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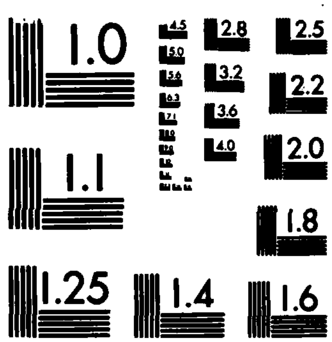


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

# AN INVESTIGATION OF FACTORS AFFECTING THE SUCCESS OF FACILITY ENERGY CONSERVATION AT AIR FORCE INSTALLATIONS

THESIS

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Captain, USAF

AFIT/GEM/DET/85S-15



DEPARTMENT OF THE AIR FORCE
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AFIT/GEM/DET/85

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AFIT/GEM/DET/85S-15

# AN INVESTIGATION OF FACTORS AFFECTING THE SUCCESS OF FACILITY ENERGY CONSERVATION AT AIR FORCE INSTALLATIONS

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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In Partial Fulfillment of the

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Master of Science in Engineering Management

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John H. Morrill

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## Abstract

This investigation studied numerous factors affecting facility energy conservation at Air Force installations. As of 30 Sept 1984, the Air Force has collectively achieved a 14.1 percent reduction in facilty energy consumption which is far short of the 20 percent goal set for FY85. A clear understanding is needed as to why certain bases have successful energy conservation programs and others do not.

The study was accomplished by a statistical analysis of a multiple linear regression model based upon energy and weather data collected on 77 bases during the years 1980 through 1984. The investigation considered 27 variables believed to affect energy conservation. The results indicated nine independent variables have a significant linear effect on energy conservation at a 0.05 level of significance. These variables include cooling degree days, costs of EMCS and ECIP projects, square footage, change in square footage from the baseline, difference between the baseline weather and the 20-year average, climatic zone 2, and bases within the Tactical Air Command.

It was concluded that the present method used to measure energy conservation does not provide a true indication of a base's energy conservation efforts. The current method fails to consider the effect of numerous uncontrollable factors affecting energy conservation. In particular, variations between the weather during the current year and the baseline year are not accounted for.

AN INVESTIGATION OF FACTORS AFFECTING THE SUCCESS OF FACILITY ENERGY CONSERVATION AT AIR FORCE INSTALLATIONS

# I. Introduction

## Statement of the Problem

The Air Force has been actively pursuing energy conservation since the realization that the nation's energy supply was uncertain as a result of the 1973 oil embargo. Executive Order 12003 established a goal for fiscal year 1985 of a 20 percent reduction in facility energy use per gross square foot as compared with fiscal year 1975. As of 30 September 1984, the Air Force has collectively achieved a 14.1 percent reduction. With the FY1985 goal less than a year away, it seems apparent the Air Force will not meet this goal.

Although several bases have surpassed the goal, the majority of the bases have fallen short. A clear understanding is needed as to why certain bases have successful energy conservation programs and others do not. The current procedures for calculating energy conservation fail to consider numerous factors that may influence energy conservation. Comparing energy consumption to a specific year (FY1975) may not reflect a representative estimate of energy conservation. This study will attempt to relate energy conservation to changes in the baseline other than energy consumption. An understanding of the variables affecting energy conservation, both controlled and uncontrolled, can help redirect the Air Force's energy conservation efforts.

## Background

In the early 1950's, this nation's demand for petroleum began to exceed its supply. Consequently, it became necessary to import crude oil from foreign countries. This imbalance between internal supply and demand continued to increase and by 1973, nearly 30 percent of all domestic energy consumption was supplied from foreign sources (22:2-3). In late 1973, the Organization of Petroleum Exporting Countries (OPEC) imposed an embargo on crude oil shipments to the United States and other industrialized western nations. The immediate and lasting effect from this embargo has been formally recognized as the beginning of the "energy crisis".

Even though the embargo was shortlived, it did have far reaching consequences, namely: (a) the rapid escalation of fuel prices and (b) the beginning of a nationwide awareness that fuel supplies are uncertain and subject to instant interruptions. In spite of these warnings, our foreign oil dependency climbed to 46 percent in 1977, but has since leveled off at 28 percent (6:15). However, the nation's energy demand growth continues to climb. Exxon Corporation estimates our energy demand growth will average

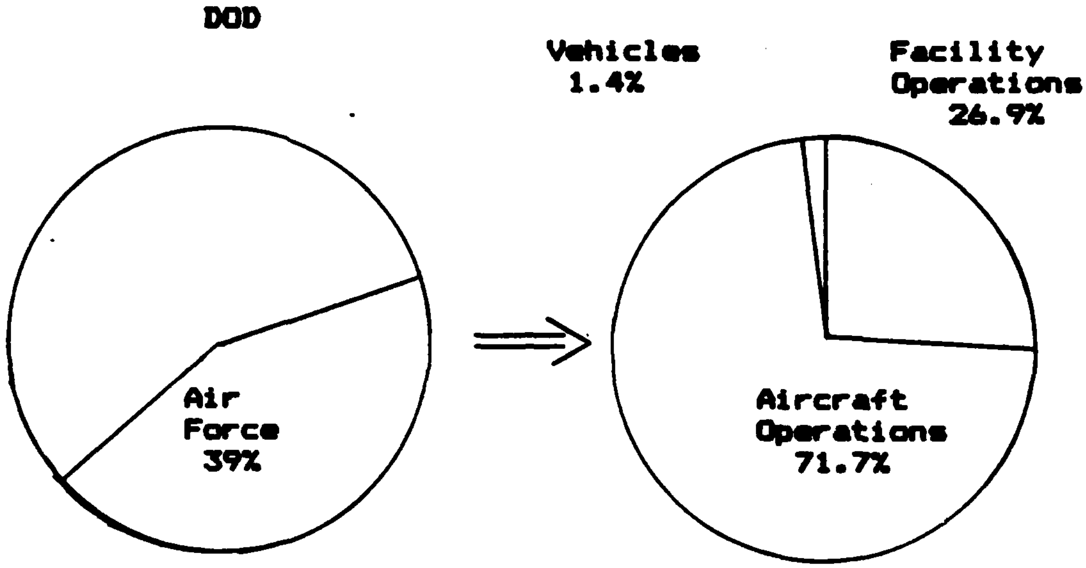


Figure 1. DoD and Air Force Energy Consumption [3]

1.1 percent during the 1980's and rise to 1.6 percent between 1990 and 2000 (10:24).

In order for this nation to continue as a world leader, our energy consumption must be curtailed to prevent the depletion of our critical energy resources. The total U.S. energy consumption in 1983 was consumed by three sectors: 1) residential and commercial (36.4%), 2) industrial (36.6%), and 3) transportation (26.9%) (6:21). The federal government accounts for approximately 3 percent of the total U.S. energy consumption (1). Furthermore, the Department of Defense (DoD) uses approximately 82 percent of the total federal energy. As shown in Figure 1, the Air Force accounts for 39 percent of the energy consumed by the Department of Defense.

## Air Force Energy Requirements

The basic philosophy of the United States Air Force is to maintain a strong and modern deterrence through the projection of airpower which must be flexible enough to perform its mission anywhere in the world in support of our national objectives (13:19-20). To accomplish this mission, the Air Force requires a vast amount of energy derived from petroleum, coal, natural gas, and other sources. The Air Force's energy demand is distributed among aircraft, vehicle, and installation operations as shown in Figure 1. The energy intensive nature of the Air Force mission relies strongly on the availability of energy. Without this energy, the Air Force would be severly handicapped in carrying out its mission. Since the OPEC oil embargo, the world's energy supply can no longer be taken for granted.

Despite decreasing its overall energy consumption 6.1 percent since 1975, the Air Force's energy cost increased by more than 200 percent (3:4-5). The Air Force spent $5.6 billion for energy in FY1983. That represented 7.5 percent of the Air Force's $75.2 billion budget (5:321).

The concern for energy conservation has never been greater. A simple and often suggested approach is to reduce aircraft operation costs. However, it would be extremely difficult to decrease aircraft operations substantially and still maintain an acceptable level of deterrence. In light of this, the federal government has placed a major emphasis on reducing facility energy costs.

## Facility Energy Conservation Goals

The President and the United States Congress realized, in the mid-1970's, that a reduction in energy consumption would retard increasing energy costs and enhance our national defense by reducing our foreign oil dependency. As a result, President Carter on 20 July 1977 issued Executive Order 12003 requiring all federal agencies to take immediate and long-term actions to reduce the federal energy demand (16).

In compliance with Executive Order 12003, the National Energy Conservation Policy Act (Public Law 95-619), and Defense Energy Program Policy Memorandums 78-2 and 80-6, the Air Force established specific goals to reduce facility energy consumptions at its more than 3000 installations around the world. These facility energy goals are (3:52-53):

1. To reduce energy usage in existing buildings 20 % per square foot of floor area by FY85, 25 percent by FY90, 30 percent by FY95, and 35 percent by FY2000. The baseline is FY75 consumption at .3152 MBTU/SF (3:38).

2. To achieve a 45 percent reduction in average annual energy for all new buildings that had not progressed beyond the 35 percent design stage as of 1 Mar 1979.

3. To reduce energy usage in military family housing 30 percent per square foot of floor area by FY90 as compared to the FY75 baseline.

## Energy Conservation Strategies

The Air Force established general strategies aimed at achieving its facility energy conservation and efficiency goals. For existing buildings, the mandated FY85 goals are to be achieved through the following strategies (12:7-8):

1. A reduction of at least 12 percent through the Energy Conservation Investment Program (ECIP). ECIP projects are funded through the Military Construction Program (MCP) and consists of energy monitoring control systems (EMCS) and building retrofit projects.

2. Obtain the additional eight percent reduction through MAJCOM directed programs and initiatives, e.g. increased administrative measures, improved energy management, more efficient operation and maintenance of mechanical rooms, and funding of small-scale energy conservation projects.

The general strategy for new buildings is to ensure the design incorporates state-of-the-art energy concepts.

## Program Results

Eight years have passed since the birth of the Air Force Energy Plan. The first milestones of the long-range goals are soon to be tested. The Air Force achieved a 14.1 percent reduction in energy consumption during FY84. This is a decline from 15.3 percent obtained in FY83 (21). The interim goal of 18 percent for FY84 was not achieved as indicated in Table 1. Only the Alaskan Air Command, the Tactical Air Command, and the Air National Guard achieved this goal.

With the FY85 goal less than a year away, Secretary of Defense Caspar Weinberger has expressed his concern that the Air Force and DoD may not meet the goal. In a 23 April

TABLE 1

RESULTS OF FY84 FACILITY ENERGY CONSERVATION [16]

| MAJCOM | FY83 GOAL | FY83 ACTUAL | FY84 GOAL | FY84 ACTUAL | FY85 GOAL |
|---|---|---|---|---|---|
| AAC | 16.0 | 14.1 | 18.5 | 18.5 | 20.0 |
| AFLC | 16.0 | 17.0 | 21.0 | 16.0 | 27.0 |
| AFRES | 16.0 | 30.8 | 22.0 | 17.9 | 25.0 |
| AFSC | 16.0 | 18.9 | 20.5 | 13.8 | 23.0 |
| ANG | 15.0 | 14.6 | 20.0 | 19.5 | 21.5 |
| ATC | 15.0 | 11.5 | 17.0 | 14.0 | 26.5 |
| AU | 15.0 | 10.1 | 13.5 | 9.1 | 21.5 |
| MAC | 15.5 | 14.4 | 17.5 | 13.1 | 19.5 |
| PACAF | 15.0 | 11.5 | 13.5 | 8.4 | 17.0 |
| SAC | 16.0 | 13.3 | 11.0 | 11.4 | 20.0 |
| SPACECMD | 16.0 | 8.6 | 16.0 | 13.5 | 20.0 |
| TAC | 15.0 | 15.0 | 17.5 | 10.8 | 20.0 |
| USAFA | 16.0 | 12.4 | 12.0 | 7.9 | 20.0 |
| USAFE | 16.0 | 15.6 | 16.0 | 12.4 | 19.0 |
| TOTAL | 16.0 | 15.3 | 18.0 | 14.1 | 20.0 |

1984 memorandum to the Secretary of the Air Force, Secretary Weinberger stated

> comparison of our results against this fiscal year goal will be the first major indicator of our dedication to efficient energy management. I am committed to its attainment because this will demonstrate the Department's efficient use of limited resources in achieving our mission objectives. Failure to attain the goal will be viewed in Congress and by the public as a lack of concern for prudent management [21].

Although the Air Force has reduced energy usage for its facility operations 14.1 percent from FY75 to FY84, it is becoming apparent the FY85 goals will not be achieved. There exists no clear explanation as to why some Air Force installations are successful in energy conservation while others are not. Energy consumption models have indicated that energy consumption depends on several variables, both controllable and uncontrollable. Nevertheless, the factors affecting energy conservation go beyond the factors affecting consumption. A better understanding of energy conservation may provide an insight as to why some bases are successful in energy conservation.

## Related Research

Facility energy conservation is measured as a percent reduction in MBTU/SF compared to the FY1975 baseline. Various studies have developed mathematical models to forecast energy consumption. An understanding of the variables affecting energy consumption can provide an insight into the conditions affecting energy conservation.

John E. Tinsley, in a 1981 AFIT thesis, developed a model to forecast coal, oil, and natural gas consumption at Air Force installations. Using multiple linear regression analysis, he identified four independent variables which appeared to be influential in forecasting heating energy consumption: facility square footage, base population, heating degree days, and cooling degree days. Based on significance testing, heating degree days was determined to be the most powerful explanatory variable within the model. The other variables were significant only for certain bases (24).

Another AFIT thesis (LSSR 1-80), written by Charles Hatch and Captain Robert Mansfield, presented an initial investigation into energy self-sufficiency for the Air

Force Logistics Command. In addressing this issue, they developed a model to forecast total energy demand for AFLC bases. Five independent variables were analyzed to determine their relationship to energy consumption: square footage of floor space, capital investments, heating degree days, cooling degree days, and manmonths. A multiple regression analysis determined that only heating and cooling degree days were significantly related to energy consumption. The remaining three variables insignificantly contributed to energy consumption (15).

The Logistics Management Institute (LMI), a consultant to the Secretary to the Defense, has conducted several studies pertaining to energy consumption at U.S. Army installations. They have proposed two methods for analyzing energy consumption: energy intensity ratios (the ratio of energy consumption costs to total costs) and regression models that relate energy usage to the principal activities associated with energy. Difficulties in partitioning costs and determining disaggregate cost deflators make the use of energy intensity ratios infeasible at organizations lower than the Military departments (14).

LMI considers energy estimating relationships (regression models) as promising, highly effective tools for analyzing energy consumption at all operational levels. At a .05 level of significance, their study resulted in building area, population served, and heating degree days as the primary predictors explaining approximately 85 percent of the total energy consumed.

## Research Objectives

The objectives of this research are:

1. To hypothesize various relationships between a base's energy conservation progress and selected independent variables.

2. To identify the most significant variables that affect the success of a base's energy conservation efforts using statistical procedures.

3. To determine whether the current method to measure facility energy conservation provides a true indication of a bases's success in conserving energy.

## Research Questions

1. Can a statistically significant relationship be hypothesized between energy conservation and selected independent variables?

2. Which independent variables substantially contribute to the explained variation in energy conservation?

3. Does the present method used to measure facility energy conservation provide a realistic indication of a base's success in conserving energy?

# II. Methodology

The primary focus of this research effort is to determine the variables having a significant effect on facility energy conservation at Air Force installations. The underlying objective is to determine why some installations are successful in energy conservation and others are not. The methodology involved collecting data from a sample of the real world in order to make statistically significant observations about the population.

The approach taken in this analysis involves four basic steps. First, the foundation of this report is built on the concept that energy conservation is a function of many other variables:

$$EC = f(X1, X2, X3, \ldots Xn)$$

In other words, energy conservation is dependent on numerous independent variables. Regression techniques will be used to evaluate the relationship between the dependent and independent variables.

The second and third steps derive from two basic questions stemming from any regression analysis: A) What is the most appropriate mathematical model to use? In other words, is the relationship linear, parabolic, logarithimic, or what? B) Given a specific relationship, what do we mean by and how do we determine the best fitting model for the data? For this study, a linear relationship is hypothesized between energy conservation and several independent variables. The model takes the form of:

$$EC = Bo + B1 + B2 + \ldots + Bn$$

The least squares method is an analytical approach for finding the best-fitting straight line through a set of data. This method minimizes the sum of squares of the lengths of the vertical-line segments drawn from the observed data points to the fitted line.

The final step is to test the linear hypothesis and determine the explanatory power of the model. It is important to be cautious about the results obtained from a regression analysis. A strong relationship found between two variables does not necessarily prove or even imply that the independent variables are causes of the dependent variable. Although causality cannot be inferred from a regression analysis, a meaningful interpretation of the relationships between variables can be described in a statistical sense.

It is through statistical techniques, such as confidence intervals and tests of hypotheses, that the researcher can infer the extent to which changes in the independent variables are related to changes in the dependent variable. Statistical statements based on regression analyses need to be distinguished from deterministic statements. Statistical statements allow for the possibility of error in the description of a relationship. Such statements, through the use of probability and statistical theory, take into account the irregularities of the real world and the problems associated with measurement errors.

This chapter defines the population, sample, and the hypothesized independent variables influencing energy conservation. In addition, the methodology used to address each research question is presented in much greater detail.

## Population

The population was defined as all Air Force installations presently on active status. All bases, air stations, Air National Guard and Air Reserve stations are included in the population since they are subject to the requirements of the Air Force Energy Conservation Program.

## Sample

Regression analyists recommend that the number of observations be 20 times the number of independent variables (11:91). In this case, 15 independent variables are being considered thus requiring a minimum of 300 observations. The selected sample consisted of 77 bases analyzed through the years 1980 - 1984, resulting in 385 total obervations. This sample represents major, active-duty bases from the six major air commands. These bases were selected as historical energy data was available and an active energy conservation program had been initiated. Overseas bases, small CONUS bases, and Air Reserve/Guard stations were not considered because their energy

TABLE 2

SAMPLE SELECTION

| No. | Base | Command | Climatic Zone | Mission | *Ranking |
|---|---|---|---|---|---|
| 1 | KI Sawyer | SAC | 1 | 1 | 41 |
| 2 | Vandenburg | | 4 | 6 | 44 |
| 3 | Fairchild | | 1 | 1 | 62 |
| 4 | Grandforks | | 1 | 1 | 42 |
| 5 | Loring | | 1 | 1 | 64 |
| 6 | Minot | | 1 | 1 | 18 |
| 7 | Wurtsmith | | 1 | 1 | 34 |
| 8 | Offutt | | 2 | 1 | 69 |
| 9 | Barksdale | | 6 | 1 | 72 |
| 10 | FE Warren | | 1 | 1 | 8 |
| 11 | Plattsburgh | | 1 | 1 | 70 |
| 12 | Griffiss | | 1 | 1 | 56 |
| 13 | McConnell | | 3 | 1 | 48 |
| 14 | Pease | | 1 | 1 | 12 |
| 15 | Whiteman | | 3 | 1 | 22 |
| 16 | Malmstrom | | 1 | 1 | 1 |
| 17 | Blytheville | | 4 | 1 | 75 |
| 18 | Grissom | | 2 | 1 | 77 |
| 19 | Dyess | | 7 | 1 | 58 |
| 20 | March | | 4 | 1 | 71 |
| 21 | Castle | | 4 | 1 | 68 |
| 22 | Beale | | 4 | 1 | 2 |
| 23 | Carswell | | 7 | 1 | 54 |
| 24 | Ellsworth | | 1 | 1 | 76 |
| 25 | Langley | TAC | 4 | 2 | 40 |
| 26 | Holloman | | 4 | 2 | 10 |
| 27 | Shaw | | 7 | 2 | 13 |
| 28 | England | | 6 | 2 | 33 |
| 29 | Myrtle Beach | | 4 | 2 | 50 |
| 30 | Seymour Johnson | | 4 | 2 | 60 |
| 31 | George | | 4 | 2 | 20 |
| 32 | MacDill | | 6 | 2 | 3 |
| 33 | Homestead | | 6 | 2 | 11 |
| 34 | Moody | | 6 | 2 | 49 |
| 35 | Nellis | | 7 | 2 | 55 |
| 36 | Cannon | | 3 | 2 | 43 |
| 37 | Bergstrom | | 6 | 2 | 19 |
| 38 | Davis Monthan | | 7 | 2 | 5 |
| 39 | Luke | | 7 | 2 | 14 |
| 40 | Mt Home | | 2 | 2 | 61 |
| 41 | Tyndall | | 6 | 1 | 67 |
| 42 | Scott | MAC | 3 | 3 | 63 |
| 43 | Charleston | | 7 | 3 | 45 |
| 44 | Altus | | 4 | 3 | 51 |

Table 2 -- Continued

| No. | Base | Command | Climatic Zone | Mission | *Ranking |
|---|---|---|---|---|---|
| 45 | Andrews | TAC | 3 | 3 | 25 |
| 46 | Travis | | 4 | 3 | 37 |
| 47 | Norton | | 4 | 3 | 47 |
| 48 | Little Rock | | 7 | 3 | 30 |
| 49 | Kirtland | | 3 | 3 | 17 |
| 50 | McChord | | 3 | 3 | 20 |
| 51 | McGuire | | 3 | 3 | 66 |
| 52 | Pope | | 4 | 3 | 15 |
| 53 | Dover | | 3 | 3 | 32 |
| 54 | Hill | AFLC | 1 | 4 | 9 |
| 55 | Tinker | | 4 | 4 | 26 |
| 56 | McClellan | | 4 | 4 | 21 |
| 57 | Kelly | | 6 | 4 | 7 |
| 58 | Robins | | 7 | 4 | 4 |
| 59 | Wright-Patterson | | 2 | 4 | 36 |
| 60 | Brooks | AFSC | 6 | 4 | 6 |
| 61 | Edwards | | 4 | 6 | 74 |
| 62 | Eglin | | 6 | 6 | 65 |
| 63 | Patrick | | 6 | 7 | 39 |
| 64 | Hanscom | | 2 | 6 | 73 |
| 65 | Keesler | ATC | 6 | 5 | 24 |
| 66 | Lackland | | 6 | 5 | 35 |
| 67 | Lowry | | 2 | 5 | 38 |
| 68 | Chanute | | 2 | 5 | 57 |
| 69 | Sheppard | | 4 | 5 | 16 |
| 70 | Columbus | | 7 | 5 | 29 |
| 71 | Vance | | 4 | 5 | 27 |
| 72 | Williams | | 7 | 5 | 31 |
| 73 | Reese | | 4 | 5 | 33 |
| 74 | Mather | | 4 | 5 | 23 |
| 75 | Maxwell | | 7 | 5 | 46 |
| 76 | Randolph | | 6 | 5 | 52 |
| 77 | Laughlin | | 6 | 5 | 59 |

* The 77 bases were ranked based on their percent reduction in energy consumption for FY84 compared to the FY75 baseline. The ranking is from best (1) to worst (77).

consumption is affected by numerous uncontrolled factors. In addition, ECIP and EMCS funds were not made avialable to these stations until 1981. Table 2 lists the 77 bases considered in this analysis. The database is shown in Appendix A.

Data Description and Validity

After reviewing several energy consumption models and testing the author's own speculations, 15 independent variables (IV) were selected as possible factors affecting energy conservation. Data was collected from several sources to best represent these variables. It was infeasible to check the accuracy of this data with any other source. However, since the data were utilized for reports submitted to the Air Staff and ultimately to DoD, it is subjected to great scrutiny. Any questionable data submitted by the bases are reviewed by the major air commands prior to forwarding to Air Staff. For these reasons, it was believed the data were accurate and reliable for purposes of this analysis.

Table 3 lists the candidate variables selected for the development of the regression model. The following discussion presents each variable and its data source.

Energy Conservation (Dependent Variable). The energy conservation variable represents the percent difference in energy consumption (MBTU/SF) between the current year and the FY75 baseline:

TABLE 3

Selected Independent Variables

| | |
|---|---|
| Dependent Variable | Energy Conservation (% reduction in MBTU/SF) |
| Candidate Independent Variables | Major Command<br>Climatic Zone<br>Base Mission<br>Cooling Degree Days<br>Heating Degree Days<br>Base Population<br>Costs of Completed ECIP Projects<br>Costs of Completed EMCS Projects<br>Facility Square Footage<br>Cooling Degree Day Change<br>Heating Degree Day Change<br>Base Population Change<br>Facility SF Change<br>Baseline CDD Change<br>Baseline HDD Change |

$$EC = \frac{FY75 - CY}{FY75} * 100$$

CY = Current Year, FY80-84

For example, the baseline consumption for Langley AFB was .3635 MBTU/SF; whereas, the FY82 consumption was .3070 MBTU/SF. Using the equation above, their energy conservation for FY82 is

$$EC = \frac{(.3635 - .3070)}{.3635} * 100 = 10.4 \%$$

The greater the value, the greater the success in energy conservation. A BTU, or British Thermal Unit, is the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit. MBTU is one million BTU (8).

### Independent Dummy Variables

Command. Each base falls under the control and authority of a major air command. The six major air commands are identified as:

1 Strategic Air Command
2 Tactical Air Command
3 Military Airlift Command
4 Air Force Logistics Command
5 Air Force Systems Command
6 Air Training Command

Geographical Climatic Zone. This variable represents the climatic zone a base is classified under. The United States is divided into seven zones based on cooling and heating degree days as shown in Figure 2.

Base Mission. This variable represents the mission of a base as identified by the DoD's Installation and Programming Category:

1 Strategic
2 General Purpose
3 Airlift Forces
4 Central Supply and Maintenance
5 Training, Medical and Other Personnel
6 Research and Development

### Independent Variables

Cooling Degree Days. The cooling degree days (CDD) for one day is the the number of degrees Fahrenheit the average daily temperature is above 65 degrees for that day (7). This variable represents the annual CDD's for each base.

