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Energy forecasting models within the Department of the Navy

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NAVAL POSTGRADUATE SCHOOL

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THESIS

ENERGY FORECASTING MODELS
WITHIN THE DEAPARTMENT OF THE NAVY

by

Leslie W. Buttolph

June 1982

Thesis Advisor: S. S. Liao

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Energy Forecasting Models Within the Department of the Navy

by

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Abstract

Executive Order 12003 requires that all federal activities reduce their energy consumption by 20% from fiscal year 1975 use by fiscal year 1985. The Defense Energy Information System for shore activities (DEIS II) provides a system of measuring, reporting, and comparing energy use levels in pursuit of that goal.

The use of regression and time series models of energy use were examined for application within the present DEIS II system. A data base of monthly electricity use, gross floor areas, four weather variables, and building area category identification codes were used in a framework study of 12 Naval Regional Medical Centers. Specific methodologies for model development, interpretation, and application to a control system are demonstrated and discussed.

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I. INTRODUCTION

A. BACKGROUND

Prior to 1973, energy was considered an inexhaustible and expendable supply. It was an inexpensive commodity. During the period between 1950 and 1973 the price of most energy products increased less rapidly than the price of other commodities. In fact, in terms of 1976 dollars, the real price of energy was actually declining. The real price of residential electricity fell by 55% ($20.30/MBTU to $8.94/MBTU), that of gasoline by 21% (63.0/gal to 49.7/gal), and that of natural gas by 20% ($2.01/MBTU to $1.60/MBTU) [Ref. 1]. A large population of observers reasoned that energy demands are determined by technological progress and economic growth. The implicit assumption was that the price of energy had a negligible impact on the use of energy.

As predicted by the first law of economic demand, decreasing energy prices encouraged consumption. By 1973, bargain priced electricity had increased in per capita use by 350%. Less dramatic declines in natural gas resulted in per capita consumption increases of 60% [Ref. 2]. The American automobile became heavier and more powerful as fuel economy became less of a consideration.

Building construction was also affected by the price of energy. Buildings were designed and constructed primarily with initial costs in mind. Construction materials were not selected on the basis of insulation qualities. Aesthetics favored large window areas. Siting was based on factors other than the benefits of solar position. The result was the creation of a vast inventory of commercial buildings which, by today's standards, utilize excessive amounts of

energy. Commercial buildings today account for approximately 8% of our national energy use [Ref. 3]. This present inventory is being replaced at the rate of only 2-3% per year. The majority of existing buildings for many years to come will be those which were originally not designed with energy conservation in mind.

The 1973 Arab oil embargo abruptly ended declining real energy prices. The effect on supply and the soaring energy prices shocked the world, dispelling the belief in an inexhaustible and expendable supply. Moreover, the belief in vertical supply and demand curves was recognized as erroneous. With the sharp rise in energy prices, energy use declined. In accord with the second law of economic demand, the response was greater in the long run than in the short run. The initial response was relatively weak as lights were turned off, thermostats reset, and fewer miles were driven. In the two year period from 1973-1975, per capita use decreased by 7%; national energy use dropped by 5% [Ref. 4]. Long range response, however, required more capital investment and time for implementation. Additional building insulation, installation of more fuel efficient machinery, and purchase of smaller cars were a few of such longer range responses.

More than an applied lesson in economic laws, the fuel crisis demonstrated how reliant American society had become on foreign oil. Such reliance was recognized as a threat to the national security. The federal government initiated programs to become less dependent upon, if not totally independent from, foreign oil. Such programs called for sharp reductions in use and the development of alternate energy sources. But such a national appeal could not overlook the fact that the federal government itself was the largest single energy user in the nation, consuming more than the

combined total of the five largest private users of energy--U.S. Steel, Union Carbide, Gulf Oil, International Paper, and General Motors Corporation. FY 1978 federal use accounted for 2.2% of the national use [Ref. 5]. The federal appeal to conserve energy precipitated a "physician, heal thyself" role.

B. ISSUES

To achieve an objective, one must first define the objective. Setting goals is very important in meeting the objective. The objective must first be realistic. If set too low, the system will not realize its full potential. If set too high, the system may even waste resources and effort trying to achieve the unattainable. It may tend to circumvent the objective, realizing its inability, failing to attain even an optimal response. Instrumental in achieving the ultimate objective is setting targets, or goals, to direct progress and efforts. Such goals must also be realistic to properly drive the intended system response.

Once goals have been established, monitoring provides a means of assesssing the realities of the goals and objective. The effectiveness and efficiency of accomplishment also become major items of concern.

These general principles are applicable to the federal energy conservation effort. The federal government, being a large energy consumer, must play a major role in achieving national energy reductions. DOD is in a similar role within the federal government. In FY 1975, total federal energy use was over 1800 million MBTU. Buildings and facilities accounted for almost half of such use at almost 900 million MBTU. DOD use represented over 81% of the total federal energy use. Its buildings accounted for over 67% of the total federal building energy use. Consequently, strong

attention has been given to reducing energy use in federal buildings and facilities.

Initially, federal goals and objectives were established relative to total energy use in FY 1973. As reporting and monitoring systems were refined, short range targets gave way to formalized planning. A formal plan was officially instituted by President Carter with the issuance of Executive Order 12003 of July 20,1977. Defining FY 1975 as the baseline year, and defining objectives and targets in terms of energy use per square foot of floor space (MBTU/SF), target percentage reductions through FY 1985 were specified within the federal sector. Defense Energy Program Policy Memorandum (DEPPM) No. 78-2 of 1 March 1978 formally implemented these goals within DOD. The following goals for building use were directed:

1. A 20% reduction in average annual energy use per square foot of existing buildings (constructed or design completed) by FY 1985.
2. A 45% reduction in average annual energy use requirements per square foot of new buildings (design completed after the date of promulgation).

Defense Energy Policy Program Memorandum (DEPPM) No. 80-6 of 3 June 1980 extended energy goals through FY 2000. These goals, which implemented not only total energy use reductions, but targets for percentage of use by energy source, in 5-year phased targets. The following goals, relating to building energy use, were specified relative to the FY 1975 baseline:

By FY 1985:

1. 20% reduction in total energy use.
2. 30% reduction in natural petroleum fuels use.
3. 10% of total use for solid fuel conversion sources, i.e., coal, solid waste, wood, etc.
4. 1% of total use from renewable sources, i.e., geothermal, wind, solar, lowhead hydropower, etc.

By FY 1990:

1. 25% reduction in total energy use.
2. 35% reduction in natural petroleum fuels use.
3. 15% of total use from solid fuels conversion.
4. 5% of total energy from renewable sources.

By 1995:

1. 30% reduction in total energy use.
2. 40% reduction in natural petroleum fuels use.
3. 20% of total use from solid fuels conversion.
4. 10% of total use from renewable sources.

By FY 2000:

1. 35% reduction in total energy use.
2. 45% reduction in natural petroleum fuels use.
3. 20% of total use from solid fuels conversion.
4. 20% of total use from renewable sources.

To gain a perspective of the extent of this application, twenty two federal agencies owned about 3.2 billion square feet of floor space in more than 490,000 buildings worldwide when the Executive Order was issued. DOD was the largest single owner with over 394,000 (80.6%) of the total federal buildings, totalling more than 2.1 billion square feet (68%) of the federal building floor space in FY 80. The total DOD building energy use was 69% of the total use in all federal buildings [Ref. 6].

The results to date of federal, DOD, and DON efforts have been less than expected. Table 1 shows the results of their efforts to date.

The reasons for this lack of satisfactory progress need to be examined and corrected if the overall 20% objective is to be reached. One explanation might be that the goals are unrealistic, either in the short range, or in the final objective, or both. Another explanation might be that the implementation methods are not effective or efficient enough to produce the intended results. One obvious, although

TABLE I

Federal and DOD Energy Reductions
In Buildings and Facilities

	FY76	FY77	FY78	FY79	FY80
Target Reductions	2%	4%	6%	8%	10%
Federal Reductions	1.8%	0.9%	2.5%	2.9%	9.3%
DOD Reductions	1.8%	1.1%	2.7%	2.6%	10.7%
DON Reductions	N/A	N/A	N/A	N/A	8.9%

impractical solution for meeting the energy goals is to channel greater capital investments to the bases to eliminate the most inefficient plant inventory and replace it with more modern, energy efficient construction, or make major conservation effective alterations. Obviously, the capital resources required will be a significant factor in such decisions. Less desirable actions to reduce base operations, or even close down bases could provide other alternatives. Such actions assume that the goals are inflexible and realistic in nature. With the assumption that the energy goals are realistic and feasible, attention is directed to the effectiveness of the implementation process. Can the current means of accomplishment be expected to achieve the objective, or are modifications necessary to improve the response?

C. PURPOSE AND SCOPE

The purpose of this thesis is to develop more effective methods of evaluating progress toward achieving energy

conservation goals. Although the present system is quite functional, its simplicity, permitting some level of control for the vast shore activity complex, has inherent problems that can distort reported results. The potential impact has financial consequences in that capital investment decisions can be adversely affected by such distortions. The limited capital resources available to undertake corrective projects can thus be less than effectively channeled.

The methods presented in this thesis are a framework that is intended to be general enough to be applied at the activity level, or functional command level, such as major claimants. The intent of this thesis to develop and discuss the realistic applications of energy use models. A brief presentation of concepts of theory will only introduce the reader to the necessary basic concepts useful in understanding and interpreting the basic methodology. A comprehensive treatment of theory will be left to textbooks. In order to be applied by the corporate body of energy managers, the methodology can not be too technical or dependent on theoretically oriented decisions. The intent here is to show the major elements of useful models to suggest working tools for general application.

The use of computers with software to handle the extensive regression and time series calculations is implicit in this methodology. The system used in this development was the IBM 370 hardware with the MINITAB software package. MINITAB is a terminal oriented, statistical package developed at the Penn State University, and was found to be flexible and easy to use without extensive previous knowlege of computers. The method developed herein is not dependent on MINITAB, however, and is readily adaptable to various statistical software packages.

The objective of the proposed methods is to identify a means of forecasting energy use to improve the effectiveness of the energy management program. The models developed will have advantages and disadvantages in particular situations that will determine actual uses. Discussion of model characteristics will demonstrate such applications.

The methods will be demonstrated within the framework of electricity use at Naval Regional Medical Centers (NRMC). This narrowing of scope will allow a more concentrated focus on the methods, without undue confusion created by introduction of indigenous issues. Selection of electricity as the energy type was based on its major, and still increasing, percentage of total energy use. Selection of the NRMCs as the sample was made on the basis of the particular characteristics of an NRMC, such as hours of operation, uniformity in mission and capabilities, separate siting at a location, concentration of spaces within one building or complex of buildings, and their geographical distribution affording sampling from different weather zones.

D. SPECIFIC RESEARCH QUESTIONS

There are three major questions that will be addressed in this thesis. The first question is: what is the impact of seasonal weather variations on energy use in Naval Regional Medical Centers? Relative to this question is the impact of such effects on established baselines and subsequent energy use evaluations for NRMCs as well as application to other types of activities.

The second question is: what are the effects of categories of use on total energy use? It is intended to determine whether particular functional uses of a building can be identified with a standard coefficient of use for each type of functional use.

The final question is: can the results be used to determine a method for establishing a control system to identify realistic goals and actual energy conserved?

E. METHODOLOGY

Development of proposed methods of forecasting energy use will be accomplished in two phases. The first phase will develop forecasting models for energy consumption using regression models and time series models. Models will be developed for each of the individual activities as well as for the total study group.

The regression model will assume four predictor variables: average monthly temperature, monthly heating/cooling degree days (sum of the departures of daily mean temperatures from the base 65 degrees F.), and monthly precipitation totals. Humidity was felt to be an additional factor of consideration. This data was not as readily available from the Naval Weather Service Detachment, Asheville, N.C., of the Naval Oceanic and Atmospheric Administration in their normal Station Climatic Summary publication. Since the emphasis herein is on methodology vice numerology, it was felt that such data was beyond a reasonable request at this time for the courtesy service provided.

Both types of models will be used to develop trends of energy use per square foot from the established FY 75 baseline. The models will be used to compare projected FY 81 use with actual use. Forecasts of FY 82 use will be shown.

The second phase of analysis will attempt to determine standard coefficients of use for electrical consumption by category code of functional use. Data analysis will be performed by regression of average monthly electrical consumption and area of functional spaces. The main

emphasis of this phase will be on the baseline data. The development of standards of use for specific category codes will be shown as a means of adjusting baseline data for changed building uses.

Finally, the results will be evaluated to demonstrate useful applications. In particular, use of the developed forecasting techniques in a a control system will be demonstrated.

F. THESIS OVERVIEW

Chapter I introduces the reader to the background of the federal energy challenge and the issues involved in setting and meeting energy conservation goals. Chapter II discusses the energy conservation program for buildings and facilities within the Naval Shore Establishment with regard to the energy conservation approach, the inherent implementation problems, and the resources available to achieve the desired results. Chapter III presents the methodolgy proposed in the development and analysis of models of energy use for the sample NRMCs and total study group to illustrate the application of the developed models. Standards of energy consumption for categories of functional useand their application for a modular baseline are examined in Chapter IV. Chapter V, Summary and Conclusions, reviews the problems of the present system of evaluating energy reduction progress, and discusses the advantages of the particular energy use models within a control system framework.

Appendices A-M summarize the model development for each of the sample sites and total study group. The parallel structure of these appendices will facilitate a comparison of results. A summary of forecasts by time series models is presented in Appendix N. A summary of data is provided in Appendix O. Statistical tables are given in Appendix P as a means of ready reference.

II. THE ENERGY CONSERVATION PROGRAM

Thus far, it has been shown what the building energy conservation goals are. Assuming that the goals are realistic and mandatory, this section will describe the implementation of these goals within DON. It will show the approach taken by DON to impose the goals, the actions by the implementing commands, and some inherent problems in the implementation.

A. THE APPROACH

The basic approach taken by Executive Order 12003 was to establish a total use standard and to specify a percentage reduction target. Such a percentage reduction was in turn allocated to the various departments. DON in turn allocated such target percentages to its fleet commands, which continued the suballocation by percentage goals to their component commands, or activities. This is a simple and basic approach, and assumes that every command is capable of identifying its energy uses and can take the necessary steps to reduce its energy use. By virtue of the size and complexity of the Naval Shore Establishment, and to an even larger extent DOD, the approach to energy conservation has to be one that is relatively simple. To get too specific and exacting would require an even greater bureaucratic network than is already required to administer the program and would become very difficult to manage effectively.

The type of energy approach in use can generally be termed an end-use restriction. Its primary focus is in achieving a particular quantity limitation. It allows a relatively simple means of establishing goals, monitoring

progress, and identifying variance. In short, it provides a means of immediate impact.

There are numerous drawbacks to such an approach, however. The National Electrical Manufacturer's Association (NEMA) makes the following critical analysis of the end-use restriction approach: [Ref. 7]

> The extent to which a system is used has no bearing on its efficiency. If, for whatever reason, a system is inefficient, it will waste energy every time it is used. End-use restrictions fail to take into consideration the systems which produce the end-use product, be it heating, cooling, lighting, etc. In other words, end-use restrictions tend to ignore the significant energy savings which can be realized by making systems operate as efficiently as possible. In a similar manner, end-use restrictions fail to consider the fact that every building is a unique system whose many systems interrelate. As a result, lowering a thermostat in winter can sometimes cause consumption of more energy, not less. Likewise, removing lamps and luminaires can sometimes cause consumption of energy sources which are in the shortest supply.

By way of contrast, NEMA advocates an alternative approach called Total Energy Management (TEM) which focuses less on the end-use and more on the efficiency of use. In describing TEM in general terms, they state: [Ref. 8]

> In essence, TEM considers every building as a unique, complex system. To conserve energy one first must understand how the building consumes energy; how user needs are met; how the systems interrelate; how the external environment affects it, and so on. By understanding how a specific building consumes energy, one can make energy conservation improvements which can be integrated into the system itself. Then, when the system is used, it runs efficiently and therefore uses the least amount of energy to get the job done. Application of a wide variety of end-use energy modifications--which are an integral element of the TEM concept when applied with flexibility---would result in even more savings."

From a macro sense, end-use goals are necessitated by the scope of the buildings involved. From a micro view, i.e., the particular bases, a more flexible approach, such as presented by TEM, is very feasible. Such an approach may, or may not be in use at the individual bases, or its component commands, already. Requirements are dictated

externally only in the setting of heating and cooling temperature standards, directing the execution of functions necessary to fulfill mission requirements, and guidelines for the protection of life, property, and security.

B. MONITORING

The Defense Energy Information System (DEIS) was established to monitor total energy use within DOD. Specifically, DEIS II identifies energy use in the buildings and facilities of the shore activities. A monthly report is sent by each shore activitiy which identifies its energy use by energy source, i.e., fuel oil, electricity, natural gas. etc., unit cost of such energy source, and explanations for differences from target. Weather variations are often identified as the source of otherwise unexplained difference.

The reports are transmitted by message to NEESA, where they are compiled and summarized by activity, type command, etc. Feedback summary reports are provided via the Energy Audit Report (EAR), showing quarterly results for each command, and for each level of command. For example, Commander, U. S. Naval Air Forces, Atlantic (COMNAVAIRLANT) would receive a summary of the stations under its command. The next echelon of command, Commander-in-Chief, U. S. Atlantic Fleet (CINCLANTFLT) would receive reports for COMNAVAIRLANT as well as the other type commanders (TYCOM) and individual stations reporting to it.

C. MEASUREMENT

The scientific nature of the reporting and monitoring efforts may lead to the the erroneous conclusion that measurement is precise and fairly routine. To understand

the limits of such data, the nature of the reporting commands and the means of measuring use needs closer examination.

A base defines an area, or group of activities under one general command. Such a command may be further broken down into operational commands. An extreme case would be the Naval Operating Base (NOB), Norfolk, Virginia. Within the fenced perimeter of the base are two major divisions--the Naval Air Station and the Naval Station--identifying air support and ship support functions. However, there is no clear line of demarcation separating the two functions within the fenced perimeter. Supporting activities may be located in either or both general areas. Functions such as the industrial Public Works Center supports all of the on base facilities, as well as facilities off base, such as family housing and NRMC Portsmouth. Each operational command has its own major claimant to which it reports. Thus, several major claimants are accountable for different portions of NOB's total energy use. There are a large number of such on-base individual commands ranging from staff headquarters to a Communications Station. Further contributing to the complexity is the fact that different commands might occupy one building or parts of several buildings. Since each command reports its energy use over its assigned floor space, measurement of the uses within buildings can be difficult.

By way of contrast to the complexity of NOB, some commands occupy a complete building in an off base location, such as some NRMCs. Energy use is more easily identified and measured in such cases, especially if the building is considered as a single metering customer by the power company.

Ideally, each building, if not each component use, would be metered so that exact use determinations would be simplified. Unfortunately, energy suppliers, such as a power company, considers a base as a single user. Its metering responsiblility is only for energy delivered "at the gate". Submetering becomes the responsibility of the base itself. Off base locations may be metered by the power company as a single customer. Family housing, either on- or off-base is usually metered per house if billing is done on the residential rate schedule.

The vast number of meters required to submeter specific uses represents a large potential cost to the government; submetering is thus considered cost prohibitive as yet. A pilot program to introduce portable electricity meters to measure specific, short term loads is to begin in FY 82. The purpose of this program is to gain perspectives on actual uses for energy conservation purposes rather than for allocation of use, though.

The alternative to metering is engineering estimates. Each subcommand of a base is generally assigned a percentage of total base use, based on connected load and estimates of actual use. Baselines and monthly uses are assigned accordingly. Adjustments can be made if projects or management actions can provide justification. This method leaves a lot to be desired in terms of accuracy and accountability. Since actual use can not be identified, there is no strong incentive to conserve at the individual command on a daily basis. There is a dependence on large scale correction projects as a result.

Without specific metering, there is a major problem of identifying actual savings. While engineering estimates may indicate a level of savings, the effects of systems' interrelationships of building systems may, in fact, be energy

additive or deductive and overlooked in calculating energy use. Thus, the possibility exists of underfunding a project which would actually have high energy savings, or overfunding a project with low energy savings, on the basis of faulty assumptions in the calculations. Portable metering as mentioned above may aid in increasing the effectiveness of estimation.

D. EVALUATION

The energy baselines are a month by month standard based on use in FY 75. Some adjustments have been made to reflect exceptional conditions that would adversely affect future comparisons. Current use is compared to the comparable baseline period and a percentage of change calculated. The calculated percentage, compared to the target percentage, provides a basis for evaluating progress. This comparison effort is done at the command level, base level, TYCOM level, major claimant level, etc. Statistics, such as shown in Table 1, provide a basis for quantitative analysis. From Table 1, it can be concluded that federal , DOD, and DON progress is below target.

To make a valid comparison, however, one must understand what is being compared. There are particular inherent factors in the present measurement system that could possibly distort the data and lead to erroneous conclusions.

One strong influence on energy use is weather. Hot, humid weather will cause greater use of air conditioning, which is a large electricity user. Cold weather usually results in higher fuel oil use, recognizing that steam heating is produced by oil fired boiler plants. Electricity and fuel oil accounted for almost 72% of total building energy use in FY 1975, and 74.5% in FY 1978. The impact of weather on these dominant energy sources is then likely to

be significant. If, however, the baseline year experienced severe weather variation, say a long, hot summer, a mild summer in the comparison year could overstate the actual conservation progress. Conversely, normal weather during the baseline month or year and an extreme variation in the comparison period could understate actual conservation results. While weather effects are significant in the magnitude of energy used, a valid comparison requires similar weather conditions in order to study controllable consumption for evaluation purposes.

A second consideration in the validity of comparisons is that the composition and specific natures of military bases are constantly changing. Energy use on a per square foot basis is an important consideration in allowing for construction and demolition changes. However, there is no consideration for the uses of buildings. Technology has continued to progress along energy intensive lines. Greater emphasis on electronics has increased the needs for environmental controls, i.e., humidity, temperature, air filtration, etc., increasing consumption beyond that needed for just equipment use. If new technological installations include construction of new facilities to house them, design and construction incorporating energy efficiencies could offset, at least partially, any increased total use or total use per square foot. Construction funding often lags technical installations, though, and bases are forced to adapt existing facilities to meet the increased requirements. For example, aviation trainers have been installed in converted warehouse spaces, increasing the electrical load with no change in square footage. Such conversion of low energy intensive use to a higher intensity use will offset other energy savings achieved.

Building uses are also often changed to correct particular facility deficiencies, such as lack of storage space. Since construction funds are limited, often with long lead times between project submission and project completion, demolitions of unnecessary but still useable buildings are reluctantly requested. Bases prefer to convert buildings no longer necessary for their original purposes to contingency uses. The low priority given to warehouse construction, often identified as a facility deficiency, invites conversion of unused, or marginally used, buildings to storage spaces which have a low energy intensity. Such buildings are usually older and beyond their expected useful life, and highly energy inefficient. Thus, while a base might show a statistical improvement, there would be no real increase in the efficiency of use.

The above examples may well be practical and wise managerial applications of using existing resources, commendably saving construction funds. However, all can distort energy use comparisons. Setting standards of use by functional category of use would permit a modular technique of evaluating energy use or adjusting baselines.

A final distortion potential consideration exists in the equity of energy baselines. It was previously mentioned that the baseline year was initially established as FY 73 and later changed to FY 1975. A command which took actions to comply with the energy reduction goals prior to FY 75 would tend to show less favorable results in later comparisons with FY 75 than the base which took no immediate reduction actions. This effect, however, would be minimal inasmuch as the measures taken at the time were directed at obvious wastes and of relatively small magnitude.

Overall, the present evaluation system is limited to providing a snapshot of use in a particular period subject

to a particular set of conditions. Such a snapshot, being subject to distortions, does not afford a good basis for comparison purposes. Nor does it permit a sound basis for control since it does not isolate non controllable factors such as weather. Modifications are needed to provide a more effective means of evaluating energy consumption relative to established targets.

E. CAPITAL INVESTMENT CONSIDERATIONS

The energy reductions required to meet the specified energy goals will require far more than individual effort to turn off lights, limit heating and cooling, or economize uses. Buildings and installed systems will require major modifications to overcome the effects of construction during the era of cheap energy as well as to offset the deterioration of buildings and their installed equipment systems. In many cases, complete replacement, incorporating energy efficiency considerations will be the cheaper alternative. It must also be realized that the interrelationships of technology, missions, and support facility requirements have not remained constant since baseline FY 75. In particular, the rapid growth and dependence on electronics has increased electricity use significantly. As a consequence, actual reductions will have to be greater than the planned target percentages to compensate for any growth. The need for capital resources to effect the required changes becomes obvious.

The investment capital required to make such modifications is not linearly related to the quantity of energy conserved. One author has described energy conservation as a "depleting resources industry" [Ref. 9]. The economic theory of depletable resources is generally associated with the law of diminishing marginal returns, which states that

when production from any activity is to be increased it can be done by adding capital or labor. As additional quantities of any one of these inputs are added to a fixed factor of production, the incremental or marginal returns associated with the inputs tend to decline. The converse of this law is the law of increasing costs which states that, since the input must be purchased, the incremental (marginal) costs of production increase. In application to energy conservation, output can be considered as the energy saved, that is energy not required to be produced. Inputs would be the material for conservation capital stocks as well as the labor costs of installation. A graph of cost versus energy conserved may be shown for the general case in Figure 1.

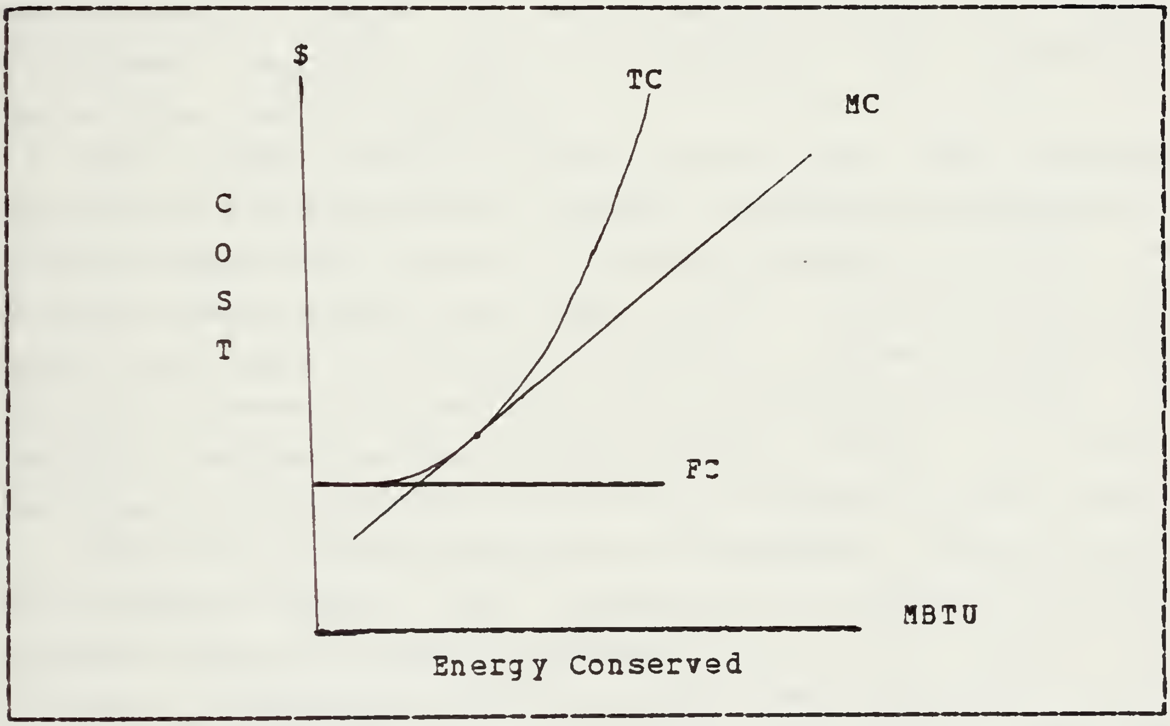


Figure 2.1 Diminishing Marginal Returns of Energy Conservation

It can be seen that there will be a fixed cost (FC) of energy. As output, conserved energy, is increased total costs (TC) will begin to rise at a low marginal cost (MC). The marginal cost, the rate of change in total costs, will increase as output increases. Succintly stated, greater energy savings incur greater costs at an increasing rate. Thus, initial conservation takes little capital investment. To achieve greater conservation levels, increasing rates of capital investment are needed.

The implication of this characteristic is that greater rates of capital investment are necessary in order to achieve the increasing percentages of total reductions required. In perspective, with the growth of electricity requirements, there is an increasing level of capital investment required just to maintain the percentage reductions thus far achieved.

The dramatic rise in energy costs since 1975 provides offsetting benefits for the capital investment requirements. Rising energy costs serve to decrease payback periods. An energy savings project can often pay for itself within a few months or years in this perspective. Under appropriated funding, however, the savings are a statistical savings, if payback periods extend beyond fiscal years. In fact, savings are more realistically cost avoidance in such cases.

There are various sources of investment dollars within the federal budget. The response to a specific project approval and the funds available vary with the cost of the project. Commanding Officers have the authority to fund projects costing less than $15,000 from their operating budgets. With no specific approvals required, funding can be done as needed. This may require sacrifices of other funding plans. Unless the payback period is short enough to realize savings within that fiscal year so that savings can

be applied elsewhere, given the expiring nature of appropriated funding, there is little motivation to make strong sacrifices of short term needs for the longer range goals. Even if the cost of purchased energy exceeds budget allowances, major claimants have no recourse but to fund the deficiency with little danger of repurcussion to the Commanding Officer.

Energy programs to provide supplemental funds for energy conservation projects have been established in recognition of funding limitations and the conflicting priorities within operational budget funding. The Energy Technology Application Program (ETAP) provides funds of up to $100,000 for retrofit of existing buildings. Program funding is requested from annual Congressional appropriations. Prior to FY 82, funding and specific project approvals were administered by the Naval Facilities Engineering Command (NAVFAC). Its geographical Engineering Field Divisions (EFD) served to provide technical expertise to evaluate and, if requested, initiate projects as well as provide funding administration within their large geographical areas. Although NAVFAC provided final approval, the EFD recommendations were generally heeded. The major commands have now been tasked with this administration and control of ETAP funds. Technical guidance will continue as a NAVFAC function. This shift of control will allow more control of energy conservation progress by the particular claimants. It will also bring greater accountability.

Major claimant control of their own energy destiny may also prove a disadvantage to the overall energy plan of DON, though. Funds are more likely to be invested in less efficient single uses, benefitting individual commands, but with less impact on the total DON requirements due to a decreased range of alternatives available to major

claimants. Each major claimant, if given a proportional share of the funds available to distribute among its total commands, will have less flexibility in magnitude of funding. Funding of a wider range of smaller projects can be expected, thereby missing opportunities for optimal funding in a wider range of greater savings projects.

Energy conservation projects to retrofit existing buildings costing over $100,000 fall under the Energy Conservation Investment Program (ECIP). As these funds are within the Military Construction Program (MILCON), they are administered by NAVFAC. Projects are submitted via the EFDs for technical approval and forwarded to NAVFAC as a line item budget submission for Congressional funding approval. Project approvals are based on economic justifications and subject to the budgetary politics of the federal budget process. With the requirement for Congressional approval, the response time between project submission and completed construction is slowed to a minimum of three fiscal years.

While ETAP and ECIP funding provide capital investment funds to effect energy conservation corrections, it must also be recognized that the political realities of appropriation funding tend to limit the amount of funds available. Cost avoidance is not an attractive proposition to the political entrepreneur. Voters receive no tangible benefits in energy conservation projects and see only an increase in government spending. Actual cost reductions are hidden in the amount of continuing rate increases. As a result, conservation funds are subject to the 'budget axe' when budget reductions are necessitated. The energy investment programs are in fact more saleable under the patriotic banner of energy independence from foreign sources.

The combined effect of these factors have put a large strain on investment dollars. The net result of the diminishing marginal returns nature of energy conservation serves to increase the greater need for investment dollars. Coincidental to this need, the amount of dollars made available tend to be limited and restrictive. The more decentralized control of investment funds at the ETAP level may limit the effectiveness of investment funding further. The message then is very clear: investment decisions will have to made wisely to achieve the maximum effectiveness from the dollars available. Accordingly, rational decisionmaking will depend on the accuracy and reliability of the information on which it is based.

III. MODELS OF ELECTRICITY USE

A. MODEL TYPES AND USES

The decisionmaker, for purposes of this thesis, will be defined as the person evaluating the energy reduction progress of an activity or group of activities with access to capital investment funds. The issues for the activity decisionmaker are how to effect the necessary energy reductions, what investment funds are needed to implement further reductions, how effective the implemented measures have been, and what level of reduction can be realistically expected relative to the prescribed targets. A higher echelon command, such as the major claimant, would be confronted with allocating its limited investment dollars. Both decisions would necessitate evaluation of the curent and expected progress.

The basic document to provide current progress is the Energy Audit Report (EAR). Figure 2 is a sample of such a report. The evaluator can read electricity use in MWH and MBTU for the baseline and current 12 month periods, the percent change from FY 75 and percentage of total use. It further shows FY 75 and current fiscal year floor areas and percent change from FY 75, MBTU/thousand square feet comparisons, and a comparison of total reduction and target reduction. EARs are provided on individual activities on their use as well as to higher echelon summarizing the progress of their reporting commands.

In a simplistic, cursory examination of the EAR, one could assess whether an activity was above or below target. One could also identify the progress by energy type. In this example, the activity relied on electricity for almost

FACSO RPT/SYM NO 9593/F75EAR08
ACTIVITY DETAIL FOR UIC
MAJOR CLAIMANT....
SUB CLAIMANT......

ENERGY AUDIT REPORT
EXECUTIVE SUMMARY
PREPARED BY...NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

ACTIVITY UIC...... SHORE ACTIVITY
ACTIVITY NAME.....

DATE	ENERGY TYPE	FY75 BASELINE MWH	FY75 BASELINE MBTU	CURRENT MWH	CURRENT MBTU	% CHG	% BY FUEL
TWELVE MONTH SUMMARY							
	ELECTRICITY	3,299	38,268	3,210	37,237	-2.69%	31.27%
	FUEL OILS		108,195		81,200	-24.95%	68.20%
	NATURAL GAS		1,037		630	-39.25%	0.53%
-->	12 MO TOTAL	3,299	147,500	3,210	119,067	-19.28%	100.00%

THOUSAND SQUARE FEET	FY75	FY82	% CHANGE
CLASS 2 (NFADB)...		383	
OTHER..............		0	
TOTAL..............	416	383	-7.93%
MBTU/THOUSAND SQUARE FEET..........	354.57	310.88	-12.32%

PROGRESS (LATEST 12 MONTHS PERFORMANCE AS COMPARED TO FY75)........................ -12.32%

PERCENT CHANGE GOAL.. -12.50%

Figure 3.1 Typical Energy Audit Report (EAR)

one third of its energy use but had only achieved a 2.7% reduction in such use, offsetting the large percentage decreases in its other energy sources.

Taking an EAR at its face value might well lead to the erroneous conclusions discussed in Chapter II. But the energy manager has little else to base his conclusions on except to review past EARs and develop an intuitive or perhaps a graphical picture of the general energy reduction progress. Would a 12% increase this fiscal year have really indicated non compliance? Or were temporary phenomena responsible? Does the 10% decrease indicate compliance? An example of this issue is provided by a review of electricity use at NRMC Jacksonville as shown in Figure 3 A sharp peak for May 1978 is evident. A comparison of FY 78 with FY 75 shows only a 5% decrease, corresponding to a target of 6%. The EAR, by itself, would not show the use spike. The 1% variance might not be considered too serious. However, visual inspection of the data would raise questions concerning the real decrease percentage.

In verification of the data with the activity, it was learned that new water chiller units were being tested during that month, "probably" causing the spike. The activity might have reasoned that without this created extra load, it would have achieved an 8% reduction instead of the reported 5% decrease. Without knowing the real effect of the additional use for the water chillers, such reasoning might be erroneous. A large expected use, perhaps due to weather conditions, would have shown less than a 3% difference due to water chillers. A low expected use might have shown more than a 3% increase. In either case, the energy manager could have evaluated the situation and taken appropriate action as a result.

The implication of this type of framework is the existence of a control system. But, such a control system is dependent upon the ability to determine expected use, rather than setting a target, directing effort toward that goal, and suffering the blurring effects of noncontrollable factors.

Predicting future events, or forecasting, with relative certainty has become a scientific discipline in the last several decades, particularly with the widespread intoduction and use of computers. Programs have been made readily available for almost all quantitative forecasting techniques. "The need for forecasting is increasing as management attempts to decrease its dependence on chance and become more scientific in dealing with its environment" [Ref. 10]. Techniques vary considerably with the situation, time horizons, factors involved, assumptions made, and types of data patterns. A basic underlying premise in almost all forecasting methods is the assumption of constancy, i.e., the pattern of the past will continue into the future.

There are two major types of forecasting models: regression and times series models. Regression models assume the factor to be forecasted has a continuing relationship with one or more independent variables. The purpose of the model is to exploit those relationships and use them to forecast future values of the dependent variable. System responses are observed and input relationships of that response are developed. To use Ohm's Law as an illustration, voltage (E) can be predicted by inputs of current(I) and impedance(Z), and the known relationship $E = I \times Z$. The key to this method is identifying the significant input variables (stimuli) and their relationship to the the output (response).

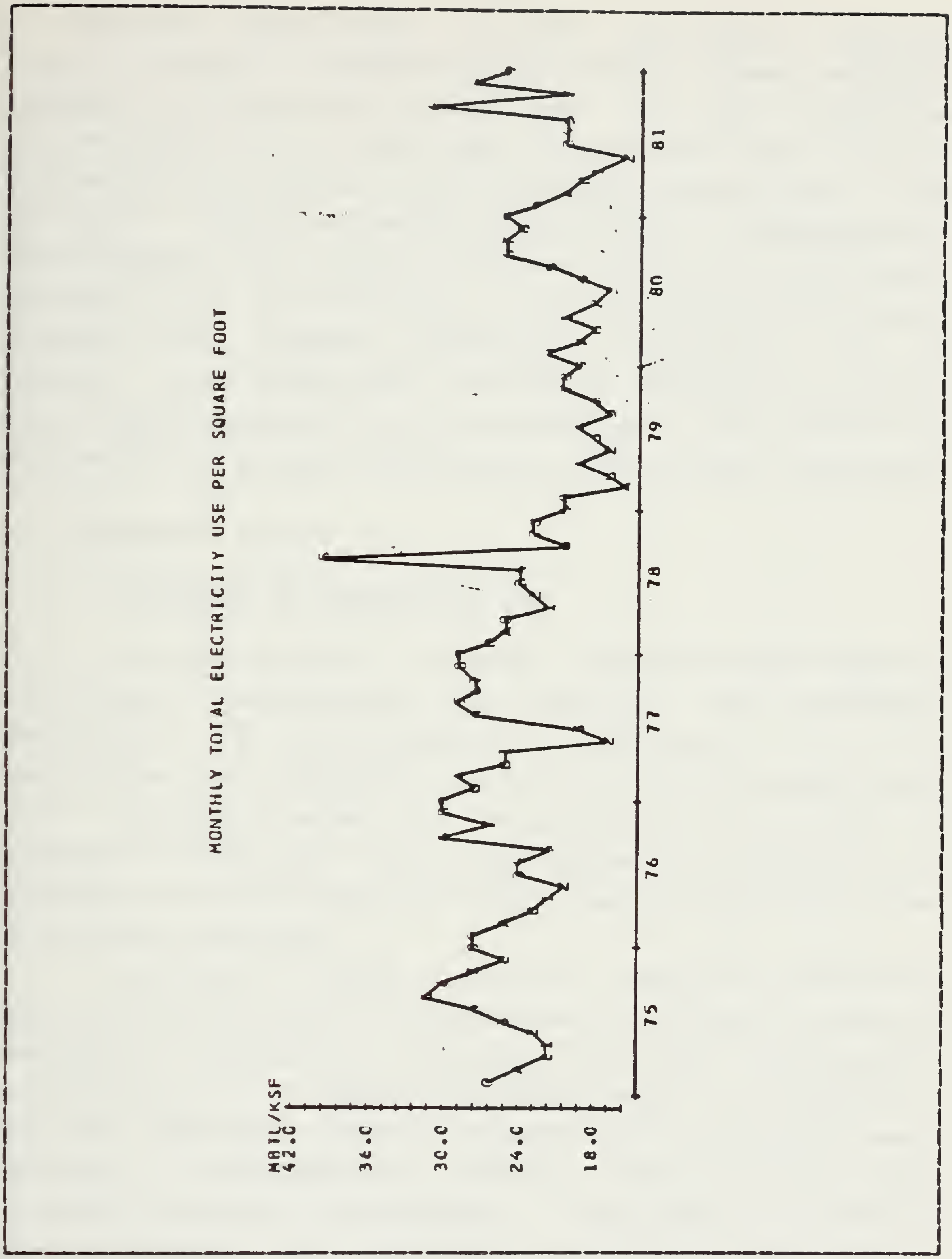


Figure 3.2 Energy Use for NRMC Jacksonville

The time series model, on the other hand, makes no effort to explain the factors that affect system response, treating the system as a black box. Its main concern is observing particular events and predicting future states. Weather can be forecast by use of a time series model. The pattern of historical events is described by mathematical relationships and used to forecast expected temperatures, sunlight, and even rainfall, without necessarily understanding the climatic conditions responsible for the results. Both models have particular advantages in particular applications and will be examined in this thesis for application to energy forecasting at Naval Shore Activities.

B. REGRESSION MODELS

1. Concepts of Electricity Use

In this section, an energy forecast model based on four weather variables will be developed using regression techniques. The main purpose of this section will be to demonstrate the techniques and discuss the interpretations of the regression model. A more specific application of regression techniques will be developed in Chapter IV to identify the relationship of energy use and functional uses of activity buildings.

In order to build a model to 'explain' electricity use, it will be useful to define some of the basic terms and concepts of electricity consumption that will be important considerations. A relatively simple model of residential home use provides a useful framework for discussing basic concepts. Each electrical device is rated as to the power it uses to perform its function. The rating is given in terms of watts. The electricity used during that performance is the product of the power rating and the hours of

use, expressed in terms of watthours. A 60 watt light bulb left on for 8 hours consumes 480 watt hours, or .48 kilowatthours. The British Thermal Unit (BTU) is often used to express energy use in terms of a common denominator relative to other energy sources, such as steam, coal, or fuel oil. One BTU is equivalent to .0116 kilowatthours, after adjustment for particular distribution losses. The previously cited example of the light bulb consumption could be expressed equivalently as 5,568 BTUs. The amount of power (watts) required to energize all devices connected to a system is its connected load. A residential home use could be calculated by summing the watt hours of each use of its connected load. In reality, the calculated amount would be less than the actual amount used since every unit has some associated energy loss, or inefficiency. The losses in a typical residential unit are relatively minor, however. The energy efficiency of a device or a system is defined as the percentage of useful energy (rated watts x hours - losses) to delivered energy (rated power x hours).

A simple residential home model would be expected to contain explanatory variables relating the effects of weather, number of occupants, and the hours that the unit is occupied. The model would express the amount of change expected in the electricity consumption per unit change in any one of the variables, or stimuli. To control the response within particular limits, it would be necessary to control the variables, if possible, or adjust the system response to a variable. Since weather is not controllable, adjustment of the system response could be effected by increasing the insulation, resetting thermostat controls, or even replacing inefficient heating or cooling units. The model would indicate the change in electricity use caused by a unit change in any one of the variables when the other

variables remain constant. A user could select the variable(s) to control that would influence the desired response.

Models for industrial electricity, such as for a military installation, are considerably more complex and involve subsystem interrelationships. Power to the installed loads is often three phase power. Simplistically, the total power to the load is provided by several wires which provide the total required power. It is important to the efficiency of the power use that each phase have the same loading. A system is said to be balanced if each phase delivers the same amount of power to a system. As the system becomes unbalanced, the efficency of use decreases. This concept applies to an entire building supplied with three phase power, a particular internal circuit, or a particular type of load. The efficiency of a building's use can be improved by shifting loads to other circuits to gain a better balance.

The power factor is another important item in energy efficiency. The power factor is the cosine of the phase angle between the current and voltage, ranging in absolute value between 1 and 0. A pure capacitive, or pure inductive load will have a phase difference of 90 degrees, and therefore a power factor (cos 90 degrees) of 0. The product of power factor and rated power is used to determine the useful or real power used relative to the power delivered. Thus, a load with a power factor of 1 would have no losses as a result of the phase difference, while a load with a power factor of 0 would be a total loss of delivered power. A pure capacitor, for example, would store energy delivered to it and would have a power factor of 0. By adding an inductive load of equal magnitude, the resultant system power factor would increase to 1. Thus, another industrial energy

conservation measure is to attempt to balance inductive and capacitive loads. In fact, power companies often give rate incentives to industrial customers who maintain a power factor of at least 0.8 as a means of increasing the power system's overall efficiency.

The major concept to be understood by the reader is that system interrelationships are significant in explaining the system total response. A change in one component of a system may in fact produce an effect opposite to the intended response. Relative to weather effects, warm weather resulting in the use of large air conditioners may increase or decrease the efficiency of a particular system or subsystem. Thus, a simple calculation of the rated power use of a particular load may not necessarily provide the true overall response. Consequently, the definition of an industrial system response needs to consider the interrelationships of its subsystems. Determining the system response is not a simple matter of inventorying connected loads.

2. Concepts of Statistical Theory

This thesis does not presuppose a strong background in statistics, nor is it the intent to provide one. Textbooks suitable for the reader's particular background would provide a more thorough and appropriate source of information. The text of this thesis is written for the corporate body of energy managers who may have had only minor exposure to a study of statistics. Consequently, a brief presentation of important statistical theory concepts will be given only to provide a better basis of understanding the interpretation and application of regression modeling.

Regression models were seen to be based on determining a system response in terms of the relationships of particular input variables, or stimuli. Theoretically, there exists a true function that completely explains output. Such a deterministic model would also be capable of forecasting future values providing the definitive equations did not change, i.e., system interrelationships and input variables remained valid. A true deterministic model of electricity use would detail every use down to the efficiency of the connected loads and the effect of energized loads on load balance, power factors, etc. Obviously, such a model would be difficult to develop and very complex. Despite the ability of computers to rapidly compute the response once the appropriate data is input, collection of that data can be costly in terms of time and money. A lesser model might be sufficiently accurate and far less costly. A useful model would be one which could reliably estimate the 'true' function and be practical enough to be effective.

Since the applied model is not deterministic, there will always be error, or differences between the expected values of the model and the observed data. The technique of least squares is used to minimize the error of a fitted curve to the input data. The sum of the squares of the errors becomes a measure of determining how well the estimator curve fits the data. The coefficient of determination, or R^2, is the ratio of 'explained' error to the total error. Its values then would range from 0, indicating no relationship between the stimuli and response, to 1, indicating a perfect fit. Maximizing R^2 is one means of determining the usefulness of a model.

The addition of variables to a regression model can not decrease the R^2 value, appearing to improve the

prediction capability of the model. However, an increase may be spurious, caused by measurement errors, or chance results of unrelated data. A plot of R^2 against the numbers and combinations of variables will result in a logarithmic type curve which flattens as it approaches a maximum. Adding variables in this region will provide little increase in R^2.

Another means of evaluating the fit of the model may be made by examination of the mean squared error (MSE). As its name implies, MSE is computed by squaring the individual error for each data point and then finding the average or mean value of the sum of those squares. The MSE gives greater weight to large errors than to small errors since the errors are squared before being summed. Plotting the MSE against the number of variables results in a parabolic curve. The graph will show a minimum point for a particular combination and number of variables. A decrease in the MSE with added variables, may not be great enough to justify the cost of additional data collection.

The variance of a function, known as S^2, indicates the dispersion of the data around the mean. This value is used to assess the extent of possible error. The F statistic uses the ratio of the 'explained' variance to the 'unexplained', or totally random, variance about the mean. If there was no correlation of the output variable with the input variables, the mean of observed output would be the best predictor. Since all variance would be 'unexplained', the ratio should be 1. As more variance was explained, the numerator would increase. The F statistic, with a known probability distribution, can be used to compare the explanatory power of different models or assess the various characteristics of a particular model.

Estimating the 'true' function, recognizing that error is involved, leaves room for doubt that a model has predicted a realistic value. Confidence levels are used to express the probability that a predicted value is accurate relative to the 'true' value. A confidence level would indicate the percentage of times, on the average, that a particular outcome would be observed in repeated trials. For confidence intervals, the desired outcome is that the computed interval include the 'true' value. Increasing the confidence level causes the interval to be longer, but less informative. All calculations used in this thesis use a 95% confidence level.

The confidence level is calculated based on known distribution characteristics. The cumulative area under such a curve is the cumulative probability. The central limit theorem states that as the sample size n increases, the distribution of the mean of a random sample taken from practically any population approaches a normal distribution. A standardized normal distribution, with its mean of 0, and standard deviation of 1, can then be used as a prototype from which to make certain statistical and probability inferences. A useful property of the standardized normal distribution is that about 95% of the area, or probability, lies within 2 standard deviations of the mean. The standardized normal curve and table of values is shown in Appendix P.

The Student's t, or simply t, distribution is used for small samples. The t distribution is actually a family of curves identified by degrees of freedom. Degrees of freedom relates to the number of variables in an equation. The residuals for the variables, i.e., the errors or differences between obseverved and calculated values, are said to be 'free' in that they can be any value, with the condition

that their sum is zero. Thus, not every residual is free once other residuals have value. Computer printouts usually print degrees of freedom as a normal output of interest. T distribution tables, such as provided in Appendix P, will yield a standardized deviation from the mean. Multiplication of this value by the model's standard deviation will yield the probability that a particular value will be greater than an expected value. It can be seen that the t distribution and standard normal distribution values converge for large numbers of observations.

The aptness of a model may also be determined by examining its prediction capability. A condition of aptness is that error is randomly distributed with constant variance around the mean over a range of values. A plot of residuals against the individual variables will demonstrate error distribution. Figure 4 demonstrates possible patterns of residual error when plotted against a variable. Figure 4 (a) illustrates constant variance (homoescadicity) over the range of X, satisfying the basic assumption. Figures 4 (b), (c), and (d) exhibit non-constant variance (heteroscedasticity). Use of the variable exhibiting the characteristics of any of the latter three examples, will introduce non random, focused error into particular data ranges and have undesired influence within the model. Correction of heteroscedasticity may be accomplished by transformation of the variables. Residual analysis, other than noting that particular variables may have undesirable influence without adjustment, is beyond the scope of this writing, however.

Multicollinearity, or correlation between independent variables, can also produce undesirable effects in a model. At best, these effects are unpredictable. Multicollinearity should be avoided, if possible.

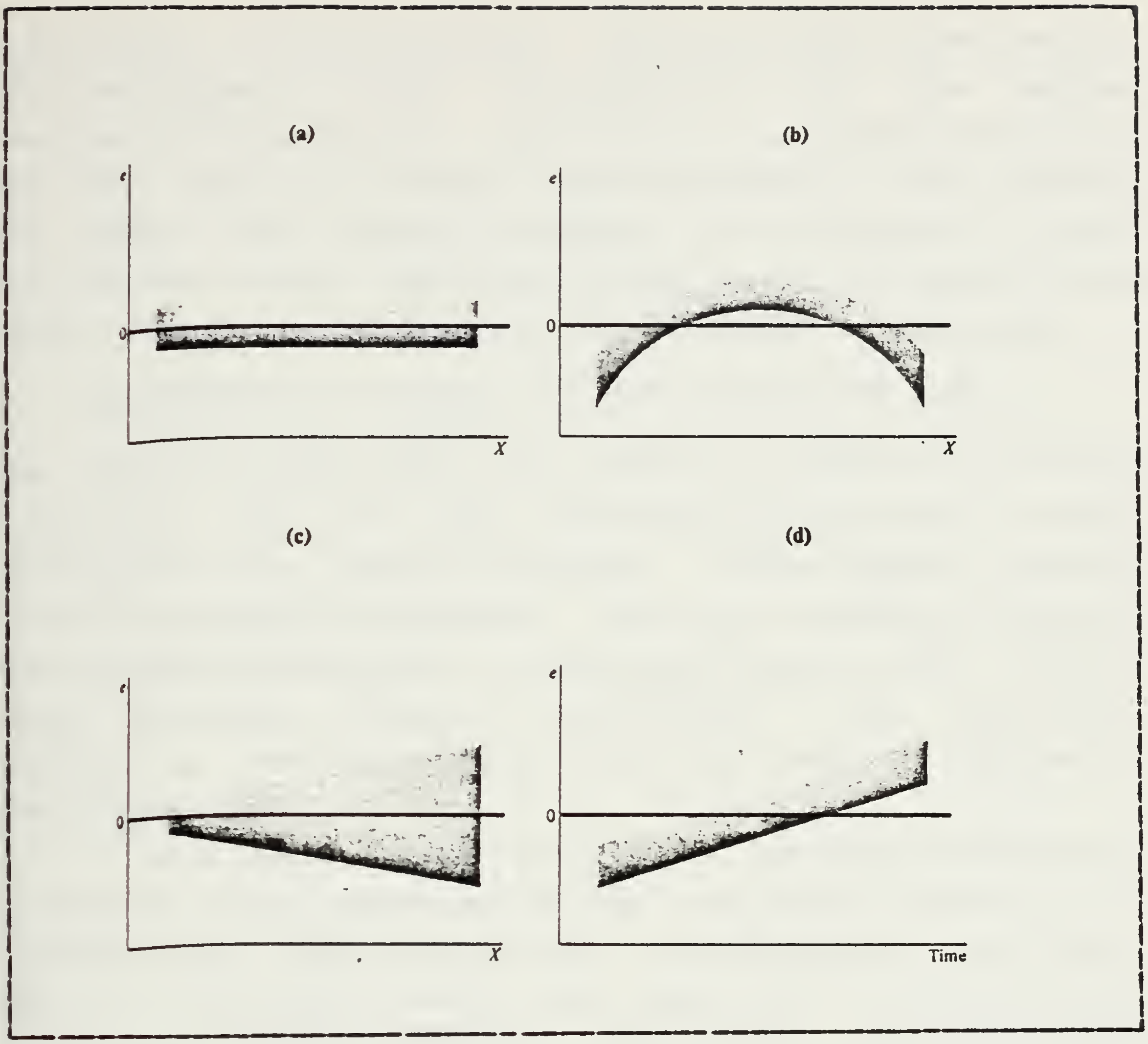


Figure 3.3 Prototype Residual Plots

C. REGRESSION MODELING TECHNIQUES

1. Parameter Selection

A regression model will have the general form,

$$Y = b0 + b1\ X1 + b2\ X2 + \ldots + bk\ Xk + \text{error}\ (e)$$

The initial selection of variables as predictors of system response depend on the purpose of the study, logical

assumptions of relationships, the practical cost/benefit considerations of data availability, and the desired complexity of the model. Selection of the weather variables for this analysis provides amplification of these points. The purpose of a weather parameter study would be to test and compare weather effects on energy use. The general form of the weather model that will be developed is given by,

MBTU/SF=b0 +b1 AVGTEMP +b2 HDD +b3 CDD +b4 PRECIP

The results of this model will assist in answering pertinent questions, such as, Does electricity use show a strong correlation with weather factors? Which weather factors have the strongest influence? Is there a general relationship between activities in the same climate zone, or even among particular types of activities? More important, though, is what affect does the model have on management decisionmaking?

An important consideration to realize before final selection of the variables is that the final results can be applied only within the context in which they were determined. The final model will show only a relationship between the input variables. For example, cooling degree days may show a strong influence in a particular model. That influence may only be relevant in the presence of the other selected variables. The addition of another variable, such as hours of sunlight, may decrease the relative significance of cooling degree days and increase the significance of precipitation. Selection of parameters for study should be given a broad consideration first with a narrowing focus.

Availability of data and cost of the data are important for obvious reasons. The cost of acquiring data, in terms of time and money, must be cost effective. It makes little sense to acquire data that requires many manhours to

assemble and refine without a strong improvement in a model and a high value placed on such improvement. For example, total year weather summaries, published for each weather station, were used to collect the necessary weather data used in this study for each activity. Selection of a wider variety of variables would have required additional processing costs by the National Climatic Center, and a greater compilation prior to computer processing. The benefits of additional data were considered less than the cost and therefore not collected.

The accuracy of data must also be considered within a cost context. Regression is often used in cost estimating large government contracts, such as the acquisition of weapons systems, ships, and aircraft. Historical data to the nearest penny requires a great deal of research; 'ball park' estimates defeat the purpose of forecasting cost. A reasonable amount of accuracy is determined by the cost of acquiring data and the purpose such accuracy will serve. Similarly, the floor areas of reporting activities must be recognized as having limited accuracy. EARs show only a single area for a fiscal year. Allowing the possibility of a net effect of zero during the year for construction and demolition combinations, the sometimes lengthy transition period between full occupancy and inactive status for new buildings or building demolitions, the attempt to refine square footage to a completely accurate number would have been cost ineffective since the final results may show only a small change for accuracy adjustments. It is highly unlikely that records would be kept to such a level of refinement. Records pertaining to actual energizing/deenergizing dates and occupancy status would be an exception rather than the rule. However, the user should realize the limits of the data and the effect on the final model before

expecting too much from the model. Alternatively, model uses can be specified to insure the data will be of appropriate accuracy.

2. Building The Model

Although graphical comparison of system response and various system stimuli is not necessarily an integral part of regression modeling, it does provide a visual indication of particular patterns and trends that may suggest certain relationships. Parts A and B of Appendices A-M exhibit graphs of energy use and weather conditions from FY 75 through FY 81. The various energy use graphs show a variety of patterns. NRMC Corpus Christi, for example, shows distinctly different patterns before and after the start of FY 79. Prior to FY 79, there was relatively small variations between successive peaks. The largest peaks seem to occur about July of each year. The mean MBTU/KSF was decreasing through FY 76, stabilized in FY 77, and rising in FY 78-79. The July peaks after the start of FY 79 show a sharp increase although winter minimums also show a significant decrease. It can also be seen that there was a milder winter in the baseline year. In fact, there was a mild winter, relative to successive years, at almost all of the sample sites. The composite study group also reflects this occurrence.

An EAR provides only yearly energy use summary statistics. The averaging of the wide variations shows only a relative degree of change of the mean. The visual picture of the monthly energy use might prompt a different type of response for the decisionmaker. One might speculate that the activity added large air conditioning units causing the large summer peaks. Without such air conditioning use, it would be possible that the remaining use level had

decreased, as indicated by the winter lows. The decisionmaker, even with confirmation of these hypothetical explanations, would be unable to assess at this point whether the increase was justifiable, assuming the necessity of the air conditioning. Did weather conditions, i.e., unusually hot, humid conditions cause greater use? Or is air conditioning use excessive?

The results of the four weather variable model for NRMC Corpus Christi is shown in part C of Appendix C. The resultant equation is seen to be,

$$\underset{(1.47)}{Y=29.7}\underset{(-.02)}{-0.0075\,AVGTEMP}\underset{(-.67)}{-0.0086HDD}\underset{(1.46)}{+0.0169CDD}\underset{(1.23)}{+0.246PRECIP}$$

Interpretation of this equation is that for a unit change in any one of the input variables, sytem response will change by the signed magnitude of the variable coefficient while the remaining variables remain constant. The magnitudes of the coefficients alone, however, do not indicate their importance, since the units of each variable are different. Relative significance is determined by the t-ratio (coefficient/standard deviation). T-ratios are shown in parentheses below the coefficients. CDD is seen to be thestrongest variable by this criteria. Recalling that the equation is an estimator of the 'true' function , the user might want to test the hypothesis that the individual coefficients are 0. That is, is the estimated coefficient non-zero because of the error in the estimate? To determine whether the value is significantly different than 0 with 95% confidence, an evaluator would compare the observed t ratio to the tabulated t distribution. Since each ratio is less than 2, the value of 0 as the true value for each coefficient would be accepted.

The t test can be applied only to a single coefficient. Even though none of the coefficients have a t statistic greater than the critical value of 2.0, it can not be said that all coefficients are 0, since deletion of one variable could change the relative significance of the remaining variables. To test the hypothesis that all coefficients are 0 simultaneously, a similar test can be performed with the F statistic. In the case of NRMC Corpus Christi, F is computed as 16.9 (498.94/29.53). The F table, as provided in part C of Appendix P would be used. Entry of the degrees of freedom of the 'explained' error (4), and degrees of freedom for the 'unexpained' error (79), yields a value of between 5.66-5.69. Interpretation of this test is that the risk of assuming that all coefficients are zero, with an F=16.9, is 95%. It would thus be concluded that all coefficients are 0.

The next step of analysis would be to delete the weakest relative variable, in this case average temperature, to narrow the focus of consideration. However, the fit of the model by R^2 and MSE criteria need to be examined to compare the relative changes in other models. The R^2 value is seen to be 46.1%, which will be the maximum for up to these four variables. It is also, as expected, an indication of a weak fit. (A value in the order of 90% would be hoped for in this type of prediction model.) The MSE (mean square of the residuals in the analysis of variance) is seen to be 29.5. Also shown in the analysis of variance is a listing of fourteen points which were identified from the total of 84 as having adverse effects either by a large standarized residual(R) or a large influence by an X value (X).

The correlation summary indicates a further problem of multicollinearity. A correlation of .956 between average

temperature and CDD indicates that the variations in the two variables are almost identical and move in the same direction. The -.884 correlation between average temperature and HDD indicates thse two variables are also strongly correlated but moved in opposite directions. That is, as average temperatures rose, CDD increased and HDD decreased. These results, as previously discussed, were expected. Elimination of average temperature to reduce the unpredictable effects of multicollinearity would further be suggested.

3. Evaluation of 'Best' Model

Each of the models which have been developed for four weather variables is considered to be the full model. That is, it contains all of the variables intended. As seen earlier, it will have the best fit since adding variables will always improve the R^2 value. But the full model may not always be the 'best' model. The criteria for 'best' is established by the decisionmaker based on the intended model use.

Prior to considering a model for selection, a determination of aptness should be made. It will be assumed herein that all models are apt since residual analysis is more appropriate to discussion of developing realistic models rather than the methodological approach taken by this thesis. The weather variables selected for this study are known to be interrelated and of little practical value by themselves.

Values of R^2 and MSE are the most commonly used indicators of fit. Criteria to be used will depend on the decisionmaker's needs and preferences. As previously discussed, a curve of R^2 against combinations of variables will generally show a sharp rise initially before flattening

as it approaches a maximum value. The 'elbow rule' criteria sets the selection of 'best' at the point where the flat zone begins. R^2 will change very little for adding variables.

The parabolic curve of MSE against variable combinations will decrease to a minimum point and begin to rise again past the 'best' point. The degree of change as MSE approaches the minimum may also be very slight, though, indicating that the addition of a variable will decrease MSE by only a small amount. The minimum point may not be the same point indicated by the R^2 'elbow rule' criteria.

The F statistic also shows the explanatory power of a model. The F statistic has no maximum or threshold value criteria. A minimum criteria can set based on the confidence level test that all variables are not 0, as discussed earlier. The minimum point determined for a 95% confidence level was found to be 5.68. Below this F level, the model would be rejected.

An important concept, basic to either criteria, however, is cost effectiveness. The cost of a model must be less than its value. The cost effectiveness should decide the complexity of the model. All else being equal, model selection should be decided by optimizing cost effectiveness.

Table 2 summarizes the results of regressions for each of the 15 combinations of models for one to four variables of each sample. The R^2 and MSE values are shown for the best model in each category of 1, 2, 3, or 4 variables. Continuing the use of NRMC Corpus Christi for illustrative purposes, a 'best' single variable model would use CDD as a predictor, with an R^2=44.3% and MSE=29.42. A 'best' two variable model would add precipitation as a predictor with a corresponding gain in R^2 of 0.9%, with a decrease of 0.16 in

TABLE II

Model Comparisons

NRFC	1 R-SQ	1 MSE	1 F	2 R-SQ	2 MSE	2 F	3 R-SQ	3 MSE	3 F	4 R-SQ	4 MSE	4 F
	NUMBER OF VARIABLES											
CAMP LEJEUNE	85.8	1.69 (3)	495.9	85.9	1.70 (1/3)	245.9	86.0	1.71 1/3/4	163.2	86.0	1.70	245.9
CHARLESTON	51.6	5.67 (3)	87.3	53.6	5.49 (3/4)	46.9	55.4	5.35 1/2/4	31.7	56.3	5.49	46.9
CORPUS CHRISTI	44.3	29.33 (3)	65.1	45.2	29.30 (3/4)	33.5	46.1	29.25 2/3/4	22.8	46.2	29.30	33.5
GREAT LAKES	28.5	1.22 (3)	32.7	31.6	1.20 (1/2)	15.9	32.2	1.20 1/2/4	12.7	32.8	1.20	15.9
JACKSONVILLE	17.8	4.04 (1)	17.8	18.5	4.05 (3/4)	8.8	19.3	4.06 1/2/3	6.4	19.5	4.05	8.8
LONG BEACH	26.6	3.59 (1)	30.4	30.6	3.52 (3/4)	17.9	30.7	3.54 2/3/4	12.2	30.7	3.56	8.8
MEMPHIS	37.9	4.23 (3)	50.1	39.4	4.21 (2/3)	26.3	39.4	4.23 1/2/4	17.3	39.4	4.26	12.8
OAKLAND	11.9	1.87 (2)	11.1	13.7	1.87 (2/3)	6.0	13.7	1.87 1/2/3	4.2	14.0	1.88	3.2
ORLANDO	33.4	40.81 (3)	41.2	33.5	41.26 (1/2)	20.4	33.5	41.77 1/2/4	40.3	33.5	42.33	10.0
PHILADELPHIA	87.5	0.94 (3)	594.2	88.6	0.92 (3/4)	315.3	88.6	0.92 2/3/4	207.8	88.6	0.93	153.9
PORTSMOUTH	87.6	1.71 (3)	580.7	89.7	1.59 (3/4)	343.8	89.7	1.58 2/3/4	232.1	89.7	1.59	172.8
SAN DIEGO	36.8	0.74 (1)	47.8	38.3	0.74 (3/4)	24.3	36.8	0.74 1/2/3	16.5	38.3	0.75	12.3
STUDY GROUP	89.1	0.74 (3)	668.4	89.2	0.74 (1/3)	335.8	89.1	0.73 2/3/4	229.7	89.7	0.73	171.5

VARIABLE CODES: AVG TEMP =1
HDD =2
CDD =3
PRECIP =4

MSE. A three variable model, adding HDD, was found to increase R^2 by 0.9%, with a decrease in MSE of 0.10. The addition of average temperature as a fourth predictor had no noticeable effect on R^2, but increased the MSE by 0.37. The F statistic shows a continuing decline as variables are added, although staying above the minimum significance level. Assuming little cost difference between a 2 variable and a 3 variable model, the 'best' overall model would appear to be the three variable model 13.

Table 2 provides a basis of making some general observations. Selection of the 'best' models based on changes versus absolute values of R^2 and MSE, and minimum F value criteria, would have made the three variable model the most popular. It is interesting to note that CDD figured as the best predictor in all but 4 of the 13 single variable models, in all but 1 of the two variable models, and in 10 of the three variable models. Non selection of a CDD model was then due to marginal differences in almost every case. The idea that more may not be best was clearly demonstrated. Full models for Oakland and Jacksonville, as well as the three variable model for Oakland were rejected on the basis of F test significance.

The approach to model selection would generally be the same for the activity level and upper echelon decisionmakers. However, the issue of cost effectiveness would be greater at the upper echelon command. The activity level decisionmaker could be relatively indifferent to the difference in complexity between a three and four variable model, or between a two variable and a three variable model. However, an upper echelon decisionmaker evaluating a group of reporting commands would find the complexity difference multiplied by the number of reporting activities. In this study, the decisionmaker would have to consider the cost of

acquiring and processing twelve sets of data against the value of increasing the R^2 value by 0.1, with almost no change in MSE, and a moderate decrease in the value of F. The purposes of the information would be a large influence in the selection. It would be expected that the three variable model would be selected.

Regression modeling can be seen to be an involved process. Its value is in the determination of relationships between sytem response and specific inputs. The relationships would be useful for developing a plan of corrective action. For example, the strong effects of cooling degree days would suggest investigation to determine ways of reducing such effects. An activity may decide to alter circuits to gain a better balance in phase loading, and/or power factor corrections. The effect of air conditioning could make a difference during the cooling season and be opposite in effect during the remainder of the year. Biannual load adjustments might then be appropriate to compensate for such effects. Increased insulation against heat losses or gains might have cumulative effects during heating and cooling seasons. Initiation and prioritization of projects to implement necessary changes might be effected. Similarly, an upper echelon command might review its priorities of funding based on the indications of particular regression models.

Evaluation of projects, however, is perhaps most significant at the EFD technical review. The estimation of energy savings and payback periods provided by the engineering staff is critical to the funding of projects in many cases. Erroneous assumptions of system interrrelationships could well provide the difference between funding or not funding a project that could either save energy or waste investment capital. Regression analysis provides a further tool that can be useful in assisting such decisionmaking.

D. TIME SERIES MODELS

Regression analysis provides a capability of examining relationships to define system output. Time series models, on the other hand, are concerned only with system output. The model defines historical patterns and trends of a variable by mathematical equations which it uses to forecast future states. The assumption in both cases is that the patterns and trends will continue into the future.

A particular value of this method is in the ability to minimize the effects of unusual events and base forecasts on expected states. One of the concerns expressed for the present sytem of evaluating energy reduction progress is the susceptibility of energy use to noncontrollable weather conditions. The strong relative influence of cooling degree days on electricity use has been shown. Although a definite factor of use, its influence would be seen in a comparison between months of differing temperatures. Comparison would be enhanced by accounting for a difference in such noncontrollable factors. A review of the monthly electricity use and weather summaries in parts A and B of Appendices A-M illustrate definite patterns.

NRMC Great Lakes shows a specific example of the occurrences of unusual weather variations. The average temperature in January 1977 was 15.5 degrees lower than the same month in the FY 75 baseline. A corresponding increase of 519 heating degree days (44.7%) in FY 77 is then seen. Comparing just the peak cooling degree days, disregarding the month of occurrence, also shows an increase of 38 cooling degree days, almost 10% greater, in FY 77. A comparison of energy uses would certainly be influenced by these noncontrollable factors and somewhat distort an appraisal of energy conservation progress. FY 75 seems to have had a milder winter at almost every one of the sample

sites. The total group summary also reflects this fact. The evaluator needs a means of comparing uses that allows consideration of such effects. By basing its forecasts on historical trends and patterns, the time series model provides a standardized, and perhaps more meaningful, basis of comparison.

1. Testing For Time Series

Autocorrelation is used to describe the association or mutual dependence between values of the time series at different time periods. It relates a series for different time lags. A pattern in a plot of residuals may imply autocorrelation. One statistical test for the existence of autocorrelation is the Durbin-Watson, or D-W test. The Durbin-Watson distribution and tabled values are shown in Part D of Appendix P. Upper and lower D-W values of D-W(u) and D-W(l) are read for the appropriate number of independent variables (k) and sample size (n). The distribution curve, symmetrical around 2.0, is divided into five intervals: (1) less than D-W(l), (2) between D-W(l) and D-W(u), (3) between D-W(u) and 4 - D-W(u), (4) between 4 - D-W(u) and 4 - D-W(l), and (5) more than 4 - D-W(l). If the D-W value is in interval (1) or (5), it is likely that autocorrelation is present. The test is inconclusive if the test value is in intervals (2) or (4).

The D-W test value for each sample is shown in part C of Appendices A-M. For 4 independent variables and 84 observations, D-W(l)=1.49 and D-W(u)=1.68. Thus, for this study, if the D-W statistic is between 1.49 and 1.68, it would be concluded that there is no autocorrelation and time series modeling would not be indicated. Camp Lejeune was the only activity in the no autocorrelation interval; San Diego data proved inconclusive. All others activities indicated definite autocorrelation.

2. Concepts of Time Series Analysis

In this section, the basic concepts needed to understand the basic premises of time series analysis before application to modeling techniques will be presented.

The general form of the regression model was established as,

$$Y = b0 + b1\ X1 + b2\ X2 + \ldots\ldots\ldots + bk\ Xk + error(e)$$

A similar concept in time series analysis is autoregression which relates past values of a dependent variable to itself, i.e, auto(self) regression. The general form of the equation would then be,

$$Y = b0 + b1\ Y(t-1) + b2\ Y(t-2) + \ldots\ldots + bk\ Y(t-k) + e$$

A time lag is the time interval offsetting the variable being forecast. The term Y(t-2) indicates a time lag of 2 from Y(t). Weather data would have a time lag of 12 months, indicating a 12 month repeating pattern.

Autoregression differs from regression in that the residuals of the independent time series variables, i.e., Y(t-1), Y(t-2), etc., usually depend on each other. The number of independent variables to include in a time series is more difficult to determine in autoregression.

Autocorrelation coefficients (ACF) can be computed as an indication of how successive values of the same variable relate to each other. They are also useful in determining whether data are random, stationary (oscillate around a constant mean), the level at which data becomes stationary, data seasonality, and the length of seasonality. Tests similar to those shown for regression analysis can be applied to ACFs to determine characteristics. The ACF in random data have a sampling distribution that can be approximated by a normal curve with mean zero and standard

approximated by a normal curve with mean zero and standard deviation of $\sqrt{n}$. Thus, residuals are not considered random if less than 95% of the ACFs are within 2 standard deviations of the mean.

