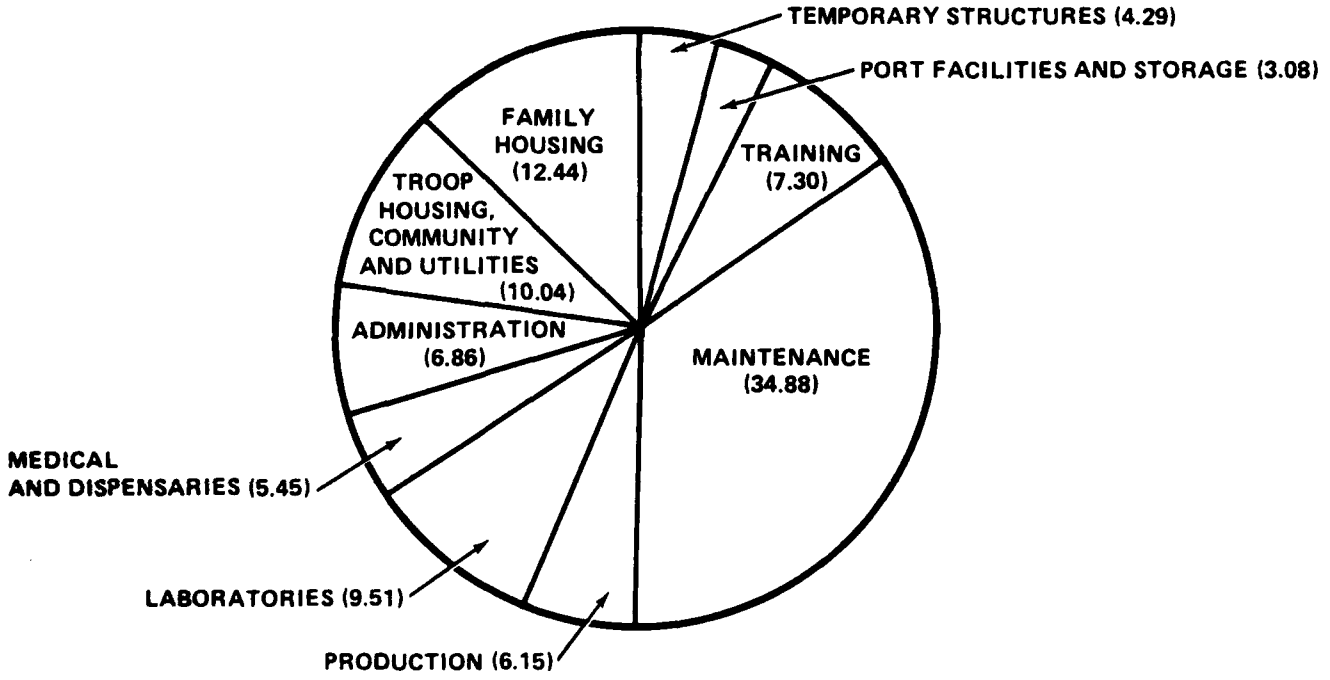

Figure 2. Mean Electrical Use Per Activity

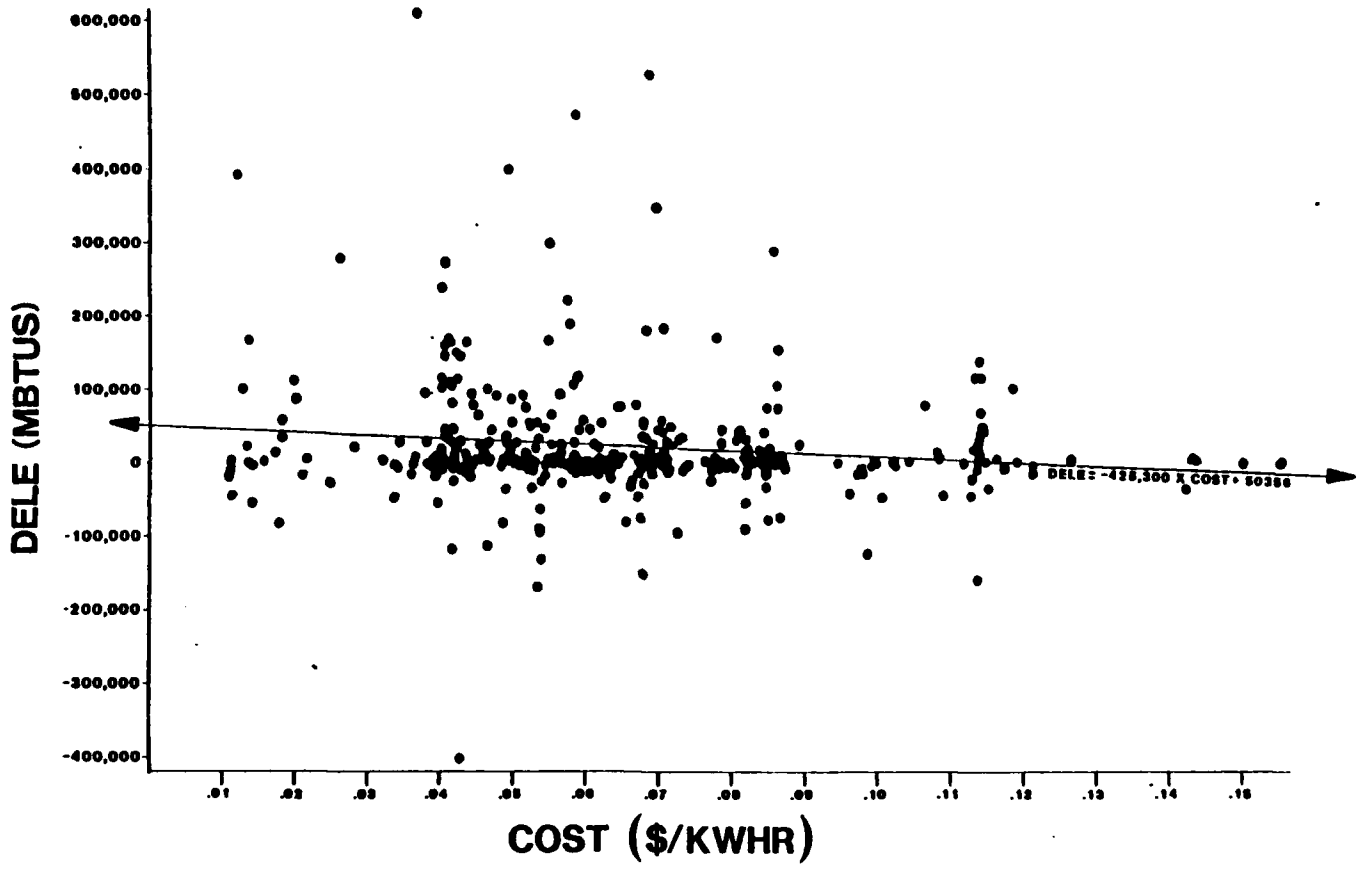

Figure 3. Change in Electrical Consumption (DELE) as a Function of Electricity Cost (COST)

4.2 Recommendations

The relationship between current electrical consumption and facility square footage area was found to have a strong correlation (R = 0.94322). If facility square footage data could be obtained for the baseline year, a similar model could be developed. A comparison between these factors would yield the best information about the increase in electrical consumption between 1975 and the present.

It is recommended that the percent model be used to determine which activities consume much greater amounts of electricity than expected, based on their facility square footages. This can be accomplished through a comparative analysis of predicted versus actual consumptions for the Navy activities included in this study.

REFERENCES

1. Neter, John and William Wasserman, Applied Linear Statistical Models, Richard D. Irwin, Inc., Homewood, Illinois, 1974.

2. deMonsabert, Sharon, A User's Guide to the Navy's Electrical Analysis Software System, developed for NCEL under Contract No. N00123-82-D-0149, Task Order J3-76, March 1984.