Heating Degree Days. The heating degree days (HDD) for one day is the number of degrees Fahrenheit the average

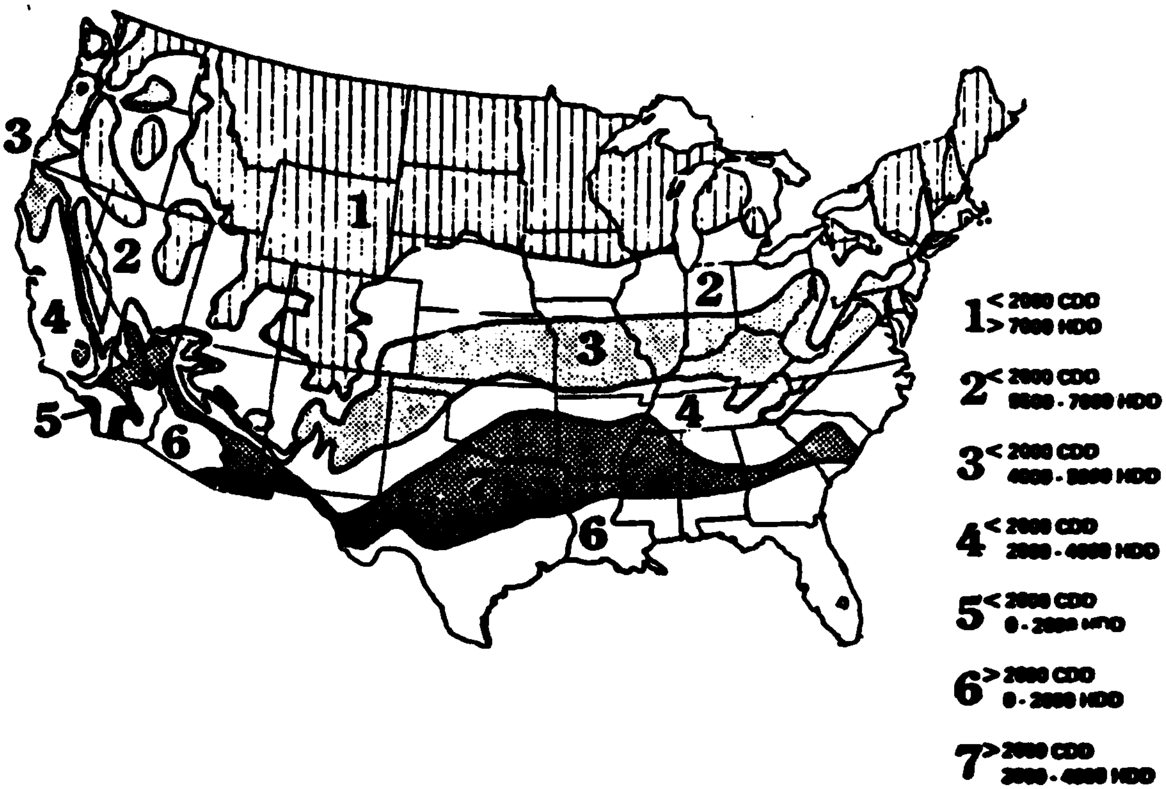


Figure 2. Climatic Zones

daily temperature is below 65 degrees for that day (7). This variable represents the annual HDD's for each base.

Base Population. The population on an individual base includes all military and civilian employees, housing occupants, contractor employees, and non-appropriated fund employees.

Costs of Completed ECIP Projects. The Energy Conservation Investment Program (ECIP) was launched in 1976 to retrofit existing buildings with energy-saving devices that would pay for themselves in less than 10 years. ECIP projects are to account for 12 percent of a base's energy conservation efforts. However, the allocation of ECIP money among Air Force bases has not been evenly distributed. This variable represents the cumulative dollar amount of completed ECIP projects. A six month time lag was used to compensate for the period before a building begins to reap the energy savings. The time periods for the five years under analysis are indicated below:

| Year | Cumulative Up To |
|---|---|
| FY80 | Mar 1980 |
| FY81 | Mar 1981 |
| FY82 | Mar 1982 |
| FY83 | Mar 1983 |
| FY84 | Mar 1984 |

Costs of Completed EMCS Projects. Energy Monitoring and Control Systems (EMCS) are computer-based surveillance systems that monitor interior and exterior environmental conditions and automatically controls building operations to ensure all systems operate at peak efficiency (3:56).

The Air Force hopes to install EMCS systems at each base, when cost-effective, by FY2000. However, at this time only selected bases have operational systems. The same time lag mentioned above was used to adjust for the period before a system provides energy savings.

Facility Square Footage. This is the total area of all existing energized base facilities. These values include military family housing and base facilities during the years 1975 and 1984.

Cooling Degree Day Change. This variable was developed to measure the severity of the cooling season for each year compared to the FY75 baseline:

$$RCDD = CDD\ (CY) - CDD\ (FY75)$$

where CY = current year, FY80 through FY84

For example, the FY82 CDD for Langley AFB was 1926; whereas the FY75 CDD was 1577. The change in CDD is computed as:

$$RCDD = 1926 - 1577 = 349$$

A positive value indicates the current year was more severe than the baseline cooling season. Likewise, a negative value indicates the current year was less severe than the baseline. A more severe cooling season should generate a greater energy demand for comfort cooling resulting in a decrease in energy conservation.

Heating Degree Day Change. This variable was developed to measure the severity of the heating season for each year compared to the FY75 baseline:

$$RHDD = HDD\ (CY) - HDD\ (FY75)$$

A positive value indicates the current year was more severe than the baseline and vise versa for a negative value. A base experiencing a heating season more severe than the baseline can be expected to consume more energy than it did in FY75.

Base Population Change. This variable was developed to measure the increase or decrease in base population as compared to the baseline:

RPOP = Population (CY) - Population (FY75)

A positive value indicates an increase in base population, whereas, a negative value indicates a decrease. A drastic change in population is expected to have an impact on a base's energy consumption rate and ultimately, their energy conservation.

Facility Square Footage Change. This variable was developed to measure the effect of changes in facility area on energy conservation:

RSF = Facility SF (FY84) - Facility SF (FY75)

The FY85 energy conservation goal is to reduce energy consumption by 20 percent for existing facilities as compared to the FY75 consumption rate. Existing facilities are defined as all existing buildings and projects that were beyond the 35 percent design stage as of 1 Mar 1979. This variable measures the square feet of facilities that had progressed beyond the 35 percent cutoff date. Therefore, this timelag explains how a base can experience an increase in existing facility square footage from FY75.

Although energy conservation is measured on a MBTU/SF basis, it is believed that a reduction (or increase) in facility SF may have a lopsided effect on energy conservation. For example, a base that has demolished several older aircraft hangars will consume less energy although their energy conservation performance may decrease. This is possible as the base's square foot total may decrease in greater proportion than the decrease in MBTU, thus resulting in a larger MBTU/SF value.

Baseline CDD Representativeness. This variable was developed to measure how representative the baseline CDD is compared to the 20-year average:

ARCDD = Baseline CDD - 20-Year Average (CDD)

Ideally, the difference should be close to zero which would indicate that the baseline is a fair representative of the 20-year average. However, in many cases, a base experienced a very severe (or mild) baseline which can have a significant impact on their energy conservation results. This is the type of problem resulting from basing all calculations on a specific year, such as FY75.

Baseline HDD Representativeness. Similar to above, this variable measures how representative the baseline HDD was compared to the 20-year average:

ARHDD = Baseline HDD - 20-Year Average HDD

The underlying logic with this variable is that a base that experienced an unseasonal cold winter in FY75, and normal winters subsequently, will show a high success in energy conservation as their energy demand should be much less than it was in FY75. In other words, the arbitrarily chosen FY75 baseline may have a significant effect on the Air Force's method of measuring energy conservation.

## Data Collection

DEIS-II Reports. The Defense Energy Information System (DEIS) is the primary data base for the Department of Defense's energy program. The DEIS provides management information to all levels of command to eliminate duplication of efforts. This information system was fully implemented on 1 October 1978. The Defense Energy Information System currently consists of the DEIS-I, Bulk Petroleum Product Report; and the DEIS-II, Utility Energy Report (3:17; 24:28).

Each base/wing within the Air Force submits a monthly DEIS report to their respective major air command. The MAJCOM's consolidate the reports and submit a monthly tabulation to the Air Force Engineering and Services Energy Group at Tyndall AFB, Florida. Detailed instructions for preparing and submitting the DEIS reports are contained in DoD Manual 5126.46-M and AFEPPM 83-1 (3:17-18).

The FY 1980-1984 annual DEIS-II reports were used to gather data on percent energy conservation, cooling degree days, heating degree days, 20-year weather data, and facility square footage.

Domestic Base Factor Report, FY80. The DoD, Office of the Assistant Secretary of Defense, Manpower, Reserve Affairs and Logistics published an annual report on installation data on each military service. The report was discontinued in 1980, however, the 1980 report still provides relevant data on all Air Force installations. The geographic climatic zones and base missions were obtained from the FY80 edition.

MCP/MFH ECIP Annual Report. Compiled by the Energy Group at Tyndall AFB, the MCP/MFH ECIP Annual report provided information on all ECIP/EMCS projects that were under design, under construction, or put on hold. The actual completion dates were used to determine the fiscal year a project was completed. Projects were not considered 100% complete until they were operational.

Air Force Magazine. The annual May edition of the Air Force magazine provides updated demographic data on all Air Force installations. Population figures were obtained by combining the military and civilians totals. It is recognized that these figures are not precise; however, they are adequate to indicate trends in populations which was the primary objective of the population variable.

## Method of Analysis

Research Question Number 1. Statistical analyses were performed on the selected sample to answer research question number 1: Can a statistically significant relationship be hypothesized between energy conservation and selected independent variables? The Statistical Package for the Social Sciences (SPSS) regression subprograms were used to determine if there were relationships between the independent and dependent variables.

Simple linear regression is a procedure for fitting a line to a data set of paired variables. The process basically relates the variability of the two variables. This estimation device is used extensively in statistics to test linear hypotheses. Multiple linear regression (MLR) is an extension of simple linear regression to account for the effect of more than one independent variable (9:422-456). Multiple regression can be viewed as: 1) a means of evaluating the overall contribution of the independent variables to a dependent variable, and 2) as a means of evaluating the contribution of a particular independent variable with the influence of the other variables controlled (20:332). In this study, the focus was on the examination of the relationship between the dependent variable (energy conservation) and selected independent variables. The ability to predict energy conservation based on its dependence on independent variables was not an objective of this study.

The general form of the model is:

$$Y = B_0 + B_1X_1 + B_2X_2 + \ldots B_nX_n$$

where Y = base-level facility energy conservation
Xi = selected independent variables (i.e. cooling

degree days, base population)
$B_i$ = regression coefficients
n = total number of independent variables

The following assumptions are made to allow statistical hypotheses to be formulated and tested:

1. The error terms, which are the vertical distances between each data point and the regression line, are statistically independent.

2. The expected average of these error terms is zero measured with respect to the regression line.

3. The error terms are independently distributed about the regression line.

4. Sample observations must be linearly independent [9:422-429].

A 0.05 level of significance for hypothesis testing was selected prior to the development of the model. This level of significance is often used in statistical analyses and is specified in AFM 25-5 for use in Air Force management engineering policies and procedures (20:i). In a statistical sense, the level of significance refers to the probability of rejecting a null hypothesis based on sample data when in fact it is true. This is commonly referred to as the probability of committing a Type I error. In other words, in our testing process we are willing to make a Type I error 5 percent of the time. In laymen's terms, a level of significance refers to the probability we will conclude that an independent variable affects energy conservation when in fact no such relationship exists.

The first step in the analysis of a statistical model is to test the hypotheses that a linear relationship does exist between energy conservation and selected independent variables. The hypotheses are:

$$Ho: B_1 = B_2 = B_3 = ... = B_n = 0$$

$$Ha: \text{At least one } B_i \text{ does not equal } 0$$

The null hypothesis, Ho, states that all of the regression coefficients are equal to zero thus a relationship does not exist between energy conservation and the independent variables. The alternate hypothesis, Ha, states that at least one of the variables is linearly related to energy conservation.

An appropriate method to test the linearity hypothesis is based on a test for lack of fit of the assumed straight-line model. The analysis is based on residual variation calculated from the linear fit (SSE). The SSE is comprised of two components: one describing the pure error (variance in the data); the other component describing the lack of fit of the straight line (17:23). Each component is divided by its respective degrees of freedom to obtain the pure error mean square (MSE) and the mean square for lack of fit (MSR). The ratio of these two mean square errors is a variable which for hypothesis testing purposes has a probability distribution commonly called an F-distribution. An F-statistic is determined as:

$$F^* = \frac{MSR}{MSE}$$

The SPSS regression subprogram conveniently calculates the F statistic as part of its normal output. If a calculated F-value is absolutely larger than the critical F-value for a test, the null hypothesis is rejected in favor of the alternative hypothesis. A rejected null hypothesis requires the acceptance of the alternative hypothesis, namely at least one Bi does not equal zero. Therefore, it can be stated that one or more of the variables is linearly related to energy conservation at a 0.05 level of significance.

Question Number 2. Continuing with the statistical analysis, the second research question can now be addressed:

Which independent variables contribute substantially to the explained variation in energy conservation? If the overall regression model is found to be significant, each regression coefficient will be tested at a 0.05 level of significance to determine which variables significantly add to the explanatory power of the model. The following hypotheses are tested using the student-t distribution:

Ho: $B_i = 0$

Ha: $B_i$ not equal to 0 $\qquad i = 1,2,...,n$

To reject the null hypothesis (Ho), the calculated t-statistic must be absolutely greater than the critical t- statistic.

Any regression coefficient proven insignificant will be grounds for deletion of the corresponding variable to simplify the model. The presence of these variables does not significantly improve the descriptive power of the model and they are therefore removed. The final step involves checking for collinearity and examining the residuals to verify whether the assumptions about the error terms are correct. Collinearity refers to the situation in which some or all of the independent variables are highly intercorrelated (20:340).

Research Question Number 3. The results obtained from the first two questions will enable research question number three to be addressed: Does the present method used to measure facility energy conservation provide a realistic indication of a base's success in conserving energy? The level of inferential statistics required to answer this question is beyond the level of this study. The results from the regression analysis will be applied in the form of descriptive statistics to propose modifications to the Air Force's existing method of calculating energy conservation. The intent is not to propose an ideal method for determining a base's energy conservation but rather to highlight the weaknesses confronting the current method. The variables identified in questions 1 and 2 should indicate the factors having a significant influence on energy conservation. At this point, it is hypothesized that both controllable and uncontrollable variables affect the success of a base's energy conservation. It is important to distinguish these variables from one another in order to explain why some bases have successful energy conservation programs and other bases do not. An analysis of these variables should explain the deficiencies resulting from basing the entire energy conservation program on the comparison of any given year to a specific baseline; in this case, FY75.

## Assumptions

1. All data collected from various sources is accurate and valid.

2. The data was compiled correctly.

3. Multiple linear regression techniques, with the underlying assumptions, are appropriate for this study.

## Limitations

This preliminary model was not designed to predict energy conservation but rather to determine the variables influencing the success of energy conservation. Any increase or decrease in the independent variables will not necessarily have a true linear relationship with energy conservation. Inferences to the population must be based on a subjective evaluation of the situation. This study only analyzed physical variables that may possibly affect energy conservation. Subjective variables such as personal attitudes toward energy conservation, top management's support and national socioeconomic factors were not considered in this study.

# III. Data Analysis

Data on selected variables were collected and formulated into a single data base. Caution was taken to ensure the data format was compatible with the computer software used to develop the regression model. The entire data analysis was performed on computer systems at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio. The Statistical Package for the Social Sciences (SPSS) was the sole statistical software used for this analysis.

This chapter will present the results of the regression analysis for energy conservation using the entire data base. The results of this analysis, as will be shown, were not very descriptive; thus further analyses were performed on subsets of the sample. A detailed statistical analysis will be presented on the first regression model. The other analyses will not be as comprehensive although the results of the critical statistical tests will be presented.

The SPSS NEW REGRESSION procedure offers numerous options that govern the results of a multiple regression model. The stepwise inclusion option was used to determine which variables were of significance to enter the model. Using this option, variables are examined at each step for entry or removal based on a .05 level of significance. This process continues until all significant variables are in the model and all insignificant variables have been removed.

The SPSS program produced the following output: a summary of observed data, a simple correlation matrix, an ANOVA table, a coefficient table with related t-values, residual error statistics, residual histograms, and selected scatterplots. Computer output for each regression run is presented in Appendices B through D.

As mentioned earlier, data was collected on 77 bases for the fiscal years 1980 through 1984. The dependent and independent variables with their algebraic notation are listed below:

EC = energy conservation
CDD = cooling degree days
HDD = heating degree days
ECIP = ECIP dollars spent
EMCS = EMCS dollars spent
RCDD = difference of CDD from FY75
RHDD = difference of HDD from FY75
RPOP = difference in population from FY75
SF = facility square footage
RSF = difference in SF from FY75
ARCDD= difference in CDD from FY75 and 20-year avg
ARHDD= difference in HDD from FY75 and 20-year avg
C1 = dummy variable, SAC
C2 = dummy variable, TAC
C3 = dummy variable, MAC
C4 = dummy variable, AFLC
C5 = dummy variable, AFSC
G1 = dummy variable, climatic zone 1
G2 = dummy variable, climatic zone 2
G3 = dummy variable, climatic zone 3
G4 = dummy variable, climatic zone 4
G5 = dummy variable, climatic zone 5
G6 = dummy variable, climatic zone 6
M1 = dummy variable, strategic mission
M2 = dummy variable, general purpose
M3 = dummy variable, airlift forces
M4 = dummy variable, training, medical
M5 = dummy variable, research & development

The initial linear model with all variables in the equation was:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + \ldots + B_nX_n$$

where $X_i$ = independent variables (i.e. CDD,RPOP,84)

$B_i$ = regression coefficient

Statistical analyses of the regression model will determine which of the 27 variables have a significant effect on energy conservation. A preliminary review of the data indicated a near perfect correlation between a base's command and its mission. Therefore, the mission variable was deleted from the analysis to prevent any misleading results from occuring.

Analysis of the Initial Regression Model

Using the SPSS stepwise inclusion option and a .05 level of significance for entry into the equation, the regression run resulted in only 9 of the 27 variables remaining. Tables 4 and 5 show the results. Table 5 simply presents the mean and standard deviation of each variable.

The correlation matrix is presented in Table 4. This matrix shows the relation between variables on a one-to-one basis. The sign of the coefficient reveals the direction of the relationship. A positive value indicates a tendency for both variables to increase or decrease together. A

## TABLE 4

### CORRELATION MATRIX FOR ENERGY CONSERVATION

| | EC | RSF | G2 | EMCS | ARCDD | ARHDD |
|---|---|---|---|---|---|---|
| EC | 1.000 | 0.260 | -0.217 | 0.188 | 0.203 | 0.031 |
| RSF | 0.260 | 1.000 | -0.077 | 0.179 | 0.126 | -0.035 |
| G2 | -0.217 | -0.077 | 1.000 | -0.061 | 0.080 | 0.021 |
| EMCS | 0.188 | 0.179 | -0.061 | 1.000 | -0.080 | -0.062 |
| ARCDD | 0.203 | 0.126 | 0.080 | -0.080 | 1.000 | -0.406 |
| ARHDD | 0.031 | -0.035 | 0.021 | -0.062 | -0.406 | 1.000 |
| SF | -0.019 | 0.210 | 0.188 | 0.372 | -0.017 | 0.076 |
| ECIP | 0.147 | 0.111 | 0.007 | 0.423 | 0.048 | -0.176 |
| C2 | 0.067 | 0.159 | -0.059 | -0.182 | 0.099 | -0.131 |
| CDD | -0.163 | -0.023 | -0.261 | 0.021 | -0.357 | -0.062 |

## TABLE 4 -- Continued

| | SF | ECIP | C2 | CDD |
|---|---|---|---|---|
| EC | -0.019 | 0.147 | 0.067 | -0.163 |
| RSF | 0.210 | 0.111 | 0.159 | -0.023 |
| G2 | 0.188 | 0.007 | -0.059 | -0.261 |
| EMCS | 03723 | 0.423 | -0.182 | 0.021 |
| ARCDD | -0.017 | 0.048 | 0.099 | -0.357 |
| ARHDD | 0.076 | -0.176 | -0.131 | -0.062 |
| SF | 1.000 | 0.523 | -0.255 | -0.139 |
| ECIP | 0.523 | 1.000 | -0.252 | -0.058 |
| C2 | -0.225 | -0.252 | 1.000 | 0.337 |
| CDD | -0.139 | -0.058 | 0.337 | 1.000 |

negative value suggests that as one variable increases in value, the other tends to decrease. A reasonable rule of thumb is to say the correlation is weak if $0 < |r| < .5$, moderate if $.5 < |r| < .8$, and strong if $.8 < |r| < 1$ (9:449). As an example, using the first row of the matrix in Table 4, the variable ARCDD has a 0.203 correlation with energy conservation (EC). This value indicates the degree to

TABLE 5

OBSERVED DATA

| Variable | Mean | Std. Deviation |
|---|---|---|
| EC | 10.82 | 8.26 |
| CDD | 1740.61 | 1029.85 |
| ECIP | 1430.53 | 1607.52 |
| EMCS | 215.60 | 485.69 |
| SF | 5482.16 | 2788.39 |
| RSF | 254.51 | 603.19 |
| ARCDD | -72.10 | 317.98 |
| ARHDD | -4.56 | 293.33 |
| C2 | 0.22 | 0.42 |
| S2 | 0.09 | 0.29 |

which change in one variable is related to change in the other. Table 4 shows that the variable RSF is the most dominant variable affecting energy conservation with a positive correlation of 0.260.

The correlation matrix also provides information on the correlation between pairs of independent variables. For example, the correlation between facility square footage (SF) and EMCS is 0.372. On the other hand, the correlation between cooling degree day (CDD) and EMCS is small at 0.021. A coefficient above 0.8 between independent variables often suggests that collinearity may exist. The largest correlation (0.523) occurs between SF and ECIP which indicates that collinearity is not a problem.

Coefficient of Determination. The coefficient of determination, R-square (R^2), denotes the explanatory power of the regression model. It indicates the proportion of variation in energy conservation "explained" by the independent variables. From the Summary table in Appendix B,

$$R^2 = \frac{\text{Explained Variation}}{\text{Total Variation}} = 0.2508$$

Therefore, 25.08 percent of the variation in energy conservation is explained by the 9 independent variables shown in Table 4. The unexplained variation is:

$$\text{Unexplained Variation} = 1 - R^2 = 1 - .2508 = .7492$$

R^2 can be artificially increased by "forcing' other independent variables into the model even though their relationship with energy conservation may be questionable. This was prevented by the stepwise inclusion option set at $\underline{a} = 0.05$.

The variables that did not enter the equation were deleted from further analysis. Although these variables were hypothesized as having an effect on energy conservation, they were proven statistically insignificant in their present form. Data transformation or expressing these variables in a different manner could possibly increase their explanatory power on energy conservation but this was not attempted in this study.

Linearity. The first step in the analysis of a regression model is to test the linearity hypothesis. As pointed out earlier, the usual strategy regarding regression begins with the hypothesis that the straight-line model is the appropriate one to use. This hypothesis may be rejected if the data indicates the use of a more complex model is waranted. The method to test the linearity hypothesis is based on the test for lack of fit of the assumed straight-line model.

The key statistic involved is SSE, the residual sum of squares (see Chapter 2). Recalling above, there are two possible reasons for a large value of SSE: the first is that there is a lot of variability in the data itself; the second is that the assumed straight-line model is not completely appropriate. In other words, the residual sum of squares is made up of a component describing the pure error and a component describing the lack of fit of the assumed straight-line model. Each component of SSE is divided by its respective degrees of freedom to obtain the pure error mean square (MSE) and the mean square for lack of fit (MSR). The final step involves comparing the F statistic

$$F* = \frac{MSR}{MSE}$$

with an F(critical) distribution obtained from statistical tables.

The output shown in Tables 6 and 7 were used in the

TABLE 6

COEFFICIENT TABLE FOR ENERGY CONSERVATION

| Variable | Regression Coefficient | Standard Error | t-Ratio |
|---|---|---|---|
| Constant | 14.6227 | 1.1327 | 12.909 |
| RSF | 0.0026 | 0.659E-3 | 3.866 |
| G2 | -6.2758 | 1.3742 | 4.567 |
| CDD | -0.0016 | 0.444E-3 | 3.699 |
| EMCS | 0.0032 | 0.879E-3 | 3.630 |
| C2 | 2.7592 | 1.0434 | 2.644 |
| ARCDD | 0.0071 | 0.0021 | 3.363 |
| ARHDD | 0.0052 | 0.0015 | 3.545 |
| SF | -0.593E-3 | -0.170E-3 | 3.481 |
| ECIP | 0.0010 | 0.296E-3 | 3.477 |

TABLE 7

ANOVA TABLE FOR ENERGY CONSERVATION

| Source | Variations | DF | Mean Square | F* |
|---|---|---|---|---|
| Explained (SSR) | 6575.7 | 9 | 730.6 | 13.95 |
| Error (SSE) | 19640.8 | 375 | 52.4 | - |
| Total (SST) | 26216.5 | 384 | - | - |

statistical analysis of this model. The regression coefficients listed in Table 6 provided the information to develop the fitted regression model:

$$EC = 14.623 - .00164CDD + .00103ECIP + .00319EMCS - .000593SF + .00255RSF + .0071ARCDD + .00522ARHDD + 2.759C2 - 6.276O2$$

The linearity hypotheses were as follows:

$$Ho: \; B_1 = B_2 = B_3 = \ldots = B_{18} = 0$$

$$Ha: \; \text{At least one } B_i \neq 0 \qquad \text{at } \underline{a} = .05$$

The decision rule for testing these hypotheses are:

If F* < F(critical), fail to reject Ho

If F* > F(critical), reject Ho

where F* = computed F-statistic
F(critical) = F(1-$\underline{a}$,k,n-k-1)
1- $\underline{a}$ = confidence level
k = number of independent variable
n = sample size

Using a .05 level of significance ($\underline{a}$=.05), the critical value for F is:

F(crit) = F(.95,9,375) = 1.89 (9:624)

and from Table 7, F* = 13.95

Since F* = 12.97 > 1.89 = F(crit), Ho is rejected in favor of Ha. Therefore, it can be concluded at a 0.05 level of significance that a linear relationship does exist and that all the independent variables considered together do explain a significant amount of the variation in energy conservation. Further testing would not have been required if Ho had been accepted.