The characteristic of stationarity can also be seen by analysis of ACF. Stationarity means there is no growth or decline in the data, i.e., data fluctuates around a constant, horizontal mean. Electricity use data will be expected to be nonstationary, hopefully decreasing. Weather, however, should be relatively stationary. ACF of stationary data drops to zero after two or three time lags, whereas ACF of nonstationary data will be significantly different from zero for several time periods, exhibiting a trend with increasing time lags. Removal of nonstationarity is necessary to eliminate the effects of a trend in the ACFs before proceeding in time series analysis. This is achieved by a method of differencing. A new series is created by subtracting successive values and using those differences as a new series. The order of differencing is determined by the number of applications before data drops to zero after two or three time lags. Generally, real data will not require more than first or second order differencing.

Normally, a moving average refers to a continuing, or moving, process of computing an average for a set of observations, adding a new observation while excluding the oldest to yield a new average. As applied in this context, moving average indicates a process to isolate data not possible by autoregression models. Instead of basing its forecasts on past values of a variable, the moving average bases its forecast on a linear combination of past estimated errors. A combination of the the two methods to make a single ARMA model is a powerful tool. But, it took third generation computers to make ARMA models applicable on an operational level.

Partial autocorrelations (PACF) are useful in identification of an appropriate ARMA model. PACF is defined as the last autoregressive term of an AR model. For an m order, or AR(m), model, only up to m terms will be statistically different from zero; further terms will not.

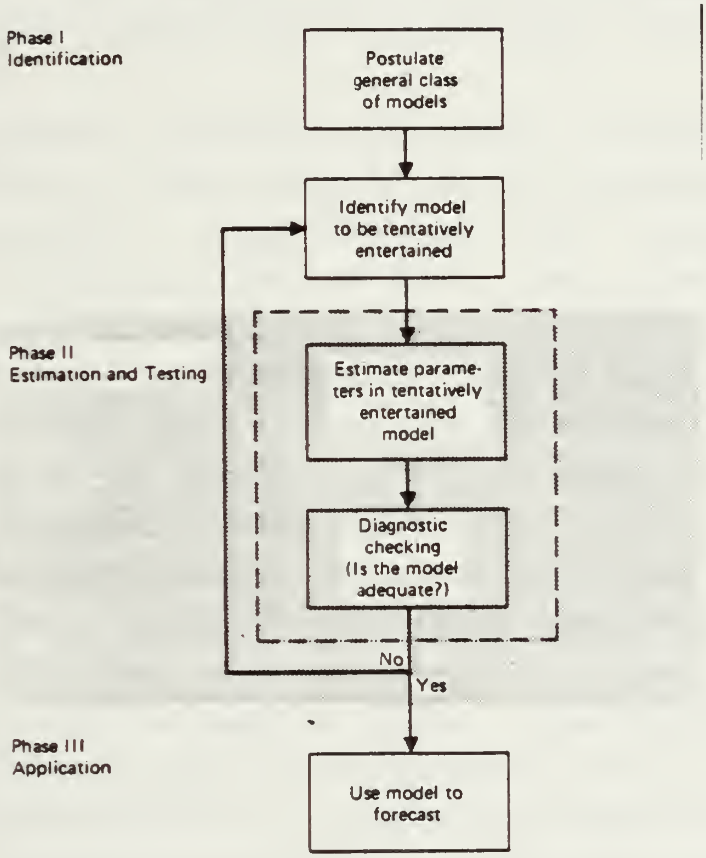
Seasonality, defined as a pattern that repeats itself over a fixed interval must be accounted for in time series analysis. Weather factors such as average temperature, heating degree days, and cooling degree days would be seasonal. Seasonality would be detected in an analysis of ACF by a pattern of high values emerging from one period to the next. Weather would be expected to show a 12 month seasonal pattern. A combination of seasonality and trend growths make autocorrelation patterns difficult to determine. Data must be made stationary before seasonality can be easily determined.

Similar to regression models, time series models use the sum of the squared errors (SS) and MSE in determining how well a curve fits the data. Since data points are 'lost' during differencing and time lag calculations, the effective sample size decreases.

E. TIME SERIES MODELING TECHNIQUES

Autoregressive (AR) models were first introduced in 1926. Moving average (MA) models were later developed in 1937. ARMA models did not begin their evolution until 1938. Since then, extensive work has been done to develop efficient procedures and extend results to include seasonal time series. In 1970, George Box and Gwilym Jenkins introduced a comprehensive method of modeling univariate time series. The Box-Jenkins method has become synonymous with general ARMA processes applied to time series analysis, forecasting, and control. [Ref. 11] A schematic representation of their

approach is shown in Figure 5 The Box-Jenkins method will be the general basis of the methodology to be presented in this section. However, it will be modified somewhat to accommodate effective implementation within operational command levels of DON. Models of electricity use per square foot will be developed for the thirteen samples with a discusssion of results highlighting important concepts and results.



Source: Makridakis, Spyros, and Wheelwright, Steven C., Forecasting: Methods and Applications, p.328 Wiley, 1978

Figure 3.4 Schematic Representation of the Box-Jenkins Approach

1. Phase I: Identification

A specific ARMA model from a general class of ARMA processes is initially selected for computation and evaluation. Selection of a model should normally be based on stationary data, necessitating application of differencing methods prior to model identification. However, some software packages, such as MINITAB, are capable of simultaneous differencing and ARMA processing. The methodology used herein will assume prior or simultaneous differencing.

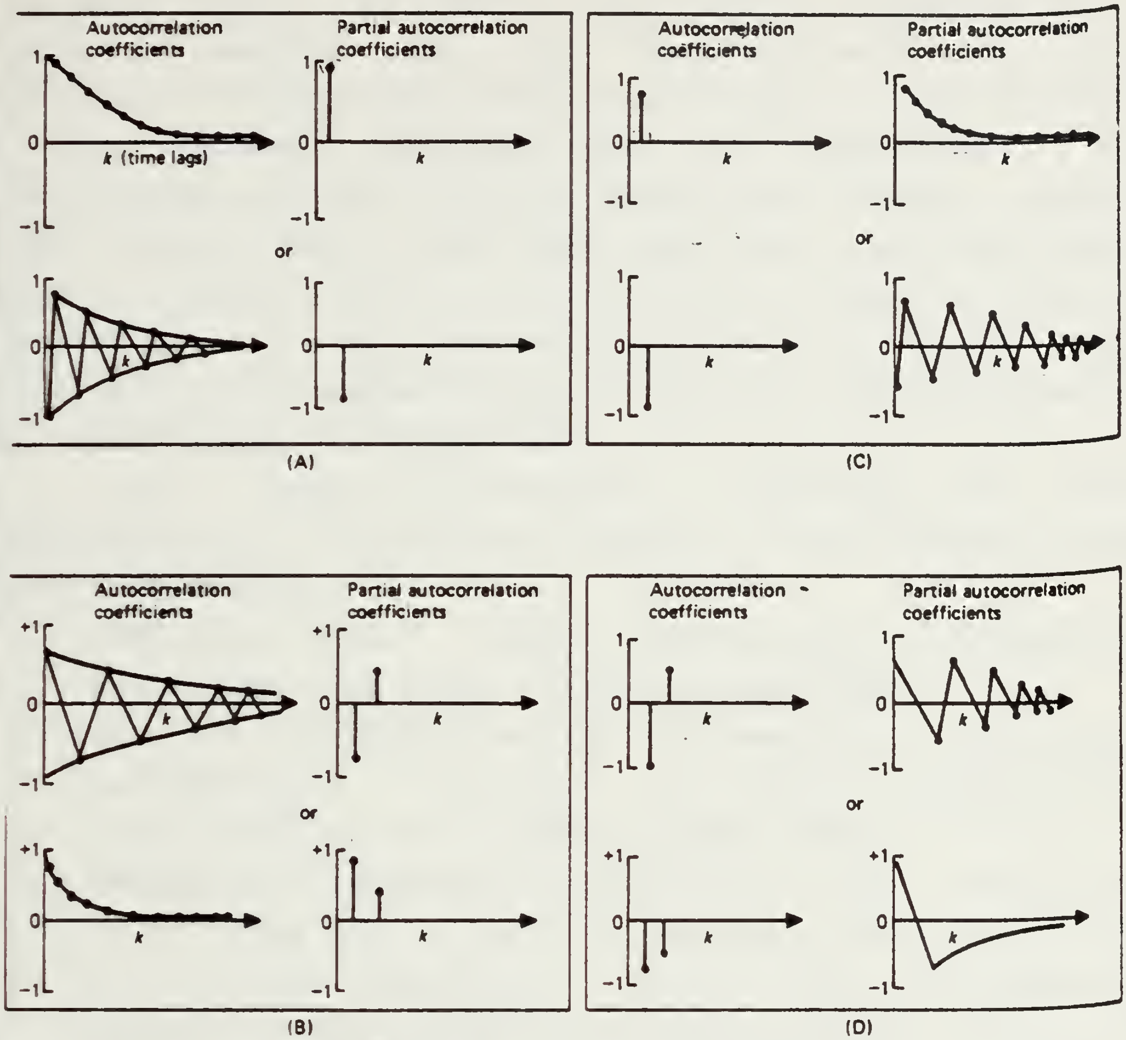
The general notation of a model is AR(p)I(d)MA(q), or simply ARIMA (p d q), where p, d, q represent the orders of autoregressive, differencing, and moving average processes. A similar notation for a model with seasonality considerations will be ARIMA (p d q)(P D Q) S=12, where the upper case letters have identical meaning as the lower case letters except for their application to seasonal orders. S is the length of the seasonal period of time, which will be defined as 12 months in this thesis.

There are various ways to estimate the initial values of orders. Such methods can be time consuming, technical, and laborious. Visual analysis, however, can also be effective and will be applied here. Identifying the order of AR process can be done by examination of the PACF plots. It will be recalled that the PACF is defined as the last significant term of an AR model. A sharp drop from a significant value to a nonsignificant value after p time lags would indicate the order of the AR process. An exponential decay from a high initial magnitude for increasing time lags would indicate an MA process instead. Before making a final first estimate of p, it must be considered that prior

differencing would normally have been done. If not, the nonstationarity effects of the data may also be included. A combination of trend and seasonality may be difficult to separate from the obsrved PACF patterns. Seasonality can be seen in the 12 month recurring pattern in PACF. In the observation of monthly energy use of the total study group, a trend of use can be seen after FY 79. Differencing, usually a first order process, would be necessary. The PACF plot shows 4 significant values before dropping to an insignificant value. A value of p=4 is suggested. A basic premise of the Box-Jenkins approach is that of parsimony, or selection of the least number of parameters. Noting the proximity of the fourth value to the critical $2/\sqrt{n}$ point, or .214, and the possible influences of seasonality and trend would suggest a lower number might be used, say p=2.

An examination of the ACF plot should specify an AR model or indicate the order of the MA process. The behavior of ACF is just the opposite of PACF. An exponential decay for increasing time lags indicate an AR process; a drop to zero after q time lags indicates an MA process of the order of significant points before a drop to zero. Figure 6 demonstrates differences in behavior of particular AR and MA models. The ACF plot for the total study group shows 2 significant values before the high initial magnitude drops to zero. A value of q=2 is indicated.

Using approximately the same reasoning process for the seasonality effects, i.e., values for time lag of about 12, would indicate P=1. It is difficult to separate seasonal trend from normal trend. An initial estimate of D=0, assuming the observed growth is all normal. The seasonal pattern in ACF shows an exponential decay for 12 month lag, and therefore a seasonal AR process is indicated, i.e., Q=0.



The expected behavior of the autocorrelation and partial autocorrelation coefficients of (A) AR(1), (B) AR(2), (C) MA(1), and (D) MA(2) models.

Source: Makradakis, and Wheelwright, *Forecasting: Methods and Aplications*, 1978

Figure 3.5 Autocorrelation and Partial Autocorrelation Functions

The final tentative model then would be ARIMA (2 1 2)(1 0 0) S=12. It must be stressed that this is a

tentative model. It may or may not be accurate for a variety of reasons, such as the existence of a noise level lowering or raising the theoretical values of ACF or PACF, or the unknown variation due to randomness. The identification process is not mechanical; human judgment plays a strong role. The final model for the study group, based on minimum MSE with no significant values of residual ACF was found to be ARIMA (2 1 2)(1 0 1) S=12. The trial-and- error approach required several iterations before the 'best' model was determined.

As a means of providing a guideline for model identification, the following summary of the procedure used above is provided:

1. Review the data. Visual observations of seasonality and trends will assist coming estimations.
2. Obtain a stationary series. If possible, this should be done next. However, if software capabilities allow, this can be included within step 3.
3. Examine the remaining correlations, i.e., those that do not drop off to zero, to determine the order of AR, MA, or ARMA processes. Figure 6 show the expected behavior of ACF and PACF for AR(1), AR(2), MA(1), and MA(2) models that may aid in determination of order.
4. Identify seasonality effects. A repeat of steps 1-4 procedures, looking at the ACF and PACF at the seasonal time intervals. Intervals may not always be exactly 12, allowing for weather variations to compress or expand the actual interval.

2. Phase II: Estimation and Testing

Estimation of parameters, according to the Box-Jenkins approach, is the next step of the process. The coefficients of the underlying mathematical equations would

be specified to give a minimum value of MSE. The parameters would then be entered into the computer for computing diagnostic information. Not all software packages require parameter specification as input, however. MINITAB, for example, requires only an ARIMA specification, such as ARIMA (2 1 2)(1 0 1) S=12, for a seasonal model, or simply ARIMA (2 1 2) if the model is not seasonal. Other software packages, such as IDA, do require parameter specification. Such specification requires a mathematical understanding of the underlying equations of the model which is beyond the scope of this paper, and would be difficult to apply at the operational command level. Thus, it will be assumed here that parameter selection is not required, or that textbooks for the basic level of mathematical theory necessary to estimate the parameters, are available. This will enable a more general presentation of methodology. The simplicity of the methodology is important to any expected application within DOD or DON. The MINITAB software package simplifies the entire approach to model building so that a thorough treatment of the identification process is not even entirely necessary. Arbitrary models can be selected, entered, and computed in a matter of seconds. The penalty for being too arbitrary is that the user loses direction. An improper initial model selection resulted in misdirection several times during the development of the models for these samples.

Diagnostic checking of the estimated model is based on two checkpoints. The first check is to see whether the ACF of residuals exhibit randomness, i.e., 95% of the ACF points should lie within 2 standard deviations of the mean. The second check is that MSE is minimal. The rigidity in applying these criteria is similar to that discussed for regression models. The existence of one or two points

outside the confidence limits may be unacceptable in view of the effort required to modify the model. The magnitude of MSE may be small enough that a change in MSE by a more complex model would be of little consequence, or the relative ease of improving the ARIMA model for even a slight improvement might justify additional complexity.

In fitting the models for the samples of this study, three models were chosen for illustrative inclusion in Part D of Appendices A-M. The first model attempted may or may not have been the model indicated during the identification phase. A second model is shown for comparative purposes as attempts to improve the ACF pattern and MSE magnitude were made. The final model shown was used to forecast.

NRMC Jacksonville can be used as an illustration. An initial model was developed on observations from ACF/PACF plots that, (1) PACF dropped to 0 after 1 time lag, (2) ACF fell to zero after 3 time lags, (3) visual survey of MBTU/SF showed nonstationarity, (4) seasonal PACF did not drop to 0 until after two seasonal time lags, (5) ACF showed some trend, and (6) ACF fell to 0 after 1 time lag. Thus an initial model of ARIMA (1 1 3)(1 1 2) S=12 was attempted. Only one ACF point was significant; an MSE of 11.518 was determined. Simplifying the model to an ARIMA (1 1 2)(1 1 1) S=12 only decreased the significance of the first point and increased an insignificant point to significance. MSE increased to 12.063. At this point, either model would be acceptable, although the second model would be preferable. The second model suggests that a seasonal adjustment might improve the model, since the significant points were at t-24, and t-37. The model ARIMA (1 1 3)(1 0 2) S=12 did improve the ACF pattern and had an MSE of 11.121. It was accordingly determined as the 'best' model for forecasting at that activity.

3. <u>Phase III: Forecasting</u>

The summary statistics for the NRMC Jacksonville ARIMA (1 1 3)(1 0 2) S=12 model display a 12 month forecast of electricity use (FY 82). The forecast, based on the historical patterns and trends of use at NRMC Jacksonville is its expected electricity use in FY 82. The fitted model and forecasted values are shown in Part F of Appendices A-M. The resultant curve is really not much easier to visually interpret than the initial electricity use curves, except that forecasted FY 82 values have been added. An imposed plot of actual FY 82 use and/or baseline use might afford a useful and easy means for comparing actual FY 82 use.

Since the basic intent of energy measurement is to compare change from the baseline, it would be useful to interpret the model results in this same light. With the fitted model values still in the computer memory bank, it is fairly simple to regress the fitted values against time to develop a curve of trend. This provides a very clear interpretation of the time model affording calculations of percentages of change anywhere along the curve.

Part E of Appendices A-M provide a statistical summary of such a regression. The value of these statistics is minimal relative to the normal information given by regression. Normal interpretation of R^2 and MSE are relatively meaningless in this application. But the curve does represent the best fit of a straight line through the fitted data points giving the trend of forecasted use. The trend line is shown in Part F of these Appendices.

A composite curve of actual use, fitted model, and trend of use is shown in Part G. The fitted curve of expected values provides a benchmark for comparison of actual use. The May 1978 spike in energy use previously discussed could now be more effectively evaluated. The

model curve indicates expected use. In fact, a fairly large increase from April would have been expected. The magnitude of the difference between expected and actual use be a potential target of investigation.

The FY 82 forecast has been drawn with 95% confidence limits, calling attention to the fact that the model curve is an expected value estimate of a 'true' function. There will be allowances for error. A confidence interval around the entire fitted curve of the model could have also been plotted. However, the loss of clarity resulting from the extra lines would not be justifiable. The forecast interval will have contol system applications to be discussed in Chapter V.

A numerical summary of actual use, model forecasts, and trend projections for each sample is provided as Appendix N. At the end of each activity summary is a comparison of particular use with the baseline. The first column is the actual use reported and resultant change. The FY 81 target was -12%. The second column shows the forecast values for FY 81 and FY 82 with the percent change from FY 75. The final column is similar to column 2 but is based on trend comparisons. For the study group, for example, a 9.3% increase was forecasted for FY 81 by the time series model. A 10.3% increase was actually reported. However, the trend of use, 10.8% might at least indicate the rate of growth from FY 75 had slowed. There are numerous applications of these results, such as relative comparisons with other activities, comparison of activities in a particular weather zone, comparisons by size, patient occupancy, or facility age, that could be meaningful to an evaluator. An extension of trend identification could be to use different origins. For example, NRMC Orlando showed a greater trend of increase after FY 79. Such trend would have been averaged out over

the FY 75 - FY 82 data period. Regression of model values against time from FY 79 would show the trend of use from FY 79. The effects of a particular event, such as facility expansion or technological innovation, could then be isolated for meaningful evaluation.

IV. USE CATEGORY MODELS OF ELECTRICITY USE

Models of electricity use by category codes using regression techniques will be examined in this chapter. The development of coefficients of use for various categories of use, and their application in a modular baselines, will be demonstrated. The average monthly electricity use and buildings relating to that use for FY 75 for the 12 NRMC sample will be the basis of this study.

The previously discussed problems of changing missions, growth of electronic technology, and the corresponding building use changes to accommodate such changes serve to confuse, if not distort, the basis of energy reduction comparisons. If the purpose of measuring electricity use on a per square foot basis is only to prorate energy use for different size bases, it would seem unreasonable then, in light of the technological growth, to expect a 20% reduction by FY 85. If, on the other hand, the goal of measurement is to effect an increased efficiency of use, there must be a means of making allowances for the changes in mission and building uses.

Conversion of a low energy intensity warehouse for installation of a greater energy intensive aviation trainer was discussed in Chapter II as a distortion of meaningful energy usage comparisons. Capital improvements for insulation, lighting, etc., may have been highly effective in raising the energy efficiency of the warehouse. However, the trainer equipment installation would probably dominate use such that the total energy use would be increased. The value of comparing the energy efficiency progress has been lost.

In other cases, building use has been downgraded as more modern, accommodating facilities have been constructed. Rather than demolish an inherently energy inefficient building, a common tactic is to use the building for a different purpose, such as office space, warehouse/storage space, or recreational space. The selection of these particular uses is common inasmuch as priority of limited construction funds is usually lower than mission essential project funding. As a result, there is usually a backlog of such projects awaiting funding. Vacated buildings easily become a target for innovative, resourceful managers to ease particular requirements. In fact, this may be a very practical action with large benefits to morale. The effect on energy use comparisons is less beneficial. The new facility may have much greater energy efficiency. The activity's overall use per square foot may improve. The converted facility may also have a lower energy use per square foot but not necessarily as a a result of any efficiency improvements, though. As would be noted by TEM advocates, energy would be wasted by the building's inefficiency even though end use would have decreased.

Only if a building's functional use remained generally constant during the period of comparison can any valid conclusions be made at present. The problem is in providing a basis of comparison when changes have occurred. A means of effecting relatively simple changes in the baseline to reflect the changed uses would be useful.

A modular construction of the baseline would offer such a means of adjustment. In the case of the warehouse-to-trainer conversion, a standard use value for warehouses could be deducted from the baseline use, and be replaced by a standard use value for a trainer facility.

An example of the opposite effect would be the conversion of a World War II vintage Butler building from an industrial shops area to a recreation center. The conversion might have taken place as the result of a new Public Works facility which had expanded to meet an increased activity mission. The Butler building with its characteristic thin, sheet metal outer walls and concrete floors would be highly energy inefficient. The replacement of the industrial equipment with recreational equipment would certainly lower the energy use. Adjustment of the baseline by replacing an FY 75 standard industrial use with a personnel support use standard would allow a valid comparison of the change. At present, however, the energy baselines are fairly rigid and rarely adjusted.

A. DATA CONSIDERATIONS

The data necessary to support a development of such standard uses is not readily available at present. The NAVFAC P-164, Detailed Inventory of Naval Shore Activities, was examined as a possible source of data. The P-164 lists all the buildings at every location throughout the Naval Shore Establishment by category code, year of construction, floor area, dimensions, cost data, and various other details of inventory data. Changes, such as would occur by new construction of facilities, alterations, demolititons, or redesignated uses, are required to be done on a timely basis. However, this reporting function generally has low activity priority. Reviews are sporadic; submissions may be several years out of date.

Activities were originally tasked with developing their own baseline areas. Then, any changes to be made were requested via official channels. It is therefore difficult to reconstruct the baseline anywhere beyond the activity

level. The areas actually shown in the P-164 may be assigned to a particular station, but its energy use accountable tc another commannd. Thus, identifying a building's existence in FY 75 by the P-164 does not necessarily mean that it has been included in the baseline area of the plant property record holder. Family housing, for example, is listed on the plant property records of the applicable activities but energy use is reported to the Housing Management Centers.

The functional use of a building or area within a building is identified in the P-164 by a 5 digit use code. Such a code is not necessarily related to its energy use. For example, 610 as the first three digits of the category code identifies an administrative use. 610-10 further identifies office spaces, while 610-20 identifies data processing centers-two very different types of energy use. Living spaces are broken down between categories of officer (724) and enlisted (721). Further distinction is made by paygrade groups, such as E1-E4 (724-11) and O3 and above (724-12). The differences in these category codes reflect only construction criteria, although energy use characteristics would be similar. In the NRMC sample there were over 80 significant category codes that would be considered as contributors to energy use. It was felt that a grouping by category codes of energy use characteristics vice functional use code would thus be more feasible. The degree of refinement within the groupings would be a matter of practicality. Subcategories of use by construction type and/or year would be specific possibilities.

Thus, P-164 data alone is insufficient to develop accurate area baselines because of its lack of timeliness and lack of energy reporting detail. The P-164 is the most complete and widely available data source available and was

thus used for purposes of this study. A more refined data base would be needed to provide the accuracy desired in an actual application.

B. METHODOLOGY

The general approach taken was to test whether average monthly electricity use (MBTU) could be forecast as a function of the component areas for types of functional uses of total floor space. The derived coefficients of a regression model used for such a forecast being in units of MBTU/SF, suggest that the coefficients will be an average, or expected value, of use for the selected categories. Interpretation of the coefficients as standard values would then have useful applications where the energy use of particular areas are being evaluated.

The selection of the categories of functional use would be made relative to the information desired. It must be recognized that the coefficients of a regression model are relative to the applied context. The coefficients may change as variables, i.e., categories of use, are added or deleted, or input data is changed. Thus, the value of a derived coefficient will depend on the input data and what other variables are present. The implications of this recognition limit use to a particular time frame, to a particular activity, or to a particular group of activities, dependent upon the context of application.

The average monthly electricity use in FY 75 was selected as the dependent variable to enable a determination of standards of use in the baseline year. This meant use of only 12 data points for the total sample group. The consequence of the small sample size was that the corresponding 12 degrees of freedom allowed a maximum of only ten use categories, allowing 2 degrees of freedom for statistical results.

The sample was accordingly sorted into ten major energy use categories using the following categories and criteria:

1. Mission. Hospital space, as a large portion of the baseline area, would be of major interest.
2. Labs. Outpatient clinics, dental clinics, as well as designated lab areas for which specialized equipment would be required. Full time occupancy would not be expected.
3. Personnel Living Spaces. Unaccompanied officer/enlisted personnel housing (UOPH/UEPH), regardless of paygrade of occupants, and temporary living facilities.
4. Maintenance/Industrial. Shops areas, including vehicle maintenance shops, utilizing a higher energy use per square foot by virtue of machinery and installed equipment.
5. Data Processing Centers.
6. Administrative. Offices, family services centers, and other areas providing spaces for performance of managerial, clerical and counseling functions.
7. Commercial Areas. Areas which involve commercial sales and support such as the various functions of the Navy Exchanges (barber/beauty shops, snack bars, retail stores) which would entail various operating hours and medium energy intensive equipment.
8. Morale and Welfare-Community Services. Areas which would have relatively few hours of use by groups of personnel, such as chapels, theaters, and child care centers, but would not not involve unusual equipment support.
9. Morale and Welfare-Recreation. Bowling alleys, gymnasiums, and hobby centers which would have more regular hours of occupancy and would require some specialized equipment support.

10. Storage. Areas in which minimal equipment installation, low personnel occupancy, and minimum heating/cooling standards would be maintained continually. Subcategorization to reflect differences in temperature standards for storage of equipment vice medical supplies would be suggested.

The results of the 'full' 10 variable model are shown in Table 3 These results indicated that the standard use for a hospital space was only .0003 MBTU/SF. The t-tests, in fact, showed no significance in any of the individual variables. It was concluded, by use of the F test, that all coefficients were insignificant. The very high R^2 value of .998 would be expected from the use of 10 variables and only 12 observations.

A stepwise regression was then attempted. It was determined that a three variable model using hospital space, storage, and maintenance/industrial categories would provide significant values for the resultant coefficients. Test results are shown in Table 4 The R^2 value was still reasonable at .908.

C. RESULTS

The results of this attempt to demonstrate model use for this sample were inconclusive overall. The full model was unable to provide any significant coefficients. The 'best' model, i.e., one which provided significant coefficients, could provide values for only three coefficients. These coefficients would only be relevant in the presence of the other two variables. That is, the standard use for the three categories could not be concluded to be the values seen, with the other categories assumed to be zero. One explanation is that the data base was too small to support a test for 10 categories of use; a smaller number of groupings

TABLE III

Regression Results of the 'Full' Model

THE REGRESSION EQUATION IS

```
  Y =    8990. + 0.0003  X1   + 0.0901 X2
                -0.0356  X3   + 0.216  X4  -  1.32   X5
               - 0.144   X6   + 0.0449 X7  - 0.0025  X8
               + 0.211   X9   + 0.0298 X10
```

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	CONSTANT	8990	9690	0.93
X1	HOSPITAL	0.00031	0.04396	0.01
X2	LABS	0.09014	0.04366	2.06
X3	LIVING SPACES	-0.03563	0.04725	-0.75
X4	MAINT/INDUSTR	0.2158	0.6162	0.35
X5	DATA PROC CTR	-1.323	1.837	-0.72
X6	ADMINISTRATIVE	-0.1441	0.2928	-0.49
X7	COMMERCIAL	0.0449	0.3709	0.12
X8	MW-COMMUNITY	-0.0025	0.3504	-0.01
X9	MW-RECREATION	0.2110	0.1116	1.89
X10	STORAGE	0.0298	0.1316	0.23

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 765.2
WITH (12-11) = 1 DEGREES OF FREEDOM

R-SQUARED = 99.8 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	10	236632633	23663253
RESIDUAL	1	585594	585594
TOTAL	11	237218284	

might yield better results. However, it was felt that further generalization of the groupings would have seriously detracted from the desired results. The derived coefficients would have been more general than practical.

Although the results were inconclusive, there is reason to believe that the proposed method merits further consideration. The results suggest that coefficients of use based on energy use categories could be developed by regression techniques. The apparent limits imposed by the size of the

TABLE IV

Reduced Three Variable Model

```
THE REGRESSION EQUATION IS
    Y =  2136  +0.0360 X1  -0.161 X2  +0.151 X3

                                        ST. DEV.   T-RATIO =
       COLUMN       COEFFICIENT         OF COEF.   COEF/S.D.
       CONSTANT          2136             1471        1.45
X1     HOSPITAL        0.036023         0.006079      5.93
X2     LABS           -0.16076          0.03600      -4.47
X3     MW-RECREATION   0.15069          0.05448       2.77

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S =  1652
WITH (  12- 4) =   8 DEGREES OF FREEDOM

R-SQUARED = 90.8 PERCENT

ANALYSIS OF VARIANCE
 DUE TO        DF          SS          MS=SS/DF
REGRESSION      3      215389442       71796474
RESIDUAL        8       21829185        2728646
TOTAL          11      237218666
```

data sample might impose certain limits. Although this study was limited to particular NRMCs, in an expansion of this method, coefficients of use for the general categories of storage, maintenance, commercial, etc., could be studied for a large sample.

The issue of accuracy can not be overlooked. The data base used in this study was recognized to be susceptible to various errors. Refinement of a data base for application to a large sample would be challenging. However, it must also be considered that even 'ball park' values might be of value. 'Standards of use', with only minimal accuracy, would still permit implementation of modular adjustments to baselines, or to any other comparison years. The basis of comparisons would be improved to at least some degree. It

is thus felt that the modular concept of adjustment and the use of regression models to develop standards of use warrants further consideration.

V. SUMMARY AND CONCLUSIONS

Energy reduction is a very significant and necessary goal in today's environment. The cost of energy has risen from a relatively insignificant level to one of major consideration. The era of cheap energy has resulted in a multitude of energy inefficient buildings that will require varying degrees of modifications.

The trend of rapidly rising costs will keep a strong focus on economizing energy use. The Arab oil embargo of 1973 not only touched off an era of spiralling energy costs, but brought about a realization of the serious consequences of our strong dependence on oil. The vulnerability of national security and the economy to supply and price manipulations were clearly demonstrated by the actions of the OPEC cartel.

Government policies and actions along with the normal market forces of supply and demand interactions would be expected to expand domestic oil supplies. These initiatives have also forced corporate and private energy users to examine the large amounts of energy being used, and wasted, as well as to search for alternate energy sources. Executive Order 12003 was issued to force the federal government-the largest single energy user-to reduce its energy use. It established the federal energy goals at a 20% reduction from FY 75 to FY 85, and a 35% reduction by FY 2000. The goals appear ominous in view of the failure to achieve yearly target levels though FY 81. A greater level of capital investment will be needed just to meet the 2% per year expected rate of reduction, and an even greater rate of investment to achieve the FY 85 overall goal. With the

limited availability of capital investment funds, effectiveness of investment becomes a vital issue. It is an issue which requires a full recognition of how energy is being used, identification of areas of greatest reduction potential, and the cost effectiveness of implementation actions.

This thesis questioned the ability of the present Defense Energy Information System (DEIS II) to provide the necessary valid comparisons of energy use as a means of identifying targets of reduction potential and evaluating the effectiveness of corrective actions. Distortions caused by noncontrollable factors, such as weather, and the particular functional uses and changes in use of buildings were shown to impair the ability of a decisionmaker to correctly evaluate reported energy uses. Electricity use at 12 Naval Regional Medical Centers was specifically studied. Regression and time series methodologies were demonstrated as means of improving the effectiveness of evaluating energy uses.

Regression models were shown to be a means of explaining a system output by means of particular stimuli, or predictor, variables. The techniques of selecting variables, evaluating the appropriateness of the stimuli, and interpreting the results were applied to weather effects on energy use. Weather factors of average temperature, heating degree days, cooling degree days, and precipitation (rainfall equivalent) were specifically studied. While weather would not be a good sole predictor of electricity use, the relative significance of various factors could be studied. Knowing the effects of weather on electricity use would in turn allow the decisionmaker to assess action to minimize such effects. Cooling degree days was seen to have a strong relative impact on energy use. Identifying this

factor and the relative magnitude of its effects would suggest certain actions to a decisionmaker. Load balancing, increased insulation, and/or use restrictions might be accordingly evaluated for implementation. A comparison of a similar regression model after implementation of corrective action would provide a further means of evaluation.

In an expanded model, weather variables would be only one type of variable. Hours of occupancy, ages of the buildings, air conditioning capacity, etc., might be other variables of interest. The results of the expanded model would be beneficial in further evaluation of system interrelationships, and relative significance among selected variables.

Time series models were shown to be a less technically oriented method of forecasting. This type of model uses historical patterns and trends in forecasting expected system outputs. Plots of the four previously cited weather factors were seen to have variations in expected levels. Of particular concern was the higher average temperatures and corresponding decrease in heating degree days experienced at most of the 12 activities during the winter months of the baseline year. Under the DEIS II system, the various effects of differing weather conditions are also being measured in the percentage of change calculations. Weather would be only one of several possible influences that could be reflected in such energy use comparisons. The time series model, in forecasting expected values, provides a more standardized basis of comparison.

The forecasts of expected values facilitate identification of variations. Comparison of a current use with an expected value, or expected value adjusted to a reduction target, might show a large variation which should be investigated promptly for corrective action. The present

system, with its potential of distortion, would only show a relative change rather than a variation from expected value. The decisionmaker can not readily assess the impact of unusual conditions on the observed change, nor assess whether a favorable change was in fact favorable. Similarly, an unfavorable variation might not be identified for a period of time due to particular conditions resulting in a lower energy use, thereby missing an opportunity for reduction.

Regression was further applied to a time series model to develop a linear trend of use. This method would allow an identification of a long term average rate of change. Although the trend of use between FY 75 through FY 82 projections was developed, the method is applicable over any time period, or from any reference point.

The results of the time series forecasts and trend projections for FY 81 are compared to actual reported uses in Table 5 It can be seen that the forecasted uses and actual uses are relatively close. The forecasted values, however, have been shown to be less subject to distortion and a more reasonable basis of comparison. Comparisons within Table 5 give a more appreciable picture of progress in meeting an established target. For example, NRMC Corpus Christi reported a 1.2% reduction from FY 75 use. Its expected use would have shown a 0.6% decrease. Thus, the activity showed a favorable variation from expected use of 0.6%. Comparison of reported results with a 1.0% trend of increase shows a 2.2% favorable variation from the long term trend of use. A similar comparison for NRMC Orlando shows a 15% unfavorable variation from expected FY 81 use, and almost no difference from the trend of increase. Comparisons can be made at the activity level or at a higher echelon of command. The total group, as might be viewed by

its major claimant, showed a 1% unfavorable variation from expected use but a 0.5% favorable variation from trend. Since these comparisons are less influenced by unusual variations of operations, weather, etc., they provide a more standard basis of comparison.

A final regression model was attempted to explain average monthly electricity use by the functional categories of use for building areas. The categories of functional use were established by identifying particular electricity use characteristics. The coefficients of the proposed model, in units of MBTU/KSF, can be interpreted as a standard of use for its corresponding category variable. It was shown that changes in a building use, or uses of areas within a building, would alter the normal energy use per square foot, thus distorting further comparison to the baseline year. By means of a modular concept of the baseline, the baseline could be adjusted by replacement of a standard use of the former designation with a standard use value of the new designation. The results of a ten variable (energy category) model were found to be inconclusive by virtue of the insignificance of the coefficients. The small size of the data base was inadequate to support the development of the necessary ten significant coefficients. The data base was capable of explaining use by three significant predictors, however. Concern for the accuracy of the data, which was based on often outdated, inaccurate property record submissions, was expressed. Further consideration of the model and modular baseline concept was felt to be justifiable, however, on the basis that even a small improvement of the present system by use of 'ball park' estimates would be useful.

The proposed methods of energy use models all have applications, either individually or in combination, in

TABLE V

Comparison of Forecasted and Reported Electricity Use

NRMC	FY 75* ACTUAL	FY 81 ACTUAL	FY 81 TIME SERIES	FY 81 TREND
Camp Lejeune	106.7	125.0 (17.2%)	126.8 (18.9%)	131.4 (23.2%)
Charleston	296.7	279.9 (-5.7%)	279.5 (-5.8%)	272.5 (-8.2%)
Corpus Christi	421.8	416.8 (-1.2%)	419.3 (-0.6%)	425.9 (1.0%)
Great Lakes	113.1	137.7 (21.7%)	133.7 (18.1%)	138.5 (22.4%)
Jacksonville	310.2	261.0 (-15.9%)	267.7 (-13.7%)	260.0 (-16.2%)
Long Beach	474.9	428.1 (-9.8%)	421.0 (-11.3%)	415.0 (-12.6%)
Memphis	277.3	384.7 (38.8%)	380.4 (37.2%)	389.0 (40.3%)
Oakland	192.8	231.7 (20.2%)	237.3 (23.1%)	241.1 (25.1%)
Orlando	243.6	445.7 (83.0%)	409.8 (68.2%)	409.9 (68.3%)
Philadelphia	125.7	121.8 (-3.1%)	126.6 (0.7%)	129.5 (3.0%)
Portsmouth	206.8	207.6 (0.4%)	211.0 (2.0%)	217.2 (5.0%)
San Diego	124.7	136.4 (9.4%)	133.8 (7.3%)	133.8 (7.4%)
Study Group	192.2	212.0 (10.3%)	210.1 (9.3%)	213.0 (10.8%)

*Electricity use in MBTU/KSF

developing an energy use control system. In general, there is no real control system within DEIS II. Targets are established by end-use restrictions based on on FY 75 use. Baseline use, susceptible to the various influences of the

conditions at that time, may not be a valid comparison for uses without those similar influences. Variation, if identified, may actually not be variation at all; if unidentified, the causes of unfavorable variation may go uncorrected for undesirable lengths of time.

Regression models using explanatory variables such as connected load factors and weather would be used to forecast expected use. A comparison of expected use with target use would indicate a degree of desired change. Analysis of the coefficients of the model would suggest opportunities for achieving desired reductions. Comparison of actual use with forecasted expected use would identify variation that should be investigated for corrective action.

Time series models would be of similar use in a control system. Targets could be developed for expected use. A comparison of actual use with target use would also identify variation for possible investigation. A particular advantage of the time series model is its ability to forecast use over a period of time. An imposed plot of actual use provides an easy, visual means of display. In contrast, regression models dependent on observed inputs such as weather would be less convenient. Expected values would require individual calculation before a plot comparison with actual use could be made. The application of regression techniques to a time series model to develop a trend of use provides a further means of useful comparison.

Application of reduction targets to the forecasts of use would be a means of establishing control targets. In Table 5, for example, a control target of a 5% reduction in expected FY 81 electricity use might have been established. Variation from that level could be used in identification of possible investigation. Similar application of targets to trend of use forecasts could be made.

A regression model based on categories of use provides at least a potential for a control system. Comparison of actual use per square foot with a standard of use would be useful in identifying the energy efficiency of a building. This method, however, would require a great deal of effort to implement. Measurement of actual use in itself is a current problem with the necessity for submetering. Meters to provide such measurement are not in general use, at least not yet, within the shore establishment. However, the cost effectiveness of such meter uses has increased rapidly and should be in greater use in the near future.

The refinement of data necessary to develop accurate standards of use would be a further obstacle to implementation of this type of model. The use of 'ball park' estimates could be of limited application in modular adjustments to the baseline. It is not known whether engineering estimates could provide more accurate or more cost effective standards.

The choice of models would depend upon the decisionmaker's needs and capabilities. Regression models of technical factors would appear to be of greatest benefit to engineering staffs such as the NAVFAC Engineering Field Divisions. Such models would provide the technical information needed to evaluate the value of particular projects. Their technical review function for ECIP and ETAP projects could be facilitated by such models. Their access to a broad range of data would be beneficial to development of the models. The variety of technical expertise readily available would also be significant in developing and applying such models.

Time series models would appear to represent the greatest general value to an activity or upper echelon command for forecasting energy use for budget purposes as

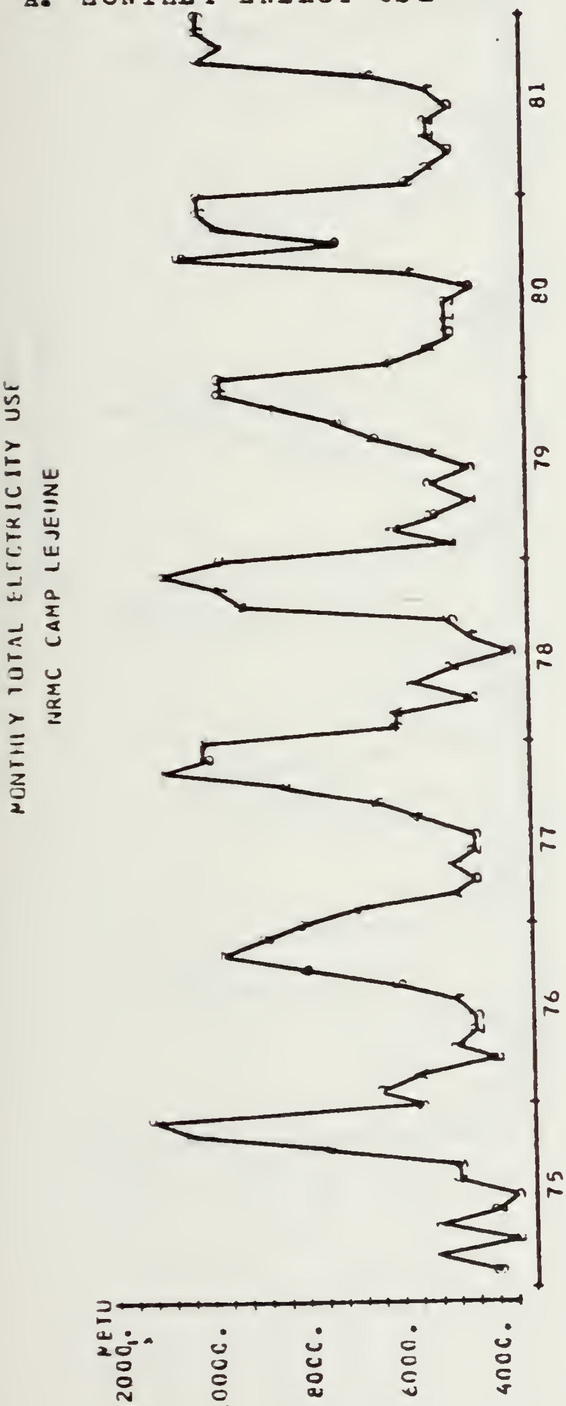
well as for control systems. Models could be developed for, or by, bases depending on the availability of computers and appropriate software.

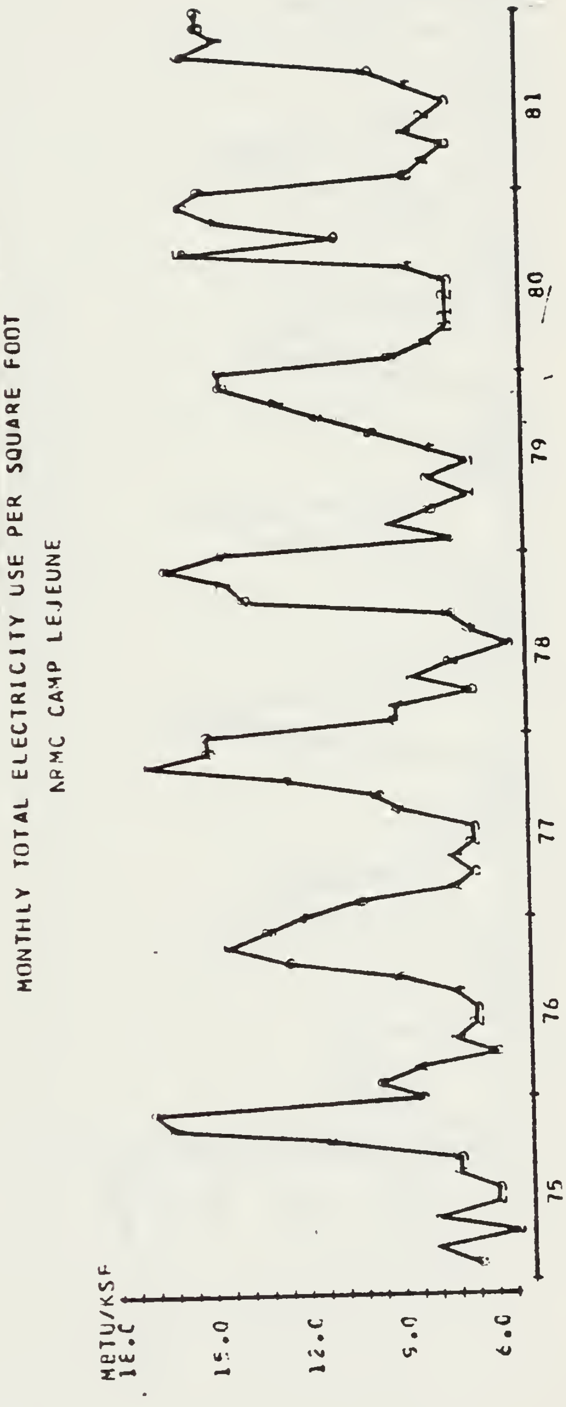
It is highly recommended that the implementation of energy use models be pursued within the energy management program of the Naval Shore establishment. Energy use models have been shown to be valuable tools in the measurement and evaluation phases of DEIS II.

APPENDIX A

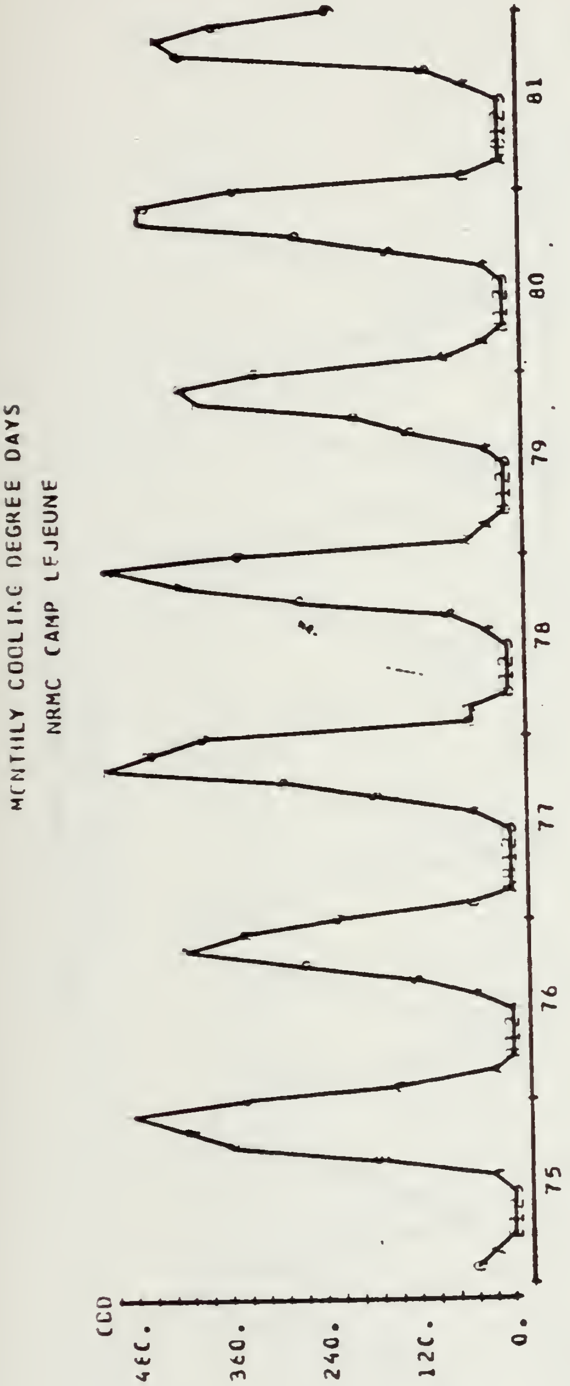
NRMC CAMP LEJEUNE

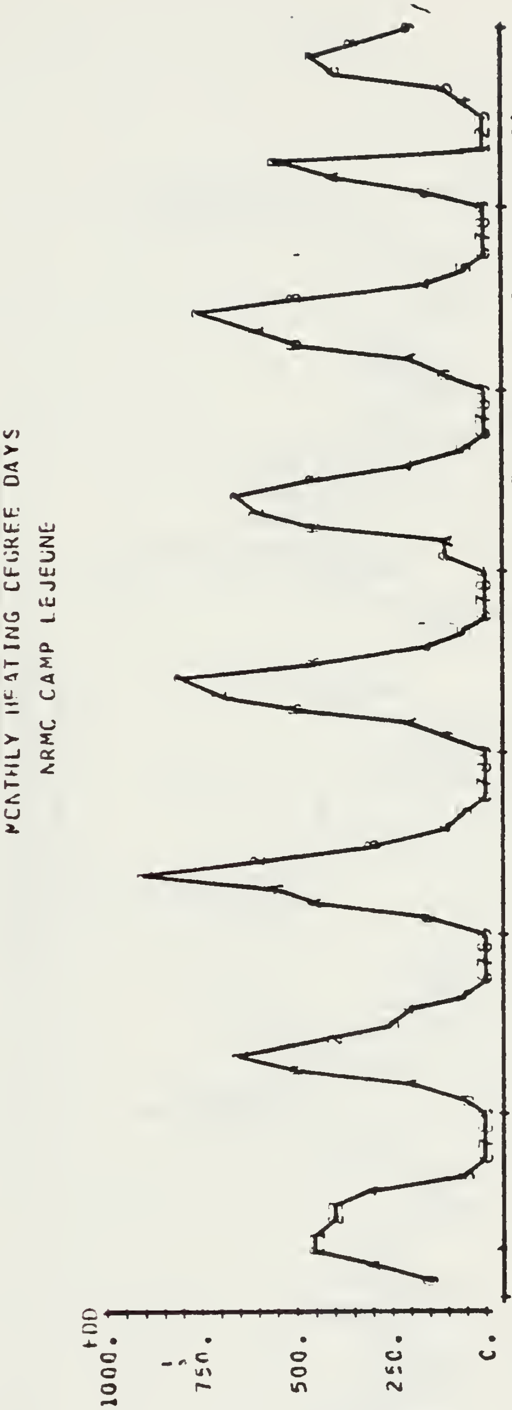
A. MONTHLY ENERGY USE

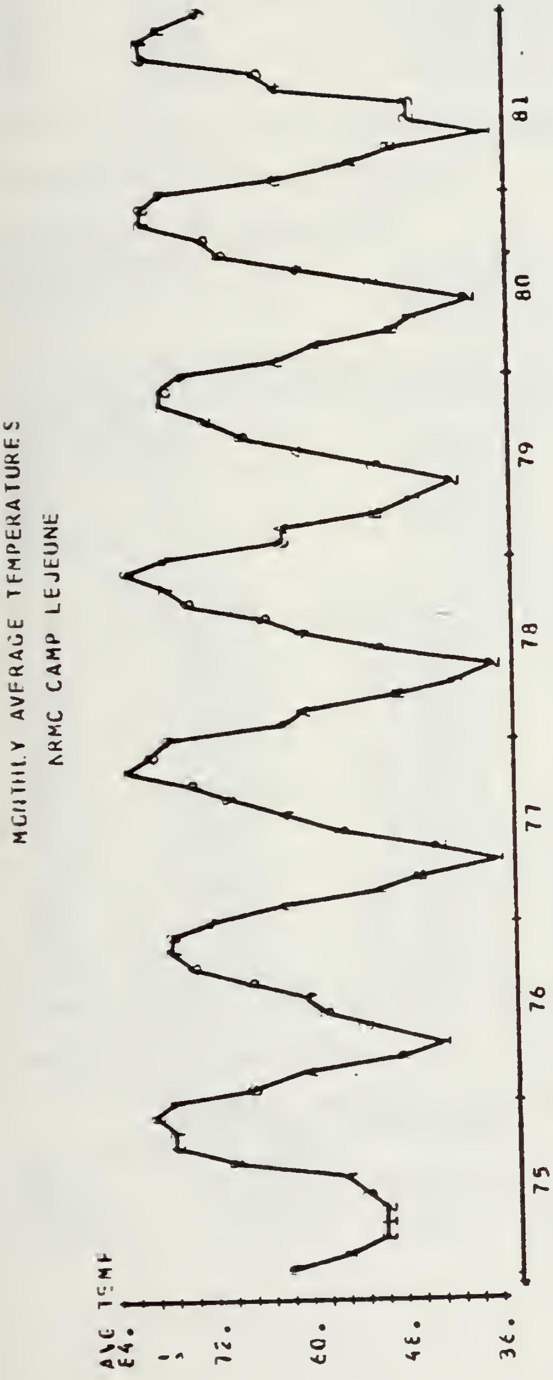


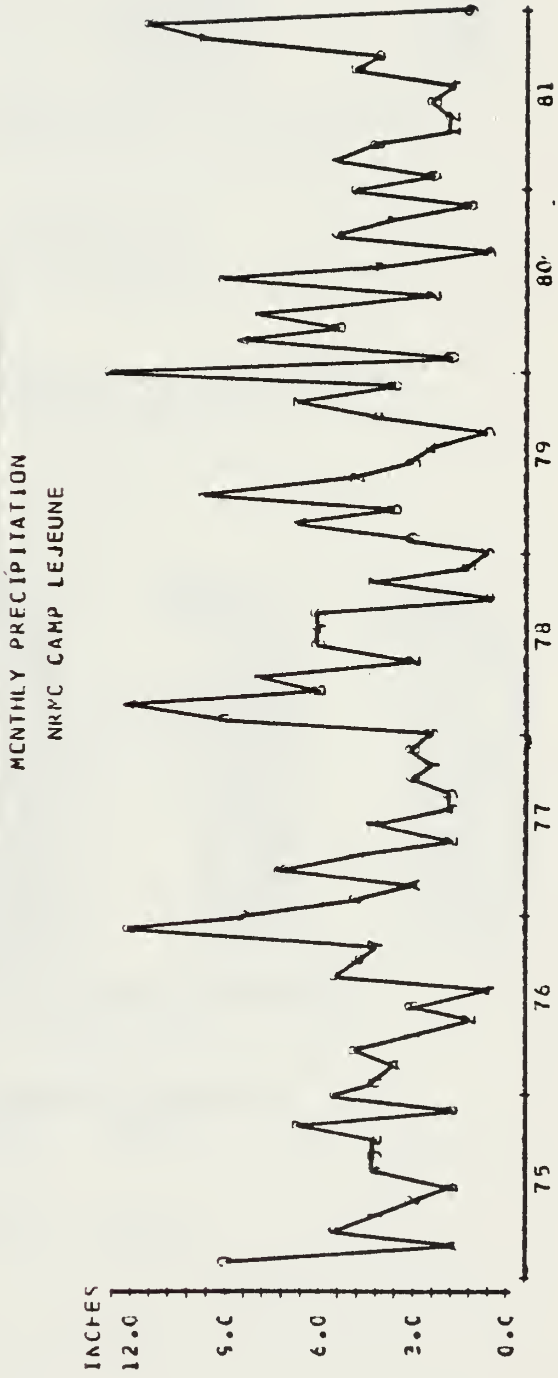


B. MONTHLY WEATHER SUMMARY






MONTHLY AVERAGE TEMPERATURES
NRMC CAMP LEJEUNE
AVG TEMP
84.
72.
60.
48.
36.
75
76
77
78
79
80
81


MONTHLY PRECIPITATION
NRMC CAMP LEJEUNE
INCHES
12.0
9.0
6.0
3.0
0.0
75
76
77
78
79
80
81

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC CAMP LEJEUNE IS:
Y = 6.48 +0.0160 X1 +0.0001 X2 +0.0080 X3 -0.0596 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	6.478	2.055	3.15
X1	AVG TEMP	0.01604	0.03490	0.46
X2	HDD	0.000089	0.001070	0.08
X3	CDD	0.017817	0.002059	8.65
X4	PRECIP	-0.03843	0.05353	-0.72

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 1.316

R-SQUARED = 86.0 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	837.488	209.372
RESIDUAL	79	136.851	1.732
TOTAL	83	974.339	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	837.488
AVG TEMP	1	679.814
HDD	1	21.197
CDD	1	135.585
PRECIP	1	0.893

ROW	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
8	69.1	7.223	10.284	0.212	-2.36R
12	76.2	8.647	13.647	0.236	-3.86R
23	75.9	13.252	13.374	0.464	-0.10 X
28	35.8	7.170	6.958	0.478	0.17 X
41	35.7	7.012	7.014	0.460	-0.00 X
60	75.2	14.342	12.770	0.503	1.29 X
68	68.6	15.520	10.274	0.282	4.08R
76	36.2	8.155	6.992	0.847	1.15 X
77	46.1	7.752	7.141	0.546	0.51 X
78	45.4	7.153	7.134	0.566	0.02 X
81	78.3	15.432	14.854	0.483	0.47 X
82	78.6	14.694	15.062	0.511	-0.30 X
83	76.5	15.185	13.733	0.486	1.19 X
84	71.5	15.185	11.478	0.337	2.91R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.75

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.835			
HDD	-0.557	-0.778		
CDD	0.926	0.891	-0.584	
PRECIP	-0.026	0.023	0.132	0.003

D. DEVELOPING A TIME SERIES MODEL

```
   ACF OF MBTU/KSF      NRMC CAMP LEJEUNE

            -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
             +----+----+----+----+----+----+----+----+----
  1    0.682                     XXXXXXXXXXXXXXXXXX
  2    0.349                     XXXXXXXXXX
  3   -0.029                   XX
  4   -0.335            XXXXXXXXX
  5   -0.508        XXXXXXXXXXXXXX
  6   -0.574       XXXXXXXXXXXXXXX
  7   -0.515        XXXXXXXXXXXXXX
  8   -0.376            XXXXXXXXXX
  9   -0.084                  XXX
 10    0.243                     XXXXXXX
 11    0.577                     XXXXXXXXXXXXXXX
 12    0.721                     XXXXXXXXXXXXXXXXXXX
 13    0.590                     XXXXXXXXXXXXXXXX
 14    0.305                     XXXXXXXXX
 15   -0.033                   XX
 16   -0.293              XXXXXXXX
 17   -0.441          XXXXXXXXXXXX
 18   -0.487         XXXXXXXXXXXXX
 19   -0.459          XXXXXXXXXXXX
 20   -0.283              XXXXXXXX
 21   -0.061                  XXX
 22    0.220                     XXXXXX
 23    0.488                     XXXXXXXXXXXXX
 24    0.585                     XXXXXXXXXXXXXXXX
 25    0.494                     XXXXXXXXXXXXX
 26    0.219                     XXXXXX
 27   -0.064                  XXX
 28   -0.297              XXXXXXXX
 29   -0.391           XXXXXXXXXXX
 30   -0.416           XXXXXXXXXXX
 31   -0.373            XXXXXXXXXX
 32   -0.262              XXXXXXXX
 33   -0.104                  XXXX
 34    0.196                     XXXXXX
 35    0.370                     XXXXXXXXXX
 36    0.510                     XXXXXXXXXXXXXX
 37    0.416                     XXXXXXXXXXX
 38    0.185                     XXXXXX
 39   -0.058                   XX
 40   -0.225               XXXXXXX
 41   -0.290              XXXXXXXX
 42   -0.329             XXXXXXXXX
 43   -0.264              XXXXXXXX
 44   -0.205                XXXXXX
 45   -0.058                   XX
 46    0.137                     XXXX
 47    0.272                     XXXXXXXX
 48    0.342                     XXXXXXXXXX
 49    0.297                     XXXXXXXX
 50    0.161                     XXXXX
```

PACF OF MBTU/KSF   NRMC CAMP LEJEUNE

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----+
 1   0.682                     XXXXXXXXXXXXXXXXXX
 2  -0.217                XXXXXX
 3  -0.334             XXXXXXXXX
 4  -0.236               XXXXXXX
 5  -0.149                 XXXXX
 6  -0.204                XXXXXX
 7  -0.167                 XXXXX
 8  -0.173                 XXXXX
 9   0.114                     XXXX
10   0.169                     XXXXX
11   0.338                     XXXXXXXXX
12   0.190                     XXXXXX
13  -0.091                   XXX
14  -0.113                  XXXX
15  -0.063                   XXX
16   0.027                     XX
17   0.085                     XXX
18   0.041                     XX
19  -0.021                    XX
20   0.129                     XXXX
21  -0.023                    XX
22  -0.020                    XX
23   0.045                     XX
24  -0.003                     X
25   0.004                     X
26  -0.104                  XXXX
27  -0.022                    XX
28  -0.000                     X
29   0.089                     XXX
30   0.024                     XX
31  -0.059                    XX
32  -0.135                  XXXX
33  -0.148                 XXXXX
34   0.150                     XXXXX
35  -0.126                  XXXX
36   0.128                     XXXX
37  -0.047                    XX
38  -0.050                    XX
39   0.031                     XX
40   0.070                     XXX
41   0.019                     X
42  -0.039                    XX
43   0.077                     XXX
44   0.026                     XX
45   0.007                     X
46   0.003                     X
47  -0.129                  XXXX
48  -0.064                   XXX
49   0.110                     XXXX
50   0.143                     XXXXX
```

```
ARIMA (2 0 4)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER     TYPE       ESTIMATE       ST. DEV.   T-RATIO
     1      AR  1     -0.1200        0.3548      -0.34
     2      AR  2      0.6523        0.2265       2.88
     3     SAR 12     -0.0977        0.1771      -0.55
     4      MA  1     -0.0013        0.3794      -0.00
     5      MA  2      0.7130        0.2360       3.02
     6      MA  3     -0.3336        0.1230      -2.71
     7      MA  4     -0.1428        0.1924      -0.74
     8     SMA 12      0.7684        0.1688       4.55

DIFFERENCING.  0 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =       120.610  (BACKFORECASTS EXCL)
               DF =    64  MS =       1.885
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF. 72

   ACF OF RESIDUAL      NRMC CAMP LEJEUNE

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----+----
  1   0.037                     XX
  2   0.033                     XX
  3  -0.100                   XXX
  4  -0.060                   XXX
  5  -0.080                   XXX
  6  -0.017                     X
  7  -0.068                   XXX
  8  -0.024                    XX
  9  -0.058                    XX
 10  -0.258               XXXXXXX
 11  -0.156                 XXXXX
 12   0.016                     X
 13   0.095                     XXX
 14   0.125                     XXXX
 15   0.124                     XXXX
 16   0.064                     XXX
 17   0.015                     X
 18  -0.006                     X
 19  -0.095                   XXX
 20   0.197                     XXXXXX
 21   0.117                     XXXX
 22  -0.073                   XXX
 23  -0.037                    XX
 24  -0.234               XXXXXXX
 25  -0.140                 XXXXX
 26  -0.074                   XXX
 27  -0.012                     X
 28   0.000                     X
 29   0.004                     X
 30   0.087                     XXX
 31   0.037                     XX
 32   0.085                     XXX
 33  -0.018                     X
 34   0.136                     XXXX
 35   0.040                     XX
 36   0.082                     XXX
 37  -0.057                    XX
 38  -0.056                    XX
 39  -0.039                    XX
 40  -0.066                   XXX
```

ARIMA (3 1 2)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-1.1024	0.2462	-4.48
2	AR 2	-0.3043	0.2141	-1.42
3	AR 3	-0.0701	0.1586	-0.44
4	SAR 12	-0.0779	0.1846	-0.42
5	MA 1	-0.0074	0.2163	-0.03
6	MA 2	0.8430	0.1870	4.51
7	SMA 12	0.7550	0.1795	4.21

```
DIFFERENCING.  1 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =        122.165  (BACKFORECASTS EXCL)
               DF =     64  MS =          1.909
NO. OF OBS.    ORIGINAL SERIES    84      AFTER DIFF. 71
```

```
   ACF OF RESIDUAL      NRMC CAMP LEJEUNE

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----
  1   0.032                         XX
  2   0.037                         XX
  3   0.006                         X
  4   0.031                         XX
  5  -0.026                       XX
  6  -0.038                       XX
  7  -0.093                      XXX
  8  -0.075                      XXX
  9  -0.075                      XXX
 10  -0.256                  XXXXXXX
 11  -0.132                     XXXX
 12   0.001                         X
 13   0.067                         XXX
 14   0.074                         XXX
 15   0.112                         XXXX
 16   0.092                         XXX
 17   0.061                         XXX
 18   0.020                         X
 19  -0.094                      XXX
 20   0.179                         XXXXX
 21   0.073                         XXX
 22  -0.113                     XXXX
 23  -0.073                      XXX
 24  -0.227                  XXXXXXX
 25  -0.164                    XXXXX
 26  -0.088                      XXX
 27  -0.052                       XX
 28  -0.046                       XX
 29  -0.051                       XX
 30   0.080                         XXX
 31   0.056                         XX
 32   0.096                         XXX
 33  -0.006                         X
 34   0.131                         XXXX
 35   0.017                         X
 36   0.134                         XXXX
 37  -0.044                       XX
 38  -0.049                       XX
 39  -0.033                       XX
 40  -0.074                      XXX
```

ARIMA (2 1 2)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-1.1239	0.1241	-9.06
2	AR 2	-0.1969	0.1281	-1.54
3	SAR 12	-0.1225	0.1972	-0.62
4	MA 1	-0.0928	0.0530	-1.75
5	MA 2	0.9445	0.0157	60.29
6	SMA 12	0.6780	0.1853	3.66

```
DIFFERENCING. 1 REGULAR    1 SEASONAL DIFF. ORDER 12
RESIDUALS.    SS =       121.775  (BACKFORECASTS EXCL)
              DF =   65  MS =         1.873
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF.  71
```

FORECASTS FROM PERIOD 84

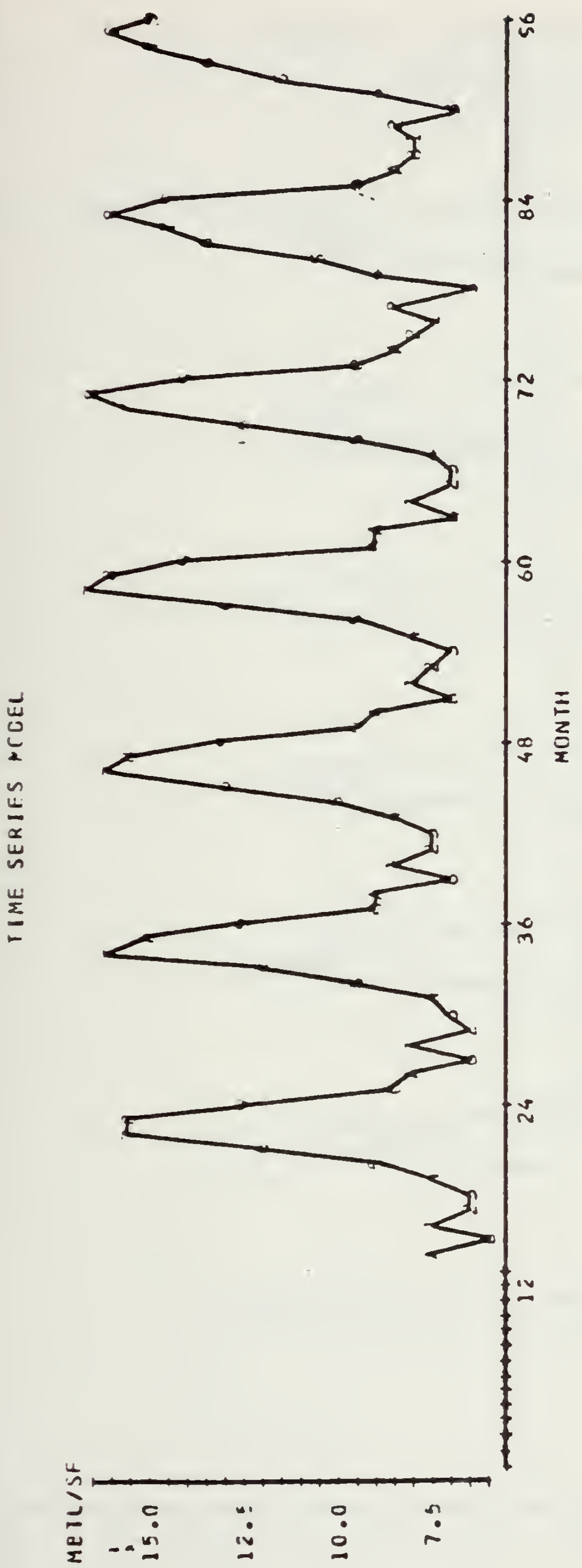
PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	9.5823	6.8990	12.2655
86	8.5642	5.8796	11.2487
87	8.0890	5.4041	10.7738
88	7.9869	5.2637	10.7101
89	8.3328	5.6075	11.0580
90	7.2372	4.4785	9.9959
91	8.8540	6.0946	11.6134
92	11.3720	8.5861	14.1580
93	13.5219	10.7359	16.3080
94	15.2200	12.4126	18.0275
95	16.1387	13.3312	18.9461
96	15.0153	12.1902	17.8404

```
   ACF OF RESIDUAL       NRMC CAMP LEJEUNE

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----
  1   0.025                     XX
  2  -0.064                   XXX
  3   0.034                     XX
  4   0.029                     XX
  5  -0.001                     X
  6  -0.036                    XX
  7  -0.081                   XXX
  8  -0.046                    XX
  9  -0.060                   XXX
 10  -0.268             XXXXXXXX
 11  -0.100                 XXXX
 12   0.029                     XX
 13   0.059                     XX
 14   0.046                     XX
 15   0.115                     XXXX
 16   0.081                     XXX
 17   0.075                     XXX
 18  -0.007                     X
 19  -0.102                 XXXX
 20   0.180                     XXXXX
 21   0.079                     XXX
 22  -0.141                XXXXX
 23  -0.043                    XX
 24  -0.203               XXXXXX
 25  -0.144                XXXXX
 26  -0.103                 XXXX
 27  -0.021                    XX
 28  -0.046                    XX
 29  -0.042                    XX
 30   0.049                     XX
```

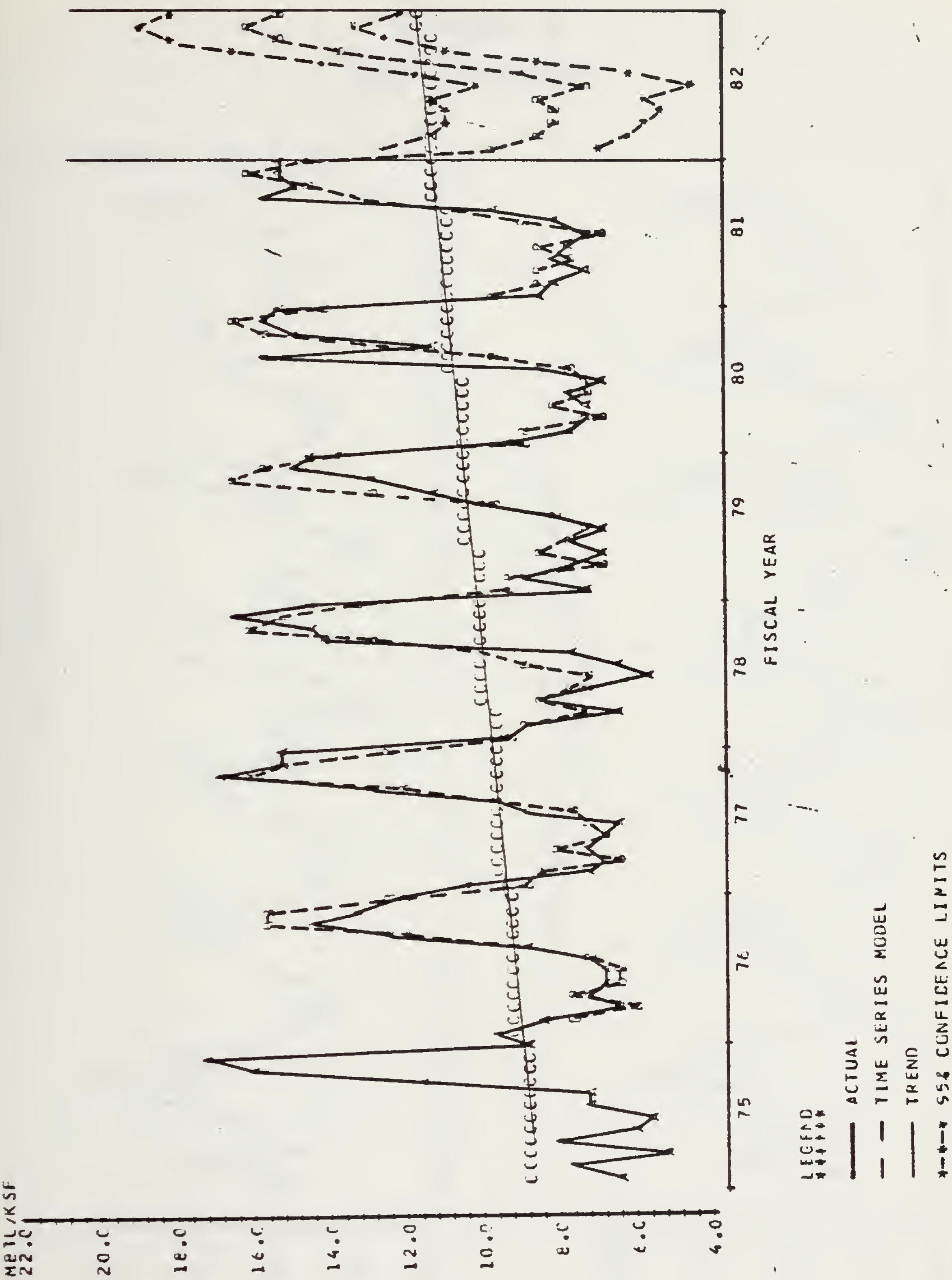
E. FITTING A TREND LINE