APPENDIX A

FACILITY SQUARE FOOTAGE AREAS

AND ELECTRICAL CONSUMPTION

Table A-1. Facility Square Footage Areas and Electrical Consumption

DEIS II UIC	1983 Electrical Consumption [MBtu]*	1975 Electrical Consumption [MBtu]	SQFTOT [ft²]	SQFT1 [ft²]	SQFT2 [ft²]	SQFT3 [ft²]	SQFT4 [ft²]	SQFT5 [ft²]	SQFT6 [ft²]	SQFT7 [ft²]	SQFT8 [ft²]	SQFT9 [ft²]	SQFT10 [ft²]	SQFT11 [ft²]	SQFT12 [ft²]
N00161	727911.6	579118.4	0.	5066	1714923	177390	12699	0	91013	0	0	266453	1561510	117911	22491
N70024	155834.4	104388.4	13061.	864	0	7904	0	409019	35771	0	0	62570	6316	60265	0
N63028	516664.0	441403.2	266270.	27472	4800	84801	301041	0	174078	0	0	61651	0	8325	17509
N00245	382486.8	334346.8	240723.	24517	93259	65313	35043	0	201824	13997	0	380268	564670	869740	8338
N61797	106047.2	63336.0	0.	0	327145	0	0	0	0	0	0	45000	0	2376	0
N63273	98994.4	71943.2	56471.	15761	0	0	0	0	0	0	0	0	0	0	0
N42237	130616.0	.0	61530.	7948	743	68267	0	0	53731	0	29821	38771	1174	59710	20291
N66081	5104.0	2876.8	0.	2066	0	0	0	0	0	0	0	0	0	0	0
N91961	1349172.8	1752180.0	3220.	11345	0	126514	3308069	132288	262402	0	0	693646	0	82328	56456
N66098	15984.8	16843.2	0.	1300	0	0	0	0	0	49863	0	0	0	0	0
N63394	61050.8	36946.0	70923.	960	0	4396	0	92930	4108	0	0	271625	0	4050	1428
N63043	322271.2	311251.2	0.	39981	193059	237580	0	0	115040	0	42084	63372	518693	200974	11593
N65889	232556.8	267206.0	169861.	0	15488	1368316	0	0	0	0	0	44500	0	0	1200
N57095	125720.8	60262.0	0.	22340	0	1474	13606	0	21130	0	0	440354	155756	47247	6544
N65492	111278.8	51643.2	0.	0	0	1440	0	0	0	224065	0	0	13713	0	8253
N00621	17887.2	16135.6	44868.	1680	2383	90644	0	0	0	0	0	17760	0	0	269
N66087	5521.6	2900.0	0.	2800	0	0	0	0	0	0	0	0	0	0	0
N66084	3839.6	2215.6	0.	2016	0	0	0	0	0	0	0	0	0	0	0
N00296	409793.2	309093.6	63255.	54731	47410	1383667	0	7600	197993	0	47736	126147	441608	430029	14349
N66022	42189.2	14186.8	57972.	0	0	10100	0	0	0	107344	0	0	0	0	0
N65923	575000.4	282181.6	0.	0	0	972007	0	0	8460	0	0	14616	0	80	2643
N60258	1510726.0	986626.4	55800.	110	1680	1836018	0	2752	855468	0	0	355763	0	95156	75466
N63822	25647.6	20752.4	-27441.	0	0	0	0	80778	0	0	0	0	0	0	0
N00153	76594.8	10080.4	0.	100	0	12460	0	0	960	0	0	0	310110	25578	0
N61690	40379.6	7064.4	61962.	0	263336	352	0	0	0	0	0	100412	0	1100	0
N68066	48047.2	38268.4	0.	10104	8304	7380	0	0	135	206399	64350	0	0	45059	1024
N63322	94621.2	112636.0	4458.	0	168792	0	0	0	0	0	0	0	0	0	0
N00281	327711.6	232255.2	11995.	96928	357057	42160	0	0	56830	0	8004	23181	546775	118959	19479
N00171	923128.0	626063.6	1324729.	159338	284456	439954	29267	83236	323786	0	0	1392895	205401	465733	126508
N63425	12296.0	11866.8	0.	7813	0	4973	0	0	0	0	0	0	0	0	723
N66095	12644.0	13247.2	-10718.	1025	800	0	0	0	0	58198	22608	0	0	0	0