At this point, it must be determined whether the addition of each independent variable, given others already in the model, significantly contributes to the explanatory power of the model. To test the individual regression coefficients, a t-test was performed to determine if any variables could be dropped from the equation. To determine the significance of a coefficient (Bi) in the regression model, the effect of the other variables is held constant. The test, therefore, allows for the elimination of variables which are of no help explaining energy conservation. The hypotheses for this test were:

$$Ho: \quad Bi = 0$$

$$Ha: \quad Bi \neq 0, \ i = 1,9 \qquad \text{at } \underline{a} = .05$$

The decision rules for testing these hypotheses were:

$$\text{If } t < t(1-\underline{a}/2, n-p), \text{ fail to reject Ho}$$

$$\text{If } t > t(1-\underline{a}/2, n-p), \text{ reject Ho}$$

where
- $t$ = computed t-statistic
- $t(crit) = t(1-\underline{a}/2, n-p)$
- $\underline{a}$ = level of significance
- $n$ = sample size
- $p$ = number of independent variables

At a 0.05 level of significance ($\underline{a} = 0.05$), the critical value for t is:

$$t(crit) = t(1-.05/2, 385-9) = 1.96 \ (9:622)$$

A two-sided t-test was performed on each coefficient as shown in Table 6. As shown, all of the t-ratios exceed the critical t-value determined at an alpha of .05 and 374 degrees of freedom. If the test concludes that a coeffi-

TABLE 8

CONFIDENCE INTERVAL TECHNIQUE
FOR REGRESSION COEFFICIENTS

| Variable | Coefficient Range | | | | |
|---|---|---|---|---|---|
| Constant | 13.4910 | < | B | < | 15.7557 |
| CDD | -0.0021 | < | B | < | -0.0012 |
| ECIP | 0.0007 | < | B | < | 0.0013 |
| EMCS | 0.0023 | < | B | < | 0.0041 |
| SF | -0.0007 | < | B | < | 0.0004 |
| RSF | 0.0019 | < | B | < | 0.0032 |
| ARCDD | 0.0050 | < | B | < | 0.0094 |
| ARHDD | 0.0038 | < | B | < | 0.0071 |
| C2 (TAC) | 1.7158 | < | B | < | 3.8025 |
| B2 (ZONE 2) | -7.6500 | < | B | < | -4.9016 |

cient is equal to zero, it can be removed from the equation without affecting its explanatory power. Therefore, in all cases the null hypothesis can be rejected in favor of the alternate hypothesis: the partial slopes of the regression lines are not zero.

Caution is in order when using repeated t-tests. The chance of error is significantly greater that the error expected from a single t-test. The rule of thumb method is commonly used but can result in misleading results. For example, the t-test on B3 considers only the marginal contribution of X3 given that the other variables are in the model. A confidence interval technique is an easier method to test the significance of each variable. The confidence interval based on an a = 0.05 for each B is approximately ± 2 standard errors. If zero does not lie within the confidence interval, Ho can be rejected. As seen in Table 8, the results are the same as those for the individual t-test. Therefore, each variable is significant and improves the explanatory power of the model.

Analysis of Regression Coefficients. Multiple regression may be viewed either as a descriptive tool by which the linear dependence of one variable on others is determined, or as an inferential tool by which the relationships in the population are evaluated from the examination of sample data. Although these two aspects of regression analysis are closely related, it is important to understand their differences. As a descriptive tool, regression techniques are used to find the best linear prediction equation and evaluate its prediction accuracy and to evaluate the contribution of a specific variable or set of variables on the dependent variable. On the other hand, regression analysis as an inferential tool enables the researcher to measure the explanatory power of a linear model fited through a set of independent variables as well as to examine the relationship between the dependent variable and a particular independent variable.

The analysis presented earlier looked at the descriptive ability of the regression model. As stated from the beginning, the primary objective of this study was not to be able to predict energy conservation but rather to identify the variables that have a significant effect on it. An understanding of these variables may provide an insight as to why some installations have successful energy conservation programs and others do not. In light of this, the following discussion describes the particular relationships between the 9 variables determined to have a statistically significant impact on energy conservation.

The regression equation developed for energy conservation based on the entire sample is shown again below:

$$EC = 14.623 - .00164CDD + .00103ECIP + .00319EMCS - .000593SF + .00255RSF + .0071ARCDD + .00522ARHDD + 2.759C2 - 6.276G2$$

The numerical values preceding each variable are the partial regression coefficients. Each coefficient represents the expected change in energy conservation resulting from a change in that variable when the other variables are held constant or are otherwise controlled. For example, for every one unit change in CDD, EC will decrease by .00164 percent. Or in other terms, for every 1000 CDD increase, a base's energy conservation can be expected to decrease by 1.64 percent. The inverse relationship expressed here is logical as one would expect a decrease in energy conservation as cooling degree days increase. It is important at this point to analyze each variable and its expected impact on energy conservation.

ECIP: Energy conservation can be expected to increase by 1.03 percent for every 1 million dollars spent on ECIP related projects. As expected, the relationship is positive. The database listed ECIP in terms of $1000 which accounts for the factor of 1000 in this analysis.

EMCS: Energy conservation can be expected to increase by 3.19 percent for every $1M spent on EMCS projects. Since ECIP and EMCS have identical units, a direct comparison of the regression coefficients can be made. Therefore, EMCS was identified as having a more significant effect on a base's energy conservation success.

SF: The regression coefficient calculated for facility square footage was -0.000593. The data was inputted in units of 1000 square feet, therefore, for every 1,000,000 square feet of energized buildings, the regression equation for energy conservation would decrease by 0.593 percent. This indicates that larger bases tend to be less successful in conserving energy than smaller bases.

RSF: This variable represents the increase or decrease in a base's facility square footage from FY75 to FY84. The partial regression coefficient was 0.00255 which indicates that a 2.55 percent increase in energy conservation can be expected for every 1 million increase in facilty square footage.

ARCDD: This variable was developed to measure the representativeness of a base's baseline (FY75) cooling degree day season to that of the 20-year average. It was believed that a base that experienced a more severe baseline cooling season than in normal years would achieve greater success in energy conservation. This was hypothesized because each year thereafter is compared to the more severe baseline year. Less energy for cooling would be consumed for a normal year than that consumed for the more severe baseline year. The results validated this hypothesis: A 1000 CDD difference between the baseline and the 20-year average can be expected to result in a 7.1 percent increase in energy conservation. For those bases where the FY75 cooling season was less severe than the norm, they would have more difficulty in achieving successful energy conservation results.

ARHDD: The same logic used in developing the ARCDD variable was used in developing the ARHDD variable: A base that experienced a more severe heating season in FY75 would achieve greater results in energy conservation. Again, this hypothesis was verified by the partial regression coefficient of 0.00522. This indicates that for every 1000 HDD difference (FY75 - 20-year average), a base's energy conservation can be expected to be greater by 5.22 percent than a base whose baseline approximated the norm.

C2: C2 is a dummy variable which would only enter the regression equation when the base is within the Tactical Air Command. The coefficient indicates a TAC base can be expected to have a 2.76 percent greater success rate in energy conservation than other non-TAC bases. This relationship reinforces the fact that TAC bases have achieved greater results than most other commands. This was observed in Table 1.

B2: This dummy variable represents the effect of a base being in climatic zone two. It only enters the model when a base is in fact from zone 2. The effect of the other climatic zones had no statistical significance on energy conservation. Thus, for bases in zone 2, their energy conservation can be expected to be 6.28 percent less than those bases in other zones. Most SAC bases are within zone 2 which may account for their overall poor results in energy conservation.

Constant: This regression coefficient (14.62) represents the energy conservation a base could expect if all the variables identified in the equation were controlled or took on values of zero.

One important point to mention is that the partial regression coefficients can not be directly compared because of their different units. For example, ARCDD is measured in CDD's, whereas, ECIP is measured in dollars. To overcome this restriction, the coefficients can be expressed as standardized regression coefficients. This is accomplished by converting the variables into units of their respective standard deviations. The SPSS regression program conveniently calculates this as part of its usual output. Refer to Appendix B where the standardized coefficients are labeled B (beta). Table 9 below shows the standardized regression coefficients in order of their relative importance on energy conservation. The cautions in interpreting regression coefficients mentioned earlier

TABLE 9

STANDARDIZED REGRESSION COEFFICIENTS

| Variable | Beta |
|---|---|
| S2 | -0.2186 |
| CDD | -0.2047 |
| SF | -0.1999 |
| ECIP | 0.1999 |
| EMCS | 0.1876 |
| ARCDD | 0.1874 |
| RSF | 0.1859 |
| ARHDD | 0.1854 |
| C2 | 0.1387 |

apply to standardized regression coefficients as well: they show the effect of the given independent variable in the context of the other independent variables in the model. The importance of the variables within the model can not be universally applied to the real world.

Analysis of Residuals. Referring back to Chapter 2, four assumptions were made about the error terms. At this time, it is appropriate to verify whether these assumptions were indeed correct. The SPSS program conveniently produces a histogram of the standardized residuals, a normal probability plot of the standardized residuals, and a standardized scatterplot of the residuals. These plots are shown in Appendix B. The various plots indicate that the error terms are indeed linearly independent, have a normal distribution, have equal variances, and a mean of zero.

Final Discussion. The first regression model was developed based on the entire sample which included 77 bases from six different major air commands. As seen from the previous analysis, the results were statistically significant although they were relatively weak. The coefficient of determination ($R^2$) indicated that only 25.1 percent of the variance in energy conservation was explained by 9 independent variables. The remaining 74.9 percent of the variance in energy conservation can be attributed to many factors; namely, there was a large amount of variance in the data, the linear model specification was not appropriate, or other important variables were not considered. In this case, it was believed the low coefficient of determination was attributed to a high variance in the data.

An analysis of a subset of this sample should reduce the variance within the data. In order to test this hypothesis, separate regression models were developed and analyzed for two subsets: Strategic Air Command and the Tactical Air Command.

The same analysis procedures used for the entire sample were used for the two subsets. The discussion of the remaining analyses will not include as much detail as provided for the first model. There are, however, explicit statistical inferences made about each model, including a model equation, F-test for significance, t-test for individual correlation, and analysis of the coefficient of determination. Computer output for these models are presented in Appendices C and D.

## Analysis of Strategic Air Command

The first subset included 24 SAC installations during the fiscal years 1980 through 1984 for a total of 120 observations. Using the same SPSS regression program and entry criteria as the previous model, the resulting regression equation consisted of 8 independent variables. Observed data, correlation matrix, ANOVA table, and a coefficient table are shown in Tables 10 through 14. The resulting linear regression equation is:

$$EC = 8.03 + .0025ECIP + .0098EMCS - .0016SF - .00187RPOP + .00769RSF - .00644RHDD + 7.69581 + 11.41383$$

Coefficient of Determination ($R^2$) = 0.5208
Coefficient of Correlation (R) = 0.7217

The correlation matrix shows that change in HDD from the baseline (RHDD) and climatic zones 1 and 3 have the largest impact on energy conservation with correlations of -0.333, 0.2077 and 0.238, respectively. Population change (RPOP) was moderately correlated with EMCS (0.679) and facilty square feet (0.553). These correlations indicate that a larger base was more apt to experience an increase in base population and receive more EMCS funds.

The same hypotheses were tested to determine whether or not a linear relationship existed between energy

TABLE 10

OBSERVED DATA - STRATEGIC AIR COMMAND

| Variable | Mean | Std. Deviation |
|---|---|---|
| EC | 11.32 | 8.77 |
| ECIP | 1066.07 | 797.40 |
| EMCS | 170.62 | 373.14 |
| RPOP | 251.58 | 1456.40 |
| SF | 4941.13 | 1816.64 |
| RSF | 143.79 | 279.78 |
| RHDD | -228.57 | 571.97 |
| G1 | 0.5 | 0.50 |
| G3 | 0.083 | 0.278 |

conservation and the 8 independent variables:

Ho: B1 = B2 = B3 = ... = Bn = 0

Ha: At least one Bi ≠ 0 at $\underline{a}$ = .05

The critical value of F from an F-distribution table is,

F(8,111,0.95) = 2.03

and F* = 15.08

Since F* > F(crit), reject Ho and conclude that one or more of the independent variables is linearly related to energy conservation at a 0.05 level of significance.

The following hypotheses were tested to determine the significance of the contribution of each independent variable:

Ho: Bi = 0
Ha: Bi ≠ 0 i = 1,8 at $\underline{a}$ = .05

Using the two-tailed t-test at 111 degrees of freedom, the results are shown below:

| Coefficient | t-ratio | | t(crit) | Conlude |
|---|---|---|---|---|
| Bo (EC) | 3.932 | > | 1.98 | Reject Ho |
| B3 (ECIP) | 3.077 | > | 1.98 | Reject Ho |
| B4 (EMCS) | 4.205 | > | 1.98 | Reject Ho |
| B6 (RHDD) | 5.764 | > | 1.98 | Reject Ho |
| B7 (RPOP) | 3.042 | > | 1.98 | Reject Ho |
| B8 (SF) | 3.413 | > | 1.98 | Reject Ho |
| B9 (RSF) | 3.191 | > | 1.98 | Reject Ho |
| B17(G1) | 5.356 | > | 1.98 | Reject Ho |
| B19(G3) | 5.082 | > | 1.98 | Reject Ho |

TABLE 11

CORRELATION MATRIX
STRATEGIC AIR COMMAND

| | EC | RHDD | G1 | G3 | ECIP | SF |
|---|---|---|---|---|---|---|
| EC | 1.000 | -0.333 | 0.277 | 0.238 | 0.207 | -0.003 |
| RHDD | -0.333 | 1.000 | -0.015 | 0.049 | -0.005 | -0.279 |
| G1 | 0.277 | -0.015 | 1.000 | -0.302 | 0.152 | 0.141 |
| G3 | 0.238 | 0.049 | -0.302 | 1.000 | -0.152 | -0.220 |
| ECIP | 0.207 | -0.005 | 0.152 | -0.152 | 1.000 | 0.392 |
| SF | -0.003 | -0.279 | 0.141 | -0.220 | 0.392 | 1.000 |
| EMCS | 0.175 | -0.317 | -0.140 | -0.138 | 0.309 | 0.590 |
| RSF | 0.070 | 0.046 | -0.342 | 0.128 | 0.061 | 0.280 |
| RPOP | -0.113 | -0.334 | -0.301 | -0.056 | 0.151 | 0.553 |

TABLE 11--Continued

| | EMCS | RSF | RPOP |
|---|---|---|---|
| EC | 0.175 | 0.070 | -0.113 |
| RHDD | -0.317 | 0.046 | -0.334 |
| G1 | -0.140 | -0.342 | -0.301 |
| G3 | -0.138 | 0.128 | -0.056 |
| ECIP | 0.309 | 0.061 | 0.151 |
| SF | 0.590 | 0.280 | 0.553 |
| EMCS | 1.000 | 0.307 | 0.679 |
| RSF | 0.307 | 1.000 | 0.322 |
| RPOP | 0.679 | 0.322 | 1.000 |

TABLE 12

COEFFICIENT TABLE - STRATEGIC AIR COMMAND

| Variable | Regression Coefficient | Standard Error | t-ratio |
|---|---|---|---|
| Constant | 8.035 | 2.043 | 3.93 |
| ECIP | 0.0025 | 0.00081 | 3.08 |
| EMCS | 0.00978 | 0.00233 | 4.21 |
| RHDD | -0.00644 | 0.00112 | 5.76 |
| RPOP | -0.00187 | 0.00062 | 3.04 |
| SF | -0.00161 | 0.00047 | 3.41 |
| RSF | 0.00767 | 0.00241 | 3.19 |
| G1 | 7.695 | 1.436 | 5.36 |
| G3 | 11.413 | 2.246 | 5.08 |

TABLE 13

ANOVA TABLE
STRATEGIC AIR COMMAND

| Source | Variations | DF | Mean Square | F |
|---|---|---|---|---|
| Explained | 4770.6 | 8 | 596.3 | 15.08 |
| Error | 4389.2 | 111 | 39.5 | |
| Total | 9159.8 | 119 | | |

In each case, Ho was rejected in favor of the alternate hypothesis. Therefore, the 8 independent variables were statistically identified as having a significant influence on energy conservation.

Discussion. The explanatory power of a regression model for energy conservation was enhanced by using a subset of the original sample. By limiting the sample to 24 SAC bases, the coefficient of determination increased from 25.1 to 52.1 percent. Therefore, the SAC model explains more than 52 percent of the variation in energy conservation at a 0.05 level of significance.

Four of the eight variables identified in the SAC model were also identified in the overall regression model. These variables are: ECIP, EMCS, SF, and RSF. The relationship of these variables on energy conservation were identical, although the regression coefficients were different as would be expected. For example, the SAC model produced a regression coefficient of +0.00769 for RSF, whereas, the overall model identified a coefficient of +0.0025. The key point here is that both models showed a positive influence on energy conservation. The regression coefficients can not be compared directly as each must be analyzed within the context of its model.

The SAC model resulted in four different variables that did not enter the overall model: RHDD, RPOP, G1 and G3. The following discussion presents the relationship of these variables with energy conservation.

RHDD: This variable was intended to measure the effect of a severe heating season on a base's energy conservation efforts. It was defined as RHDD = HDD(CY) - HDD(FY75) where CY = current year. The model indicates that a base's annual energy conservation can be expected to decrease 6.44 percent for every 1000 HDD's above the FY75 baseline. For example, a SAC base that recorded 5700 HDD's in FY83 and 5200 HDD's in FY75 can expect to conserve 3.22 percent less energy than a SAC base whose RHDD was zero:

$$(-0.00644)*(5700 - 5200) = -3.22,$$

given that the other variables in the model are zero or are controlled. This validates the hypothesis that extremes in weather have a significant but uncontrollable effect on facility energy conservation. Since SAC bases are mainly concentrated in northern climates, it might be expected that heating degree days would have more effect on SAC than on the Air Force as a whole.

RPOP: This variable was designed to measure the effect of population change on energy conservation. The results indicate that for every 1000 person increase in base population from the FY75 baseline, a base's energy conservation can be expected to decrease 1.87 percent. Again, this variable validates the original hypothesis that increases or decreases in population have a significant influence on energy conservation.

G1: This dummy variable represents the effect of a

TABLE 14

STANDARDIZED REGRESSION COEFFICIENTS
STRATEGIC AIR COMMAND

| Variable | Beta |
|---|---|
| G1 | 0.4404 |
| RHDD | -0.4196 |
| EMCS | 0.4159 |
| G3 | 0.3611 |
| SF | -0.3335 |
| RPOP | -0.3112 |
| ECIP | 0.2273 |

base being in climatic zone 1. It only enters the equation when a base in question is from zone 1. The results indicate that energy conservation for a base in zone 1 can be expected to be 7.70 percent higher than those bases in other zones (except zone 3, see below).

G3: Similar to zone 1, a base in zone 3 can expect to have energy conservation results 11.41 percent greater than other bases outside zone 3 (except zone 1, see above).

The relative importance of each variable can not be determined by the value of its regression coefficient. However, as previously explained, their coefficients can be converted to standardized regression coefficients which allow direct comparison. Table 14 lists the standardized regression coefficient of each variable in order of their relative importance on energy conservation.

The residual plots shown in Appendix C indicate that the original assumptions concerning the error terms were indeed correct.

## Analysis of Tactical Air Command

This subset included 17 TAC installations during the fiscal years 1980 through 1984 for a total of 85 observations. Using the same SPSS regression program and entry criteria as the previous models, the resulting regression equation included 5 independent variables. Tables 15 through 18 show the results of this regression. The resulting linear regression model is:

$$EC = 8.678 + .00308ECIP - .00534RCDD + .0054RSF - .00158RPOP - 7.2582$$

Coefficient of Determination = .3850
Coefficient of Correlation = .6205

The correlation matrix in Table 16 indicates that RSF and 82 have the largest correlation with energy conservation, 0.340 and -0.346, respectiviely. A correlation of -0.306 was observed between RSF anf 82 which may indicate that bases in zone 2 tended to experience a decrease in facility square footage since FY75.

The following hypotheses were tested in order to determine whether a linear relationship existed between energy conservation and the five independent variables:

Ho: $B1 = B2 = B3 = B4 = B5 = 0$

Ha: At least one $Bi \neq 0$ at $\underline{a} = .05$

The critical value of F from an F-distribution table is,

$$F(crit) = F(5,79) = 2.35$$

and $F* = 9.89$

Since F* > F(crit), reject Ho and conclude that one or more of the five independent variables is linearly related to energy conservation at a .05 level of significance.

The following hypotheses were tested to determine which variables significantly contributed to the explanatory power of the model:

$$\begin{aligned} Ho&: Bi = 0 \\ Ha&: Bi \neq 0 \quad i=1,5 \quad \text{at } \underline{a} = .05 \end{aligned}$$

For 79 degrees of freedom, the results of the two-tailed t-test are shown in Table 17. The null hypothesis was rejected in each case thus each variable is statistically identified as having a significant influence on energy conservation.

Discussion. The explanatory power of this regression model was greater than the overall model but substantially less than the SAC model. Only 38.5 percent of the variance in energy conservation at TAC bases can be explained by the five independent variables at a .05 level of significance. An interesting point to note, however, is that three of the five variables were also identified in the overall model (ECIP, RSF, G2). In addition, three of the variables were present in the SAC model (ECIP, RSF, RPOP). The common variables in all three models were ECIP and RSF.

The only new variable that entered the TAC model was RCDD. Similar to RHDD discussed in the SAC analysis, this

TABLE 15

OBSERVED DATA
TACTICAL AIR COMMAND

| Variable | Mean | Std. Deviation |
|---|---|---|
| EC | 11.86 | 6.73 |
| ECIP | 669.84 | 604.78 |
| RCDD | -18.92 | 335.84 |
| RPOP | 569.88 | 1209.13 |
| RSF | 434.53 | 436.29 |
| 82 | 0.06 | 0.24 |

TABLE 16

CORRELATION MATRIX
TACTICAL AIR COMMAND

| | EC | 82 | ECIP | RCDD | RSF | RPOP |
|---|---|---|---|---|---|---|
| EC | 1.000 | -0.346 | 0.309 | -0.216 | 0.340 | -0.124 |
| 82 | -0.346 | 1.000 | -0.056 | -0.100 | -0.306 | -0.015 |
| ECIP | 0.309 | -0.056 | 1.000 | -0.096 | 0.166 | 0.229 |
| RCDD | -0.216 | -0.100 | -0.096 | 1.000 | 0.185 | 0.047 |
| RSF | 0.340 | -0.306 | 0.166 | 0.185 | 1.000 | 0.300 |
| RPOP | -0.124 | -0.015 | 0.229 | 0.047 | 0.300 | 1.000 |

variable was intended to measure the severity of the cooling season to that experienced during the FY75 baseline. It was hypothesized that a base experiencing a more severe cooling season than FY75 would result in a decrease in their success to conserve energy for that year. The results indicate that for every 1000 CDD's above the FY75

TABLE 17

COEFFICIENT TABLE - TACTICAL AIR COMMAND

| Variable | Regression Coefficient | Standard Error | t-ratio |
|---|---|---|---|
| EC | 8.578 | 1.070 | 8.11 |
| G2 | -7.250 | 2.649 | 2.74 |
| ECIP | 0.00308 | 0.00102 | 3.01 |
| RCDD | -0.00534 | 0.00182 | 2.94 |
| RSF | 0.00540 | 0.00153 | 3.52 |
| RPOP | -0.00158 | 0.00053 | 2.99 |

TABLE 18

ANOVA TABLE
TACTICAL AIR COMMAND

| Source | Variations | DF | Mean Square | F* |
|---|---|---|---|---|
| Explained | 1465.5 | 5 | 293.1 | 9.89 |
| Error | 2340.7 | 79 | 29.6 | |
| Total | 3805.2 | 84 | | |

baseline, a base's energy conservation can be expected to be 5.34 percent less than a TAC base whose cooling season matched their baseline. This validates the hypothesis stated above.

As expained for the other models, the relative importance of each variable on energy conservation can not be determined by a direct comparison of the regression coeffi-

TABLE 19

STANDARDIZED REGRESSION COEFFICIENTS
TACTICAL AIR COMMAND

| Variable | Beta |
|---|---|
| RSF | 0.3499 |
| RPOP | -0.2831 |
| ECIP | 0.2763 |
| RCDD | -0.2663 |
| 82 | -0.2549 |

cients because of different units. However, Table 19 lists the standardized regression coefficients listed in order of their relative importance. The variable RSF was identified as having the greatest change in energy conservation in terms of standard deviations per standard deviation change in RSF.

The residual plots shown in Appendix D indicate that the original assumptions concerning the error terms were indeed correct.

# IV. Summary, Conclusions and Recommendations

## Summary

The purpose of this research was to investigate and analyze the factors affecting the success of facility energy conservation at Air Force installations. The Air Force has been actively pursuing energy conservation since the realization that the nation's energy supply was uncertain as a result of the 1973 oil embargo. It is becoming apparent the Air Force will fall short of the FY85 goal of reducing facility energy use by 20 percent per gross square foot compared to the FY75 consumption rate. A clear understanding is needed as to why certain bases have met this goal and other bases have not.

This study presented a background on federal energy consumption and its importance to the mission of the United States Air Force. The Air Force's energy requirements, energy conservation goals, and strategies to meet these goals were discussed. Related research on modeling energy consumption was reviewed to learn from the efforts of others.

The research methodology discussed the sample selection, data collection, and data validity. The actual analysis included 77 CONUS bases from six major air commands during the years 1980 through 1984. Fifteen independent variables believed to have a significant affect on energy conservation were identified and defined. From this point, the specific approach to answer each research question was discussed. Multiple linear regression analysis was used to determine the overall and individual contribution of the independent variables on energy conservation. Statistical hypothesis testing techniques were used to infer the extent to which changes in the independent variables are related to changes in energy conservation. Statistical statements based on regression analyses take into account the irregularities of the real world and the problems associated with measurement errors.

## Conclusions

Each research question can now be answered from the overall analysis. Inferential and descriptives statistics were used to reach these conclusions and to provide an insight into the problems facing the Air Force's present method of measuring energy conservation.