```
REGRESSION OF MODELED MBTU/KSF   VS   MONTH

   83 CASES USED
   13 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      8.66 +0.0291 X1

                                             ST. DEV.      T-RATIO =
        COLUMN      COEFFICIENT              OF COEF.      COEF/S.D.
        --              8.6644               0.8739            9.92
X1      MONTH          0.02908               0.01457           2.00

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 3.179
WITH (  83- 2) =  81 DEGREES OF FREEDOM

R-SQUARED =  4.7 PERCENT

ANALYSIS OF VARIANCE
 DUE TO       DF           SS         MS=SS/DF
REGRESSION     1        40.30            40.30
RESIDUAL      81       818.84            10.11
TOTAL         82       859.14

               X1            Y     PRED. Y     ST.DEV.
ROW         MONTH        ARIMA     LN          VALUE        PRED.     Y
ST.RES.
 34          34.0       16.145        9.653        0.464         2.06R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.42
```

F. DECOMPOSITION LINES



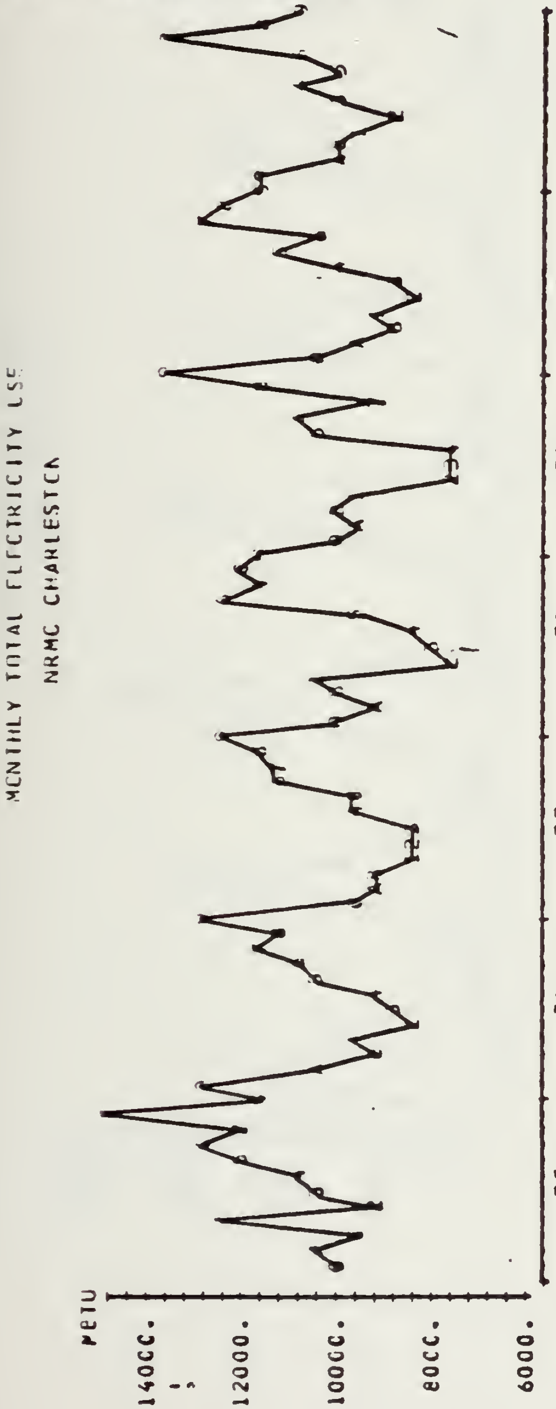
G. ACTUAL USE AND FORECAST MODELS

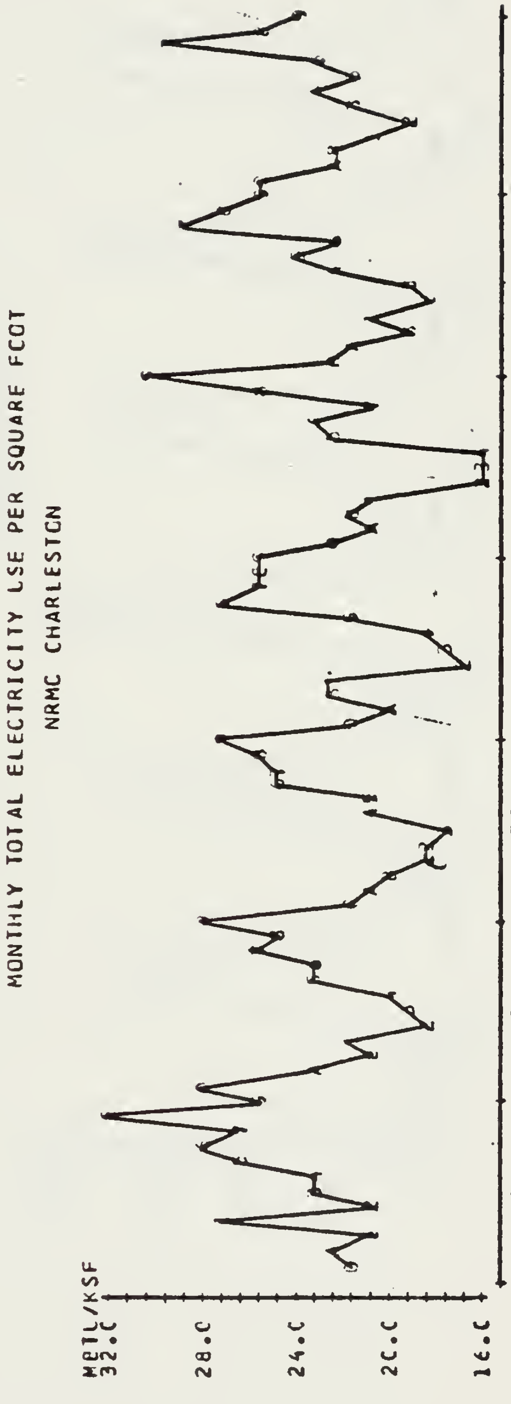


APPENDIX B

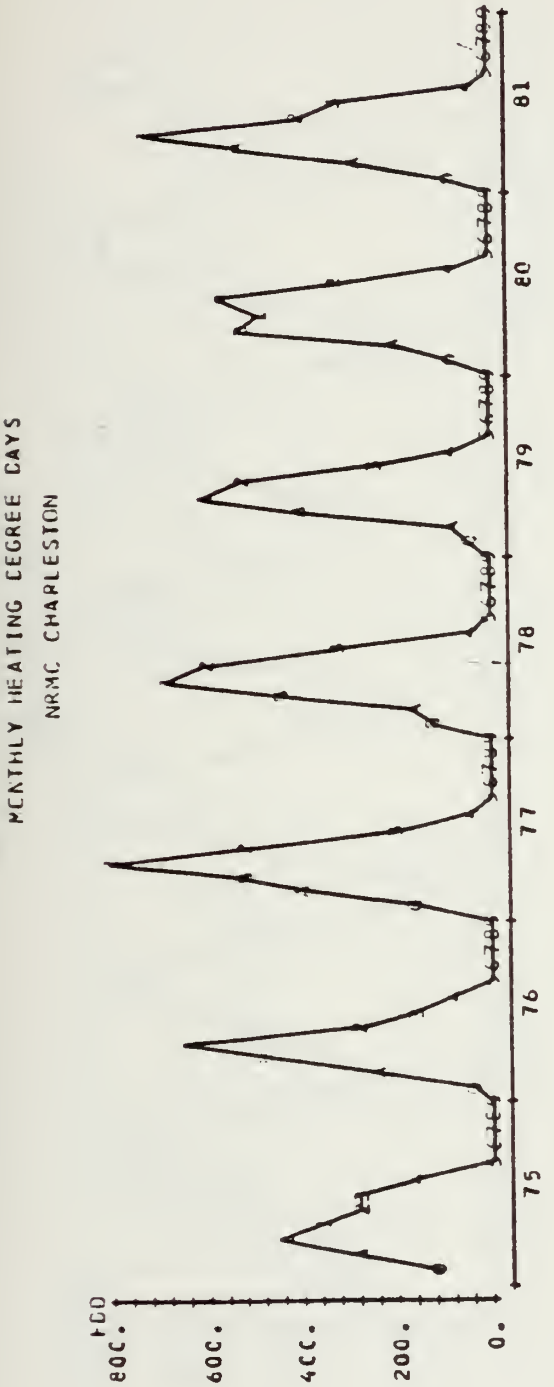
NRMC CHARLESTON

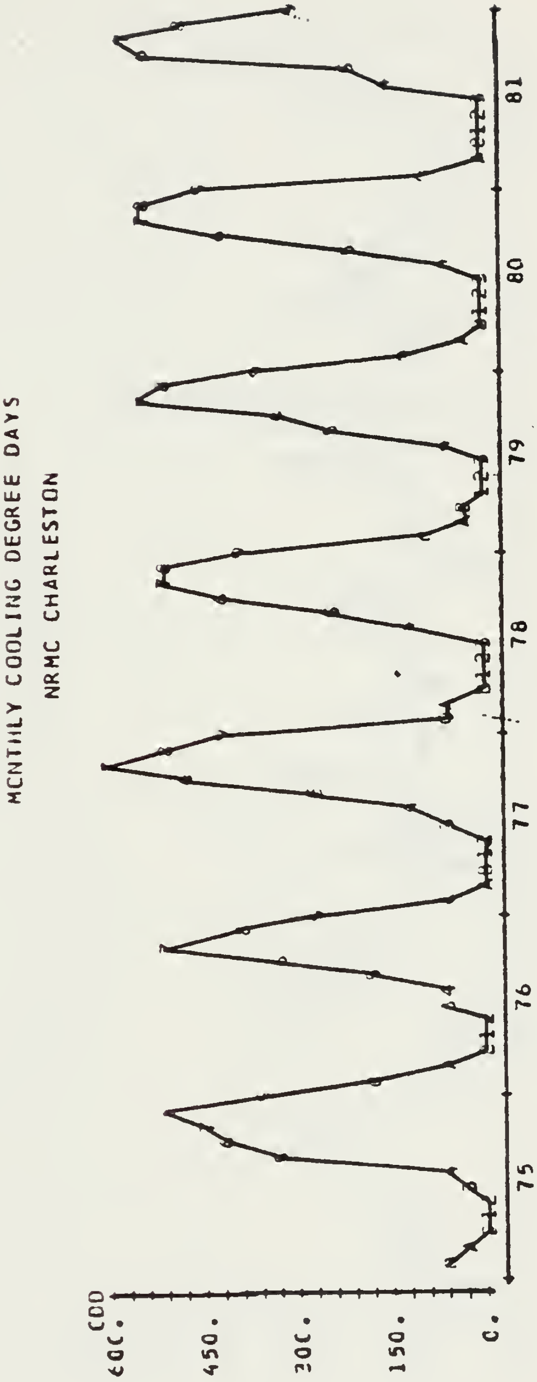
A. MONTHLY ENERGY USE

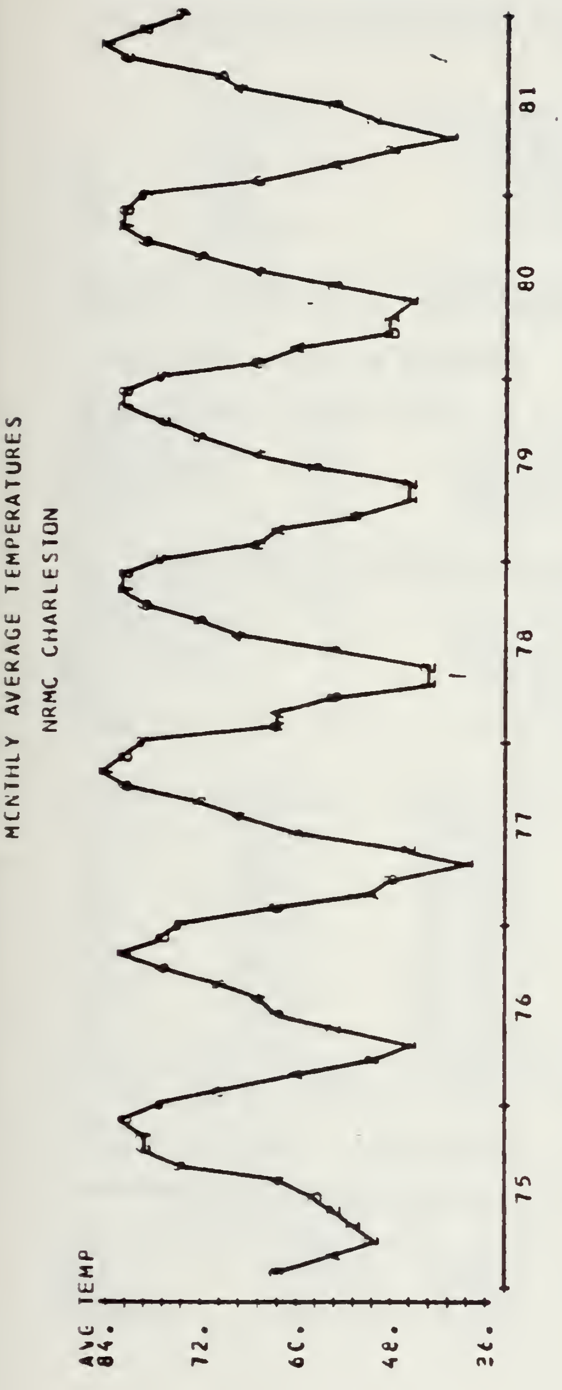


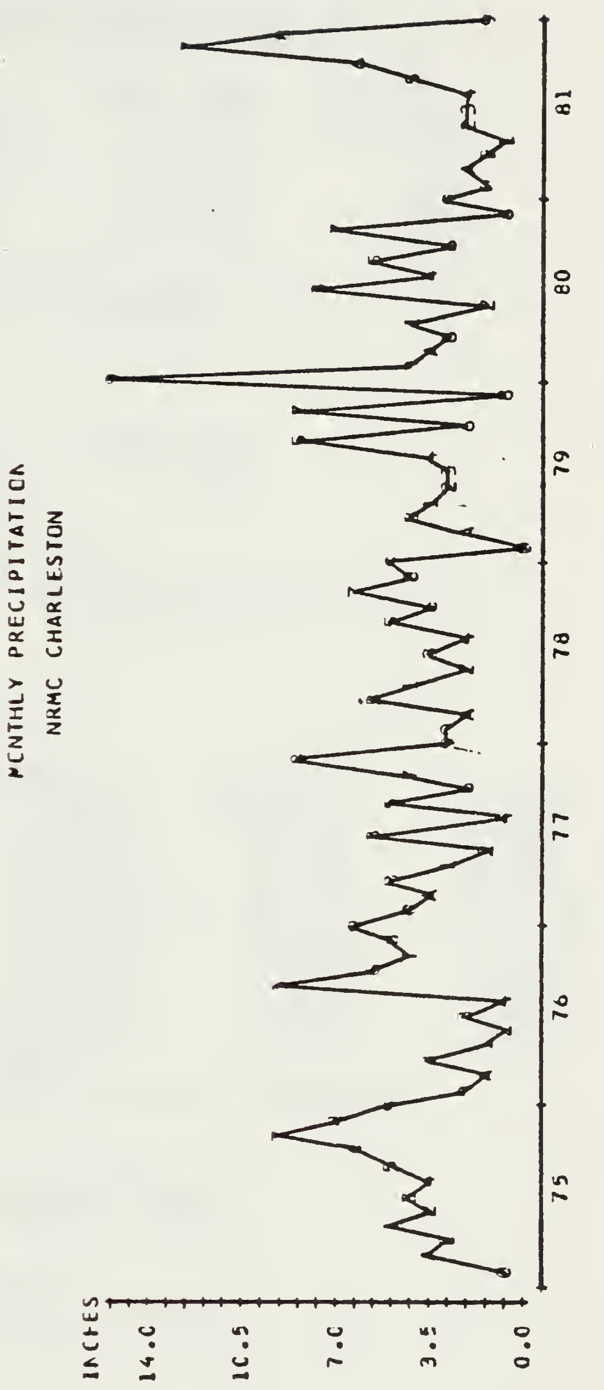


B. MONTHLY WEATHER SUMMARY






MONTHLY AVERAGE TEMPERATURES
NRMC CHARLESTON
AVG TEMP
84.
72.
60.
48.
36.
75
76
77
78
79
80
81


MONTHLY PRECIPITATION
NRMC CHARLESTON
INCHES
14.0
10.5
7.0
3.5
0.0
75
76
77
78
79
80
81

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC CHARLESTON IS:
Y = -23.1 + 0.670 X1 +0.0205 X2 -0.0120 X3 + 0.177 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	-23.09	23.25	-0.99
X1	AVG TEMP	0.6703	0.3591	1.87
X2	HDD	0.02051	0.01189	1.72
X3	CDD	-0.01196	0.01175	-1.02
X4	PRECIP	0.1771	0.1056	1.68

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 2.312
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 56.0 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	537.499	134.375
RESIDUAL	79	422.464	5.348
TOTAL	83	959.964	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	537.499
AVG TEMP	1	463.244
HDD	1	52.033
CDD	1	7.193
PRECIP	1	15.030

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
4	53.8	27.219	20.918	0.405	2.77R
11	81.5	32.230	26.634	0.516	2.48R
13	69.0	27.956	22.278	0.418	2.50R
28	38.7	18.340	19.896	0.881	-0.73 X
39	55.0	22.028	24.212	1.887	-1.63 X
41	42.7	16.737	18.480	0.906	-0.82 X
55	64.9	16.357	21.666	0.469	-2.34R
58	82.0	20.401	26.973	0.580	-2.94R
60	76.5	30.118	26.668	1.147	1.72 X
82	83.5	29.814	28.156	0.905	0.78 X

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.41

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.695			
HDD	-0.569	-0.937		
CDD	0.718	0.924	-0.737	
PRECIP	0.448	0.407	-0.309	0.444

D. DEVELOPING A TIME SERIES MODEL

```
      ACF OF MBTU/KSF        NRMC CHARLESTON

             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
              +----+----+----+----+----+----+----+----+
 1    0.571                       XXXXXXXXXXXXXXX
 2    0.346                       XXXXXXXXXX
 3    0.093                       XXX
 4   -0.178                   XXXXX
 5   -0.402             XXXXXXXXXXX
 6   -0.540          XXXXXXXXXXXXXX
 7   -0.419             XXXXXXXXXXX
 8   -0.261                XXXXXXXX
 9    0.025                       XX
10    0.206                       XXXXXX
11    0.499                       XXXXXXXXXXXXX
12    0.567                       XXXXXXXXXXXXXXX
13    0.417                       XXXXXXXXXXX
14    0.221                       XXXXXXX
15   -0.000                       X
16   -0.209                  XXXXXX
17   -0.460           XXXXXXXXXXXXX
18   -0.504          XXXXXXXXXXXXXX
19   -0.451            XXXXXXXXXXXX
20   -0.209                  XXXXXX
21   -0.066                     XXX
22    0.200                       XXXXXX
23    0.367                       XXXXXXXXXX
24    0.396                       XXXXXXXXXXX
25    0.358                       XXXXXXXXXX
26    0.190                       XXXXXX
27    0.019                       X
28   -0.189                  XXXXXX
29   -0.339               XXXXXXXXX
30   -0.403             XXXXXXXXXXX
31   -0.323               XXXXXXXXX
32   -0.198                  XXXXXX
33   -0.086                     XXX
34    0.114                       XXXX
35    0.252                       XXXXXXX
36    0.355                       XXXXXXXXXX
37    0.284                       XXXXXXXX
38    0.144                       XXXXX
39   -0.007                       X
40   -0.151                   XXXXX
41   -0.279                XXXXXXXX
42   -0.328               XXXXXXXXX
43   -0.260                XXXXXXXX
44   -0.208                  XXXXXX
45   -0.136                    XXXX
46    0.053                       XX
47    0.136                       XXXX
48    0.199                       XXXXXX
49    0.170                       XXXXX
50    0.053                       XX
```

```
PACF OF MBTU/KSF        NRMC CHARLESTON

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
 1   0.571                      XXXXXXXXXXXXXXX
 2   0.029                      XX
 3  -0.172                  XXXXX
 4  -0.267               XXXXXXXX
 5  -0.273               XXXXXXXX
 6  -0.245                XXXXXXX
 7   0.078                      XXX
 8   0.075                      XXX
 9   0.222                      XXXXXXX
10   0.030                      XX
11   0.294                      XXXXXXXX
12   0.092                      XXX
13  -0.120                   XXXX
14  -0.147                  XXXXX
15  -0.033                     XX
16  -0.010                      X
17  -0.090                    XXX
18  -0.032                     XX
19  -0.051                     XX
20   0.103                      XXXX
21  -0.118                   XXXX
22   0.064                      XXX
23  -0.090                    XXX
24  -0.039                     XX
25   0.038                      XX
26   0.056                      XX
27  -0.029                     XX
28   0.062                      XXX
29  -0.025                     XX
30   0.026                      XX
31  -0.041                     XX
32  -0.022                     XX
33  -0.139                   XXXX
34  -0.038                     XX
35   0.016                      X
36   0.131                      XXXX
37  -0.026                     XX
38  -0.119                   XXXX
39  -0.071                    XXX
40  -0.030                     XX
41   0.002                      X
42  -0.005                      X
43   0.054                      XX
44  -0.064                    XXX
45  -0.178                  XXXXX
46   0.033                      XX
47  -0.147                  XXXXX
48  -0.067                    XXX
49   0.016                      X
50  -0.118                   XXXX
```

ARIMA (3 1 3)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-1.9098	0.1432	-13.34
2	AR 2	-1.0220	0.2575	-3.97
3	AR 3	-0.0508	0.1365	-0.37
4	SAR 12	-0.1433	0.2012	-0.71
5	MA 1	-1.1105	0.0023	-487.72
6	MA 2	0.5977	0.0561	10.65
7	MA 3	0.7541	0.0632	11.94
8	SMA 12	0.7184	0.2147	3.35

```
DIFFERENCING.  1 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =      278.967  (BACKFORECASTS EXCL)
               DF =    63  MS =          4.428
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF. 71
```

ACF OF RESIDUAL   NRMC CHARLESTON

```
              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----+----
  1    0.035                        XX
  2   -0.133                     XXXX
  3    0.057                        XX
  4    0.152                        XXXXX
  5    0.040                        XX
  6    0.137                        XXXX
  7   -0.072                      XXX
  8    0.077                        XXX
  9   -0.011                        X
 10   -0.033                       XX
 11    0.088                        XXX
 12    0.090                        XXX
 13   -0.141                    XXXXX
 14    0.032                        XX
 15    0.074                        XXX
 16   -0.056                       XX
 17    0.003                        X
 18   -0.103                     XXXX
 19   -0.100                      XXX
 20   -0.022                       XX
 21    0.004                        X
 22    0.089                        XXX
 23   -0.047                       XX
 24   -0.298                 XXXXXXXX
 25   -0.012                        X
 26    0.173                        XXXXX
 27    0.053                        XX
 28    0.037                        XX
 29    0.029                        XX
 30   -0.010                        X
 31    0.074                        XXX
 32   -0.012                        X
 33   -0.013                        X
 34    0.036                        XX
 35   -0.040                       XX
 36   -0.038                       XX
 37    0.089                        XXX
 38   -0.033                       XX
 39    0.002                        X
 40   -0.004                        X
```

```
ARIMA  (3  1  3)(0  1  1)  S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE      ST. DEV.   T-RATIO
     1      AR   1     -1.9882      0.1363     -14.58
     2      AR   2     -1.1877      0.2522      -4.71
     3      AR   3     -0.1481      0.1351      -1.10
     4      MA   1     -1.1479      0.0001  -21285.67
     5      MA   2      0.5421      0.0559       9.70
     6      MA   3      0.7276      0.0591      12.32
     7     SMA  12      0.7422      0.1446       5.13

DIFFERENCING.  1 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =        278.354  (BACKFORECASTS EXCL)
               DF =     64  MS =         4.349
NO. OF OBS.    ORIGINAL SERIES    84      AFTER DIFF. 71

   ACF OF RESIDUAL          NRMC CHARLESTON

             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
                +----+----+----+----+----+----+----+----
  1    0.078                        XXX
  2   -0.123                     XXXX
  3    0.030                        XX
  4    0.149                        XXXXX
  5    0.057                        XX
  6    0.114                        XXXX
  7   -0.052                       XX
  8    0.064                        XXX
  9   -0.034                       XX
 10   -0.015                        X
 11    0.064                        XXX
 12    0.060                        XX
 13   -0.159                    XXXXX
 14    0.009                        X
 15    0.069                        XXX
 16   -0.058                       XX
 17   -0.016                        X
 18   -0.129                     XXXX
 19   -0.101                     XXXX
 20   -0.037                       XX
 21    0.024                        XX
 22    0.072                        XXX
 23   -0.070                      XXX
 24   -0.275                 XXXXXXXX
 25   -0.001                        X
 26    0.158                        XXXXX
 27    0.059                        XX
 28    0.040                        XX
 29    0.029                        XX
 30    0.015                        X
 31    0.060                        XXX
 32    0.008                        X
 33   -0.005                        X
 34    0.037                        XX
 35   -0.034                       XX
 36    0.007                        X
 37    0.082                        XXX
 38   -0.007                        X
 39    0.017                        X
 40    0.003                        X
```

```
ARIMA (3 1 4)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE        ST. DEV.   T-RATIO
     1       AR  1     -0.0809         0.2997      -0.27
     2       AR  2     -0.4300         0.2365      -1.82
     3       AR  3     -0.7862         0.2833      -2.78
     4      SAR 12     -0.1765         0.1803      -0.98
     5       MA  1      0.6583         0.2973       2.21
     6       MA  2     -0.2343         0.4512      -0.52
     7       MA  3     -0.5470         0.4057      -1.35
     8       MA  4      0.7112         0.1946       3.65
     9      SMA 12      0.7617         0.1790       4.25

DIFFERENCING. 1 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =       258.314   (BACKFORECASTS EXCL)
               DF =     62  MS =           4.328
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF.   71

   ACF OF RESIDUAL        NRMC CHARLESTON

             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
               +----+----+----+----+----+----+----+----
  1  -0.074                      XXX
  2  -0.041                       XX
  3   0.182                        XXXXXX
  4   0.086                        XXX
  5   0.084                        XXX
  6   0.005                        X
  7   0.062                        XXX
  8   0.062                        XXX
  9   0.124                        XXXX
 10  -0.134                     XXXX
 11   0.026                        XX
 12   0.148                        XXXXX
 13  -0.100                      XXX
 14   0.166                        XXXXX
 15  -0.012                        X
 16  -0.118                     XXXX
 17  -0.004                        X
 18   0.002                        X
 19  -0.034                       XX
 20  -0.048                       XX
 21  -0.096                      XXX
 22   0.075                        XXX
 23   0.016                        X
 24  -0.207                   XXXXXX
 25  -0.023                       XX
 26   0.081                        XXX
 27   0.008                        X
 28   0.071                        XXX
 29   0.095                        XXX
 30   0.009                        X
 31   0.017                        X
 32  -0.070                      XXX
 33  -0.053                       XX
 34   0.136                        XXXX
 35  -0.054                       XX
 36  -0.024                       XX
 37   0.008                        X
 38  -0.051                       XX
 39   0.007                        X
 40   0.046                        XX
```

ARIMA (3 1 4)(0 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.0333	0.2954	-0.11
2	AR 2	-0.3261	0.2108	-1.55
3	AR 3	-0.7117	0.2911	-2.44
4	MA 1	0.7775	0.3081	2.52
5	MA 2	-0.1522	0.3470	-0.44
6	MA 3	-0.6985	0.3489	-2.00
7	MA 4	0.6711	0.2278	2.95
8	SMA 12	0.7620	0.1452	5.25

DIFFERENCING. 1 REGULAR 1 SEASONAL DIFF. ORDER 12
RESIDUALS. SS = 276.627 (BACKFORECASTS EXCL)
DF = 63 MS = 4.391
NO. OF OBS. ORIGINAL SERIES 84 AFTER DIFF. 71

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	22.9995	18.8916	27.1074
86	21.4991	17.3183	25.6799
87	21.7961	17.6116	25.9805
88	21.8813	17.5210	26.2416
89	18.1863	13.7126	22.6600
90	18.7108	14.1050	23.3166
91	20.8789	16.2543	25.5035
92	23.1021	18.4427	27.7615
93	24.9590	20.2446	29.6733
94	26.4219	21.5702	31.2735
95	26.3726	21.4239	31.3213
96	26.1972	21.1943	31.2002

ACF OF RESIDUAL NRMC CHARLESTON

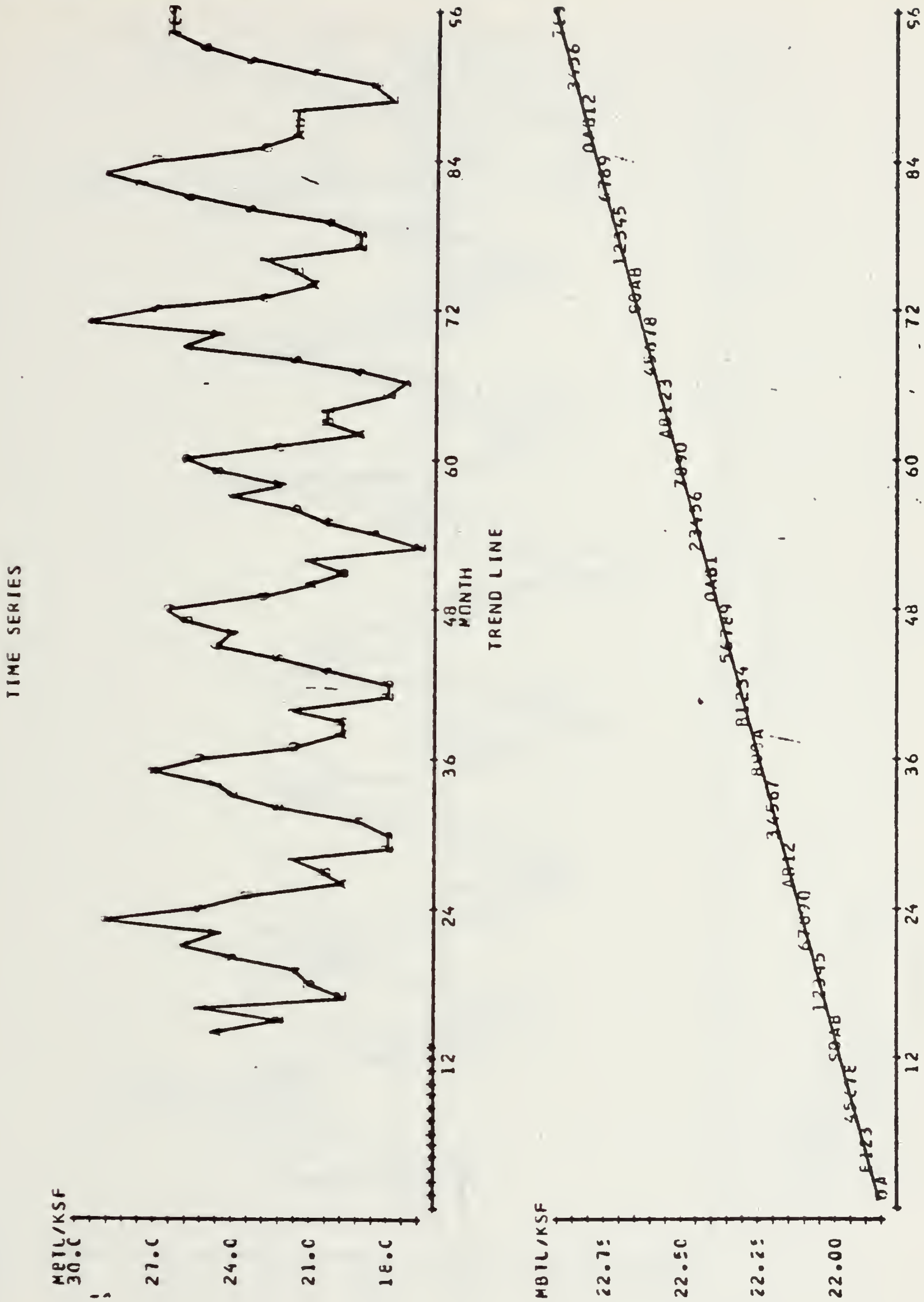
```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
 1  -0.020                    XX
 2   0.056                     XX
 3   0.077                     XXX
 4   0.011                     X
 5   0.093                     XXX
 6   0.042                     XX
 7   0.112                     XXXX
 8   0.007                     X
 9   0.060                     XXX
10  -0.123                  XXXX
11   0.028                     XX
12   0.101                     XXXX
13  -0.114                  XXXX
14   0.122                     XXXX
15  -0.005                     X
16  -0.080                   XXX
17  -0.058                    XX
18  -0.092                   XXX
19  -0.085                   XXX
20  -0.012                     X
21  -0.029                    XX
22   0.069                     XXX
23  -0.062                   XXX
24  -0.208                XXXXXX
25  -0.029                    XX
26   0.081                     XXX
27   0.074                     XXX
28   0.094                     XXX
29   0.073                     XXX
30  -0.012                     X
```

E. FITTING A TREND LINE

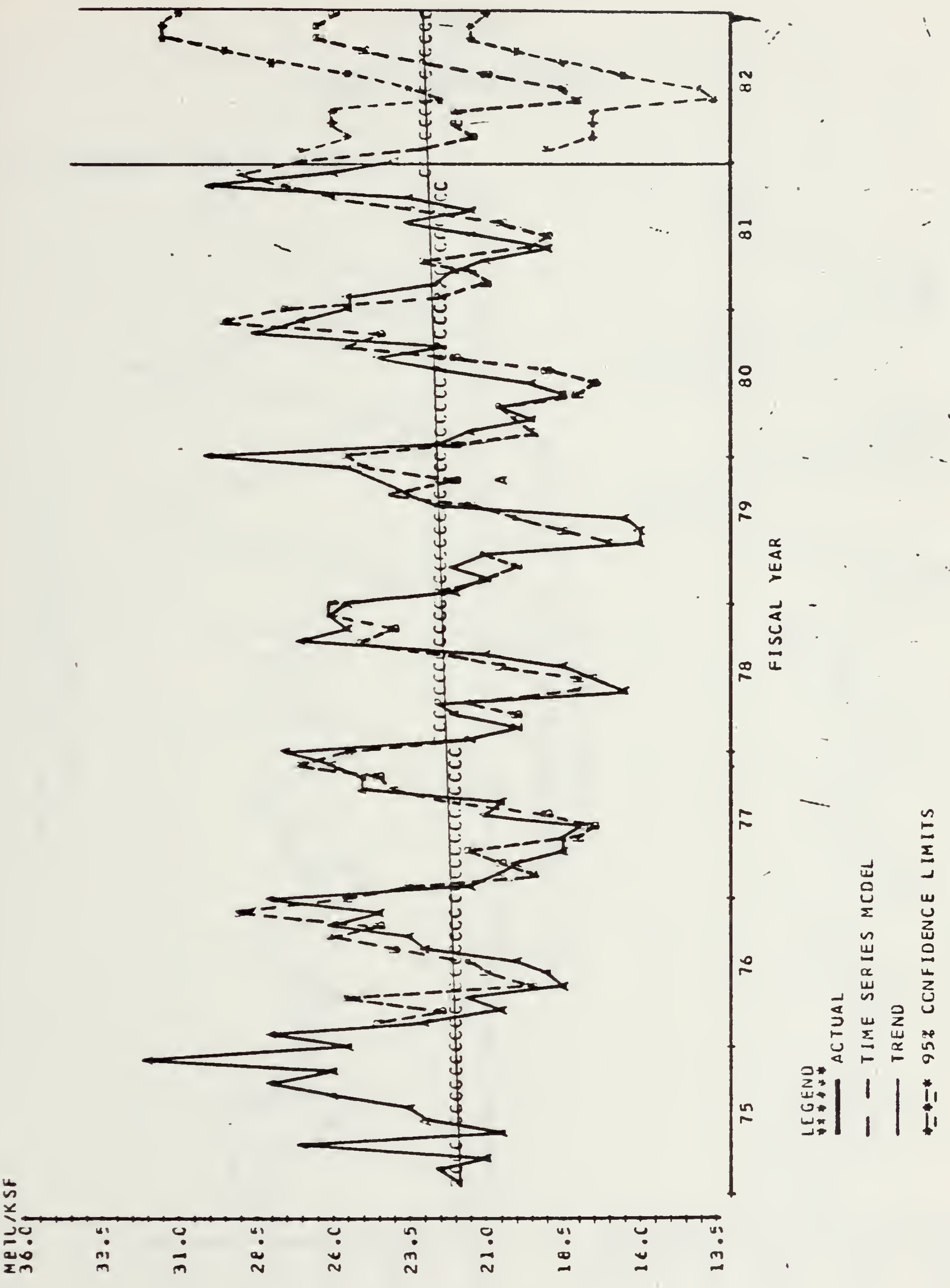
REGRESSION OF MODELED MBTU/KSF VS MONTH

```
   83 CASES USED
   13 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC CHARLESTON IS:
Y =      21.9 +0.0109 X1

                                            ST. DEV.   T-RATIO=
       COLUMN       COEFFICIENT             OF COEF.   COEF/S.D.
         --            21.8511               0.8327      26.24
X1     MONTH            0.01089              0.01388      0.78

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 3.03
WITH (  83- 2) =  81 DEGREES OF FREEDOM

R-SQUARED =  0.8 PERCENT

ANALYSIS OF VARIANCE
 DUE TO       DF          SS          MS=SS/DF
REGRESSION     1        5.653            5.653
RESIDUAL      81      743.595            9.180
TOTAL         82      749.248

              X1           Y       PRED. Y     ST.DEV.
ROW         MONTH     ARIMA LN      VALUE     PRED. Y        ST.RES.
 23          23.0      28.983      22.102       0.555         2.31R
 71          71.0      29.255      22.624       0.400         2.21R
 83          83.0      28.880      22.755       0.512         2.05R
R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.60
```

F. DECOMPOSITION LINES



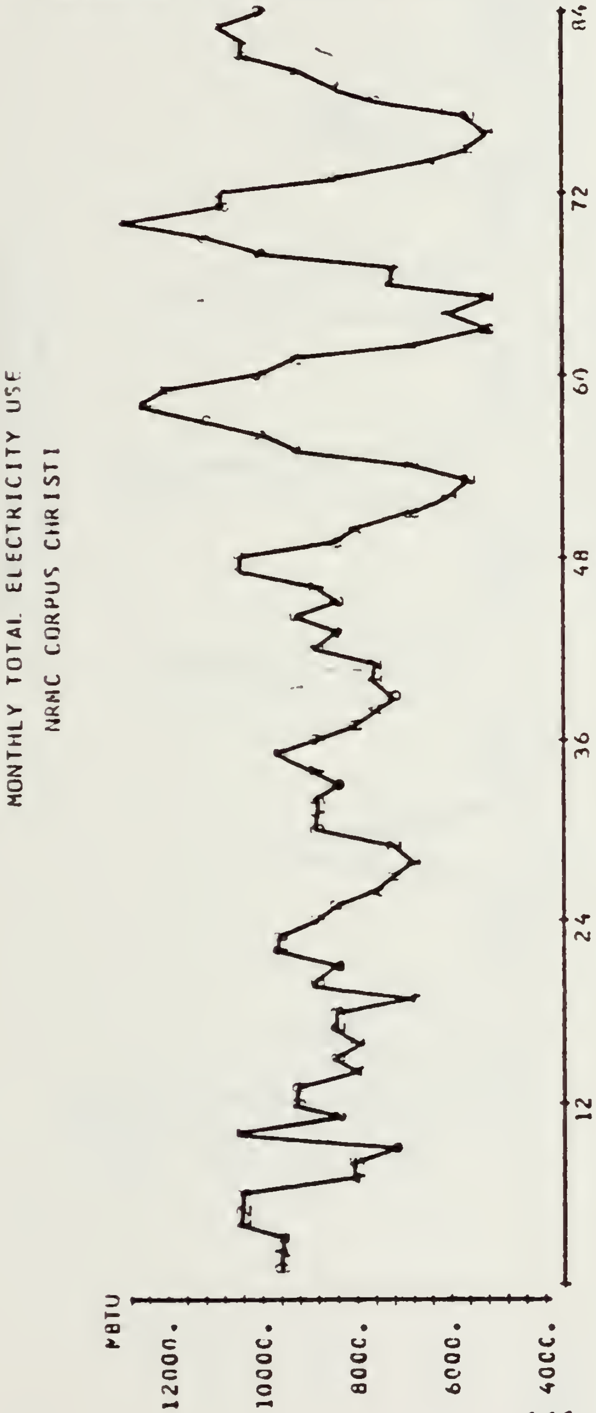
G. ACTUAL USE AND FORECAST MODELS

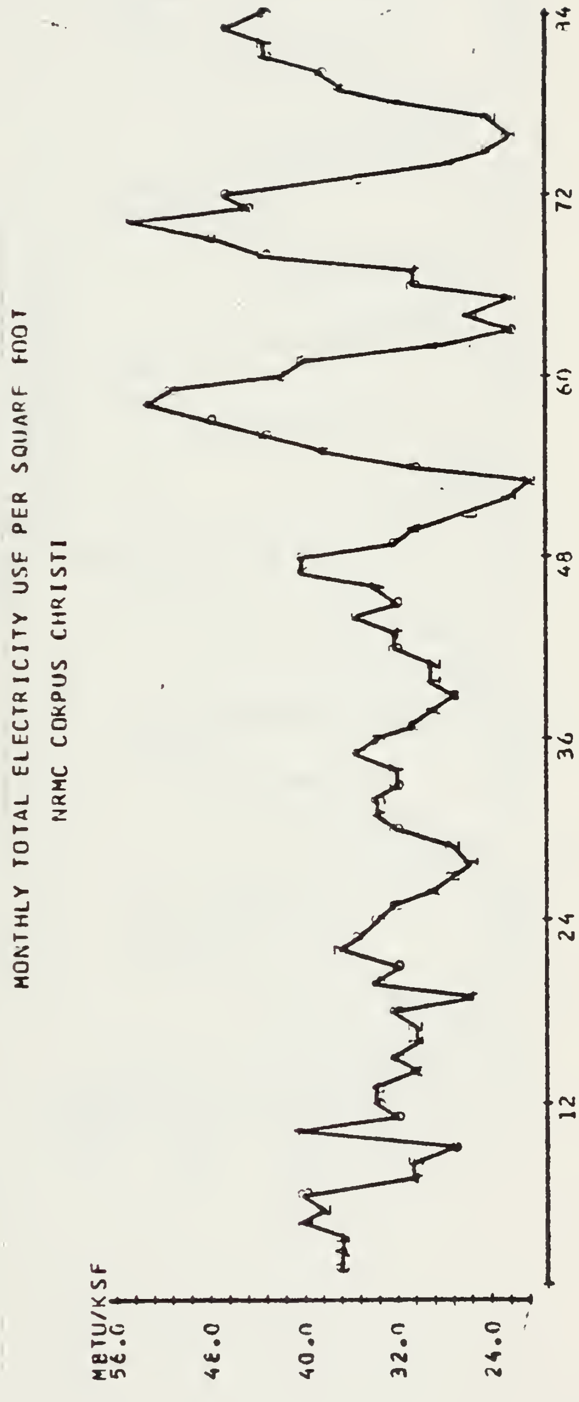


APPENDIX C

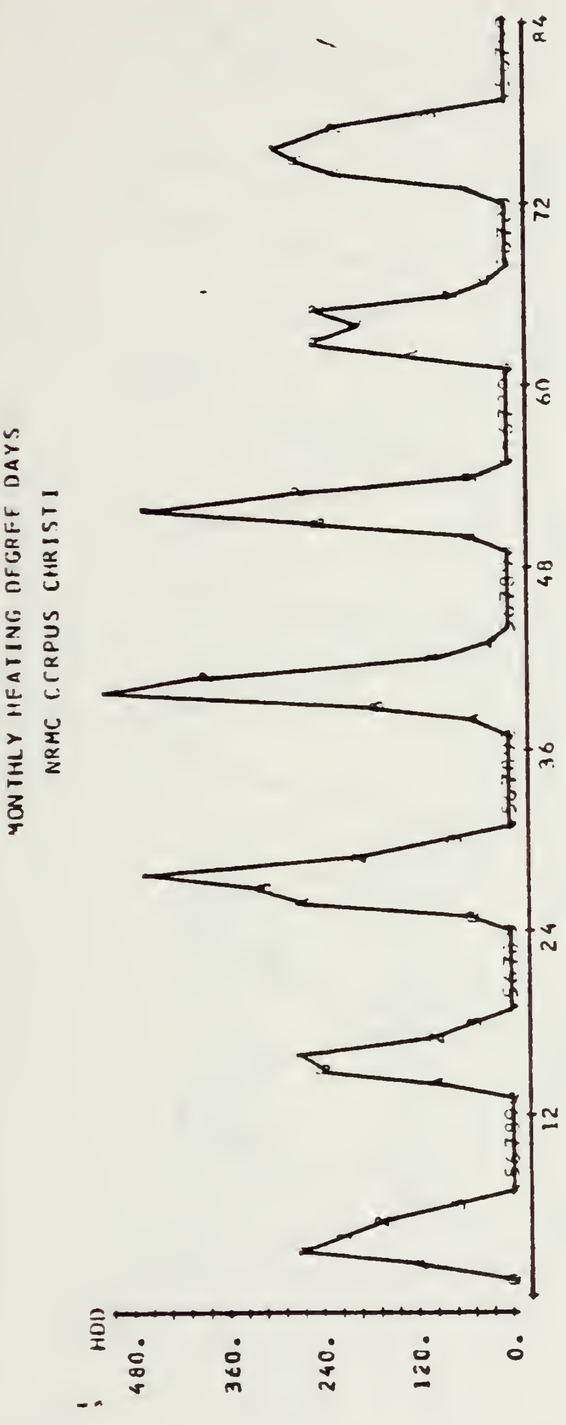
NRMC CORPUS CHRISTI

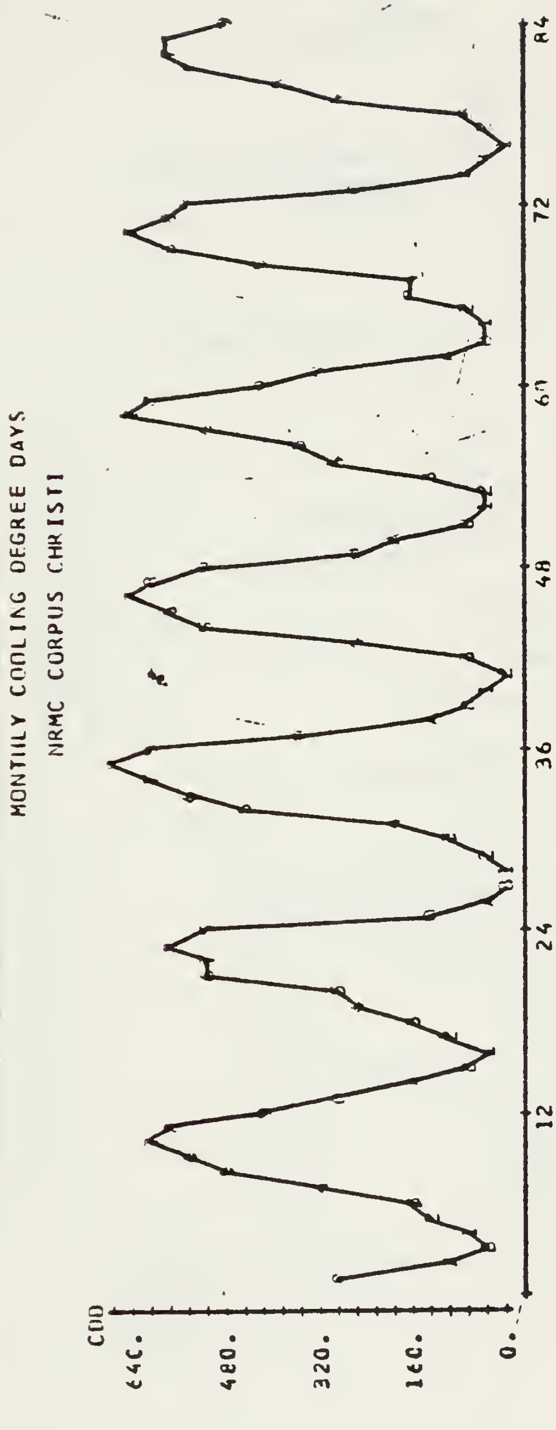
A. MONTHLY ENERGY USE

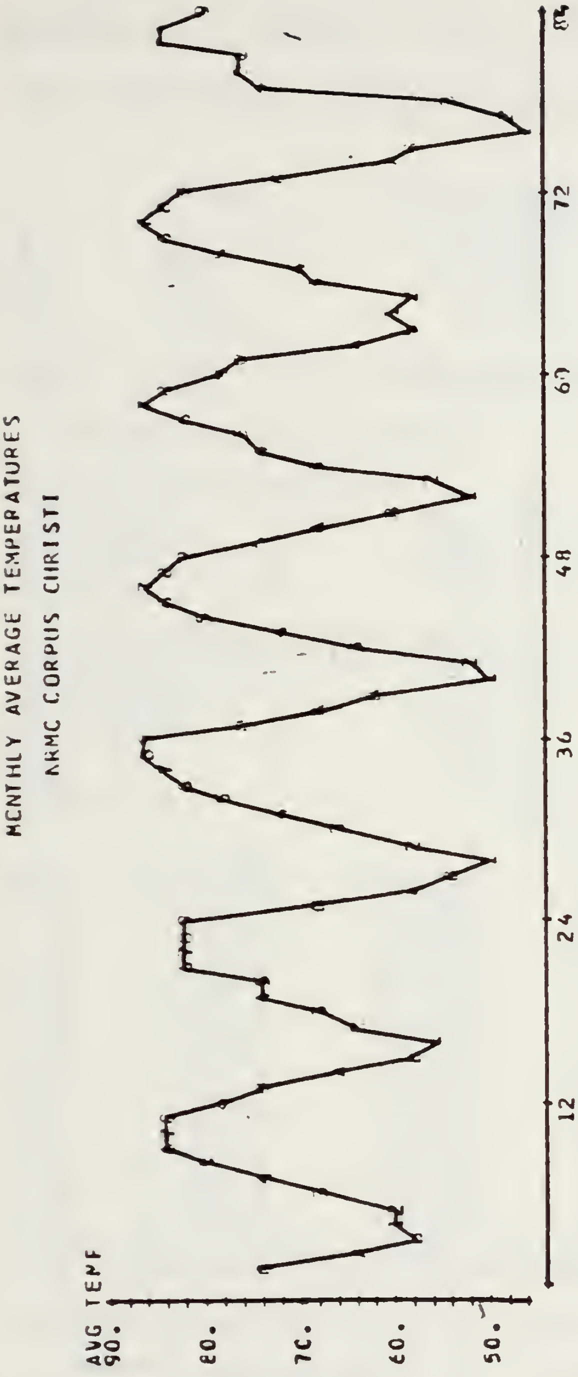


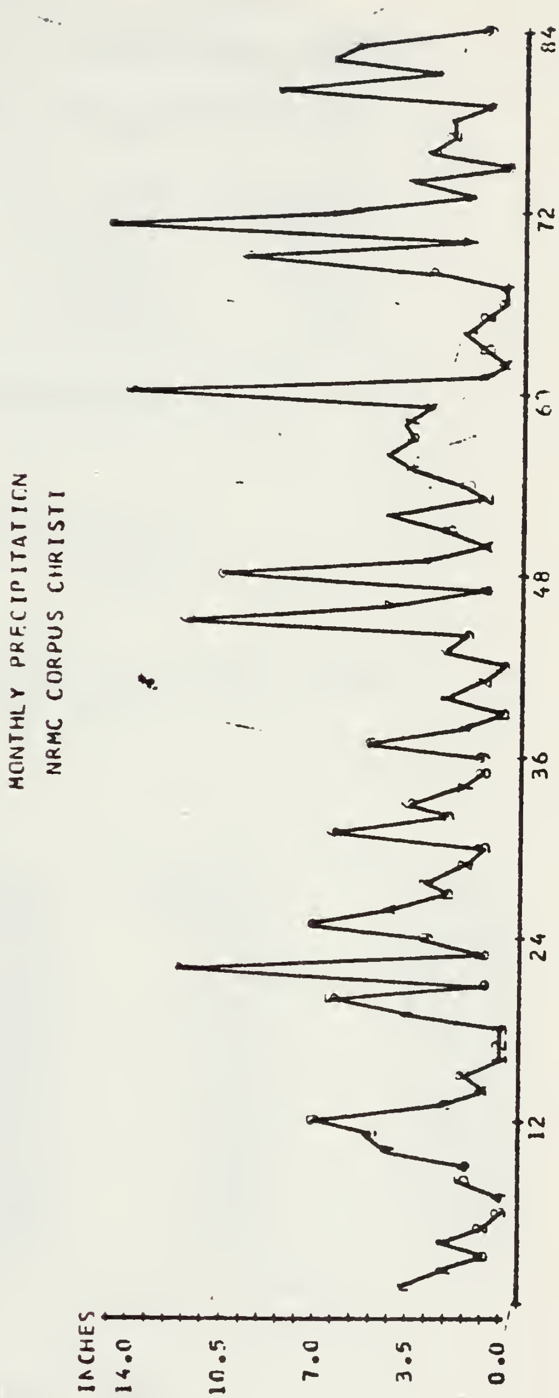


B. MONTHLY WEATHER SUMMARY






MONTHLY AVERAGE TEMPERATURES
NRMC CORPUS CHRISTI
AVG TEMP
90.
80.
70.
60.
50.
12
24
36
48
60
72
84


MONTHLY PRECIPITATION
NRMC CORPUS CHRISTI
INCHES
14.0
10.5
7.0
3.5
0.0
12
24
36
48
60
72
84

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC CORPUS CHRISTI IS:
Y = 29.7 -0.0075 X1 -0.0086 X2 +0.0169 X3 + 0.246 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO= COEF/S.D.
	--	29.69	20.23	1.47
X1	AVG TEMP	-0.0075	0.3150	-0.02
X2	HDD	-0.00857	0.01283	-0.67
X3	CDD	0.01685	0.01155	1.46
X4	PRECIP	0.2462	0.2006	1.23

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 5.434
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 46.1 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	1995.75	498.94
RESIDUAL	79	2332.62	29.53
TOTAL	83	4328.37	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	1995.75
AVG TEMP	1	1872.11
HDD	1	4.61
CDD	1	74.56
PRECIP	1	44.47

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
4	59.7	39.807	28.955	0.950	2.03R
9	83.4	27.549	38.775	1.136	-2.11R
28	50.3	25.966	26.249	2.115	-0.06 X
40	49.2	29.129	25.819	2.427	0.68 X
52	51.3	23.114	26.900	2.110	-0.76 X
58	85.5	52.421	40.685	1.216	2.22R
59	84.9	51.336	40.193	1.226	2.11R
60	78.8	42.153	39.585	2.164	0.52 X
70	85.8	53.753	40.346	1.405	2.55R
71	83.2	45.511	42.314	2.282	0.65 X
76	46.1	22.557	27.522	2.840	-1.07 X
77	49.0	24.136	28.592	2.981	-0.98 X
78	54.2	32.481	30.059	2.971	0.53 X
81	76.3	43.881	38.878	2.066	1.00 X

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.60

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.658			
HDD	-0.566	-0.884		
CDD	0.665	0.956	-0.764	
PRECIP	0.344	0.357	-0.274	0.379

D. DEVELOPING A TIME SERIES MODEL

```
  ACF OF MBTU/KSF      NRMC CORPUS CHRISTI

           -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
             +----+----+----+----+----+----+----+----+
  1   0.775                      XXXXXXXXXXXXXXXXXXXX
  2   0.479                      XXXXXXXXXXXXX
  3   0.063                      XXX
  4  -0.293               XXXXXXXX
  5  -0.560        XXXXXXXXXXXXXXX
  6  -0.640     XXXXXXXXXXXXXXXXX
  7  -0.533         XXXXXXXXXXXXXX
  8  -0.275               XXXXXXXX
  9   0.049                      XX
 10   0.366                      XXXXXXXXXX
 11   0.590                      XXXXXXXXXXXXXXXX
 12   0.656                      XXXXXXXXXXXXXXXXX
 13   0.542                      XXXXXXXXXXXXXXX
 14   0.326                      XXXXXXXXX
 15   0.024                      XX
 16  -0.236                XXXXXXX
 17  -0.390           XXXXXXXXXXX
 18  -0.442          XXXXXXXXXXXX
 19  -0.381           XXXXXXXXXXX
 20  -0.202                 XXXXXX
 21  -0.014                      X
 22   0.185                      XXXXXX
 23   0.294                      XXXXXXXX
 24   0.353                      XXXXXXXXXX
 25   0.303                      XXXXXXXXX
 26   0.175                      XXXXX
 27   0.000                      X
 28  -0.137                   XXXX
 29  -0.236                XXXXXXX
 30  -0.266               XXXXXXXX
 31  -0.239                XXXXXXX
 32  -0.149                  XXXXX
 33  -0.051                     XX
 34   0.059                      XX
 35   0.101                      XXXX
 36   0.118                      XXXX
 37   0.091                      XXX
 38   0.025                      XX
 39  -0.066                    XXX
 40  -0.135                   XXXX
 41  -0.169                  XXXXX
 42  -0.168                  XXXXX
 43  -0.144                  XXXXX
 44  -0.081                    XXX
 45  -0.032                     XX
 46   0.023                      XX
 47   0.027                      XX
 48   0.037                      XX
 49  -0.001                      X
 50  -0.044                     XX
```

PACF OF MBTU/KSF   NRMC CORPUS CHRISTI

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
  1   0.775                    XXXXXXXXXXXXXXXXXXXX
  2  -0.305            XXXXXXXXX
  3  -0.512       XXXXXXXXXXXXXX
  4  -0.196               XXXXXX
  5  -0.148                XXXXX
  6   0.002                    X
  7   0.127                    XXXX
  8   0.128                    XXXX
  9   0.096                    XXX
 10   0.136                    XXXX
 11   0.130                    XXXX
 12   0.042                    XX
 13  -0.041                   XX
 14   0.106                    XXXX
 15  -0.025                   XX
 16   0.059                    XX
 17   0.179                    XXXXX
 18  -0.074                  XXX
 19  -0.127                 XXXX
 20   0.073                    XXX
 21  -0.156                XXXXX
 22  -0.033                   XX
 23  -0.048                   XX
 24   0.049                    XX
 25  -0.018                    X
 26  -0.086                  XXX
 27  -0.059                   XX
 28   0.023                    XX
 29   0.001                    X
 30   0.016                    X
 31  -0.077                  XXX
 32   0.031                    XX
 33  -0.010                    X
 34  -0.024                   XX
 35  -0.116                 XXXX
 36  -0.055                   XX
 37   0.017                    X
 38  -0.077                  XXX
 39  -0.118                 XXXX
 40  -0.005                    X
 41   0.000                    X
 42  -0.103                 XXXX
 43  -0.035                   XX
 44   0.040                    XX
 45  -0.083                  XXX
 46   0.012                    X
 47  -0.010                    X
 48   0.030                    XX
 49  -0.031                   XX
 50  -0.038                   XX
```

```
ARIMA  (3  0  3) (0  0  1)  S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
    1       AR  1       0.8811        0.4921      1.79
    2       AR  2       0.3797        0.8122      0.47
    3       AR  3      -0.7284        0.4624     -1.58
    4       MA  1       0.2945        0.5275      0.56
    5       MA  2       0.2956        0.5783      0.51
    6       MA  3      -0.2940        0.3174     -0.93
    7      SMA 12      -0.2247        0.1261     -1.78
    8      CONSTANT    15.8557        0.3332     47.59
           MEAN        33.9091        0.7125

RESIDUALS.     SS =        946.172  (BACKFORECASTS EXCL)
N = 84         DF =     76   MS =        12.450

   ACF OF RESIDUAL      NRMC CORPUS CHRISTI

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----+----
  1   0.039                     XX
  2  -0.001                     X
  3  -0.039                    XX
  4   0.111                     XXXX
  5   0.056                     XX
  6   0.079                     XXX
  7   0.160                     XXXXX
  8   0.045                     XX
  9   0.048                     XX
 10   0.037                     XX
 11   0.165                     XXXXX
 12  -0.028                    XX
 13   0.093                     XXX
 14   0.146                     XXXXX
 15   0.018                     X
 16  -0.103                  XXXX
 17   0.099                     XXX
 18  -0.024                    XX
 19  -0.073                   XXX
 20   0.088                     XXX
 21   0.027                     XX
 22   0.003                     X
 23  -0.157                 XXXXX
 24   0.067                     XXX
 25   0.058                     XX
 26   0.004                     X
 27  -0.074                   XXX
 28  -0.019                     X
 29  -0.049                    XX
 30  -0.011                     X
 31  -0.068                   XXX
 32  -0.127                  XXXX
 33  -0.137                  XXXX
 34   0.026                     XX
 35  -0.045                    XX
 36  -0.111                  XXXX
 37   0.015                     X
 38   0.034                     XX
 39  -0.111                  XXXX
 40  -0.163                 XXXXX
```

ARIMA (3 0 2)(0 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	1.9347	0.2468	7.84
2	AR 2	-1.3725	0.4190	-3.28
3	AR 3	0.2293	0.2330	0.98
4	MA 1	1.3300	0.2020	6.58
5	MA 2	-0.6600	0.1664	-3.97
6	SMA 12	-0.2090	0.1239	-1.69
7	CONSTANT	7.0646	0.1534	46.04
	MEAN	33.8761	0.7357	

RESIDUALS. SS = 950.059 (BACKFORECASTS EXCL)
N = 84 DF = 77 MS = 12.338

ACF OF RESIDUAL NRMC CORPUS CHRISTI

```
                  -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                    +----+----+----+----+----+----+----+----
   1  -0.020                            X
   2   0.140                            XXXXX
   3  -0.109                         XXXX
   4   0.089                            XXX
   5  -0.017                            X
   6   0.081                            XXX
   7   0.134                            XXXX
   8   0.067                            XXX
   9   0.070                            XXX
  10   0.023                            XX
  11   0.148                            XXXXX
  12  -0.032                           XX
  13   0.072                            XXX
  14   0.100                            XXXX
  15   0.022                            XX
  16  -0.080                          XXX
  17   0.095                            XXX
  18   0.012                            X
  19  -0.047                           XX
  20   0.101                            XXXX
  21  -0.027                           XX
  22   0.012                            X
  23  -0.178                        XXXXX
  24   0.048                            XX
  25   0.006                            X
  26   0.032                            XX
  27  -0.061                          XXX
  28   0.022                            XX
  29  -0.047                           XX
  30  -0.006                            X
  31  -0.096                          XXX
  32  -0.107                         XXXX
  33  -0.147                        XXXXX
  34   0.021                            XX
  35  -0.043                           XX
  36  -0.057                           XX
  37   0.021                            XX
  38   0.026                            XX
  39  -0.102                         XXXX
  40  -0.137                         XXXX
```

ARIMA (3 1 2)(0 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	1.2987	0.1052	12.35
2	AR 2	-0.2496	0.1796	-1.39
3	AR 3	-0.4105	0.1061	-3.87
4	MA 1	1.7107	0.0033	518.10
5	MA 2	-0.7901	0.0217	-36.43
6	SMA 12	-0.0834	0.1235	-0.68

```
DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =        911.000  (BACKFORECASTS EXCL)
               DF =    77  MS =      11.831
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF.  83
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	95 PERCENT LIMITS UPPER
85	37.6420	30.8989	44.3850
86	32.0876	24.2650	39.9101
87	28.0208	19.2339	36.8076
88	25.7451	16.7390	34.7512
89	26.0624	17.0438	35.0809
90	29.0579	19.9858	38.1301
91	33.2666	24.0415	42.4917
92	37.7870	28.4266	47.1474
93	41.9543	32.5675	51.3410
94	44.1309	34.7177	53.5441
95	44.4665	34.7818	54.1511
96	42.2428	31.9090	52.5766

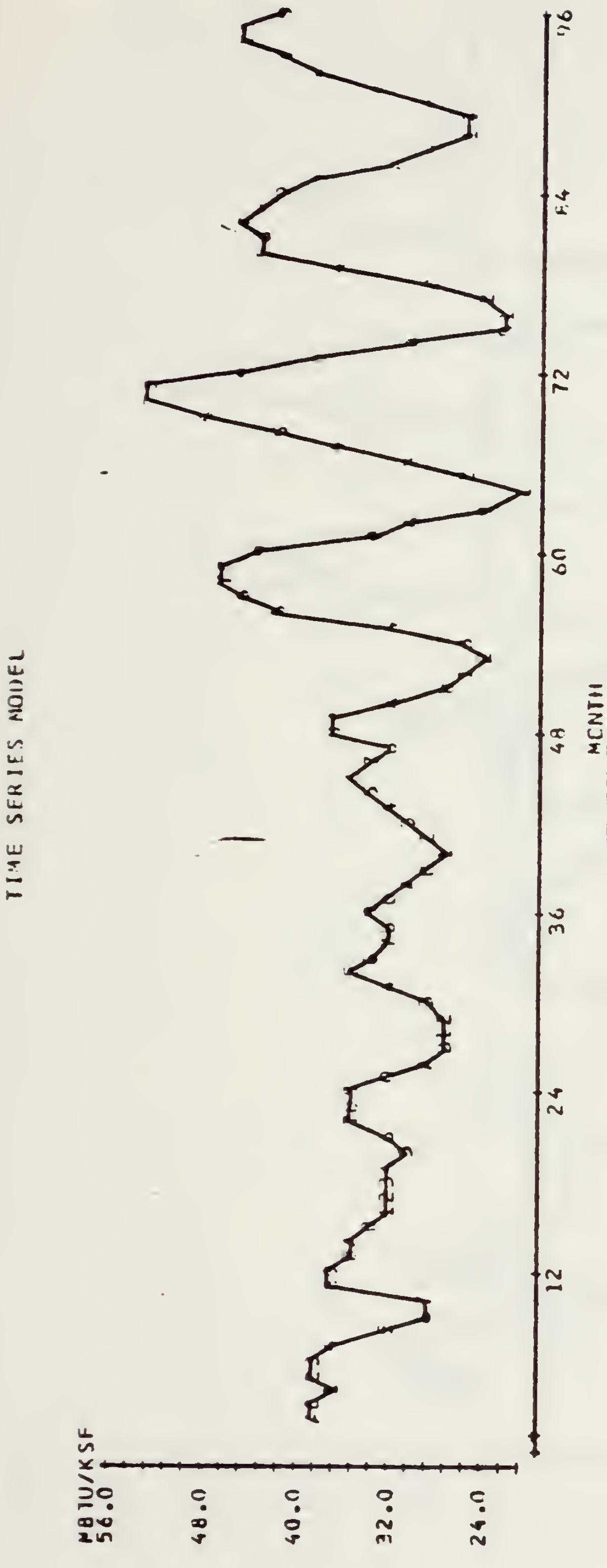
```
  ACF OF RESIDUAL      NRMC CORPUS CHRISTI

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
          +----+----+----+----+----+----+----+----+----
 1   0.017                     X
 2  -0.005                     X
 3  -0.045                    XX
 4   0.093                     XXX
 5  -0.020                    XX
 6  -0.004                     X
 7   0.043                     XX
 8  -0.006                     X
 9  -0.074                   XXX
10  -0.044                    XX
11   0.039                     XX
12  -0.017                     X
13  -0.011                     X
14   0.059                     XX
15  -0.074                   XXX
16  -0.119                  XXXX
17   0.093                     XXX
18  -0.013                     X
19  -0.083                   XXX
20   0.091                     XXX
21   0.029                     XX
22   0.024                     XX
23  -0.162                 XXXXX
24   0.044                     XX
25   0.056                     XX
26   0.026                     XX
27  -0.080                   XXX
28  -0.006                     X
29  -0.012                     X
30   0.046                     XX
```

E. FITTING A TREND LINE

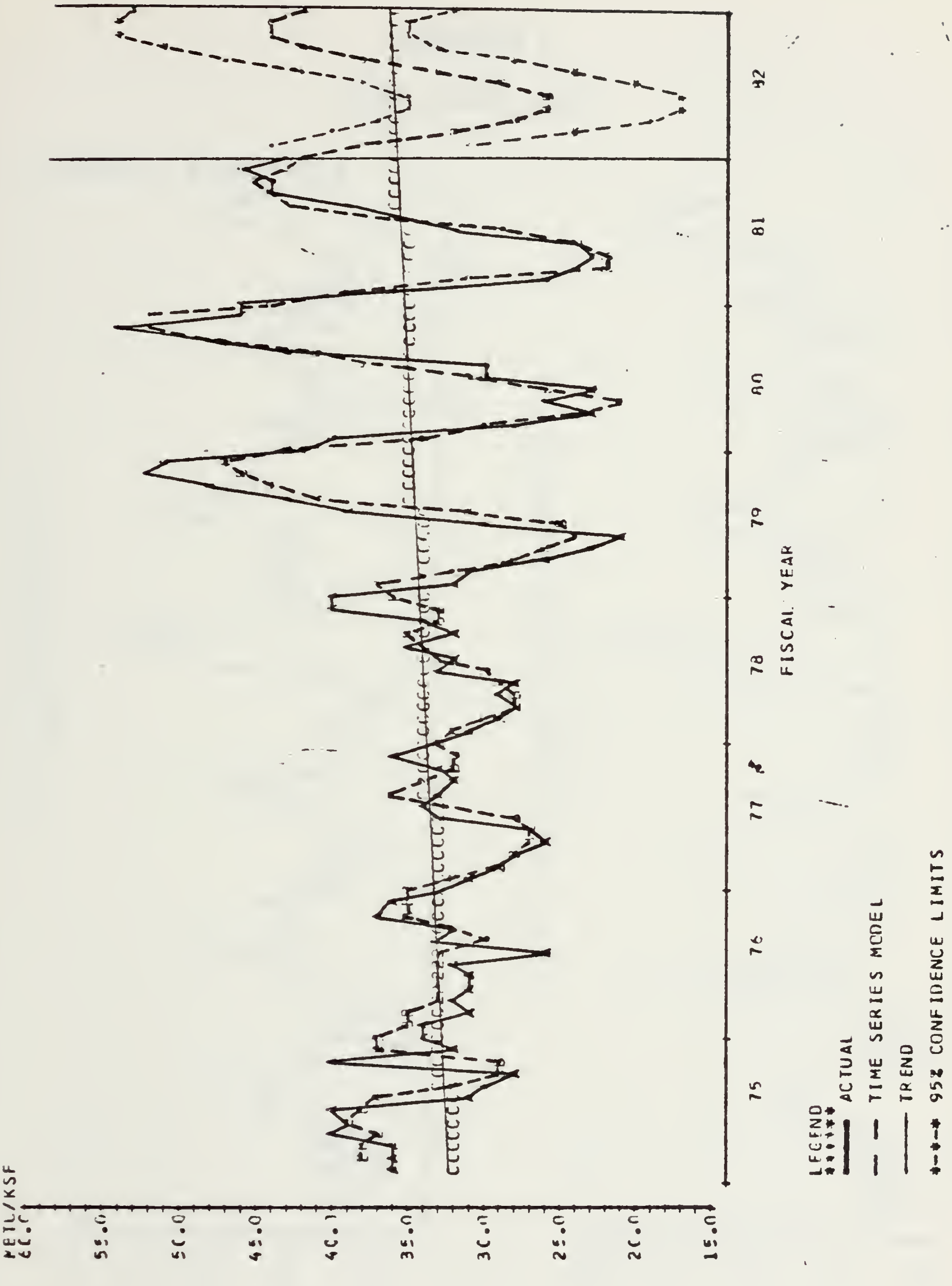
REGRESSION OF MODELED MBTU/KSF VS MONTH

```
    95 CASES USED
     1 CASES CONTAINED MISSING VALUES

 THE REGRESSION EQUATION IS
   Y =  32.2 +0.0422 X1

                                             ST. DEV.   T-RATIO =
        COLUMN       COEFFICIENT             OF COEF.   COEF/S.D.
        --                32.175               1.396       23.05
 X1     MONTH             0.04225             0.02486      1.70

 THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 6.644
 WITH (  95- 2) =  93 DEGREES OF FREEDOM

 R-SQUARED =  3.0 PERCENT

 ANALYSIS OF VARIANCE
  DUE TO        DF           SS          MS=SS/DF
 REGRESSION      1        127.52          127.52
 RESIDUAL       93       4105.73           44.15
 TOTAL          94       4233.25

             X1          Y        PRED. Y      ST.DEV.
 ROW       MONTH   ARIMA LN        VALUE     PRED. Y       ST.RES.
  64        64.0     20.760       34.873       0.777        -2.14R
  70        70.0     52.398       35.132       0.859         2.62R
  71        71.0     52.496       35.174       0.874         2.63R
  76        76.0     21.683       35.385       0.957        -2.08R

 R ==> OBS. WITH A LARGE ST. RES.
 X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