N62376	474660.4	298542.4	0.	1031	0	104174	0	498203	4602	0	0	0	0	2244	24284
N64267	71931.6	41238.0	0.	10504	10974	66547	2432	288314	7700	0	3175	84126	0	40460	1625
N68356	12191.6	11043.2	54335.	0	259330	384	0	0	0	0	0	0	0	0	0
N62791	11681.2	10660.4	71519.	0	0	0	0	0	0	0	0	50614	0	26648	0
N68437	253819.6	.0	0.	0	324500	0	0	0	0	0	0	0	0	0	13809
N70092	90990.4	96314.8	0.	5646	0	9199	0	33086	0	0	0	457544	14087	40022	0
N63082	366931.2	164128.4	2120.	4088	313403	5198	0	0	39992	0	0	58946	445865	139675	0
N05864	35066.8	29800.4	0.	44763	0	0	0	0	0	0	0	0	0	0	0
N68097	249887.2	175600.8	8570.	124	44498	29220	0	0	56850	543158	0	0	102568	138217	8929
N70272	75527.6	38210.4	0.	53571	0	960	0	0	5120	0	0	0	0	0	0
N60376	262716.8	258123.2	16889.	89017	55590	387365	0	0	71653	0	31009	62559	220557	164701	10593
N96095	491086.0	448989.6	169653.	9673	0	82050	508558	55600	40871	0	462	0	0	8396	34841
N00173	1093961.2	928440.8	0.	1291	82314	131584	0	2304805	24144	0	0	245280	0	110844	24876
N62892	49972.8	38361.2	0.	46190	0	840	0	0	16415	0	0	16162	0	3457	664
N00189	551185.6	406974.4	-825(.	642032	30950	88325	548	2031	9868396	1260	4296	42077	45178	230314	18587
N70273	165624.8	151356.8	53367.	44312	0	19099	0	0	6160	0	0	3386	12824	18036	9179
N63139	14766.8	20613.2	186596.	0	4552	203852	0	0	13132	0	0	1000	0	0	0
N62285	53650.0	38802.0	12567.	792	0	2447	0	185340	456	0	0	0	0	15350	11157
N60191	732389.2	573759.2	17430.	90138	212788	953342	1013	0	202369	0	960	80735	558595	406283	23567
N62021	198893.6	188488.4	-1162.	215936	173877	142828	8540	0	19056	0	0	241409	666324	200141	1568
N63393	11530.4	13084.8	0.	0	0	0	0	0	0	0	0	57988	0	0	0
N00193	131671.6	141995.6	19551.	44766	3248	246589	14778	0	177131	0	0	59508	77490	252411	10926
N00421	769381.6	682729.6	124341.	107574	91471	1462885	23554	375708	267606	7472	0	275643	401031	475057	94219
N00215	190112.4	126312.4	122901.	26367	122863	442790	0	0	64826	0	26322	81700	149142	166101	5273
N68436	437157.6	.0	0.	45001	13972	151040	0	720	76688	5200	29520	203700	254303	283264	70157
N65584	20586.8	18270.0	5300.	0	0	62114	0	0	0	0	0	12960	0	0	0
N66001	518153.6	400559.6	196315.	19366	2233	37274	5120	1379723	8821	0	0	94713	0	10621	2424
N62661	278242.4	242405.2	87684.	38206	537714	248180	0	0	275166	0	0	122543	852662	431768	97183
N63408	83984.0	69519.6	0.	280	97645	108531	0	0	5732	2060	0	78320	224978	82243	0
N00204	425244.4	378238.8	13600.	78284	349087	466658	18277	0	956857	903	0	678398	974310	878156	8824
N91041	328813.6	339285.2	19032.	0	0	0	451214	0	24600	0	0	337258	0	1504	0
N60508	266672.4	209960.0	11908.	35783	130744	326487	0	0	57602	0	31968	40792	473180	223203	40376
N66005	11959.6	12307.6	0.	2809	0	0	0	0	0	0	0	0	0	0	0