Research Question Number 1. Can a statistically significant relationship be hypothesized between energy conservation and selected independent variables? A linear relationship was hypothesized and tested using statistical techniques. Nine independent variables were identified as having a significant linear affect on energy conservation at a 0.05 level of significance. These variables include:

CDD = cooling degree days
ECIP = dollars spent on ECIP projects
EMCS = dollars spent on EMCS projects
SF = a base's facility square footage

RSF = the change in a base's facility square footage from FY75 to FY84
ARCDD= the difference in a base's FY75 CDD season from the 20-year average
ARHDD= the difference in a base's FY75 HDD season from the 20-year average
C2 = the effect of being in TAC
G2 = the effect of being in zone 2

The other independent variables were proven statistically insignificant. The nine variables that were determined significant only explained 25.1 percent of the variation in energy conservation. A 25.1 percent coefficient of determination is considered relatively low for this type of analysis. The remaining 74.9 percent of the variance in energy conservation was believed to be attributable to a high variance in the data and to the failure to consider several key variables affecting energy conservation. Factors such as upper level management support for the energy conservation program and energy awareness campaigns may have a significant effect on energy conservation. However, they are not easily quantifiable and so were not considered in this report.

Since nearly three quarters of the variance was not explained by the initial model, additional analyses were performed on subsets of the original sample. The second analysis considered only bases within the Strategic Air Command. This increased the coefficient of determination to 52.1 percent. The statistically significant variables affecting energy conservation at SAC bases include:

ECIP
EMCS

SF
RSF
RHDD = the difference in HDD's for any given year from the FY75 baseline
RPOP = the difference in base population for any given year from the FY75 baseline
θ1 = the effect of being in zone 1
θ2 = the effect of being in zone 3

The model of the Tactical Air Command, the third analysis, resulted in a coefficient of determination of 38.5 percent. Although this was an improvement over the initial model, it was substantially lower than the SAC model. The four variables having a significant affect on energy conservation at TAC bases include:

ECIP
RSF
RPOP
RCDD = the difference in CDD's for any given year from the FY75 baseline

In each analysis, it can be concluded at a 0.05 level of significance that a linear relationship does exist and that the independent variables remaining in each model do explain a significant amount of the variation in energy conservation.

<u>Research Question Number 2</u>. Which variables contribute substantially to the explained variation in energy conservation? The number of independent variables in a multiple regression model has a definite impact on the validity of the results. Each variable was analyzed to determine whether it significantly contributed to the explanatory power of the model. The intent is to simplify the model by deleting the variables that do not explain a

significant amount of the variation in energy conservation.

All nine variables in the initial regression analysis were determined to make a significant contribution to the explanatory power of the model. Therefore, the model was not simplified by deleting any of these variables. The variable RSF was the most influential accounting for 6.5 percent of the variance in energy conservation. The variables RSF, G2, and CDD together explained 15.4 percent of the variation in energy conservation. Thus, these three variables accounted for approximately 61 percent of the variance explained by the nine variables.

The eight variables in the SAC model were also determined to significantly contribute to the explanatory power of the model thus none were deleted. The variable RHDD was the most influential, explaining 11.1 percent of the variation in energy conservation. The variables RHDD, G1, G3, and ECIP together accounted for 33 percent of the variation or approximately 63 percent of the total explained by the eight variables.

The four variables in the TAC model significantly contributed to the explanatory power of the model. The variable G2 was the most influential (12.0 percent) while the variables G2 and ECIP together explained 18.5 percent of the variation in energy conservation.

<u>Research Question Number 3</u>. Does the present method used to measure facility energy conservation provide a realistic indication of a base's success in conserving

energy? The heart of this research effort centers upon this question. Understanding the relationship of each variable on energy conservation prepares us to answer question number 3. It is important to realize that some of these variables are controllable and some are uncontrollable. The only truly controllable variables affecting energy conservation are the expenditure of ECIP and EMCS funds. The seven other variables are uncontrollable but as can be seen, have a significant affect on the success of energy conservation. At this point, it is important to go back to the variables highlighted earlier and explain their true relationship on energy conservation. There is much to gain from the initial regression analysis although the results were relativiely weak.

As explained in Chapter 3, the variables ECIP and EMCS were determined to have a positive linear affect on energy conservation. A base's energy conservation can be expected to increase relative to the amount of ECIP and EMCS funds spent on their base. This indicates that the Energy Conservation Investment Program initiated by the DoD is successful in increasing energy conservation at Air Force installations. Every $1 million invested in ECIP and EMCS projects at a base accounts for 1.03 and 3.19 percent points in energy conservation, respectively.

Cooling degree days (CDD) have an inverse affect on energy conservation as might be expected. This indicates that bases in southern climates can expect to experience a lower success in energy conservation. This may be attributable to an increase in the number of air conditioners used to support electronic equipment and for comfort cooling at these bases. Thus both increased technology and people awareness programs have affected energy conservation.

The variable square footage (SF) resulted in an inverse relationship with energy conservation. This indicates that larger bases tend to be less successful in energy conservation. On the other hand, the variable RSF has a positive affect on energy conservation which indicates that the buildings built after FY75 are more efficient than those built earlier.

The variables ARCDD and ARHDD were designed to measure the representativeness of a base's weather baseline as compared to a 20-year average. The results validate the original hypothesis that the baseline weather does indeed have a significant affect on energy conservation. A base that experienced a much warmer cooling season in FY75 consumed more energy that year than in prior years. The results indicate that a baseline 1000 CDD's above the 20-year average will result in a base having an energy conservation program 7.1 percentage points above a base whose baseline approximated the norm. The ARHDD variable indicates the same except the percent gain is 5.22.

Command and geographic zone were also determined to have an effect on energy conservation. Bases in the Tactical Air Command can be expected to have a more successful energy conservation program than other commands by 2.76 percentage points. This reflects upon two points: first, TAC has placed much emphasis on energy conservation, both financially and managerially; second, most TAC bases are located in midsouthern states where the weather is conducive for flying. These areas are normally free of any extremes in weather.

Bases in zone two were determined to experience less successful results in energy conservation by 6.28 percentage points. As seen in the climatic map in Chapter 2, zone 2 covers a wide stretch of area. Most SAC bases are located in zone 2 which may account for their low reduction in energy use (11.4%) compared to the Air Force average of 14.1 percent (FY84 figures).

As discussed earlier, the majority of the nine variables affecting energy conservation are uncontrollable. An argument could be made that a base should be able to control approximately 75 percent of its energy conservation since these variables explained less than 25 percent of the total variance in energy conservation. Regardless, the success of a base's energy conservation program is contingent upon numerous factors beyond their control. The present method used by the Air Force to measure energy conservation is based strictly on a base's annual energy consumption (in MBTU/SF) compared to its FY75 consumption level. There are two primary flaws associated with this approach. First, this approach measures the change in energy consumption without any consideration for the conditions of the baseline year nor subsequent years thereafter. For example, the weather during the baseline year may have been more severe or mild than normal years or a base may have increased in size and population since 1975. Second, this approach fails to account for the numerous factors affecting energy conservation. All the bases are compared together without any consideration for weather patterns nor climate zones.

In light of this, it is concluded that the present method to measure energy conservation does not provide a true indication of a base's energy conservation efforts. There are numerous factors affecting energy conservation that the current approach fails to account for. These uncontrollable factors may prevent a base from achieving successful results regardless of their energy conservation efforts.

Although the preceding discussion was based on the initial regression analysis, the same conclusions were reached using the SAC and TAC models. In each case, several uncontrollable factors were determined to influence the success of a base's energy conservation efforts.

## Recommendations for Further Research

The author recommends several areas requiring further research. A study should be conducted to identify a new approach to better reflect the energy conservation efforts of a base. This approach should provide a means to account for the uncontrollble factors affecting energy conservation. In addition, this study should investigate for additional factors that may explain a greater share of the variation in energy conservation. As identified in this analysis, the factors affecting energy conservation varied between SAC and TAC. Therefore, it may be appropriate to develop different adjustment factors that apply to each command. This will alleviate the problems resulting from large variations between commands.

Another study is recommended to investigate the qualitative factors affecting energy conservation. A survey instrument is needed to measure the effect of energy awareness programs, MAJCOM's support, top management's support (i.e. wing commander, base civil engineer), on energy conservation. In addition, this research should study the affect of socioeconomic factors, such as the price of gasoline, to measure the general apathy toward the need to conserve energy.

# Appendix A: Database

The following headings refer to the column numbers indicated on the succeeding pages:

| Column | Heading |
|---|---|
| 1 | Counter |
| 2 | Observation number |
| 3 | Base (see Table 2) |
| 4 | Fiscal year |
| 5 | Command |
| 6 | Climatic zone |
| 7 | Mission |
| 8 | Energy conservation |
| 9 | Cooling degree days |
| 10 | Heating degree days |
| 11 | Base population |
| 12 | ECIP (cumulative) |
| 13 | EMCS (cumulative) |
| 14 | RCDD |
| 15 | RHDD |
| 16 | RPOP |
| 17 | was not used |
| 18 | Facility square footage |
| 19 | ARCDD |
| 20 | ARHDD |
| 21 | RSF |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1. | 1. | 80. | 1. | 1. | 1. | 7.7783 | 232. | 9313. | 4213. | 48.0 | .0 | -54. | 26. | -212. | 999. | 4331. | 96. | -323. | -4225. |
| 2 | 2. | 2. | 80. | 1. | 4. | 6. | 11.6508 | 97. | 2245. | 10741. | 567.3 | 317.7 | 26. | -1326. | 4254. | 999. | 9178. | -1. | 415. | -8866. |
| 3 | 3. | 3. | 80. | 1. | 1. | 1. | 7.7544 | 157. | 7032. | 5025. | 1027.4 | .0 | -226. | -124. | 31. | 999. | 6198. | -27. | 320. | -6636. |
| 4 | 4. | 4. | 80. | 1. | 1. | 1. | 16.8236 | 488. | 9031. | 5845. | 2706.1 | .0 | 69. | -321. | 31. | 999. | 5666. | 20. | -489. | -5628. |
| 5 | 5. | 5. | 80. | 1. | 1. | 1. | 6.9867 | 155. | 9143. | 4182. | .0 | .0 | -160. | -255. | -80. | 999. | 6402. | 143. | -127. | -6380. |
| 6 | 6. | 6. | 80. | 1. | 1. | 1. | 17.3533 | 415. | 9102. | 6812. | 1962.1 | .0 | -18. | -335. | 46. | 999. | 6946. | 37. | -171. | -6793. |
| 7 | 7. | 7. | 80. | 1. | 1. | 1. | 17.3744 | 479. | 7639. | 3549. | 1621.0 | .0 | -25. | 71. | 97. | 999. | 4165. | 122. | -325. | -3709. |
| 8 | 8. | 8. | 80. | 1. | 2. | 1. | 7.4934 | 1240. | 6196. | 14568. | 1321.3 | 853.3 | 154. | -196. | 1722. | 999. | 10104. | -57. | 158. | -9121. |
| 9 | 9. | 9. | 80. | 1. | 6. | 1. | 3.5828 | 2787. | 2507. | 6381. | 943.7 | .0 | 347. | 388. | -1321. | 999. | 5060. | 23. | -229. | -4900. |
| 10 | 10. | 10. | 80. | 1. | 1. | 1. | 8.2554 | 408. | 7202. | 4116. | 208.0 | .0 | 215. | -621. | -235. | 999. | 3861. | -125. | 567. | -3290. |
| 11 | 11. | 11. | 80. | 1. | 1. | 1. | 9.4428 | 411. | 7638. | 4458. | 933.5 | .0 | -114. | -107. | -78. | 999. | 5083. | 168. | -295. | -5043. |
| 12 | 12. | 12. | 80. | 1. | 1. | 1. | 18.1992 | 461. | 7034. | 6743. | 1114.9 | 469.1 | -87. | -155. | -894. | 999. | 5585. | 87. | -218. | -5665. |
| 13 | 13. | 13. | 80. | 1. | 3. | 1. | 14.4111 | 2380. | 4715. | 4889. | 248.4 | .0 | 773. | -206. | 324. | 999. | 3629. | -122. | 292. | -3345. |
| 14 | 14. | 14. | 80. | 1. | 1. | 1. | 22.1288 | 560. | 6467. | 4391. | 394.4 | 243.3 | 42. | -170. | -153. | 999. | 3576. | 11. | -134. | -3647. |
| 15 | 15. | 15. | 80. | 1. | 3. | 1. | 23.7130 | 1624. | 5154. | 3497. | 401.9 | .0 | 247. | -1. | -168. | 999. | 3615. | -14. | 89. | -3375. |
| 16 | 16. | 16. | 80. | 1. | 1. | 1. | 29.2142 | 269. | 6850. | 6172. | 567.8 | .0 | 79. | -1410. | 227. | 999. | 4744. | -160. | 538. | -4886. |
| 17 | 17. | 17. | 80. | 1. | 4. | 1. | 3.9271 | 2386. | 3834. | 3217. | 78.0 | .0 | 532. | 303. | 116. | 999. | 2470. | 26. | -194. | -2280. |
| 18 | 18. | 18. | 80. | 1. | 2. | 1. | 2.1081 | 1269. | 5908. | 4879. | 1094.7 | .0 | 327. | -79. | 1280. | 999. | 3542. | 58. | -186. | -3443. |
| 19 | 19. | 19. | 80. | 1. | 7. | 1. | 3.3624 | 2960. | 2472. | 5273. | 916.4 | .0 | 939. | -262. | 309. | 999. | 3318. | -429. | 80. | -3286. |
| 20 | 20. | 20. | 80. | 1. | 4. | 1. | 5.4432 | 1348. | 1798. | 5582. | 617.4 | .0 | 161. | -892. | -203. | 999. | 3872. | -144. | 479. | -4098. |
| 21 | 21. | 21. | 80. | 1. | 4. | 1. | 9.9835 | 1288. | 2450. | 6515. | 399.1 | .0 | -145. | -675. | 621. | 999. | 3415. | -113. | 469. | -3187. |
| 22 | 22. | 22. | 80. | 1. | 4. | 1. | 20.7190 | 1205. | 2485. | 4945. | 1354.9 | 435.2 | -678. | -138. | -457. | 999. | 4761. | 310. | -26. | -4376. |
| 23 | 23. | 23. | 80. | 1. | 7. | 1. | 10.2813 | 3250. | 2350. | 6328. | 142.1 | .0 | 793. | -21. | 406. | 999. | 3274. | -350. | 45. | -3093. |
| 24 | 24. | 24. | 80. | 1. | 1. | 1. | 12.0657 | 823. | 6998. | 6715. | 494.3 | .0 | 94. | -152. | 346. | 999. | 5792. | 2. | 47. | -5864. |
| 25 | 25. | 25. | 80. | 2. | 4. | 2. | 16.3136 | 1926. | 3623. | 10434. | 957.8 | .0 | 349. | 239. | 384. | 999. | 6255. | 22. | -179. | -4884. |
| 26 | 26. | 26. | 80. | 2. | 4. | 2. | 9.2578 | 2046. | 3237. | 8415. | 103.7 | .0 | 317. | 68. | 2561. | 999. | 5482. | -90. | -55. | -5213. |
| 27 | 27. | 27. | 80. | 2. | 7. | 2. | 17.7019 | 2121. | 2567. | 6062. | 270.2 | .0 | 110. | 197. | 10. | 999. | 5264. | -139. | -44. | -4000. |
| 28 | 28. | 28. | 80. | 2. | 6. | 2. | 5.9906 | 2888. | 1985. | 3550. | 81.4 | .0 | 642. | 318. | 200. | 999. | 2578. | -341. | -279. | -2222. |
| 29 | 29. | 29. | 80. | 2. | 4. | 2. | 12.5357 | 2182. | 2511. | 4009. | 69.8 | .0 | -254. | 624. | 687. | 999. | 2723. | 494. | -596. | -2573. |
| 30 | 30. | 30. | 80. | 2. | 4. | 2. | 11.3260 | 1969. | 2909. | 6329. | 891.9 | .0 | -132. | 440. | 305. | 999. | 4445. | 272. | -524. | -4345. |
| 31 | 31. | 31. | 80. | 2. | 4. | 2. | 16.1651 | 1794. | 2689. | 5386. | 362.1 | .0 | -88. | -507. | 116. | 999. | 4742. | 27. | 305. | -4335. |
| 32 | 32. | 32. | 80. | 2. | 6. | 2. | 12.0819 | 3652. | 497. | 7631. | 123.6 | .0 | -221. | 198. | 974. | 999. | 4234. | 325. | -260. | -3980. |
| 33 | 33. | 33. | 80. | 2. | 6. | 2. | 10.9333 | 4297. | 182. | 6550. | 1757.1 | .0 | 245. | 106. | 794. | 999. | 5334. | 79. | -119. | -4869. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 34. | 34. | 80. | 2. | 6. | 2. | 6.9697 | 2731. | 1625. | 3352. | 363.2 | .0 | 202. | 283. | 500. | 999. | 1727. | -189. | -184. | -1599. |
| 35 | 35. | 35. | 80. | 2. | 7. | 2. | 12.1318 | 2944. | 2146. | 10144. | 70.7 | .0 | 6. | -560. | 2701. | 999. | 6280. | -136. | 308. | -4963. |
| 36 | 36. | 36. | 80. | 2. | 3. | 2. | 6.7678 | 1725. | 3842. | 4177. | 214.1 | .0 | 465. | -211. | -639. | 999. | 3291. | -47. | 40. | -3247. |
| 37 | 37. | 37. | 80. | 2. | 6. | 2. | 1.8260 | 3196. | 1790. | 5469. | 551.9 | .0 | 533. | 215. | -335. | 999. | 3247. | -331. | -142. | -2909. |
| 38 | 38. | 38. | 80. | 2. | 7. | 2. | 11.2230 | 2952. | 1431. | 7180. | 161.9 | .0 | 190. | -578. | -1937. | 999. | 5110. | -192. | 388. | -4700. |
| 39 | 39. | 39. | 80. | 2. | 7. | 2. | 5.3798 | 3905. | 1374. | 8300. | 560.1 | .0 | 367. | -312. | 1673. | 999. | 4381. | -86. | 271. | -3971. |
| 40 | 40. | 40. | 80. | 2. | 2. | 2. | 5.5746 | 486. | 5712. | 4493. | 301.6 | .0 | -382. | -118. | 278. | 999. | 4072. | 12. | -23. | -4168. |
| 41 | 41. | 41. | 80. | 2. | 6. | 1. | .8829 | 2891. | 1098. | 5900. | 156.5 | .0 | 366. | -3. | 1234. | 999. | 4052. | -216. | -211. | -3852. |
| 42 | 42. | 42. | 80. | 3. | 3. | 3. | 4.4888 | 1697. | 5164. | 10662. | 1230.2 | .0 | 92. | 542. | 3494. | 999. | 5599. | 190. | -244. | -5188. |
| 43 | 43. | 43. | 80. | 3. | 7. | 3. | 17.2705 | 2397. | 2241. | 8799. | 1961.5 | 440.0 | 151. | 305. | 2658. | 999. | 3841. | 79. | -213. | -3734. |
| 44 | 44. | 44. | 80. | 3. | 4. | 3. | 4.7505 | 2725. | 3456. | 4162. | .0 | .0 | 983. | -112. | -473. | 999. | 3264. | -550. | 199. | -2961. |
| 45 | 45. | 45. | 80. | 3. | 3. | 3. | 18.0640 | 1465. | 4218. | 7757. | 927.7 | 1047.6 | 65. | 309. | -1907. | 999. | 8385. | 168. | -577. | -6749. |
| 46 | 46. | 46. | 80. | 3. | 4. | 3. | 14.1319 | 631. | 2600. | 12516. | 997.9 | .0 | -204. | -511. | 426. | 999. | 7673. | -34. | 416. | -7533. |
| 47 | 47. | 47. | 80. | 3. | 4. | 3. | 14.2081 | 1411. | 1701. | 8220. | 4061.0 | 1102.0 | 75. | -739. | -785. | 999. | 5914. | -165. | 434. | -5927. |
| 48 | 48. | 48. | 80. | 3. | 7. | 3. | 14.5056 | 2697. | 3518. | 7131. | 3183.9 | .0 | 969. | 361. | -59. | 999. | 4720. | -306. | -98. | -4265. |
| 49 | 49. | 49. | 80. | 3. | 3. | 3. | 15.8268 | 1556. | 4164. | 16258. | 241.0 | .0 | 450. | -719. | 10026. | 999. | 9371. | -254. | 515. | -8683. |
| 50 | 50. | 50. | 80. | 3. | 3. | 3. | 18.3765 | 18. | 5546. | 6754. | 274.3 | .0 | -33. | 251. | 99. | 999. | 4283. | -46. | 16. | -4081. |
| 51 | 51. | 51. | 80. | 3. | 3. | 3. | 6.3325 | 1389. | 4772. | 7013. | 1026.2 | 548.0 | 432. | -131. | -346. | 999. | 6186. | -33. | -199. | -5810. |
| 52 | 52. | 52. | 80. | 3. | 4. | 3. | 19.6741 | 2121. | 3091. | 4153. | 317.1 | .0 | 145. | 302. | 593. | 999. | 2417. | 176. | -313. | -1984. |
| 53 | 53. | 53. | 80. | 3. | 3. | 3. | 7.8147 | 1224. | 4458. | 6468. | 991.9 | .0 | 99. | -22. | -434. | 999. | 5429. | -14. | -199. | -4832. |
| 54 | 54. | 54. | 80. | 4. | 1. | 4. | 8.2398 | 597. | 6294. | 19361. | 2926.2 | .0 | 21. | -632. | 1013. | 999. | 11173. | -311. | 782. | -9922. |
| 55 | 55. | 55. | 80. | 4. | 4. | 4. | -4.1114 | 2614. | 3386. | 21700. | 2232.0 | .0 | 930. | -145. | -1024. | 999. | 12195. | -323. | -59. | -11024. |
| 56 | 56. | 56. | 80. | 4. | 4. | 4. | 23.3136 | 1130. | 2540. | 16140. | 1671.4 | 839.0 | -418. | -170. | -3331. | 999. | 9391. | 151. | 115. | -9125. |
| 57 | 57. | 57. | 80. | 4. | 6. | 4. | -16.0556 | 3550. | 1474. | 22276. | 2722.8 | .0 | 900. | 46. | -2485. | 999. | 9951. | -470. | -91. | -13363. |
| 58 | 58. | 58. | 80. | 4. | 7. | 4. | 7.6594 | 2351. | 2253. | 18900. | 1627.2 | 858.0 | 155. | 387. | -1194. | 999. | 12474. | -57. | -344. | -10671. |
| 59 | 59. | 59. | 80. | 4. | 2. | 4. | 3.7487 | 1169. | 5482. | 24200. | 2834.0 | .0 | 73. | 105. | -810. | 999. | 15777. | 79. | -119. | -15757. |
| 60 | 60. | 60. | 80. | 5. | 6. | 4. | -.9189 | 3550. | 1474. | 2280. | 689.0 | 494.0 | 900. | 46. | 158. | 999. | 1700. | -470. | -91. | -1573. |
| 61 | 61. | 61. | 80. | 5. | 4. | 6. | -2.4220 | 1712. | 2686. | 8862. | .0 | .0 | -3. | -846. | 3056. | 999. | 8220. | -78. | 427. | -7623. |
| 62 | 62. | 62. | 80. | 5. | 6. | 6. | 7.9155 | 2544. | 1605. | 16190. | 563.2 | .0 | 168. | 147. | 1290. | 999. | 9712. | -234. | -169. | -9128. |
| 63 | 63. | 63. | 80. | 5. | 6. | 4. | 10.6836 | 3509. | 446. | 8925. | 2591.0 | .0 | -506. | 269. | 4133. | 999. | 5459. | 500. | -253. | -5277. |
| 64 | 64. | 64. | 80. | 5. | 2. | 6. | 7.7778 | 625. | 6224. | 5070. | 1199.7 | .0 | 50. | -159. | 607. | 999. | 4001. | -7. | -144. | -3799. |
| 65 | 65. | 65. | 80. | 6. | 6. | 5. | 10.2572 | 2920. | 1430. | 14701. | 394.5 | .0 | 249. | 235. | -2352. | 999. | 8975. | -138. | -323. | -8466. |
| 66 | 66. | 66. | 80. | 6. | 6. | 5. | 14.0452 | 3550. | 1474. | 35377. | 2318.3 | 2244.7 | 900. | 46. | 12055. | 999. | 10265. | -470. | -91. | -9477. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | 67. | 67. | 80. | 6. | 2. | 5. | 2.2507 | 952. | 5965. | 13182. | 369.8 | .0 | 403. | -332. | 4373. | 999. | 6126. | -141. | 334. | -6380. |
| 68 | 68. | 68. | 80. | 6. | 2. | 5. | 12.7312 | 1181. | 6360. | 8772. | 805.7 | .0 | 207. | 283. | -2911. | 999. | 6352. | -65. | 83. | -6549. |
| 69 | 69. | 69. | 80. | 6. | 4. | 5. | 1.3405 | 3065. | 3087. | 12000. | 665.0 | .0 | 925. | 51. | 778. | 999. | 6841. | -418. | 45. | -6987. |
| 70 | 70. | 70. | 80. | 6. | 7. | 5. | 2.2567 | 2448. | 2824. | 3068. | 258.8 | .0 | 480. | 204. | -171. | 999. | 2412. | -61. | -231. | -2321. |
| 71 | 71. | 71. | 80. | 6. | 4. | 5. | 7.9077 | 2452. | 4092. | 2600. | 41.8 | .0 | 776. | -319. | 1229. | 999. | 1245. | -373. | 409. | -1385. |
| 72 | 72. | 72. | 80. | 6. | 7. | 5. | -4.0616 | 3520. | 1330. | 4420. | 235.8 | .0 | 376. | -642. | 535. | 999. | 2454. | -378. | 428. | -2609. |
| 73 | 73. | 73. | 80. | 6. | 4. | 5. | 10.6622 | 2401. | 3465. | 3328. | 38.0 | .0 | 584. | 21. | 364. | 999. | 1648. | 51. | 29. | -1681. |
| 74 | 74. | 74. | 80. | 6. | 4. | 5. | 5.0062 | 1244. | 2657. | 6687. | 256.6 | .0 | -291. | 43. | -1163. | 999. | 4244. | 222. | -30. | -4053. |
| 75 | 75. | 75. | 80. | 6. | 7. | 5. | 10.2870 | 2535. | 2068. | 4551. | 504.4 | .0 | 177. | 63. | -1167. | 999. | 6155. | -95. | -113. | -6105. |
| 76 | 76. | 76. | 80. | 6. | 6. | 5. | -1.4838 | 3137. | 1699. | 7745. | 406.3 | .0 | 495. | 121. | -161. | 999. | 4415. | -245. | -24. | -4424. |
| 77 | 77. | 77. | 80. | 6. | 6. | 1. | -2.5567 | 3949. | 1393. | 3001. | 55.5 | .0 | 1195. | 9. | 51. | 999. | 2055. | -457. | -136. | -2117. |
| 78 | 78. | 1. | 81. | 1. | 1. | 1. | 8.8469 | 148. | 9051. | 4213. | 48.0 | .0 | -138. | -236. | -212. | 999. | 4331. | 96. | -323. | -4225. |
| 79 | 79. | 2. | 81. | 1. | 4. | 6. | 14.7419 | 228. | 2280. | 11575. | 567.3 | 317.7 | 157. | -1291. | 5088. | 999. | 9178. | -1. | 415. | -8866. |
| 80 | 80. | 3. | 81. | 1. | 1. | 1. | 11.3489 | 460. | 6401. | 5025. | 1027.4 | .0 | 77. | -755. | 31. | 999. | 6198. | -27. | 320. | -6636. |
| 81 | 81. | 4. | 81. | 1. | 1. | 1. | 9.7247 | 383. | 8416. | 5845. | 2706.1 | .0 | -36. | -936. | 31. | 999. | 5666. | 20. | -489. | -5628. |
| 82 | 82. | 5. | 81. | 1. | 1. | 1. | 10.0681 | 162. | 9222. | 4122. | .0 | .0 | -153. | -176. | -140. | 999. | 6402. | 143. | -127. | -6380. |
| 83 | 83. | 6. | 81. | 1. | 1. | 1. | 20.0499 | 506. | 8247. | 6297. | 2115.1 | .0 | 73. | -1190. | -469. | 999. | 6946. | 37. | -171. | -6793. |
| 84 | 84. | 7. | 81. | 1. | 1. | 1. | 17.6337 | 268. | 7926. | 3551. | 1621.0 | .0 | -236. | 358. | 99. | 999. | 4165. | 122. | -325. | -3709. |
| 85 | 85. | 8. | 81. | 1. | 2. | 1. | 11.4058 | 1135. | 5522. | 14574. | 1335.7 | 853.3 | 49. | -870. | 1728. | 999. | 10104. | -57. | 158. | -9121. |
| 86 | 86. | 9. | 81. | 1. | 6. | 1. | 3.8216 | 2233. | 2455. | 6409. | 943.7 | .0 | -207. | 336. | -1293. | 999. | 5060. | 23. | -229. | -4900. |
| 87 | 87. | 10. | 81. | 1. | 1. | 1. | 15.0285 | 294. | 6136. | 4113. | 208.0 | .0 | 101. | -1687. | -238. | 999. | 3861. | -125. | 567. | -3290. |
| 88 | 88. | 11. | 81. | 1. | 1. | 1. | 5.3720 | 289. | 8287. | 4398. | 1093.6 | .0 | -236. | 542. | -138. | 999. | 5083. | 168. | -295. | -5043. |
| 89 | 89. | 12. | 81. | 1. | 1. | 1. | 17.4329 | 455. | 7420. | 6741. | 1114.9 | 469.1 | -93. | 231. | -896. | 999. | 5585. | 87. | -218. | -5665. |
| 90 | 90. | 13. | 81. | 1. | 3. | 1. | 18.0442 | 1729. | 3969. | 3687. | 248.4 | .0 | 122. | -952. | -878. | 999. | 3629. | -122. | 292. | -3345. |
| 91 | 91. | 14. | 81. | 1. | 1. | 1. | 13.6601 | 538. | 6754. | 4391. | 638.7 | 243.3 | 20. | 117. | -153. | 999. | 3576. | 11. | -134. | -3647. |
| 92 | 92. | 15. | 81. | 1. | 3. | 1. | 25.1690 | 1574. | 4630. | 3598. | 1104.4 | .0 | 197. | -525. | -67. | 999. | 3615. | -14. | 89. | -3375. |
| 93 | 93. | 16. | 81. | 1. | 1. | 1. | 30.7410 | 352. | 6646. | 4941. | 567.8 | 465.0 | 162. | -1614. | -1004. | 999. | 4744. | -160. | 538. | -4886. |
| 94 | 94. | 17. | 81. | 1. | 4. | 1. | 7.2874 | 1928. | 3467. | 3062. | 78.0 | .0 | 74. | -64. | -39. | 999. | 2470. | 26. | -194. | -2280. |
| 95 | 95. | 18. | 81. | 1. | 2. | 1. | 8.1948 | 891. | 5961. | 4755. | 1094.7 | .0 | -51. | -26. | 1156. | 999. | 3542. | 58. | -186. | -3443. |
| 96 | 96. | 19. | 81. | 1. | 7. | 1. | 6.8908 | 2539. | 2337. | 5355. | 916.4 | .0 | 518. | -397. | 391. | 999. | 3318. | -429. | 80. | -3286. |
| 97 | 97. | 20. | 81. | 1. | 4. | 1. | 6.1175 | 2030. | 1308. | 5427. | 617.4 | .0 | 843. | -1382. | -358. | 999. | 3872. | -144. | 479. | -4098. |
| 98 | 98. | 21. | 81. | 1. | 4. | 1. | 8.9521 | 1855. | 2539. | 6340. | 399.1 | .0 | 422. | -586. | 446. | 999. | 3415. | -113. | 469. | -3187. |
| 99 | 99. | 22. | 81. | 1. | 4. | 1. | 21.7892 | 1616. | 2452. | 4730. | 1781.9 | 435.2 | -267. | -171. | -672. | 999. | 4761. | 310. | -26. | -4376. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 100. | 23. | 81. | 1. | 7. | 1. | 12.9971 | 2500. | 2171. | 6667. | 142.1 | .0 | 43. | -200. | 745. | 999. | 3274. | -350. | 45. | -3093. |
| 101 | 101. | 24. | 81. | 1. | 1. | 1. | 9.6336 | 628. | 5889. | 6455. | 494.3 | .0 | -101. | -1261. | 86. | 999. | 5792. | 2. | 47. | -5864. |
| 102 | 102. | 25. | 81. | 2. | 4. | 2. | 19.8074 | 1715. | 3794. | 10377. | 974.6 | .0 | 138. | 410. | 327. | 999. | 6255. | 22. | -179. | -4884. |
| 103 | 103. | 26. | 81. | 2. | 4. | 2. | 7.7734 | 1728. | 3201. | 7108. | 103.7 | .0 | -1. | 32. | 1254. | 999. | 5482. | -90. | -55. | -5213. |
| 104 | 104. | 27. | 81. | 2. | 7. | 2. | 15.7005 | 2064. | 2573. | 5508. | 426.5 | .0 | 53. | 203. | -544. | 999. | 5264. | -139. | -44. | -4000. |
| 105 | 105. | 28. | 81. | 2. | 6. | 2. | 9.9603 | 2462. | 2238. | 3709. | 81.4 | .0 | 216. | 571. | 359. | 999. | 2578. | -341. | -279. | -2222. |
| 106 | 106. | 29. | 81. | 2. | 4. | 2. | 9.6786 | 1949. | 2642. | 3601. | 432.7 | .0 | -487. | 755. | 279. | 999. | 2723. | 494. | -596. | -2573. |
| 107 | 107. | 30. | 81. | 2. | 4. | 2. | 17.4724 | 1560. | 3345. | 5887. | 891.9 | .0 | -541. | 876. | -137. | 999. | 4445. | 272. | -524. | -4345. |
| 108 | 108. | 31. | 81. | 2. | 4. | 2. | 17.0679 | 2463. | 2298. | 5313. | 362.1 | .0 | 581. | -898. | 43. | 999. | 4742. | 27. | 305. | -4335. |
| 109 | 109. | 32. | 81. | 2. | 6. | 2. | 11.2628 | 3337. | 879. | 7584. | 123.6 | .0 | -536. | 580. | 927. | 999. | 4234. | 325. | -260. | -3980. |
| 110 | 110. | 33. | 81. | 2. | 6. | 2. | 15.3905 | 3914. | 274. | 6741. | 1757.1 | .0 | -138. | 198. | 985. | 999. | 5334. | 79. | -119. | -4869. |
| 111 | 111. | 34. | 81. | 2. | 6. | 2. | 3.8258 | 2643. | 1746. | 3220. | 363.2 | .0 | 114. | 404. | 368. | 999. | 1727. | -189. | -184. | -1599. |
| 112 | 112. | 35. | 81. | 2. | 7. | 2. | 12.0543 | 3505. | 1960. | 10383. | 70.7 | .0 | 567. | -746. | 2940. | 999. | 6280. | -136. | 308. | -4963. |
| 113 | 113. | 36. | 81. | 2. | 3. | 2. | 10.9685 | 1254. | 3676. | 4275. | 214.1 | .0 | -6. | -377. | -541. | 999. | 3291. | -47. | 40. | -3247. |
| 114 | 114. | 37. | 81. | 2. | 6. | 2. | 7.7694 | 2702. | 1704. | 4606. | 551.9 | .0 | 39. | 129. | -1198. | 999. | 3247. | -331. | -142. | -2909. |
| 115 | 115. | 38. | 81. | 2. | 7. | 2. | 10.8501 | 3190. | 1197. | 6707. | 258.5 | .0 | 428. | -812. | -2410. | 999. | 5110. | -192. | 388. | -4700. |
| 116 | 116. | 39. | 81. | 2. | 7. | 2. | 5.7911 | 4353. | 1011. | 7900. | 560.1 | .0 | 815. | -675. | 1273. | 999. | 4381. | -86. | 271. | -3971. |
| 117 | 117. | 40. | 81. | 2. | 2. | 2. | 3.2073 | 865. | 5733. | 4755. | 335.2 | .0 | -3. | -97. | 540. | 999. | 4072. | 12. | -23. | -4168. |
| 118 | 118. | 41. | 81. | 2. | 6. | 1. | -3.3397 | 2636. | 1486. | 5400. | 201.6 | .0 | 111. | 385. | 734. | 999. | 4052. | -216. | -211. | -3852. |
| 119 | 119. | 42. | 81. | 3. | 3. | 3. | 8.5723 | 1281. | 4676. | 10264. | 5995.0 | .0 | -324. | 54. | 3096. | 999. | 5599. | 190. | -244. | -5188. |
| 120 | 120. | 43. | 81. | 3. | 7. | 3. | 19.2067 | 2348. | 2423. | 8748. | 1961.5 | 440.0 | 102. | 487. | 2607. | 999. | 3841. | 79. | -213. | -3734. |
| 121 | 121. | 44. | 81. | 3. | 4. | 3. | 8.3832 | 2327. | 2854. | 3940. | .0 | .0 | 585. | -714. | -695. | 999. | 3264. | -550. | 199. | -2961. |
| 122 | 122. | 45. | 81. | 3. | 3. | 3. | 15.8159 | 1156. | 4563. | 8596. | 5687.1 | 1047.6 | -244. | 654. | -1068. | 999. | 8385. | 168. | -577. | -6749. |
| 123 | 123. | 46. | 81. | 3. | 4. | 3. | 15.5227 | 1123. | 2421. | 12312. | 997.9 | .0 | 288. | -690. | 222. | 999. | 7673. | -34. | 416. | -7533. |
| 124 | 124. | 47. | 81. | 3. | 4. | 3. | 11.9457 | 2122. | 1237. | 8194. | 4839.3 | 1102.0 | 786. | -1203. | -811. | 999. | 5914. | -165. | 434. | -5927. |
| 125 | 125. | 48. | 81. | 3. | 7. | 3. | 18.0580 | 1808. | 3317. | 7143. | 3603.9 | .0 | 80. | 160. | -47. | 999. | 4720. | -306. | -98. | -4265. |
| 126 | 126. | 49. | 81. | 3. | 3. | 3. | 20.0142 | 1444. | 4004. | 16612. | 241.0 | .0 | 338. | -879. | 10380. | 999. | 9371. | -254. | 515. | -8683. |
| 127 | 127. | 50. | 81. | 3. | 3. | 3. | 22.6607 | 172. | 4762. | 6629. | 1017.3 | .0 | 121. | -533. | -26. | 999. | 4283. | -46. | 16. | -4081. |
| 128 | 128. | 51. | 81. | 3. | 3. | 3. | 12.3351 | 900. | 5289. | 7358. | 1026.2 | 548.0 | -57. | 386. | -1. | 999. | 6186. | -33. | -199. | -5810. |
| 129 | 129. | 52. | 81. | 3. | 4. | 3. | 19.1176 | 1828. | 3289. | 4400. | 317.1 | .0 | -148. | 500. | 840. | 999. | 2417. | 176. | -313. | -1984. |
| 130 | 130. | 53. | 81. | 3. | 3. | 3. | 12.0678 | 889. | 5037. | 6468. | 991.9 | .0 | -236. | 557. | -434. | 999. | 5429. | -14. | -199. | -4832. |
| 131 | 131. | 54. | 81. | 4. | 1. | 4. | 10.5730 | 940. | 5703. | 19263. | 2926.2 | .0 | 364. | -1223. | 915. | 999. | 11173. | -311. | 782. | -9922. |
| 132 | 132. | 55. | 81. | 4. | 4. | 4. | -2.5967 | 2154. | 2967. | 21700. | 2232.0 | .0 | 470. | -564. | -1024. | 999. | 12195. | -323. | -59. | -11024. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133 | 133. | 56. | 81. | 4. | 4. | 4. | 21.5345 | 1869. | 2303. | 16409. | 1671.4 | 839.0 | 321. | -407. | -3062. | 999. | 9391. | 151. | 115. | -9125. |
| 134 | 134. | 57. | 81. | 4. | 6. | 4. | -26.4444 | 3166. | 1243. | 22351. | 3002.8 | .0 | 516. | -185. | -2410. | 999. | 9951. | -470. | -91. | -13363. |
| 135 | 135. | 58. | 81. | 4. | 7. | 4. | 4.8094 | 2028. | 2544. | 19007. | 3590.7 | 858.0 | -168. | 678. | -1087. | 999. | 12474. | -57. | -344. | -10671. |
| 136 | 136. | 59. | 81. | 4. | 2. | 4. | 4.3175 | 897. | 5761. | 23425. | 2834.0 | .0 | -199. | 384. | -1585. | 999. | 15777. | 79. | -119. | -15757. |
| 137 | 137. | 60. | 81. | 5. | 6. | 4. | 3.3081 | 3166. | 1243. | 2298. | 689.0 | 494.0 | 516. | -185. | 176. | 999. | 1700. | -470. | -91. | -1573. |
| 138 | 138. | 61. | 81. | 5. | 4. | 6. | 12.2569 | 2359. | 2321. | 8517. | .0 | .0 | 644. | -1211. | 2711. | 999. | 8220. | -78. | 427. | -7623. |
| 139 | 139. | 62. | 81. | 5. | 6. | 6. | 3.1831 | 2532. | 1679. | 13265. | 1097.4 | .0 | 156. | 221. | -1635. | 999. | 9712. | -234. | -169. | -9128. |
| 140 | 140. | 63. | 81. | 5. | 6. | 4. | 11.0198 | 2932. | 767. | 8600. | 2876.7 | .0 | -1083. | 590. | 3808. | 999. | 5459. | 500. | -253. | -5277. |
| 141 | 141. | 64. | 81. | 5. | 2. | 6. | 4.7619 | 512. | 6623. | 4873. | 1199.7 | .0 | -63. | 240. | 410. | 999. | 4001. | -7. | -144. | -3799. |
| 142 | 142. | 65. | 81. | 6. | 6. | 5. | 9.6926 | 2892. | 1675. | 17925. | 394.5 | .0 | 221. | 480. | 872. | 999. | 8975. | -138. | -323. | -8466. |
| 143 | 143. | 66. | 81. | 6. | 6. | 5. | 10.1416 | 3166. | 1243. | 24751. | 2318.3 | 2244.7 | 516. | -185. | 1429. | 999. | 10265. | -470. | -91. | -9477. |
| 144 | 144. | 67. | 81. | 6. | 2. | 5. | 6.4404 | 912. | 4741. | 13852. | 369.8 | .0 | 363. | -1556. | 5043. | 999. | 6126. | -141. | 334. | -6380. |
| 145 | 145. | 68. | 81. | 6. | 2. | 5. | 10.8816 | 900. | 6086. | 9300. | 805.7 | .0 | -74. | 9. | -2383. | 999. | 6352. | -65. | 83. | -6549. |
| 146 | 146. | 69. | 81. | 6. | 4. | 5. | 9.9196 | 2552. | 2654. | 11200. | 665.0 | .0 | 412. | -382. | -22. | 999. | 6841. | -418. | 45. | -6987. |
| 147 | 147. | 70. | 81. | 6. | 7. | 5. | 10.4412 | 2033. | 2876. | 3314. | 258.8 | .0 | 65. | 256. | 75. | 999. | 2412. | -61. | -231. | -2321. |
| 148 | 148. | 71. | 81. | 6. | 4. | 5. | 11.0708 | 2299. | 3315. | 2700. | 41.8 | .0 | 623. | -1096. | 1329. | 999. | 1245. | -373. | 409. | -1385. |
| 149 | 149. | 72. | 81. | 6. | 7. | 5. | -3.8866 | 4011. | 1051. | 4420. | 235.8 | .0 | 867. | -921. | 535. | 999. | 2454. | -378. | 428. | -2609. |
| 150 | 150. | 73. | 81. | 6. | 4. | 5. | 7.3208 | 1816. | 2948. | 3236. | 211.6 | .0 | -1. | -496. | 272. | 999. | 1648. | 51. | 29. | -1681. |
| 151 | 151. | 74. | 81. | 6. | 4. | 5. | 4.5925 | 1500. | 2575. | 6750. | 285.4 | .0 | -35. | -39. | -1100. | 999. | 4244. | 222. | -30. | -4053. |
| 152 | 152. | 75. | 81. | 6. | 7. | 5. | 8.6843 | 2364. | 2347. | 4362. | 504.4 | .0 | 6. | 342. | -1356. | 999. | 6155. | -95. | -113. | -6105. |
| 153 | 153. | 76. | 81. | 6. | 6. | 5. | .3514 | 2842. | 1439. | 7642. | 406.3 | .0 | 200. | -139. | -264. | 999. | 4415. | -245. | -24. | -4424. |
| 154 | 154. | 77. | 81. | 6. | 6. | 1. | -1.0309 | 2759. | 1598. | 3153. | 55.5 | .0 | 5. | 214. | 203. | 999. | 2055. | -457. | -136. | -2117. |
| 155 | 155. | 1. | 82. | 1. | 1. | 1. | 10.6113 | 185. | 9592. | 4095. | 329.0 | .0 | -101. | 305. | -330. | 999. | 4331. | 96. | -323. | -4225. |
| 156 | 156. | 2. | 82. | 1. | 4. | 6. | 13.4171 | 73. | 2592. | 14320. | 2300.4 | 1947.7 | 2. | -979. | 7833. | 999. | 9178. | -1. | 415. | -8866. |
| 157 | 157. | 3. | 82. | 1. | 1. | 1. | 9.2084 | 428. | 6838. | 5700. | 1027.4 | .0 | 45. | -318. | 706. | 999. | 6198. | -27. | 320. | -6636. |
| 158 | 158. | 4. | 82. | 1. | 1. | 1. | 11.7530 | 302. | 9976. | 5585. | 2706.1 | .0 | -117. | 624. | -229. | 999. | 5666. | 20. | -489. | -5628. |
| 159 | 159. | 5. | 82. | 1. | 1. | 1. | 4.3354 | 136. | 9659. | 4038. | .0 | .0 | -179. | 261. | -224. | 999. | 6402. | 143. | -127. | -6380. |
| 160 | 160. | 6. | 82. | 1. | 1. | 1. | 15.7553 | 403. | 9668. | 6236. | 2672.1 | .0 | -30. | 231. | -530. | 999. | 6946. | 37. | -171. | -6793. |
| 161 | 161. | 7. | 82. | 1. | 1. | 1. | 16.9854 | 181. | 8296. | 3551. | 1961.0 | .0 | -323. | 728. | 99. | 999. | 4165. | 122. | -325. | -3709. |
| 162 | 162. | 8. | 82. | 1. | 2. | 1. | 4.5756 | 922. | 6421. | 14574. | 1556.6 | 853.3 | -164. | 29. | 1728. | 999. | 10104. | -57. | 158. | -9121. |
| 163 | 163. | 9. | 82. | 1. | 6. | 1. | -1.0748 | 2472. | 2433. | 7058. | 1204.9 | .0 | 32. | 314. | -644. | 999. | 5060. | 23. | -229. | -4900. |
| 164 | 164. | 10. | 82. | 1. | 1. | 1. | 13.5006 | 289. | 7153. | 4242. | 208.0 | .0 | 96. | -670. | -109. | 999. | 3861. | -125. | 567. | -3290. |
| 165 | 165. | 11. | 82. | 1. | 1. | 1. | 5.0384 | 250. | 7988. | 4360. | 1093.6 | .0 | -275. | 243. | -176. | 999. | 5083. | 168. | -295. | -5043. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 166 | 166. | 12. | 82. | 1. | 1. | 1. | 9.1133 | 296. | 7812. | 6741. | 2507.9 | 469.1 | -252. | 623. | -896. | 999. | 5585. | 87. | -218. | -5665. |
| 167 | 167. | 13. | 82. | 1. | 3. | 1. | 13.9873 | 1682. | 4820. | 4811. | 248.4 | .0 | 75. | -101. | 246. | 999. | 3629. | -122. | 292. | -3345. |
| 168 | 168. | 14. | 82. | 1. | 1. | 1. | 9.7738 | 347. | 7063. | 4125. | 638.7 | 243.3 | -171. | 426. | -419. | 999. | 3576. | 11. | -134. | -3647. |
| 169 | 169. | 15. | 82. | 1. | 3. | 1. | 22.1269 | 1297. | 5298. | 3551. | 1104.4 | .0 | -80. | 143. | -114. | 999. | 3615. | -14. | 89. | -3375. |
| 170 | 170. | 16. | 82. | 1. | 1. | 1. | 24.9389 | 347. | 8241. | 4830. | 567.8 | 465.0 | 157. | -19. | -1115. | 999. | 4744. | -160. | 538. | -4886. |
| 171 | 171. | 17. | 82. | 1. | 4. | 1. | 1.7814 | 1829. | 3836. | 3070. | 183.0 | .0 | -25. | 305. | -31. | 999. | 2470. | 26. | -194. | -2280. |
| 172 | 172. | 18. | 82. | 1. | 2. | 1. | -.8610 | 803. | 6535. | 3520. | 1094.7 | .0 | -139. | 548. | -79. | 999. | 3542. | 58. | -186. | -3443. |
| 173 | 173. | 19. | 82. | 1. | 7. | 1. | 8.3852 | 2767. | 2550. | 5440. | 916.4 | .0 | 746. | -184. | 476. | 999. | 3318. | -429. | 80. | -3286. |
| 174 | 174. | 20. | 82. | 1. | 4. | 1. | 3.7091 | 1243. | 1895. | 5563. | 948.5 | .0 | 56. | -795. | -222. | 999. | 3872. | -144. | 479. | -4098. |
| 175 | 175. | 21. | 82. | 1. | 4. | 1. | 5.8993 | 1226. | 2746. | 5452. | 399.1 | .0 | -207. | -379. | -442. | 999. | 3415. | -113. | 469. | -3187. |
| 176 | 176. | 22. | 82. | 1. | 4. | 1. | 18.5785 | 1072. | 2522. | 4730. | 1781.9 | 435.2 | -811. | -101. | -672. | 999. | 4761. | 310. | -26. | -4376. |
| 177 | 177. | 23. | 82. | 1. | 7. | 1. | 11.8978 | 3005. | 2218. | 6154. | 446.1 | .0 | 548. | -153. | 232. | 999. | 3274. | -350. | 45. | -3093. |
| 178 | 178. | 24. | 82. | 1. | 1. | 1. | 1.8004 | 437. | 7754. | 6827. | 494.3 | .0 | -292. | 604. | 458. | 999. | 5792. | 2. | 47. | -5864. |
| 179 | 179. | 25. | 82. | 2. | 4. | 2. | 15.5433 | 1244. | 4005. | 11000. | 974.6 | .0 | -333. | 621. | 950. | 999. | 6255. | 22. | -179. | -4884. |
| 180 | 180. | 26. | 82. | 2. | 4. | 2. | 2.5391 | 1856. | 3079. | 7108. | 158.1 | .0 | 127. | -90. | 1254. | 999. | 5482. | -90. | -55. | -5213. |
| 181 | 181. | 27. | 82. | 2. | 7. | 2. | 16.8737 | 1690. | 2719. | 5708. | 732.6 | .0 | -321. | 349. | -344. | 999. | 5264. | -139. | -44. | -4000. |
| 182 | 182. | 28. | 82. | 2. | 6. | 2. | 14.9405 | 2709. | 1809. | 3713. | 81.4 | .0 | 463. | 142. | 363. | 999. | 2578. | -341. | -279. | -2222. |
| 183 | 183. | 29. | 82. | 2. | 4. | 2. | 9.9643 | 2051. | 2570. | 3601. | 685.2 | .0 | -385. | 683. | 279. | 999. | 2723. | 494. | -596. | -2573. |
| 184 | 184. | 30. | 82. | 2. | 4. | 2. | 17.0925 | 1752. | 3212. | 5992. | 1195.2 | .0 | -349. | 743. | -32. | 999. | 4445. | 272. | -524. | -4345. |
| 185 | 185. | 31. | 82. | 2. | 4. | 2. | 11.5649 | 1639. | 2583. | 5623. | 555.7 | .0 | -243. | -613. | 353. | 999. | 4742. | 27. | 305. | -4335. |
| 186 | 186. | 32. | 82. | 2. | 6. | 2. | 15.3925 | 3711. | 388. | 7592. | 123.6 | .0 | -162. | 89. | 935. | 999. | 4234. | 325. | -260. | -3980. |
| 187 | 187. | 33. | 82. | 2. | 6. | 2. | 11.0857 | 4163. | 138. | 7680. | 1757.1 | .0 | 111. | 62. | 1924. | 999. | 5334. | 79. | -119. | -4869. |
| 188 | 188. | 34. | 82. | 2. | 6. | 2. | 13.7121 | 2496. | 1457. | 3096. | 363.2 | .0 | -33. | 115. | 244. | 999. | 1727. | -189. | -184. | -1599. |
| 189 | 189. | 35. | 82. | 2. | 7. | 2. | 11.3178 | 2953. | 2059. | 10282. | 718.2 | .0 | 15. | -647. | 2839. | 999. | 6280. | -136. | 308. | -4963. |
| 190 | 190. | 36. | 82. | 2. | 3. | 2. | 9.9183 | 1474. | 3352. | 4275. | 327.0 | .0 | 214. | -701. | -541. | 999. | 3291. | -47. | 40. | -3247. |
| 191 | 191. | 37. | 82. | 2. | 6. | 2. | 13.4264 | 3119. | 162[illegible]. | 4550. | 1034.0 | .0 | 456. | 46. | -1254. | 999. | 3247. | -331. | -142. | -2909. |
| 192 | 192. | 38. | 82. | 2. | 7. | 2. | 14.6160 | 2763. | 1233. | 7052. | 258.5 | .0 | 1. | -776. | -2065. | 999. | 5110. | -192. | 388. | -4700. |