 DURBIN-WATSON STATISTIC = 0.31
```

F. DECOMPOSITION LINES



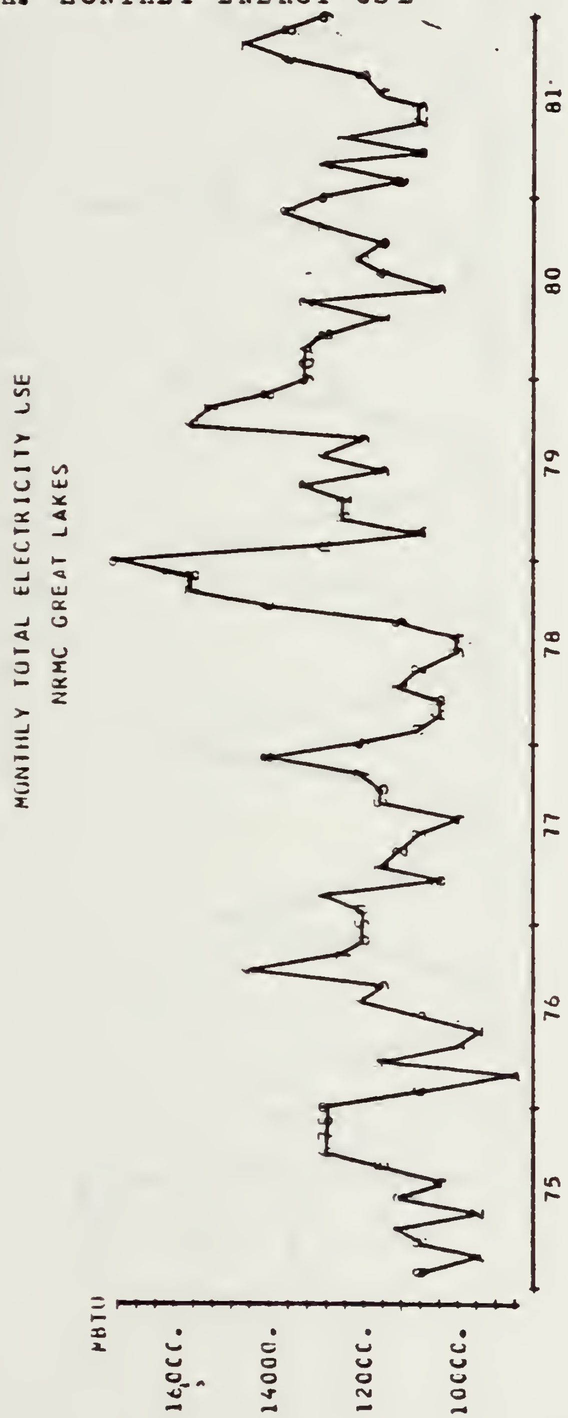
G. ACTUAL USE AND FORECAST MODELS

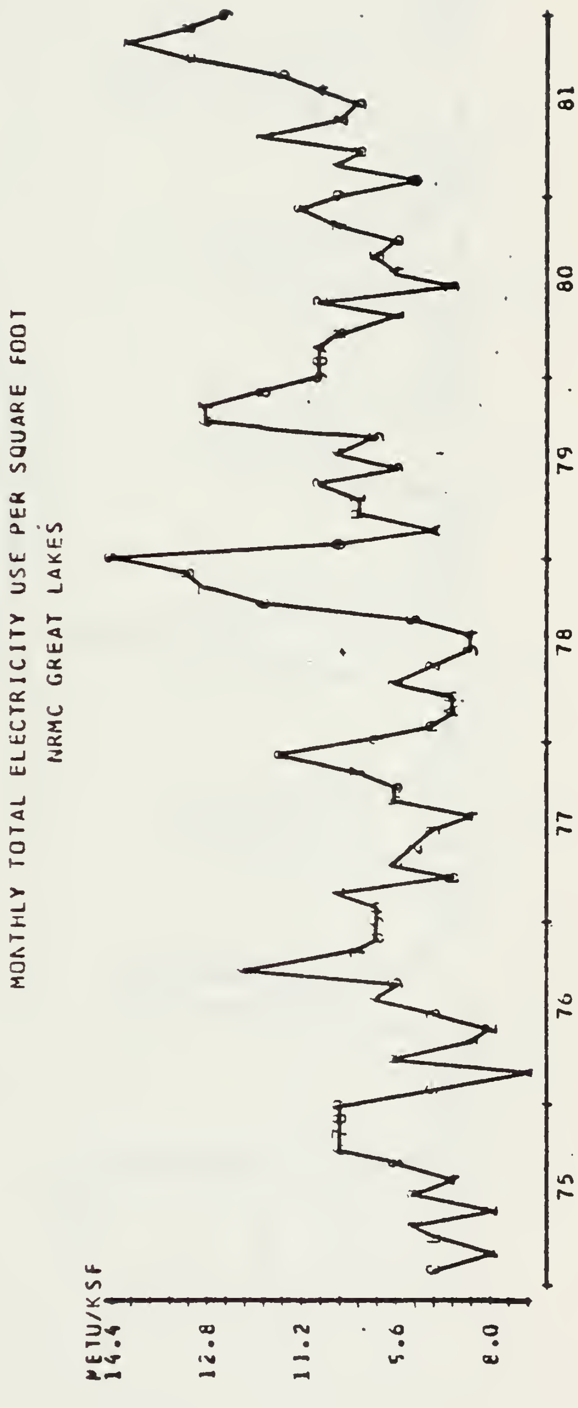


APPENDIX D

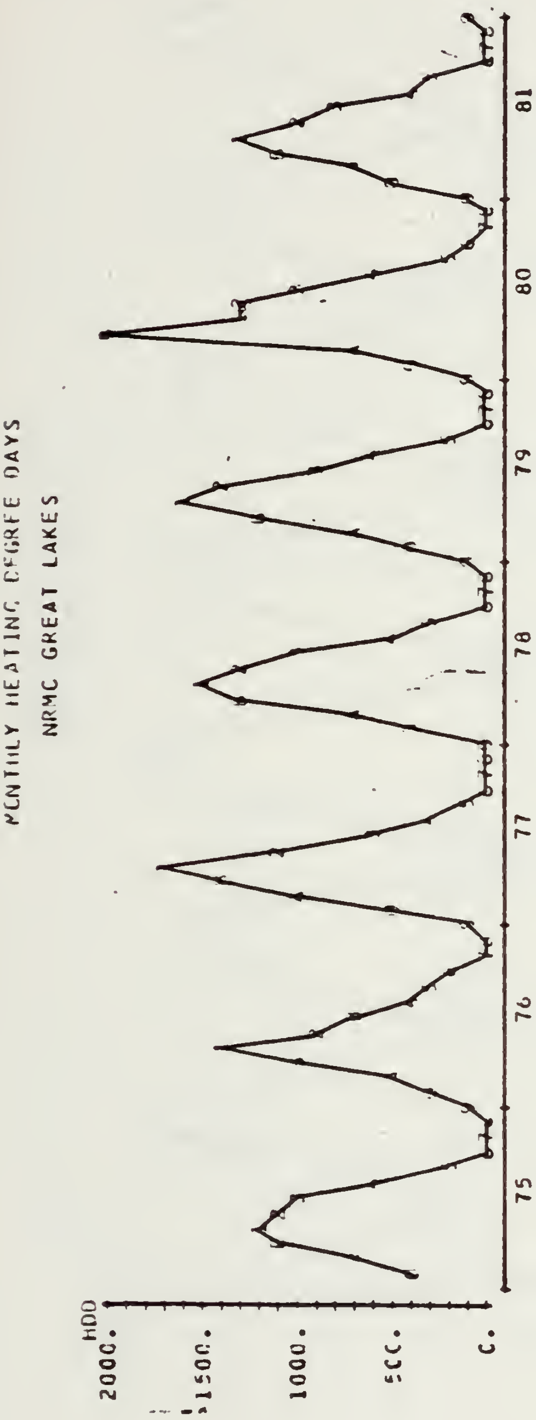
NRMC GREAT LAKES

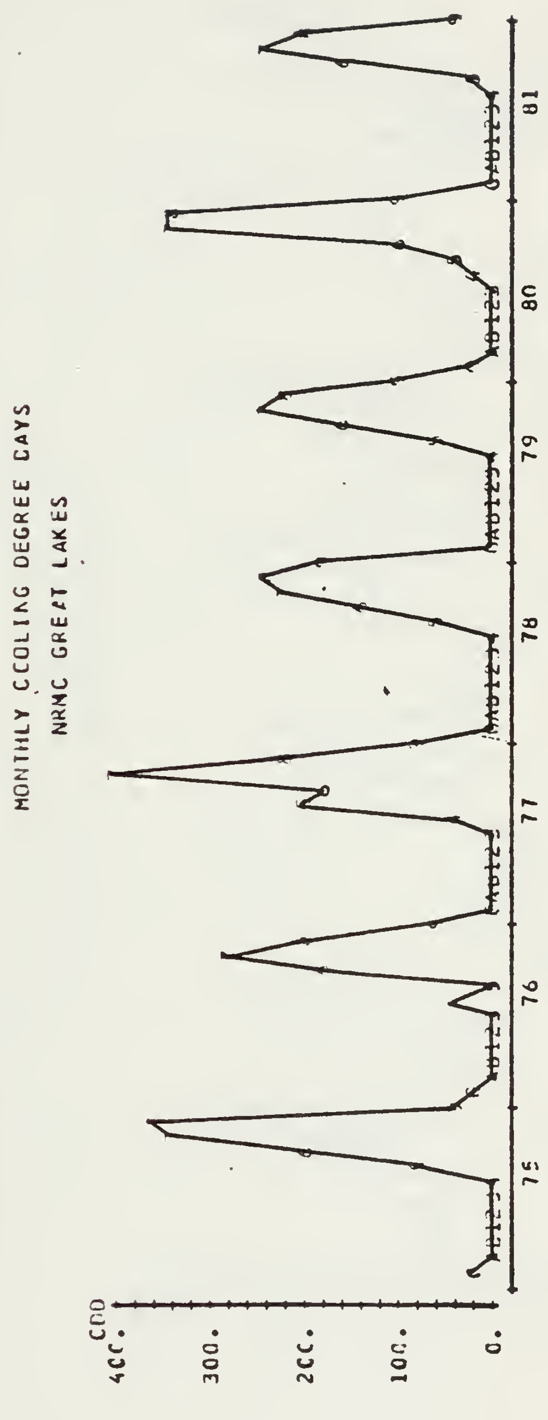
A. MONTHLY ENERGY USE



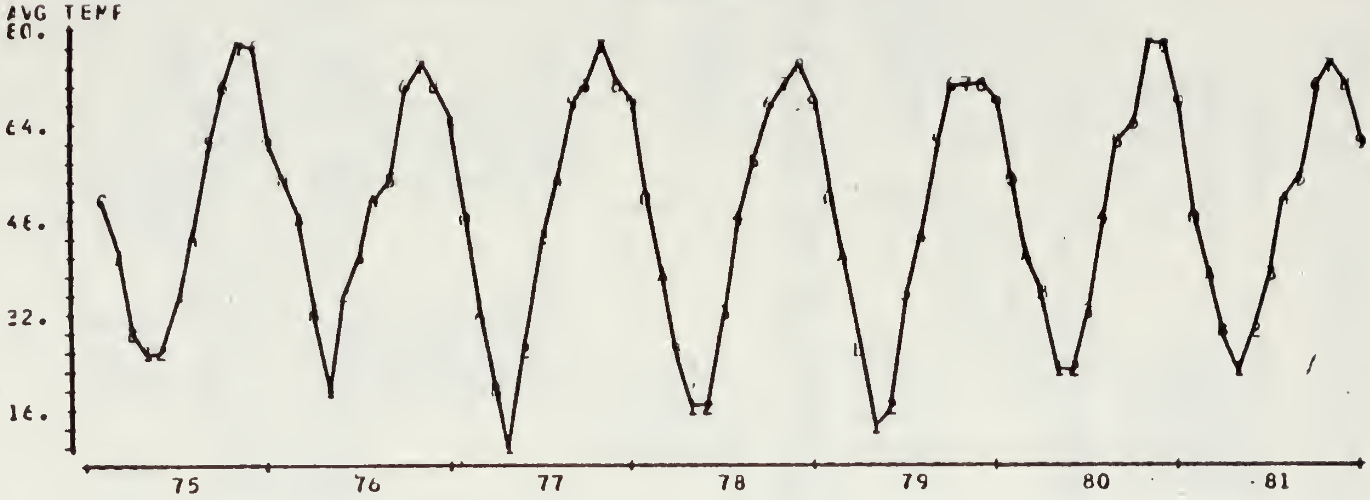


B. MONTHLY WEATHER SUMMARY

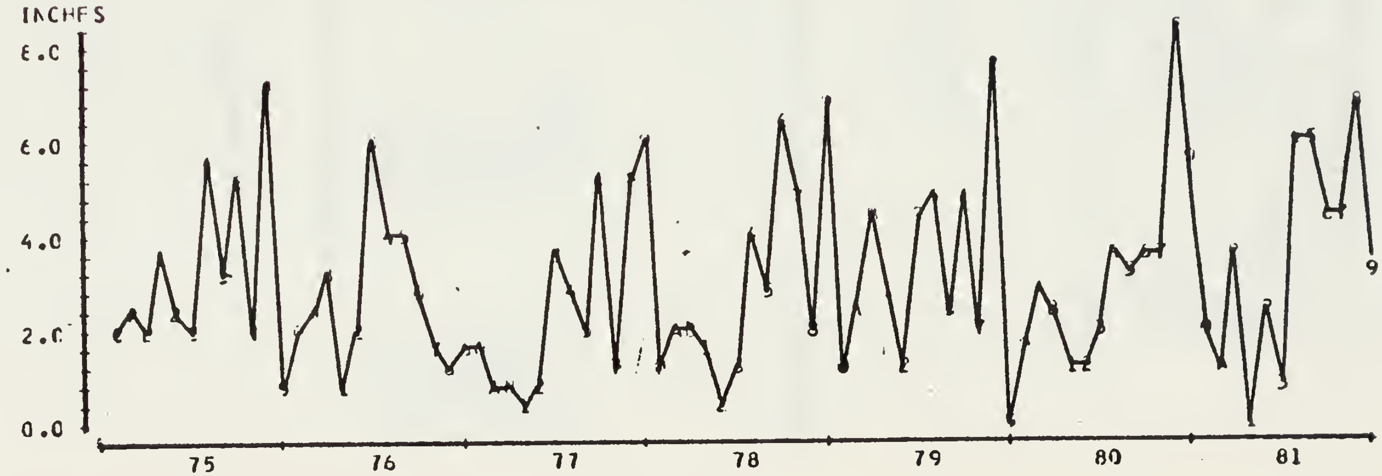




MONTHLY AVERAGE TEMPERATURES
NRMC GREAT LAKES



MONTHLY PRECIPITATION
NRMC GREAT LAKES



C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC GREAT LAKES IS:
Y = 7.13 +0.0385 X1 +0.0009 X2 +0.0040 X3 + 0.119 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO= COEF/S.D.
	--	7.135	2.301	3.10
X1	AVG TEMP	0.03847	0.03655	1.05
X2	HDD	0.000929	0.001137	0.82
X3	CDD	0.003967	0.002272	1.75
X4	PRECIP	0.11920	0.07732	1.54

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 1.206
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 32.8 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	56.073	14.018
RESIDUAL	79	114.964	1.455
TOTAL	83	171.036	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	56.073
AVG TEMP	1	43.001
HDD	1	5.145
CDD	1	4.468
PRECIP	1	3.458

ROW	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
11	76.3	10.518	12.369	0.461	-1.66 X
34	77.5	10.093	11.831	0.522	-1.60 X
48	68.8	14.275	11.374	0.297	2.48R
63	33.7	10.586	10.566	1.158	0.06 X
71	75.7	11.339	12.424	0.496	-0.99 X
76	22.6	11.966	9.232	0.274	2.33R
82	72.5	13.951	11.451	0.253	2.12R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.84

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.501			
HDD	-0.441	-0.967		
CDD	0.534	0.791	-0.693	
PRECIP	0.368	0.477	-0.456	0.385

D. DEVELOPING A TIME SERIES MODEL

```
    ACF OF MBTU/KSF        NRMC GREAT LAKES

           -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
             +----+----+----+----+----+----+----+----
  1   0.646                      XXXXXXXXXXXXXXXXX
  2   0.425                      XXXXXXXXXXXX
  3   0.216                      XXXXXX
  4   0.053                      XX
  5   0.015                      X
  6   0.007                      X
  7  -0.041                     XX
  8  -0.057                     XX
  9   0.055                      XX
 10   0.183                      XXXXXX
 11   0.318                      XXXXXXXXX
 12   0.333                      XXXXXXXXX
 13   0.278                      XXXXXXXX
 14   0.137                      XXXX
 15  -0.029                     XX
 16  -0.089                    XXX
 17  -0.081                    XXX
 18  -0.143                  XXXXX
 19  -0.094                    XXX
 20  -0.084                    XXX
 21  -0.045                     XX
 22   0.133                      XXXX
 23   0.270                      XXXXXXXX
 24   0.310                      XXXXXXXXX
 25   0.306                      XXXXXXXXX
 26   0.211                      XXXXXX
 27   0.123                      XXXX
 28   0.016                      X
 29  -0.018                      X
 30  -0.071                    XXX
 31  -0.112                   XXXX
 32  -0.100                    XXX
 33  -0.007                      X
 34   0.088                      XXX
 35   0.226                      XXXXXXX
 36   0.333                      XXXXXXXXX
 37   0.203                      XXXXXX
 38   0.028                      XX
 39  -0.088                    XXX
 40  -0.204                 XXXXXX
 41  -0.234                XXXXXXX
 42  -0.228                XXXXXXX
 43  -0.294               XXXXXXXX
 44  -0.267               XXXXXXXX
 45  -0.244                XXXXXXX
 46  -0.132                   XXXX
 47  -0.048                     XX
 48  -0.011                      X
 49  -0.015                      X
 50  -0.050                     XX
```

```
PACF OF MBTU/KSF     NRMC GREAT LAKES

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
 1   0.656                      XXXXXXXXXXXXXXXXX
 2  -0.011                      X
 3  -0.102                   XXXX
 4  -0.084                    XXX
 5   0.076                      XXX
 6   0.020                      XX
 7  -0.098                    XXX
 8  -0.015                      X
 9   0.223                      XXXXXXX
10   0.168                      XXXXX
11   0.137                      XXXX
12  -0.038                     XX
13   0.004                      X
14  -0.100                   XXXX
15  -0.161                  XXXXX
16   0.008                      X
17   0.105                      XXXX
18  -0.127                   XXXX
19   0.078                      XXX
20  -0.041                     XX
21   0.005                      X
22   0.166                      XXXXX
23   0.098                      XXX
24   0.023                      XX
25   0.087                      XXX
26  -0.009                      X
27   0.053                      XX
28  -0.136                   XXXX
29   0.053                      XX
30  -0.051                     XX
31  -0.033                     XX
32  -0.002                      X
33   0.069                      XXX
34  -0.002                      X
35   0.134                      XXXX
36   0.028                      XX
37  -0.189                 XXXXXX
38  -0.217                 XXXXXX
39  -0.009                      X
40  -0.055                     XX
41   0.001                      X
42  -0.026                     XX
43  -0.072                    XXX
44  -0.003                      X
45  -0.175                  XXXXX
46  -0.109                   XXXX
47  -0.068                    XXX
48  -0.036                     XX
49   0.024                      XX
50   0.080                      XXX
```

ARIMA (1 1 2)(0 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	0.5936	0.1331	4.46
2	MA 1	0.9762	0.1105	8.83
3	MA 2	-0.0270	0.1230	-0.22
4	SMA 12	-0.1516	0.1240	-1.22

```
DIFFERENCING. 1 REGULAR
RESIDUALS.    SS =        92.2120   (BACKFORECASTS EXCL)
              DF =    79  MS =        1.1672
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF.  83
```

ACF OF RESIDUAL   NRMC GREAT LAKES

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----
 1  -0.034                    XX
 2   0.026                     XX
 3  -0.008                     X
 4  -0.128                  XXXX
 5  -0.060                   XXX
 6   0.027                     XX
 7  -0.079                   XXX
 8  -0.198                XXXXXX
 9   0.017                     X
10   0.006                     X
11   0.209                     XXXXXX
12  -0.021                    XX
13   0.113                     XXXX
14   0.063                     XXX
15  -0.186                XXXXXX
16  -0.137                  XXXX
17   0.040                     XX
18  -0.182                XXXXXX
19  -0.039                    XX
20  -0.013                     X
21  -0.249               XXXXXXX
22   0.040                     XX
23   0.142                     XXXXX
24   0.074                     XXX
25   0.137                     XXXX
26   0.001                     X
27   0.069                     XXX
28  -0.030                    XX
29  -0.004                     X
30  -0.034                    XX
31  -0.078                   XXX
32  -0.130                  XXXX
33   0.052                     XX
34  -0.003                     X
35   0.058                     XX
36   0.333                     XXXXXXXXX
37   0.130                     XXXX
38  -0.049                    XX
39   0.015                     X
40  -0.088                   XXX
```

```
ARIMA  (1  1 3) (1  0  1)  S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
     1     AR  1        0.2276        2.8776       0.08
     2    SAR 12        0.9908        0.0275      36.08
     3     MA  1        0.7873        2.8820       0.27
     4     MA  2       -0.0746        1.6118      -0.05
     5     MA  3        0.0120        0.2600       0.05
     6    SMA 12        0.8423        0.1179       7.15

DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =       71.7551   (BACKFORECASTS EXCL)
               DF =     77  MS =        0.9319
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF. 83

   ACF OF RESIDUAL        NRMC GREAT LAKES

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
  1  -0.017                     X
  2  -0.020                    XX
  3   0.019                     X
  4  -0.085                   XXX
  5  -0.040                    XX
  6   0.082                     XXX
  7  -0.055                    XX
  8  -0.135                  XXXX
  9   0.074                     XXX
 10  -0.002                     X
 11   0.054                     XX
 12  -0.218                XXXXXX
 13  -0.034                    XX
 14   0.022                     XX
 15  -0.136                  XXXX
 16  -0.031                    XX
 17   0.107                     XXXX
 18  -0.111                  XXXX
 19   0.049                     XX
 20   0.082                     XXX
 21  -0.157                 XXXXX
 22   0.003                     X
 23   0.015                     X
 24  -0.226               XXXXXXX
 25  -0.067                   XXX
 26   0.024                     XX
 27   0.190                     XXXXXX
 28   0.124                     XXXX
 29   0.078                     XXX
 30   0.002                     X
 31  -0.076                   XXX
 32  -0.040                    XX
 33   0.123                     XXXX
 34  -0.047                    XX
 35  -0.033                    XX
 36   0.180                     XXXXX
 37   0.014                     X
 38  -0.035                    XX
 39   0.024                     XX
 40  -0.008                     X
```

ARIMA (1 1 2)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.7785	0.3206	-2.43
2	SAR 12	0.9918	0.0239	41.52
3	MA 1	-0.2134	0.3074	-0.69
4	MA 2	0.5575	0.1725	3.23
5	SMA 12	0.8608	0.1132	7.61

```
DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =        70.6475  (BACKFORECASTS EXCL)
               DF =    78  MS =        0.9057
NO. OF OBS.    ORIGINAL SERIES    84      AFTER DIFF. 83
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	11.7292	9.8635	13.5949
86	11.4740	9.4395	13.5085
87	11.7168	9.5980	13.8357
88	12.0119	9.7600	14.2639
89	11.7710	9.4326	14.1094
90	11.2263	8.7757	13.6770
91	11.7983	9.2622	14.3344
92	12.0538	9.4188	14.6889
93	13.5296	10.8115	16.2477
94	13.7003	10.8924	16.5083
95	13.7738	10.8858	16.6617
96	13.3748	10.4036	16.3459

```
   ACF OF RESIDUAL       NRMC GREAT LAKES

                -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
                   +----+----+----+----+----+----+----+----
  1   -0.009                           X
  2    0.044                           XX
  3   -0.054                          XX
  4   -0.068                         XXX
  5   -0.063                         XXX
  6    0.067                           XXX
  7   -0.054                          XX
  8   -0.137                        XXXX
  9    0.081                           XXX
 10   -0.006                           X
 11    0.068                           XXX
 12   -0.209                      XXXXXX
 13   -0.025                          XX
 14   -0.009                           X
 15   -0.100                        XXXX
 16   -0.054                          XX
 17    0.113                           XXXX
 18   -0.105                        XXXX
 19    0.056                           XX
 20    0.040                           XX
 21   -0.129                        XXXX
 22   -0.021                          XX
 23    0.011                           X
 24   -0.217                      XXXXXX
 25   -0.070                         XXX
 26    0.020                           XX
 27    0.202                           XXXXXX
 28    0.134                           XXXX
 29    0.102                           XXXX
 30   -0.017                           X
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

95 CASES USED
1 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC GREAT LAKES IS:
Y = 8.95 +0.0331 MONTH

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO= COEF/S.D.
	--	8.9460	0.2099	42.62
X1	MONTH	0.033053	0.003738	8.84

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 0.9991
WITH (95- 2) = 93 DEGREES OF FREEDOM

R-SQUARED = 45.7 PERCENT

ANALYSIS OF VARIANCE

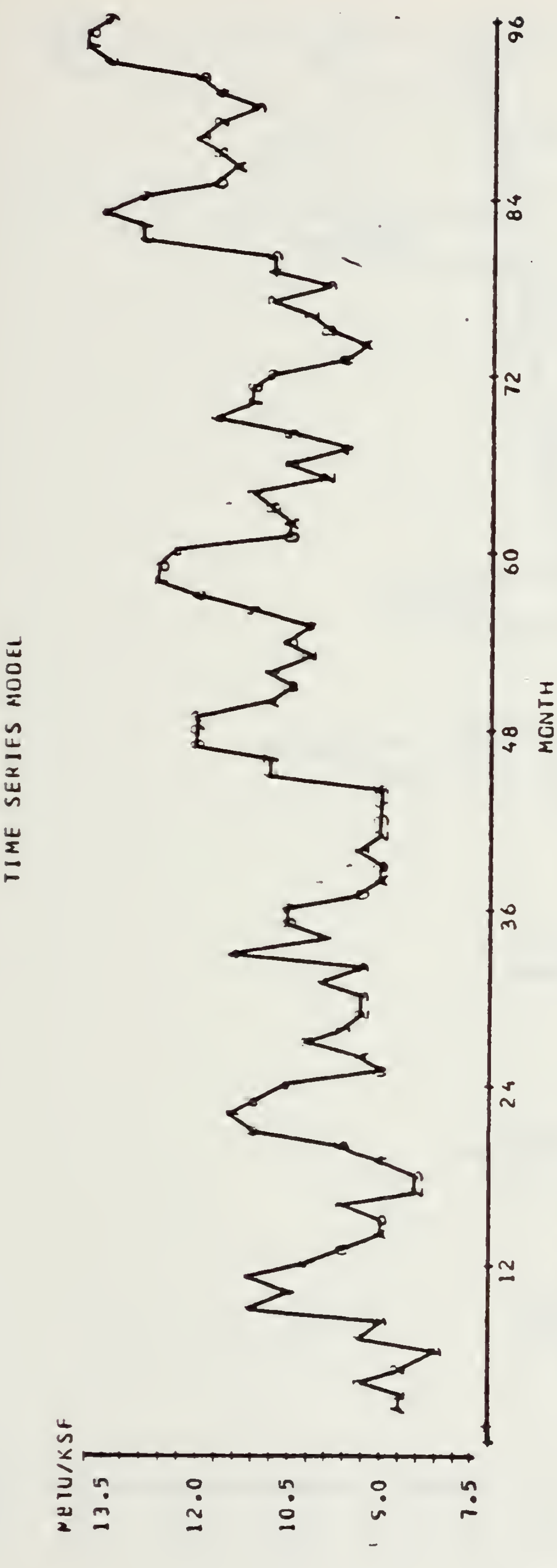
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	78.0487	78.0487
RESIDUAL	93	92.8401	0.9983
TOTAL	94	170.8889	

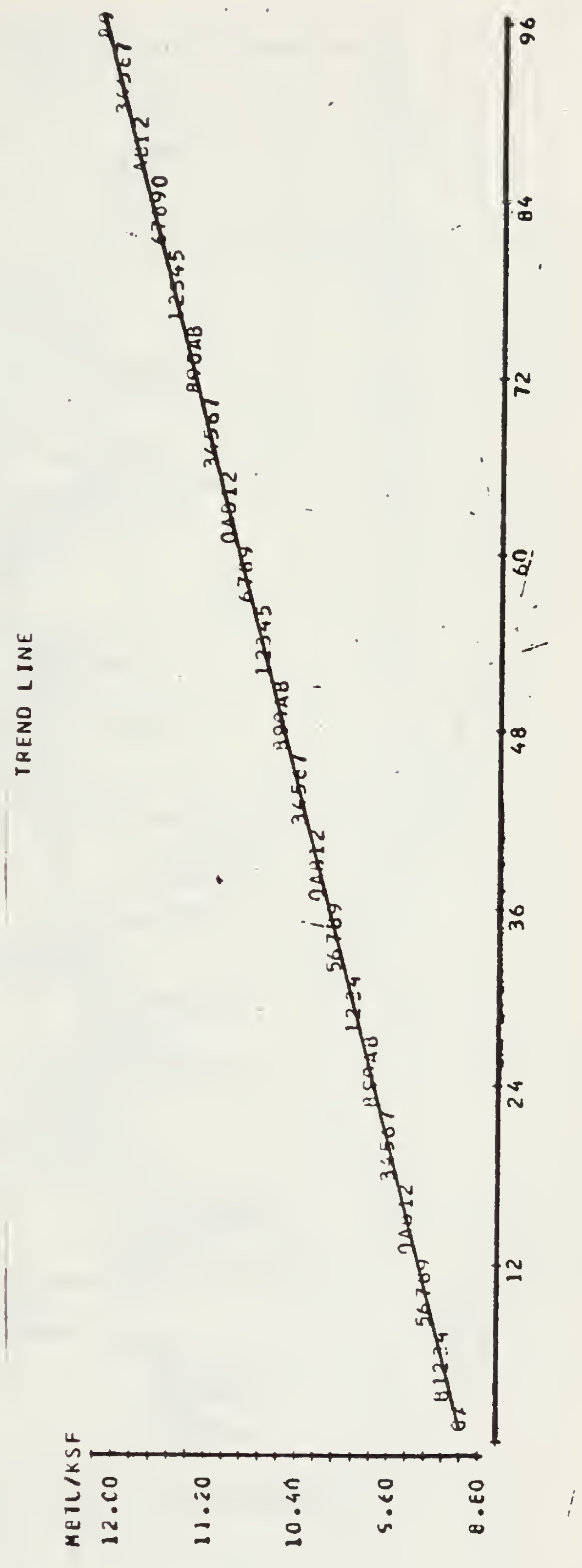
ROW	X1 MONTH	Y ARIMA	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
74	74.0	9.334	11.392	0.139	-2.08R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

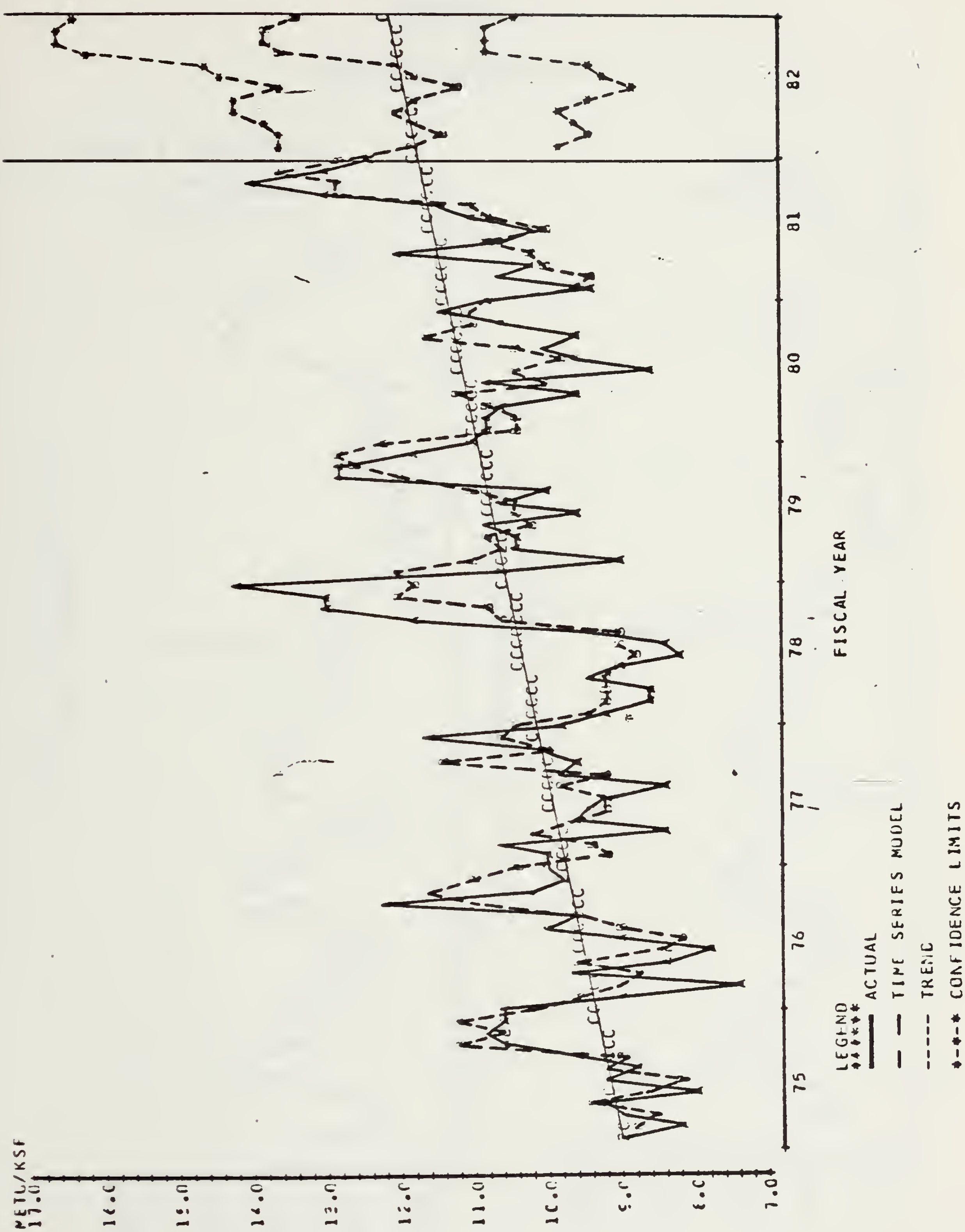
DURBIN-WATSON STATISTIC = 0.60

F. DECOMPOSITION LINES





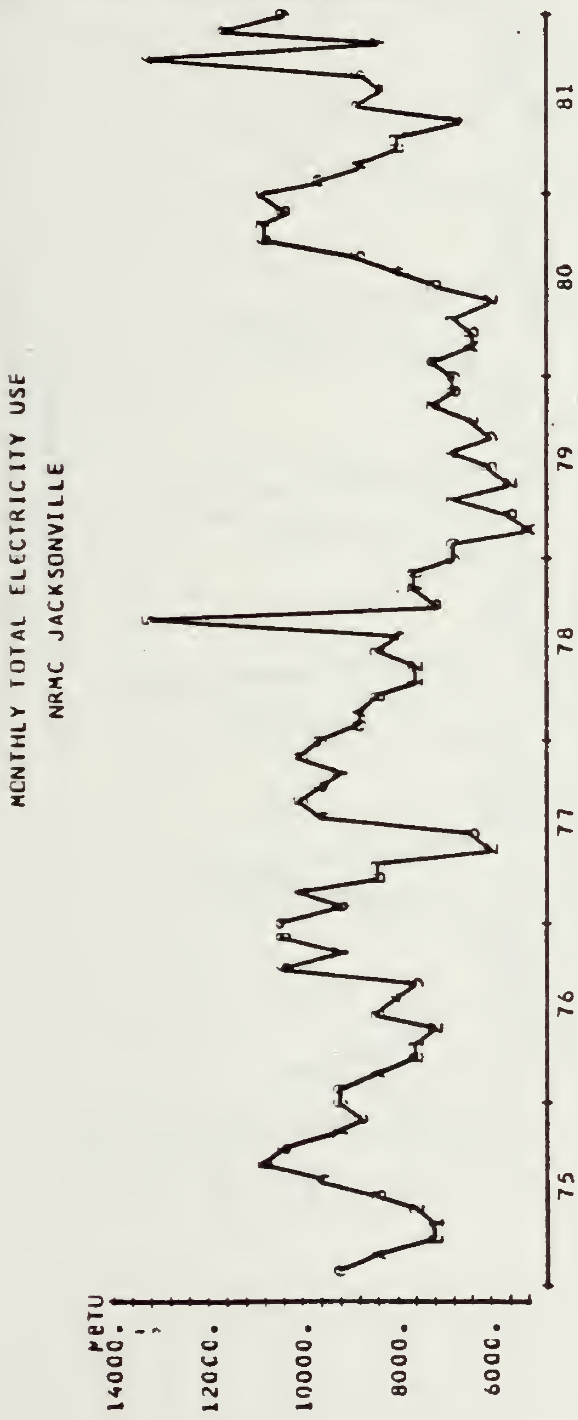
G. ACTUAL USE AND FORECAST MODELS

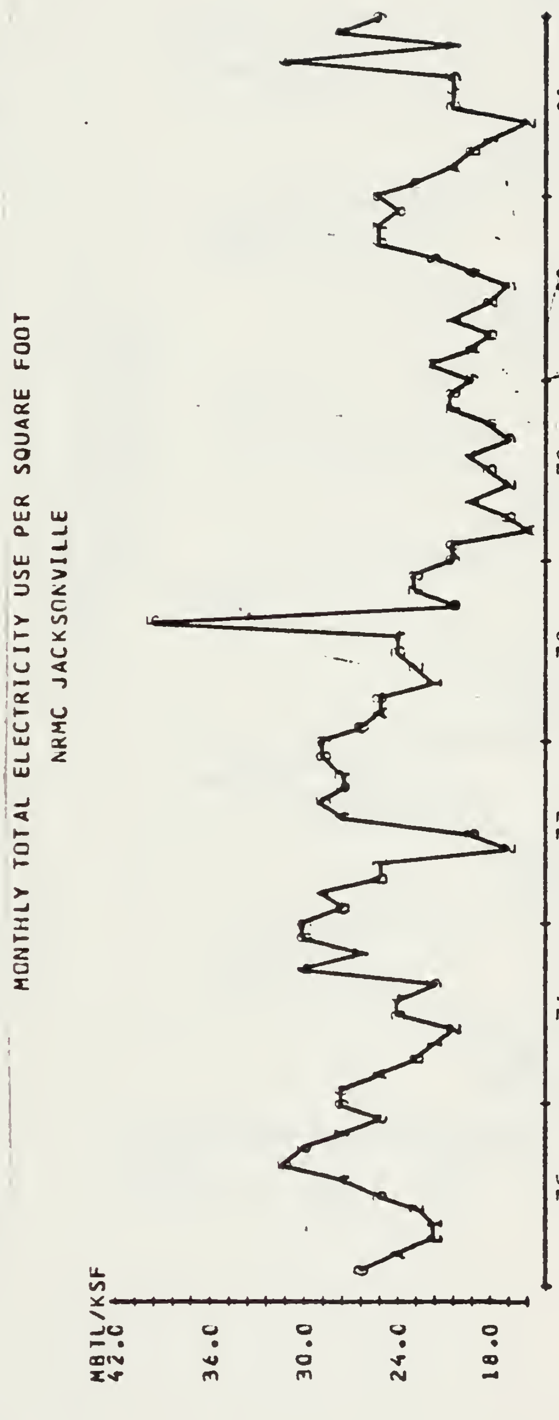


APPENDIX E

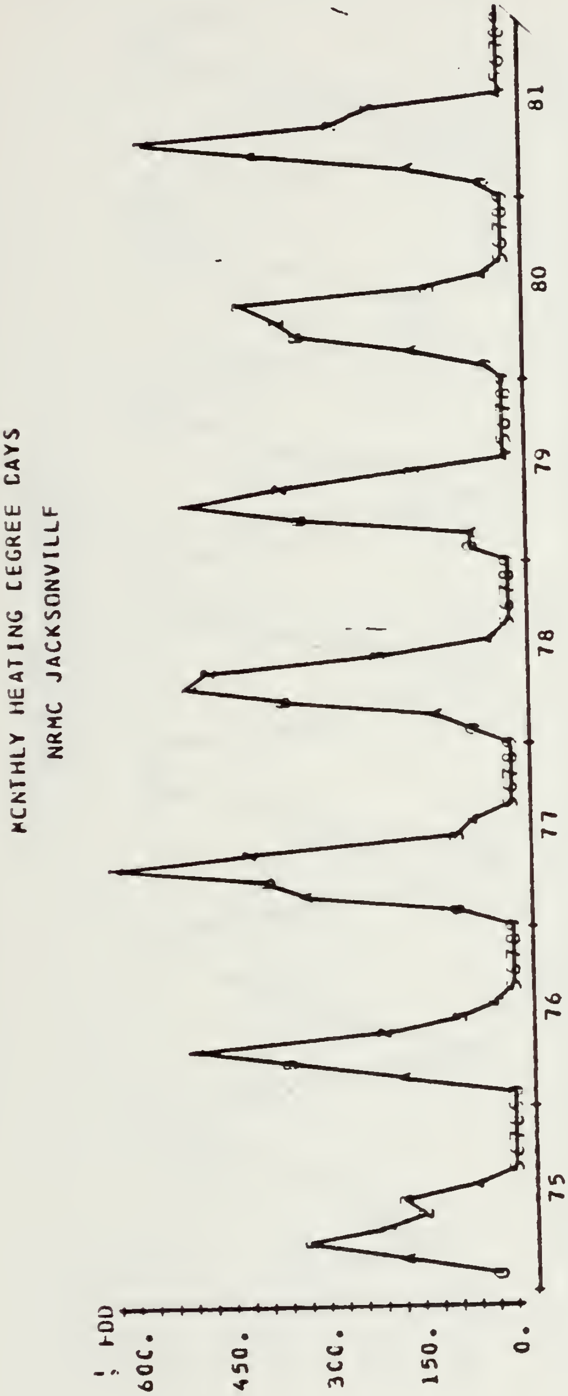
NRMC JACKSONVILLE

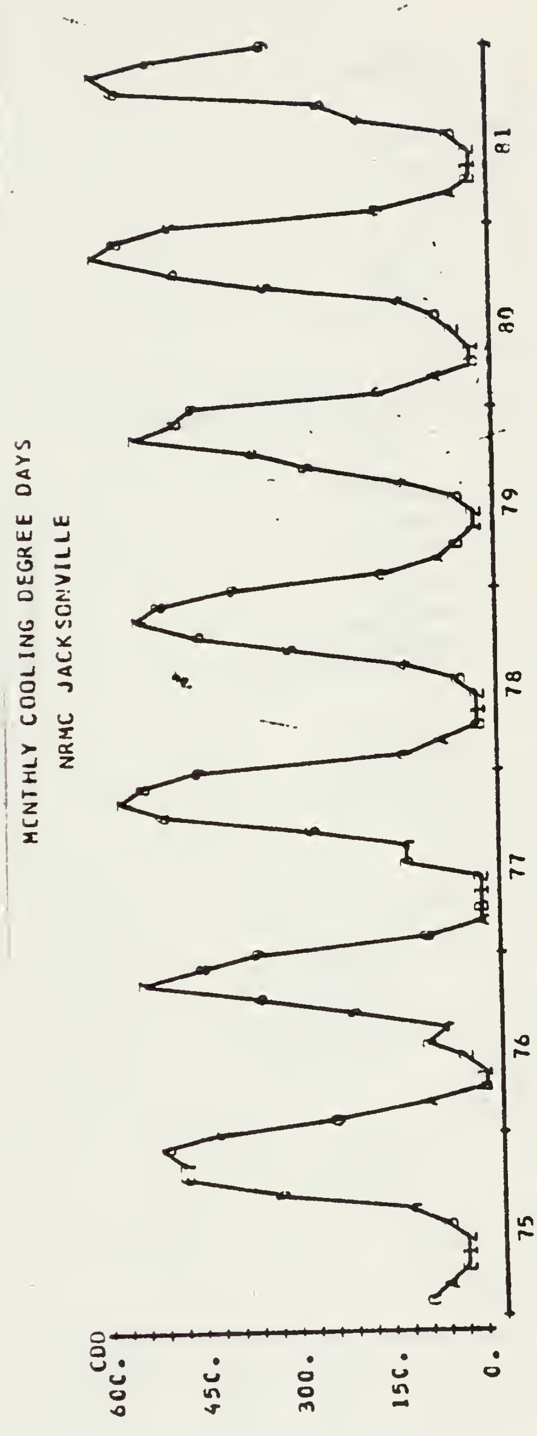
A. MONTHLY ENERGY USE



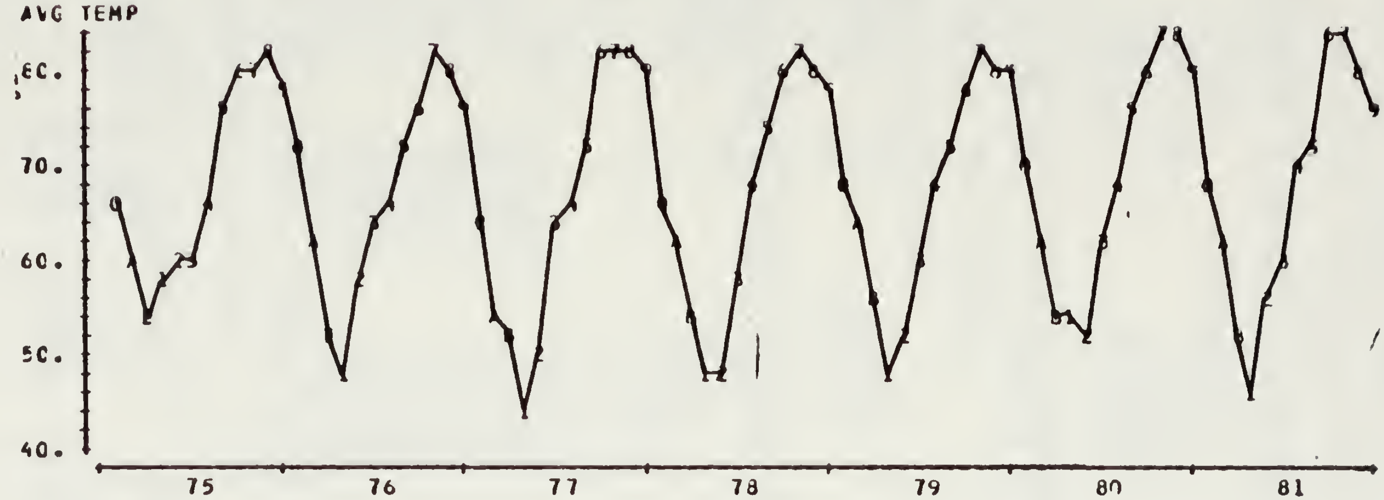


B. MONTHLY WEATHER SUMMARY

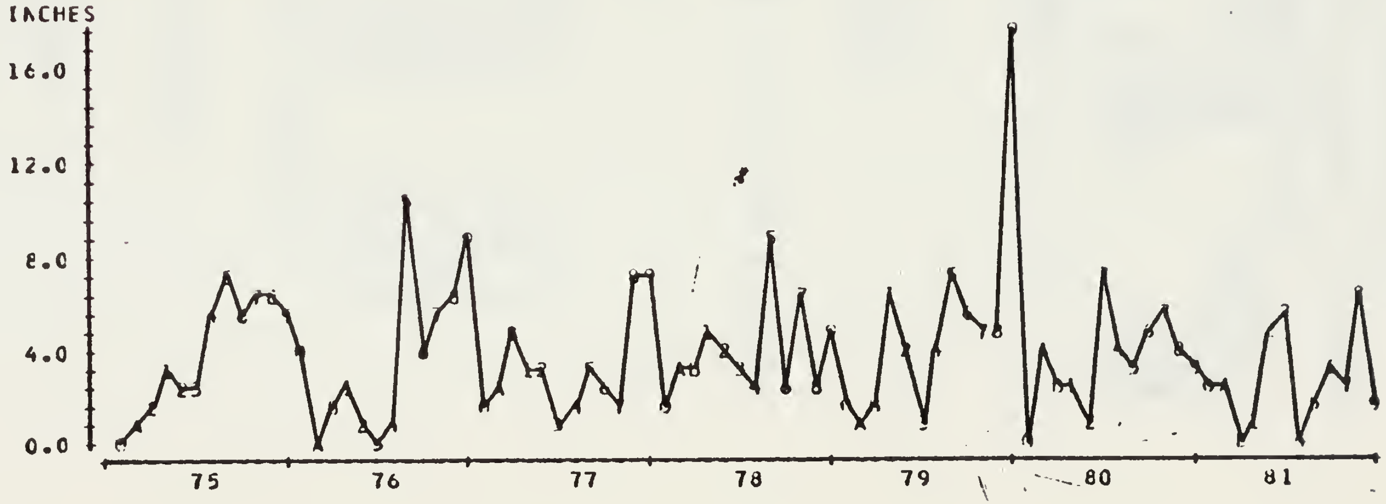




MONTHLY AVERAGE TEMPERATURES
NRMC JACKSONVILLE



MONTHLY PRECIPITATION
NRMC JACKSONVILLE



C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

NOTE: CDD HIGHLY CORRELATED WITH OTHER PREDICTOR VARIABLES

```
THE REGRESSION EQUATION FOR NRMC JACKSONVILLE IS:
  Y = -72.6 +1.46 X1 +0.0454 X2 -0.0407 X3 +0.0897 X4
                                           ST. DEV.     T-RATIO =
      COLUMN       COEFFICIENT             OF COEF.     COEF/S.D.
        --            -72.56                90.29          -0.80
X1     AVG TEMP         1.457                1.394           1.05
X2     HDD              0.04536              0.04614         0.98
X3     CDD             -0.04066              0.04563        -0.89
X4     PRECIP           0.0897               0.1804          0.50

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 4.076
WITH (  84- 5) =  79 DEGREES OF FREEDOM

R-SQUARED = 19.6 PERCENT

ANALYSIS OF VARIANCE
DUE TO        DF           SS          MS=SS/DF
REGRESSION     4        318.99           79.75
RESIDUAL      79       1312.45           16.61
TOTAL         83       1631.44

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN
 DUE TO        DF          SS
REGRESSION     4        318.99
AVG TEMP       1        290.53
HDD            1         11.58
CDD            1         12.76
PRECIP         1          4.11

      X1            Y        PRED. Y      ST.DEV.
  AVG TEMP   MBTU/KSF        VALUE      PRED. Y        ST.RES.
28  44.0     25.173        21.004        1.693         1.12 X
29  50.0     17.381        19.347        1.828        -0.54 X
41  47.5     22.654        19.002        2.124         1.05 X
44  74.8     39.050        24.688        1.081         3.65R
52  47.9     19.525        21.593        1.449        -0.54 X
53  52.0     16.498        19.869        1.557        -0.89 X
60  79.3     19.355        26.888        2.435        -2.30RX
76  46.5     18.521        21.154        1.570        -0.70 X
R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.98

     ******* CORRELATION OF VARIABLES*******
MBTU/KSF AVG TEMP     HDD       CDD
AVG TEMP    0.422
HDD        -0.352   -0.915
CDD         0.421    0.940   -0.724
PRECIP      0.216    0.368   -0.250    0.419
```

D. DEVELOPING A TIME SERIES MODEL

```
 ACF OF MBTU/KSF        NRMC JACKSONVILLE

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----+----
 1   0.562                     XXXXXXXXXXXXXXX
 2   0.487                     XXXXXXXXXXXXX
 3   0.356                     XXXXXXXXXX
 4   0.170                     XXXXX
 5   0.173                     XXXXX
 6   0.056                     XX
 7   0.084                     XXX
 8   0.174                     XXXXX
 9   0.229                     XXXXXXX
10   0.287                     XXXXXXXX
11   0.351                     XXXXXXXXXX
12   0.342                     XXXXXXXXXX
13   0.277                     XXXXXXXX
14   0.164                     XXXXX
15   0.064                     XXX
16   0.040                     XX
17   0.008                     X
18  -0.033                    XX
19  -0.073                   XXX
20   0.007                     X
21  -0.027                    XX
22  -0.028                    XX
23   0.077                     XXX
24   0.016                     X
25   0.062                     XXX
26   0.060                     XXX
27  -0.070                   XXX
28  -0.114                  XXXX
29  -0.158                 XXXXX
30  -0.185                XXXXXX
31  -0.179                 XXXXX
32  -0.179                 XXXXX
33  -0.194                XXXXXX
34  -0.075                   XXX
35  -0.046                    XX
36  -0.027                    XX
37   0.053                     XX
38  -0.143                 XXXXX
39  -0.153                 XXXXX
40  -0.239               XXXXXXX
41  -0.295              XXXXXXXX
42  -0.274              XXXXXXXX
43  -0.227               XXXXXXX
44  -0.216                XXXXXX
45  -0.130                  XXXX
46  -0.063                   XXX
47  -0.041                    XX
48  -0.023                    XX
49  -0.050                    XX
50  -0.070                   XXX
```

PACF OF MBTU/KSF NRMC JACKSONVILLE

```
            -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
              +----+----+----+----+----+----+----+----+----
1     0.560                       XXXXXXXXXXXXXXX
2     0.250                       XXXXXXX
3     0.016                       X
4    -0.165                   XXXXX
5     0.082                       XXX
6    -0.059                      XX
7     0.079                       XXX
8     0.181                       XXXXXX
9     0.154                       XXXXX
10    0.054                       XX
11    0.125                       XXXX
12    0.043                       XX
13   -0.069                     XXX
14   -0.124                    XXXX
15   -0.061                     XXX
16    0.040                       XX
17    0.026                       XX
18   -0.070                     XXX
19   -0.148                   XXXXX
20    0.044                       XX
21   -0.114                    XXXX
22   -0.101                    XXXX
23    0.159                       XXXXX
24   -0.009                       X
25    0.008                       X
26    0.091                       XXX
27   -0.139                    XXXX
28   -0.209                  XXXXXX
29    0.006                       X
30    0.067                       XXX
31   -0.009                       X
32    0.023                       XX
33   -0.089                     XXX
34    0.058                       XX
35    0.038                       XX
36   -0.057                      XX
37    0.095                       XXX
38   -0.229                 XXXXXXX
39   -0.068                     XXX
40   -0.021                      XX
41    0.031                       XX
42   -0.082                     XXX
43    0.078                       XXX
44   -0.005                       X
45    0.034                       XX
46   -0.036                      XX
47    0.011                       X
48   -0.039                      XX
49    0.012                       X
50    0.092                       XXX
```

```
ARIMA (1 1 3)(1 1 2) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE        ST. DEV.   T-RATIO
   1      AR   1       0.2589         0.4979       0.52
   2     SAR  12      -0.5733         0.3195      -1.79
   3      MA   1       1.0629         0.4890       2.17
   4      MA   2      -0.4108         0.3995      -1.03
   5      MA   3       0.1900         0.1233       1.54
   6     SMA  12       0.0293         0.3351       0.09
   7     SMA  24       0.7587         0.2365       3.21

DIFF.  1 REGULAR    1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =       737.144  (BACKFORECASTS EXCL)
     DF =   64  MS =      11.518
NO. OF OBS.  ORIGINAL SERIES   84    AFTER DIFF. 71

 ACF OF RESIDUAL    NRMC JACKSONVILLE

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----+----
1  -0.037                     XX
2  -0.002                      X
3   0.119                      XXXX
4  -0.070                    XXX
5   0.093                      XXX
6  -0.064                    XXX
7  -0.074                    XXX
8   0.039                      XX
9   0.061                      XXX
10  0.089                      XXX
11  0.052                      XX
12 -0.141                  XXXXX
13 -0.002                      X
14 -0.156                  XXXXX
15 -0.175                  XXXXX
16 -0.023                     XX
17  0.036                      XX
18  0.044                      XX
19 -0.101                   XXXX
20  0.086                      XXX
21  0.071                      XXX
22 -0.136                   XXXX
23 -0.041                     XX
24 -0.220                 XXXXXX
25 -0.157                  XXXXX
26  0.137                      XXXX
27 -0.013                      X
28  0.005                      X
29  0.037                      XX
30  0.049                      XX
31  0.042                      XX
32 -0.059                     XX
33 -0.101                   XXXX
34  0.047                      XX
35 -0.120                   XXXX
36 -0.116                   XXXX
37  0.265                      XXXXXXXX
38 -0.076                    XXX
39  0.087                      XXX
40  0.078                      XXX
```

```
ARIMA (1 1 2)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
   1     AR  1        -0.9427        0.0715     -13.19
   2    SAR 12        -0.1474        0.1551      -0.95
   3     MA  1        -0.2873        0.1064      -2.70
   4     MA  2         0.7086        0.0654      10.84
   5    SMA 12         0.8677        0.1274       6.81

DIFF.  1 REGULAR     1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =       796.180  (BACKFORECASTS EXCL)
     DF =   66  MS =        12.063
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF. 71

 ACF OF RESIDUAL      NRMC JACKSONVILLE

        -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
          +----+----+----+----+----+----+----+----+----
1  -0.102                  XXXX
2   0.082                     XXX
3   0.063                     XXX
4  -0.120                  XXXX
5   0.067                     XXX
6  -0.116                  XXXX
7  -0.077                   XXX
8   0.085                     XXX
9   0.120                     XXXX
10  0.050                     XX
11  0.088                     XXX
12  0.020                     X
13 -0.065                   XXX
14 -0.120                  XXXX
15 -0.165                 XXXXX
16 -0.017                     X
17  0.088                     XXX
18  0.074                     XXX
19 -0.066                   XXX
20  0.140                     XXXX
21  0.025                     XX
22 -0.145                 XXXXX
23  0.012                     X
24 -0.362            XXXXXXXXXX
25 -0.049                    XX
26  0.055                     XX
27 -0.018                     X
28  0.053                     XX
29  0.056                     XX
30  0.036                     XX
31  0.014                     X
32 -0.049                    XX
33 -0.107                  XXXX
34  0.006                     X
35 -0.052                    XX
36 -0.203                XXXXXX
37  0.233                     XXXXXXX
38 -0.126                  XXXX
39  0.094                     XXX
40  0.032                     XX
```

ARIMA (1 1 3)(1 0 2) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE		ESTIMATE	ST. DEV.	T-RATIO
1	AR	1	0.5968	0.1005	5.94
2	SAR	12	-0.3983	0.3715	-1.07
3	MA	1	1.3202	0.0250	52.82
4	MA	2	-0.6212	0.1223	-5.08
5	MA	3	0.2703	0.1168	2.31
6	SMA	12	-0.8027	0.4115	-1.95
7	SMA	24	0.0752	0.2730	0.28

```
DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =       845.205  (BACKFORECASTS EXCL)
     DF =    76  MS =      11.121
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF.  83
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	22.5015	15.9640	29.0391
86	21.5890	14.8059	28.3720
87	20.8942	13.4581	28.3304
88	21.1246	13.4190	28.8301
89	19.3083	11.4755	27.1411
90	21.3503	13.4487	29.2518
91	22.7005	14.7564	30.6447
92	19.0189	11.0447	26.9931
93	24.7058	16.7080	32.7036
94	20.3671	12.3492	28.3850
95	23.3292	15.2932	31.3652
96	21.9963	13.9433	30.0493

ACF OF RESIDUAL   NRMC JACKSONVILLE

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
1    0.038                      XX
2    0.015                      X
3    0.063                      XXX
4   -0.084                    XXX
5    0.020                      X
6   -0.158                  XXXXX
7   -0.107                   XXXX
8    0.000                      X
9   -0.002                      X
10   0.086                      XXX
11   0.126                      XXXX
12   0.041                      XX
13   0.169                      XXXXX
14  -0.071                    XXX
15  -0.093                    XXX
16   0.002                      X
17  -0.015                      X
18  -0.055                     XX
19  -0.124                   XXXX
20   0.041                      XX
21  -0.022                     XX
22  -0.114                   XXXX
23   0.086                      XXX
24   0.011                      X
25   0.024                      XX
26   0.176                      XXXXX
27  -0.065                    XXX
28  -0.065                    XXX
29  -0.044                     XX
30  -0.088                    XXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

95 CASES USED
1 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC JACKSONVILLE IS:
Y = 26.0 -0.0556 X1

COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
--	26.0272	0.5719	45.51
X1 MONTH	-0.05556	0.01019	-5.45

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS S=2.722
WITH (95- 2) = 93 DEGREES OF FREEDOM

R-SQUARED = 24.2 PERCENT

ANALYSIS OF VARIANCE

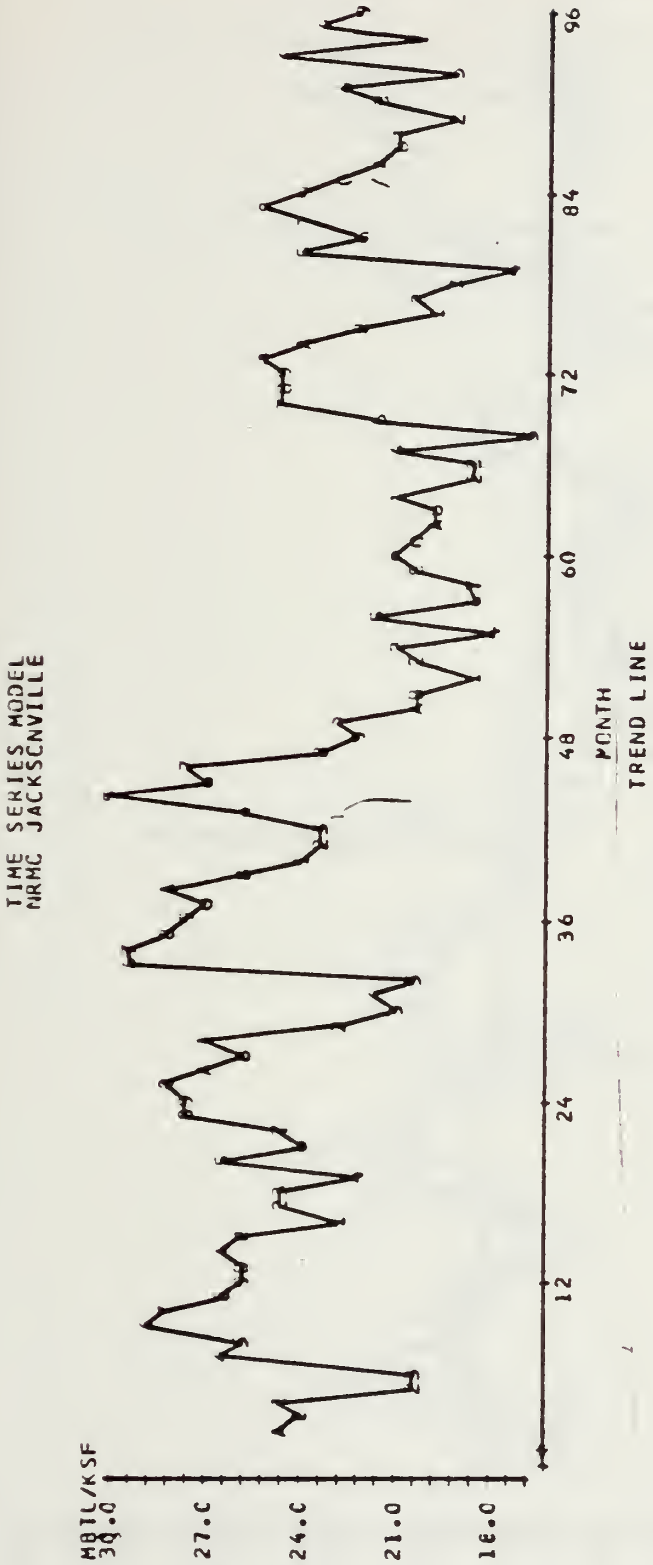
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	220.544	220.544
RESIDUAL	93	689.306	7.412
TOTAL	94	909.850	

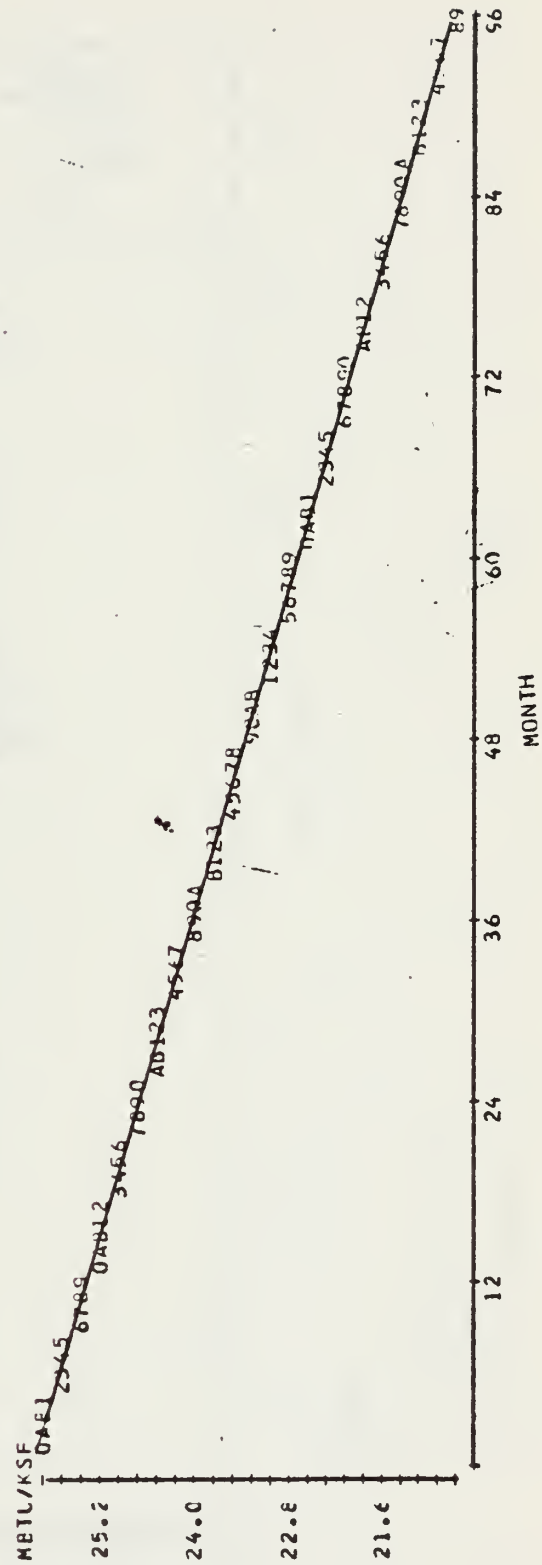
ROW	X1 MO.	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
5	5	20.395	25.749	0.528	-2.00R
34	34	29.550	24.138	0.318	2.00R
44	44	29.750	23.583	0.284	2.28R
68	68	16.698	22.249	0.340	-2.05R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

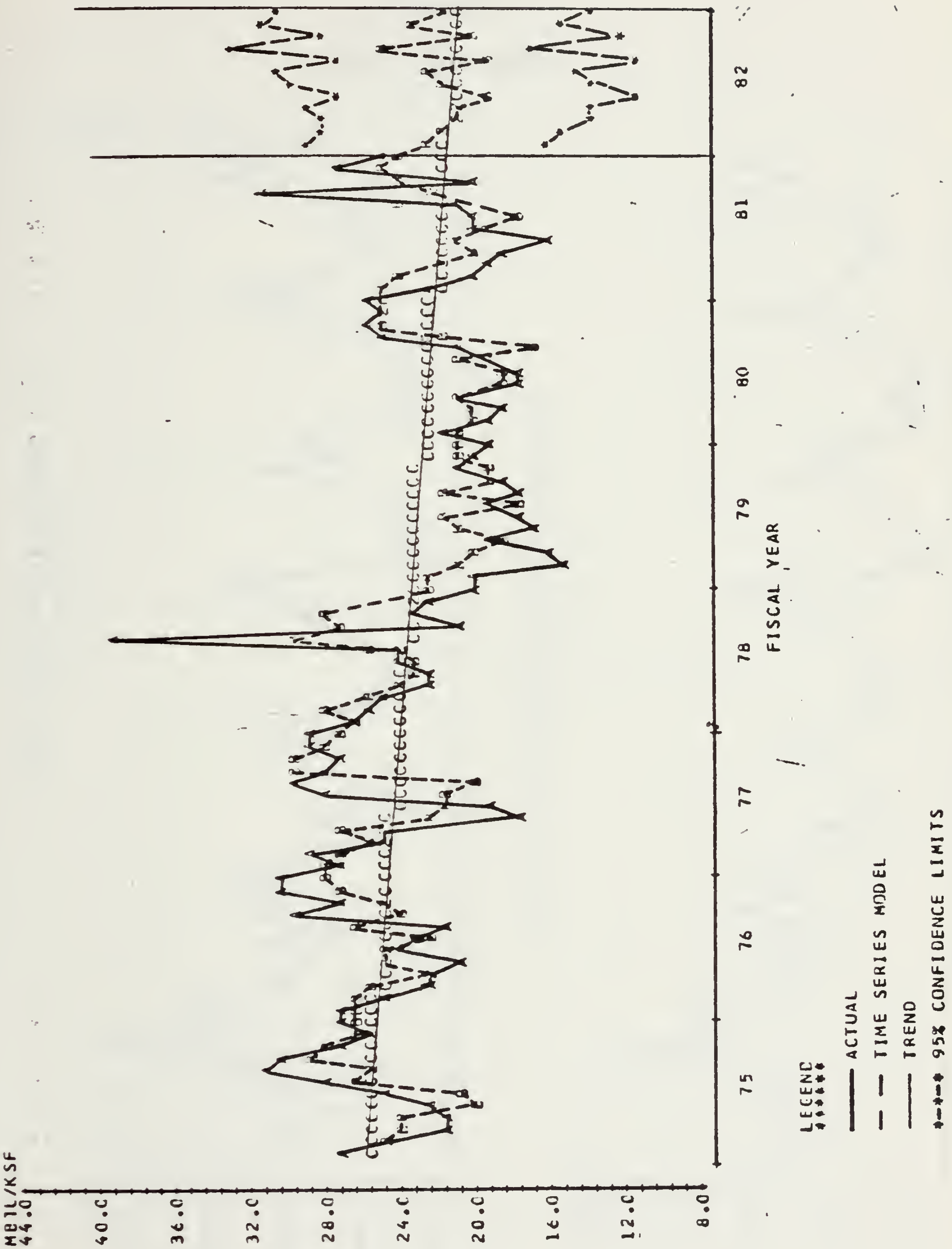
DURBIN-WATSON STATISTIC = 0.30

F. DECOMPOSITION LINES





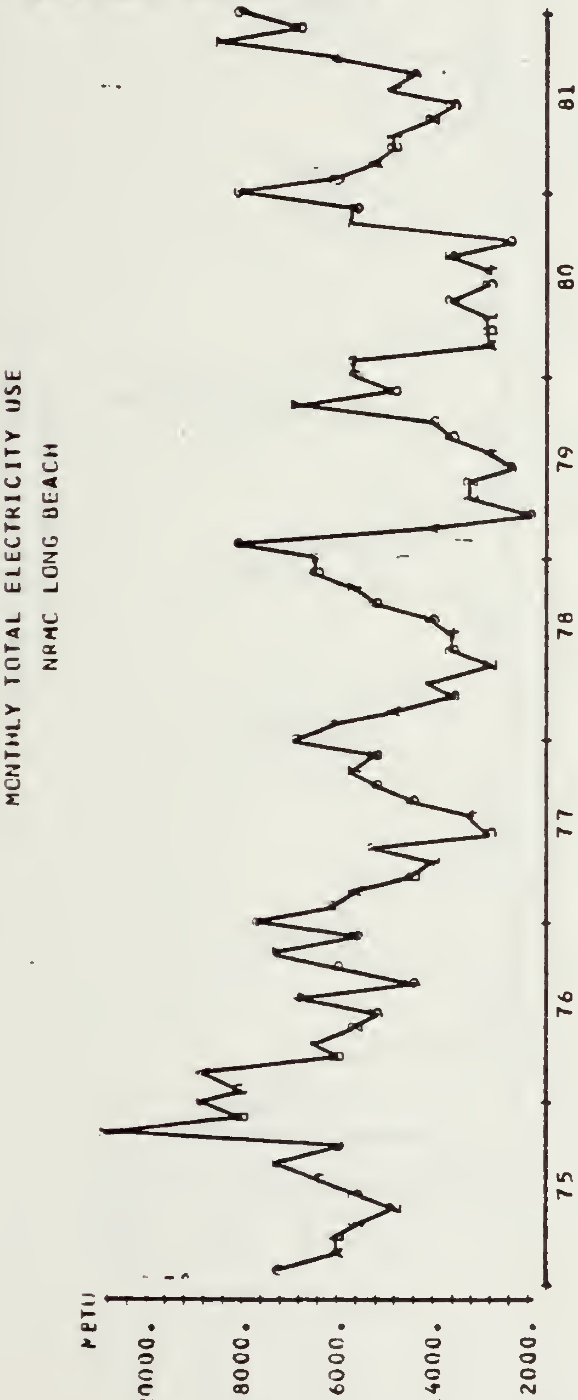
G. ACTUAL USE AND FORECAST MODELS

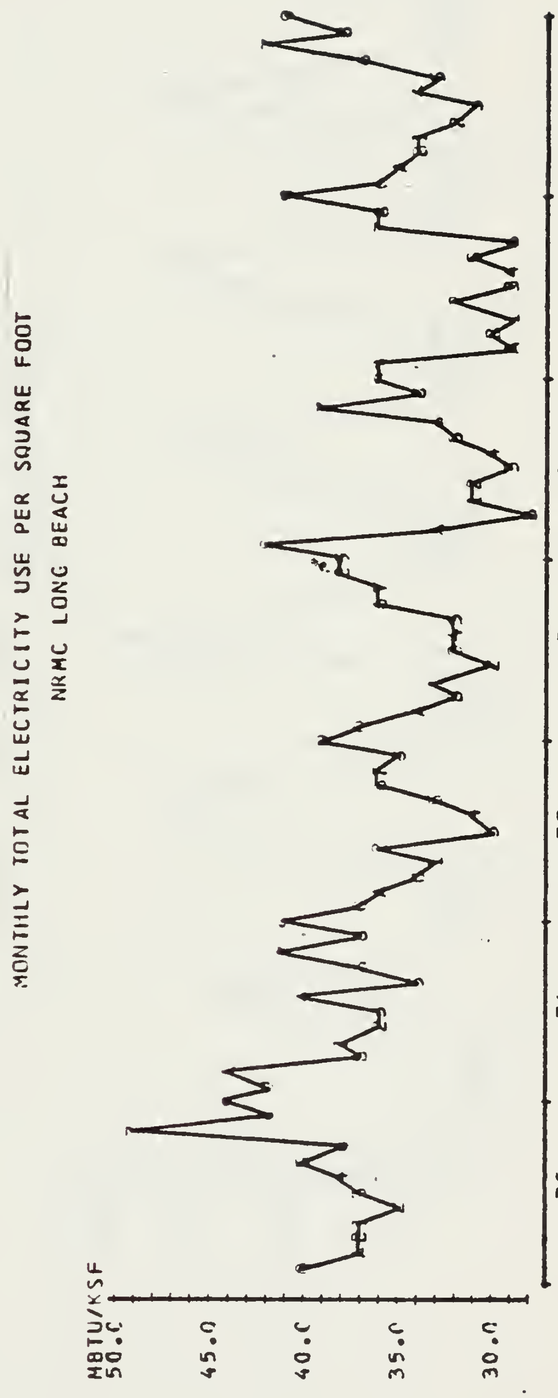


APPENDIX F

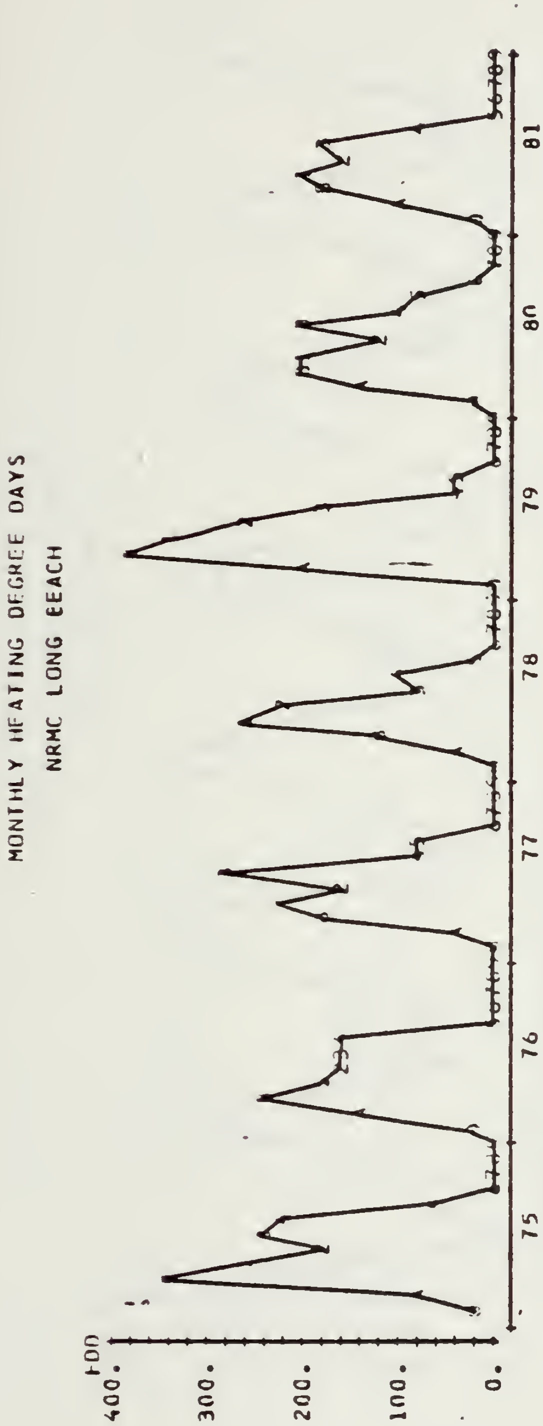
NRMC LONG BEACH

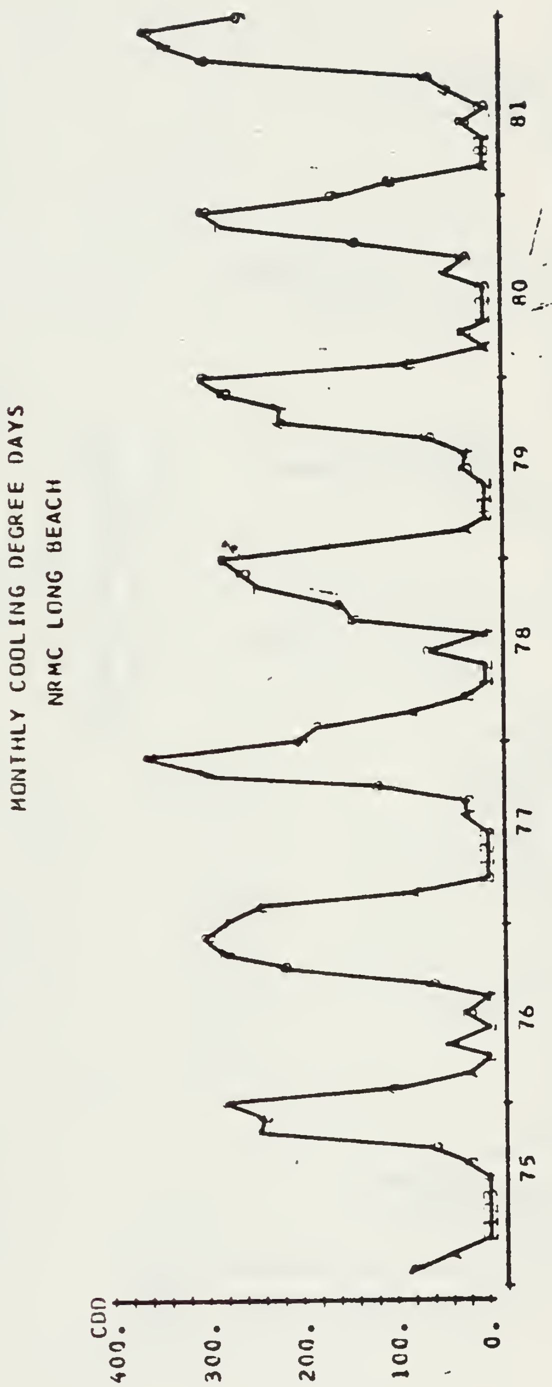
A. MONTHLY ENERGY USE



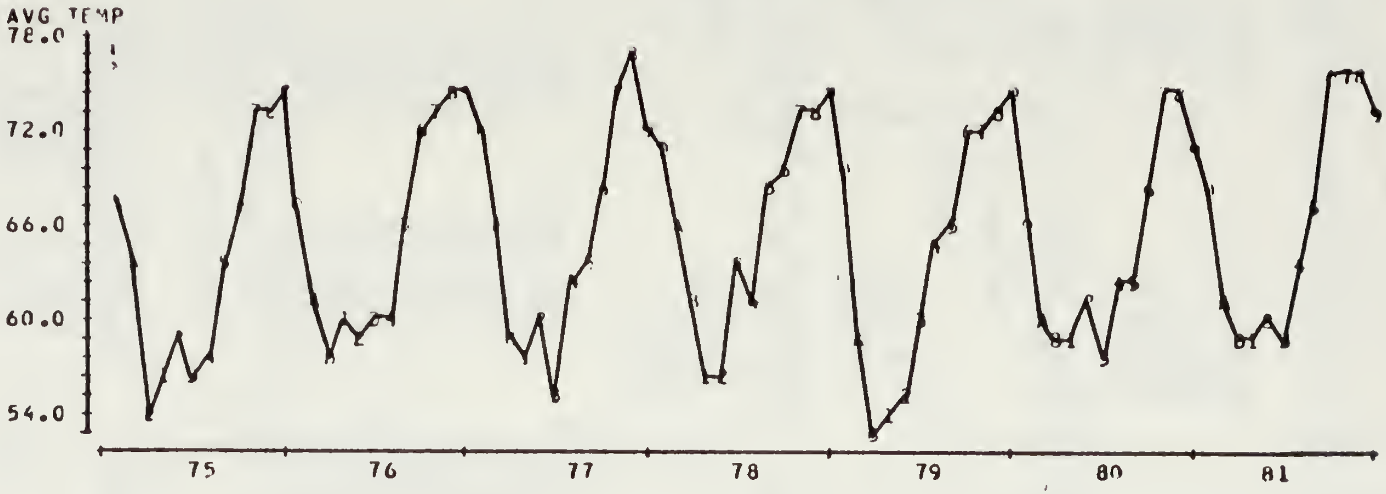


B. MONTHLY WEATHER SUMMARY

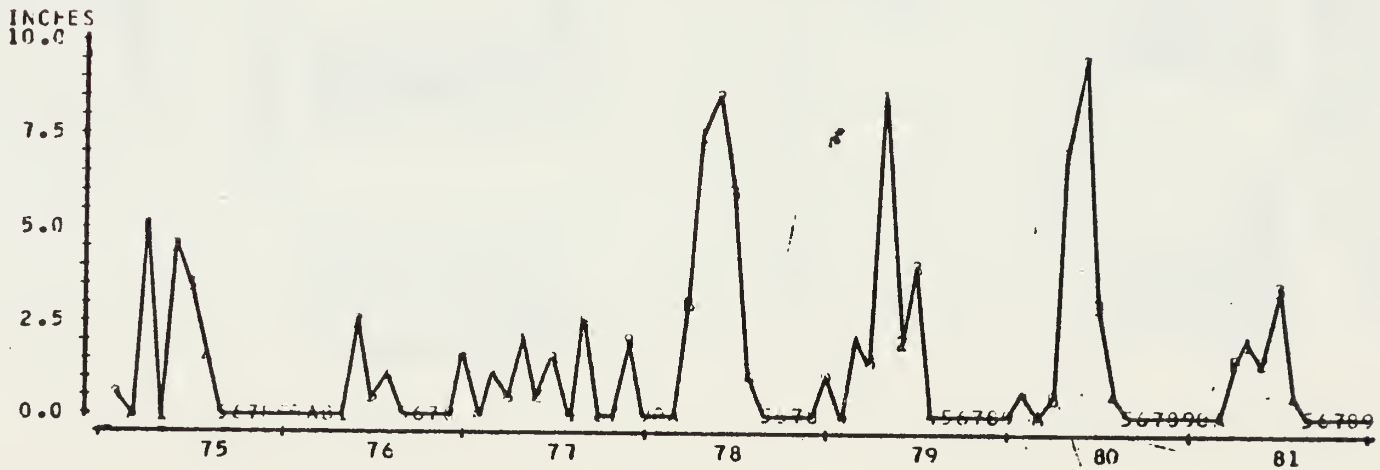




MONTHLY AVERAGE TEMPERATURES
NRMC LONG BEACH



MONTHLY PRECIPITATION
NRMC LONG BEACH



C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

NOTE:CDD HIGHLY CORRELATED WITH OTHER PREDICTOR VARIABLES

THE REGRESSION EQUATION FOR NRMC LONG BEACH IS:
Y = 3.65 +0.477 X1 +0.0149 X2 -0.0009 X3 -0.400 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	3.6	142.3	0.03
X1	AVG TEMP	0.477	2.198	0.22
X2	HDD	0.01485	0.07199	0.21
X3	CDD	-0.00086	0.07224	-0.01
X4	PRECIP	-0.4001	0.2174	-1.84

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S= 3.558
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 30.7 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	443.01	110.75
RESIDUAL	79	1000.02	12.66
TOTAL	83	1443.03	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	443.01
AVG TEMP	1	389.99
HDD	1	9.35
CDD	1	0.77
PRECIP	1	42.89

	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
10	72.8	48.796	38.140	0.634	3.04R
14	60.6	44.493	34.625	0.612	2.82R
40	56.2	32.812	31.329	1.280	0.45 X
41	56.9	30.033	30.646	1.726	-0.20 X
51	52.6	28.190	33.742	1.554	-1.73 X
52	53.7	31.397	30.994	1.581	0.13 X
53	55.2	30.770	33.045	1.899	-0.76 X
64	58.5	29.080	31.565	1.238	-0.75 X
65	60.9	31.580	30.640	1.812	0.31 X
69	68.9	28.734	36.545	0.690	-2.24R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.93

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.520			
HDD	-0.452	-0.927		
CDD	0.516	0.945	-0.754	
PRECIP	-0.394	-0.518	0.567	-0.410

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF   NRMC LONG BEACH

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+
 1   0.645                      XXXXXXXXXXXXXXXXX
 2   0.559                      XXXXXXXXXXXXXXX
 3   0.360                      XXXXXXXXXX
 4   0.178                      XXXXX
 5   0.065                      XXX
 6  -0.010                      X
 7   0.052                      XX
 8   0.091                      XXX
 9   0.270                      XXXXXXXX
10   0.346                      XXXXXXXXXX
11   0.456                      XXXXXXXXXXXX
12   0.505                      XXXXXXXXXXXXXX
13   0.334                      XXXXXXXXX
14   0.220                      XXXXXX
15   0.055                      XX
16  -0.062                    XXX
17  -0.208                 XXXXXX
18  -0.222                XXXXXXX
19  -0.223                XXXXXXX
20  -0.177                  XXXXX
21  -0.014                      X
22   0.074                      XXX
23   0.240                      XXXXXXX
24   0.248                      XXXXXXX
25   0.169                      XXXXX
26   0.078                      XXX
27  -0.059                     XX
28  -0.165                  XXXXX
29  -0.271               XXXXXXXX
30  -0.262               XXXXXXXX
31  -0.265               XXXXXXXX
32  -0.157                  XXXXX
33  -0.058                     XX
34   0.058                      XX
35   0.145                      XXXXX
36   0.144                      XXXXX
37   0.065                      XXX
38  -0.046                     XX
39  -0.061                    XXX
40  -0.263               XXXXXXXX
41  -0.296               XXXXXXXX
42  -0.290               XXXXXXXX
43  -0.293               XXXXXXXX
44  -0.222                XXXXXXX
45  -0.167                  XXXXX
46  -0.054                     XX
47  -0.052                     XX
48  -0.006                      X
49  -0.110                   XXXX
50  -0.155                  XXXXX
```