*Conversion factor: 11.6 MBtu = 1 MWHr

Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DEIS II UIC	1983 Electrical Consumption [MBtu]*	1975 Electrical Consumption [MBtu]	SQFTOT [ft²]	SQFT1 [ft²]	SQFT2 [ft²]	SQFT3 [ft²]	SQFT4 [ft²]	SQFT5 [ft²]	SQFT6 [ft²]	SQFT7 [ft²]	SQFT8 [ft²]	SQFT9 [ft²]	SQFT10 [ft²]	SQFT11 [ft²]	SQFT12 [ft²]
N00750	113506.0	20961.2	-47913.	0	397021	0	0	0	0	0	0	161961	0	0	0
N00396	29870.0	24974.8	38340.	12000	0	196633	0	0	10719	0	2644	17266	18282	31324	4398
N00028	194404.4	238577.2	11000.	69492	551443	25927	0	21670	165982	0	73037	427174	724648	575170	14967
N61414	478458.4	364019.6	226309.	270360	318889	331559	0	0	145892	0	0	180698	842172	722091	64892
N65928	628530.0	773267.8	2931.	9145	839173	88894	8677	0	140695	22029	86804	244830	1953247	1016554	11783
N00236	282402.0	394887.2	-111839.	66043	1280	897380	2864	0	435201	10248	39130	189421	656523	600440	5241
N62906	13827.2	23211.6	25918.	0	0	0	0	0	0	0	0	82630	0	0	0
N68258	14430.4	16031.2	9990.	0	235224	5724	0	0	0	0	0	0	0	0	448
N60530	942407.2	988737.6	18174.	73956	19633	557682	6240	1674162	248742	0	31089	205658	286067	327681	49221
N62741	52223.2	62442.8	0.	0	72664	4342	0	0	0	0	9893	14270	117301	84389	4089
N60259	660689.6	560280.0	-5478.	97171	322765	1229928	11102	22140	535345	1724	20200	131919	673205	790196	41450
N00255	114712.4	118876.8	252451.	21012	257686	119778	0	12719	438240	0	33992	363069	54311	380346	6606
N60241	257056.0	268366.0	14821.	46733	86163	388138	960	0	69608	0	26627	41027	305384	206775	14205
N92782	84587.2	62883.6	0.	0	0	28620	109968	2911	0	0	0	300	0	438	1226
N32528	15254.0	6681.8	17430.	0	0	0	0	0	0	0	59200	0	0	0	0
N00167	332409.6	290812.0	2800.	0	0	32235	0	1305277	42792	0	1080	39409	0	13640	15607
N00213	521605.6	568980.0	56700.	170436	178501	552086	0	172686	317848	0	18792	328813	649274	426050	48226
N00788	86872.4	63869.6	476.	0	960	4046	0	0	9010	0	0	108464	77922	36365	9157
N63891	88914.0	93275.6	8000.	51299	0	12880	0	0	4998	0	2465	5129	50239	51681	9448
N68084	129827.2	135279.2	0.	0	0	0	0	0	40438	367688	48262	0	29304	0	0
N68093	175044.0	69344.8	-17502.	5280	0	11192	0	0	48271	846389	76544	3663	108307	14181	4412
N68890	84032.0	71630.0	384.	21027	49202	416775	36738	0	335489	11008	36185	35687	269125	518137	409
N62887	962.8	1206.4	0.	0	0	0	0	0	0	0	0	41371	0	0	0
N00196	57246.0	53510.8	7965.	5866	29915	135162	653	0	54591	0	24050	15300	83830	44476	5736
N62795	15184.4	22828.8	0.	0	0	0	9250	0	0	0	0	0	82500	0	0
N68441	3897.6	452.4	1170.	0	0	0	0	0	0	17802	0	0	0	0	0
N61720	33721.2	28605.6	0.	0	168506	3649	0	0	2123	0	0	392	24662	90531	0
N65918	76594.8	59600.8	480.	0	0	323288	0	0	1266	0	0	33444	0	0	0
N55631	22712.8	32306.0	13087.	0	0	110109	0	0	0	0	0	0	0	444	704
N63387	66653.6	36238.4	176161.	14072	420	464048	64	46337	14975	0	0	110570	0	169506	114106