| 193 | 193. | 39. | 82. | 2. | 7. | 2. | 8.2595 | 3442. | 1190. | 8000. | 560.1 | .0 | -96. | -496. | 1373. | 999. | 4381. | -86. | 271. | -3971. |
| 194 | 194. | 40. | 82. | 2. | 2. | 2. | -.9164 | 773. | 6191. | 4888. | 663.7 | .0 | -95. | 361. | 673. | 999. | 4072. | 12. | -23. | -4168. |
| 195 | 195. | 41. | 82. | 2. | 6. | 1. | -3.4165 | 2651. | 1219. | 5448. | 324.9 | .0 | 126. | 118. | 782. | 999. | 4052. | -216. | -211. | -3852. |
| 196 | 196. | 42. | 82. | 3. | 3. | 3. | 6.5461 | 1271. | 5153. | 9836. | 6138.7 | .0 | -334. | 531. | 2668. | 999. | 5599. | 190. | -244. | -5188. |
| 197 | 197. | 43. | 82. | 3. | 7. | 3. | 15.2405 | 2091. | 2288. | 8748. | 3871.6 | 440.0 | -155. | 352. | 2607. | 999. | 3841. | 79. | -213. | -3734. |
| 198 | 198. | 44. | 82. | 3. | 4. | 3. | 3.1537 | 2234. | 3066. | 4384. | 310.0 | .0 | 492. | -502. | -251. | 999. | 3264. | -550. | 199. | -2961. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 199 | 199. | 45. | 82. | 3. | 3. | 3. | 16.9003 | 989. | 4992. | 8596. | 5816.1 | 1047.6 | -411. | 1083. | -1068. | 999. | 8385. | 168. | -577. | -6749. |
| 200 | 200. | 46. | 82. | 3. | 4. | 3. | 12.8309 | 582. | 2525. | 11363. | 1392.6 | .0 | -253. | -586. | -727. | 999. | 7673. | -34. | 416. | -7533. |
| 201 | 201. | 47. | 82. | 3. | 4. | 3. | 14.0724 | 1435. | 1937. | 8194. | 4839.3 | 1102.0 | 99. | -503. | -811. | 999. | 5914. | -165. | 434. | -5927. |
| 202 | 202. | 48. | 82. | 3. | 7. | 3. | 14.0320 | 1941. | 3517. | 6995. | 3603.9 | .0 | 213. | 360. | -195. | 999. | 4720. | -306. | -98. | -4265. |
| 203 | 203. | 49. | 82. | 3. | 3. | 3. | 20.3691 | 1344. | 4095. | 16966. | 241.0 | .0 | 238. | -788. | 10734. | 999. | 9371. | -254. | 515. | -8683. |
| 204 | 204. | 50. | 82. | 3. | 3. | 3. | 18.2074 | 81. | 5395. | 7406. | 1883.0 | .0 | 30. | 100. | 751. | 999. | 4283. | -46. | 16. | -4081. |
| 205 | 205. | 51. | 82. | 3. | 3. | 3. | 11.4116 | 847. | 5180. | 6600. | 1026.2 | 548.0 | -110. | 277. | -759. | 999. | 6186. | -33. | -199. | -5810. |
| 206 | 206. | 52. | 82. | 3. | 4. | 3. | 13.7520 | 1760. | 3118. | 4451. | 686.6 | .0 | -216. | 329. | 891. | 999. | 2417. | 176. | -313. | -1984. |
| 207 | 207. | 53. | 82. | 3. | 3. | 3. | 12.6210 | 842. | 5131. | 6200. | 2218.5 | .0 | -283. | 651. | -702. | 999. | 5429. | -14. | -199. | -4832. |
| 208 | 208. | 54. | 82. | 4. | 1. | 4. | 4.3119 | 964. | 6135. | 19599. | 2926.2 | .0 | 388. | -791. | 1251. | 999. | 11173. | -311. | 782. | -9922. |
| 209 | 209. | 55. | 82. | 4. | 4. | 4. | -4.0303 | 1847. | 3717. | 22200. | 2232.0 | .0 | 163. | 186. | -524. | 999. | 12195. | -323. | -59. | -11024. |
| 210 | 210. | 56. | 82. | 4. | 4. | 4. | 17.3462 | 1191. | 2376. | 17500. | 1671.4 | 839.0 | -357. | -334. | -1971. | 999. | 9391. | 151. | 115. | -9125. |
| 211 | 211. | 57. | 82. | 4. | 6. | 4. | -29.9444 | 3366. | 1387. | 22720. | 3075.1 | .0 | 716. | -41. | -2041. | 999. | 9951. | -470. | -91. | -13363. |
| 212 | 212. | 58. | 82. | 4. | 7. | 4. | 2.6006 | 1941. | 2454. | 19105. | 5241.5 | 858.0 | -255. | 588. | -989. | 999. | 12474. | -57. | -344. | -10671. |
| 213 | 213. | 59. | 82. | 4. | 2. | 4. | 5.0155 | 706. | 5915. | 23900. | 3802.8 | .0 | -390. | 538. | -1110. | 999. | 15777. | 79. | -119. | -15757. |
| 214 | 214. | 60. | 82. | 5. | 6. | 4. | -1.9808 | 3366. | 1387. | 2410. | 1099.0 | 494.0 | 716. | -41. | 288. | 999. | 1700. | -470. | -91. | -1573. |
| 215 | 215. | 61. | 82. | 5. | 4. | 6. | 12.9541 | 1609. | 2609. | 8394. | .0 | .0 | -106. | -923. | 2588. | 999. | 8220. | -78. | 427. | -7623. |
| 216 | 216. | 62. | 82. | 5. | 6. | 6. | 4.5634 | 2499. | 1536. | 13265. | 1097.4 | .0 | 123. | 78. | -1635. | 999. | 9712. | -234. | -169. | -9128. |
| 217 | 217. | 63. | 82. | 5. | 6. | 4. | 10.9077 | 3152. | 458. | 9978. | 2876.7 | .0 | -863. | 281. | 5186. | 999. | 5459. | 500. | -253. | -5277. |
| 218 | 218. | 64. | 82. | 5. | 2. | 6. | 4.7884 | 424. | 6849. | 4873. | 1244.9 | .0 | -151. | 466. | 410. | 999. | 4001. | -7. | -144. | -3799. |
| 219 | 219. | 65. | 82. | 6. | 6. | 5. | 14.8683 | 2805. | 1375. | 17376. | 2633.8 | 1980.0 | 134. | 180. | 323. | 999. | 8975. | -138. | -323. | -8466. |
| 220 | 220. | 66. | 82. | 6. | 6. | 5. | 10.4095 | 3366. | 1387. | 24751. | 3201.3 | 2244.7 | 716. | -41. | 1429. | 999. | 10265. | -470. | -91. | -9477. |
| 221 | 221. | 67. | 82. | 6. | 2. | 5. | 4.0166 | 612. | 5639. | 5852. | 1348.8 | .0 | 63. | -658. | -2957. | 999. | 6126. | -141. | 334. | -6380. |
| 222 | 222. | 68. | 82. | 6. | 2. | 5. | 5.1788 | 791. | 6811. | 9200. | 805.7 | .0 | -183. | 734. | -2483. | 999. | 6352. | -65. | 83. | -6549. |
| 223 | 223. | 69. | 82. | 6. | 4. | 5. | 8.5408 | 2323. | 3142. | 11205. | 2421.6 | .0 | 183. | 106. | -17. | 999. | 6841. | -418. | 45. | -6987. |
| 224 | 224. | 70. | 82. | 6. | 7. | 5. | 10.2391 | 1979. | 2708. | 3878. | 258.8 | .0 | 11. | 88. | 639. | 999. | 2412. | -61. | -231. | -2321. |
| 225 | 225. | 71. | 82. | 6. | 4. | 5. | 5.0412 | 1883. | 4262. | 2700. | 41.8 | .0 | 207. | -149. | 1329. | 999. | 1245. | -373. | 409. | -1385. |
| 226 | 226. | 72. | 82. | 6. | 7. | 5. | .1050 | 3171. | 1104. | 4370. | 235.8 | .0 | 27. | -868. | 485. | 999. | 2454. | -378. | 428. | -2609. |
| 227 | 227. | 73. | 82. | 6. | 4. | 5. | 6.4399 | 1551. | 2885. | 3105. | 211.6 | .0 | -266. | -559. | 141. | 999. | 1648. | 51. | 29. | -1681. |
| 228 | 228. | 74. | 82. | 6. | 4. | 5. | 8.0265 | 915. | 2861. | 7000. | 285.4 | .0 | -620. | 247. | -850. | 999. | 4244. | 222. | -30. | -4053. |
| 229 | 229. | 75. | 82. | 6. | 7. | 5. | 12.2997 | 2412. | 2166. | 6257. | 504.4 | .0 | 54. | 161. | 539. | 999. | 6155. | -95. | -113. | -6105. |
| 230 | 230. | 76. | 82. | 6. | 6. | 5. | .2733 | 2916. | 1697. | 7886. | 406.3 | .0 | 274. | 119. | -20. | 999. | 4415. | -245. | -24. | -4424. |
| 231 | 231. | 77. | 82. | 6. | 6. | 1. | -4.0825 | 3573. | 1353. | 3100. | 55.5 | .0 | 819. | -31. | 150. | 999. | 2055. | -457. | -136. | -2117. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 232 | 232. | 1. | 83. | 1. | 1. | 1. | 13.9662 | 434. | 8625. | 4866. | 329.0 | 850.0 | 140. | -662. | 441. | 999. | 4331. | 96. | -323. | -4225. |
| 233 | 233. | 2. | 83. | 1. | 4. | 6. | 15.8967 | 324. | 1895. | 12915. | 2300.4 | 1947.7 | 253. | -1676. | 6428. | 999. | 9178. | -1. | 415. | -8866. |
| 234 | 234. | 3. | 83. | 1. | 1. | 1. | 9.8950 | 334. | 6689. | 4836. | 1027.4 | .0 | -49. | -467. | -158. | 999. | 6198. | -27. | 320. | -6636. |
| 235 | 235. | 4. | 83. | 1. | 1. | 1. | 14.1072 | 674. | 8613. | 5607. | 2706.1 | .0 | 255. | -739. | -207. | 999. | 5666. | 20. | -489. | -5628. |
| 236 | 236. | 5. | 83. | 1. | 1. | 1. | 8.4916 | 200. | 8689. | 4111. | .0 | .0 | -115. | -709. | -151. | 999. | 6402. | 143. | -127. | -6380. |
| 237 | 237. | 6. | 83. | 1. | 1. | 1. | 20.0250 | 705. | 8819. | 6334. | 2672.1 | .0 | 272. | -618. | -432. | 999. | 6946. | 37. | -171. | -6793. |
| 238 | 238. | 7. | 83. | 1. | 1. | 1. | 20.4214 | 656. | 6979. | 3491. | 1961.0 | .0 | 152. | -589. | 39. | 999. | 4165. | 122. | -325. | -3709. |
| 239 | 239. | 8. | 83. | 1. | 2. | 1. | 3.6804 | 1344. | 5893. | 16228. | 1556.6 | 853.3 | 258. | -499. | 3382. | 999. | 10104. | -57. | 158. | -9121. |
| 240 | 240. | 9. | 83. | 1. | 6. | 1. | -.7962 | 2020. | 2511. | 7198. | 1204.9 | .0 | -420. | 392. | -504. | 999. | 5060. | 23. | -229. | -4900. |
| 241 | 241. | 10. | 83. | 1. | 1. | 1. | 16.9669 | 263. | 7673. | 4049. | 208.0 | .0 | 70. | -150. | -302. | 999. | 3861. | -125. | 567. | -3290. |
| 242 | 242. | 11. | 83. | 1. | 1. | 1. | 5.2052 | 562. | 7103. | 4445. | 1093.6 | .0 | 37. | -642. | -91. | 999. | 5083. | 168. | -295. | -5043. |
| 243 | 243. | 12. | 83. | 1. | 1. | 1. | 13.6563 | 515. | 6439. | 6741. | 2507.9 | 469.1 | -33. | -750. | -896. | 999. | 5585. | 87. | -218. | -5665. |
| 244 | 244. | 13. | 83. | 1. | 3. | 1. | 11.5047 | 1798. | 4870. | 5079. | 439.4 | .0 | 191. | -51. | 514. | 999. | 3629. | -122. | 292. | -3345. |
| 245 | 245. | 14. | 83. | 1. | 1. | 1. | 32.7146 | 637. | 6038. | 4131. | 2269.7 | 243.3 | 119. | -599. | -413. | 999. | 3576. | 11. | -134. | -3647. |
| 246 | 246. | 15. | 83. | 1. | 3. | 1. | 23.2449 | 1741. | 4820. | 3574. | 1104.4 | .0 | 364. | -335. | -91. | 999. | 3615. | -14. | 89. | -3375. |
| 247 | 247. | 16. | 83. | 1. | 1. | 1. | 31.0261 | 483. | 6942. | 4378. | 567.8 | 465.0 | 293. | -1318. | -1567. | 999. | 4744. | -160. | 538. | -4886. |
| 248 | 248. | 17. | 83. | 1. | 4. | 1. | .2429 | 1966. | 3641. | 3332. | 183.0 | .0 | 112. | 110. | 231. | 999. | 2470. | 26. | -194. | -2280. |
| 249 | 249. | 18. | 83. | 1. | 2. | 1. | 9.2933 | 1362. | 5292. | 3802. | 1094.7 | .0 | 420. | -695. | 203. | 999. | 3542. | 58. | -186. | -3443. |
| 250 | 250. | 19. | 83. | 1. | 7. | 1. | 2.9473 | 2482. | 2866. | 5614. | 916.4 | .0 | 461. | 132. | 650. | 999. | 3318. | -429. | 80. | -3286. |
| 251 | 251. | 20. | 83. | 1. | 4. | 1. | -5.4913 | 1152. | 2583. | 5013. | 948.5 | .0 | -35. | -107. | -772. | 999. | 3872. | -144. | 479. | -4098. |
| 252 | 252. | 21. | 83. | 1. | 4. | 1. | 8.2921 | 1414. | 2900. | 5424. | 707.1 | .0 | -19. | -225. | -470. | 999. | 3415. | -113. | 469. | -3187. |
| 253 | 253. | 22. | 83. | 1. | 4. | 1. | 26.6465 | 1560. | 2792. | 4801. | 1781.9 | 435.2 | -323. | 169. | -601. | 999. | 4761. | 310. | -26. | -4376. |
| 254 | 254. | 23. | 83. | 1. | 7. | 1. | 9.6993 | 2400. | 2572. | 5954. | 446.1 | .0 | -57. | 201. | 32. | 999. | 3274. | -350. | 45. | -3093. |
| 255 | 255. | 24. | 83. | 1. | 1. | 1. | 4.5403 | 812. | 6864. | 6752. | 1052.8 | .0 | 83. | -286. | 383. | 999. | 5792. | 2. | 47. | -5864. |
| 256 | 256. | 25. | 83. | 2. | 4. | 2. | 19.5873 | 1736. | 3227. | 10968. | 974.6 | 1239.0 | 159. | -157. | 918. | 999. | 6255. | 22. | -179. | -4884. |
| 257 | 257. | 26. | 83. | 2. | 4. | 2. | .3906 | 1666. | 3625. | 7038. | 158.1 | .0 | -63. | 456. | 1184. | 999. | 5482. | -90. | -55. | -5213. |
| 258 | 258. | 27. | 83. | 2. | 7. | 2. | 18.0814 | 1794. | 2641. | 6117. | 737.4 | .0 | -217. | 271. | 65. | 999. | 5264. | -139. | -44. | -4000. |
| 259 | 259. | 28. | 83. | 2. | 6. | 2. | 19.2349 | 2144. | 1908. | 3713. | 278.4 | .0 | -102. | 241. | 363. | 999. | 2578. | -341. | -279. | -2222. |
| 260 | 260. | 29. | 83. | 2. | 4. | 2. | 12.7143 | 1903. | 2509. | 3725. | 685.2 | .0 | -533. | 622. | 403. | 999. | 2723. | 494. | -596. | -2573. |
| 261 | 261. | 30. | 83. | 2. | 4. | 2. | 22.6519 | 1782. | 2806. | 5992. | 1195.2 | .0 | -319. | 337. | -32. | 999. | 4445. | 272. | -524. | -4345. |
| 262 | 262. | 31. | 83. | 2. | 4. | 2. | 13.7575 | 1577. | 3274. | 6292. | 741.7 | .0 | -305. | 78. | 1022. | 999. | 4742. | 27. | 305. | -4335. |
| 263 | 263. | 32. | 83. | 2. | 6. | 2. | 17.6109 | 3181. | 598. | 7592. | 123.6 | .0 | -692. | 299. | 935. | 999. | 4234. | 325. | -260. | -3980. |
| 264 | 264. | 33. | 83. | 2. | 6. | 2. | 21.7524 | 3998. | 131. | 6964. | 1757.1 | .0 | -54. | 55. | 1208. | 999. | 5334. | 79. | -119. | -4869. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 265 | 265. | 34. | 83. | 2. | 6. | 2. | 12.6515 | 2193. | 1705. | 4099. | 839.8 | .0 | -336. | 363. | 1247. | 999. | 1727. | -189. | -184. | -1599. |
| 266 | 266. | 35. | 83. | 2. | 7. | 2. | 8.5659 | 2910. | 2225. | 10349. | 718.2 | .0 | -28. | -481. | 2906. | 999. | 6280. | -136. | 308. | -4963. |
| 267 | 267. | 36. | 83. | 2. | 3. | 2. | 6.9623 | 1303. | 4594. | 4318. | 455.8 | .0 | 43. | 541. | -498. | 999. | 3291. | -47. | 40. | -3247. |
| 268 | 268. | 37. | 83. | 2. | 6. | 2. | 20.3724 | 2539. | 1784. | 5965. | 1034.0 | .0 | -124. | 209. | 161. | 999. | 3247. | -331. | -142. | -2909. |
| 269 | 269. | 38. | 83. | 2. | 7. | 2. | 19.7241 | 2500. | 1994. | 7816. | 258.5 | .0 | -262. | -15. | -1301. | 999. | 5110. | -192. | 388. | -4700. |
| 270 | 270. | 39. | 83. | 2. | 7. | 2. | 11.4873 | 3670. | 1531. | 7300. | 634.2 | .0 | 132. | -155. | 673. | 999. | 4381. | -86. | 271. | -3971. |
| 271 | 271. | 40. | 83. | 2. | 2. | 2. | 4.2764 | 636. | 6248. | 4874. | 663.7 | .0 | -232. | 418. | 659. | 999. | 4072. | 12. | -23. | -4168. |
| 272 | 272. | 41. | 83. | 2. | 6. | 1. | .0384 | 2480. | 1515. | 5448. | 324.9 | .0 | -45. | 414. | 782. | 999. | 4052. | -216. | -211. | -3852. |
| 273 | 273. | 42. | 83. | 3. | 3. | 3. | 2.5561 | 1595. | 4669. | 10286. | 6138.7 | .0 | -10. | 47. | 3118. | 999. | 5599. | 190. | -244. | -5188. |
| 274 | 274. | 43. | 83. | 3. | 7. | 3. | 10.9307 | 2014. | 2086. | 8462. | 3871.6 | 440.0 | -232. | 150. | 2321. | 999. | 3841. | 79. | -213. | -3734. |
| 275 | 275. | 44. | 83. | 3. | 4. | 3. | 8.6627 | 2423. | 3331. | 4355. | 310.0 | .0 | 681. | -237. | -280. | 999. | 3264. | -550. | 199. | -2961. |
| 276 | 276. | 45. | 83. | 3. | 3. | 3. | 18.6988 | 1309. | 4211. | 10995. | 5816.1 | 1047.6 | -91. | 302. | 1331. | 999. | 8385. | 168. | -577. | -6749. |
| 277 | 277. | 46. | 83. | 3. | 4. | 3. | 13.9076 | 678. | 3038. | 11363. | 1880.3 | 487.7 | -157. | -73. | -727. | 999. | 7673. | -34. | 416. | -7533. |
| 278 | 278. | 47. | 83. | 3. | 4. | 3. | 15.1131 | 1406. | 2272. | 8529. | 4968.8 | 1102.0 | 70. | -168. | -476. | 999. | 5914. | -165. | 434. | -5927. |
| 279 | 279. | 48. | 83. | 3. | 7. | 3. | 13.6767 | 2068. | 3248. | 6950. | 3603.9 | .0 | 340. | 91. | -240. | 999. | 4720. | -306. | -98. | -4265. |
| 280 | 280. | 49. | 83. | 3. | 3. | 3. | 16.6430 | 1444. | 4788. | 18515. | 1288.3 | 803.3 | 338. | -95. | 12283. | 999. | 9371. | -254. | 515. | -8683. |
| 281 | 281. | 50. | 83. | 3. | 3. | 3. | 21.6460 | 19. | 5423. | 2273. | 1883.0 | .0 | -32. | 128. | -4382. | 999. | 4283. | -46. | 16. | -4081. |
| 282 | 282. | 51. | 83. | 3. | 3. | 3. | 10.7850 | 1192. | 4748. | 6600. | 1379.2 | 548.0 | 235. | -155. | -759. | 999. | 6186. | -33. | -199. | -5810. |
| 283 | 283. | 52. | 83. | 3. | 4. | 3. | 22.8537 | 1712. | 3099. | 4560. | 686.6 | .0 | -264. | 310. | 1000. | 999. | 2417. | 176. | -313. | -1984. |
| 284 | 284. | 53. | 83. | 3. | 3. | 3. | 16.4592 | 1195. | 4217. | 6483. | 2218.5 | .0 | 70. | -263. | -419. | 999. | 5429. | -14. | -199. | -4832. |
| 285 | 285. | 54. | 83. | 4. | 1. | 4. | 5.9657 | 748. | 6469. | 19599. | 6353.3 | .0 | 172. | -457. | 1251. | 999. | 11173. | -311. | 782. | -9922. |
| 286 | 286. | 55. | 83. | 4. | 4. | 4. | 12.0909 | 1996. | 3564. | 24000. | 7163.9 | .0 | 312. | 33. | 1276. | 999. | 12195. | -323. | -59. | -11024. |
| 287 | 287. | 56. | 83. | 4. | 4. | 4. | 20.1260 | 1371. | 2862. | 18000. | 2096.1 | 839.0 | -177. | 152. | -1471. | 999. | 9391. | 151. | 115. | -9125. |
| 288 | 288. | 57. | 83. | 4. | 6. | 4. | 22.2778 | 2811. | 1578. | 23597. | 6067.0 | .0 | 161. | 150. | -1164. | 999. | 9951. | -470. | -91. | -13363. |
| 289 | 289. | 58. | 83. | 4. | 7. | 4. | 16.7439 | 2065. | 2475. | 19326. | 6842.1 | 858.0 | -131. | 609. | -768. | 999. | 12474. | -57. | -344. | -10671. |
| 290 | 290. | 59. | 83. | 4. | 2. | 4. | 5.1706 | 1175. | 5108. | 24000. | 4713.8 | .0 | 79. | -269. | -1010. | 999. | 15777. | 79. | -119. | -15757. |
| 291 | 291. | 60. | 83. | 5. | 6. | 4. | 20.2374 | 2811. | 1578. | 2600. | 1099.0 | 494.0 | 161. | 150. | 478. | 999. | 1700. | -470. | -91. | -1573. |
| 292 | 292. | 61. | 83. | 5. | 4. | 6. | -.5867 | 1520. | 3577. | 8517. | .0 | .0 | -195. | 45. | 2711. | 999. | 8220. | -78. | 427. | -7623. |
| 293 | 293. | 62. | 83. | 5. | 6. | 6. | 8.6479 | 2349. | 1719. | 14928. | 2992.7 | 1560.0 | -27. | 261. | 28. | 999. | 9712. | -234. | -169. | -9128. |
| 294 | 294. | 63. | 83. | 5. | 6. | 4. | 9.7871 | 3544. | 406. | 9978. | 3378.7 | .0 | -471. | 229. | 5186. | 999. | 5459. | 500. | -253. | -5277. |
| 295 | 295. | 64. | 83. | 5. | 2. | 6. | 2.8307 | 636. | 6170. | 5037. | 1258.2 | .0 | 61. | -213. | 574. | 999. | 4001. | -7. | -144. | -3799. |
| 296 | 296. | 65. | 83. | 6. | 6. | 5. | 16.1053 | 2550. | 1520. | 16296. | 4564.7 | 2993.9 | -121. | 325. | -757. | 999. | 8975. | -138. | -323. | -8466. |
| 297 | 297. | 66. | 83. | 6. | 6. | 5. | 15.9587 | 2811. | 1578. | 26352. | 3201.3 | 2244.7 | 161. | 150. | 3030. | 999. | 10265. | -470. | -91. | -9477. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298 | 298. | 67. | 83. | 6. | 2. | 5. | 4.4668 | 685. | 6583. | 15122. | 1348.8 | .0 | 136. | 286. | 6313. | 999. | 6126. | -141. | 334. | -6380. |
| 299 | 299. | 68. | 83. | 6. | 2. | 5. | 11.9605 | 1206. | 5550. | 8400. | 805.7 | .0 | 232. | -527. | -3283. | 999. | 6352. | -65. | 83. | -6549. |
| 300 | 300. | 69. | 83. | 6. | 4. | 5. | 14.5921 | 2273. | 3338. | 9353. | 2421.6 | .0 | 133. | 302. | -1869. | 999. | 6841. | -418. | 45. | -6987. |
| 301 | 301. | 70. | 83. | 6. | 7. | 5. | 20.2425 | 1814. | 2868. | 3927. | 258.8 | .0 | -154. | 248. | 688. | 999. | 2412. | -61. | -231. | -2321. |
| 302 | 302. | 71. | 83. | 6. | 4. | 5. | 15.4860 | 2046. | 4141. | 2600. | 41.8 | .0 | 370. | -270. | 1229. | 999. | 1245. | -373. | 409. | -1385. |
| 303 | 303. | 72. | 83. | 6. | 7. | 5. | 12.4650 | 4255. | 1150. | 4370. | 306.3 | .0 | 1111. | -822. | 485. | 999. | 2454. | -378. | 428. | -2609. |
| 304 | 304. | 73. | 83. | 6. | 4. | 5. | 9.0826 | 1561. | 4214. | 3426. | 211.6 | .0 | -256. | 770. | 462. | 999. | 1648. | 51. | 29. | -1681. |
| 305 | 305. | 74. | 83. | 6. | 4. | 5. | 16.0116 | 1042. | 3201. | 7300. | 285.4 | .0 | -493. | 587. | -550. | 999. | 4244. | 222. | -30. | -4053. |
| 306 | 306. | 75. | 83. | 6. | 7. | 5. | 9.2061 | 1923. | 2235. | 6185. | 504.4 | .0 | -435. | 230. | 467. | 999. | 6155. | -95. | -113. | -6105. |
| 307 | 307. | 76. | 83. | 6. | 6. | 5. | -9.0590 | 2123. | 1944. | 7886. | 406.3 | .0 | -519. | 366. | -20. | 999. | 4415. | -245. | -24. | -4424. |
| 308 | 308. | 77. | 83. | 6. | 6. | 1. | 3.0928 | 2792. | 1636. | 3523. | 55.5 | .0 | 38. | 252. | 573. | 999. | 2055. | -457. | -136. | -2117. |
| 309 | 309. | 1. | 84. | 1. | 1. | 1. | 13.4692 | 121. | 9338. | 4495. | 329.0 | 850.0 | -165. | 51. | 70. | . | 4331. | 96. | -323. | -4225. |
| 310 | 310. | 2. | 84. | 1. | 4. | 6. | 11.9565 | 465. | 1740. | 13950. | 2300.4 | 1947.7 | 394. | -1831. | 7463. | . | 9178. | -1. | 415. | -8866. |
| 311 | 311. | 3. | 84. | 1. | 1. | 1. | 2.9887 | 433. | 7200. | 4940. | 1721.6 | .0 | 50. | 44. | -54. | . | 6198. | -27. | 320. | -6636. |
| 312 | 312. | 4. | 84. | 1. | 1. | 1. | 13.6726 | 629. | 9168. | 5884. | 2706.1 | .0 | 210. | -184. | 70. | . | 5666. | 20. | -489. | -5628. |
| 313 | 313. | 5. | 84. | 1. | 1. | 1. | 2.2573 | 249. | 9350. | 4120. | .0 | .0 | -66. | -48. | -142. | . | 6402. | 143. | -127. | -6380. |
| 314 | 314. | 6. | 84. | 1. | 1. | 1. | 19.7004 | 545. | 9136. | 6450. | 2672.1 | .0 | 112. | -301. | -316. | . | 6946. | 37. | -171. | -6793. |
| 315 | 315. | 7. | 84. | 1. | 1. | 1. | 16.5964 | 374. | 7916. | 4005. | 2479.6 | .0 | -130. | 348. | 553. | . | 4165. | 122. | -325. | -3709. |
| 316 | 316. | 8. | 84. | 1. | 2. | 1. | 2.9841 | 1147. | 6878. | 15076. | 1632.2 | 853.3 | 61. | 486. | 2230. | . | 10104. | -57. | 158. | -9121. |
| 317 | 317. | 9. | 84. | 1. | 6. | 1. | -2.4682 | 2206. | 2810. | 6991. | 2263.5 | 430.9 | -234. | 691. | -711. | . | 5060. | 23. | -229. | -4900. |
| 318 | 318. | 10. | 84. | 1. | 1. | 1. | 24.2417 | 211. | 8221. | 4049. | 297.8 | .0 | 18. | 398. | -302. | . | 3861. | -125. | 567. | -3290. |
| 319 | 319. | 11. | 84. | 1. | 1. | 1. | -1.2012 | 445. | 7903. | 4851. | 1093.6 | .0 | -80. | 158. | 315. | . | 5083. | 168. | -295. | -5043. |
| 320 | 320. | 12. | 84. | 1. | 1. | 1. | 7.7723 | 470. | 7329. | 7792. | 2507.9 | 469.1 | -78. | 140. | 155. | . | 5585. | 87. | -218. | -5665. |
| 321 | 321. | 13. | 84. | 1. | 3. | 1. | 10.9900 | 1726. | 5206. | 4658. | 439.4 | .0 | 119. | 285. | 93. | . | 3629. | -122. | 292. | -3345. |
| 322 | 322. | 14. | 84. | 1. | 1. | 1. | 29.5824 | 479. | 6765. | 4242. | 2269.7 | 243.3 | -39. | 128. | -302. | . | 3576. | 11. | -134. | -3647. |
| 323 | 323. | 15. | 84. | 1. | 3. | 1. | 18.8768 | 1462. | 5541. | 3605. | 1325.8 | .0 | 85. | 386. | -60. | . | 3615. | -14. | 89. | -3375. |
| 324 | 324. | 16. | 84. | 1. | 1. | 1. | 34.1002 | 542. | 7495. | 4580. | 774.7 | 465.0 | 352. | -765. | -1365. | . | 4744. | -160. | 538. | -4886. |
| 325 | 325. | 17. | 34. | 1. | 4. | 1. | -5.0202 | 1701. | 4239. | 3228. | 228.2 | .0 | -153. | 708. | 127. | . | 2470. | 26. | -194. | -2280. |
| 326 | 326. | 18. | 84. | 1. | 2. | 1. | -12.6485 | 1013. | 6358. | 4803. | 1094.7 | .0 | 71. | 371. | 1204. | . | 3542. | 58. | -186. | -3443. |
| 327 | 327. | 19. | 84. | 1. | 7. | 1. | 6.1436 | 2585. | 3111. | 6538. | 930.5 | .0 | 564. | 377. | 1574. | . | 3318. | -429. | 80. | -3286. |
| 328 | 328. | 20. | 84. | 1. | 4. | 1. | -1.4451 | 1619. | 1929. | 5013. | 948.5 | .0 | 432. | -761. | -772. | . | 3872. | -144. | 479. | -4098. |
| 329 | 329. | 21. | 84. | 1. | 4. | 1. | -.2888 | 1784. | 2518. | 5968. | 707.1 | .0 | 351. | -607. | 74. | . | 3415. | -113. | 469. | -3187. |
| 330 | 330. | 22. | 84. | 1. | 4. | 1. | 26.4819 | 1683. | 2082. | 4929. | 2211.2 | 435.2 | -200. | -541. | -473. | . | 4761. | 310. | -26. | -4376. |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 331 | 331. | 23. | 84. | 1. | 7. | 1. | 8.3737 | 2787. | 2771. | 6010. | 446.1 | .0 | 330. | 400. | 88. | . | 3274. | -350. | 45. | -3093. |
| 332 | 332. | 24. | 84. | 1. | 1. | 1. | -5.7170 | 652. | 7610. | 6592. | 1052.8 | .0 | -77. | 460. | 223. | . | 5792. | 2. | 47. | -5864. |
| 333 | 333. | 25. | 84. | 2. | 4. | 2. | 14.4979 | 1530. | 3488. | 11337. | 2928.8 | 1239.0 | -47. | 104. | 1287. | . | 6255. | 22. | -179. | -4884. |
| 334 | 334. | 26. | 84. | 2. | 4. | 2. | 23.7891 | 1713. | 3224. | 7694. | 1004.5 | .0 | -16. | 55. | 1840. | . | 5482. | -90. | -55. | -5213. |
| 335 | 335. | 27. | 84. | 2. | 7. | 2. | 20.0828 | 1574. | 2695. | 7519. | 759.4 | .0 | -437. | 325. | 1467. | . | 5264. | -139. | -44. | -4000. |
| 336 | 336. | 28. | 84. | 2. | 6. | 2. | 16.8170 | 2075. | 2270. | 3709. | 533.0 | .0 | -171. | 603. | 359. | . | 2578. | -341. | -279. | -2222. |
| 337 | 337. | 29. | 84. | 2. | 4. | 2. | 10.2500 | 1865. | 2468. | 3905. | 708.3 | .0 | -571. | 581. | 583. | . | 2723. | 494. | -596. | -2573. |
| 338 | 338. | 30. | 84. | 2. | 4. | 2. | 5.3177 | 1474. | 3083. | 6340. | 1195.2 | .0 | -627. | 614. | 316. | . | 4445. | 272. | -524. | -4345. |
| 339 | 339. | 31. | 84. | 2. | 4. | 2. | 18.4127 | 2176. | 2488. | 6461. | 1974.2 | 867.8 | 294. | -708. | 1191. | . | 4742. | 27. | 305. | -4335. |
| 340 | 340. | 32. | 84. | 2. | 6. | 2. | 26.2116 | 2976. | 663. | 7855. | 230.0 | .0 | -897. | 364. | 1198. | . | 4234. | 325. | -260. | -3980. |
| 341 | 341. | 33. | 84. | 2. | 6. | 2. | 22.2476 | 4003. | 189. | 8800. | 3459.9 | .0 | -49. | 113. | 3044. | . | 5334. | 79. | -119. | -4869. |
| 342 | 342. | 34. | 84. | 2. | 6. | 2. | 10.4167 | 2112. | 1742. | 3834. | 1693.3 | 853.6 | -417. | 400. | 982. | . | 1727. | -189. | -184. | -1599. |
| 343 | 343. | 35. | 84. | 2. | 7. | 2. | 8.1395 | 3493. | 2144. | 12097. | 802.8 | .0 | 555. | -562. | 4654. | . | 6280. | -136. | 308. | -4963. |
| 344 | 344. | 36. | 84. | 2. | 3. | 2. | 13.4189 | 1052. | 4402. | 4415. | 1308.6 | .0 | -208. | 349. | -401. | . | 3291. | -47. | 40. | -3247. |
| 345 | 345. | 37. | 84. | 2. | 6. | 2. | 19.4057 | 3004. | 1855. | 6176. | 1034.0 | .0 | 341. | 280. | 372. | . | 3247. | -331. | -142. | -2909. |
| 346 | 346. | 38. | 84. | 2. | 7. | 2. | 25.1678 | 2630. | 1660. | 5406. | 377.5 | .0 | -132. | -349. | -3711. | . | 5110. | -192. | 388. | -4700. |
| 347 | 347. | 39. | 84. | 2. | 7. | 2. | 21.7722 | 4035. | 1343. | 7280. | 634.2 | .0 | 497. | -343. | 653. | . | 4381. | -86. | 271. | -3971. |
| 348 | 348. | 40. | 84. | 2. | 2. | 2. | .8018 | 816. | 6586. | 4554. | 715.0 | .0 | -52. | 756. | 339. | . | 4072. | 12. | -23. | -4168. |
| 349 | 349. | 41. | 84. | 2. | 6. | 1. | 1.3052 | 2271. | 1477. | 5800. | 777.6 | .0 | -254. | 376. | 1134. | . | 4052. | -216. | -211. | -3852. |
| 350 | 350. | 42. | 84. | 3. | 3. | 3. | 2.7743 | 1220. | 5399. | 10006. | 10634.1 | 1050.0 | -385. | 777. | 2838. | . | 5599. | 190. | -244. | -5188. |
| 351 | 351. | 43. | 84. | 3. | 7. | 3. | 12.0550 | 1918. | 2132. | 5615. | 3912.0 | 440.0 | -328. | 196. | -526. | . | 3841. | 79. | -213. | -3734. |
| 352 | 352. | 44. | 84. | 3. | 4. | 3. | 10.0998 | 2498. | 3747. | 4463. | 897.4 | 587.4 | 756. | 179. | -172. | . | 3264. | -550. | 199. | -2961. |
| 353 | 353. | 45. | 84. | 3. | 3. | 3. | 18.5136 | 1065. | 4826. | 7997. | 7805.8 | 1047.6 | -335. | 917. | -1667. | . | 8385. | 168. | -577. | -6749. |
| 354 | 354. | 46. | 84. | 3. | 4. | 3. | 15.9713 | 906. | 2565. | 14954. | 2053.4 | 487.7 | 71. | -546. | 2864. | . | 7673. | -34. | 416. | -7533. |
| 355 | 355. | 47. | 84. | 3. | 4. | 3. | 11.6742 | 2066. | 1505. | 8372. | 4973.7 | 1102.0 | 730. | -935. | -633. | . | 5914. | -165. | 434. | -5927. |
| 356 | 356. | 48. | 84. | 3. | 7. | 3. | 17.7916 | 1702. | 3879. | 6950. | 4240.3 | 636.4 | -26. | 722. | -240. | . | 4720. | -306. | -98. | -4265. |
| 357 | 357. | 49. | 84. | 3. | 3. | 3. | 19.7658 | 1206. | 4510. | 17958. | 1613.1 | 803.3 | 100. | -373. | 11726. | . | 9371. | -254. | 515. | -8683. |
| 358 | 358. | 50. | 84. | 3. | 3. | 3. | 19.1094 | 56. | 5280. | 7885. | 1883.0 | .0 | 5. | -15. | 1230. | . | 4283. | -46. | 16. | -4081. |
| 359 | 359. | 51. | 84. | 3. | 3. | 3. | 1.6491 | 919. | 5447. | 6521. | 1391.9 | 548.0 | -38. | 544. | -838. | . | 6186. | -33. | -199. | -5810. |
| 360 | 360. | 52. | 84. | 3. | 4. | 3. | 20.6280 | 1677. | 3220. | 4895. | 1155.4 | 414.5 | -299. | 431. | 1335. | . | 2417. | 176. | -313. | -1984. |
| 361 | 361. | 53. | 84. | 3. | 3. | 3. | 16.7704 | 1025. | 4838. | 6866. | 2232.2 | 762.6 | -100. | 358. | -36. | . | 5429. | -14. | -199. | -4832. |
| 362 | 362. | 54. | 84. | 4. | 1. | 4. | 23.9220 | 867. | 6936. | 20600. | 6574.1 | .0 | 291. | 10. | 2252. | . | 11173. | -311. | 782. | -9922. |
| 363 | 363. | 55. | 84. | 4. | 4. | 4. | 18.2851 | 2046. | 4096. | 24570. | 7411.2 | .0 | 362. | 565. | 1846. | . | 12195. | -323. | -59. | -11024. |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 364 | 364. | 56. | 84. | 4. | 4. | 4. | 19.0882 | 1827. | 2346. | 18032. | 2096.1 | 839.0 | 279. | -364. | -1439. | . | 9391. | 151. | 115. | -9125. |
| 365 | 365. | 57. | 84. | 4. | 6. | 4. | 24.2778 | 3203. | 1654. | 23053. | 6067.0 | 1691.0 | 553. | 226. | -1708. | . | 9951. | -470. | -91. | -13363. |
| 366 | 366. | 58. | 84. | 4. | 7. | 4. | 25.6858 | 2039. | 2294. | 19924. | 8202.3 | 858.0 | -157. | 428. | -170. | . | 12474. | -57. | -344. | -10671. |
| 367 | 367. | 59. | 84. | 4. | 2. | 4. | 16.1841 | 1003. | 6073. | 26000. | 6431.2 | .0 | -93. | 696. | 990. | . | 15777. | 79. | -119. | -15757. |
| 368 | 368. | 60. | 84. | 5. | 6. | 4. | 24.3912 | 3203. | 1654. | 2600. | 4209.0 | 494.0 | 553. | 226. | 478. | . | 1700. | -470. | -91. | -1573. |
| 369 | 369. | 61. | 84. | 5. | 4. | 6. | -3.3761 | 1828. | 2858. | 8934. | .0 | .0 | 113. | -674. | 3128. | . | 8220. | -78. | 427. | -7623. |
| 370 | 370. | 62. | 84. | 5. | 6. | 6. | 1.9437 | 2170. | 1852. | 15717. | 2992.7 | 1560.0 | -206. | 394. | 817. | . | 9712. | -234. | -169. | -9128. |
| 371 | 371. | 63. | 84. | 5. | 6. | 4. | 14.3071 | 3155. | 598. | 4670. | 3378.7 | .0 | -860. | 421. | -122. | . | 5459. | 500. | -253. | -5277. |
| 372 | 372. | 64. | 84. | 5. | 2. | 6. | -2.8307 | 526. | 6816. | 5200. | 1258.2 | .0 | -49. | 433. | 737. | . | 4001. | -7. | -144. | -3799. |
| 373 | 373. | 65. | 84. | 6. | 6. | 5. | 18.5696 | 2326. | 1829. | 15220. | 4564.7 | 2993.9 | -345. | 634. | -1833. | . | 8975. | -138. | -323. | -8466. |
| 374 | 374. | 66. | 84. | 6. | 6. | 5. | 16.2648 | 3203. | 1654. | 24014. | 3201.3 | 2244.7 | 553. | 226. | 692. | . | 10265. | -470. | -91. | -9477. |
| 375 | 375. | 67. | 84. | 6. | 2. | 5. | 14.9931 | 638. | 6799. | 15841. | 1348.8 | .0 | 89. | 502. | 7032. | . | 6126. | -141. | 334. | -6380. |
| 376 | 376. | 68. | 84. | 6. | 2. | 5. | 7.1208 | 934. | 6458. | 7490. | 907.5 | .0 | -40. | 381. | -4193. | . | 6352. | -65. | 83. | -6549. |
| 377 | 377. | 69. | 84. | 6. | 4. | 5. | 20.2987 | 2446. | 3617. | 9559. | 2960.6 | .0 | 306. | 581. | -1663. | . | 6841. | -418. | 45. | -6987. |
| 378 | 378. | 70. | 84. | 6. | 7. | 5. | 17.9859 | 1846. | 3075. | 3724. | 1254.7 | .0 | -122. | 455. | 485. | . | 2412. | -61. | -231. | -2321. |
| 379 | 379. | 71. | 84. | 6. | 4. | 5. | 18.1549 | 2156. | 4423. | 2700. | 151.9 | .0 | 480. | 12. | 1329. | . | 1245. | -373. | 409. | -1385. |
| 380 | 380. | 72. | 84. | 6. | 7. | 5. | 16.7717 | 4528. | 907. | 4370. | 306.3 | .0 | 1384. | -1065. | 485. | . | 2454. | -378. | 428. | -2609. |
| 381 | 381. | 73. | 84. | 6. | 4. | 5. | 9.2649 | 1417. | 4115. | 3158. | 211.6 | .0 | -400. | 671. | 194. | . | 1648. | 51. | 29. | -1681. |
| 382 | 382. | 74. | 84. | 6. | 4. | 5. | 18.6181 | 1378. | 2744. | 7500. | 752.8 | .0 | -157. | 130. | -350. | . | 4244. | 222. | -30. | -4053. |
| 383 | 383. | 75. | 84. | 6. | 7. | 5. | 11.9642 | 1837. | 2515. | 6038. | 504.4 | .0 | -521. | 510. | 320. | . | 6155. | -95. | -113. | -6105. |
| 384 | 384. | 76. | 84. | 6. | 6. | 5. | 9.2932 | 2399. | 2061. | 8325. | 1894.8 | 1485.0 | -243. | 483. | 419. | . | 4415. | -245. | -24. | -4424. |
| 385 | 385. | 77. | 84. | 6. | 6. | 1. | 5.9381 | 2991. | 1848. | 3849. | 318.5 | .0 | 237. | 464. | 899. | . | 2055. | -457. | -136. | -2117. |