PACF OF MBTU/KSF   NRMC LONG BEACH

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----
 1   0.621                      XXXXXXXXXXXXXXXXX
 2   0.245                      XXXXXXX
 3  -0.128                   XXXX
 4  -0.182                 XXXXXX
 5  -0.034                     XX
 6   0.030                      XX
 7   0.206                      XXXXXX
 8   0.102                      XXXX
 9   0.256                      XXXXXXX
10   0.092                      XXX
11   0.120                      XXXX
12   0.111                      XXXX
13  -0.268               XXXXXXXX
14  -0.182                 XXXXXX
15  -0.051                     XX
16   0.001                      X
17  -0.135                   XXXX
18  -0.061                    XXX
19  -0.097                    XXX
20  -0.098                    XXX
21   0.079                      XXX
22   0.085                      XXX
23   0.198                      XXXXXX
24   0.064                      XXX
25  -0.084                    XXX
26  -0.025                     XX
27  -0.043                     XX
28   0.004                      X
29   0.047                      XX
30   0.044                      XX
31  -0.030                     XX
32  -0.007                      X
33  -0.117                   XXXX
34  -0.065                    XXX
35  -0.056                     XX
36   0.012                      X
37  -0.071                    XXX
38  -0.089                    XXX
39   0.167                      XXXXX
40  -0.199                 XXXXXX
41  -0.093                    XXX
42   0.110                      XXXX
43   0.043                      XX
44  -0.058                     XX
45  -0.096                    XXX
46  -0.033                     XX
47  -0.138                   XXXX
48   0.011                      X
49  -0.032                     XX
50   0.003                      X
```

ARIMA (3 0 3)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	0.5421	28.8103	0.02
2	AR 2	0.3378	27.1997	0.01
3	AR 3	-0.0506	2.0028	-0.03
4	SAR 12	0.9762	0.0450	21.69
5	MA 1	0.2702	28.8105	0.01
6	MA 2	0.0409	19.3868	0.00
7	MA 3	-0.1186	7.3329	-0.02
8	SMA 12	0.6939	0.1500	4.63
9	CONSTANT	0.14032	0.06857	2.05
	MEAN	34.61	16.91	

RESIDUALS.   SS =   406.858 (BACKFORECASTS EXCL)
N = 84   DF =   75 MS =   5.425

ACF OF RESIDUAL   NRMC LONG BEACH

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----
   1 -0.064                   XXX
   2 -0.047                    XX
   3 -0.018                     X
   4  0.104                     XXXX
   5  0.059                     XX
   6 -0.095                   XXX
   7  0.161                     XXXXX
   8  0.003                     X
   9  0.075                     XXX
  10  0.055                     XX
  11  0.129                     XXXX
  12 -0.121                  XXXX
  13 -0.079                   XXX
  14 -0.020                    XX
  15 -0.095                   XXX
  16  0.146                     XXXXX
  17 -0.119                  XXXX
  18  0.043                     XX
  19  0.022                     XX
  20 -0.167                 XXXXX
  21 -0.042                    XX
  22 -0.104                  XXXX
  23  0.181                     XXXXXX
  24 -0.151                 XXXXX
  25  0.013                     X
  26  0.065                     XXX
  27 -0.119                  XXXX
  28  0.062                     XXX
  29 -0.009                     X
  30  0.011                     X
  31 -0.097                   XXX
  32  0.011                     X
  33 -0.022                    XX
  34  0.011                     X
  35  0.093                     XXX
  36 -0.058                    XX
  37 -0.019                     X
  38 -0.040                    XX
  39  0.264                     XXXXXXXX
  40 -0.171                 XXXXX
```

```
ARIMA (2 1 3)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE        ST. DEV.   T-RATIO
     1     AR  1       -0.7894         0.8042      -0.98
     2     AR  2        0.0161         0.5065       0.03
     3    SAR 12        0.9943         0.0158      62.74
     4     MA  1        0.0057         0.7925       0.01
     5     MA  2        0.4716         0.7795       0.61
     6     MA  3       -0.2042         0.4562      -0.45
     7    SMA 12        0.8210         0.1123       7.31

DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =       374.659  (BACKFORECASTS EXCL)
               DF =    76  MS =       4.930
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF.   83

   ACF OF RESIDUAL        NRMC LONG BEACH

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----
  1    -.003                        X
  2   -0.009                        X
  3   -0.059                       XX
  4    0.097                        XXX
  5    0.011                        X
  6   -0.090                      XXX
  7    0.146                        XXXXX
  8    0.053                        XX
  9    0.073                        XXX
 10    0.073                        XXX
 11    0.114                        XXXX
 12   -0.102                     XXXX
 13   -0.152                    XXXXX
 14   -0.040                       XX
 15   -0.089                      XXX
 16    0.161                        XXXXX
 17   -0.106                     XXXX
 18    0.044                        XX
 19    0.041                        XX
 20   -0.140                    XXXXX
 21   -0.053                       XX
 22   -0.103                     XXXX
 23    0.144                        XXXXX
 24   -0.150                    XXXXX
 25   -0.036                       XX
 26    0.054                        XX
 27   -0.061                      XXX
 28    0.107                        XXXX
 29    0.027                        XX
 30    0.050                        XX
 31   -0.062                      XXX
 32    0.014                        X
 33   -0.001                        X
 34    0.009                        X
 35    0.075                        XXX
 36   -0.072                      XXX
 37   -0.011                        X
 38    0.004                        X
 39    0.289                        XXXXXXXX
 40   -0.096                      XXX
```

ARIMA (2 1 4)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.5817	0.2643	-2.20
2	AR 2	-0.6454	0.2572	-2.51
3	SAR 12	0.9964	0.0145	68.67
4	MA 1	0.1921	0.2653	0.72
5	MA 2	-0.3313	0.2261	-1.47
6	MA 3	0.5007	0.1747	2.87
7	MA 4	-0.3064	0.1174	-2.61
8	SMA 12	0.8183	0.1202	6.81

DIFFERENCING. 1 REGULAR
RESIDUALS. SS = 357.747 (BACKFORECASTS EXCL)
DF = 75 MS = 4.770
NO. OF OBS. ORIGINAL SERIES 84 AFTER DIFF. 83

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	40.6142	36.3326	44.8957
86	37.5592	33.1694	41.9490
87	34.5403	29.8846	39.1960
88	35.1914	30.3818	40.0010
89	35.3649	30.0150	40.7148
90	33.5681	27.8895	39.2468
91	35.2408	29.3857	41.0958
92	35.9436	29.7605	42.1267
93	36.7558	30.2666	43.2449
94	41.7828	35.0950	48.4706
95	39.5677	32.6331	46.5024
96	42.3875	35.1879	49.5871

```
   ACF OF RESIDUAL        NRMC LONG BEACH

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----
  1  -0.018                     X
  2   0.021                     XX
  3   0.042                     XX
  4  -0.061                   XXX
  5  -0.003                     X
  6  -0.045                    XX
  7   0.112                     XXXX
  8   0.050                     XX
  9   0.124                     XXXX
 10   0.071                     XXX
 11   0.078                     XXX
 12  -0.122                  XXXX
 13  -0.121                  XXXX
 14  -0.064                   XXX
 15  -0.111                  XXXX
 16   0.172                     XXXXX
 17  -0.088                   XXX
 18   0.042                     XX
 19   0.044                     XX
 20  -0.120                  XXXX
 21  -0.050                    XX
 22  -0.139                  XXXX
 23   0.145                     XXXXX
 24  -0.168                 XXXXX
 25  -0.041                    XX
 26   0.087                     XXX
 27  -0.078                   XXX
 28   0.117                     XXXX
 29   0.030                     XX
 30   0.031                     XX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

95 CASES USED
1 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC LONG BEACH IS:
Y = 37.7 -0.0396 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	37.6888	0.8027	46.95
X1	MONTH	-0.03955	0.01430	-2.77

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 3.821
WITH (95- 2) = 93 DEGREES OF FREEDOM

R-SQUARED = 7.6 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	111.76	111.76
RESIDUAL	93	1357.75	14.60
TOTAL	94	1469.51	

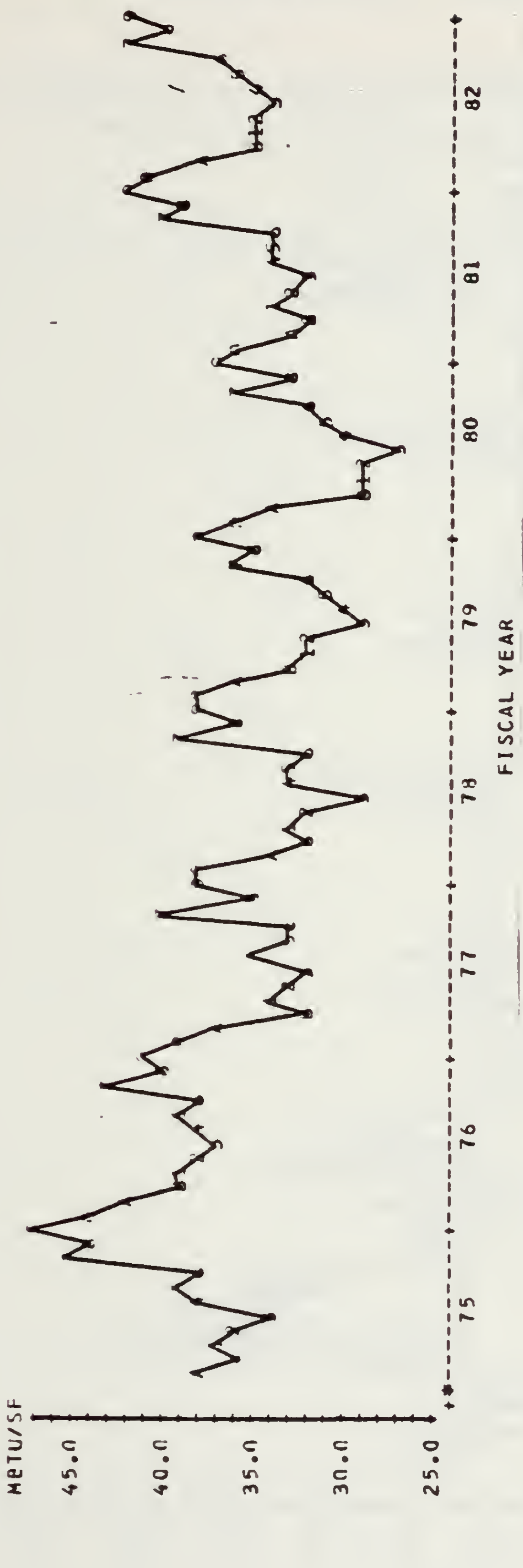
	X1 MONTH	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
10	10.0	45.060	37.293	0.682	2.07R
12	12.0	46.556	37.214	0.658	2.48R
66	66.0	27.418	35.078	0.461	-2.02R
94	94.0	41.783	33.971	0.753	2.09R
96	96.0	42.387	33.892	0.778	2.27R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

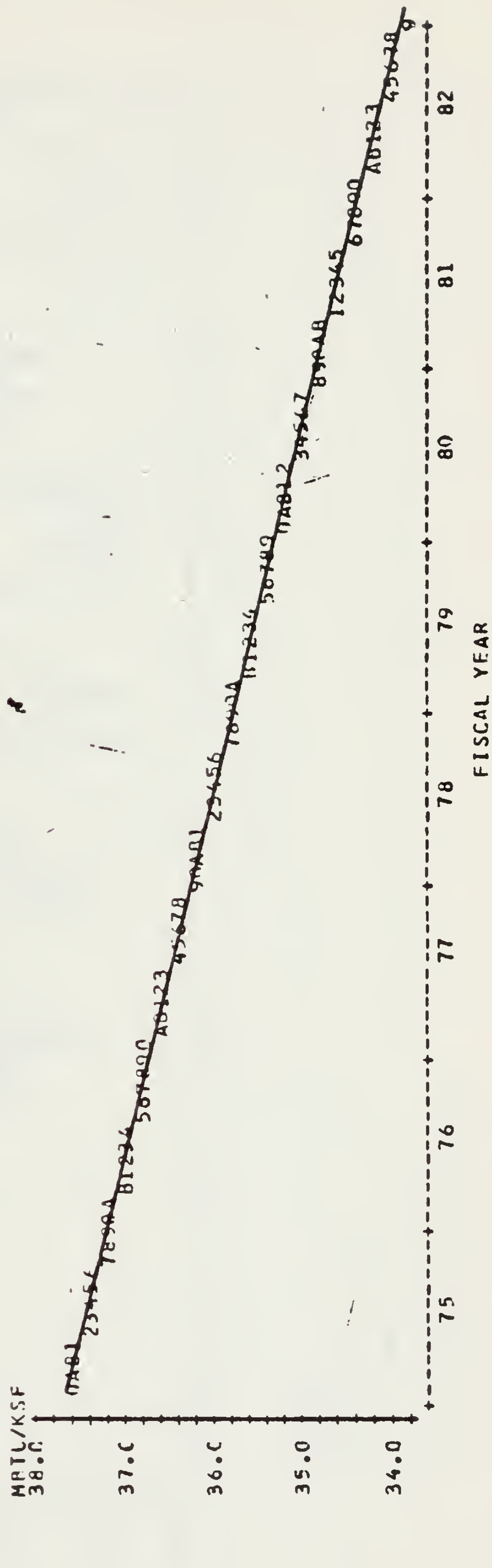
DURBIN-WATSON STATISTIC = 0.48

F. DECOMPOSITION LINES

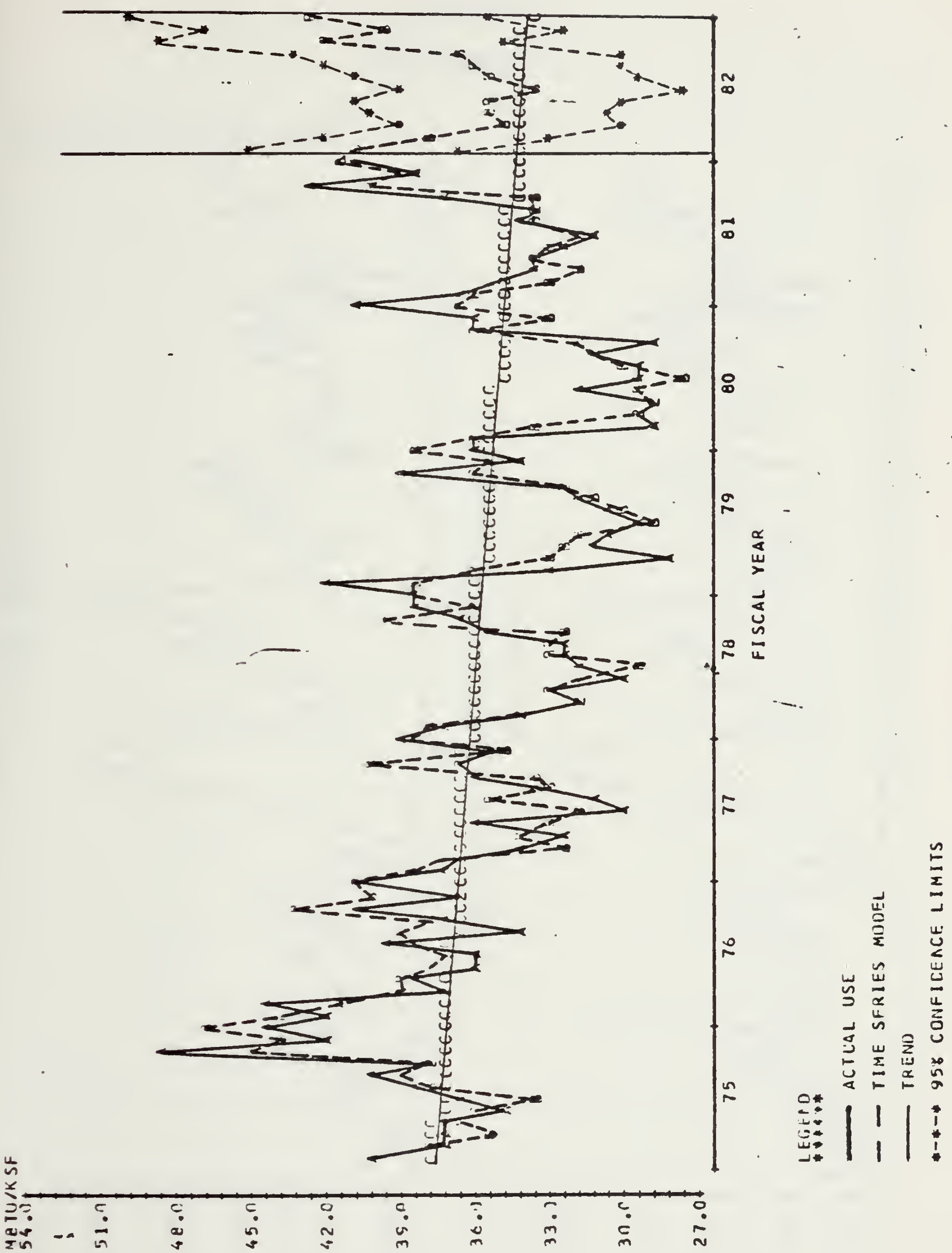
TIME SERIES MODEL



TREND LINE



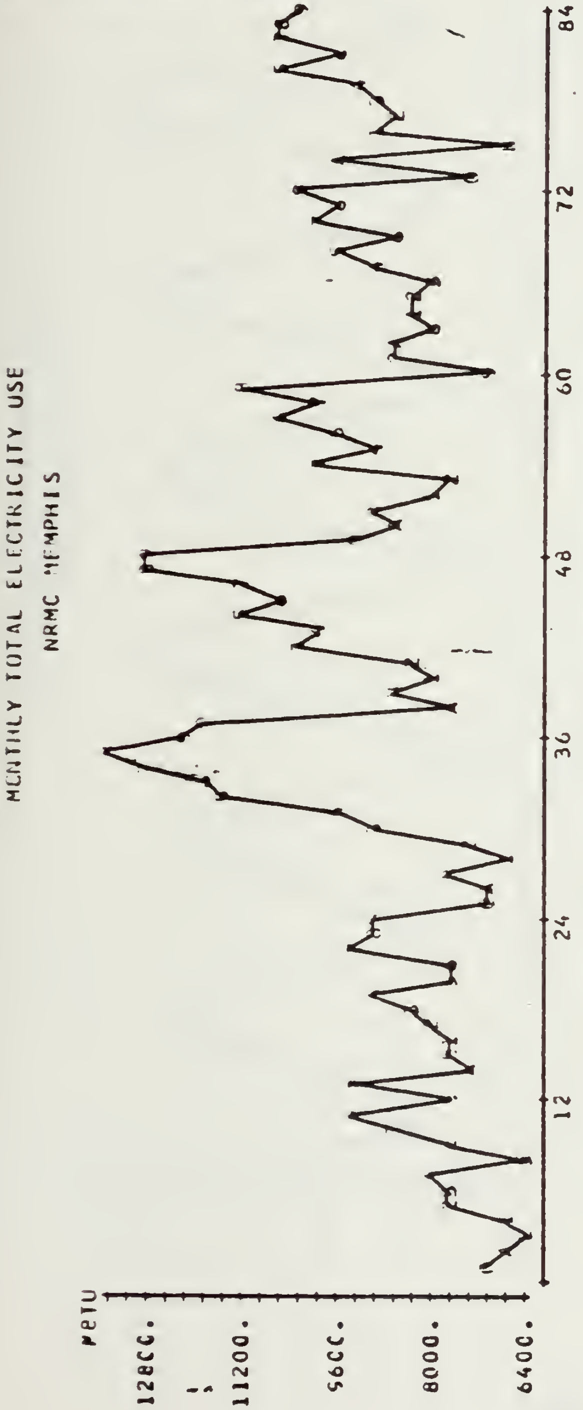
G. ACTUAL USE AND FORECAST MODELS

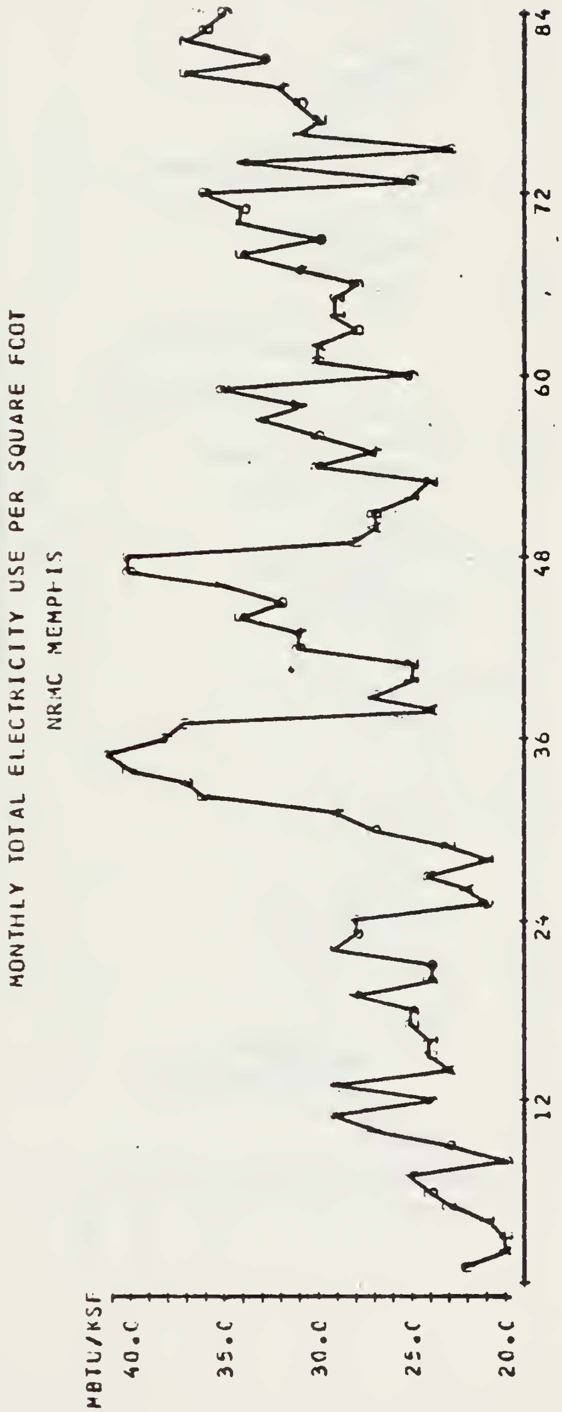


APPENDIX G

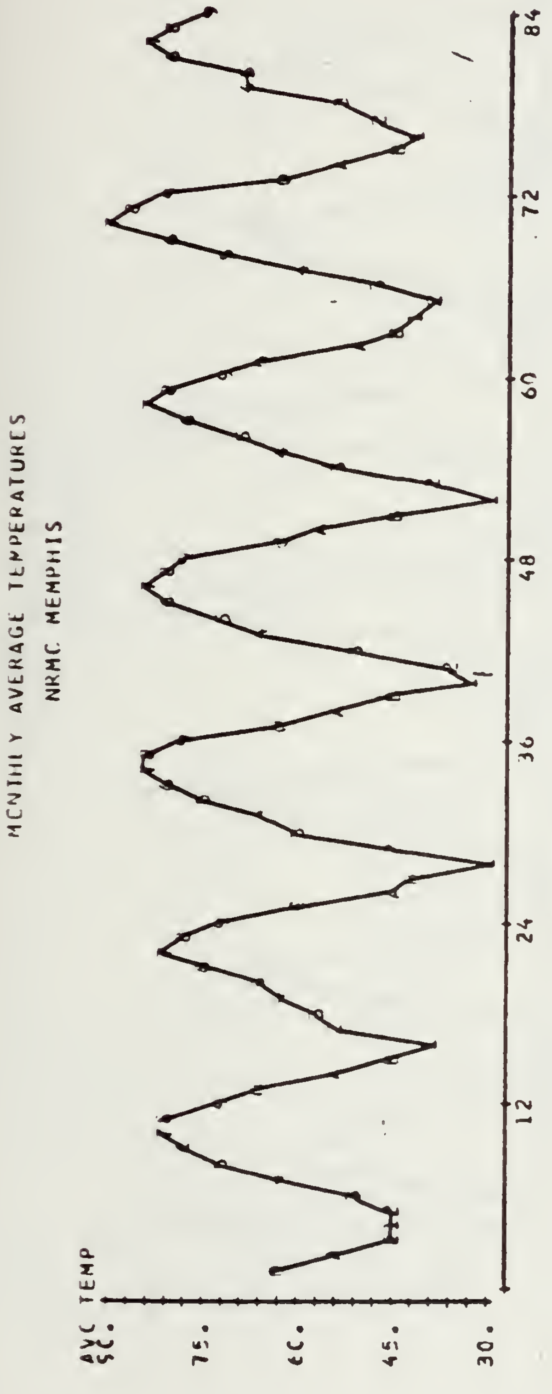
NRMC MEMPHIS

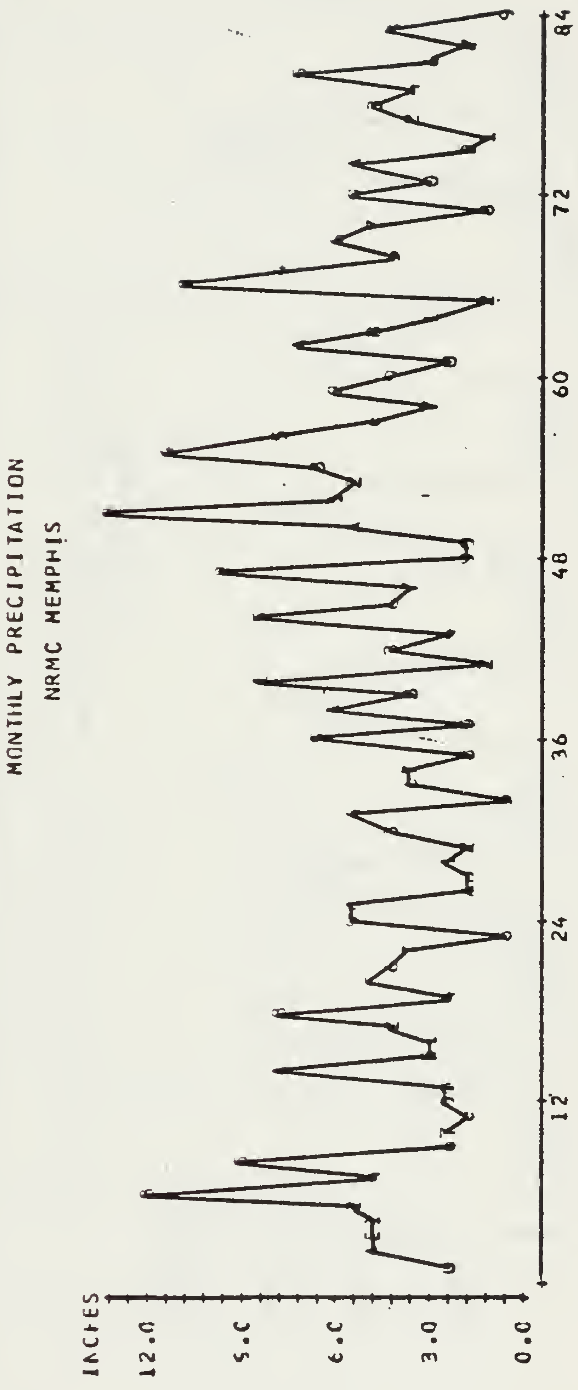
A. MONTHLY ENERGY USE



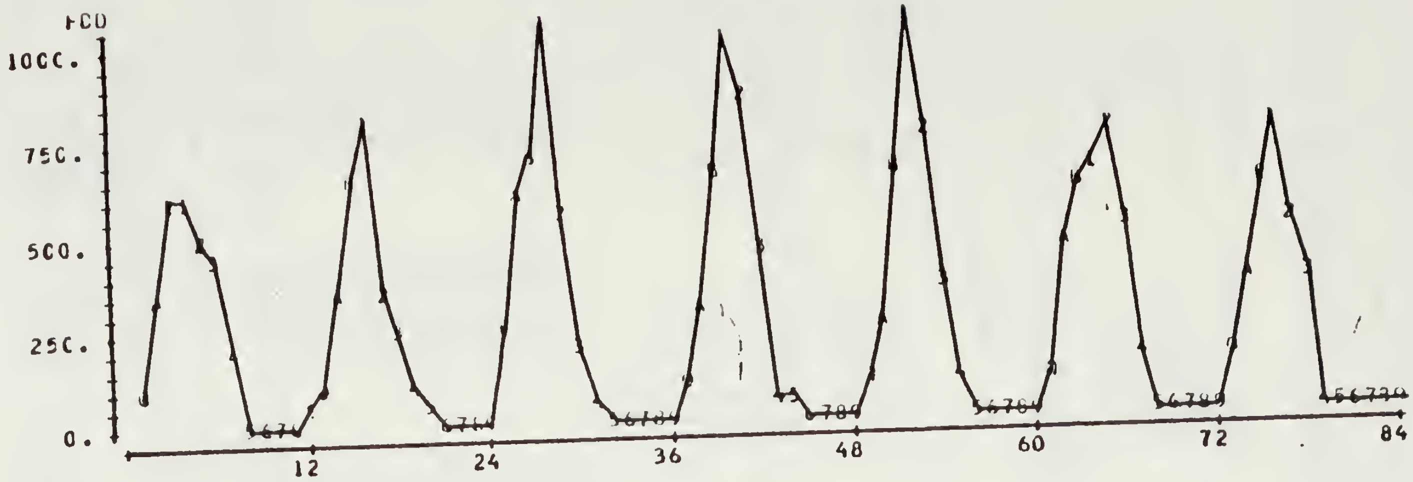


B. MONTHLY WEATHER SUMMARY

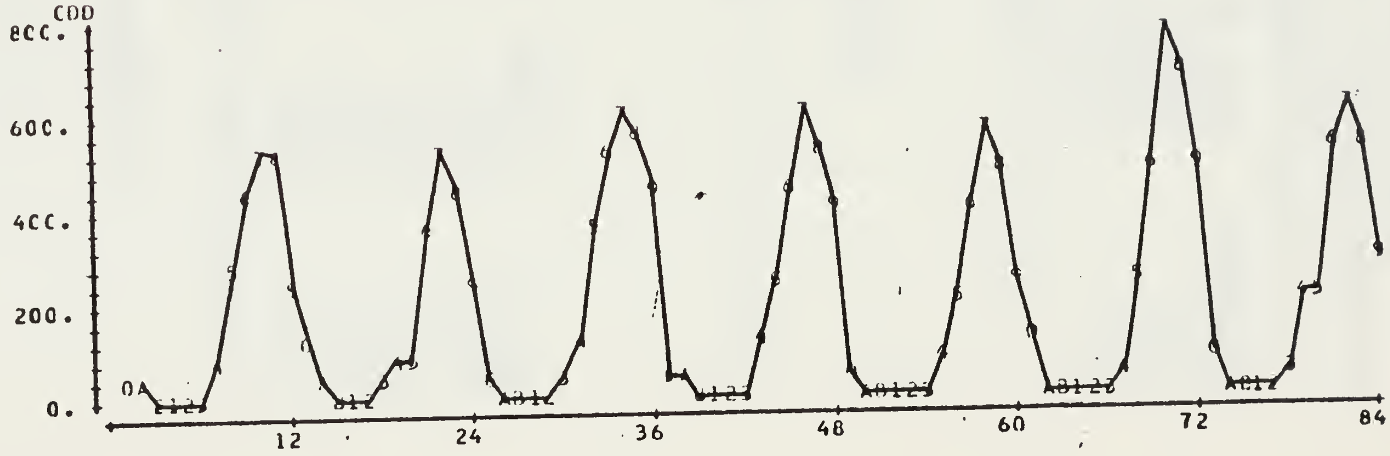




MONTHLY HEATING DEGREE DAYS
NRMC MEMPHIS



MONTHLY COOLING DEGREE DAYS
NRMC MEMPHIS



C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

NOTE: CDD HIGHLY CORRELATED WITH OTHER PREDICTOR VARIABLES

THE REGRESSION EQUATION FOR NRMC MEMPHIS IS:
Y = 22.6 +0.0702 X1 -0.0007 X2 +0.0097 X3 +0.0201 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	22.63	57.34	0.39
X1	AVG TEMP	0.0702	0.8868	0.08
X2	HDD	-0.00067	0.02939	-0.02
X3	CDD	0.00966	0.02912	0.33
X4	PRECIP	0.0201	0.1827	0.11

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 4.260
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 39.4 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	930.73	232.68
RESIDUAL	79	1433.82	18.15
TOTAL	83	2364.55	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	930.73
AVG TEMP	1	867.37
HDD	1	61.31
CDD	1	1.83
PRECIP	1	0.22

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
8	73.5	19.512	30.591	1.004	-2.68R
9	78.8	23.414	32.276	0.789	-2.12R
28	30.7	20.978	24.133	1.711	-0.81 X
29	45.1	22.839	25.471	1.589	-0.67 X
37	62.2	36.876	27.351	1.038	2.31R
40	32.7	24.630	24.426	1.665	0.05 X
41	35.0	25.241	24.557	2.212	0.19 X
51	44.0	27.173	25.554	1.716	0.42 X
52	30.9	24.883	24.221	1.657	0.17 X
53	38.5	23.522	24.957	2.042	-0.38 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.86

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.606			
HDD	-0.521	-0.947		
CDD	0.616	0.898	-0.710	
PRECIP	-0.099	-0.127	0.067	-0.198

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF   NRMC MEMPHIS

```
             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
               +----+----+----+----+----+----+----+----+----
  1    0.682                       XXXXXXXXXXXXXXXXXX
  2    0.581                       XXXXXXXXXXXXXXXX
  3    0.341                       XXXXXXXXXX
  4    0.186                       XXXXXX
  5    0.026                       XX
  6   -0.017                       X
  7   -0.047                      XX
  8    0.029                       XX
  9    0.124                       XXXX
 10    0.276                       XXXXXXXX
 11    0.393                       XXXXXXXXXXX
 12    0.416                       XXXXXXXXXXX
 13    0.391                       XXXXXXXXXXX
 14    0.226                       XXXXXXX
 15    0.136                       XXXX
 16   -0.055                      XX
 17   -0.091                     XXX
 18   -0.167                   XXXXX
 19   -0.158                   XXXXX
 20   -0.051                      XX
 21   -0.004                       X
 22    0.109                       XXXX
 23    0.159                       XXXXX
 24    0.217                       XXXXXX
 25    0.132                       XXXX
 26    0.039                       XX
 27   -0.110                    XXXX
 28   -0.193                  XXXXXX
 29   -0.242                 XXXXXXX
 30   -0.250                 XXXXXXX
 31   -0.252                 XXXXXXX
 32   -0.143                   XXXXX
 33   -0.079                     XXX
 34    0.024                       XX
 35    0.180                       XXXXX
 36    0.154                       XXXXX
 37    0.176                       XXXXX
 38    0.037                       XX
 39   -0.052                      XX
 40   -0.111                    XXXX
 41   -0.152                   XXXXX
 42   -0.176                   XXXXX
 43   -0.155                   XXXXX
 44   -0.092                     XXX
 45   -0.029                      XX
 46    0.044                       XX
 47    0.107                       XXXX
 48    0.151                       XXXXX
 49    0.088                       XXX
 50    0.045                       XX
```

PACF OF MBTU/KSF   NRMC MEMPHIS

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
 1   0.682                     XXXXXXXXXXXXXXXXXX
 2   0.217                XXXXXX
 3  -0.229               XXXXXXX
 4  -0.112                  XXXX
 5  -0.074                   XXX
 6   0.081                     XXX
 7   0.051                     XX
 8   0.134                     XXXX
 9   0.151                     XXXXX
10   0.196                     XXXXXX
11   0.150                     XXXXX
12  -0.058                    XX
13  -0.056                    XX
14  -0.226               XXXXXXX
15   0.016                     X
16  -0.108                  XXXX
17   0.099                     XXX
18   0.021                     XX
19  -0.055                    XX
20   0.177                     XXXXX
21  -0.155                 XXXXX
22  -0.002                     X
23  -0.079                   XXX
24   0.087                     XXX
25  -0.102                  XXXX
26  -0.121                  XXXX
27  -0.033                    XX
28  -0.043                    XX
29   0.184                     XXXXXX
30  -0.121                  XXXX
31  -0.048                    XX
32   0.052                     XX
33  -0.025                    XX
34   0.070                     XXX
35   0.155                     XXXXX
36  -0.025                    XX
37  -0.016                     X
38  -0.053                    XX
39  -0.074                   XXX
40   0.142                     XXXXX
41   0.010                     X
42  -0.022                    XX
43  -0.000                     X
44   0.014                     X
45  -0.047                    XX
46  -0.075                   XXX
47   0.013                     X
48   0.054                     XX
49  -0.066                   XXX
50  -0.036                    XX
```

ARIMA (2 1 3)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	0.3719	0.3447	1.08
2	AR 2	0.0249	0.3885	0.06
3	SAR 12	-0.2144	0.1653	-1.30
4	MA 1	1.0727	0.3279	3.27
5	MA 2	-0.5338	0.5013	-1.06
6	MA 3	0.3119	0.2531	1.23
7	SMA 12	0.7505	0.1562	4.80

DIFFERENCING. 1 REGULAR 1 SEASONAL DIFF. OF ORDER 12
RESIDUALS. SS = 766.232 (BACKFORECASTS EXCL)
N = 84 DF = 64 MS = 11.972

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	31.5179	24.7347	38.3011
86	29.7048	22.6246	36.7851
87	29.4005	21.2432	37.5577
88	28.9877	20.4355	37.5399
89	29.2190	20.4203	38.0177
90	31.9342	22.9441	40.9242
91	32.6365	23.4778	41.7951
92	34.7039	25.3873	44.0205
93	34.3345	24.8658	43.8033
94	36.4759	26.8587	46.0930
95	38.2480	28.4852	48.0107
96	35.5722	25.6662	45.4781

```
      ACF OF RESIDUAL          NRMC MEMPHIS
                  -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                    +----+----+----+----+----+----+----+----+----
  1    0.012                            X
  2    0.012                            X
  3    0.077                            XXX
  4    0.004                            X
  5   -0.049                           XX
  6   -0.032                           XX
  7   -0.166                        XXXXX
  8   -0.055                           XX
  9   -0.082                          XXX
 10    0.094                            XXX
 11    0.056                            XX
 12    0.015                            X
 13   -0.030                           XX
 14    0.018                            X
 15    0.218                            XXXXXX
 16   -0.125                         XXXX
 17    0.023                            XX
 18    0.006                            X
 19   -0.169                        XXXXX
 20    0.136                            XXXX
 21   -0.047                           XX
 22   -0.081                          XXX
 23   -0.149                        XXXXX
 24   -0.142                        XXXXX
 25   -0.046                           XX
 26    0.029                            XX
 27   -0.148                        XXXXX
 28   -0.029                           XX
 29    0.104                            XXXX
 30    0.124                            XXXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

83 CASES USED
13 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC MEMPHIS IS:
Y = 24.4 + 0.102 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	24.443	1.020	23.95
X1	MONTH	0.10152	0.01701	5.97

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 3.713
WITH (83- 2) = 81 DEGREES OF FREEDOM

R-SQUARED = 30.5 PERCENT

ANALYSIS OF VARIANCE

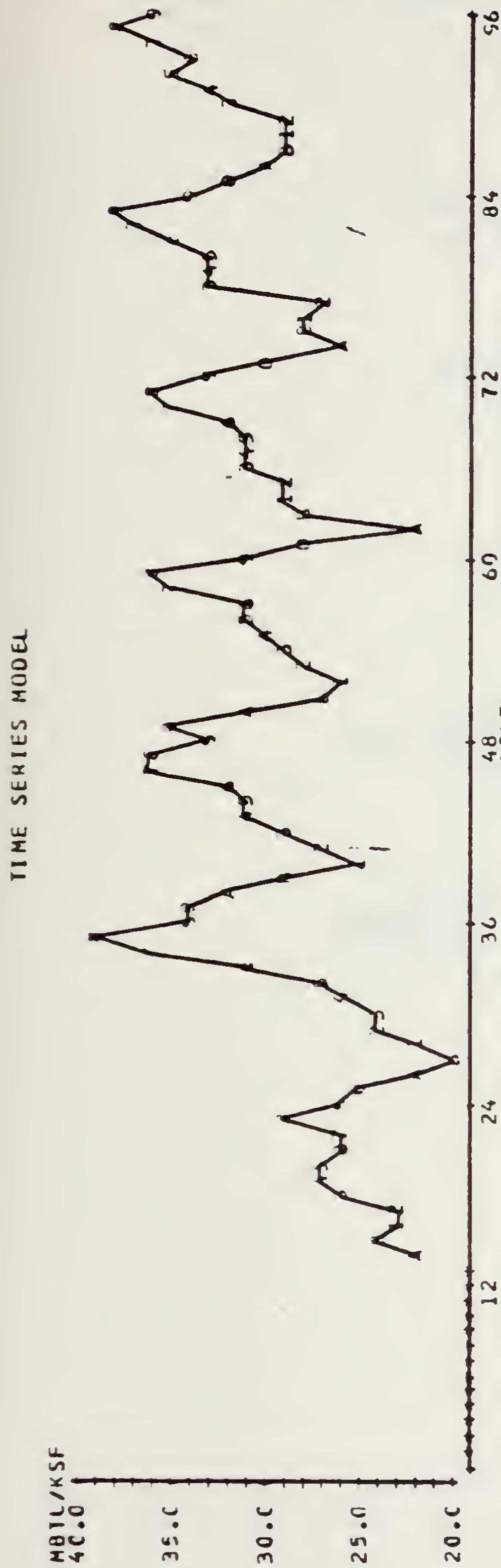
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	491.07	491.07
RESIDUAL	81	1116.64	13.79
TOTAL	82	1607.72	

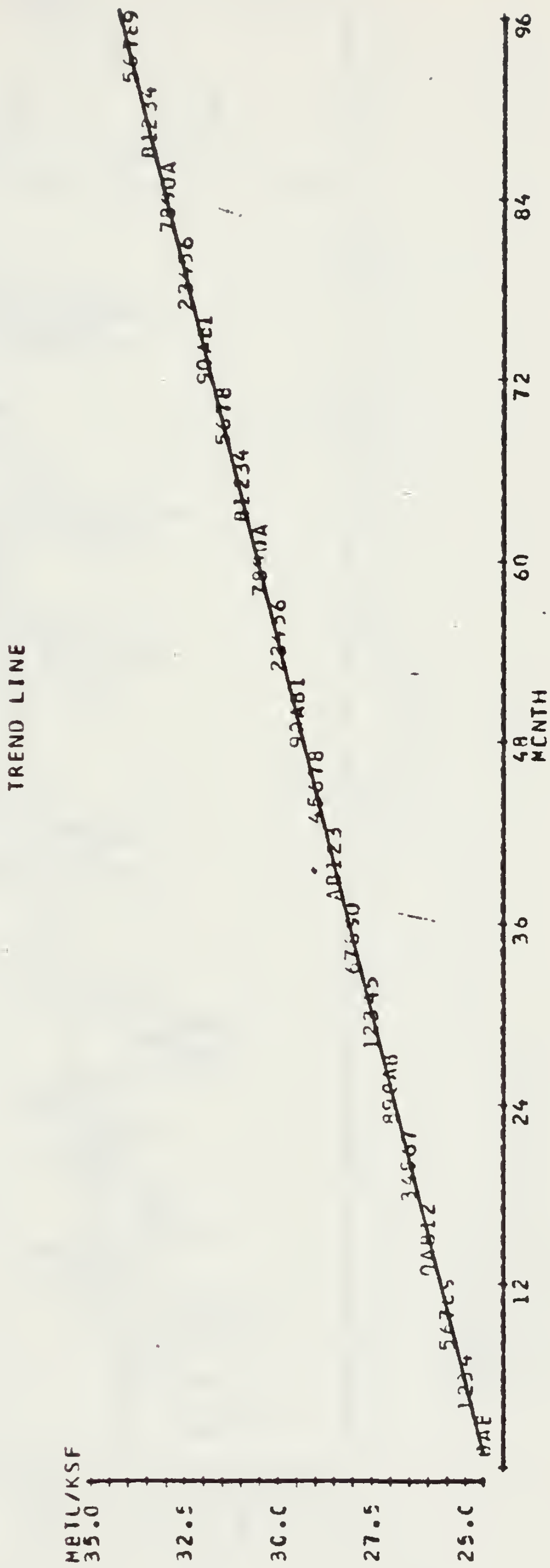
ROW	X1 MONTH	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
34	34.0	36.421	27.895	0.542	2.32R
35	35.0	38.941	27.997	0.531	2.98R
62	62.0	22.153	30.738	0.425	-2.33R

R ==>OBS. WITH A LARGE ST. RES.
X ==>OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

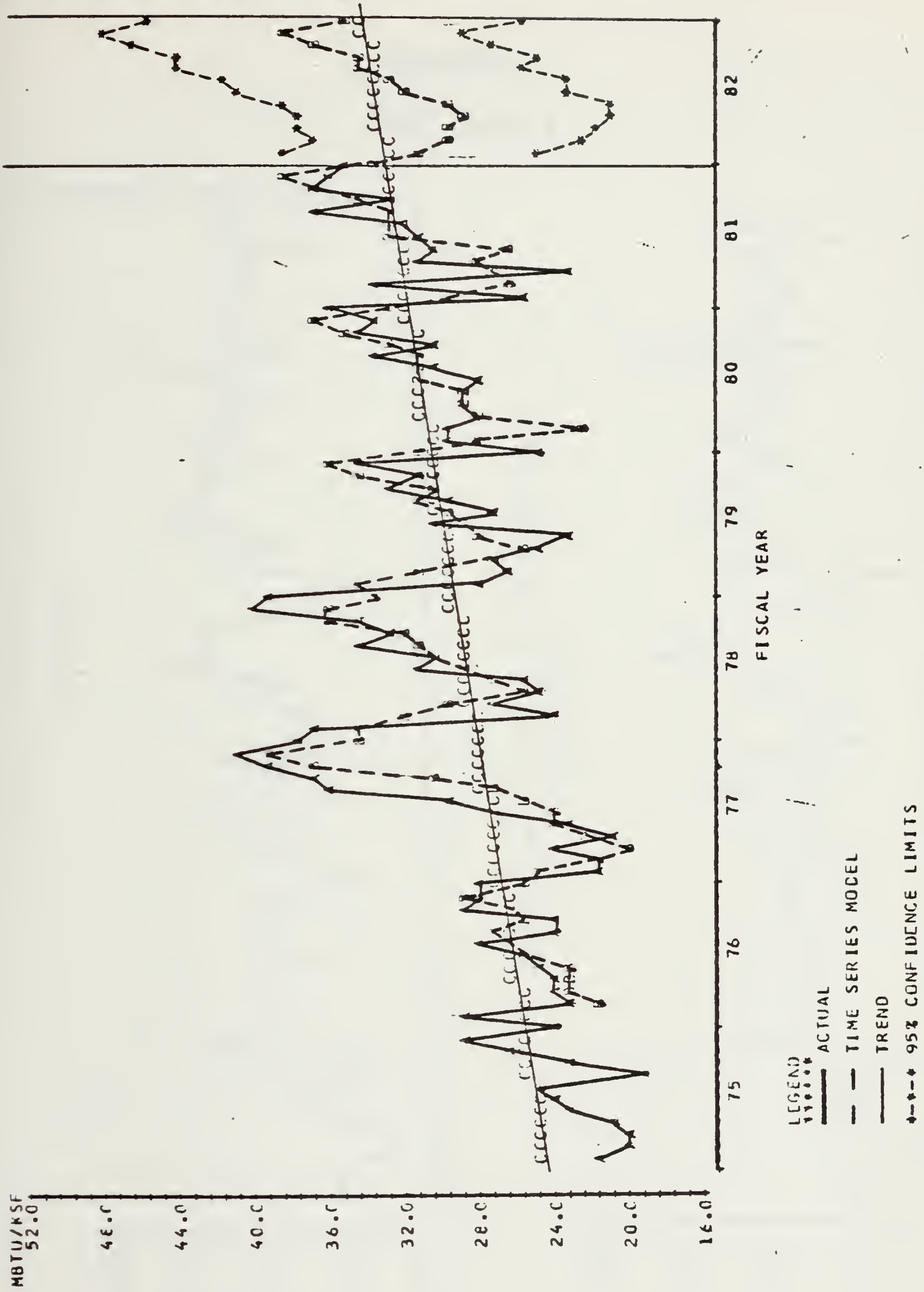
DURBIN-WATSON STATISTIC = 0.46

F. DECOMPOSITION LINES





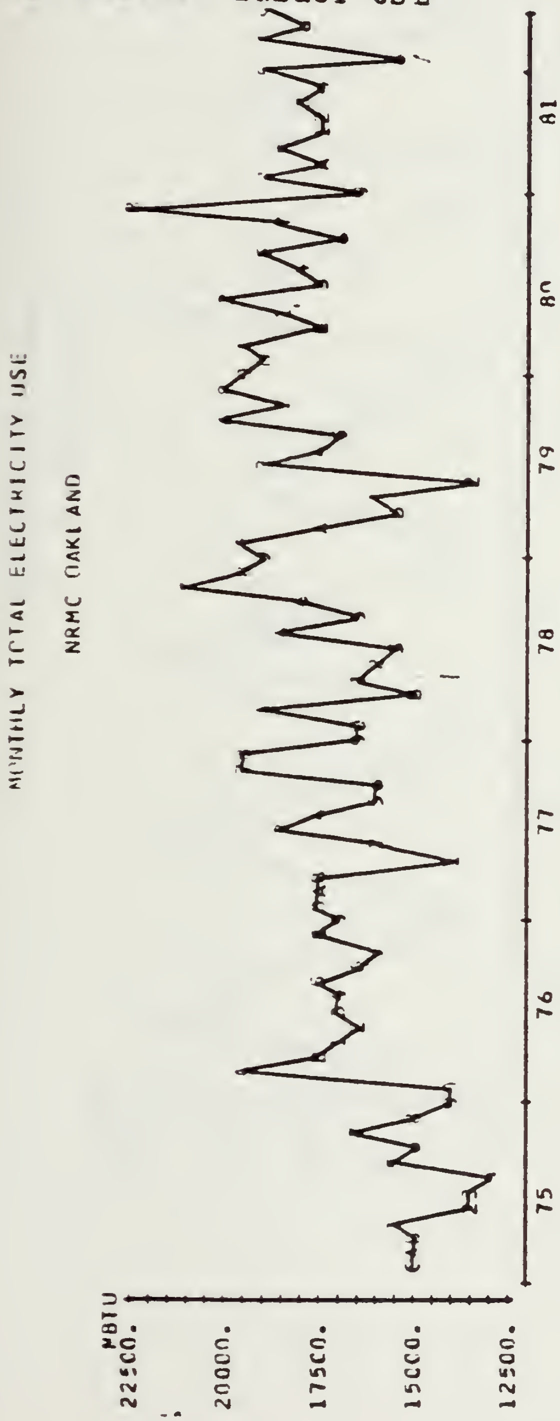
G. ACTUAL USE AND FORECAST MODELS

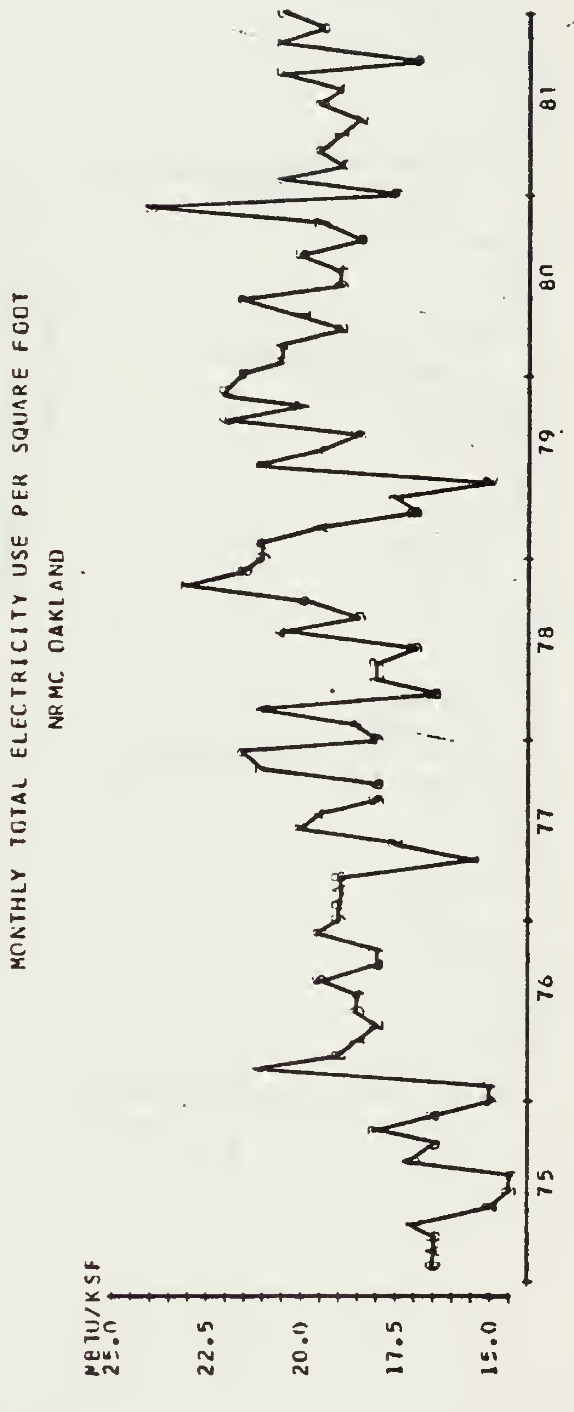


APPENDIX H

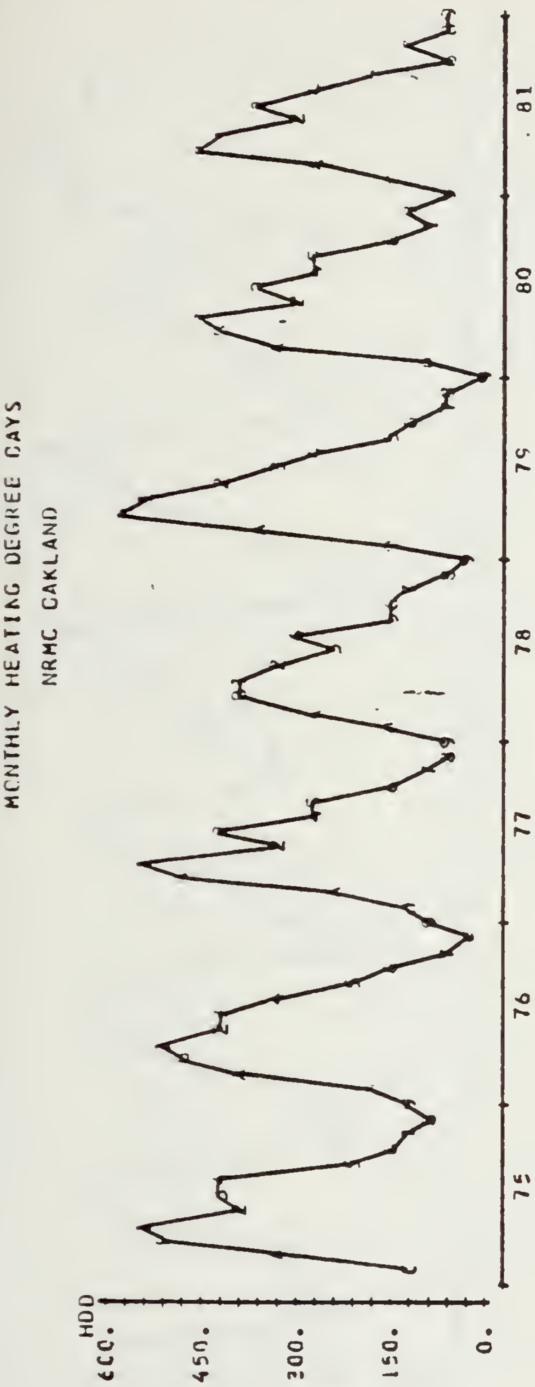
NRMC OAKLAND

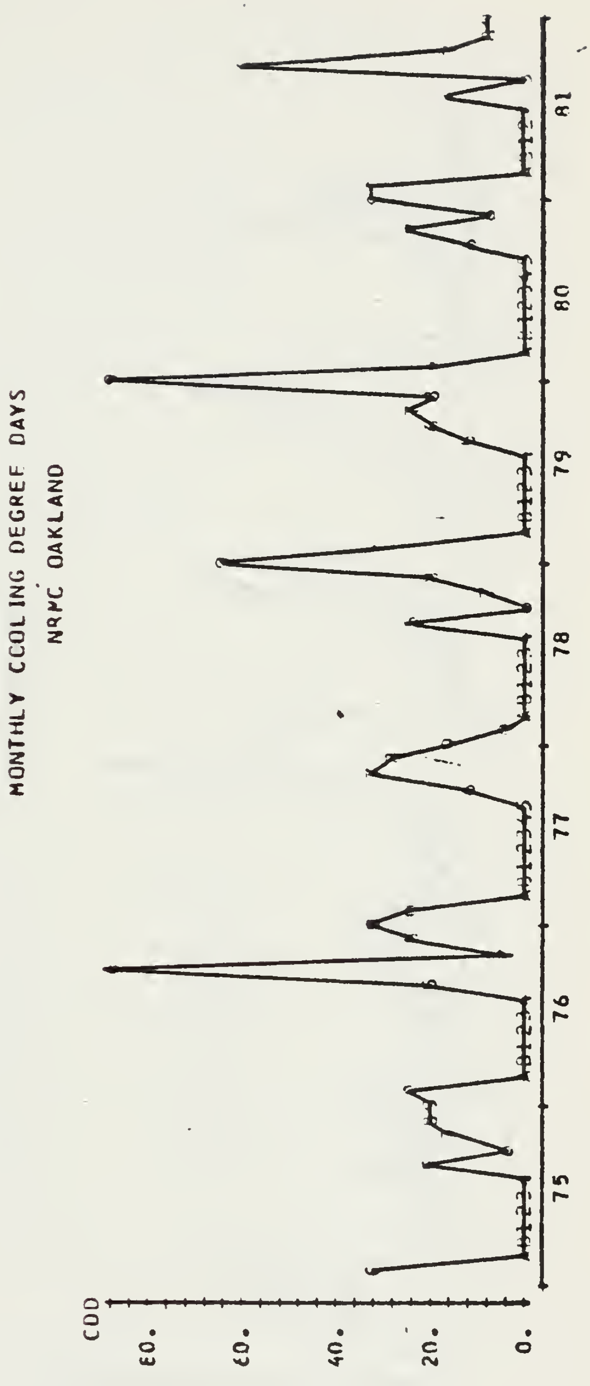
A. MONTHLY ENERGY USE

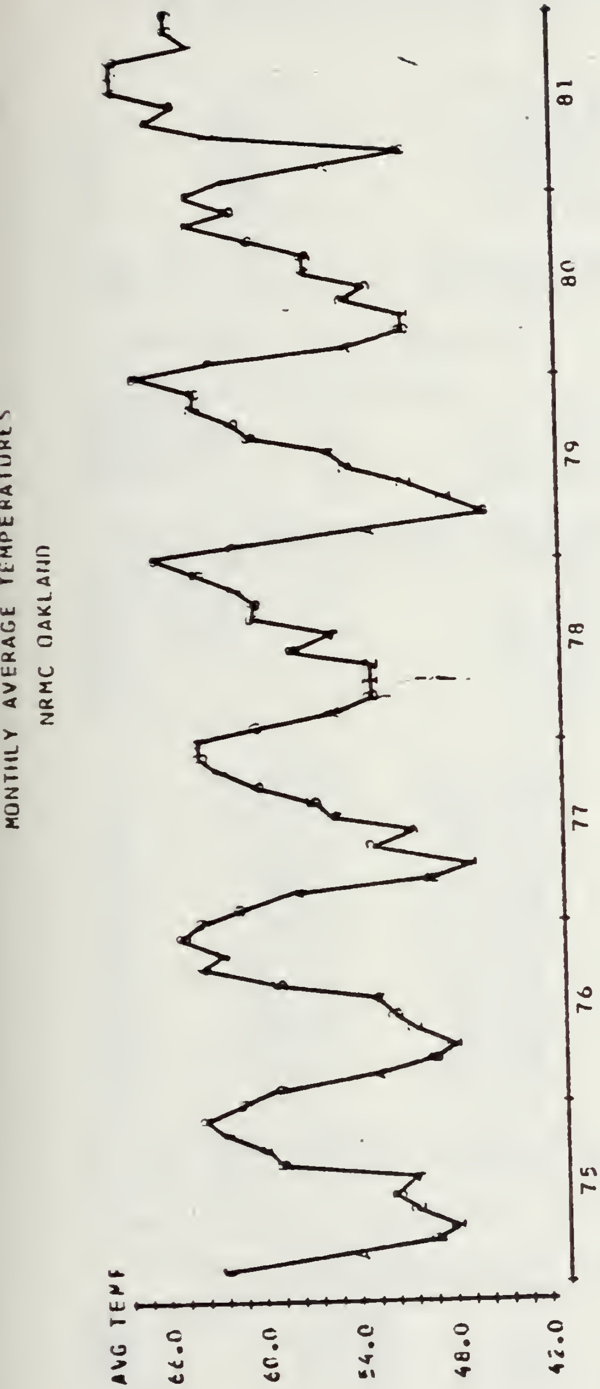


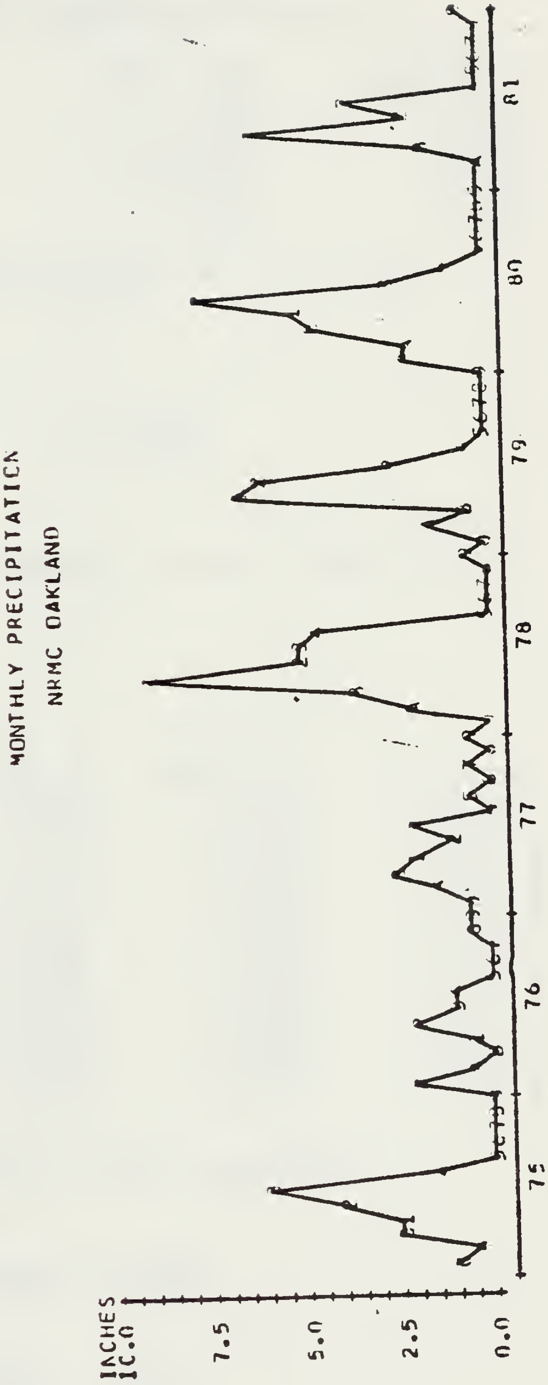


B. MONTHLY WEATHER SUMMARY






MONTHLY AVERAGE TEMPERATURES
NRMC OAKLAND
AVG TEMP
6E.0
60.0
54.0
48.0
42.0
75
76
77
78
79
80
81


MONTHLY PRECIPITATICN
NRMC OAKLAND
INCHES
1C.0
7.5
5.0
2.5
0.0
75
76
77
78
79
80
81

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC OAKLAND IS:
Y = 15.7 +0.0707 X1 -0.0027 X2 -0.0163 X3 -0.0549 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	15.567	5.146	3.04
X1	AVG TEMP	0.07073	0.07817	0.90
X2	HDD	-0.002707	0.003189	-0.85
X3	CDD	-0.01534	0.01480	-1.10
X4	PRECIP	-0.0549	0.1239	-0.52

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 1.883
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 14.0 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	45.689	11.422
RESIDUAL	79	280.174	3.547
TOTAL	83	325.862	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	45.689
AVG TEMP	1	38.147
HDD	1	2.508
CDD	1	4.061
PRECIP	1	0.973

	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
12	61.4	15.127	19.375	0.282	-2.28R
21	63.2	17.941	18.331	1.032	-0.25 X
40	52.5	18.081	17.772	0.844	0.18 X
51	46.0	16.808	17.307	0.660	-0.28 X
60	67.3	21.290	18.955	0.952	1.44 X
65	54.4	21.573	18.214	0.761	1.95 X
71	61.5	24.057	19.608	0.358	2.41R
76	62.2	18.853	18.534	0.942	0.20 X
77	65.5	18.543	19.342	0.802	-0.47 X
78	64.5	19.350	19.027	0.877	0.19 X
79	68.0	18.952	19.429	0.925	-0.29 X
80	68.1	20.294	19.992	0.756	0.17 X
81	68.1	16.816	19.344	0.652	-1.43 X

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.36

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.342			
HDD	-0.345	-0.892		
CDD	0.136	0.605	-0.620	
PRECIP	-0.232	-0.493	0.567	-0.393

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF NRMC OAKLAND

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----
 1   0.415                      XXXXXXXXXXX
 2   0.344                      XXXXXXXXXX
 3   0.332                      XXXXXXXXX
 4   0.233                      XXXXXXX
 5   0.200                      XXXXXX
 6   0.122                      XXXX
 7   0.028                      XX
 8   0.127                      XXXX
 9   0.163                      XXXXX
10   0.114                      XXXX
11   0.351                      XXXXXXXXXX
12   0.213                      XXXXXX
13   0.133                      XXXX
14   0.161                      XXXXX
15   0.061                      XXX
16   0.170                      XXXXX
17   0.034                      XX
18  -0.135                   XXXX
19   0.057                      XX
20   0.043                      XX
21   0.062                      XXX
22   0.055                      XX
23   0.100                      XXX
24   0.136                      XXXX
25   0.119                      XXXX
26   0.001                      X
27   0.032                      XX
28   0.011                      X
29  -0.094                    XXX
30   0.023                      XX
31  -0.054                     XX
32  -0.050                     XX
33  -0.020                     XX
34  -0.040                     XX
35  -0.010                      X
36  -0.013                      X
37  -0.062                    XXX
38  -0.080                    XXX
39  -0.081                    XXX
40  -0.052                     XX
41  -0.092                    XXX
42  -0.156                  XXXXX
43  -0.172                  XXXXX
44  -0.059                     XX
45  -0.063                    XXX
46  -0.047                     XX
47  -0.082                    XXX
48  -0.051                     XX
49  -0.081                    XXX
50  -0.065                    XXX
```

```
  PACF OF MBTU/KSF       NRMC OAKLAND

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
           +----+----+----+----+----+----+----+----+----
 1   0.415                      XXXXXXXXXXX
 2   0.207                      XXXXXX
 3   0.168                      XXXXX
 4   0.017                      X
 5   0.025                      XX
 6  -0.047                     XX
 7  -0.097                    XXX
 8   0.116                      XXXX
 9   0.128                      XXXX
10   0.022                      XX
11   0.322                      XXXXXXXXX
12  -0.044                     XX
13  -0.126                   XXXX
14  -0.052                     XX
15  -0.099                    XXX
16   0.172                      XXXXX
17  -0.080                    XXX
18  -0.164                  XXXXX
19   0.157                      XXXXX
20  -0.040                     XX
21   0.108                      XXXX
22  -0.119                   XXXX
23   0.081                      XXX
24   0.121                      XXXX
25  -0.121                   XXXX
26  -0.023                     XX
27  -0.102                   XXXX
28  -0.014                      X
29   0.092                      XXX
30   0.030                      XX
31  -0.011                      X
32  -0.135                   XXXX
33  -0.011                      X
34   0.061                      XXX
35  -0.157                  XXXXX
36  -0.002                      X
37   0.035                      XX
38  -0.002                      X
39  -0.011                      X
40  -0.031                     XX
41  -0.041                     XX
42  -0.073                    XXX
43  -0.068                    XXX
44   0.118                      XXXX
45   0.029                      XX
46   0.012                      X
47  -0.052                     XX
48   0.040                      XX
49  -0.122                   XXXX
50   0.009                      X
```