N63126	735300.8	690872.8	130562.	191930	44068	801127	2450	1153539	226039	0	19020	366986	374227	263417	40600
N61165	225585.2	279745.6	1912.	80491	124310	124050	0	1863	7237	19951	0	142074	648367	486040	6118
N00181	1452702.8	846138.8	56973.	2587	34883	3277327	0	121	1709371	0	45187	688189	306307	389764	96172
N00247	482026.4	413366.0	-43208.	1570	1134191	96387	1920	0	136685	0	0	182103	2269520	747579	9688
N00228	350528.8	243089.6	-318438.	427822	158254	348402	183446	903	8746787	8900	7726	536972	0	806825	38065
N64619	200308.8	171656.8	2000.	0	280898	210	0	0	144	0	0	0	0	0	0
N62701	12713.6	10927.2	0.	3200	0	2810	0	64025	832	0	0	0	0	445	895
N00886	309418.4	363230.8	0.	188354	0	198576	0	0	5424394	0	7530	82225	79463	113983	5324
N00101	100166.0	78613.2	0.	22637	8000	383233	0	0	67851	0	13255	28394	117700	60424	19413
N57056	17214.4	14917.6	0.	17498	0	8455	0	0	4200	0	744	0	25167	25982	744
N66079	1948.8	1948.8	0.	2066	0	0	0	0	0	0	0	0	0	0	0
N62578	65760.4	217407.2	1319.	80593	226414	200928	0	0	1952196	0	629	297945	292974	232023	15934
N62339	15126.4	10428.4	0.	206	0	62149	0	6463	1346	0	0	0	0	60	6598
N61665	127646.4	138109.6	23310.	10912	181481	4723	0	324	520	0	0	37689	0	3866	200
N65765	7331.2	6020.4	17479.	18783	0	21303	0	0	14289	0	0	2505	0	6861	1530
N63402	433132.4	116614.8	107253.	35751	2399	358897	0	0	289774	0	0	74200	0	1750	18498
N0464A	5440.4	4384.8	4500.	0	0	22705	0	58953	14765	0	0	21491	0	1830	170
N00124	69031.6	49694.4	0.	0	388861	0	0	0	30000	0	0	0	0	215042	0
N00162	14500.0	24081.6	0.	0	0	0	0	0	0	5555	116656	0	21449	0	0
N00206	241535.2	150544.8	35126.	64128	41490	504405	0	0	89997	0	18822	49372	116624	63536	3807
N00174	109527.2	88171.6	225982.	4590	48334	280652	595683	431376	223710	0	9525	172624	88275	122423	114270
N00948	135279.2	95502.8	-3688.	82	286498	18892	7974	0	0	0	6130	32295	135095	404	2092
N61726	29116.0	9686.0	-5251.	0	22693	0	0	47186	0	129853	10482	19380	0	0	0
N68085	146902.4	105768.8	22554.	0	0	16431	0	0	0	386873	52000	0	21190	11169	390
N62583	287111.6	259700.8	-13536.	217152	348606	363240	4800	48765	1772312	8590	75188	425048	410953	518986	31272
N61337	96952.8	68544.4	911.	0	0	15208	0	0	527	361668	0	0	81647	22890	7719
N10151	24360.0	9022.8	0.	0	56101	0	0	0	0	0	0	0	0	0	120
N68357	23142.0	19105.2	0.	0	635114	13645	0	0	0	0	0	0	0	144	869
N00244	224286.0	146972.0	57775.	335438	8140	130029	0	2766	3121333	2304	0	399551	0	2071	1486
N00191	1082848.4	1075923.2	5498.	1608	58218	2052790	2160	3600	299780	0	0	623554	560	284650	100263
N68378	41307.6	38117.6	114382.	5606	0	195108	826	0	1575	0	0	3104	0	2665	34939
N90845	674698.0	857367.8	110330.	2600	0	18864	1281067	0	413289	0	0	0	0	1187	9958
N70240	105028.4	69484.0	66659.	63233	0	28642	0	0	2531	0	0	0	5750	14310	0
N00408	76028.4	44091.6	-39117.	26311	0	0	0	0	936132	0	0	0	0	0	0