EOT..

## FY75 Database

The following headings refer to the column numbers on the succeeding pages:

| Column | Heading |
|---|---|
| 1 | Observation |
| 2 | Base (see Table 2) |
| 3 | CDD 20-year average |
| 4 | CDD in FY75 |
| 5 | HDD 20-year average |
| 6 | HDD in FY75 |
| 7 | Facility sqaure footage |
| 8 | Base Population |
| 9 | MBTU/SF baseline |
| 10 | ECIP (FY 76-79) |
| 11 | EMCS (FY 76-79) |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 190 | 286 | 9610 | 9287 | 4225 | 4425 | .4024 | 48.0 | 0 |
| 2 | 2 | 72 | 71 | 3156 | 3571 | 8866 | 6487 | .2944 | 250.2 | 317.7 |
| 3 | 3 | 410 | 383 | 6836 | 7156 | 6636 | 4994 | .2476 | 1027.4 | 0 |
| 4 | 4 | 399 | 419 | 9841 | 9352 | 5628 | 5814 | .5522 | 2706.1 | 0 |
| 5 | 5 | 172 | 315 | 9525 | 9398 | 6380 | 4262 | .2791 | 0 | 0 |
| 6 | 6 | 396 | 433 | 9608 | 9437 | 6793 | 6766 | .4005 | 1962.1 | 0 |
| 7 | 7 | 382 | 504 | 7893 | 7568 | 3709 | 3452 | .3085 | 1621.0 | 0 |
| 8 | 8 | 1143 | 1086 | 6234 | 6392 | 9121 | 12846 | .3016 | 1321.3 | 853.3 |
| 9 | 9 | 2417 | 2440 | 2348 | 2119 | 4900 | 7702 | .2512 | 943.7 | 0 |
| 10 | 10 | 318 | 193 | 7256 | 7823 | 3290 | 4351 | .4385 | 208.0 | 0 |
| 11 | 11 | 357 | 525 | 8040 | 7745 | 5043 | 4536 | .2997 | 933.5 | 0 |
| 12 | 12 | 461 | 548 | 7407 | 7189 | 5665 | 7637 | .3654 | 1114.9 | 469.1 |
| 13 | 13 | 1729 | 1607 | 4629 | 4921 | 3345 | 4565 | .3303 | 248.4 | 0 |
| 14 | 14 | 507 | 518 | 6771 | 6637 | 3647 | 4544 | .3448 | 394.4 | 0 |
| 15 | 15 | 1391 | 1377 | 5066 | 5155 | 3375 | 3665 | .3846 | 401.9 | 0 |
| 16 | 16 | 350 | 190 | 7722 | 8260 | 4886 | 5945 | .4912 | 567.8 | 0 |
| 17 | 17 | 1828 | 1854 | 3725 | 3531 | 2280 | 3101 | .2470 | 78.0 | 0 |
| 18 | 18 | 884 | 942 | 6173 | 5987 | 3443 | 3599 | .3368 | 1094.7 | 0 |
| 19 | 19 | 2450 | 2021 | 2654 | 2734 | 3286 | 4964 | .2409 | 916.4 | 0 |
| 20 | 20 | 1331 | 1187 | 2211 | 2690 | 4098 | 5785 | .2076 | 617.4 | 0 |
| 21 | 21 | 1546 | 1433 | 2656 | 3125 | 3187 | 5894 | .2424 | 399.1 | 0 |
| 22 | 22 | 1573 | 1883 | 2649 | 2623 | 4376 | 5402 | .3644 | 1354.9 | 0 |
| 23 | 23 | 2807 | 2457 | 2326 | 2371 | 3093 | 5922 | .3093 | 142.1 | 0 |
| 24 | 24 | 727 | 729 | 7103 | 7150 | 5864 | 6369 | .3166 | 494.3 | 0 |
| 25 | 25 | 1555 | 1577 | 3563 | 3384 | 4884 | 10050 | .3635 | 253.4 | 0 |
| 26 | 26 | 1819 | 1729 | 3224 | 3169 | 5213 | 5854 | .2560 | 103.7 | 0 |
| 27 | 27 | 2150 | 2011 | 2414 | 2370 | 4000 | 6052 | .2898 | 244.2 | 0 |
| 28 | 28 | 2587 | 2246 | 1946 | 1667 | 2222 | 3350 | .2771 | 81.4 | 0 |
| 29 | 29 | 1942 | 2436 | 2483 | 1887 | 2573 | 3322 | .2800 | 63.6 | 0 |
| 30 | 30 | 1829 | 2101 | 2993 | 2469 | 4345 | 6024 | .2896 | 891.9 | 0 |
| 31 | 31 | 1855 | 1882 | 2891 | 3196 | 4335 | 5270 | .2326 | 362.1 | 0 |
| 32 | 32 | 3548 | 3873 | 559 | 299 | 3980 | 6657 | .2930 | 123.6 | 0 |
| 33 | 33 | 3973 | 4052 | 195 | 76 | 4869 | 5756 | .2625 | 1757.1 | 0 |
| 34 | 34 | 2718 | 2520 | 1526 | 1342 | 1599 | 2852 | .2640 | 363.2 | 0 |
| 35 | 35 | 3074 | 2938 | 2398 | 2706 | 4963 | 7443 | .2580 | 0 | 0 |
| 36 | 36 | 1307 | 1260 | 4013 | 4053 | 3247 | 4816 | .2571 | 189.8 | 0 |
| 37 | 37 | 2994 | 2663 | 1717 | 1575 | 2909 | 5804 | .2793 | 513.2 | 0 |
| 38 | 38 | 2954 | 2762 | 1621 | 2009 | 4700 | 9117 | .2682 | 137.0 | 0 |
| 39 | 39 | 3624 | 3538 | 1415 | 1686 | 3971 | 6627 | .3160 | 560.1 | 0 |
| 40 | 40 | 856 | 868 | 5853 | 5830 | 4168 | 4215 | .2619 | 301.6 | 0 |
| 41 | 41 | 2741 | 2525 | 1312 | 1101 | 3852 | 4666 | .2605 | 156.5 | 0 |
| 42 | 42 | 1415 | 1605 | 4866 | 4622 | 5188 | 7168 | .3208 | 180.2 | 0 |
| 43 | 43 | 2167 | 2246 | 2149 | 1936 | 3734 | 6141 | .3202 | 1961.5 | 440.0 |
| 44 | 44 | 2292 | 1742 | 3369 | 3568 | 2961 | 4635 | .2505 | 0 | 0 |
| 45 | 45 | 1232 | 1400 | 4486 | 3909 | 6749 | 9664 | .3781 | 927.7 | 0 |
| 46 | 46 | 869 | 835 | 2695 | 3111 | 7533 | 12090 | .2229 | 997.9 | 0 |
| 47 | 47 | 1501 | 1336 | 2006 | 2440 | 5927 | 9005 | .2210 | 4061.0 | 1102.0 |
| 48 | 48 | 2034 | 1728 | 3255 | 3157 | 4265 | 7190 | .3378 | 3183.9 | 0 |
| 49 | 49 | 1360 | 1106 | 4368 | 4883 | 8683 | 6232 | .2818 | 241.0 | 0 |
| 50 | 50 | 97 | 51 | 5279 | 5295 | 4081 | 6655 | .3548 | 274.3 | 0 |
| 51 | 51 | 990 | 957 | 5102 | 4903 | 5810 | 7359 | .3032 | 808.8 | 548.0 |
| 52 | 52 | 1800 | 1976 | 3102 | 2789 | 1984 | 3560 | .2516 | 317.1 | 0 |
| 53 | 53 | 1139 | 1125 | 4679 | 4480 | 4832 | 6902 | .2892 | 991.9 | 0 |
| 54 | 54 | 887 | 576 | 6144 | 6926 | 9922 | 18348 | .3386 | 526.7 | 0 |
| 55 | 55 | 2007 | 1684 | 3590 | 3531 | 11024 | 22724 | .3697 | 962.2 | 0 |
| 56 | 56 | 1397 | 1548 | 2595 | 2710 | 9125 | 19471 | .2698 | 1671.4 | 839.0 |
| 57 | 57 | 3120 | 2650 | 1519 | 1428 | 13363 | 24761 | .1800 | 676.0 | 0 |
| 58 | 58 | 2253 | 2196 | 2210 | 1866 | 10671 | 20094 | .2807 | 759.0 | 858.0 |
| 59 | 59 | 1017 | 1096 | 5496 | 5377 | 15757 | 25010 | .3868 | 1994.2 | 0 |
| 60 | 60 | 3120 | 2650 | 1519 | 1428 | 1573 | 2122 | .4897 | 689.0 | 494.0 |
| 61 | 61 | 1793 | 1715 | 3105 | 3532 | 7623 | 5806 | .2725 | 0 | 0 |
| 62 | 62 | 2610 | 2376 | 1627 | 1458 | 9128 | 14900 | .3550 | 505.1 | 0 |
| 63 | 63 | 3515 | 4015 | 430 | 177 | 5277 | 4792 | .2677 | 2591.0 | 0 |
| 64 | 64 | 582 | 575 | 6527 | 6383 | 3799 | 4463 | .3780 | 832.1 | 0 |