ARIMA (3 1 2)(0 1 3) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-2.1116	0.1096	-19.26
2	AR 2	-1.9637	0.1596	-12.30
3	AR 3	-0.7359	0.1089	-6.76
4	MA 1	-1.5149	0.0774	-19.56
5	MA 2	-0.9413	0.0634	-14.84
6	SMA 12	0.8296	0.1412	5.88
7	SMA 24	0.0723	0.1834	0.39
8	SMA 36	-0.1151	0.2189	-0.53

```
DIFFERENCING. 1 REGULAR  1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =        207.324  (BACKFORECASTS EXCL)
              DF =     63  MS =       3.291
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF. 71
```

```
   ACF OF RESIDUAL         NRMC OAKLAND

                  -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                    +----+----+----+----+----+----+----+----
  1  -0.054                            XX
  2  -0.145                         XXXXX
  3  -0.195                        XXXXXX
  4  -0.049                            XX
  5   0.092                             XXX
  6  -0.061                           XXX
  7   0.089                             XXX
  8  -0.288                      XXXXXXXX
  9  -0.032                            XX
 10   0.067                             XXX
 11   0.205                             XXXXXX
 12   0.013                             X
 13  -0.166                         XXXXX
 14   0.019                             X
 15  -0.022                            XX
 16   0.148                             XXXXX
 17  -0.016                             X
 18  -0.066                           XXX
 19   0.143                             XXXXX
 20  -0.080                           XXX
 21  -0.064                           XXX
 22  -0.078                           XXX
 23   0.092                             XXX
 24   0.045                             XX
 25  -0.047                            XX
 26  -0.066                           XXX
 27  -0.103                          XXXX
 28  -0.027                            XX
 29   0.062                             XXX
 30   0.265                             XXXXXXXX
 31   0.103                             XXXX
 32  -0.136                          XXXX
 33  -0.067                           XXX
 34   0.082                             XXX
 35   0.010                             X
 36  -0.129                          XXXX
 37  -0.088                           XXX
 38  -0.073                           XXX
 39  -0.056                            XX
 40   0.153                             XXXXX
```

```
ARIMA (3 1 4)(0 1 2) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE        ST. DEV.   T-RATIO
     1      AR   1    -0.5434         0.2977       -1.83
     2      AR   2    -0.0722         0.3194       -0.23
     3      AR   3     0.5691         0.2907        1.96
     4      MA   1     0.2911         0.3426        0.85
     5      MA   2     0.3191         0.2832        1.13
     6      MA   3     0.6713         0.1070        6.28
     7      MA   4    -0.2482         0.3351       -0.74
     8     SMA  12     0.8223         0.1512        5.44
     9     SMA  24    -0.0388         0.1672       -0.23

DIFFERENCING. 1 REGULAR  1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =       170.573  (BACKFORECASTS EXCL)
              DF =    62  MS =          2.751
NO. OF OBS.   ORIGINAL SERIES    84     AFTER DIFF.  71

   ACF OF RESIDUAL          NRMC OAKLAND

             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
               +----+----+----+----+----+----+----+----
  1  -0.039                      XX
  2  -0.001                       X
  3  -0.006                       X
  4   0.059                       XX
  5  -0.042                      XX
  6   0.015                       X
  7  -0.002                       X
  8  -0.168                   XXXXX
  9   0.018                       X
 10   0.038                       XX
 11   0.227                       XXXXXXX
 12  -0.074                     XXX
 13  -0.076                     XXX
 14   0.068                       XXX
 15  -0.040                      XX
 16   0.151                       XXXXX
 17  -0.006                       X
 18  -0.118                    XXXX
 19   0.126                       XXXX
 20  -0.001                       X
 21  -0.050                      XX
 22  -0.069                     XXX
 23   0.038                       XX
 24  -0.101                    XXXX
 25  -0.006                       X
 26  -0.087                     XXX
 27  -0.052                      XX
 28   0.042                       XX
 29  -0.020                       X
 30   0.292                       XXXXXXXX
 31   0.106                       XXXX
 32  -0.044                      XX
 33  -0.052                      XX
 34   0.078                       XXX
 35  -0.068                     XXX
 36  -0.149                   XXXXX
 37  -0.050                      XX
 38  -0.087                     XXX
 39  -0.057                      XX
 40   0.092                       XXX
```

ARIMA (3 1 3)(0 1 2) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.9157	0.1647	-5.56
2	AR 2	-0.5750	0.2136	-2.70
3	AR 3	0.3103	0.1619	1.92
4	MA 1	-0.2115	0.1188	-1.78
5	MA 2	0.0689	0.1170	0.59
6	MA 3	0.8601	0.1039	8.28
7	SMA 12	0.8970	0.1422	6.31
8	SMA 24	-0.0955	0.1634	-0.59

```
DIFFERENCING. 1 REGULAR     1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =       173.809  (BACKFORECASTS EXCL)
              DF =     63  MS =        2.759
NO. OF OBS.   ORIGINAL SERIES    84     AFTER DIFF.   71
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	20.9411	17.6850	24.1973
86	20.0963	16.7006	23.4919
87	18.8915	15.3619	22.4211
88	19.3262	15.7623	22.8902
89	17.9989	14.4287	21.5692
90	20.0712	16.4250	23.7174
91	19.9775	16.3211	23.6339
92	19.1778	15.5083	22.8473
93	20.2596	16.5222	23.9969
94	21.0886	17.3470	24.8302
95	21.7286	17.9606	25.4965
96	20.6440	16.8237	24.4644

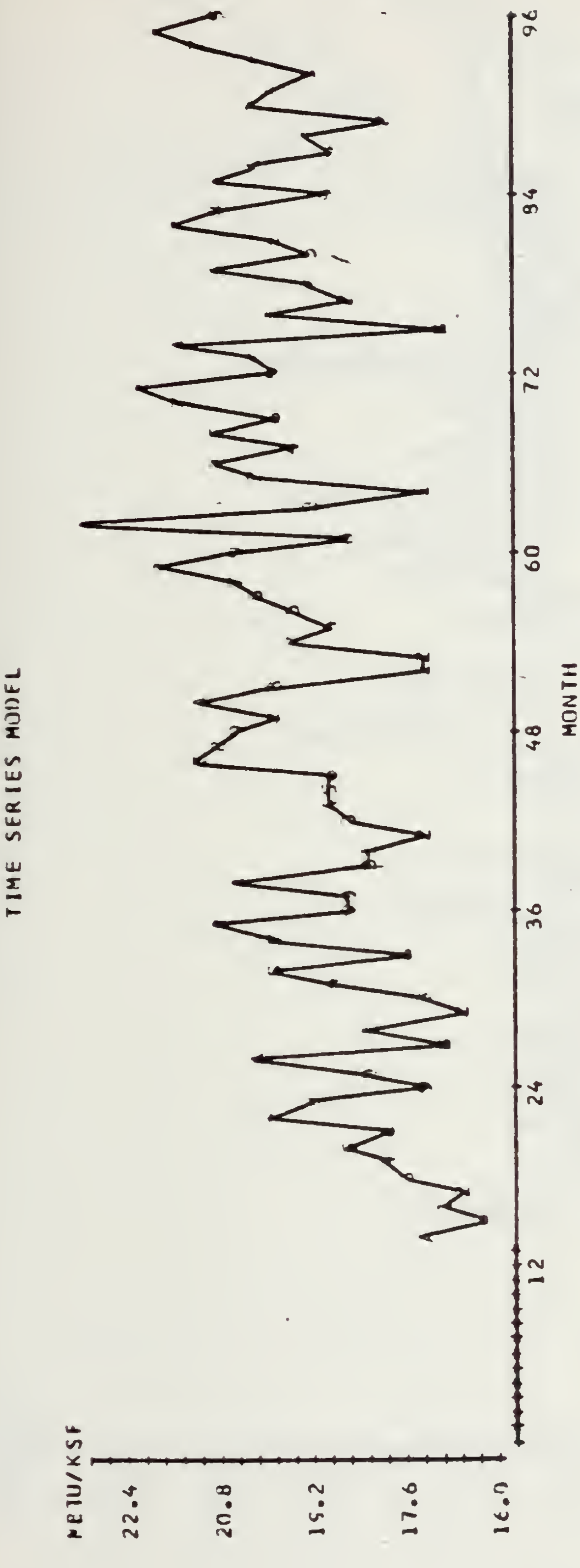
ACF OF RESIDUAL   NRMC OAKLAND

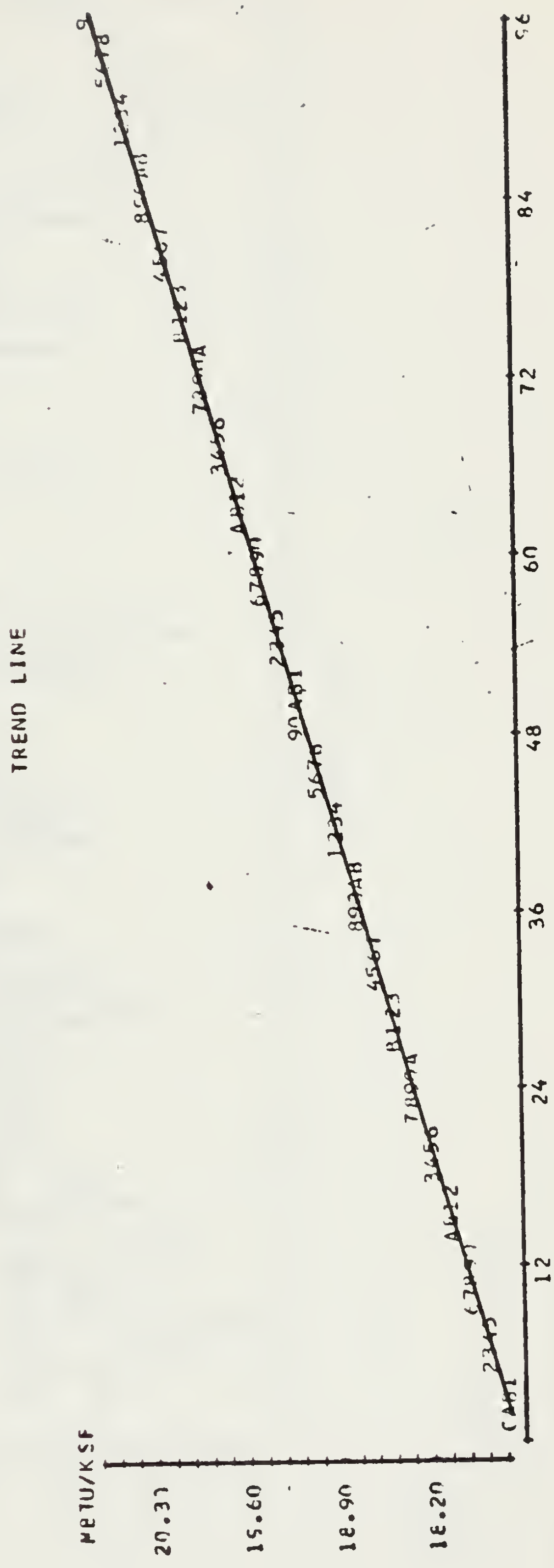
```
              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----+----
  1  -0.036                        XX
  2   0.057                         XX
  3   0.051                         XX
  4   0.086                         XXX
  5  -0.076                       XXX
  6  -0.003                         X
  7   0.031                         XX
  8  -0.181                    XXXXXX
  9   0.055                         XX
 10   0.039                         XX
 11   0.166                         XXXXX
 12  -0.014                         X
 13  -0.017                         X
 14   0.047                         XX
 15   0.009                         X
 16   0.165                         XXXXX
 17  -0.041                        XX
 18  -0.048                        XX
 19   0.136                         XXXX
 20  -0.018                         X
 21  -0.015                         X
 22  -0.101                      XXXX
 23   0.042                         XX
 24  -0.101                      XXXX
 25  -0.043                        XX
 26  -0.053                        XX
 27  -0.024                        XX
 28   0.054                         XX
 29   0.014                         X
 30   0.255                         XXXXXXX
```

E. FITTING A TREND LINE

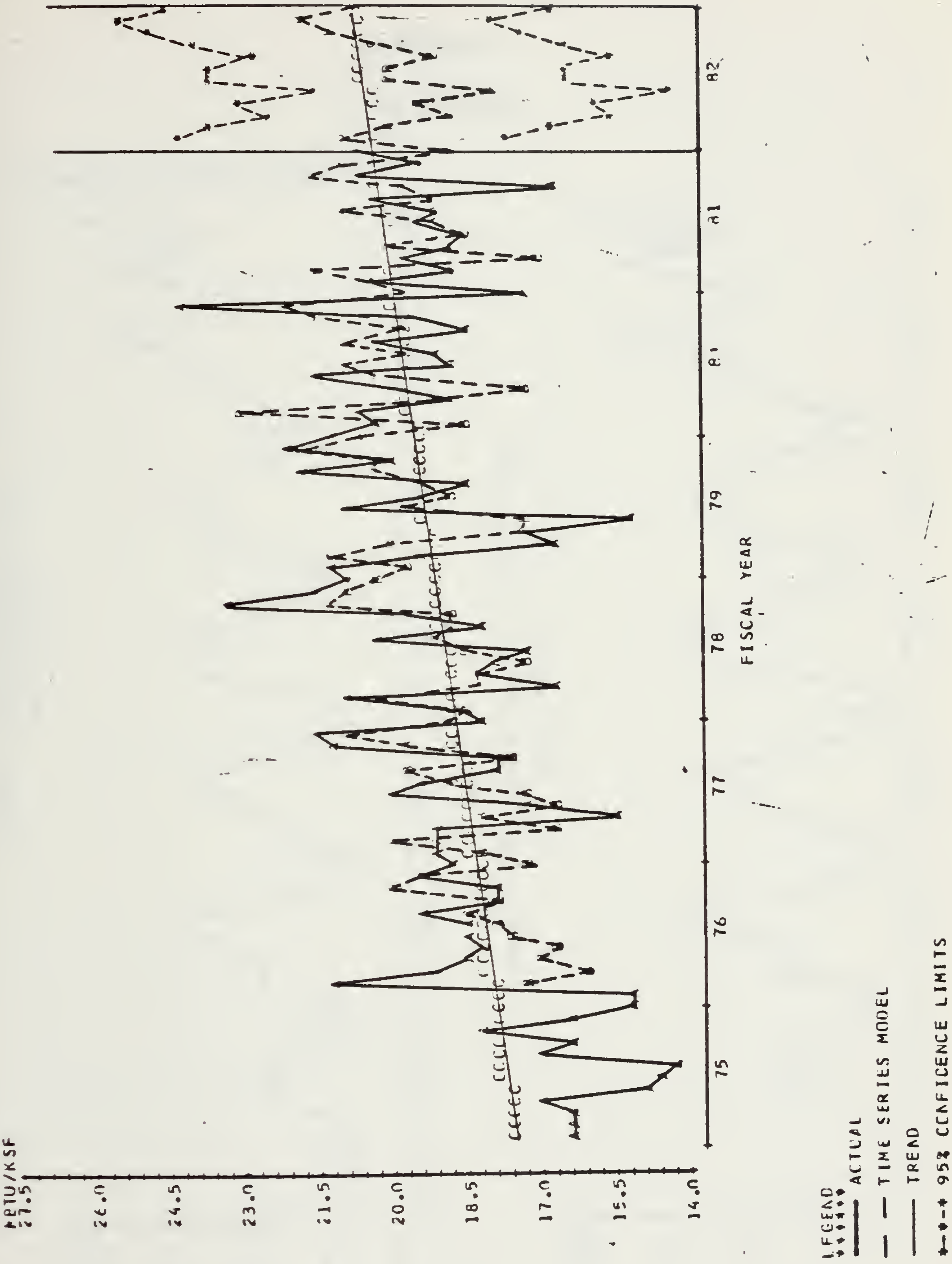
```
REGRESSION OF MODELED MBTJ/KSF  VS  MONTH

   83 CASES USED
   13 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS:
     Y =    17.6 +0.0322 X1

                                           ST. DEV.      T-RATIO =
       COLUMN       COEFFICIENT            OF COEF.      COEF/S.D.
       --             17.5678               0.3465         50.70
X1     MONTH          0.032152            0.005776          5.57

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S =1.251
WITH (  83-  2)  =  81 DEGREES OF FREEDOM

R-SQUARED = 27.7 PERCENT

ANALYSIS OF VARIANCE
 DUE TO      DF          SS           MS=SS/DF
REGRESSION    1        49.250          49.250
RESIDUAL     81       128.740           1.589
TOTAL        82       177.990

            X1           Y       PRED. Y      ST.DEV.
          MONTH     ARIMA LN      VALUE      PRED. Y       ST.RES.
 62        62.0      22.936      19.561        0.144        2.69R
 75        75.0      17.070      19.979        0.180       -2.33R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC =  1.63
```

F. DECOMPOSITION LINES





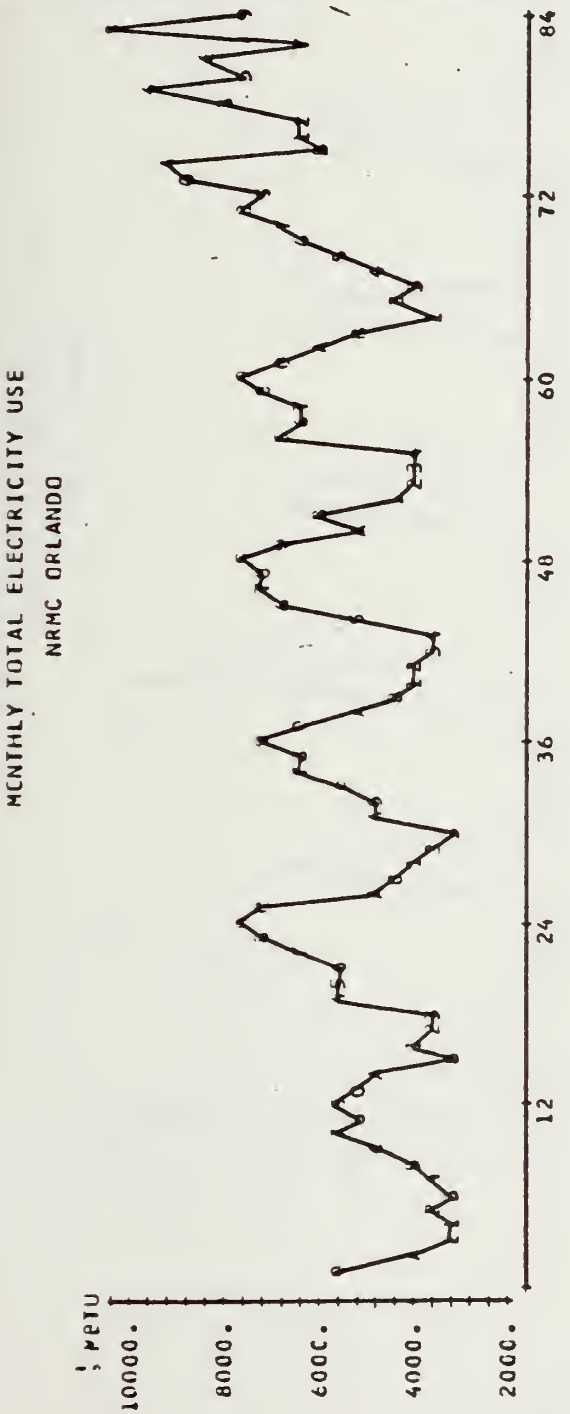
G. ACTUAL USE AND FORECAST MODELS

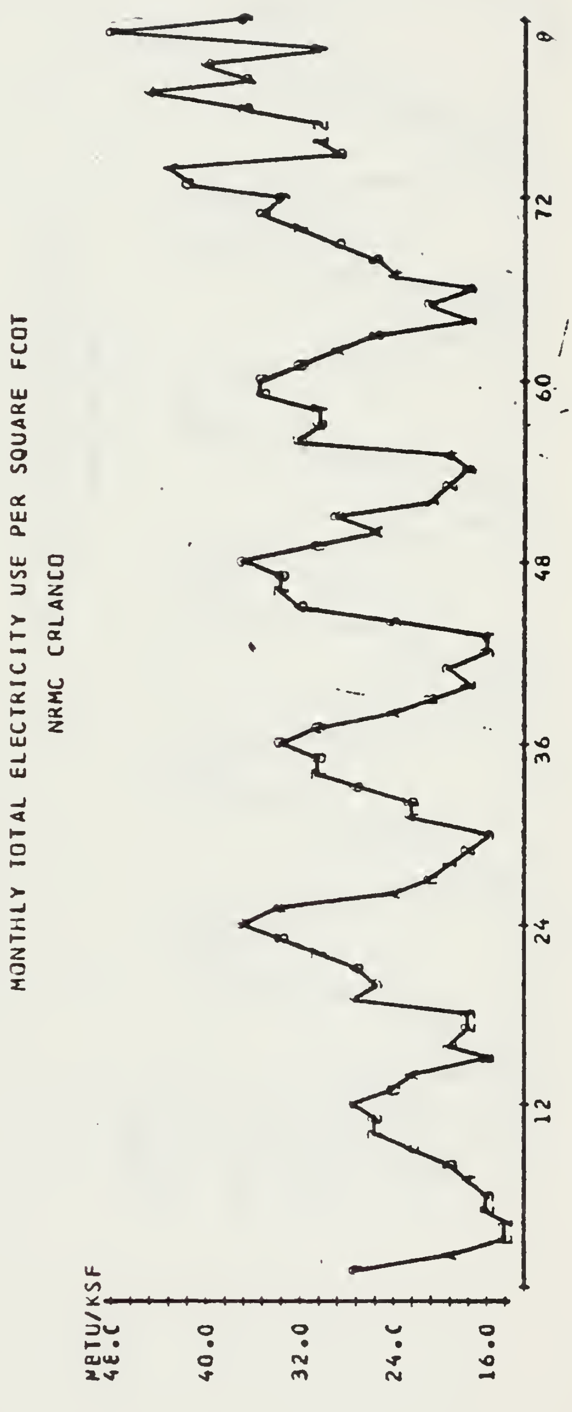


APPENDIX I

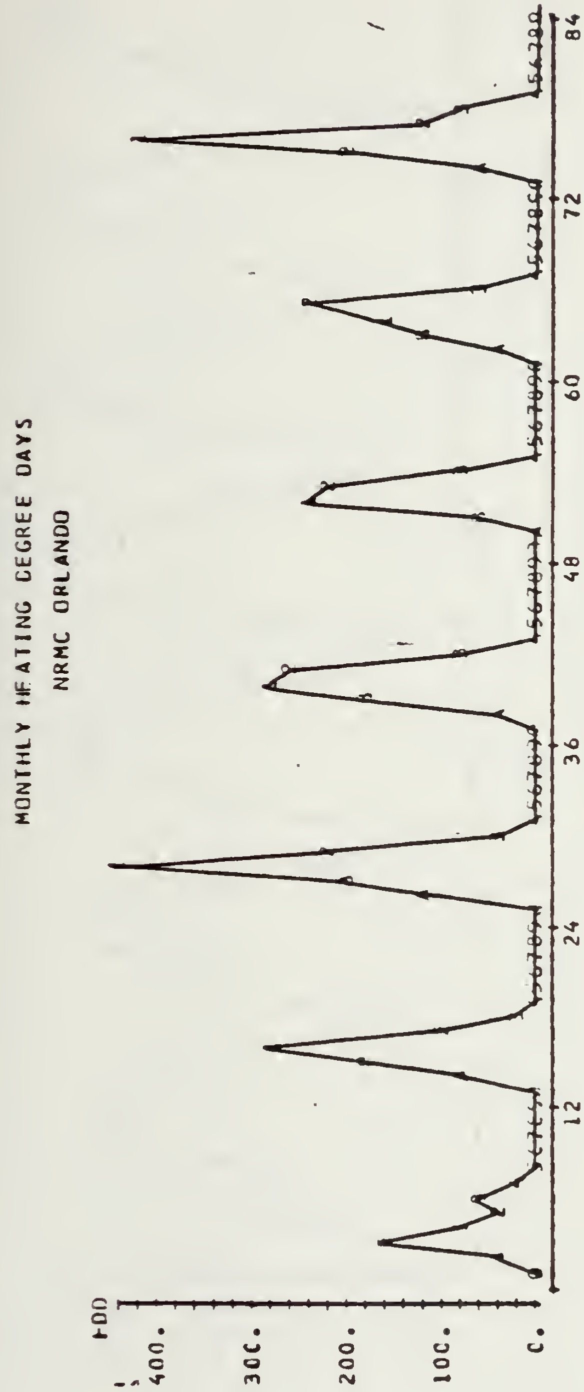
NRMC ORLANDO

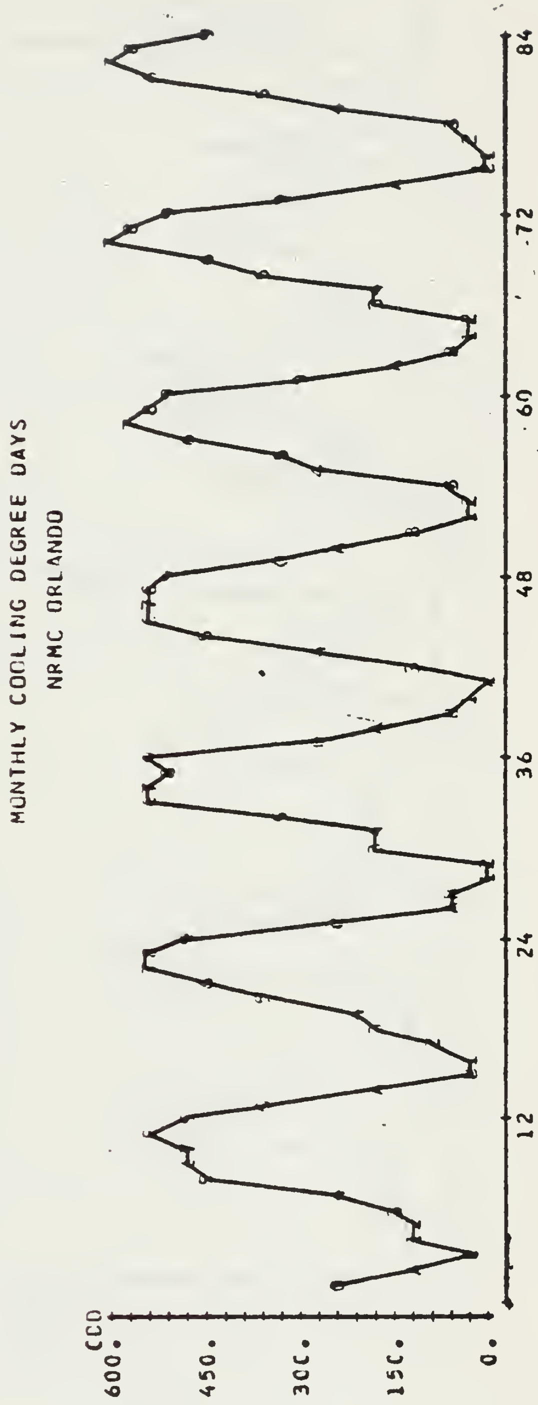
A. MONTHLY ENERGY SUMMARY



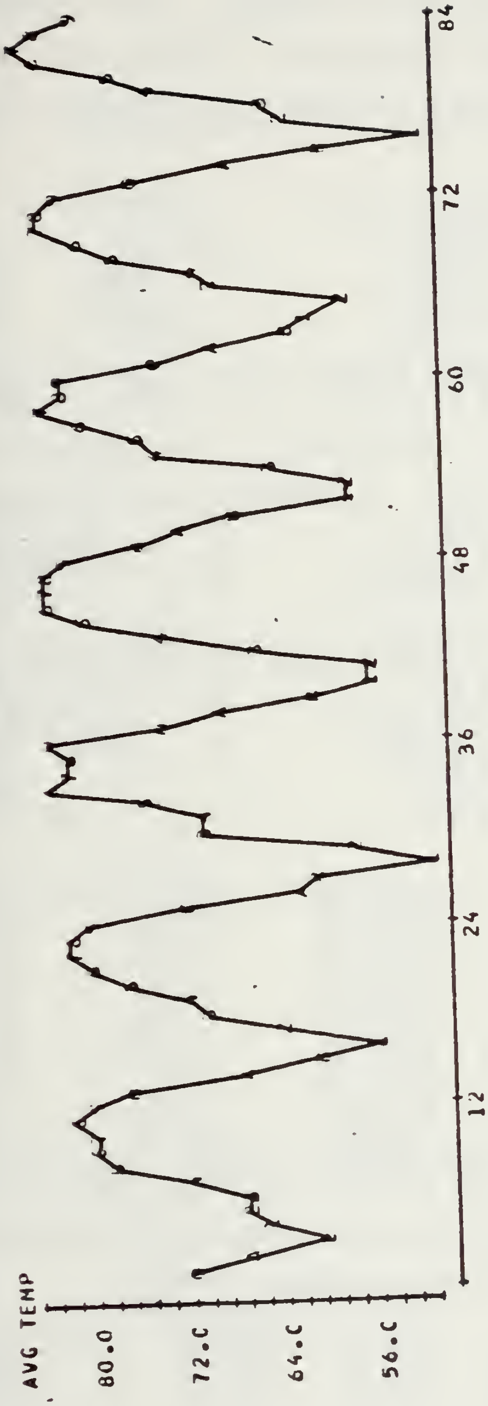


B. MONTHLY WEATEHR SUMMARY

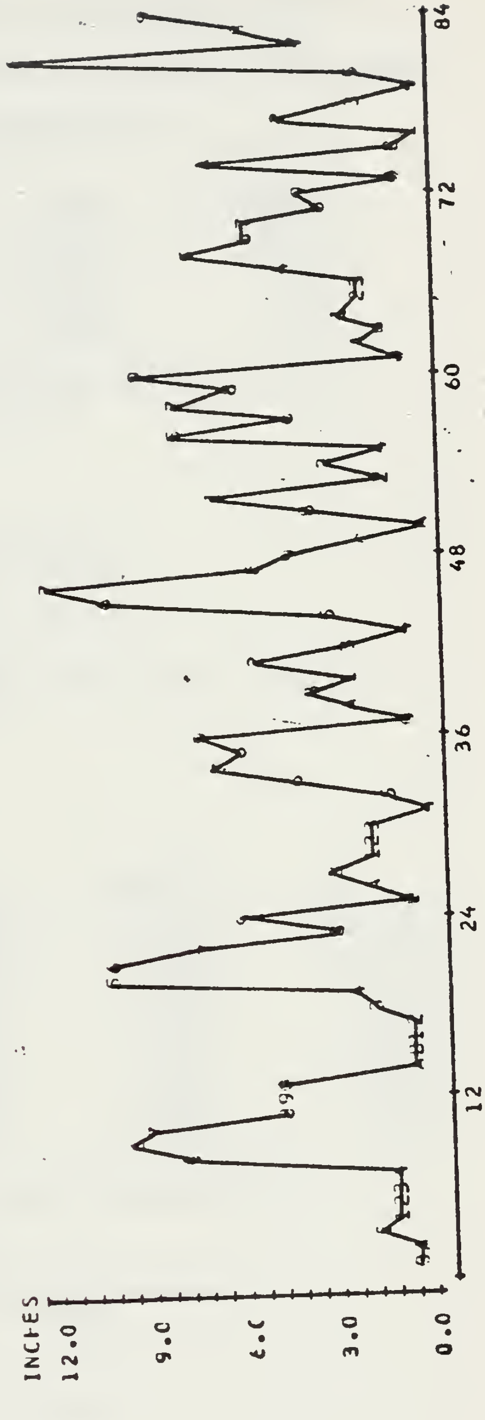




MONTHLY AVERAGE TEMPERATURES
NRMC ORLANDO



MONTHLY PRECIPITATION
NRMC ORLANDO



C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS AND PRECIPITATION

NOTE:CDD HIGHLY CORRELATED WITH OTHER PREDICTOR VARIABLES

THE REGRESSION EQUATION FOR NRMC ORLANDO IS:
Y = -24.1 +0.679 X1 +0.0250 X2 +0.0011 X3 -0.0099 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	-24.1	186.0	-0.13
X1	AVG TEMP	0.679	2.872	0.24
X2	HDD	0.02503	0.09539	0.26
X3	CDD	0.00113	0.09367	0.01
X4	PRECIP	-0.0099	0.3055	-0.03

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 6.504
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 33.5 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	1684.85	421.21
RESIDUAL	79	3341.65	42.30
TOTAL	83	5026.50	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	1684.85
AVG TEMP	1	1556.88
HDD	1	127.92
CDD	1	0.01
PRECIP	1	0.04

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
28	50.6	18.552	21.258	3.400	-0.49 X
41	55.8	19.533	20.125	2.869	-0.10 X
46	83.6	33.156	33.181	2.909	-0.00 X
73	75.4	40.873	27.501	1.342	2.10R
74	67.1	43.500	23.237	1.702	3.23R
76	51.3	30.585	21.148	3.244	1.67 X
78	64.0	36.934	21.306	1.317	2.45R
79	73.1	44.377	25.854	1.369	2.91R
81	83.2	39.670	32.906	2.279	1.11 X
83	82.9	48.698	32.778	1.386	2.51R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.65

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.557			
HDD	-0.407	-0.871		
CDD	0.578	0.971	-0.730	
PRECIP	0.362	0.559	-0.323	0.518

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF   NRMC ORLANDO

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+
 1    0.755                     XXXXXXXXXXXXXXXXXXXX
 2    0.557                     XXXXXXXXXXXXXXX
 3    0.336                     XXXXXXXXX
 4    0.124                     XXXX
 5   -0.019                     X
 6   -0.160                 XXXXX
 7   -0.156                 XXXXX
 8   -0.053                    XX
 9    0.161                     XXXXX
10    0.329                     XXXXXXXXX
11    0.450                     XXXXXXXXXXXX
12    0.480                     XXXXXXXXXXXXX
13    0.385                     XXXXXXXXXXX
14    0.245                     XXXXXXX
15    0.040                     XX
16   -0.156                 XXXXX
17   -0.279             XXXXXXXX
18   -0.326            XXXXXXXXX
19   -0.319            XXXXXXXXX
20   -0.151                 XXXXX
21    0.018                     X
22    0.221                     XXXXXXX
23    0.358                     XXXXXXXXXX
24    0.374                     XXXXXXXXXX
25    0.345                     XXXXXXXXXX
26    0.229                     XXXXXXX
27    0.099                     XXX
28   -0.072                   XXX
29   -0.210               XXXXXX
30   -0.271             XXXXXXXX
31   -0.233              XXXXXXX
32   -0.097                   XXX
33   -0.003                     X
34    0.114                     XXXX
35    0.209                     XXXXXX
36    0.229                     XXXXXXX
37    0.209                     XXXXXX
38    0.115                     XXXX
39   -0.031                    XX
40   -0.152                 XXXXX
41   -0.258              XXXXXXX
42   -0.263             XXXXXXXX
43   -0.241              XXXXXXX
44   -0.193               XXXXXX
45   -0.101                  XXXX
46    0.002                     X
47    0.079                     XXX
48    0.096                     XXX
49    0.095                     XXX
50    0.047                     XX
```

```
   PACF OF MBTU/KSF         NRMC ORLANDO

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----
 1   0.785                      XXXXXXXXXXXXXXXXXXXX
 2  -0.028                     XX
 3  -0.174                  XXXXX
 4  -0.151                  XXXXX
 5  -0.017                      X
 6  -0.128                   XXXX
 7   0.165                      XXXXX
 8   0.226                      XXXXXXX
 9   0.344                      XXXXXXXXXX
10   0.083                      XXX
11   0.048                      XX
12  -0.103                   XXXX
13  -0.232                XXXXXXX
14  -0.160                  XXXXX
15  -0.089                    XXX
16  -0.021                     XX
17   0.127                      XXXX
18   0.105                      XXXX
19  -0.107                   XXXX
20   0.141                      XXXXX
21  -0.055                     XX
22   0.110                      XXXX
23   0.042                      XX
24   0.001                      X
25   0.024                      XX
26   0.023                      XX
27   0.041                      XX
28  -0.001                      X
29  -0.092                    XXX
30  -0.046                     XX
31  -0.016                      X
32   0.022                      XX
33  -0.115                   XXXX
34  -0.078                    XXX
35   0.013                      X
36  -0.048                     XX
37   0.044                      XX
38   0.078                      XXX
39   0.010                      X
40  -0.004                      X
41  -0.057                     XX
42   0.082                      XXX
43  -0.057                     XX
44  -0.106                   XXXX
45  -0.045                     XX
46   0.035                      XX
47  -0.048                     XX
48  -0.023                     XX
49   0.055                      XX
50   0.057                      XX
```

```
ARIMA (1 1 3)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
     1      AR  1       0.2526        0.7505       0.34
     2     SAR 12       0.9905        0.0306      32.41
     3      MA  1       0.9246        0.7423       1.25
     4      MA  2      -0.1964        0.4941      -0.40
     5      MA  3       0.1092        0.1508       0.72
     6     SMA 12       0.7531        0.1426       5.28

DIFFERENCING. 1 REGULAR
RESIDUALS.     SS =        1361.37   (BACKFORECASTS EXCL)
               DF =      77  MS =        17.68
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF.   83

   ACF OF RESIDUAL          NRMC ORLANDO

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
  1  -0.001                     X
  2   0.016                     X
  3  -0.003                     X
  4   0.053                     XX
  5   0.205                     XXXXXX
  6  -0.029                    XX
  7  -0.099                   XXX
  8  -0.205                XXXXXX
  9   0.021                     XX
 10  -0.123                  XXXX
 11   0.030                     XX
 12   0.059                     XX
 13  -0.123                  XXXX
 14   0.018                     X
 15   0.002                     X
 16  -0.076                   XXX
 17   0.081                     XXX
 18   0.065                     XXX
 19  -0.207                XXXXXX
 20   0.022                     XX
 21  -0.079                   XXX
 22   0.084                     XXX
 23   0.104                     XXXX
 24  -0.119                  XXXX
 25  -0.037                    XX
 26  -0.005                     X
 27   0.154                     XXXXX
 28   0.072                     XXX
 29   0.126                     XXXX
 30  -0.084                   XXX
 31  -0.096                   XXX
 32   0.164                     XXXXX
 33  -0.017                     X
 34  -0.008                     X
 35  -0.046                    XX
 36  -0.147                 XXXXX
 37  -0.025                    XX
 38   0.005                     X
 39  -0.026                    XX
 40   0.010                    X
```

```
ARIMA  (1  1  3)(1  1  1)  S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
     1     AR  1      -0.1203        0.9565      -0.13
     2    SAR 12      -0.1045        0.2220      -0.47
     3     MA  1       0.5865        0.9411       0.62
     4     MA  2       0.0034        0.5712       0.01
     5     MA  3       0.1423        0.1334       1.07
     6    SMA 12       0.9184        0.1225       7.50

DIFFERENCING.  1 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =       1240.08   (BACKFORECASTS EXCL)
               DF =    65  MS =         19.08
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF. 71

   ACF OF RESIDUAL           NRMC ORLANDO

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----
  1  -0.008                     X
  2  -0.008                     X
  3   0.018                     X
  4   0.019                     X
  5   0.182                     XXXXXX
  6  -0.010                     X
  7  -0.127                  XXXX
  8  -0.201                XXXXXX
  9   0.001                     X
 10  -0.155                 XXXXX
 11   0.017                     X
 12   0.068                     XXX
 13  -0.154                 XXXXX
 14  -0.019                     X
 15   0.006                     X
 16  -0.069                   XXX
 17   0.140                     XXXXX
 18   0.032                     XX
 19  -0.231               XXXXXXX
 20   0.052                     XX
 21  -0.080                   XXX
 22   0.099                     XXX
 23   0.096                     XXX
 24  -0.178                 XXXXX
 25  -0.050                    XX
 26   0.007                     X
 27   0.115                     XXXX
 28   0.084                     XXX
 29   0.159                     XXXXX
 30  -0.130                  XXXX
 31  -0.080                   XXX
 32   0.154                     XXXXX
 33  -0.011                     X
 34   0.043                     XX
 35  -0.060                    XX
 36  -0.209                XXXXXX
 37   0.007                     X
 38   0.039                     XX
 39  -0.041                    XX
 40   0.025                     XX
```

ARIMA (1 1 4)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.9419	0.0681	-13.83
2	SAR 12	0.9257	0.0896	10.33
3	MA 1	-0.4023	0.1155	-3.48
4	MA 2	0.5591	0.0703	7.96
5	MA 3	0.1928	0.1175	1.64
6	MA 4	0.2800	0.1022	2.74
7	SMA 12	0.3850	0.2205	1.75

```
DIFFERENCING.  1 REGULAR
RESIDUALS.     SS =        1337.91   (BACKFORECASTS EXCL)
               DF =     76  MS =        17.60
NO. OF OBS.    ORIGINAL SERIES    84     AFTER DIFF.   83
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	44.2338	36.0085	52.4591
86	42.7805	33.7254	51.8355
87	33.8866	24.2253	43.5478
88	34.2675	24.3642	44.1708
89	32.9387	22.9854	42.8920
90	37.5728	27.3988	47.7468
91	41.4543	31.2252	51.6835
92	40.1612	29.7293	50.5931
93	41.6831	31.1914	52.1747
94	38.8001	28.1209	49.4794
95	48.4722	37.7291	59.2152
96	42.6358	31.7181	53.5535

```
   ACF OF RESIDUAL          NRMC ORLANDO

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
                +----+----+----+----+----+----+----+----
 1  -0.048                         XX
 2  -0.032                         XX
 3   0.068                          XXX
 4   0.076                          XXX
 5   0.182                          XXXXXX
 6  -0.036                         XX
 7  -0.062                        XXX
 8  -0.171                      XXXXX
 9   0.052                          XX
10  -0.121                       XXXX
11   0.032                          XX
12  -0.006                          X
13  -0.144                      XXXXX
14   0.077                          XXX
15  -0.058                         XX
16  -0.151                      XXXXX
17   0.038                          XX
18   0.053                          XX
19  -0.181                     XXXXXX
20  -0.011                          X
21  -0.082                        XXX
22   0.100                          XXXX
23   0.113                          XXXX
24  -0.114                       XXXX
25   0.044                          XX
26   0.026                          XX
27   0.090                          XXX
28   0.085                          XXX
29   0.132                          XXXX
30  -0.128                       XXXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

95 CASES USED
1 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC ORLANDO IS:
Y = 17.8 + 0.209 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	17.762	1.168	15.21
X1	MONTH	0.20883	0.02080	10.04

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 5.559
WITH (95- 2) = 93 DEGREES OF FREEDOM

R-SQUARED = 52.0 PERCENT

ANALYSIS OF VARIANCE

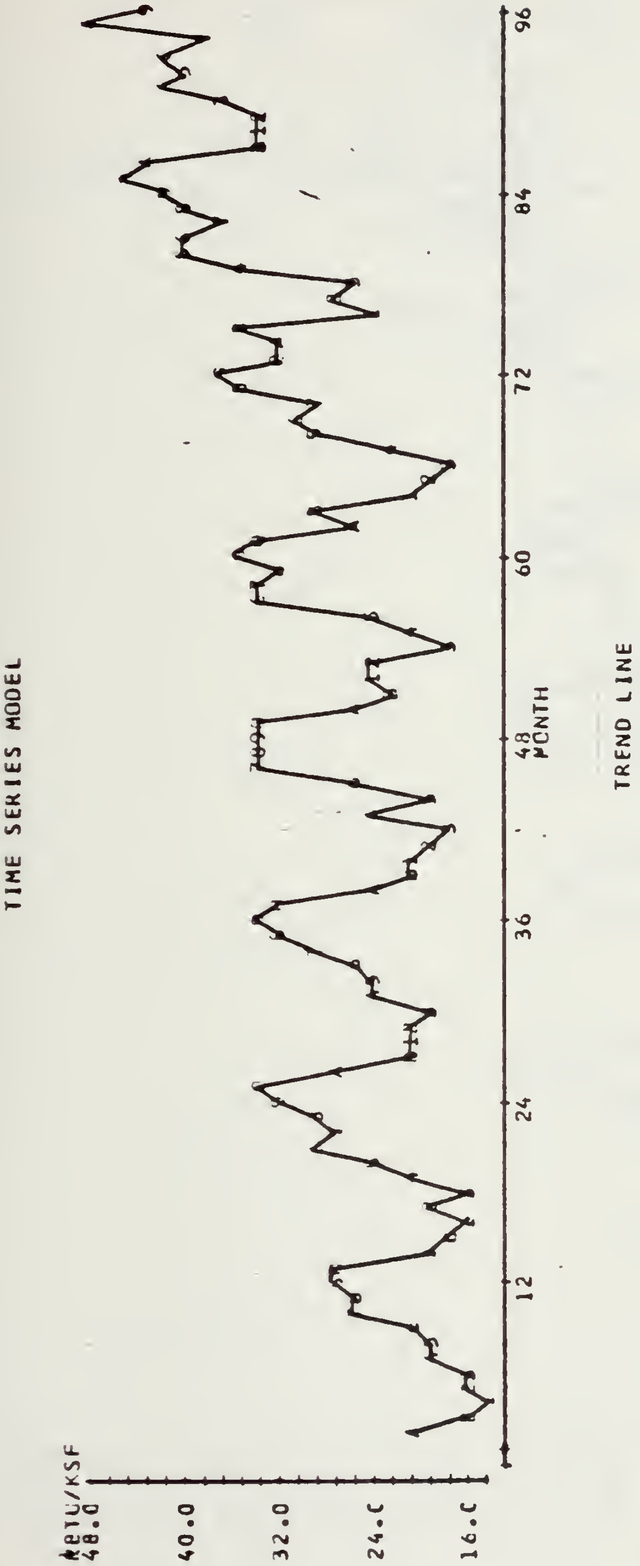
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	3115.43	3115.43
RESIDUAL	93	2874.33	30.91
TOTAL	94	5989.76	

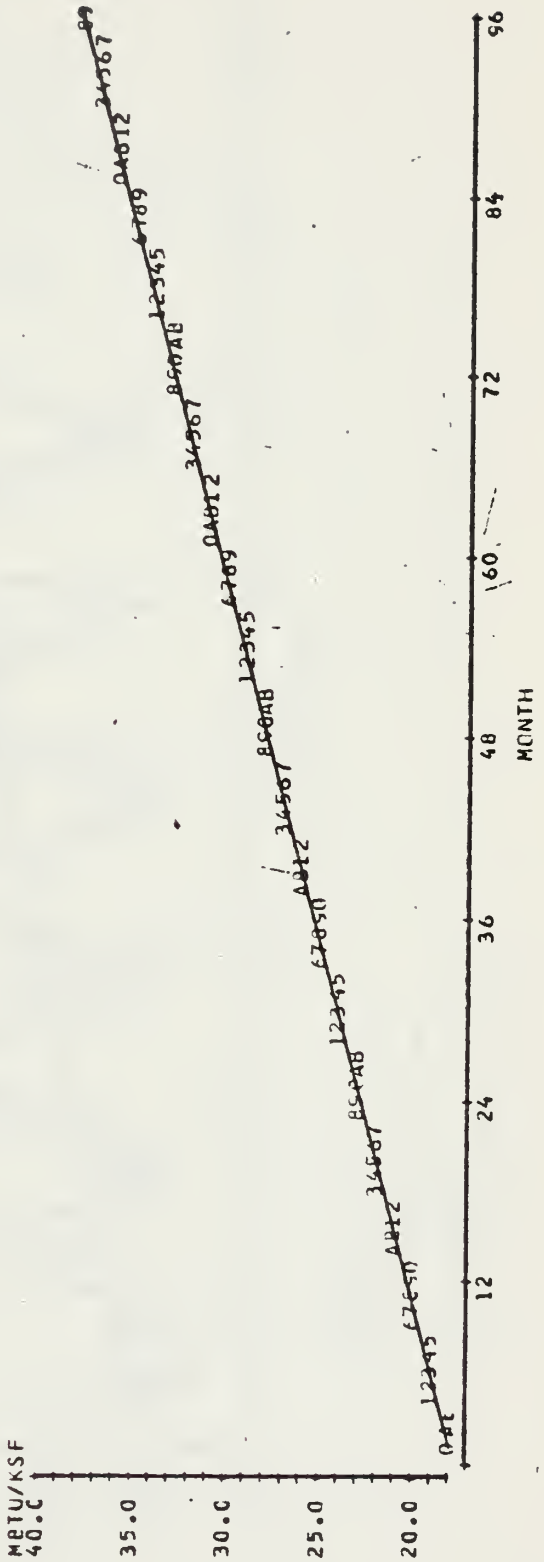
ROW	X1 MONTH	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
54	54.0	17.269	29.039	0.580	-2.13R
65	65.0	19.682	31.336	0.660	-2.11R
66	66.0	17.754	31.544	0.671	-2.50R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

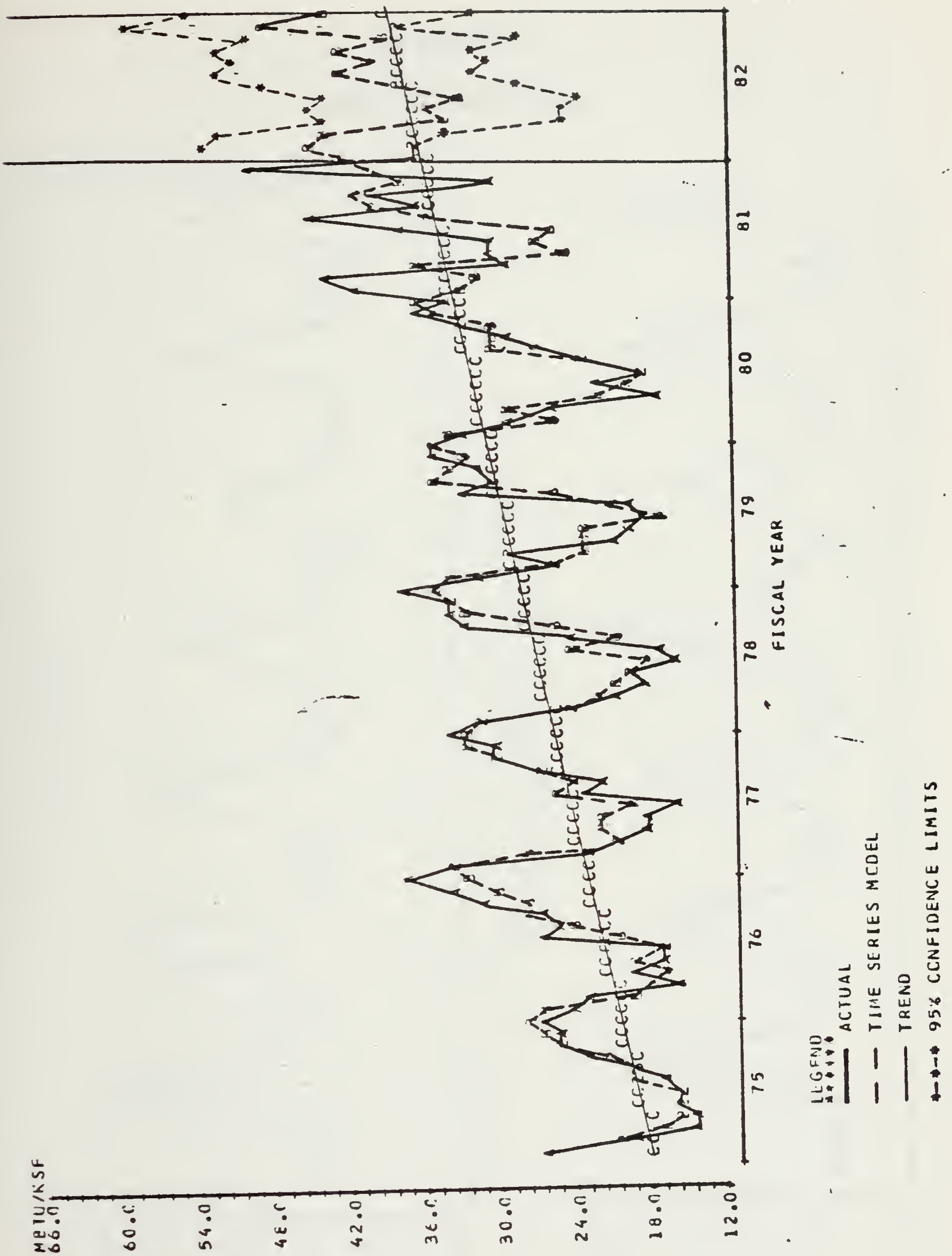
DURBIN-WATSON STATISTIC = 0.57

F. DECOMPOSITION LINES





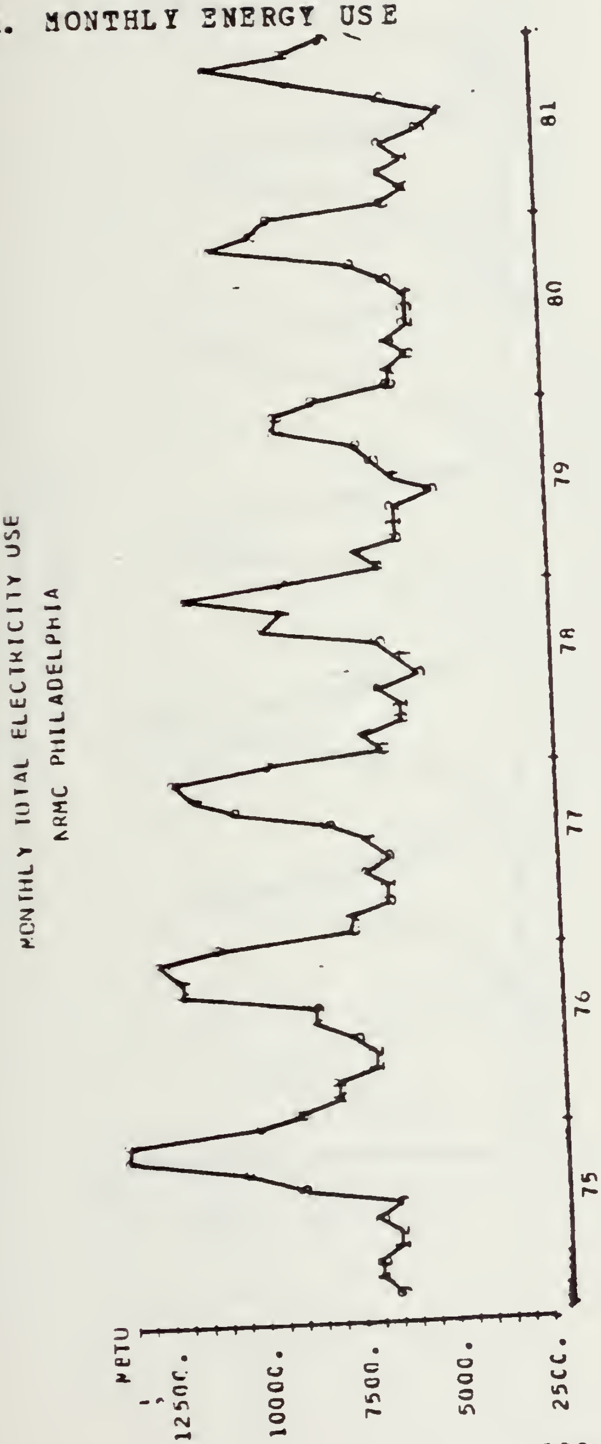
G. ACTUAL USE AND FORECAST MODELS

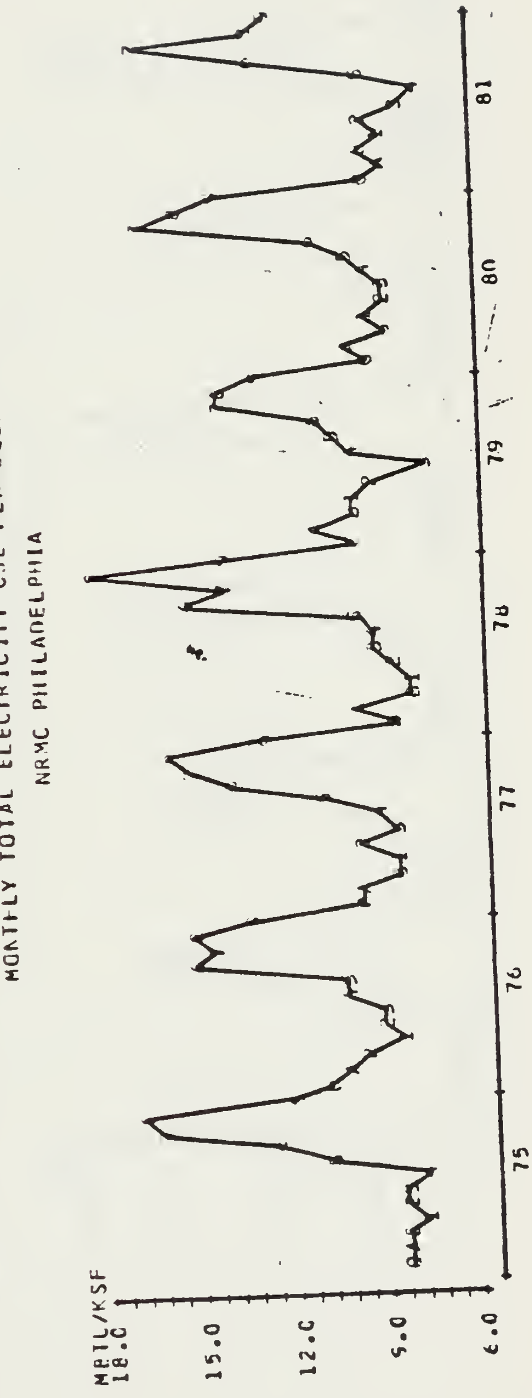


APPENDIX J

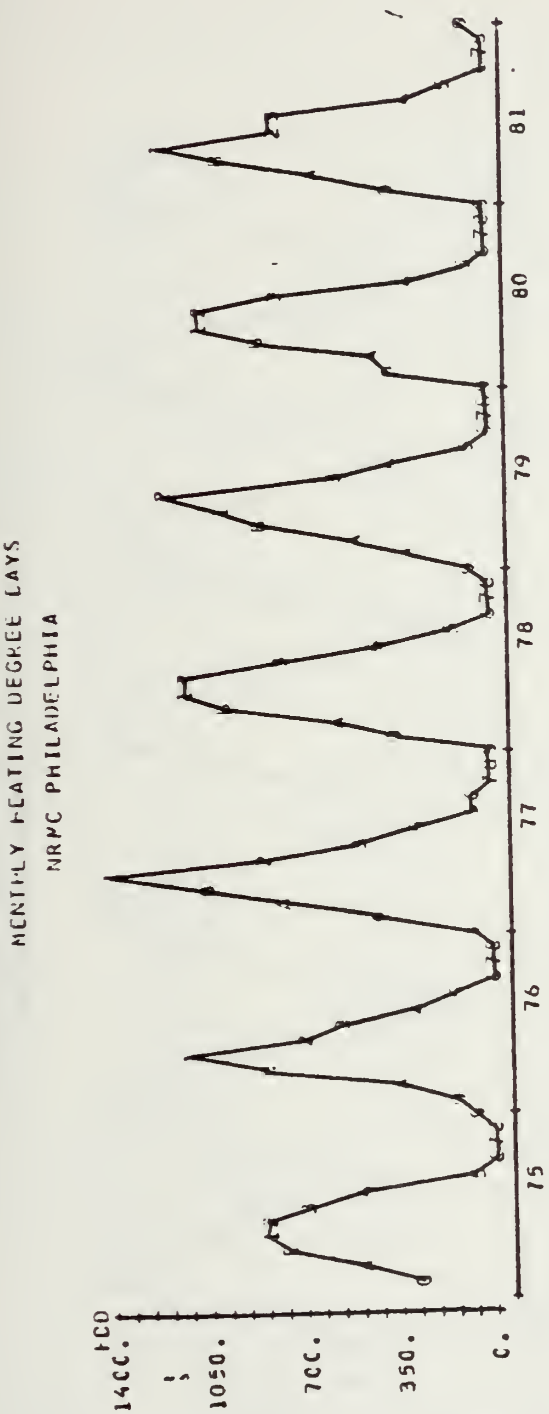
NRMC PHILADELPHIA

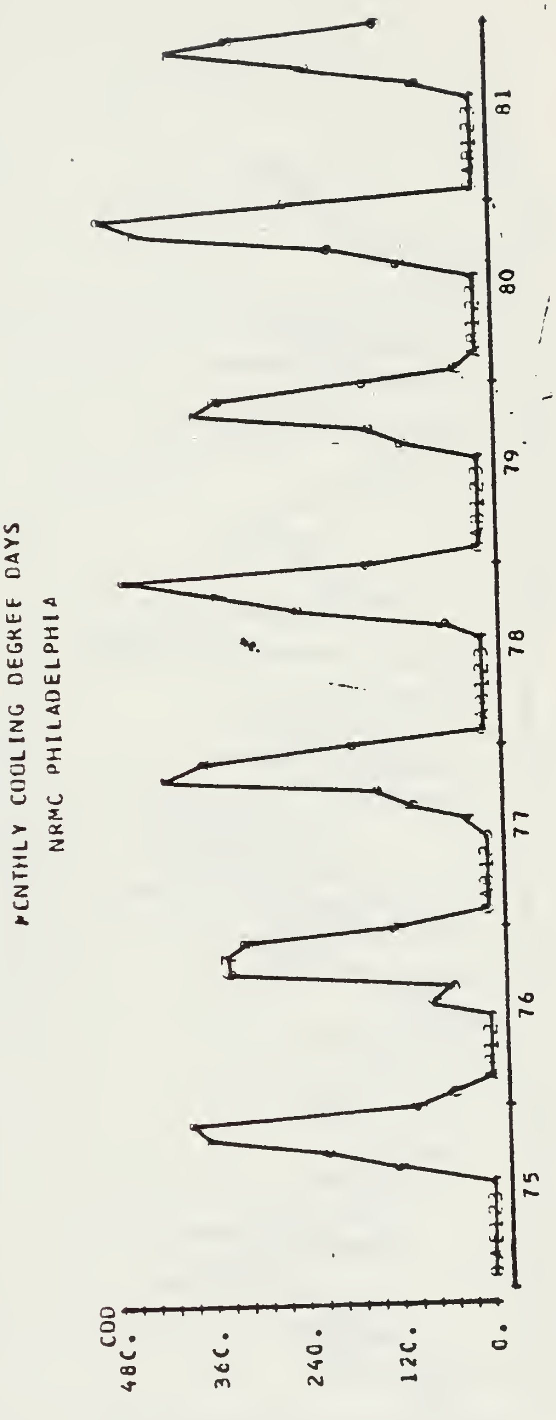
A. MONTHLY ENERGY USE

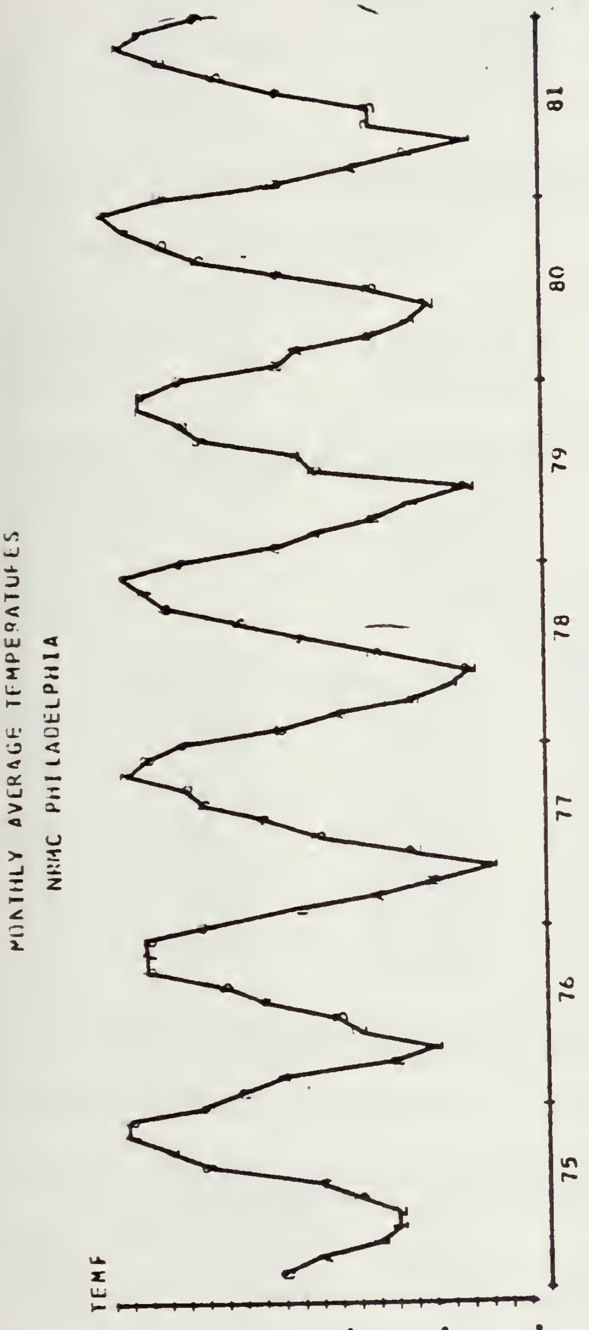


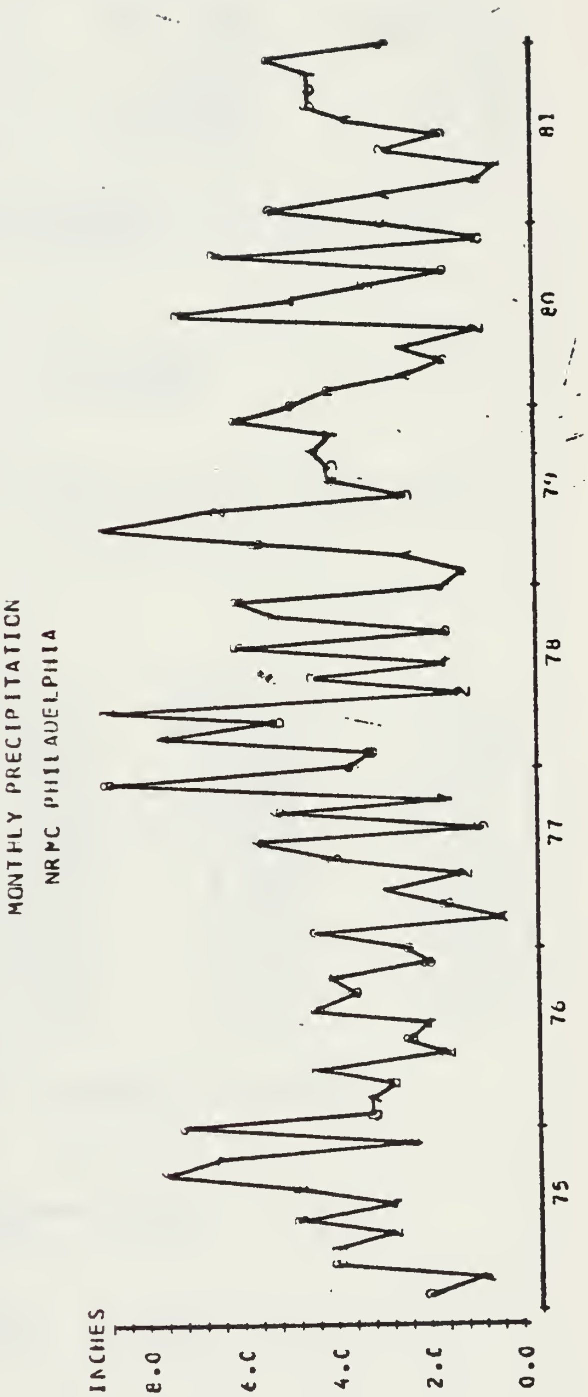


B. MONTHLY WEATHER SUMMARY






MONTHLY AVERAGE TEMPERATURES
NRMC PHILADELPHIA
AVG TEMP
75.
60.
45.
30.
15.
75
76
77
78
79
80
81


MONTHLY PRECIPITATION
NRMC PHILADELPHIA
INCHES
8.0
6.0
4.0
2.0
0.0
75
76
77
78
79
80
81

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPIATION

THE REGRESSION EQUATION FOR NRMC PHILADELPHIA IS:
Y = 11.4 -0.0318 X1 -0.0019 X2 +0.0171 X3 +0.0084 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	11.369	8.713	1.30
X1	AVG TEMP	-0.0318	0.1345	-0.24
X2	HDD	-0.001868	0.004483	-0.42
X3	CDD	0.017141	0.004432	3.87
X4	PRECIP	0.00839	0.05114	0.16