*Conversion factor: 11.6 MBtu = 1 MWHr

Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DEIS II UIC	1983 Electrical Consumption [MBtu]*	1975 Electrical Consumption [MBtu]	SQFTOT [ft²]	SQFT1 [ft²]	SQFT2 [ft²]	SQFT3 [ft²]	SQFT4 [ft²]	SQFT5 [ft²]	SQFT6 [ft²]	SQFT7 [ft²]	SQFT8 [ft²]	SQFT9 [ft²]	SQFT10 [ft²]	SQFT11 [ft²]	SQFT12 [ft²]
N60200	634844.8	415813.6	151255.	100129	224945	1064121	0	0	188403	0	46800	120394	616346	245830	27952
N65887	771608.8	626284.0	8764.	442	0	2496814	0	0	0	0	0	31845	0	0	7459
N68306	12516.4	13212.4	0.	460	312112	7800	0	0	0	0	0	0	0	0	12368
N63099	20543.6	24302.0	-22534.	0	0	130930	0	0	0	0	0	42780	0	0	480
N63042	425731.6	508080.0	64255.	36907	153846	833559	984	0	270504	0	0	46273	662803	412370	37707
N00203	216676.4	53719.6	5956.	0	36245	0	0	194363	800	318094	43933	11944	31010	3622	3780
N68438	231130.0	.0	0.	6407	0	421248	0	0	43058	0	0	0	0	0	10308
N65888	753675.2	745856.8	249806.	0	0	2141566	0	0	0	0	0	204390	909	319	0
N63061	12562.8	20172.4	0.	21310	0	0	0	0	0	0	0	0	0	0	0
N66818	269027.2	224796.4	15880.	0	66272	60435	0	0	60680	978406	0	21080	85140	84505	22776
N00251	2063616.8	1489173.2	834368.	13144	49829	2559726	14792	0	747289	22850	12254	633711	214069	592057	121121
N00129	434153.2	64426.4	69620.	53059	19200	276872	0	1344	261271	0	0	243216	714135	441697	62526
N67230	6646.8	7157.2	0.	10599	0	0	0	0	0	0	0	0	77597	0	0
N00178	384888.0	307608.8	134466.	71261	0	87671	0	640781	122552	0	8856	62832	59017	108198	11686
N57054	12713.6	13583.6	125.	10116	1940	7689	0	0	2986	0	0	2628	19798	14139	1925
N68359	19499.6	10428.4	600.	0	256474	14253	0	0	0	0	0	0	0	0	0
N61339	88809.6	67104.4	11731.	0	640	0	0	91897	76000	0	0	179172	0	0	4296
N65980	70655.6	22701.2	98989.	320	0	41774	6700	70260	280	0	0	97514	0	5918	487
N63094	13502.4	18084.4	0.	0	382205	8550	0	0	0	0	0	31950	0	0	0
N62383	22399.6	19024.0	214901.	0	0	10116	0	0	11156	0	0	0	0	0	0
N66097	10474.8	5672.4	3214.	0	0	0	0	0	0	41400	0	0	0	0	0
N90691	113413.2	125825.2	0.	0	0	0	0	23449	1216	0	0	0	0	1048	0
N00207	849514.4	667301.6	225040.	136840	203953	1109864	10777	1008	1408532	26175	0	257748	595838	975145	57600
N60036	161298.0	138863.6	0.	136398	10251	369787	3679	3234	350058	0	10444	80076	35472	74884	17291
N42063	37700.0	16727.2	8000.	19897	0	0	0	0	0	0	0	0	0	0	0
N00109	293712.0	275117.2	0.	213818	4261	889511	359382	91202	817061	0	17102	141172	122207	128943	27556
N68836	4419.6	.0	0.	12777	0	16769	0	0	8425	0	0	4586	0	13131	8001
N68520	28014.0	.0	0.	0	0	0	0	0	0	0	0	181322	0	0	0
N39142	11484.0	11820.4	0.	7756	0	640	0	0	100	0	0	0	0	0	0
N62604	222476.4	242324.0	10574.	110027	240838	171910	0	0	1232725	0	22378	208422	464911	212062	8479
N68322	77708.4	44207.6	0.	37977	91001	2526	0	0	49325	0	0	260513	71447	71272	2312
N00187	706938.8	435626.4	2483235.	50448	82709	424606	0	55466	73595	21012	65800	227393	0	514288	214954
N00168	1105839.6	417391.2	88629.	0	830965	77081	0	166492	21085	1571227	17420	194915	217512	1126693	28555
N00612	120802.4	111336.8	0.	58697	0	4456	26720	0	1381268	0	0	32109	0	3591	690
N62603	24696.4	25902.8	3720.	0	134240	0	0	0	4088	0	0	0	0	0	800
N68090	188012.8	201944.4	0.	0	0	0	0	0	2472	411088	0	0	19456	4724	0
N61533	78590.0	177549.6	58517.	5235	2700	27208	0	407037	36300	0	0	2584	0	9343	216
N60042	142749.6	151913.6	1700.	34154	4920	329511	1178	9018	75214	0	10357	24345	135776	155282	23670
N62759	14824.8	23130.4	0.	0	0	0	0	95525	0	0	0	23501	0	0	0
N95918	226362.4	200076.8	0.	1148	0	32181	157786	209372	138114	0	0	96969	0	9454	9349
N00216	407438.4	430290.4	3000.	35326	131544	759407	8439	0	819885	9905	0	184724	488840	490059	38317
N66060	12272.8	12690.4	0.	2282	0	0	0	0	0	0	0	0	0	0	0
N66604	438085.6	191701.6	10200.	27945	60530	151740	0	645921	64110	0	1480	150990	50390	324	0
N65114	17423.2	19464.8	-6453.	6603	0	172982	0	0	0	0	0	28806	0	18318	147036
N68307	23258.0	33396.4	0.	0	353288	3170	0	0	100	0	0	0	0	540	0
N66898	123806.8	.0	0.	0	0	0	0	0	0	226059	0	0	0	0	5617
N62844	28675.2	39706.8	0.	139505	0	0	0	1248	0	0	0	0	0	0	0
N61174	71827.2	108239.6	0.	21632	0	80767	0	0	35244	0	0	481267	48115	165290	7169
N68350	16321.2	24394.8	0.	4264	366988	17052	0	0	4512	0	0	0	2045	0	0
N57055	13224.0	11530.4	0.	9506	0	9402	0	0	2716	0	0	0	21769	13583	1323
N68306	8468.0	9570.0	336.	0	183456	21600	0	0	4252	0	0	8950	0	0	0
N57074	192629.6	146716.8	0.	172875	0	0	0	0	0	0	0	0	0	0	0
N63401	74321.2	24174.4	0.	0	128562	0	0	0	0	0	0	0	0	0	0
N00072	50587.6	32932.4	118169.	0	10440	0	0	0	0	0	0	0	0	0	0
N00285	95305.6	111706.0	3000.	0	800	2064	0	0	500	227457	0	0	0	944	2124
N66082	211781.2	205273.6	0.	11330	0	0	0	0	0	0	0	0	0	0	0
N35723	5776.8	.0	1400.	0	0	0	0	0	0	16068	0	0	0	0	0
N32575	18954.4	5011.2	18500.	0	0	0	0	0	0	0	52650	0	0	0	0
N00205	268621.2	233334.0	-281859.	14541	11378	77124	0	0	552457	0	0	679273	124133	711172	2665
N63134	143294.8	49021.6	0.	72324	0	3602	0	2500	0	0	0	27460	0	0	0
N68305	16796.8	19418.4	6207.	4920	0	286	0	102792	0	0	0	87068	0	80	5568
N68056	228311.2	213498.0	125239.	121	8832	16468	0	6784	0	625445	341768	64213	187432	82757	939
N60201	494902.4	307771.2	18500.	71850	11480	282999	96	543	61831	720	0	124891	135857	311694	29733
N00267	18216.8	32213.2	0.	2150	0	2361	0	0	4526	30106	99910	0	5880	2152	0

*Conversion factor: 11.6 MBtu = 1 MWHr

Table A-1. Facility Square Footage Areas and Electrical Consumption (Continued)