AD-A160 909 AN INVESTIGATION OF FACTORS AFFECTING THE SUCCESS OF FACILITY ENERGY CONS (U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST J H MORRILL 2/2

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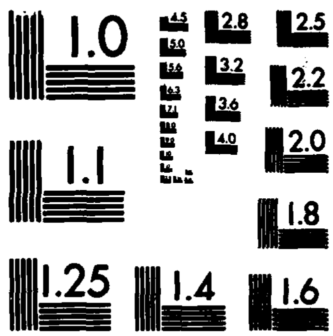
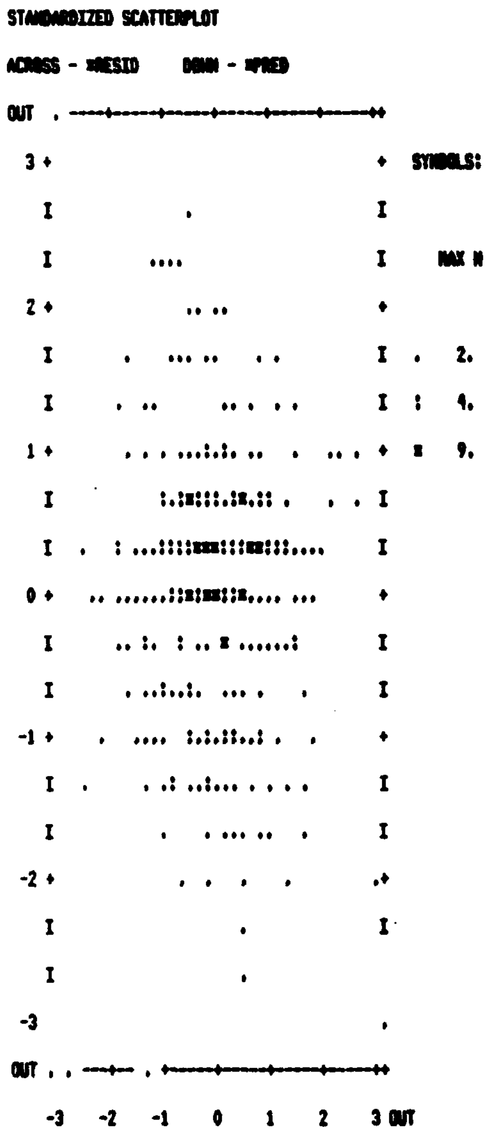
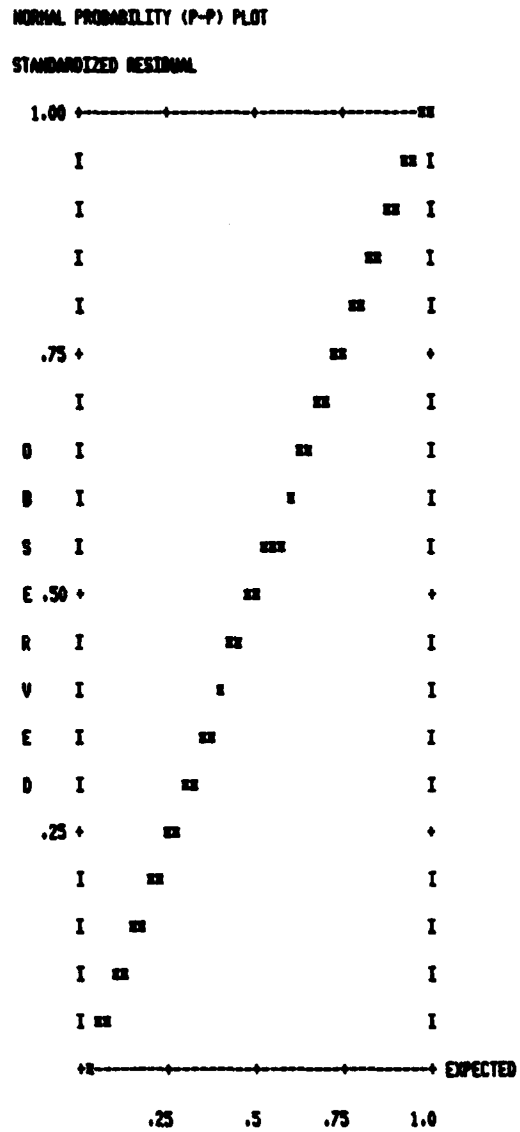

1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 65 | 2809 | 2671 | 1518 | 1195 | 8466 | 17053 | .3188 | 394.5 | 0 |
| 66 | 66 | 3120 | 2650 | 1519 | 1428 | 9477 | 23322 | .2613 | 3.4 | 0 |
| 67 | 67 | 690 | 549 | 5963 | 6297 | 6380 | 8809 | .2888 | 369.8 | 0 |
| 68 | 68 | 1039 | 974 | 5994 | 6077 | 6549 | 11683 | .3244 | 805.7 | 0 |
| 69 | 69 | 2558 | 2140 | 2991 | 3036 | 6987 | 11222 | .2611 | 665.0 | 0 |
| 70 | 70 | 2029 | 1968 | 2851 | 2620 | 2321 | 3239 | .2969 | 258.8 | 0 |
| 71 | 71 | 2049 | 1676 | 4002 | 4411 | 1385 | 1371 | .3035 | 22.5 | 0 |
| 72 | 72 | 3522 | 3144 | 1544 | 1972 | 2609 | 3885 | .2856 | 151.0 | 0 |
| 73 | 73 | 1766 | 1817 | 3415 | 3444 | 1681 | 2964 | .3292 | 38.0 | 0 |
| 74 | 74 | 1313 | 1535 | 2644 | 2614 | 4053 | 7850 | .2417 | 214.0 | 0 |
| 75 | 75 | 2453 | 2358 | 2118 | 2005 | 6105 | 5718 | .2683 | 504.4 | 0 |
| 76 | 76 | 2887 | 2642 | 1602 | 1578 | 4424 | 7906 | .2561 | 269.9 | 0 |
| 77 | 77 | 3211 | 2754 | 1520 | 1384 | 2117 | 2950 | .2425 | 55.5 | 0 |

# Appendix B: Initial Regression Model



## SUMMARY TABLE

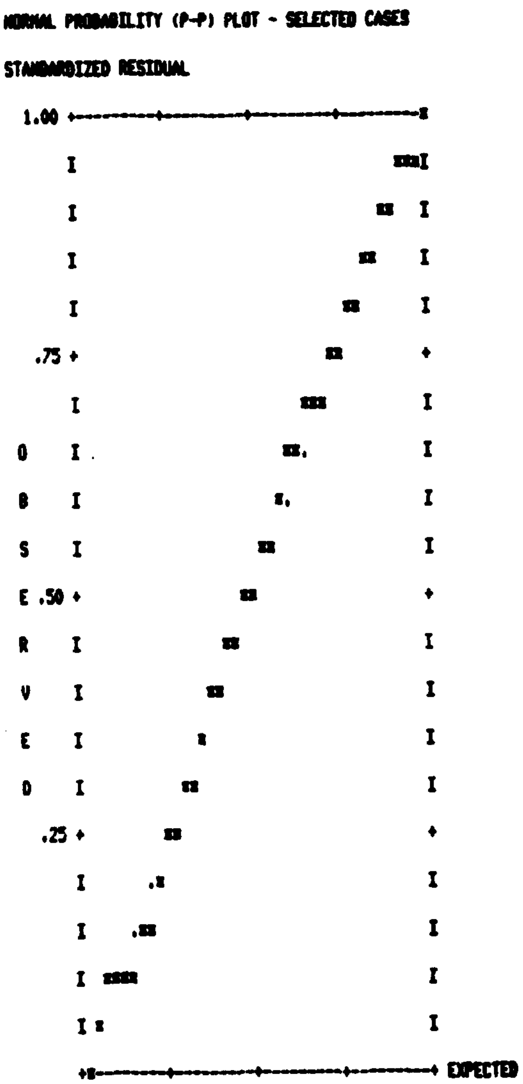
| STEP | MULTR | RSQ | ADJRSQ | F(EQU) | SIGF | RSQCH | FCH | SIGCH | | VARIABLE | BETAIN | CORREL | LABEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.2603 | 0.0678 | 0.0653 | 27.846 | 0.000 | 0.0678 | 27.846 | 0.000 | IN: | RSF | 0.2603 | 0.2603 | SQ FOOTAGE (FY84 VS.FY75 |
| 2 | 0.3266 | 0.1067 | 0.1020 | 22.805 | 0.000 | 0.0389 | 16.629 | 0.000 | IN: | C2 | -0.1978 | -0.2166 | |
| 3 | 0.3922 | 0.1538 | .1471 | 23.082 | -.000 | 0.0471 | 21.221 | 0.000 | IN: | CDD | -0.2251 | -0.1633 | COOLING DEGREE DA |
| 4 | 0.4156 | 0.1727 | .1640 | 19.834 | -.000 | 0.0189 | 8.690 | 0.003 | IN: | EMCS | 0.1400 | 0.1883 | CUMALATIVE EMCS $ |
| 5 | 0.4377 | 0.1916 | .1809 | 17.966 | -.000 | 0.0189 | 8.854 | 0.003 | IN: | ARCDD | 0.1491 | 0.2030 | CDD (FY75 VS. 20 YEAR AV |
| 6 | 0.4528 | 0.2050 | 0.1924 | 16.246 | 0.000 | 0.0134 | 6.373 | 0.012 | IN: | ARHDD | 0.1315 | 0.0308 | HDD (FY75 VS. 20 YEAR AV |
| 7 | 0.4669 | 0.2180 | .2035 | 15.012 | -.000 | 0.0130 | 6.255 | 0.013 | IN: | SF | -0.1295 | -0.0194 | FACILITY SQUARE FOOTAGE |
| 8 | 0.4867 | 0.2368 | .2206 | 14.587 | -.000 | 0.0189 | 9.298 | 0.002 | IN: | ECIP | 0.1742 | 0.1471 | CUMALATIVE ECIP $ |
| 9 | 0.5000 | 0.2500 | 0.2328 | 13.950 | 0.000 | 0.0140 | 6.993 | 0.009 | IN: | C2 | 0.1387 | 0.0669 | |

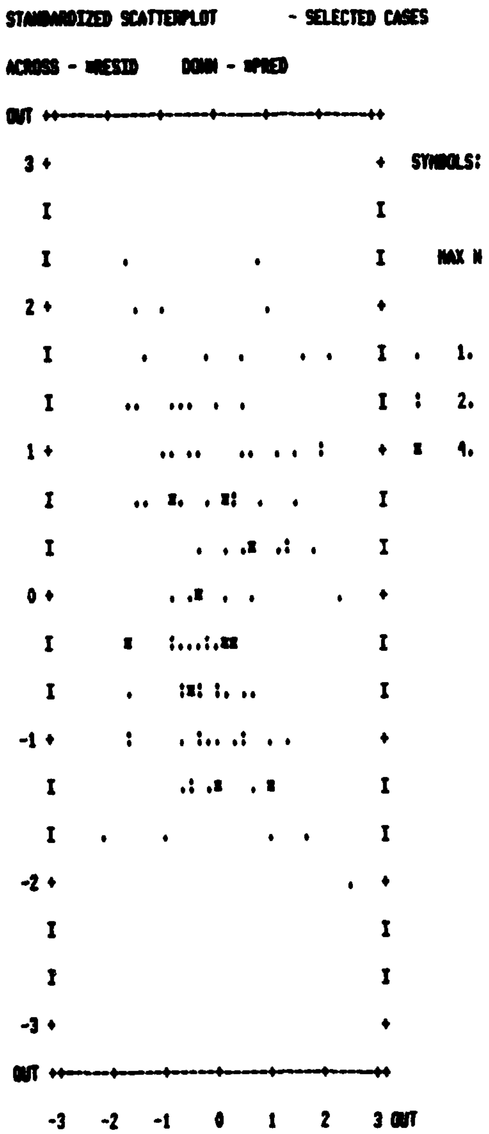
HISTOGRAM

STANDARDIZED RESIDUAL

```
 N EXP N    ( x = 1 CASES,    . : = NORMAL CURVE)
 1  0.30   OUT x
 1  0.59  3.00
 2  1.50  2.66 x
 3  3.43  2.33 xx
 4  7.02  2.00 xxxx
13 12.87  1.66 xxxxxxxxxxxxx
19 21.12  1.33 xxxxxxxxxxxxxxxxxxx
29 31.05  1.00 xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
43 40.89  0.66 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xx
53 48.23  0.33 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxx
50 50.96  0.00 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
53 48.23 -0.33 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxx
39 40.89 -0.66 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
31 31.05 -1.00 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
22 21.12 -1.33 xxxxxxxxxxxxxxxxxxxxx x
11 12.87 -1.66 xxxxxxxxxxx
 4  7.02 -2.00 xxxx
 4  3.43 -2.33 xx x
 0  1.50 -2.66
 2  0.59 -3.00  x
 1  0.30   OUT x
```

# Appendix C: Strategic Air Command



SUMMARY TABLE

-------------

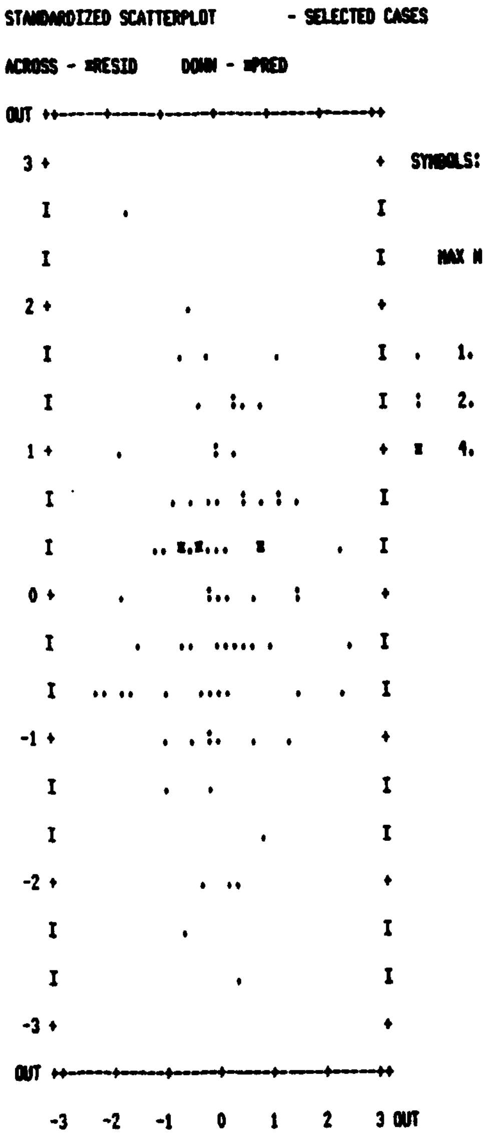
| STEP | MULTR | RSQ | ADJRSQ | F(EQU) | SIGF | RSQCH | FCH | SIGCH | | VARIABLE | BETAIN | CORREL | LABEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.3333 | 0.1111 | 0.1035 | 14.745 | 0.000 | 0.1111 | 14.745 | 0.000 | IN: | RHDD | -0.3333 | -0.3333 | HDD [CY VS. FY75] |
| 2 | 0.4304 | 0.1852 | 0.1713 | 13.298 | 0.000 | 0.0741 | 10.645 | 0.001 | IN: | G1 | 0.2723 | 0.2772 | |
| 3 | 0.5566 | 0.3098 | 0.2919 | 17.352 | 0.000 | 0.1245 | 20.931 | 0.000 | IN: | G3 | 0.3705 | 0.2378 | |
| 4 | 0.5938 | 0.3526 | 0.3301 | 15.658 | 0.000 | 0.0428 | 7.610 | 0.007 | IN: | ECIP | 0.2108 | 0.2071 | CUMALATIVE ECIP $ |
| 5 | 0.6173 | 0.3811 | .3540 | 14.040 | -.000 | 0.0285 | 5.251 | 0.024 | IN: | SF | -0.1955 | -0.0030 | FACILITY SQUARE FOOTAGE |
| 6 | 0.6623 | 0.4386 | 0.4088 | 14.714 | 0.000 | 0.0575 | 11.576 | 0.001 | IN: | EMCS | 0.3214 | 0.1752 | CUMALATIVE EMCS $ |
| 7 | 0.6935 | 0.4809 | 0.4484 | 14.822 | 0.000 | 0.0423 | 9.120 | 0.003 | IN: | RSF | 0.2403 | 0.0698 | SQ FOOTAGE [FY84 VS.FY75 |
| 8 | 0.7217 | 0.5208 | 0.4863 | 15.081 | 0.000 | 0.0399 | 9.251 | 0.003 | IN: | RPOP | -0.3112 | -0.1125 | POPULATION [CY VS. FY75] |

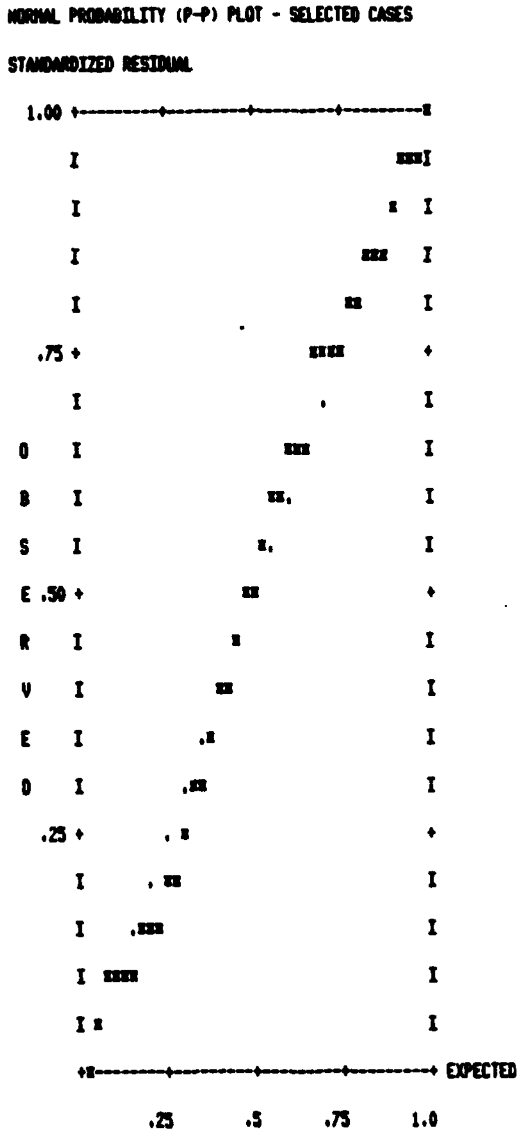
HISTOGRAM - SELECTED CASES

STANDARDIZED RESIDUAL

```
 N EXP N    ( * = 1 CASES,   . : = NORMAL CURVE)
 0  0.00  OUT
 0  0.00  4.50
 0  0.01  4.00
 0  0.06  3.50
 0  0.29  3.00
 2  1.11  2.50  *
 4  3.34  2.00 ** *
 7  7.87  1.50 *******
10 14.52  1.00 **********
21 20.96  0.50 *********************
25 23.69  0.00 ************************ *
26 20.96 -0.50 ********************* *****
11 14.52 -1.00 ***********
13  7.87 -1.50 ******* *****
 1  3.34 -2.00 *
 0  1.11 -2.50
 0  0.29 -3.00
 0  0.06 -3.50
 0  0.01 -4.00
 0  0.00 -4.50
 0  0.00  OUT
```

# Appendix D: Tactical Air Command



## SUMMARY TABLE

| STEP | MULTR | RSQ | ADJRSQ | F(EQN) | SIGF | RSQCH | FCH | SIGCH | | VARIABLE | BETAIN | CORREL | LABEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.3464 | 0.1200 | 0.1094 | 11.316 | 0.001 | 0.1200 | 11.316 | 0.001 | IN: | G2 | -0.3464 | -0.3464 | |
| 2 | 0.4520 | 0.2043 | 0.1849 | 10.529 | 0.000 | 0.0843 | 8.692 | 0.004 | IN: | ECIP | 0.2909 | 0.3093 | CUMALATIVE ECIP $ |
| 3 | 0.5042 | 0.2542 | 0.2266 | 9.203 | 0.000 | 0.0499 | 5.418 | 0.022 | IN: | RCDD | -0.2256 | -0.2158 | CDD [CY VS. FY75] |
| 4 | 0.5615 | 0.3153 | 0.2811 | 9.211 | 0.000 | 0.0611 | 7.141 | 0.009 | IN: | RSF | 0.2673 | 0.3396 | SQ FOOTAGE [FY84 VS.FY75 |
| 5 | 0.6205 | 0.3850 | 0.3461 | 9.892 | 0.000 | 0.0697 | 8.955 | 0.004 | IN: | RPOP | -0.2830 | -0.1235 | POPULATION [CY VS. FY75] |

HISTOGRAM - SELECTED CASES

STANDARDIZED RESIDUAL

```
 N EXP N     ( * = 1 CASES,   . : = NORMAL CURVE)
 0  0.00   OUT
 0  0.00  4.50
 0  0.01  4.00
 0  0.04  3.50
 0  0.20  3.00
 3  0.79  2.50  **
 0  2.37  2.00
 5  5.58  1.50 *****
10 10.28  1.00 *********
13 14.85  0.50 *************
22 16.78  0.00 **************** *****
18 14.85 -0.50 ************** ***
 6 10.28 -1.00 ******
 3  5.58 -1.50 ***
 4  2.37 -2.00 * **
 1  0.79 -2.50
 0  0.20 -3.00
 0  0.04 -3.50
 0  0.01 -4.00
 0  0.00 -4.50
```

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## VITA

Captain John H. Morrill graduated in 1977 from Vermont Technical College with an Associates in Engineering degree. After a brief period with the New Hampshire Highway Department, he attended the University of Vermont and received the degree of Bachelor of Science in Civil Engineering in May 1980. Upon graduation, he recieved a commission in the USAF through the ROTC program at St. Michaels College. He has served as Technical Design Engineer at Grissom AFB, Indiana and Chief, Architect-Engineer Services at Misawa Air Base, Japan. He entered the Graduate Engineering Management program in May 1984. His next assignment will be as an instructor at the School of Civil Engineering, Air Force Institute of Technology.

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Air Force Institute of Technology
Wright-Patterson AFB, OH 45433

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Thesis Chairman: Steve Tom, Captain, USAF
Assistant Professor of Mechanical Engineering


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This investigation studied ~~numerous~~ factors affecting facility energy conservation at Air Force installations. As of 30 Sept 1984, the Air Force has collectively achieved a 14.1 percent reduction in facilty energy consumption which is far short of the 20 percent goal set for FY85. A clear understanding is needed as to why certain bases have successful energy conservation programs and others do not.

The study was accomplished by a statistical analysis of a multiple linear regression model based upon energy and weather data collected on 77 bases during the years 1980 through 1984. The investigation considered 27 variables believed to affect energy conservation. The results indicated nine independent variables have a significant linear effect on energy conservation at a 0.05 level of significance. These variables include cooling degree days, costs of EMCS and ECIP projects, square footage, change in square footage from the baseline, difference between the baseline weather and the 20-year average, climatic zone 2, and bases within the Tactical Air Command.

It was concluded that the present method used to measure energy conservation does not provide a true indication of a base's energy conservation efforts. The current method fails to consider the effect of numerous uncontrollable factors affecting energy conservation. In particular, variations between the weather during the current year and the baseline year are not accounted for.

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