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 0.9292
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 88.6 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	531.6197	132.9050
RESIDUAL	79	68.2060	0.8634
TOTAL	83	599.8256	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	531.6197
AVG TEMP	1	407.1041
HDD	1	111.5627
CDD	1	12.9299
PRECIP	1	0.0232

ROW	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
24	67.3	13.209	11.145	0.175	2.26R
28	20.0	8.234	8.159	0.354	0.09 X
29	33.6	9.361	8.682	0.349	0.79 X
40	28.0	7.603	8.426	0.371	-0.97 X
41	24.7	8.129	8.502	0.453	-0.46 X
48	68.5	13.866	11.753	0.186	2.32R
50	47.9	10.827	8.919	0.146	2.08R
52	32.5	9.658	8.544	0.338	1.29 X
53	23.0	8.938	8.507	0.510	0.56 X
71	80.0	14.855	16.891	0.361	-2.38RX
76	25.3	8.453	8.287	0.327	0.19 X
79	54.7	7.032	9.239	0.163	-2.41R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.54

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.824			
HDD	-0.723	-0.981		
CDD	0.937	0.828	-0.707	
PRECIP	0.169	0.160	-0.136	0.173

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF NRMC PHILADELPHIA

-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8

1	0.698
2	0.318
3	-0.080
4	-0.366
5	-0.466
6	-0.552
7	-0.536
8	-0.422
9	-0.180
10	0.206
11	0.557
12	0.721
13	0.554
14	0.242
15	-0.065
16	-0.314
17	-0.416
18	-0.467
19	-0.445
20	-0.353
21	-0.149
22	0.153
23	0.461
24	0.609
25	0.501
26	0.241
27	-0.039
28	-0.247
29	-0.339
30	-0.385
31	-0.394
32	-0.312
33	-0.164
34	0.124
35	0.378
36	0.516
37	0.470
38	0.231
39	0.035
40	-0.146
41	-0.230
42	-0.287
43	-0.320
44	-0.287
45	-0.178
46	0.011
47	0.216
48	0.321
49	0.296
50	0.145

PACF OF MBTU/KSF   NRMC PHILADELPHIA

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----+----
 1   0.698                      XXXXXXXXXXXXXXXXXX
 2  -0.330              XXXXXXXXX
 3  -0.318              XXXXXXXXX
 4  -0.164                  XXXXX
 5  -0.035                     XX
 6  -0.398            XXXXXXXXXXX
 7  -0.247                XXXXXXX
 8  -0.158                  XXXXX
 9  -0.019                      X
10   0.212                      XXXXXX
11   0.265                      XXXXXXXX
12   0.126                      XXXX
13  -0.265               XXXXXXXX
14  -0.117                   XXXX
15  -0.032                     XX
16  -0.153                  XXXXX
17   0.011                      X
18   0.085                      XXX
19   0.034                      XX
20  -0.123                   XXXX
21  -0.055                     XX
22  -0.127                   XXXX
23   0.032                      XX
24   0.089                      XXX
25  -0.022                     XX
26  -0.070                    XXX
27  -0.004                      X
28  -0.024                     XX
29  -0.061                    XXX
30  -0.041                     XX
31  -0.058                     XX
32   0.048                      XX
33  -0.094                    XXX
34   0.061                      XXX
35  -0.099                    XXX
36   0.012                      X
37   0.078                      XXX
38  -0.120                   XXXX
39   0.130                      XXXX
40   0.029                      XX
41   0.081                      XXX
42  -0.073                    XXX
43   0.096                      XXX
44  -0.081                    XXX
45  -0.019                      X
46  -0.103                   XXXX
47  -0.072                    XXX
48  -0.108                   XXXX
49  -0.068                    XXX
50  -0.024                     XX
```

ARIMA (2 0 3)

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	1.5084	0.1149	13.12
2	AR 2	-0.7401	0.1156	-6.40
3	MA 1	0.8451	0.1512	5.60
4	MA 2	-0.1054	0.1550	-0.69
5	MA 3	0.2046	0.1465	1.40
6	CONSTANT	2.48380	0.01263	196.71
	MEAN	10.7218	0.0545	

```
RESIDUALS.    SS =       204.196  (BACKFORECASTS EXCL)
N = 84        DF =    78  MS =         2.618
```

ACF OF RESIDUAL   NRMC PHILADELPHIA

```
          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
            +----+----+----+----+----+----+----+----
  1 -0.032                     XX
  2 -0.038                     XX
  3 -0.005                      X
  4 -0.103                   XXXX
  5  0.238                      XXXXXXX
  6  0.040                      XX
  7  0.057                      XX
  8 -0.006                      X
  9 -0.162                  XXXXX
 10 -0.030                     XX
 11  0.132                      XXXX
 12  0.388                      XXXXXXXXXXX
 13  0.042                      XX
 14 -0.111                   XXXX
 15 -0.046                     XX
 16 -0.152                  XXXXX
 17  0.045                      XX
 18  0.011                      X
 19  0.001                      X
 20 -0.059                     XX
 21 -0.151                  XXXXX
 22 -0.114                   XXXX
 23  0.095                      XXX
 24  0.233                      XXXXXXX
 25  0.070                      XXX
 26 -0.080                    XXX
 27 -0.120                   XXXX
 28 -0.137                   XXXX
 29  0.017                      X
 30  0.036                      XX
 31 -0.050                     XX
 32 -0.007                      X
 33 -0.222                XXXXXXX
 34  0.003                      X
 35  0.033                      XX
 36  0.129                      XXXX
 37  0.208                      XXXXXX
 38 -0.198                 XXXXXX
 39 -0.049                     XX
 40 -0.115                   XXXX
```

```
ARIMA  (2 0 3)(0 0 1)  S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER     TYPE       ESTIMATE       ST. DEV.    T-RATIO
     1    AR   1       1.3249        0.1594        8.31
     2    AR   2      -0.5340        0.1616       -3.30
     3    MA   1       0.7886        0.1611        4.90
     4    MA   2      -0.2256        0.1544       -1.46
     5    MA   3       0.3920        0.1345        2.91
     6   SMA  12      -0.5400        0.1046       -5.16
     7   CONSTANT      2.23800      0.01803      124.10
          MEAN        10.6998        0.0862

RESIDUALS.     SS =       156.302  (BACKFORECASTS EXCL)
N = 84         DF =    77  MS =       2.030

   ACF OF RESIDUAL        NRMC PHILADELPHIA

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----
  1  -0.037                    XX
  2  -0.038                    XX
  3   0.084                     XXX
  4  -0.111                  XXXX
  5   0.173                     XXXXX
  6  -0.024                    XX
  7  -0.119                  XXXX
  8   0.038                     XX
  9  -0.183                XXXXXX
 10   0.007                     X
 11   0.221                     XXXXXXX
 12   0.029                     XX
 13   0.128                     XXXX
 14  -0.115                  XXXX
 15  -0.075                   XXX
 16  -0.066                   XXX
 17  -0.085                   XXX
 18  -0.054                    XX
 19   0.023                     XX
 20  -0.125                  XXXX
 21  -0.011                     X
 22  -0.086                   XXX
 23   0.099                     XXX
 24   0.299                     XXXXXXXX
 25  -0.044                    XX
 26   0.066                     XXX
 27  -0.070                   XXX
 28  -0.091                   XXX
 29   0.045                     XX
 30  -0.032                    XX
 31  -0.079                   XXX
 32   0.051                     XX
 33  -0.162                 XXXXX
 34   0.091                     XXX
 35   0.027                     XX
 36   0.078                     XXX
 37   0.223                     XXXXXXX
 38  -0.161                 XXXXX
 39  -0.021                    XX
 40  -0.072                   XXX
```

ARIMA (1 0 2)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	0.7283	0.2031	3.59
2	SAR 12	-0.1559	0.1629	-0.96
3	MA 1	0.7431	0.2202	3.37
4	MA 2	-0.2605	0.1241	-2.10
5	SMA 12	0.8276	0.1297	6.38

```
DIFFERENCING. 0 REGULAR  1 SEASONAL DIFF. OF ORDER 12
RESIDUALS.    SS =      70.0484   (BACKFORECASTS EXCL)
              DF =    67  MS =        1.0455
NO. OF OBS.   ORIGINAL SERIES   84     AFTER DIFF.  72
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	9.0106	7.0061	11.0150
86	9.0094	7.0047	11.0141
87	8.2751	6.2088	10.3413
88	8.2393	6.1411	10.3375
89	8.3859	6.2710	10.5009
90	8.1628	6.0390	10.2866
91	8.9487	6.8202	11.0771
92	9.8097	7.6788	11.9406
93	12.4318	10.2996	14.5640
94	14.9380	12.8051	17.0710
95	15.2020	13.0687	17.3353
96	12.9014	10.7680	15.0349

```
   ACF OF RESIDUAL        NRMC PHILADELPHIA

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
                +----+----+----+----+----+----+----+----
  1  -0.030                       XX
  2  -0.056                       XX
  3  -0.028                       XX
  4  -0.002                        X
  5   0.199                        XXXXXX
  6  -0.043                       XX
  7  -0.185                   XXXXXX
  8  -0.120                     XXXX
  9  -0.035                       XX
 10   0.047                        XX
 11   0.025                        XX
 12   0.079                        XXX
 13  -0.188                   XXXXXX
 14   0.057                        XX
 15   0.089                        XXX
 16  -0.009                        X
 17   0.077                        XXX
 18  -0.007                        X
 19  -0.033                       XX
 20   0.084                        XXX
 21   0.020                        X
 22  -0.003                        X
 23   0.034                        XX
 24  -0.114                     XXXX
 25   0.005                        X
 26   0.103                        XXXX
 27  -0.011                        X
 28   0.006                        X
 29   0.072                        XXX
 30   0.130                        XXXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

84 CASES USED
12 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y = 10.3 +0.0063 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	10.2973	0.6720	15.32
X1	MONTH	0.00631	0.01127	0.56

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 2.504
WITH (84- 2) = 82 DEGREES OF FREEDOM

R-SQUARED = 0.4 PERCENT

ANALYSIS OF VARIANCE

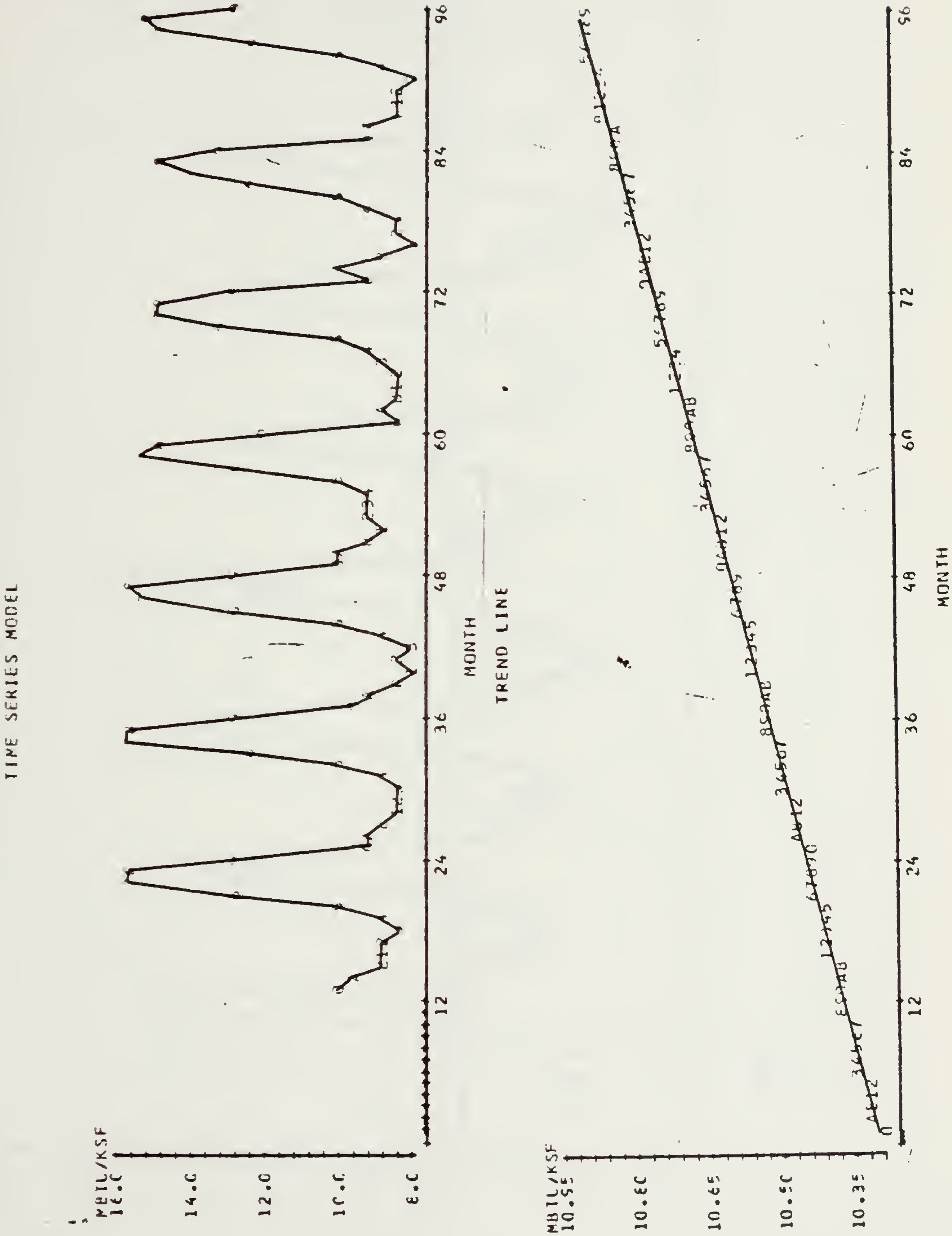
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	1.964	1.964
RESIDUAL	82	513.951	6.268
TOTAL	83	515.914	

ROW	X1 C21	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
22	22.0	15.498	10.436	0.457	2.06R
23	23.0	15.765	10.442	0.448	2.16R
34	34.0	15.492	10.512	0.358	2.01R
35	35.0	15.600	10.518	0.351	2.05R
47	47.0	15.670	10.594	0.286	2.04R

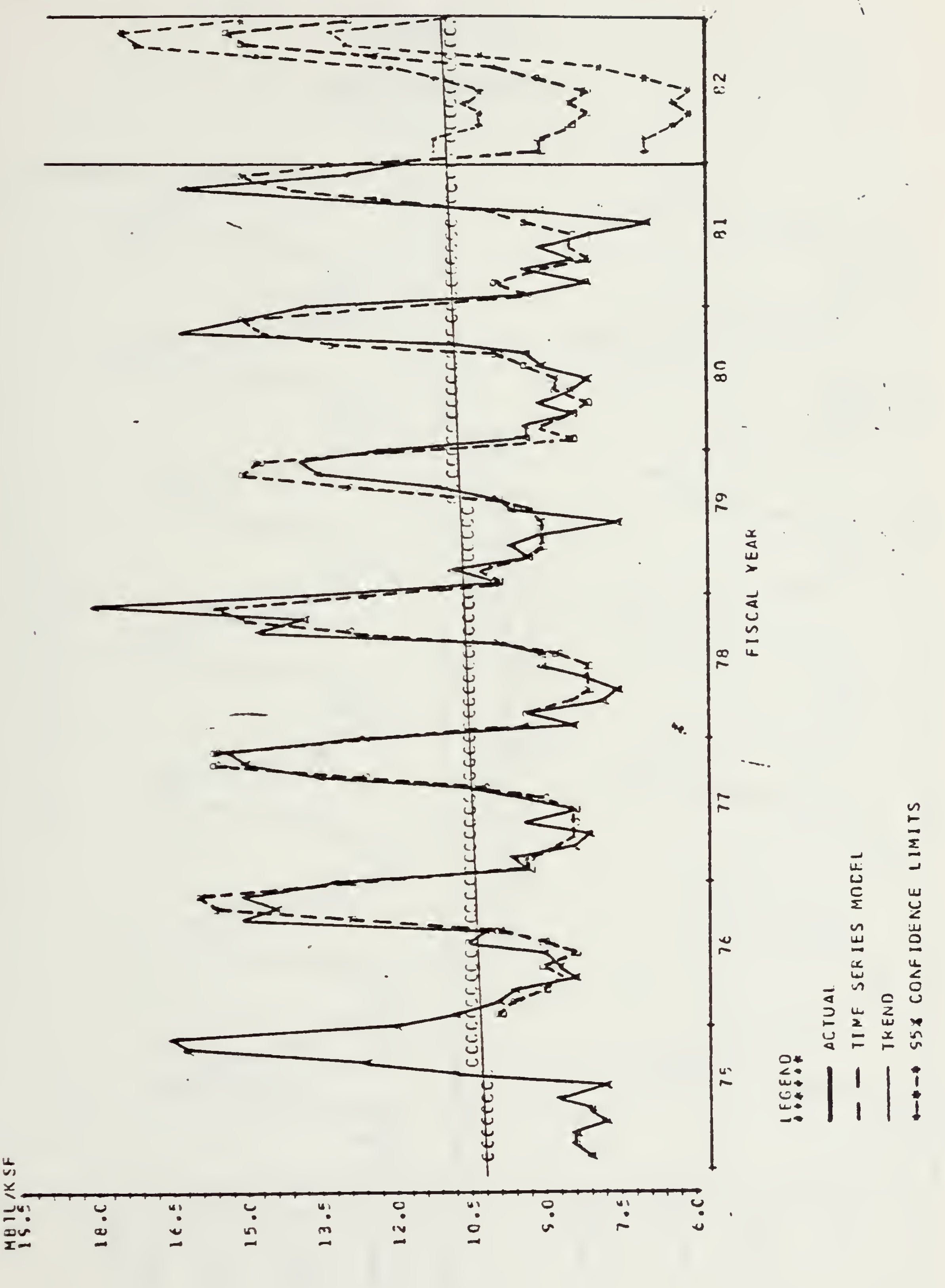
R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.44

F. DECOMPOSITION LINES



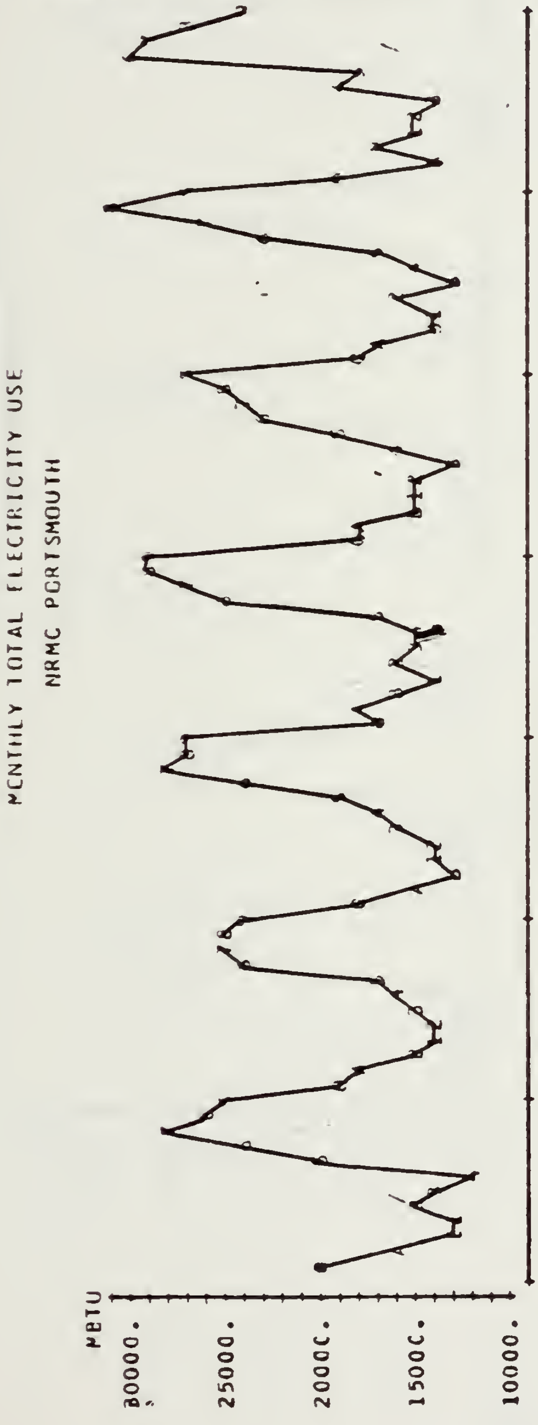
G. ACTUAL USE AND FORECAST MODELS

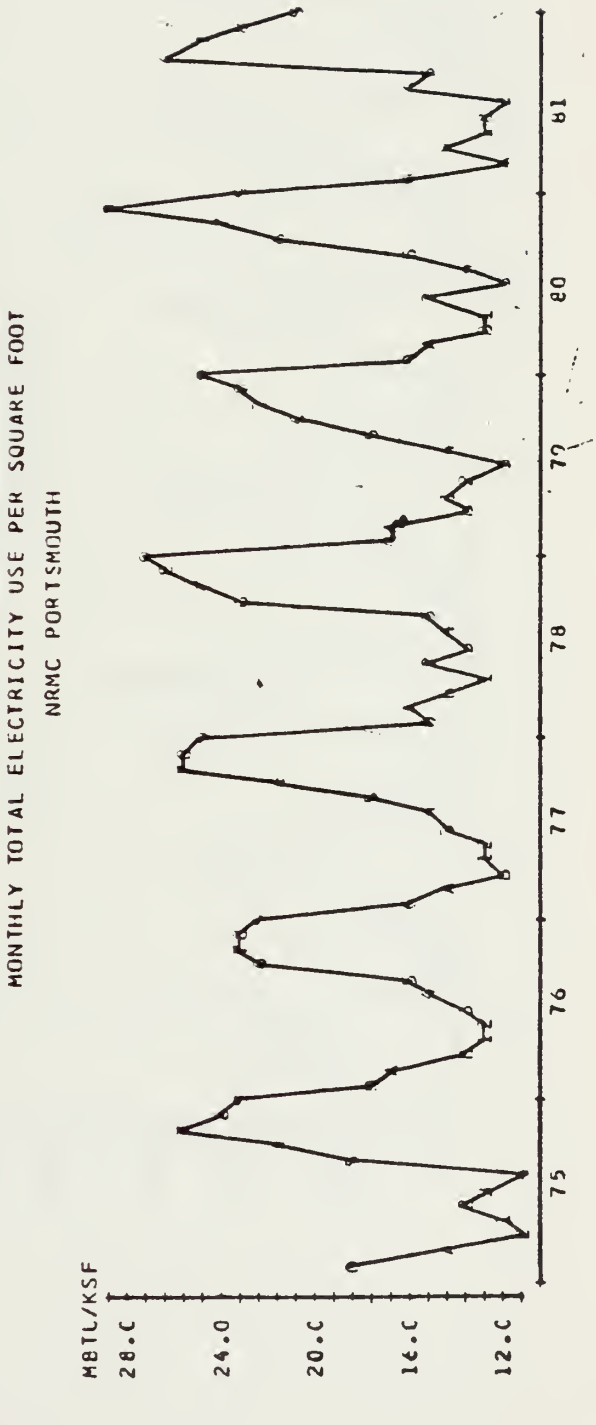


APPENDIX K

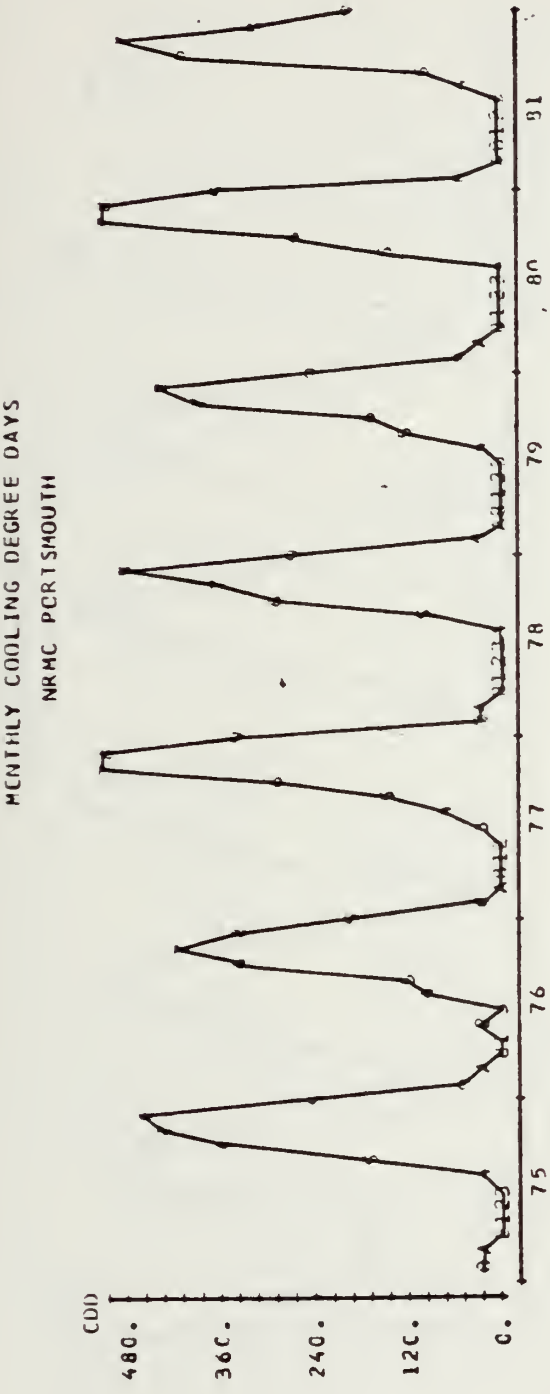
NRMC PORTSMOUTH

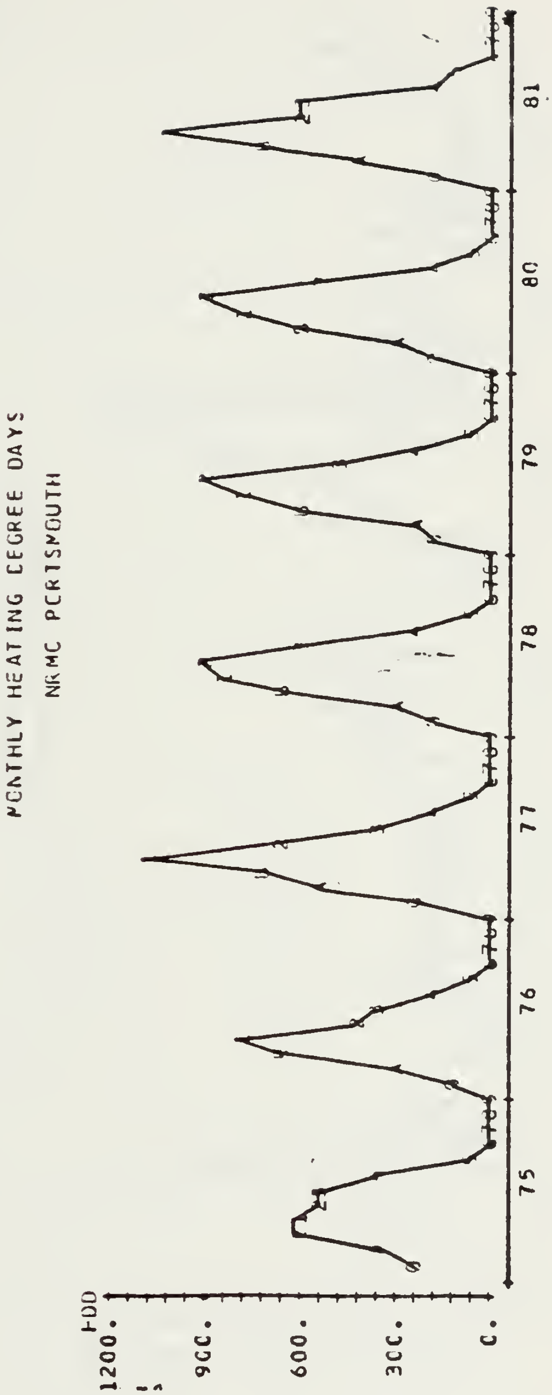
A. MONTHLY ENERGY USE

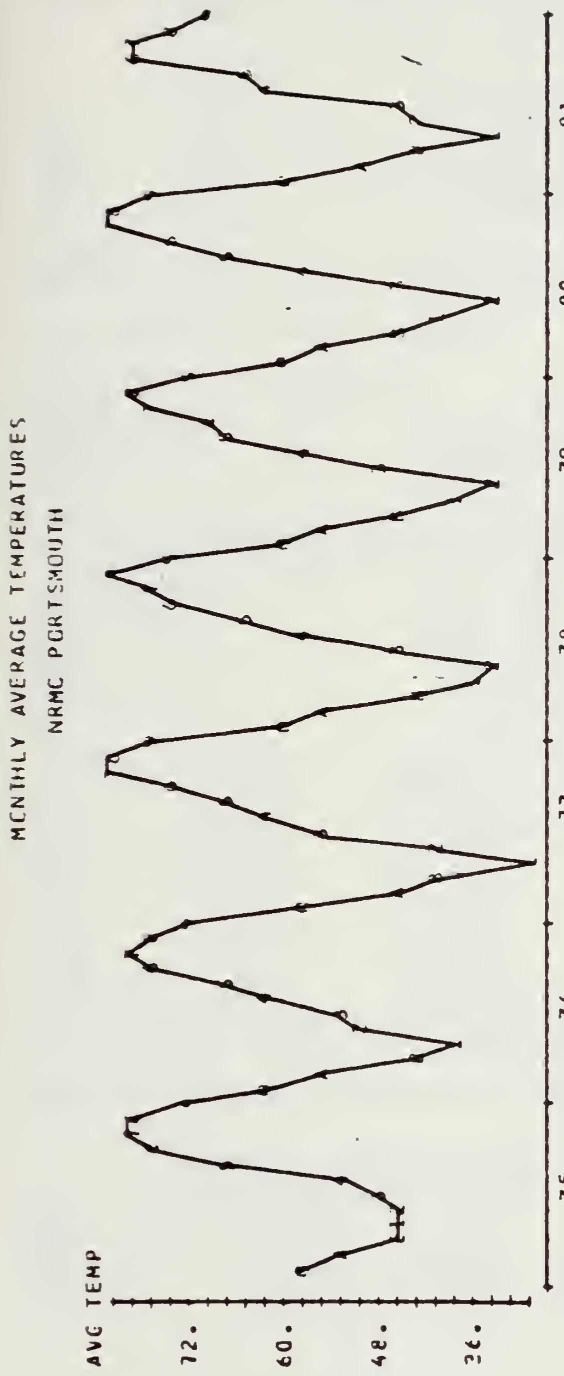




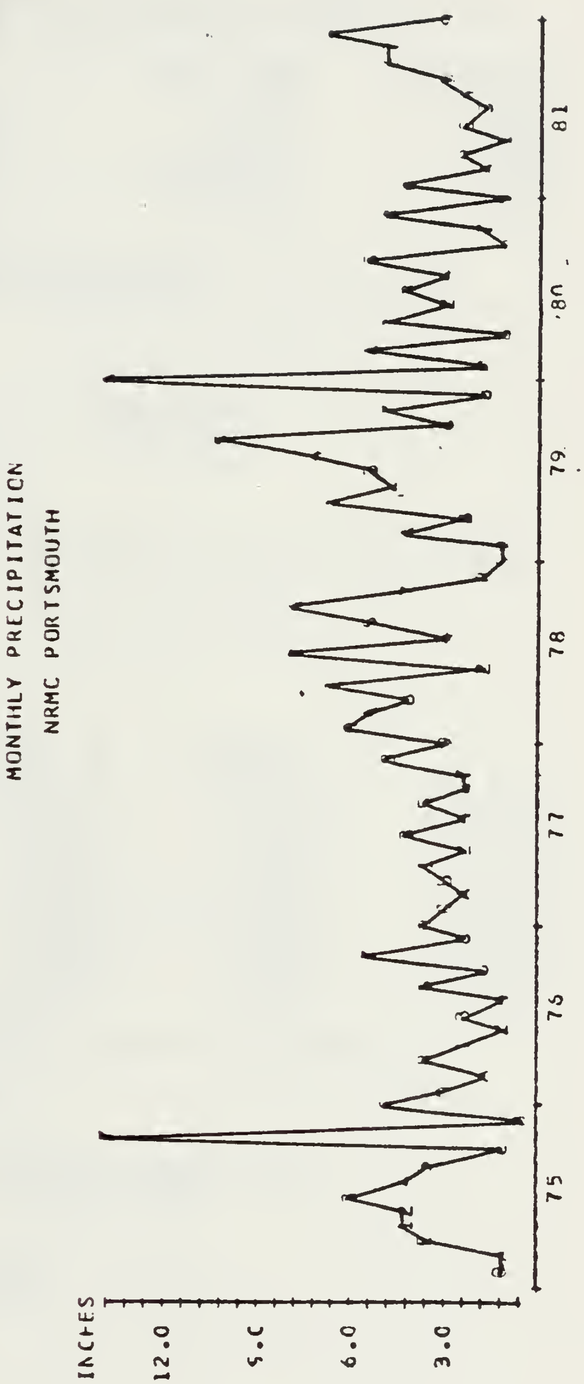
B. MONTHLY WEATHER SUMMARY







MONTHLY AVERAGE TEMPERATURES
NRMC PORTSMOUTH
AVG TEMP
72.
60.
48.
36.
75
76
77
78
79
80
81



MONTHLY PRECIPITATION
NRMC PORTSMOUTH
INCHES
12.0
9.0
6.0
3.0
75
76
77
78
79
80
81

C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR NRMC PORTSMOUTH IS:
Y = 26.2 - 0.173 X1 -0.0087 X2 +0.0280 X3 +0.0997 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	26.20	19.33	1.36
X1	AVG TEMP	-0.1730	0.2978	-0.58
X2	HDD	-0.008738	0.009950	-0.88
X3	CDD	0.028010	0.009693	2.89
X4	PRECIP	0.09974	0.07254	1.37

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 1.587
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 89.7 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	1740.611	435.153
RESIDUAL	79	199.012	2.519
TOTAL	83	1939.622	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	1740.611
AVG TEMP	1	1516.201
HDD	1	199.513
CDD	1	20.135
PRECIP	1	4.762

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
7	52.7	11.333	14.778	0.228	-2.19R
10	78.6	25.548	25.987	0.791	-0.32 X
28	29.2	12.550	11.834	0.640	0.49 X
29	41.5	12.934	13.614	0.568	-0.46 X
41	32.6	14.855	12.869	0.797	1.45 X
48	73.2	26.839	20.824	0.316	3.87R
53	33.3	13.660	13.258	0.819	0.30 X
60	72.8	24.843	21.675	0.751	2.27RX
76	32.7	12.914	11.962	0.570	0.64 X

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.75

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.884			
HDD	-0.771	-0.966		
CDD	0.936	0.876	-0.723	
PRECIP	0.130	0.104	-0.106	0.077

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF   NRMC PORTSMOUTH

```
             -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
              +----+----+----+----+----+----+----+----+----

 1   0.735                        XXXXXXXXXXXXXXXXXXX
 2   0.378                        XXXXXXXXXX
 3  -0.062                      XXX
 4  -0.412              XXXXXXXXXXX
 5  -0.608         XXXXXXXXXXXXXXXX
 6  -0.679       XXXXXXXXXXXXXXXXXX
 7  -0.612         XXXXXXXXXXXXXXXX
 8  -0.431             XXXXXXXXXXXX
 9  -0.073                      XXX
10   0.333                        XXXXXXXXX
11   0.631                        XXXXXXXXXXXXXXXXX
12   0.774                        XXXXXXXXXXXXXXXXXXXX
13   0.595                        XXXXXXXXXXXXXXXX
14   0.290                        XXXXXXXX
15  -0.064                      XXX
16  -0.354               XXXXXXXXXX
17  -0.507           XXXXXXXXXXXXXX
18  -0.575          XXXXXXXXXXXXXXX
19  -0.504           XXXXXXXXXXXXXX
20  -0.351               XXXXXXXXXX
21  -0.050                       XX
22   0.271                        XXXXXXXX
23   0.526                        XXXXXXXXXXXXXX
24   0.656                        XXXXXXXXXXXXXXXXX
25   0.508                        XXXXXXXXXXXXXX
26   0.262                        XXXXXXXX
27  -0.050                       XX
28  -0.304                XXXXXXXXX
29  -0.426             XXXXXXXXXXXX
30  -0.478            XXXXXXXXXXXXX
31  -0.429             XXXXXXXXXXXX
32  -0.325                XXXXXXXXX
33  -0.063                      XXX
34   0.207                        XXXXXX
35   0.424                        XXXXXXXXXXXX
36   0.532                        XXXXXXXXXXXXXX
37   0.431                        XXXXXXXXXXXX
38   0.226                        XXXXXXX
39  -0.009                        X
40  -0.199                   XXXXXX
41  -0.319                XXXXXXXXX
42  -0.376               XXXXXXXXXX
43  -0.347               XXXXXXXXXX
44  -0.265                 XXXXXXXX
45  -0.070                      XXX
46   0.140                        XXXX
47   0.317                        XXXXXXXXX
48   0.377                        XXXXXXXXXX
49   0.308                        XXXXXXXXX
50   0.171                        XXXXX
```

```
PACF OF MBTU/KSF        NRMC PORTSMOUTH

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----
 1   0.735                          XXXXXXXXXXXXXXXXXXX
 2  -0.354                 XXXXXXXXXX
 3  -0.442               XXXXXXXXXXXX
 4  -0.210                     XXXXXX
 5  -0.127                       XXXX
 6  -0.300                  XXXXXXXXX
 7  -0.293                   XXXXXXXX
 8  -0.241                    XXXXXXX
 9   0.167                          XXXXX
10   0.242                          XXXXXXX
11   0.029                          XX
12   0.173                          XXXXX
13  -0.218                     XXXXXX
14  -0.071                        XXX
15   0.008                          X
16  -0.028                         XX
17   0.127                          XXXX
18  -0.010                          X
19  -0.008                          X
20  -0.104                       XXXX
21  -0.020                         XX
22  -0.055                         XX
23   0.055                          XX
24   0.184                          XXXXXX
25  -0.096                        XXX
26   0.010                          X
27  -0.059                         XX
28  -0.057                         XX
29   0.123                          XXXX
30   0.007                          X
31  -0.048                         XX
32  -0.091                        XXX
33   0.075                          XXX
34  -0.067                        XXX
35  -0.106                       XXXX
36  -0.002                          X
37   0.092                          XXX
38  -0.019                          X
39   0.021                          XX
40   0.025                          XX
41  -0.043                         XX
42   0.037                          XX
43   0.014                          X
44   0.049                          XX
45   0.001                          X
46  -0.046                         XX
47   0.008                          X
48  -0.173                      XXXXX
49   0.015                          X
50   0.027                          XX
```

ARIMA (3 0 2)(1 0 3) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	1.8318	0.2248	8.37
2	AR 2	-1.1650	0.4815	-2.42
3	AR 3	0.1464	0.2144	0.68
4	SAR 12	0.9965	0.0176	56.61
5	MA 1	1.6287	0.1942	8.39
6	MA 2	-0.7927	0.3341	-2.37
7	SMA 12	0.5352	0.1906	2.81
8	SMA 24	-0.4086	0.2234	-1.83
9	SMA 36	0.6552	0.2426	2.70
10	CONSTANT	0.00521	0.01886	0.28
	MEAN	10.94	39.56	

```
RESIDUALS.     SS =       172.872  (BACKFORECASTS EXCL)
N =  84        DF =    74      MS =         2.336
```

ACF OF RESIDUAL   NRMC PORTSMOUTH

```
         -1.0 -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
  1  -0.074                  XXX
  2   0.046                    XX
  3  -0.063                  XXX
  4   0.141                    XXXXX
  5  -0.056                   XX
  6   0.082                    XXX
  7  -0.195               XXXXXX
  8  -0.009                    X
  9  -0.164                XXXXX
 10   0.114                    XXXX
 11   0.042                    XX
 12  -0.096                  XXX
 13  -0.125                 XXXX
 14   0.049                    XX
 15   0.071                    XXX
 16   0.070                    XXX
 17  -0.014                    X
 18   0.019                    X
 19  -0.089                  XXX
 20   0.062                    XXX
 21  -0.013                    X
 22  -0.088                  XXX
 23  -0.078                  XXX
 24  -0.113                 XXXX
 25  -0.031                   XX
 26  -0.014                    X
 27  -0.143                XXXXX
 28  -0.153                XXXXX
 29   0.015                    X
 30   0.079                    XXX
 31   0.094                    XXX
 32   0.002                    X
 33   0.053                    XX
 34   0.098                    XXX
 35   0.050                    XX
 36  -0.019                    X
 37   0.044                    XX
 38  -0.092                  XXX
 39  -0.076                  XXX
 40   0.093                    XXX
```

```
ARIMA (2 0 2)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE      ST. DEV.   T-RATIO
     1       AR  1      0.2107        4.6073      0.05
     2       AR  2     -0.3163        1.4869     -0.21
     3     SAR 12       0.9975        0.0077    128.80
     4       MA  1      0.1347        4.6120      0.03
     5       MA  2     -0.3108        1.4191     -0.22
     6     SMA 12       0.8134        0.1187      6.85
     7     CONSTANT     0.04405       0.04272     1.03
           MEAN          16.01         15.53

RESIDUALS.     SS =        172.705  (BACKFORECASTS EXCL)
N = 84         DF =    77  MS =          2.243

  ACF OF RESIDUAL        NRMC PORTSMOUTH

              -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                +----+----+----+----+----+----+----+----
 1   -0.034                        XX
 2    0.051                         XX
 3   -0.112                      XXXX
 4    0.114                         XXXX
 5   -0.061                       XXX
 6    0.049                         XX
 7   -0.115                      XXXX
 8   -0.008                         X
 9   -0.072                       XXX
10    0.128                         XXXX
11   -0.014                         X
12   -0.148                     XXXXX
13   -0.105                      XXXX
14    0.009                         X
15    0.026                         XX
16    0.112                         XXXX
17    0.087                         XXX
18   -0.019                         X
19   -0.044                        XX
20    0.072                         XXX
21    0.005                         X
22   -0.060                        XX
23   -0.074                       XXX
24   -0.078                       XXX
25   -0.064                       XXX
26    0.032                         XX
27   -0.167                     XXXXX
28   -0.128                      XXXX
29   -0.018                         X
30    0.087                         XXX
31    0.085                         XXX
32   -0.054                        XX
33    0.118                         XXXX
34    0.052                         XX
35   -0.020                        XX
36   -0.106                      XXXX
37    0.058                         XX
38   -0.084                       XXX
39   -0.024                        XX
40    0.106                         XXXX
```

ARIMA (3 0 2)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-0.3103	1.1686	-0.27
2	AR 2	0.2587	0.9634	0.27
3	AR 3	-0.1477	0.1801	-0.82
4	SAR 12	0.9970	0.0082	121.32
5	MA 1	-0.3769	1.1632	-0.32
6	MA 2	0.1821	1.0096	0.18
7	SMA 12	0.8012	0.1254	6.39
8	CONSTANT	0.05960	0.04462	1.34
	MEAN	16.33	12.23	

RESIDUALS. SS = 169.047 (BACKFORECASTS EXCL)
N = 84 DF = 76 MS = 2.224

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	16.4451	13.5214	19.3689
86	14.6189	11.6887	17.5492
87	14.1712	11.2364	17.1060
88	12.7650	9.7986	15.7314
89	13.9838	11.0138	16.9539
90	12.6326	9.6570	15.6082
91	14.7822	11.8024	17.7621
92	16.1121	13.1300	19.0943
93	23.1043	20.1203	26.0882
94	24.1303	21.1451	27.1155
95	25.0319	22.0458	28.0180
96	23.2605	20.2738	26.2472

```
   ACF OF RESIDUAL       NRMC PORTSMOUTH

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----
 1  -0.006                     X
 2  -0.010                     X
 3   0.027                     XX
 4   0.033                     XX
 5   0.011                     X
 6   0.006                     X
 7  -0.083                   XXX
 8  -0.030                    XX
 9  -0.064                   XXX
10   0.093                     XXX
11   0.014                     X
12  -0.181                XXXXXX
13  -0.085                   XXX
14   0.015                     X
15   0.008                     X
16   0.110                     XXXX
17   0.098                     XXX
18  -0.019                     X
19  -0.058                    XX
20   0.083                     XXX
21   0.001                     X
22  -0.074                   XXX
23  -0.062                   XXX
24  -0.097                   XXX
25  -0.076                   XXX
26   0.032                     XX
27  -0.195                XXXXXX
28  -0.118                  XXXX
29  -0.026                    XX
30   0.088                     XXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

THE REGRESSION EQUATION FOR NRMC PORTSMOUTH IS:
Y = 16.8 +0.0169 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	16.7780	0.9621	17.44
X1	MONTH	0.01688	0.01722	0.98

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 4.677
S = 4.677
WITH (96- 2) = 94 DEGREES OF FREEDOM

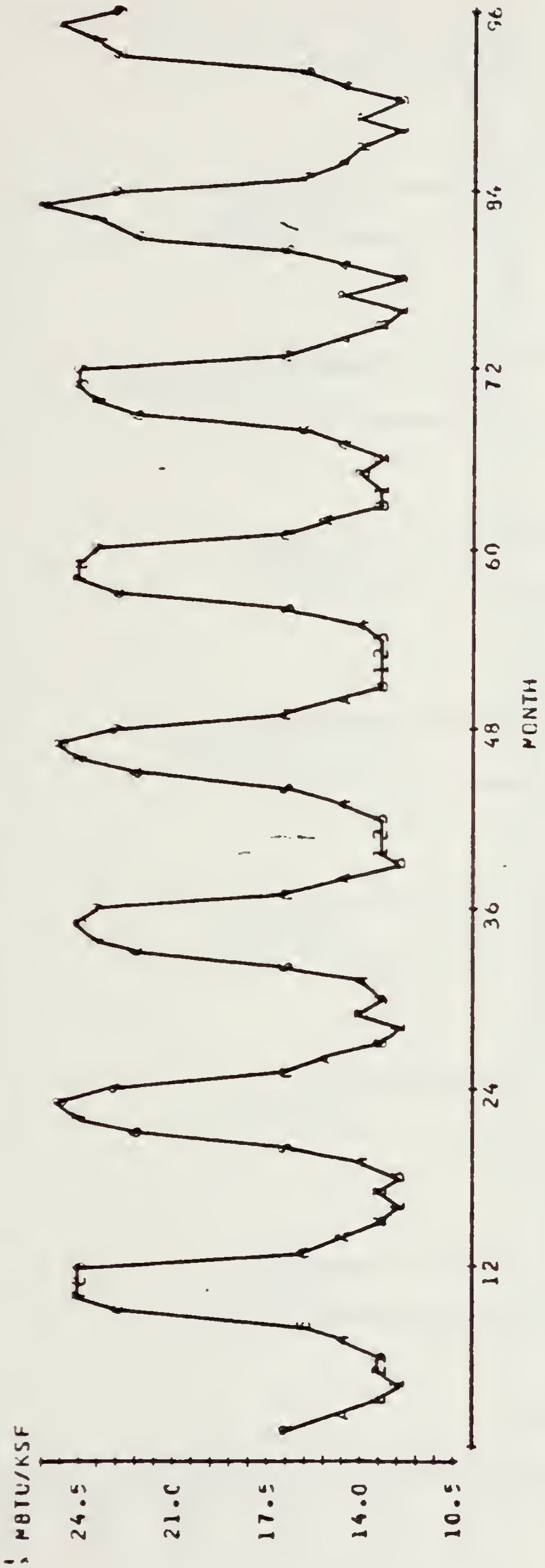
R-SQUARED = 1.0 PERCENT

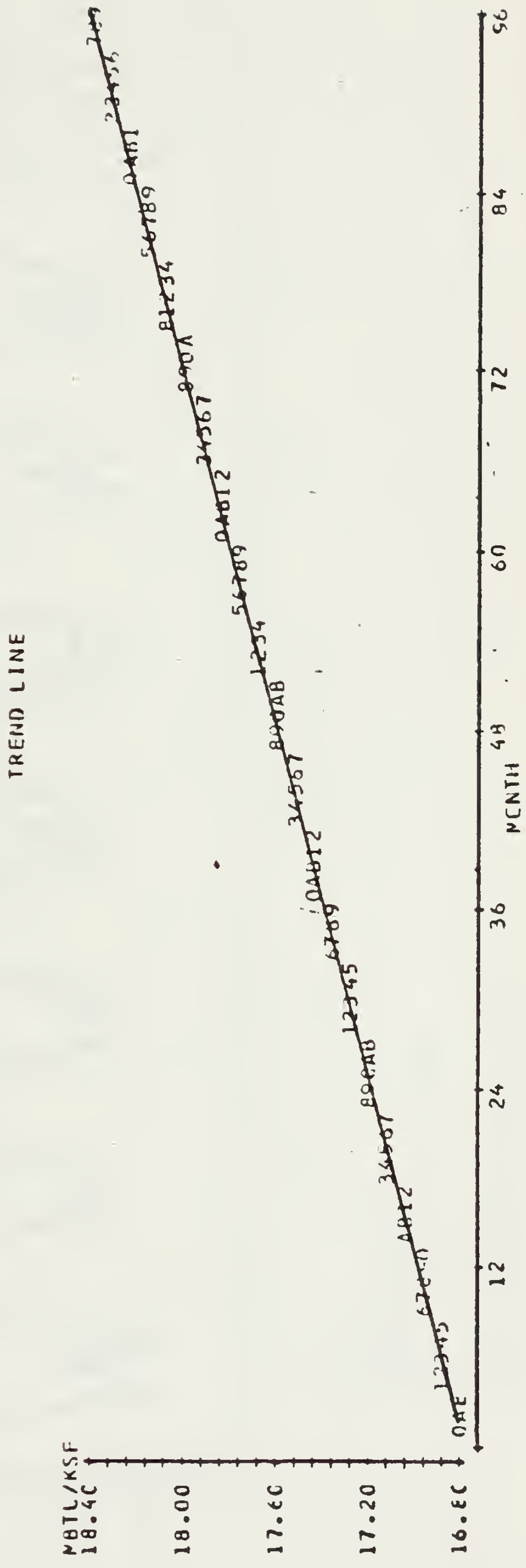
ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	21.02	21.02
RESIDUAL	94	2055.87	21.87
TOTAL	95	2076.88	

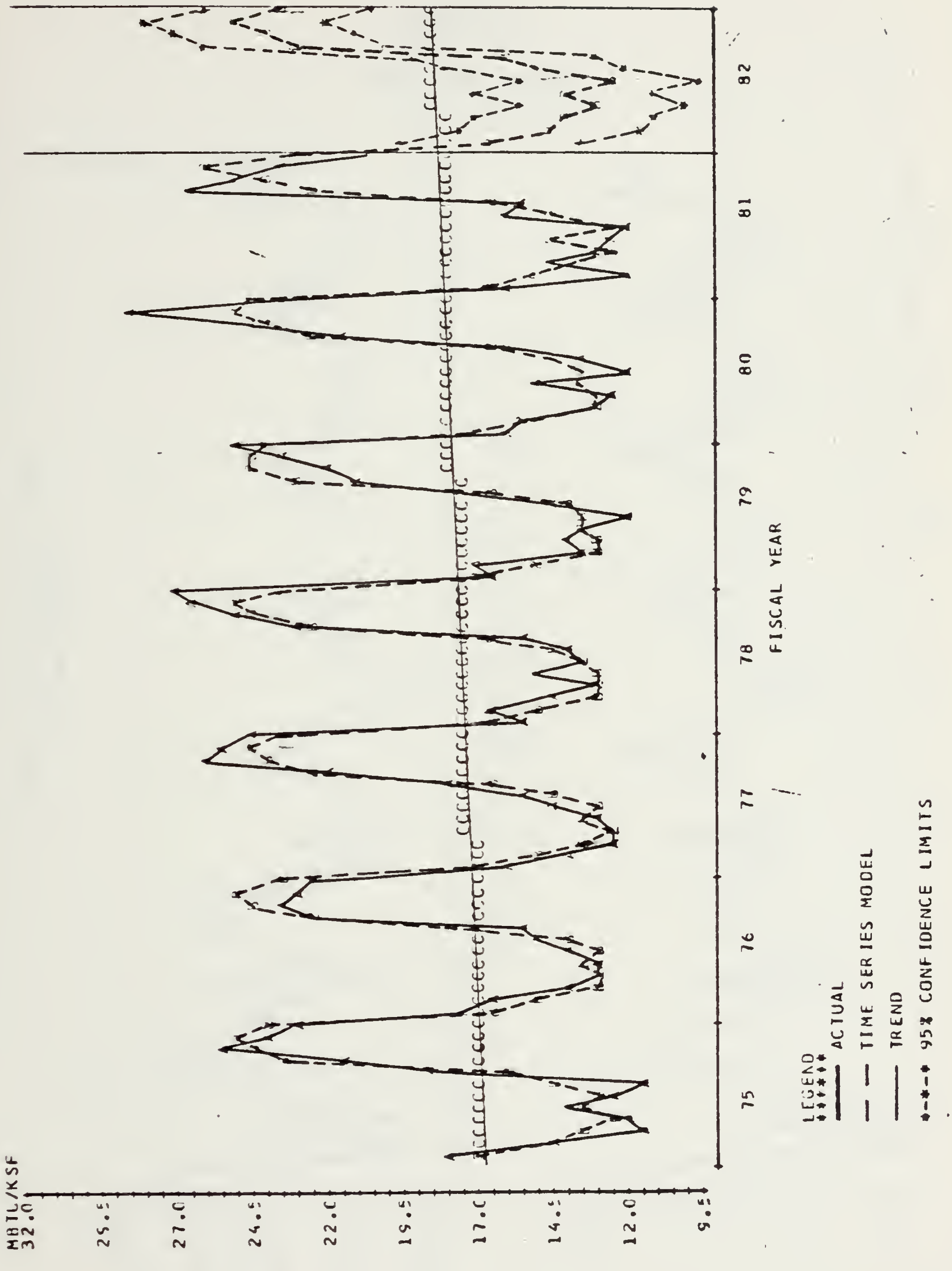
DURBIN-WATSON STATISTIC = 0.41

F. DECOMPOSITION LINES





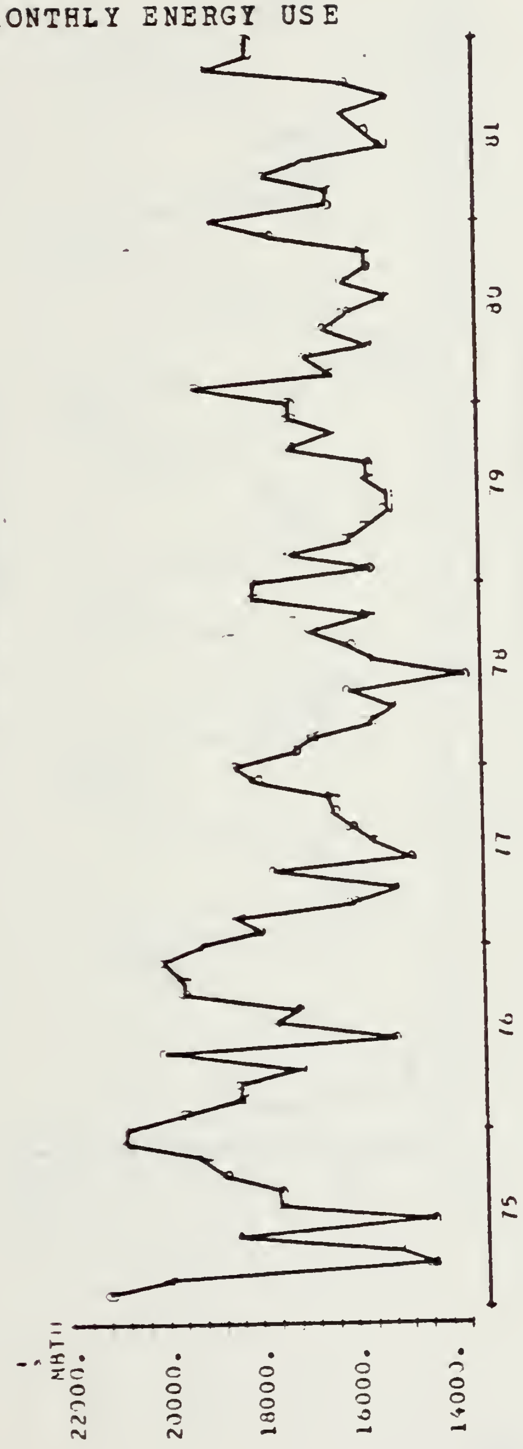
G. ACTUAL USE AND FORECAST MODELS



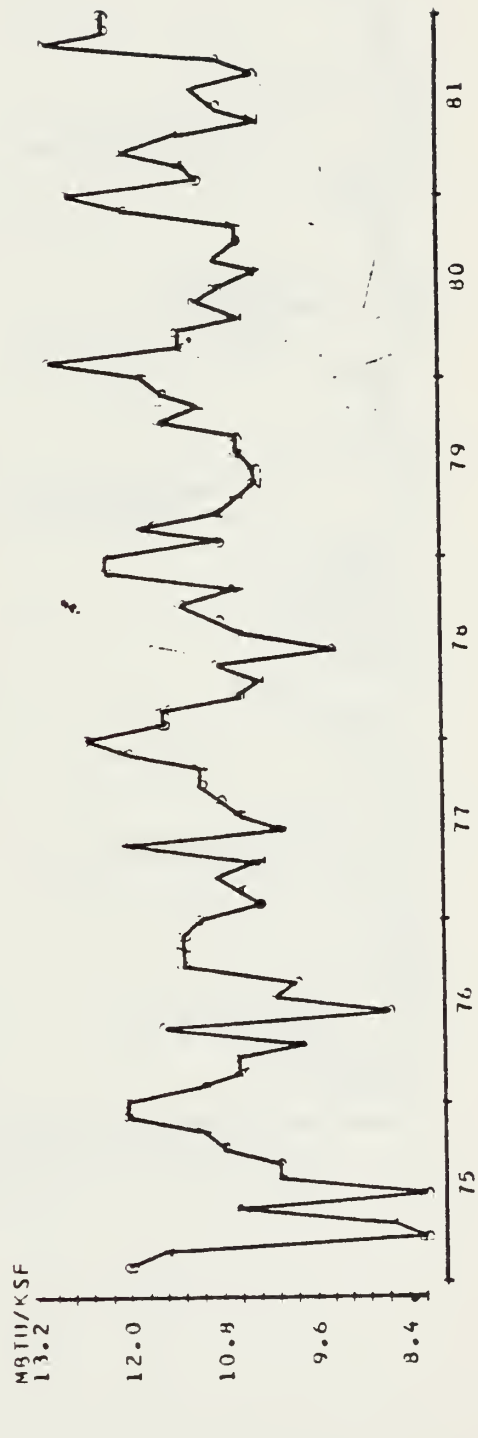
APPENDIX L

NRMC SAN DIEGO

A. MONTHLY ENERGY USE

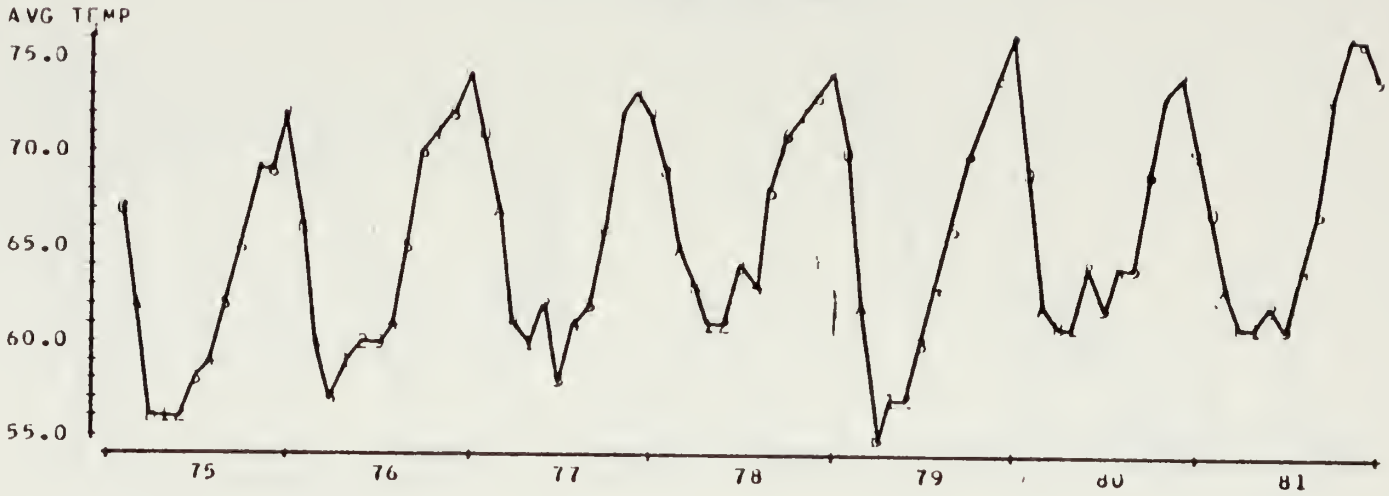


MONTHLY TOTAL ELECTRICITY USE
NRMC SAN DIEGO

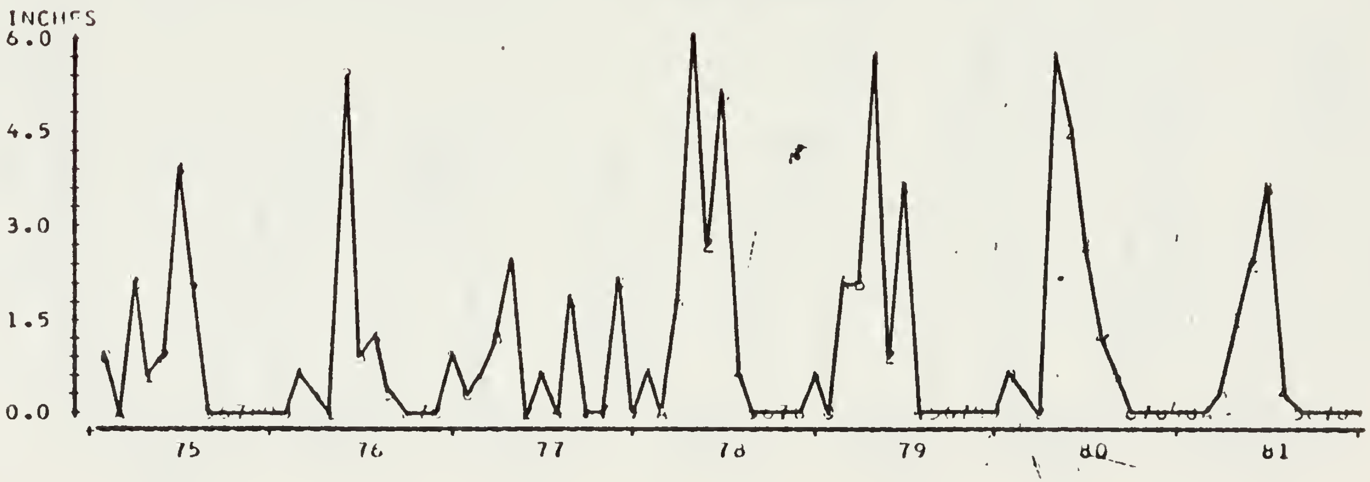


MONTHLY TOTAL ELECTRICITY USE PER SQUARE FOOT
NRMC SAN DIEGO

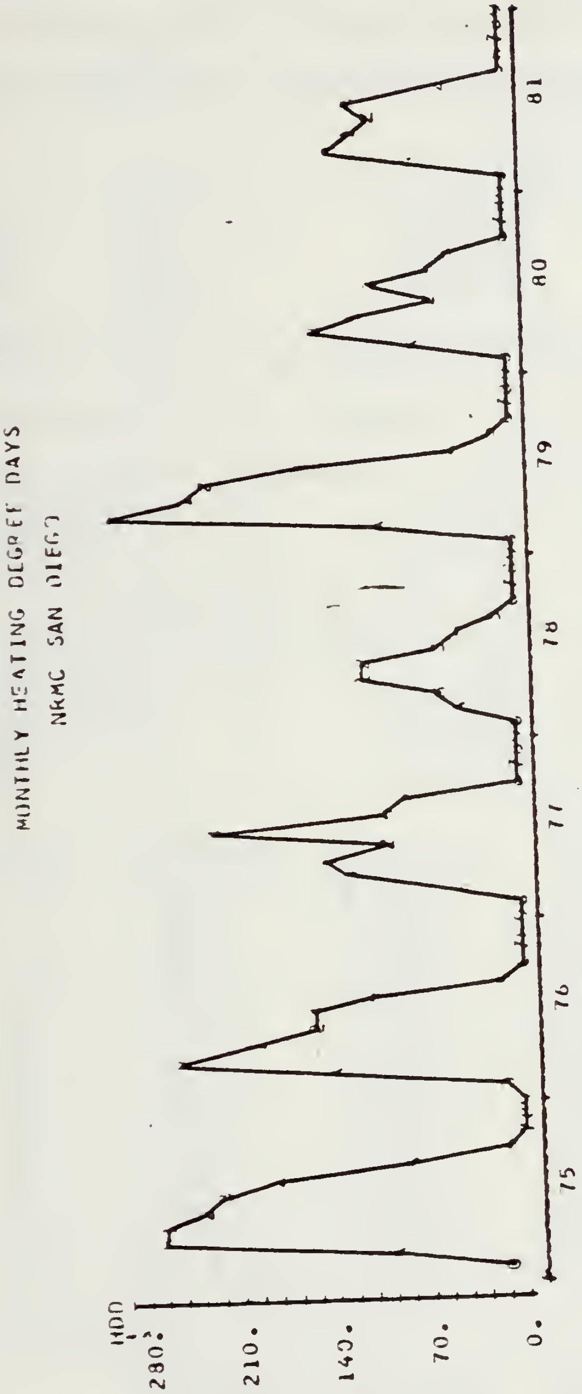
MONTHLY AVERAGE TEMPERATURES
NRMC SAN DIEGO

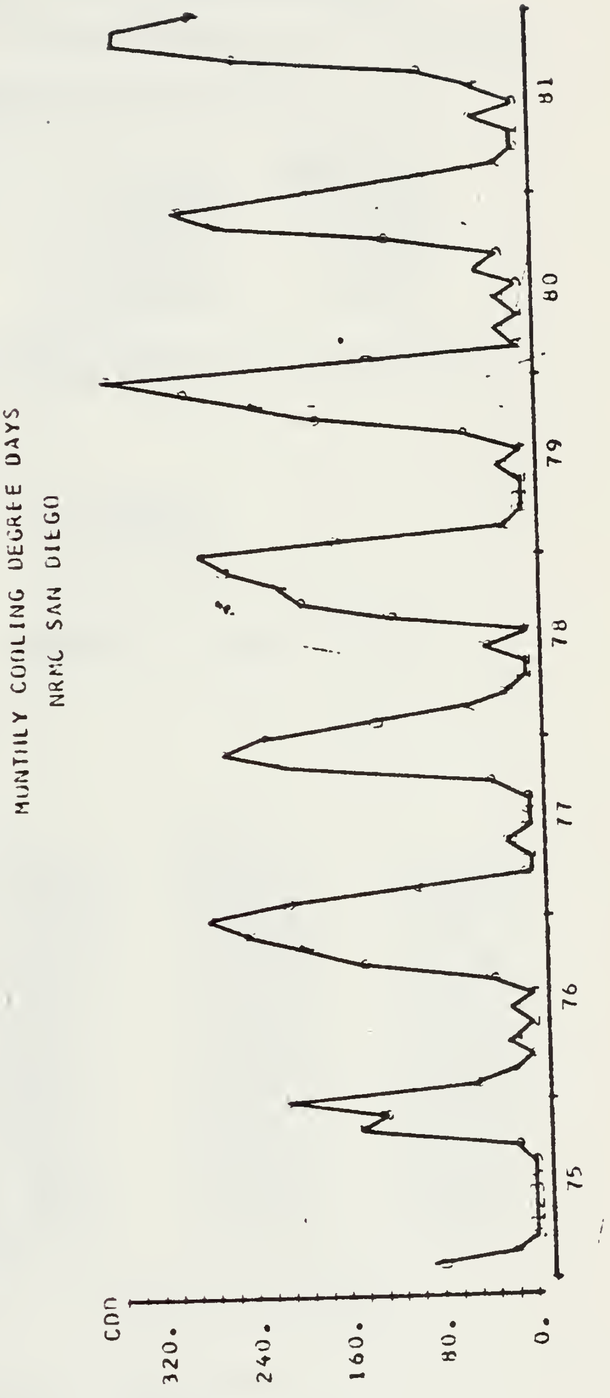


MONTHLY PRECIPITATION
NRMC SAN DIEGO



B. MONTHLY WEATHER SUMMARY





C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREE DAYS, AND PRECIPITATION

NOTE:CDD HIGHLY CORRELATED WITH OTHER PREDICTOR VARIABLES

THE REGRESSION EQUATION for nrmc san diego IS:
Y = 42.0 -0.478 X1 -0.0196 X2 +0.0183 X3 -0.0203 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	41.96	33.50	1.25
X1	AVG TEMP	-0.4783	0.5175	-0.92
X2	HDD	-0.01961	0.01696	-1.16
X3	CDD	0.01827	0.01705	1.07
X4	PRECIP	-0.02028	0.06048	-0.34

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 0.7458
WITH (84- 5) = 79 DEGREES OF FREEDOM

R-SQUARED = 38.3 PERCENT

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	27.2390	6.8097
RESIDUAL	79	43.9354	0.5561
TOTAL	83	71.1744	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	27.2390
AVG TEMP	1	26.1998
HDD	1	0.3187
CDD	1	0.6580
PRECIP	1	0.0625