DEIS II UIC	1983 Electrical Consumption [MBtu]*	1975 Electrical Consumption [MBtu]	SQFTOT [ft²]	SQFT1 [ft²]	SQFT2 [ft²]	SQFT3 [ft²]	SQFT4 [ft²]	SQFT5 [ft²]	SQFT6 [ft²]	SQFT7 [ft²]	SQFT8 [ft²]	SQFT9 [ft²]	SQFT10 [ft²]	SQFT11 [ft²]	SQFT12 [ft²]
N62798	30090.4	124711.6	0.	0	0	5000	0	8440	276400	0	0	0	0	3200	616
N68095	77024.0	21146.8	0.	36	0	0	0	0	5524	256800	0	0	22356	1580	0
N00253	407368.8	320090.4	605.	103906	9769	527488	150071	74062	386087	0	2382	79414	36946	31370	27442
N68331	17608.8	22875.2	0.	1320	348572	6207	0	0	0	0	0	25482	20347	0	440
N68094	149918.4	152772.0	2675.	0	0	12143	0	0	96	466975	0	0	53955	28947	19787
N62688	351712.0	252021.6	443000.	61796	70153	81179	0	0	42700	67400	0	336292	1082716	766021	946
N00620	498985.6	389458.4	-4581.	149789	196622	714000	0	0	164007	0	0	112983	597620	531231	24265
N66843	19963.6	15671.6	0.	0	0	0	0	0	10080	0	0	0	0	109393	882
N57053	40658.0	43838.4	100.	34942	2690	11565	0	0	3744	0	1779	4135	33911	19969	3473
N0552A	169916.8	162492.8	0.	51132	0	13814	0	0	0	0	0	2620	3538	24264	7768
N93880	84506.0	165810.4	35307.	0	0	0	0	272942	954	0	0	0	0	827	2073
N00182	51074.8	20532.0	0.	0	1596	169663	10992	16000	350010	0	0	93749	0	13304	9799
N00849	65853.2	86002.4	0.	41702	1920	20309	812	0	8098	0	0	12312	38013	48836	5313
N60478	145417.6	102381.6	52952.	63506	50628	294013	21373	61206	285268	0	0	68369	85726	150649	15328
N65885	614695.6	522997.6	214613.	0	23049	2051357	0	0	0	0	0	0	0	0	7802
N68328	19082.0	20334.8	1908.	3885	346508	32623	0	0	4330	1440	0	0	0	28	7036
N60921	295985.6	313269.6	5024.	67037	0	34843	0	1006673	30364	0	0	130075	0	51230	34787
N30018	14233.2	12702.0	24761.	0	0	0	0	2000	0	0	0	0	0	0	0
N91285	398100.4	473222.0	25722.	0	0	0	560394	221592	36282	0	0	1200	0	1192	1852
N00221	1503696.4	1114040.8	101993.	146589	120584	3236524	164149	1784	1928976	0	15114	525762	0	211318	144017
N35328	215516.4	191922.0	-5446.	36197	0	23696	0	0	2217	0	0	0	13114	6863	1771
N67030	7238.4	4071.6	0.	0	2150	11712	0	0	64	0	0	1909	133150	4699	0
N62271	160555.6	129850.4	0.	500	645212	45009	0	0	7149	0	0	269585	94850	109695	8142
N68335	290696.0	260327.2	69390.	19425	13445	473288	0	816088	138743	6650	16142	215183	184744	183248	42038
N63290	125477.2	103251.6	400.	0	340242	0	0	0	881	0	0	50264	168774	36	273
N62640	6820.8	5498.4	3800.	4893	149895	0	0	0	0	0	0	0	0	892	580
N66086	3735.2	3082.4	0.	2793	0	0	0	0	0	0	0	0	0	0	0
N61331	160938.4	107729.2	16133.	1796	59266	37213	0	258445	26084	0	4481	136791	73755	54412	8582
N00188	501746.4	389818.0	0.	267746	208052	944493	0	0	555002	0	0	243352	620110	158132	7960
N00246	803358.0	691487.6	90923.	194658	452275	1384079	797	3038	938554	0	13022	657519	938833	649400	11969
N57011	8328.8	11147.6	7410.	0	0	0	0	0	0	0	0	46410	0	0	0
N93055	964447.2	616598.0	173058.	6000	29972	28427	755872	415764	162535	0	0	62498	0	8906	1233
N60701	182839.2	134223.6	94945.	25813	24435	736403	136098	0	209068	0	9001	76381	57326	38358	16562
N68311	160335.2	191063.6	414.	0	136495	103445	0	0	1590	24648	24728	115584	312646	709484	2429
N65886	458002.8	400852.4	41934.	0	0	1361220	0	0	0	0	0	35005	0	0	36
N62474	27457.2	22225.6	4134.	0	47319	8610	4000	0	0	0	0	196438	0	0	745

*Conversion factor: 11.6 MBtu = 1 MWHr

APPENDIX B

FAMILY HOUSING SQUARE FOOTAGE AREAS

AND ELECTRICAL CONSUMPTION

Table B-1. Family Housing Square Footage Areas and Electrical Consumption

DEIS II UIC	1983 Area [ft^2]	1983 Electrical Consumption [MBtu]	1975 Area [ft^2]	1975 Electrical Consumption [MBtu]
D00620	1761235	313420.4	1734276	359310.0
D00207	559103	67848.4	523000	63544.8
D00174	453304	29394.4	419648	29174.0
D57075	265068	27840.0	303823	32990.4
D68101	38094	1740.0	38094	1925.6
D63032	1209528	128064.0	1183612	65134.0
D63126	1367491	77963.6	1367491	89992.8
D65928	1424251	297447.2	1020869	204786.4
D00743	0	.0	198560	39741.6
D00129	3536518	298120.0	2932943	244620.8
D00178	321120	39115.2	271027	35751.2
D00216	1184505	164685.2	1170147	212303.2
D60200	467358	73184.4	127583	25682.4
D57041	0	.0	38186	5997.2
D57056	50682	10706.8	49966	12783.2
D60036	174014	12400.4	173544	11275.2
D00109	511110	67999.2	341755	44973.2
D62735	179745	9488.8	279863	30658.8
D00168	28066	1786.4	28000	2018.4
D00205	425607	61224.8	176000	28559.2
D60478	105455	6264.0	102203	6264.0
D00702	203892	20149.2	151572	10776.4
D68311	2295072	151217.6	2310773	134954.4
D62661	2827596	115918.8	2496431	124595.6
D62395	4480921	1065958.8	3989259	1156728.8
D00197	22233	2528.8	22282	2076.4
D68330	39708	8700.0	48708	3398.8
D00886	107963	4234.0	97108	4303.6
D00181	559363	64960.0	624588	54253.2
D62507	716443	65609.6	385446	56155.6
D57054	29925	1914.0	29125	2900.0
D66833	560094	88670.4	604847	104806.0
D60087	909963	114155.6	914145	114480.4
D57040	0	.0	37677	4883.6
D35328	36980	2714.4	36990	4628.4
D70310	64876	4883.6	44625	6090.0
D70278	100060	11054.8	99989	14233.2
D00104	180701	9871.6	176950	11066.4
D00421	1071049	122612.0	992129	96430.8
D63891	209730	34498.4	191390	40368.0
D68436	2209960	396882.4	579224	90201.6
D00788	43563	5278.0	43663	6159.6
D57049	37024	12249.6	37024	7308.0
D65114	1191353	109260.4	1221121	113888.8
D0534A	88082	10266.0	87550	10869.2
D00389	1540523	340309.2	1383000	362047.6
D63042	2125231	400988.8	2125231	239087.6
D62585	109776	649.6	0	.0
D00164	98467	7319.6	96812	9639.6
D60201	1536651	318512.8	948365	204809.6
D62863	1113849	21831.2	1118848	696.0
D60508	677138	65192.0	673584	73010.4
D66818	46004	3897.6	42275	3642.4
D62741	85753	7052.8	85753	9639.6
D61174	1024081	50692.0	1021283	50158.4
D00296	590273	45796.8	621018	43836.4
D62271	1270004	81234.8	1235025	73451.2
D60462	1066078	.0	899685	.0
D00102	440660	31958.0	269861	26030.4
D57055	41811	7180.4	41811	8711.6
D62995	171917	18560.0	171917	23130.4
D00025	0	.0	2171000	122530.8
D68335	343016	61097.2	343000	36888.0
D00187	4708978	599592.4	3468373	362569.6

Table B-1. Family Housing Square Footage Areas and Electrical Consumption (Continued)

DEIS II UIC	1983 Area [ft^2]	1983 Electrical Consumption [MBtu]	1975 Area [ft^2]	1975 Electrical Consumption [MBtu]
D00161	996106	78520.4	996106	55320.4
D62269	363206	36876.4	338000	31436.0
D00396	13953	1160.0	13953	997.6
D61414	1563382	196515.6	1507699	189033.6
D57053	80716	3584.4	37800	1774.8
D00383	35768	7424.0	36408	6484.4
D63038	88291	6658.4	63566	3572.8
D60514	1381927	.0	1401321	.0
D60042	224960	23072.4	310914	38326.4
D62604	182411	29255.2	8797	626.4
D42237	455984	40066.4	0	.0
D32960	30470	13827.2	5400	429.2
D00215	19130	2122.8	18600	2714.4
D63427	246673	43302.8	260115	40379.6
D00153	9783	696.0	0	.0
D65113	3358577	237092.4	2933494	203649.6
D60376	490165	84053.6	501584	81664.0
D00221	1251121	61700.4	1406741	75782.8
D00171	606944	67999.2	651701	94029.6
D63395	114181	25891.2	44800	8874.0
D60495	374941	23084.0	344895	19766.4
D00255	365877	53209.2	362624	69263.6
D61331	87635	16541.6	87635	16216.8
D00213	2668474	370770.8	2057822	532184.8
D68378	4849004	305474.4	4784144	387440.0
D00639	1328549	175948.8	1245221	145290.0
D00158	19759	2911.6	19759	788.8
D00173	36586	3619.2	41866	1589.2
D62285	16987	.0	14467	.0
D00193	3788098	459255.6	2712811	369529.6
D63073	286429	46910.4	198732	10672.0
D63387	8901161	572042.4	6099000	434756.4
D66754	205414	44752.8	203814	59624.0
D00275	74679	4164.4	164000	6913.6
D62808	2473765	330565.2	2164262	420766.8
D60530	1460925	135186.4	2980785	213057.2
D61533	28602	2064.8	0	.0
D0417A	0	4118.0	0	3886.0
D60701	18663	649.6	18663	1090.4
D32778	75452	3909.2	75452	5417.2
D65115	2485237	267542.4	2518170	278864.0
D00151	1591117	150104.0	1006438	93298.8
D00281	43155	6588.8	43155	8456.4
D00206	305604	46052.0	14000	1995.2
D63043	697933	84703.2	446071	57153.2
D00196	14382	1310.8	14382	1948.8
D62578	25827	1206.4	200000	8990.0
D65995	86474	23640.8	0	.0
D60259	120330	5115.6	122847	12249.6
D60241	302291	43766.8	304978	54021.2
D61337	67548	9500.4	79478	8062.0
D62583	979168	46098.4	774152	42931.6
D68349	51458	6751.2	76238	8665.2
D62588	546205	48464.8	183088	16193.6
D62755	9188808	1235806.0	8565358	1313560.8
D00101	387343	24313.6	432913	22318.4
D60191	1464464	123412.4	1469873	127808.8
D62481	521575	12330.8	199127	.0

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