MONTH	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
3	56.3	8.2208	9.7979	0.2522	-2.25R
4	56.1	8.6009	9.7713	0.3026	-1.72 X
5	56.4	10.5080	10.3242	0.3730	0.28 X
6	57.5	8.2144	9.9760	0.2105	-2.46R
15	56.9	10.5092	9.9205	0.2578	0.84 X
17	59.6	11.4071	10.4095	0.2810	1.44 X
18	60.3	8.7328	10.3861	0.1263	-2.25R
40	61.0	10.2306	10.3941	0.2862	-0.24 X
42	64.3	9.2469	10.7856	0.2621	-2.20RX
51	55.2	10.7422	9.6967	0.2790	1.51 X
52	56.9	10.5061	9.8492	0.2978	0.96 X
53	56.9	10.3955	10.4402	0.4022	-0.07 X
61	68.7	13.0163	11.2803	0.1094	2.35R
64	61.1	10.5929	10.3720	0.2702	0.32 X
75	60.8	11.9227	10.4000	0.1630	2.09R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.63

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.607			
HDD	-0.571	-0.891		
CDD	0.550	0.938	-0.680	
PRECIP	-0.322	-0.474	0.457	-0.420

D. DEVELOPING A TIME SERIES MODEL

```
ACF OF MBTU/KSF        NRMC SAN DIEGO

            -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
              +----+----+----+----+----+----+----+----+----
  1   0.403                       XXXXXXXXXXX
  2   0.253                       XXXXXXX
  3   0.093                       XXX
  4  -0.061                     XXX
  5  -0.264                XXXXXXXX
  6  -0.256                 XXXXXXX
  7  -0.173                   XXXXX
  8  -0.170                   XXXXX
  9  -0.013                       X
 10   0.241                       XXXXXXX
 11   0.274                       XXXXXXXX
 12   0.429                       XXXXXXXXXXXX
 13   0.206                       XXXXXX
 14   0.218                       XXXXXX
 15   0.088                       XXX
 16  -0.030                      XX
 17  -0.195                  XXXXXX
 18  -0.189                  XXXXXX
 19  -0.213                  XXXXXX
 20  -0.142                   XXXXX
 21   0.057                       XX
 22   0.156                       XXXXX
 23   0.152                       XXXXX
 24   0.308                       XXXXXXXXX
 25   0.212                       XXXXXX
 26   0.121                       XXXX
 27   0.063                       XXX
 28  -0.024                      XX
 29  -0.247                 XXXXXXX
 30  -0.276                XXXXXXXX
 31  -0.212                  XXXXXX
 32  -0.202                  XXXXXX
 33  -0.108                    XXXX
 34   0.093                       XXX
 35   0.170                       XXXXX
 36   0.281                       XXXXXXXX
 37   0.187                       XXXXXX
 38   0.138                       XXXX
 39   0.078                       XXX
 40  -0.062                     XXX
 41  -0.233                 XXXXXXX
 42  -0.211                  XXXXXX
 43  -0.156                   XXXXX
 44  -0.174                   XXXXX
 45  -0.077                     XXX
 46   0.096                       XXX
 47   0.092                       XXX
 48   0.155                       XXXXX
 49   0.170                       XXXXX
 50   0.101                       XXXX
```

```
  PACF OF MBTU/KSF      NRMC SAN DIEGO

         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
 1   0.403                     XXXXXXXXXXX
 2   0.108                     XXXX
 3  -0.050                    XX
 4  -0.129                  XXXX
 5  -0.249               XXXXXXX
 6  -0.071                   XXX
 7   0.043                     XX
 8  -0.060                   XXX
 9   0.084                     XXX
10   0.252                     XXXXXXX
11   0.081                     XXX
12   0.267                     XXXXXXXX
13  -0.173                 XXXXX
14   0.084                     XXX
15   0.077                     XXX
16  -0.008                     X
17  -0.077                   XXX
18   0.009                     X
19  -0.079                   XXX
20   0.067                     XXX
21   0.120                     XXXX
22  -0.051                    XX
23  -0.003                     X
24   0.109                     XXXX
25  -0.022                    XX
26  -0.067                   XXX
27   0.057                     XX
28  -0.042                    XX
29  -0.098                   XXX
30  -0.101                  XXXX
31  -0.037                    XX
32  -0.067                   XXX
33  -0.039                    XX
34   0.063                     XXX
35   0.045                     XX
36   0.080                     XXX
37  -0.098                   XXX
38  -0.049                    XX
39   0.066                     XXX
40  -0.007                     X
41  -0.069                   XXX
42   0.032                     XX
43   0.066                     XXX
44   0.037                     XX
45  -0.027                    XX
46  -0.036                    XX
47  -0.001                     X
48   0.005                     X
49   0.002                     X
50  -0.051                    XX
```

```
ARIMA (1 0 2)(1 1 2) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE    ESTIMATE       ST. DEV.   T-RATIO
     1      AR   1    0.5532        1.9152       0.29
     2     SAR  12    0.4744        0.7530       0.63
     3      MA   1    0.3514        1.9312       0.18
     4      MA   2    0.0660        0.4369       0.15
     5     SMA  12    1.1255        0.7531       1.49
     6     SMA  24   -0.4942        0.3952      -1.25

DIFFERENCING. 0 REGULAR    1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =       31.2610  (BACKFORECASTS EXCL)
               DF =    66  MS =        0.4737
NO. OF OBS.    ORIGINAL SERIES   84     AFTER DIFF.  72

   ACF OF RESIDUAL       NRMC SAN DIEGO

                  -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
                    +----+----+----+----+----+----+----+----
  1  -0.097                           XXX
  2  -0.091                           XXX
  3  -0.025                            XX
  4  -0.006                             X
  5  -0.116                          XXXX
  6  -0.056                            XX
  7   0.175                             XXXXX
  8  -0.234                       XXXXXXX
  9  -0.047                            XX
 10   0.020                             X
 11   0.104                             XXXX
 12   0.014                             X
 13  -0.130                          XXXX
 14   0.077                             XXX
 15  -0.072                           XXX
 16   0.000                             X
 17  -0.025                            XX
 18   0.092                             XXX
 19  -0.155                         XXXXX
 20  -0.084                           XXX
 21   0.259                             XXXXXXX
 22   0.001                             X
 23  -0.094                           XXX
 24   0.036                             XX
 25   0.011                             X
 26  -0.120                          XXXX
 27   0.013                             X
 28   0.166                             XXXXX
 29  -0.068                           XXX
 30  -0.070                           XXX
 31   0.009                             X
 32   0.059                             XX
 33  -0.020                             X
 34   0.090                             XXX
 35   0.038                             XX
 36  -0.043                            XX
 37  -0.112                          XXXX
 38  -0.055                            XX
 39   0.064                             XXX
 40  -0.001                             X
```

```
ARIMA (2 0 2)(1 1 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER      TYPE      ESTIMATE       ST. DEV.   T-RATIO
     1      AR   1     -0.4010       27.3723      -0.01
     2      AR   2     -0.0483        1.3895      -0.03
     3     SAR  12     -0.1413        0.4025      -0.35
     4      MA   1     -0.5940       27.3715      -0.02
     5      MA   2     -0.1115        7.0895      -0.02
     6     SMA  12      0.2804        0.4007       0.70

DIFFERENCING. 0 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.    SS =       36.3251  (BACKFORECASTS EXCL)
              DF =    66  MS =       0.5504
NO. OF OBS.   ORIGINAL SERIES    84     AFTER DIFF.  72

   ACF OF RESIDUAL          NRMC SAN DIEGO

          -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
            +----+----+----+----+----+----+----+----
  1  -0.081                  XXX
  2  -0.051                   XX
  3  -0.021                   XX
  4   0.018                     X
  5  -0.145                 XXXXX
  6  -0.076                  XXX
  7   0.165                     XXXXX
  8  -0.207                XXXXXX
  9  -0.081                  XXX
 10  -0.013                     X
 11   0.111                     XXXX
 12  -0.094                  XXX
 13  -0.089                  XXX
 14   0.090                     XXX
 15  -0.026                   XX
 16  -0.012                     X
 17  -0.021                   XX
 18   0.111                     XXXX
 19  -0.138                  XXXX
 20  -0.015                     X
 21   0.228                     XXXXXXX
 22  -0.032                   XX
 23  -0.105                  XXXX
 24   0.013                     X
 25   0.026                     XX
 26  -0.120                  XXXX
 27   0.021                     XX
 28   0.162                     XXXXX
 29  -0.037                   XX
 30  -0.052                   XX
 31   0.020                     X
 32   0.046                     XX
 33  -0.048                   XX
 34   0.038                     XX
 35   0.051                     XX
 36  -0.016                     X
 37  -0.082                  XXX
 38  -0.060                  XXX
 39   0.056                     XX
 40  -0.038                   XX
```

ARIMA (2 0 2)(1 1 2) S=12

FINAL ESTIMATES OF PARAMETERS

NUMBER	TYPE	ESTIMATE	ST. DEV.	T-RATIO
1	AR 1	-1.0035	0.2325	-4.32
2	AR 2	-0.6694	0.1874	-3.57
3	SAR 12	0.4238	1.0639	0.40
4	MA 1	-1.2196	0.1800	-6.77
5	MA 2	-0.8685	0.1276	-6.80
6	SMA 12	1.0789	1.0616	1.02
7	SMA 24	-0.4183	0.5978	-0.70

```
DIFFERENCING.  0 REGULAR     1 SEASONAL DIFF. ORDER 12
RESIDUALS.     SS =      31.0963  (BACKFORECASTS EXCL)
               DF =    65  MS =       0.4784
NO. OF OBS.    ORIGINAL SERIES   84     AFTER DIFF. 72
```

FORECASTS FROM PERIOD 84

PERIOD	FORECAST	95 PERCENT LIMITS LOWER	UPPER
85	11.5324	10.1765	12.8884
86	11.6437	10.2564	13.0309
87	11.3239	9.9365	12.7114
88	10.8928	9.4947	12.2909
89	10.7836	9.3729	12.1944
90	10.5658	9.1531	11.9785
91	10.6436	9.2299	12.0572
92	10.7411	9.3238	12.1584
93	10.8590	9.4401	12.2779
94	11.5163	10.0974	12.9352
95	12.0529	10.6333	13.4726
96	12.3352	10.9149	13.7556

```
   ACF OF RESIDUAL       NRMC SAN DIEGO

            -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
              +----+----+----+----+----+----+----+----
  1  -0.121                   XXXX
  2  -0.024                     XX
  3   0.054                      XX
  4  -0.105                   XXXX
  5  -0.056                     XX
  6  -0.066                    XXX
  7   0.069                      XXX
  8  -0.140                  XXXXX
  9  -0.067                    XXX
 10  -0.013                      X
 11   0.087                      XXX
 12   0.003                      X
 13  -0.120                   XXXX
 14   0.069                      XXX
 15  -0.076                    XXX
 16   0.014                      X
 17  -0.047                     XX
 18   0.056                      XX
 19  -0.112                   XXXX
 20  -0.050                     XX
 21   0.203                      XXXXXX
 22  -0.013                      X
 23  -0.050                     XX
 24   0.021                      XX
 25   0.017                      X
 26  -0.082                    XXX
 27  -0.008                      X
 28   0.155                      XXXXX
 29  -0.055                     XX
 30  -0.088                    XXX
```

E. FITTING A TREND LINE

REGRESSION OF MODELED MBTU/KSF VS MONTH

84 CASES USED
12 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION FOR NRMC SAN DIEGO IS:
Y = 10.2 +0.0117 X1

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	10.2391	0.2046	50.04
X1	MONTH	0.011653	0.003430	3.40

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 0.7623
WITH (84- 2) = 82 DEGREES OF FREEDOM

R-SQUARED = 12.3 PERCENT

ANALYSIS OF VARIANCE

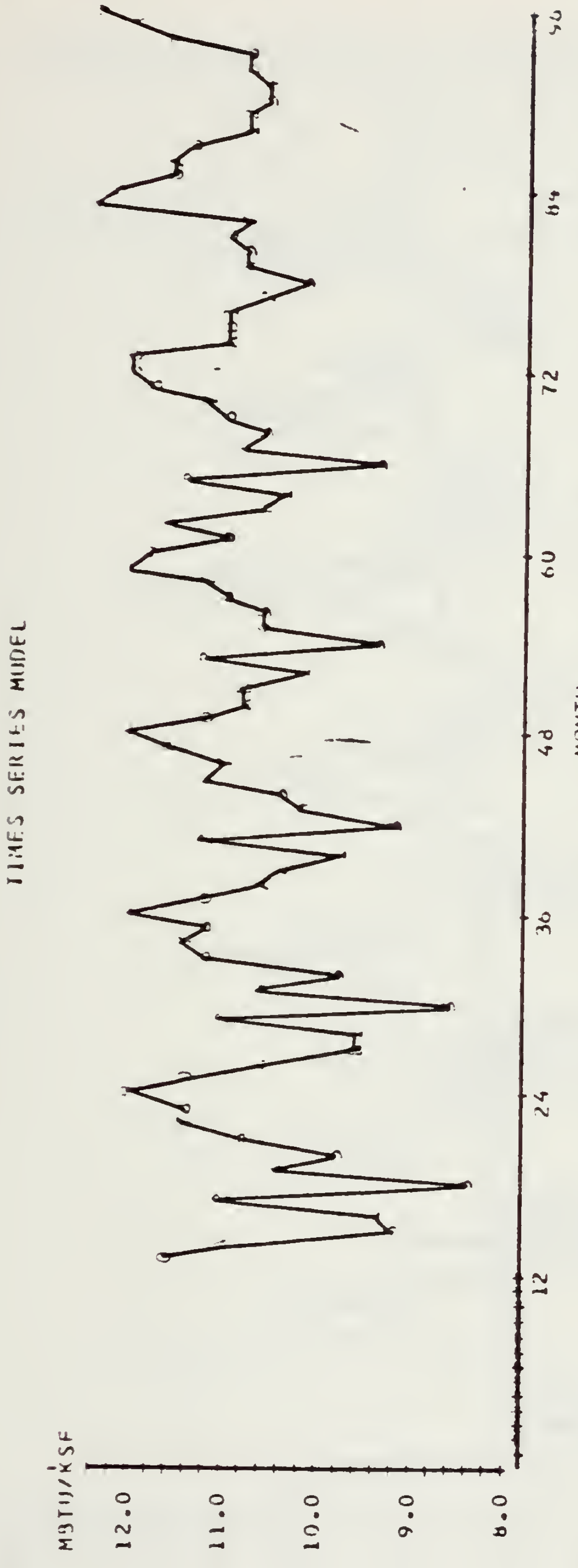
DUE TO	DF	SS	MS=SS/DF
REGRESSION	1	6.7050	6.7060
RESIDUAL	82	47.6539	0.5811
TOTAL	83	54.3599	

ROW	X1 MONTH	Y ARIMA LN	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
18	18.0	8.4528	10.4489	0.1503	-2.67R
30	30.0	8.6903	10.5887	0.1182	-2.52R
42	42.0	9.2029	10.7285	0.0936	-2.02R
66	66.0	9.4614	11.0082	0.0921	-2.04R

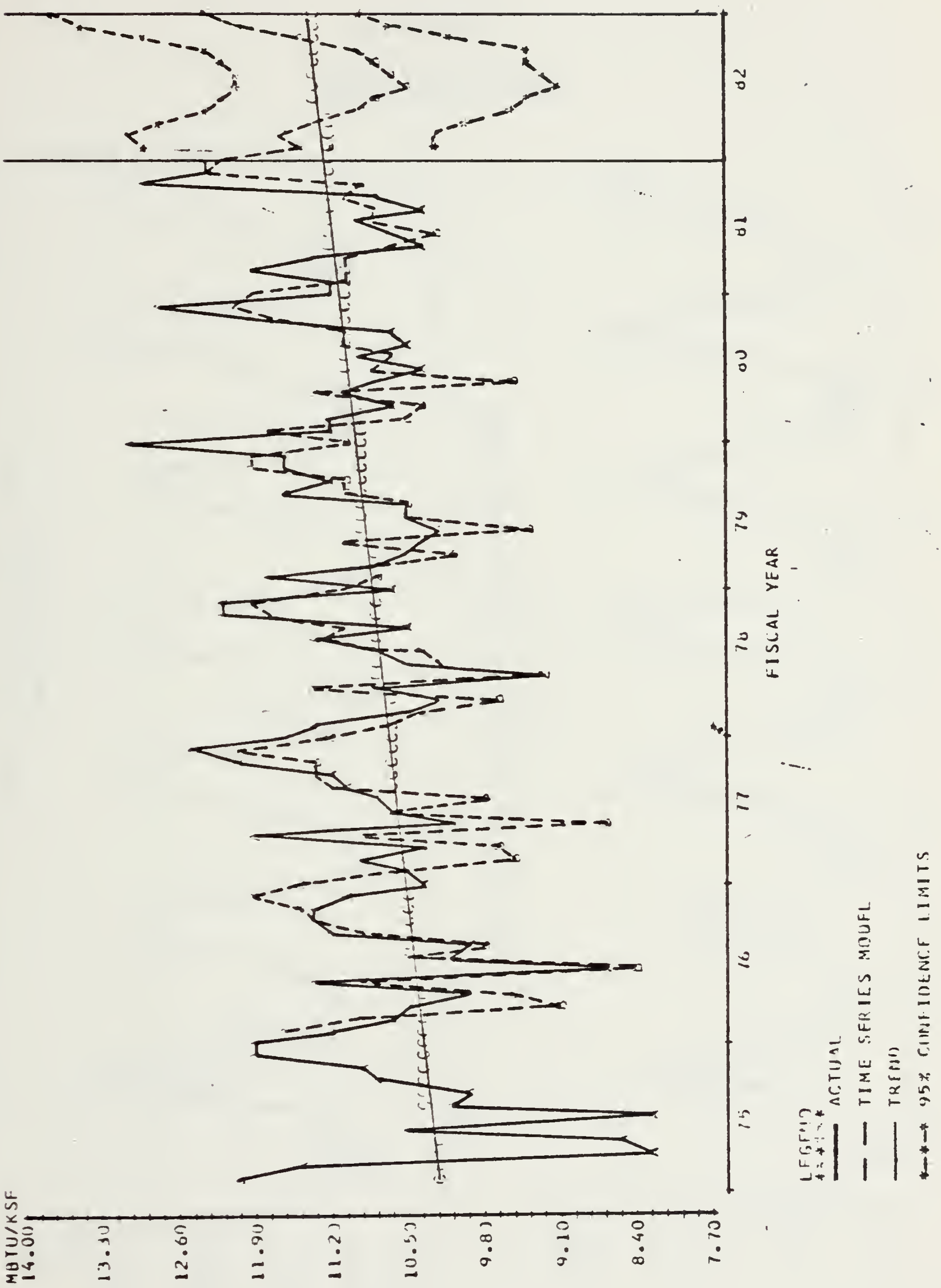
R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.38

F. DECOMPOSITION LINES



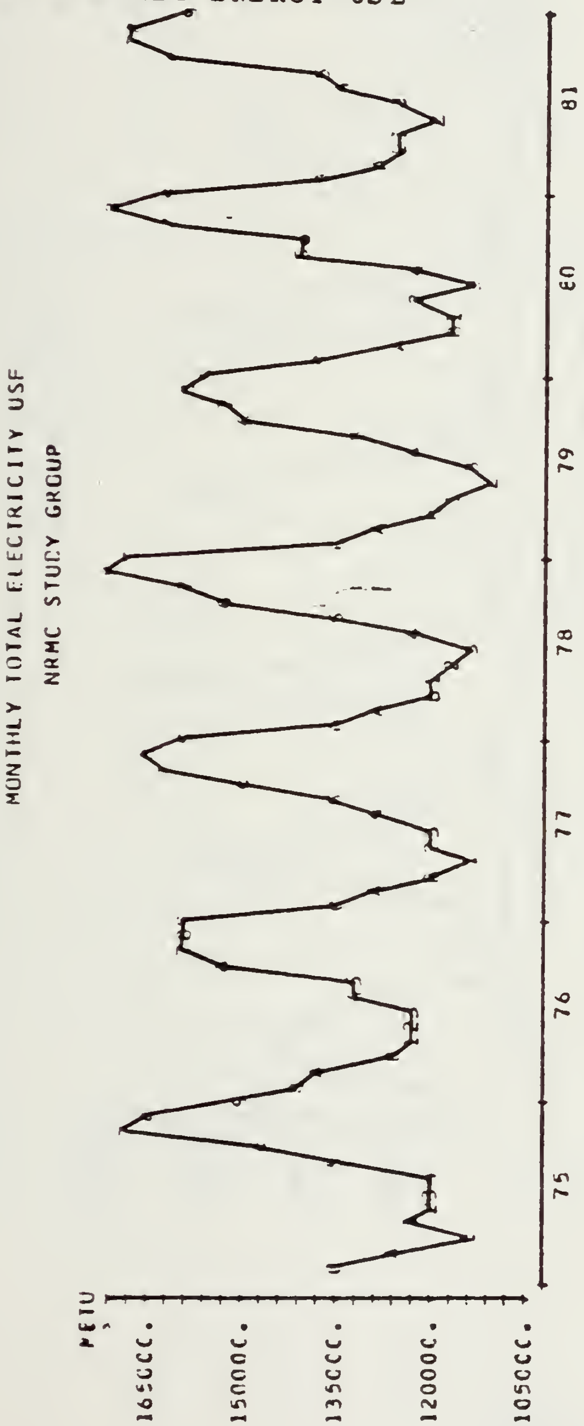
G. ACTUAL USE AND FORECAST MODELS

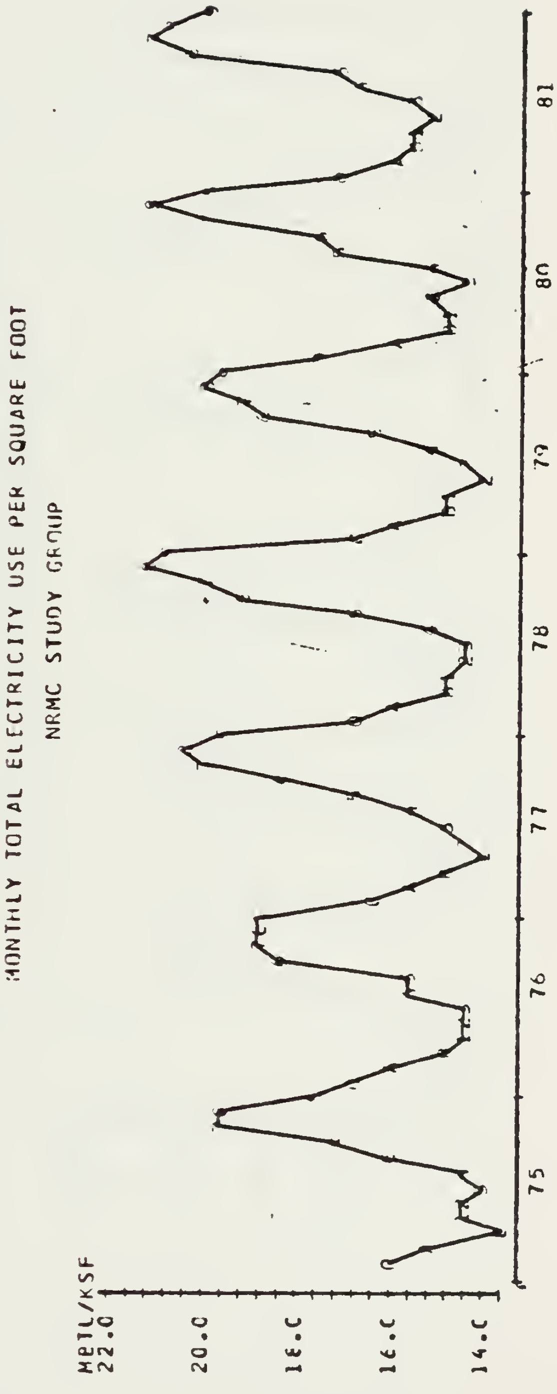


APPENDIX M

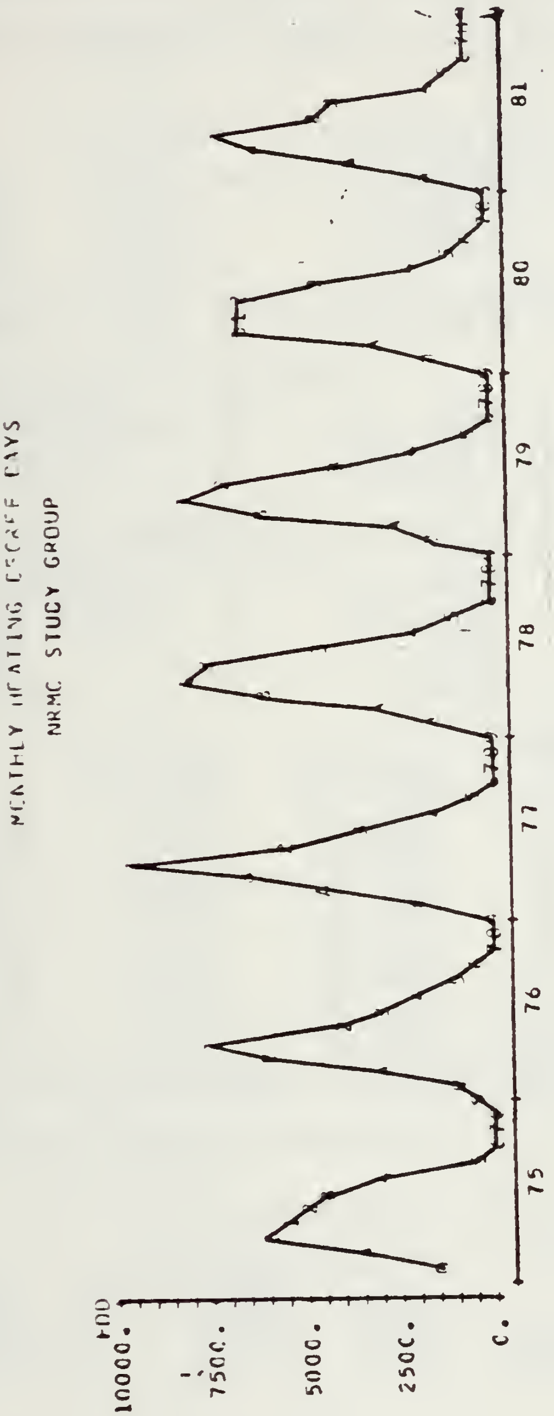
NRMC STUDY GROUP

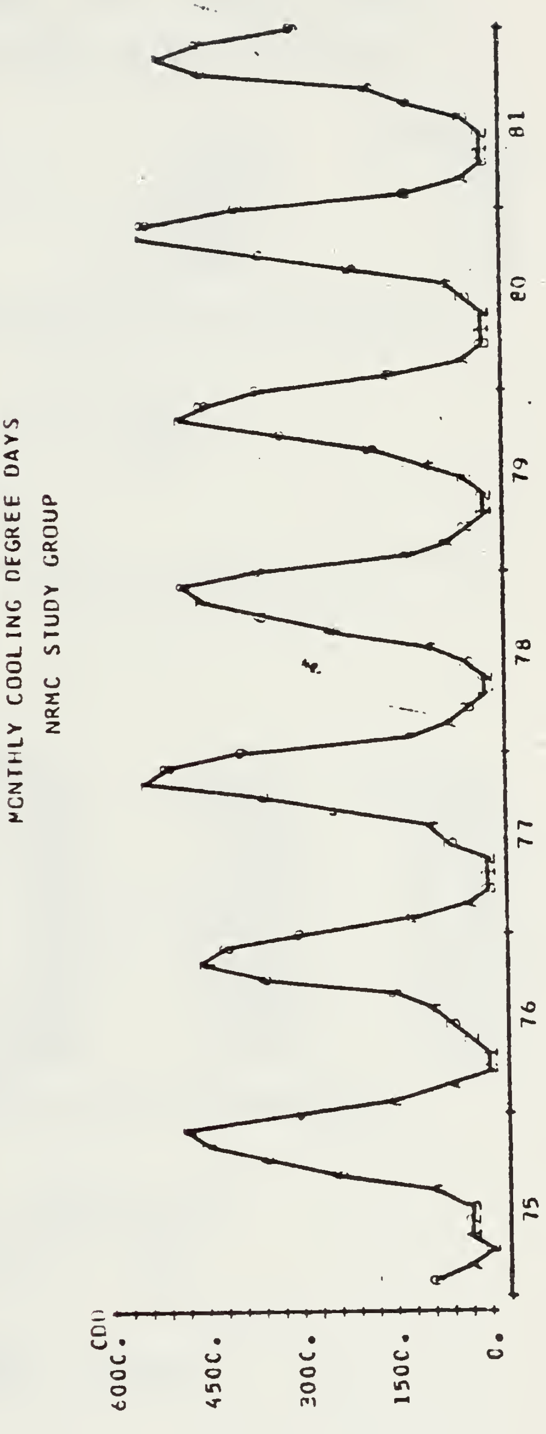
A. MONTHLY ENERGY USE





B. MONTHLY WEATHER SUMMARY





C. REGRESSION OF MBTU/KSF VS WEATHER VARIABLES

REGRESSION OF MBTU/SF VS AVERAGE TEMPERATURE, HEATING DEGREE DAYS, COOLING DEGREEE DAYS, AND PRECIPITATION

THE REGRESSION EQUATION FOR THE NRMC STUDY GROUP IS:
Y = 8.43 + 0.105 X1 +0.0003 X2 +0.0009 X3 -0.0113 X4

	COLUMN	COEFFICIENT	ST. DEV. OF COEF.	T-RATIO = COEF/S.D.
	--	8.426	7.720	1.09
X1	AVG TEMP	0.1047	0.1195	0.88
X2	HDD	0.0002508	0.0003337	0.75
X3	CDD	0.0008557	0.0003395	2.52
X4	PRECIP	-0.011269	0.006457	-1.75

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS: S = 0.7322
WITH (84- 5) = 79 DEGREES OF FREEDOM

ANALYSIS OF VARIANCE

DUE TO	DF	SS	MS=SS/DF
REGRESSION	4	367.5940	91.8985
RESIDUAL	79	42.3552	0.5361
TOTAL	83	409.9438	

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE ENTERED IN THE ORDER GIVEN

DUE TO	DF	SS
REGRESSION	4	367.5940
AVG TEMP	1	327.8056
HDD	1	34.6090
CDD	1	3.5468
PRECIP	1	1.6329

	X1 AVG TEMP	Y MBTU/KSF	PRED. Y VALUE	ST.DEV. PRED. Y	ST.RES.
9	74.2	17.3502	18.8235	0.1144	-2.04R
28	39.6	14.0230	14.5923	0.2926	-0.85 X
40	43.6	14.7480	14.2500	0.2824	0.74 X
41	42.8	14.5081	14.3762	0.2651	0.19 X
48	74.8	20.9813	19.0447	0.1188	2.68R
52	43.5	14.7143	14.1805	0.3118	0.81 X
60	74.2	19.4747	18.1695	0.3531	2.03RX
63	50.5	14.8327	15.1331	0.4147	-0.50 X
76	43.8	15.7464	14.5587	0.2836	1.76 X
77	50.6	15.0018	14.5803	0.2938	0.63 X
84	72.3	19.9337	18.3920	0.1788	2.17R

R ==> OBS. WITH A LARGE ST. RES.
X ==> OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 0.77

******* CORRELATION OF VARIABLES*******

	MBTU/KSF	AVG TEMP	HDD	CDD
AVG TEMP	0.894			
HDD	-0.788	-0.966		
CDD	0.944	0.932	-0.812	
PRECIP	0.211	0.211	-0.129	0.291

D. DEVELOPING A TIME SERIES MODEL

ACF OF MBTU/KSF   NRMC STUDY GROUP

```
            -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6  0.8
              +----+----+----+----+----+----+----+----
  1    0.811                      XXXXXXXXXXXXXXXXXXXXX
  2    0.460                      XXXXXXXXXXXX
  3    0.038                      XX
  4   -0.349             XXXXXXXXXX
  5   -0.592       XXXXXXXXXXXXXXXX
  6   -0.691     XXXXXXXXXXXXXXXXXX
  7   -0.606       XXXXXXXXXXXXXXXX
  8   -0.371             XXXXXXXXXX
  9   -0.016                      X
 10    0.374                      XXXXXXXXXX
 11    0.680                      XXXXXXXXXXXXXXXXXX
 12    0.786                      XXXXXXXXXXXXXXXXXXXXX
 13    0.656                      XXXXXXXXXXXXXXXXX
 14    0.353                      XXXXXXXXXX
 15   -0.023                     XX
 16   -0.335              XXXXXXXXX
 17   -0.545        XXXXXXXXXXXXXXX
 18   -0.624      XXXXXXXXXXXXXXXXX
 19   -0.541        XXXXXXXXXXXXXXX
 20   -0.334              XXXXXXXXX
 21   -0.027                     XX
 22    0.303                      XXXXXXXXX
 23    0.563                      XXXXXXXXXXXXXXX
 24    0.667                      XXXXXXXXXXXXXXXXXX
 25    0.553                      XXXXXXXXXXXXXXX
 26    0.297                      XXXXXXXX
 27   -0.018                      X
 28   -0.302              XXXXXXXXX
 29   -0.476          XXXXXXXXXXXXX
 30   -0.531         XXXXXXXXXXXXXX
 31   -0.465          XXXXXXXXXXXXX
 32   -0.300              XXXXXXXXX
 33   -0.042                     XX
 34    0.244                      XXXXXXX
 35    0.452                      XXXXXXXXXXXX
 36    0.542                      XXXXXXXXXXXXXXX
 37    0.448                      XXXXXXXXXXXX
 38    0.242                      XXXXXXX
 39   -0.007                      X
 40   -0.220                XXXXXXX
 41   -0.353             XXXXXXXXXX
 42   -0.406            XXXXXXXXXXX
 43   -0.359             XXXXXXXXXX
 44   -0.239                XXXXXXX
 45   -0.063                    XXX
 46    0.150                      XXXXX
 47    0.303                      XXXXXXXXX
 48    0.359                      XXXXXXXXXX
 49    0.302                      XXXXXXXXX
 50    0.164                      XXXXX
```

PACF OF MBTU/KSF   NRMC STUDY GROUP

```
         -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
           +----+----+----+----+----+----+----+----+----
 1   0.811                     XXXXXXXXXXXXXXXXXXXXX
 2  -0.578       XXXXXXXXXXXXXXX
 3  -0.358            XXXXXXXXXX
 4  -0.225               XXXXXXX
 5  -0.019                     X
 6  -0.229               XXXXXXX
 7   0.030                     XX
 8   0.064                     XXX
 9   0.291                     XXXXXXXX
10   0.265                     XXXXXXXX
11   0.214                     XXXXXX
12  -0.072                   XXX
13  -0.134                  XXXX
14  -0.082                   XXX
15  -0.013                     X
16   0.192                     XXXXXX
17   0.002                     X
18  -0.079                   XXX
19   0.020                     X
20  -0.068                   XXX
21  -0.058                    XX
22   0.018                     X
23   0.103                     XXXX
24   0.089                     XXX
25  -0.118                  XXXX
26   0.019                     X
27  -0.034                    XX
28  -0.016                     X
29   0.085                     XXX
30   0.043                     XX
31  -0.032                    XX
32  -0.124                  XXXX
33   0.027                     XX
34   0.042                     XX
35  -0.137                  XXXX
36   0.092                     XXX
37  -0.062                   XXX
38   0.117                     XXXX
39   0.034                     XX
40   0.046                     XX
41  -0.017                     X
42  -0.012                     X
43   0.001                     X
44  -0.029                    XX
45  -0.136                  XXXX
46   0.078                     XXX
47  -0.169                 XXXXX
48   0.026                     XX
49   0.040                     XX
50  -0.006                     X
```

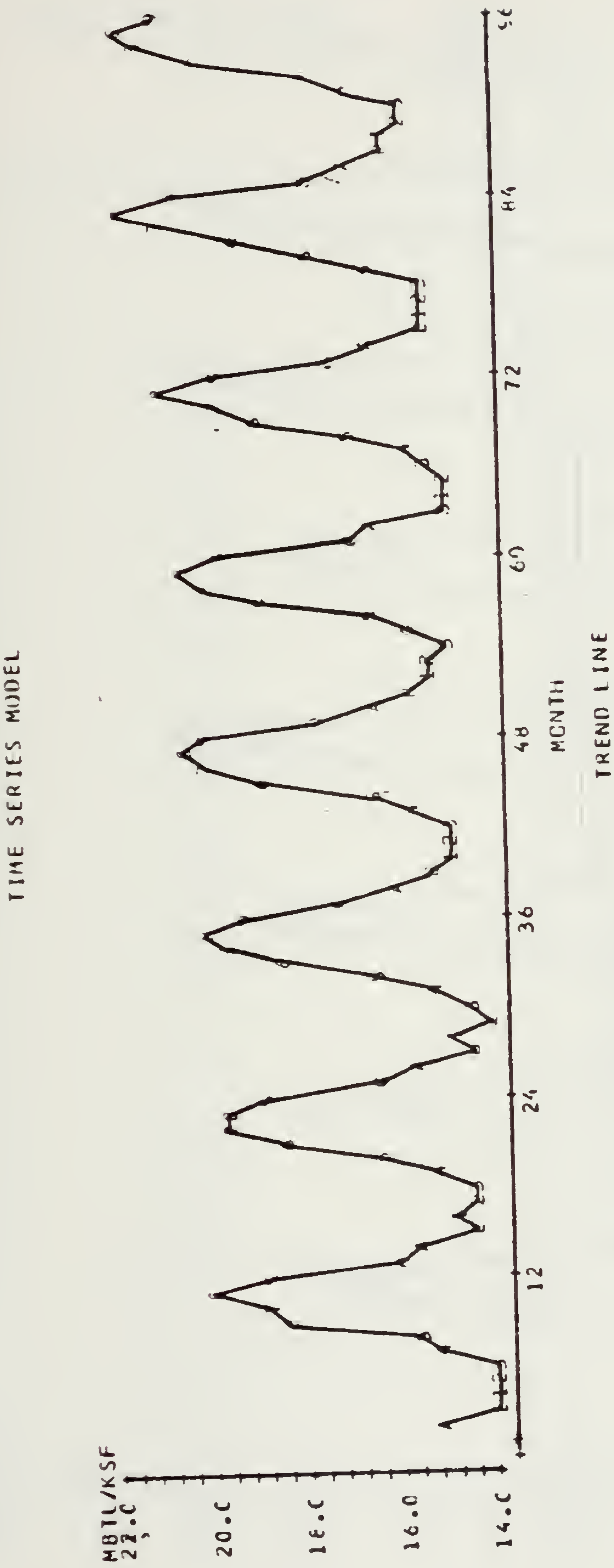
```
ARIMA (2 1 2)(1 0 1) S=12

FINAL ESTIMATES OF PARAMETERS
NUMBER     TYPE      ESTIMATE      ST. DEV.   T-RATIO
    1       AR  1     -0.3687       0.5551     -0.66
    2      SAR 12      0.9989       0.0063    157.67
    3       MA  1      0.3029       0.5219      0.58
    4       MA  2      0.4478       0.4029      1.11
    5      SMA 12      0.8379       0.1061      7.90

DIFFERENCING. 1 REGULAR
RESIDUALS.    SS =        26.0363  (BACKFORECASTS EXCL)
              DF =    78  MS =       0.3338
NO. OF OBS.   ORIGINAL SERIES    84     AFTER DIFF.  83

FORECASTS FROM PERIOD  84
                                    95 PERCENT LIMITS
PERIOD       FORECAST             LOWER           UPPER
  85          17.7835            16.6508         18.9161
  86          16.9069            15.7147         18.0990
  87          15.9526            14.7516         17.1535
  88          15.8998            14.6772         17.1224
  89          15.7038            14.4653         16.9423
  90          15.7643            14.5082         17.0204
  91          16.7215            15.4488         17.9943
  92          17.7577            16.4682         19.0471
  93          19.8128            18.5069         21.1186
  94          21.0590            19.7370         22.3810
  95          21.5333            20.1953         22.8714
  96          20.6973            19.3434         22.0512

   ACF OF RESIDUAL        NRMC STUDY GROUP

           -0.8 -0.6 -0.4 -0.2  0.0  0.2  0.4  0.6 0.8
             +----+----+----+----+----+----+----+----
  1  -0.010                      X
  2   0.054                      XX
  3   0.130                      XXXX
  4  -0.021                     XX
  5  -0.041                     XX
  6  -0.125                   XXXX
  7  -0.147                  XXXXX
  8  -0.128                   XXXX
  9  -0.049                     XX
 10  -0.055                     XX
 11   0.165                      XXXXX
 12  -0.193                 XXXXXX
 13   0.071                      XXX
 14   0.110                      XXXX
 15  -0.048                     XX
 16   0.154                      XXXXX
 17   0.085                      XXX
 18  -0.054                     XX
 19  -0.087                    XXX
 20   0.002                      X
 21  -0.009                      X
 22  -0.167                  XXXXX
 23  -0.094                    XXX
 24  -0.126                   XXXX
 25  -0.100                    XXX
 26  -0.066                    XXX
 27  -0.021                     XX
 28  -0.056                     XX
 29  -0.032                     XX
 30   0.178                      XXXXX
```

E. FITTING A TREND LINE

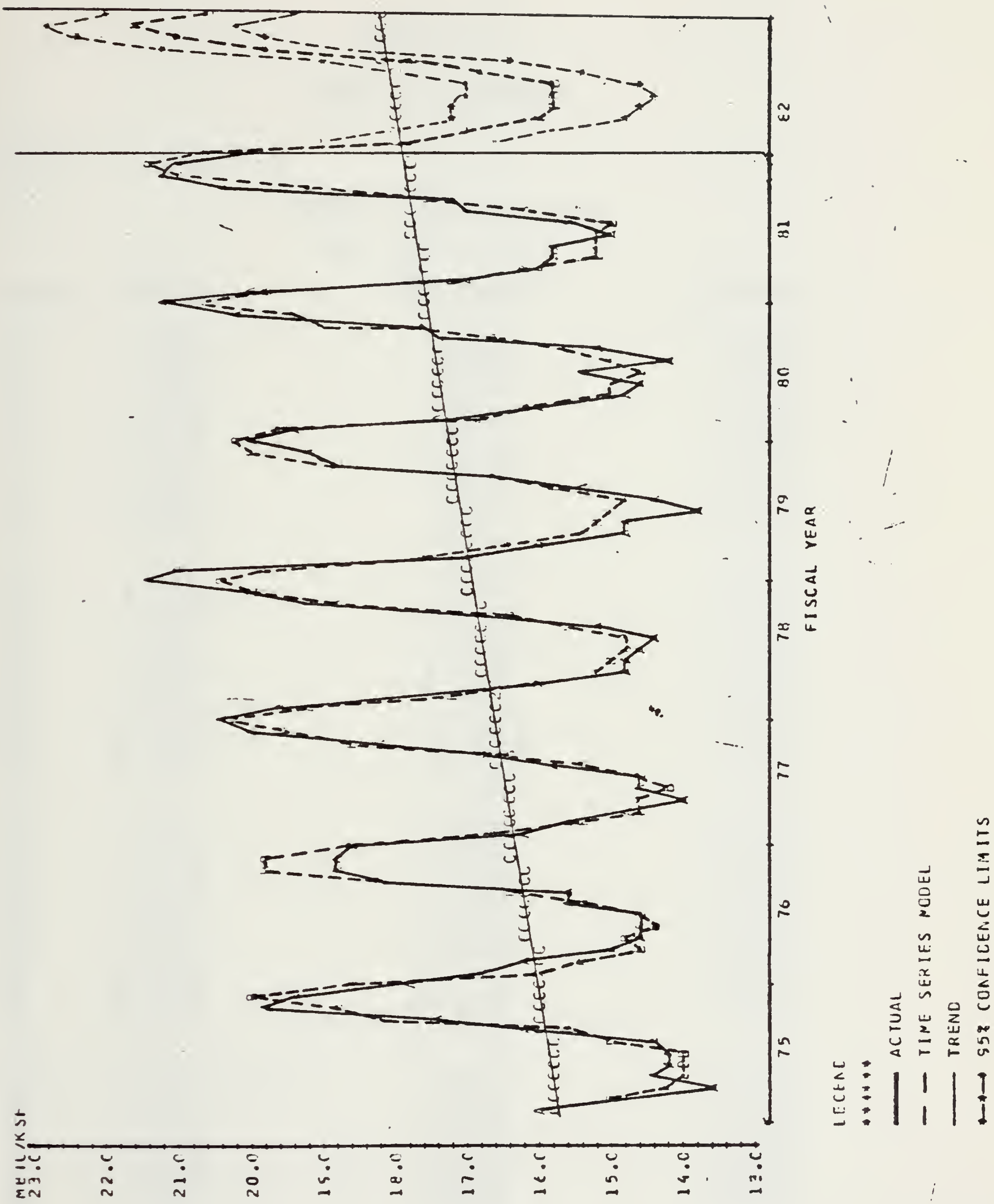
REGRESSION OF MODELED MBTU/KSF VS MONTH

```
   95 CASES USED
    1 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
  Y = 15.7 +0.0260 X1

                                          ST. DEV.     T-RATIO =
       COLUMN     COEFFICIENT             OF COEF.     COEF/S.D.
       --            15.7066               0.4348        36.12
X1     MONTH          0.026022             0.007743       3.36

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 2.070
WITH (  95- 2) =  93 DEGREES OF FREEDOM

R-SQUARED = 10.8 PERCENT

ANALYSIS OF VARIANCE
 DUE TO        DF            SS        MS=SS/DF
REGRESSION      1        48.377          48.377
RESIDUAL       93       398.363           4.283
TOTAL          94       446.740

DURBIN-WATSON STATISTIC = 0.33
```

F. DECOMPOSITION LINES



G. ACTUAL USE AND FORECAST MODELS



APPENDIX N

PROJECTION SUMMARY

(MONTH 1 = OCT 1974)

SUMMARY OF PROJECTIONS

NRMC CAMP LEJEUNE

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	6.3621	******	8.6935
2	7.6985	******	8.7226
3	5.3954	******	8.7516
4	7.9606	******	8.7807
5	5.9045	******	8.8098
6	5.7288	******	8.8389
7	7.2227	******	8.8680
8	7.2227	******	8.8971
9	11.4939	******	8.9261
10	15.9939	******	8.9552
11	17.0303	******	8.9843
12	8.6470	******	9.0134
13	9.6833	******	9.0425
14	8.3485	7.5947	9.0716
15	6.2742	6.1150	9.1007
16	7.0651	7.5850	9.1297
17	6.8364	6.5956	9.1588
18	6.8364	6.3099	9.1879
19	7.2758	7.3941	9.2170
20	8.9106	9.1079	9.2461
21	12.3909	11.9630	9.2752
22	14.5348	15.4157	9.3042
23	13.2515	15.5164	9.3333
24	11.9333	12.3039	9.3624
25	10.2636	8.6088	9.3915
26	7.0121	8.2190	9.4206
27	6.8182	6.5268	9.4497
28	7.1697	8.1156	9.4787
29	6.8182	6.6879	9.5078
30	6.5197	7.0127	9.5369
31	8.7167	7.4122	9.5660
32	9.5076	9.4405	9.5951
33	12.7424	11.9082	9.6242
34	16.6257	16.1445	9.6532
35	15.0970	15.1854	9.6823
36	15.1318	12.5899	9.7114
37	9.1394	9.1747	9.7405
38	8.8227	8.9897	9.7696
39	6.5197	7.2362	9.7987
40	8.2076	8.4463	9.8278
41	7.0121	7.6119	9.8568
42	5.6409	7.3533	9.8859
43	6.5030	8.6760	9.9150
44	7.4515	9.8464	9.9441
45	13.9015	12.9715	9.9732

46	14.4636	15.9937	10.0023
47	16.2576	15.3746	10.0313
48	14.4636	13.1552	10.0604
49	7.1000	9.3164	10.0895
50	8.7879	9.1894	10.1186
51	7.7864	6.9902	10.1477
52	6.8197	8.2257	10.1768
53	7.7515	7.4022	10.2058
54	6.7318	7.1337	10.2349
55	7.8909	7.9414	10.2640
56	9.8424	9.6657	10.2931
57	11.1954	12.9159	10.3222
58	12.8833	16.3678	10.3513
59	14.6227	15.7830	10.3804
60	14.3424	13.7758	10.4094
61	9.2091	8.7623	10.4385
62	7.6636	8.8354	10.4676
63	7.2591	6.9900	10.4967
64	7.1364	8.1336	10.5258
65	7.4879	7.0904	10.5549
66	6.9606	7.0111	10.5839
67	8.4015	7.4475	10.6130
68	15.5197	9.5293	10.6421
69	11.0379	12.2674	10.6712
70	14.6939	15.6182	10.7003
71	15.4485	16.3244	10.7294
72	15.1848	13.9316	10.7584
73	8.5591	9.6084	10.7875
74	7.9273	8.5884	10.8166
75	7.2591	8.2150	10.8457
76	8.1545	7.5898	10.8748
77	7.7515	8.2749	10.9039
78	7.1530	6.6597	10.9329
79	8.1197	8.8852	10.9620
80	9.5970	10.4102	10.9911
81	15.4318	13.2603	11.0202
82	14.6939	14.5509	11.0493
83	15.1848	16.1730	11.0784
84	15.1848	14.5555	11.1075
85		9.5823	11.1365
86		8.5642	11.1656
87		8.0890	11.1947
88		7.9869	11.2238
89		8.3328	11.2529
90		7.2372	11.2820
91		8.8540	11.3110
92		11.3720	11.3401
93		13.5219	11.3692
94		15.2200	11.3983
95		16.1387	11.4274
96		15.0153	11.4565

PROJECTION COMPARISONS

FY 75 USE *** 106.660
FY 81 USE *** 125.017
CHANGE *** 17.2%

PROJECTED FY 81 USE *****	126.771	131.370
CHANGE FROM FY 75 *****	18.9%	23.2%
PROJECTED FY 82 USE *****	129.914	135.558
CHANGE FROM FY 75 *****	21.8%	27.1%

SUMMARY OF PROJECTIONS

NRMC CHARLESTON

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	21.9781	*******	21.8620
2	22.4605	*******	21.8728
3	20.8333	*******	21.8837
4	27.2193	*******	21.8946
5	20.4254	*******	21.9055
6	22.9452	*******	21.9164
7	23.3004	*******	21.9273
8	26.0987	*******	21.9382
9	27.7785	*******	21.9491
10	26.0746	*******	21.9600
11	32.2303	*******	21.9709
12	25.3114	*******	21.9818
13	27.9561	*******	21.9927
14	22.9693	24.6088	22.0036
15	20.5022	22.3177	22.0145
16	21.4430	25.4558	22.0254
17	18.3158	19.6902	22.0363
18	18.9254	20.8673	22.0471
19	19.8158	21.4614	22.0580
20	23.2237	23.8436	22.0689
21	23.5307	25.9810	22.0798
22	25.8706	24.6532	22.0907
23	24.6228	28.9829	22.1016
24	28.0329	25.2768	22.1125
25	21.4189	23.4732	22.1234
26	20.4781	19.6892	22.1343
27	19.9167	20.4706	22.1452
28	18.3399	21.4919	22.1561
29	18.2632	17.7805	22.1670
30	17.9846	17.7234	22.1779
31	20.7566	19.2124	22.1888
32	20.6294	21.9142	22.1996
33	24.9539	24.1866	22.2105
34	24.9298	24.6602	22.2214
35	25.8443	26.7564	22.2323
36	27.2939	25.4049	22.2432
37	21.5965	21.5914	22.2541
38	20.1711	19.9966	22.2650
39	22.0285	19.9498	22.2759
40	22.6908	21.5085	22.2868
41	16.7368	17.9696	22.2977
42	17.3224	17.8264	22.3086
43	18.3399	20.3403	22.3195
44	21.2412	21.9908	22.3304
45	26.9649	24.7585	22.3413
46	25.3860	23.9765	22.3522
47	25.9474	26.0388	22.3630
48	25.6162	26.1732	22.3739
49	22.1579	22.5927	22.3848
50	20.8596	21.0078	22.3957
51	21.8268	20.0181	22.4066
52	20.7829	20.7987	22.4175
53	16.2303	16.8700	22.4284
54	16.2281	18.3163	22.4393
55	16.3575	20.1262	22.4502
56	22.4123	21.3642	22.4611
57	23.3268	24.0654	22.4720

58	20.4013	22.1415	22.4829
59	25.6667	24.8582	22.4938
60	30.1184	25.5770	22.5047
61	22.4627	22.1876	22.5155
62	21.2675	19.2959	22.5264
63	19.3838	20.1687	22.5373
64	20.5285	20.4906	22.5482
65	18.3925	17.9279	22.5591
66	19.3596	17.5737	22.5700
67	22.2851	18.9889	22.5809
68	24.3947	21.7620	22.5918
69	22.4364	25.6346	22.6027
70	28.4145	24.5994	22.6136
71	26.8640	29.2552	22.6245
72	25.5658	27.2719	22.6354
73	25.6667	22.6971	22.6463
74	22.3092	20.9537	22.6572
75	22.0044	21.6018	22.6680
76	21.0373	22.8474	22.6789
77	19.0526	19.2687	22.6898
78	21.4956	19.1798	22.7007
79	23.4539	20.5284	22.7116
80	21.6732	23.6601	22.7225
81	23.5044	25.7638	22.7334
82	29.8136	27.3081	22.7443
83	25.8575	28.8799	22.7552
84	24.0132	26.8105	22.7661
85		22.9995	22.7770
86		21.4991	22.7879
87		21.7961	22.7988
88		21.8813	22.8097
89		18.1863	22.8206
90		18.7108	22.8315
91		20.8789	22.8423
92		23.1021	22.8532
93		24.9590	22.8641
94		26.4219	22.8750
95		26.3726	22.8859
96		26.1972	22.8968

PROJECTION COMPARISONS

FY 75 USE **** 296.655

FY 81 USE **** 279.881

CHANGE **** -5.7%

PROJECTED FY 81 USE ****	279.499	272.474
CHANGE FROM FY 75 ****	-5.8%	-8.2%
PROJECTED FY 82 USE ****	273.004	274.042
CHANGE FROM FY 75 ****	-8.0%	-7.6%

SUMMARY OF PROJECTIONS

NRMC CORPUS CHRISTI

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	36.3788	*******	32.2168
2	36.2045	37.8700	32.2591
3	36.2045	38.2275	32.3013
4	39.8068	37.3549	32.3436
5	38.7538	38.7194	32.3858
6	39.7197	38.3831	32.4281
7	30.7576	37.4367	32.4703
8	29.9204	31.8535	32.5126
9	27.5492	28.6919	32.5548
10	39.8523	28.8573	32.5971
11	32.4242	36.9095	32.6393
12	34.2273	37.0969	32.6815
13	34.2727	34.8457	32.7238
14	30.8864	35.3717	32.7661
15	31.6780	33.0694	32.8083
16	30.7576	32.7525	32.8505
17	31.1515	32.5878	32.8928
18	31.7651	32.7169	32.9350
19	26.2614	32.5895	32.9773
20	33.1288	29.7519	33.0195
21	32.2500	32.1336	33.0618
22	36.6894	35.0751	33.1040
23	35.7651	35.1679	33.1463
24	33.3939	35.1962	33.1885
25	31.2841	32.3439	33.2308
26	29.1288	29.4230	33.2730
27	27.9432	27.9816	33.3153
28	25.9659	27.3772	33.3575
29	27.2841	27.0355	33.3998
30	32.6439	28.4302	33.4420
31	33.6136	32.5888	33.4843
32	33.1288	35.6919	33.5265
33	31.6364	34.3624	33.5688
34	32.7348	32.4001	33.6110
35	35.7651	31.8336	33.6533
36	33.3030	33.4489	33.6955
37	30.8447	32.4619	33.7378
38	29.2197	29.6820	33.7800
39	27.9432	28.2155	33.8223
40	29.1288	27.6689	33.8645
41	28.1212	29.1612	33.9068
42	32.6439	30.1962	33.9490
43	32.0303	32.7742	33.9913
44	35.1932	33.6422	34.0335
45	31.9432	34.5626	34.0758
46	33.8750	33.1390	34.1180
47	39.5871	32.6689	34.1602
48	39.8068	36.0530	34.2025
49	32.4697	37.0626	34.2448
50	30.6704	31.5467	34.2870
51	25.9697	27.8819	34.3293
52	23.1136	26.0343	34.3715
53	20.7386	24.4888	34.4137
54	29.7149	24.8530	34.4560
55	39.0936	31.3780	34.4982
56	42.7489	41.0474	34.5405
57	48.4298	44.1671	34.5827

58	52.4213	45.6354	34.6250
59	51.3362	46.7455	34.6672
60	42.1532	43.4815	34.7095
61	39.5872	34.2959	34.7517
62	28.0851	29.7205	34.7940
63	22.5106	24.1976	34.8362
64	25.6681	20.7602	34.8785
65	22.8042	26.1307	34.9207
66	30.2085	30.9008	34.9630
67	30.3574	37.5025	35.0052
68	43.2894	40.9156	35.0475
69	47.5830	47.9237	35.0897
70	53.7532	52.3984	35.1320
71	45.5106	52.4958	35.1742
72	46.4000	44.2044	35.2165
73	35.8851	38.7386	35.2587
74	26.4596	31.0274	35.3010
75	23.7915	22.4789	35.3432
76	22.5574	21.6827	35.3855
77	24.1362	23.9412	35.4277
78	32.4809	28.6876	35.4700
79	36.2808	36.3794	35.5122
80	38.8468	42.8224	35.5545
81	43.8808	43.6910	35.5967
82	43.9830	45.0708	35.6389
83	45.8553	43.0186	35.6812
84	42.6000	41.7520	35.7234
85		37.6420	35.7657
86		32.0876	35.8080
87		28.0208	35.8502
88		25.7451	35.8924
89		26.0624	35.9347
90		29.0579	35.9769
91		33.2666	36.0192
92		37.7870	36.0614
93		41.9543	36.1037
94		44.1309	36.1459
95		44.4665	36.1882
96		42.2428	36.2304

PROJECTION COMPARISONS

FY 75 USE *** 421.799

FY 81 USE *** 416.757

CHANGE *** -1.2%

PROJECTED FY 81 USE ******	419.291	425.893
CHANGE FROM FY 75 ******	-0.6%	1.0%
PROJECTED FY 82 USE ******	422.464	431.977
CHANGE FROM FY 75 ******	0.2%	2.4%

SUMMARY OF PROJECTIONS

NRMC GREAT LAKES

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	8.9051	******	8.9791
2	8.1382	8.7687	9.0122
3	8.9051	8.6237	9.0452
4	9.1857	9.3918	9.0783
5	8.0841	8.6666	9.1113
6	9.1657	8.1988	9.1444
7	8.7410	9.2300	9.1774
8	9.6878	9.0374	9.2105
9	10.5087	11.1611	9.2435
10	10.7019	10.5413	9.2766
11	10.5179	11.1693	9.3096
12	10.5953	10.2898	9.3427
13	8.9534	9.6808	9.3757
14	7.4754	9.0685	9.4088
15	9.5620	8.8748	9.4418
16	8.3447	9.6659	9.4749
17	7.8618	8.4258	9.5079
18	9.0599	8.2519	9.5410
19	10.0067	8.9918	9.5741
20	9.5237	9.6407	9.6071
21	12.1116	11.0618	9.6402
22	10.1707	11.5053	9.6732
23	9.8709	10.9965	9.7063
24	10.0549	10.4767	9.7393
25	9.9101	9.1379	9.7724
26	10.6536	9.3405	9.8054
27	8.4996	10.2047	9.8385
28	9.5137	9.7311	9.8715
29	9.4388	9.2674	9.9046
30	9.1174	9.2443	9.9376
31	8.3930	9.8164	9.9707
32	9.7169	9.2782	10.0037
33	9.5812	11.3720	10.0368
34	10.0932	10.0333	10.0698
35	11.5229	10.6276	10.1029
36	9.8709	10.4478	10.1360
37	9.1082	9.4059	10.1690
38	8.6828	9.1111	10.2021
39	8.6728	9.1234	10.2351
40	9.4654	9.2963	10.2682
41	9.0017	8.9185	10.3012
42	8.2190	8.8830	10.3343
43	8.3106	9.0045	10.3673
44	9.3972	9.0380	10.4004
45	11.7835	10.6803	10.4334
46	12.9329	10.8517	10.4665
47	13.0778	12.0393	10.4995
48	14.2754	11.8526	10.5326
49	10.5665	12.0407	10.5656
50	9.0018	10.9244	10.5987
51	10.3637	10.6169	10.6317
52	10.3154	10.8313	10.6648
53	10.8756	10.2173	10.6978
54	9.6200	10.3706	10.7309
55	10.6341	10.3160	10.7640
56	10.0450	10.9790	10.7970
57	12.8942	11.9843	10.8301

58	12.8170	12.5518	10.8631
59	11.8221	12.7109	10.8962
60	10.9625	12.2814	10.9292
61	10.8853	10.4144	10.9623
62	10.8949	10.4538	10.9953
63	10.5858	10.7252	11.0284
64	9.6007	11.1225	11.0614
65	10.8853	10.0455	11.0945
66	8.5189	10.3776	11.1275
67	9.6200	9.7127	11.1606
68	9.9387	10.3633	11.1936
69	9.6972	11.5637	11.2267
70	10.6921	11.0036	11.2597
71	11.3392	10.9983	11.2928
72	10.7114	10.8868	11.3259
73	9.4365	9.6427	11.3589
74	10.5086	9.3336	11.3920
75	10.2359	10.0054	11.4250
76	11.9656	10.1738	11.4581
77	10.5134	10.8759	11.4911
78	10.2581	9.9280	11.5242
79	11.0010	10.8185	11.5572
80	11.4560	10.9344	11.5903
81	13.0640	12.7581	11.6233
82	13.9512	12.7941	11.6564
83	13.0086	13.6149	11.6894
84	12.3432	12.7839	11.7225
85		11.7292	11.7555
86		11.4740	11.7886
87		11.7168	11.8216
88		12.0119	11.8547
89		11.7710	11.8877
90		11.2263	11.9208
91		11.7983	11.9539
92		12.0538	11.9869
93		13.5296	12.0200
94		13.7003	12.0530
95		13.7738	12.0861
96		13.3748	12.1191

PROJECTION COMPARISONS

FY 75 USE **** 113.136

FY 81 USE **** 137.742

CHANGE **** 21.7%

PROJECTED FY 81 USE *******	133.663	138.488
CHANGE FROM FY 75 *******	18.1%	22.4%
PROJECTED FY 82 USE *******	148.160	143.248
CHANGE FROM FY 75 *******	31.0%	26.6%

SUMMARY OF PROJECTIONS

NRMC JACKSONVILLE

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	26.8739	*******	25.9717
2	24.4575	24.7423	25.9161
3	21.3284	24.0219	25.8605
4	21.2258	24.3904	25.8050
5	22.2815	20.3949	25.7494
6	24.6628	20.6501	25.6939
7	27.6891	26.4446	25.6383
8	31.0909	25.8184	25.5827
9	30.5454	28.5312	25.5272
10	27.1789	28.3360	25.4716
11	25.4428	26.3663	25.4161
12	27.3842	26.0948	25.3605
13	27.4839	26.0260	25.3049
14	25.1730	26.2543	25.2494
15	22.4839	25.6716	25.1938
16	22.0410	22.6317	25.1382
17	20.7507	24.4831	25.0827
18	24.1847	24.7292	25.0271
19	23.4721	22.0177	24.9716
20	21.8710	26.2326	24.9160
21	29.9355	24.1446	24.8604
22	26.9736	24.8000	24.8049
23	30.3431	27.3609	24.7493
24	30.0352	27.8083	24.6938
25	27.2463	28.1939	24.6382
26	29.0146	26.9647	24.5826
27	24.9677	25.8100	24.5271
28	25.1730	26.8147	24.4715
29	17.3812	22.7333	24.4160
30	19.2522	21.2239	24.3604
31	27.6891	21.3546	24.3048
32	29.3900	20.1258	24.2493
33	27.9941	29.5590	24.1937
34	27.2815	29.5502	24.1381
35	29.1525	28.2209	24.0826
36	28.5044	27.3374	24.0270
37	26.2610	26.7397	23.9715
38	25.5132	27.9201	23.9159
39	24.9677	25.9503	23.8603
40	22.1114	24.1404	23.8048
41	22.6539	23.2059	23.7492
42	24.1173	23.2003	23.6936
43	23.6422	25.9301	23.6381
44	39.0499	29.7497	23.5825
45	20.5454	26.8240	23.5270
46	22.8592	27.8661	23.4714
47	22.7918	23.5148	23.4158
48	20.1026	22.2983	23.3603
49	20.0352	22.5733	23.3047
50	15.3754	20.6052	23.2492
51	16.3636	20.1814	23.1936
52	19.5249	18.6797	23.1380
53	16.4985	20.5025	23.0825
54	17.8944	21.2804	23.0269
55	19.4252	17.9201	22.9714
56	17.3138	21.4627	22.9158
57	18.4047	18.8810	22.8602
58	20.6833	18.8595	22.8047

59	20.3754	20.5806	22.7491
60	19.3548	20.7276	22.6936
61	21.2962	20.4028	22.6380
62	19.2551	19.9695	22.5824
63	18.4721	19.9743	22.5269
64	20.4106	21.1031	22.4713
65	17.6539	18.6569	22.4157
66	17.3184	18.7593	22.3602
67	18.9057	21.1704	22.3046
68	21.1486	16.6982	22.2491
69	25.1981	21.6785	22.1935
70	25.4976	24.5423	22.1379
71	24.4575	24.6679	22.0824
72	25.6627	24.4178	22.0268
73	22.4622	24.9124	21.9713
74	20.2995	23.9606	21.9157
75	19.0141	21.9466	21.8601
76	18.5212	19.7842	21.8046
77	15.9222	20.4128	21.7490
78	20.2995	19.4129	21.6935
79	19.9174	17.6951	21.6379
80	20.7641	24.0136	21.5823
81	31.5990	22.3976	21.5268
82	20.1368	23.9293	21.4712
83	27.3868	25.1257	21.4156
84	24.6509	24.0807	21.3601
85		22.5015	21.3045
86		21.5890	21.2490
87		20.8942	21.1934
88		21.1246	21.1378
89		19.3083	21.0823
90		21.3503	21.0267
91		22.7005	20.9711
92		19.0189	20.9156
93		24.7058	20.8600
94		20.3671	20.8045
95		23.3292	20.7489
96		21.9963	20.6933

PROJECTION COMPARISONS

FY 75 USE **** 310.161

FY 81 USE **** 260.974

CHANGE **** -15.9%

PROJECTED FY 81 USE ******	267.671	259.988
CHANGE FROM FY 75 ******	-13.7%	-16.2%
PROJECTED FY 82 USE ******	258.885	251.987
CHANGE FROM FY 75 ******	-16.5%	-18.8%

SUMMARY OF PROJECTIONS

NRMC LONG BEACH

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	40.4624	********	37.6493
2	37.2488	38.0135	37.6097
3	37.0892	35.5878	37.5702
4	36.9507	36.5989	37.5306
5	35.0986	36.0857	37.4911
6	36.8967	33.8563	37.4515
7	38.2300	37.6221	37.4120
8	40.1643	38.7144	37.3724
9	37.8498	38.0372	37.3329
10	48.7958	45.0602	37.2933
11	41.9343	43.6900	37.2538
12	44.1667	46.5558	37.2142
13	41.9601	43.6946	37.1747
14	44.4930	41.6203	37.1351
15	37.1408	39.0935	37.0956
16	38.3662	39.0575	37.0560
17	36.2418	38.0477	37.0164
18	36.1056	37.3597	36.9769
19	39.5094	38.1417	36.9373
20	33.9812	39.0803	36.8978
21	37.4131	37.8889	36.8582
22	40.7887	43.1346	36.8187
23	36.5962	40.4101	36.7791
24	40.8451	41.0004	36.7396
25	37.1948	38.6542	36.7000
26	36.4061	37.0446	36.6605
27	34.1878	32.4733	36.6209
28	32.5117	34.0863	36.5814
29	36.1338	33.0370	36.5418
30	30.1690	31.7689	36.5023
31	31.0141	35.2738	36.4627
32	33.3826	33.1652	36.4232
33	35.8873	33.3167	36.3836
34	36.4319	40.0220	36.3441
35	35.2887	35.0612	36.3045
36	39.1549	38.3702	36.2650
37	37.3052	37.6448	36.2254
38	34.4178	34.1890	36.1858
39	31.5869	31.5814	36.1463
40	32.8122	33.2914	36.1067
41	30.0329	31.8708	36.0672
42	31.7488	29.2835	36.0276
43	32.3474	32.7377	35.9881
44	32.4836	32.8206	35.9485
45	35.5352	32.2218	35.9090
46	36.4319	39.3312	35.8694
47	38.2300	36.1415	35.8299
48	38.2300	38.3872	35.7903
49	41.9061	38.1451	35.7508
50	32.8662	36.1367	35.7112
51	28.1901	33.0488	35.6717
52	31.3967	32.3813	35.6321
53	30.7699	31.6447	35.5926
54	29.4084	28.9929	35.5530
55	30.3897	30.0507	35.5134
56	31.7512	31.4059	35.4739
57	32.6761	32.2128	35.4343

58	39.0469	36.1987	35.3948
59	34.3638	35.4524	35.3552
60	36.1560	38.3062	35.3157
61	36.0504	36.0367	35.2761
62	28.9472	33.6730	35.2366
63	29.5596	29.1219	35.1970
64	29.0803	28.6528	35.1575
65	31.5803	29.2195	35.1179
66	29.2385	27.4178	35.0784
67	29.3716	29.9650	35.0388
68	31.3670	31.0681	34.9993
69	28.7339	31.9926	34.9597
70	36.2110	36.0003	34.9202
71	36.0504	32.9998	34.8806
72	40.8394	36.6131	34.8411
73	36.4220	36.1711	34.8015
74	34.6927	33.0958	34.7619
75	33.6835	31.8573	34.7224
76	33.5504	33.5884	34.6828
77	32.4862	32.8530	34.6433
78	30.9151	31.7605	34.6037
79	34.0023	33.7153	34.5642
80	33.4174	33.6453	34.5246
81	37.1147	33.8618	34.4851
82	42.3830	39.9810	34.4455
83	38.4725	38.9226	34.4060
84	41.0000	41.5720	34.3664
85		40.6142	34.3269
86		37.5592	34.2873
87		34.5403	34.2478
88		35.1914	34.2082
89		35.3649	34.1687
90		33.5681	34.1291
91		35.2408	34.0896
92		35.9436	34.0500
93		36.7558	34.0105
94		41.7828	33.9709
95		39.5677	33.9314
96		42.3875	33.8918

PROJECTION COMPARISONS

FY 75 USE *** 474.886

FY 81 USE *** 428.139

CHANGE *** -9.8%

PROJECTED FY 81 USE ******	421.024	415.007
CHANGE FROM FY 75 ******	-11.3%	-12.6%
PROJECTED FY 82 USE ******	448.516	409.312
CHANGE FROM FY 75 ******	-5.6%	-13.8%

SUMMARY OF PROJECTIONS

NRMC MEMPHIS

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	21.8025	*******	24.5450
2	20.3333	*******	24.6465
3	19.7253	*******	24.7480
4	20.8364	*******	24.8496
5	23.4506	*******	24.9511
6	24.0586	*******	25.0526
7	24.7037	*******	25.1541
8	19.5123	*******	25.2557
9	23.4136	*******	25.3572
10	26.5278	*******	25.4587
11	28.9259	*******	25.5602
12	23.9876	*******	25.6618
13	28.5339	*******	25.7633
14	22.9136	21.7136	25.8648
15	23.8086	23.5313	25.9664
16	23.9876	22.9053	26.0679
17	24.7037	23.4844	26.1694
18	25.3117	25.8451	26.2709
19	27.6018	26.7902	26.3725
20	23.9136	26.9769	26.4740
21	23.8426	25.9711	26.5755
22	28.8920	26.1474	26.6770
23	27.9259	28.9303	26.7785
24	28.0679	25.8380	26.8801
25	21.2654	24.6037	26.9816
26	21.9444	21.9112	27.0831
27	23.7346	20.2692	27.1846
28	20.9784	22.1230	27.2862
29	22.8395	24.1591	27.3877
30	27.3518	24.3810	27.4892
31	29.2130	25.9518	27.5907
32	35.6234	27.2219	27.6923
33	36.6234	30.7608	27.7938
34	39.5957	36.4210	27.8953
35	40.9938	38.9407	27.9968
36	37.6265	34.1998	28.0984
37	36.8765	34.1737	28.1999
38	23.9506	31.9388	28.3014
39	26.9228	29.3098	28.4029
40	24.6296	25.3098	28.5045
41	25.2407	26.8528	28.6060
42	31.1481	28.6266	28.7075
43	30.6821	30.7580	28.8091
44	34.2623	30.8344	28.9106
45	32.4352	31.9740	29.0121
46	34.5123	35.9639	29.1136
47	39.8457	36.2076	29.2151
48	39.5247	33.2098	29.3167
49	28.2839	34.7122	29.4182
50	26.6358	31.3243	29.5197
51	27.1728	26.9432	29.6212
52	24.8827	25.8548	29.7228
53	23.5216	28.1218	29.8243
54	30.1821	29.1669	29.9258
55	27.3889	29.8830	30.0273
56	29.9660	31.1818	30.1289
57	32.9753	30.7665	30.2304

58	31.0062	34.6068	30.3319
59	34.5864	36.1641	30.4334
60	24.6055	31.1292	30.5350
61	29.8616	27.6323	30.6365
62	29.5813	22.1535	30.7380
63	27.7370	27.7663	30.8395
64	28.9792	29.0495	30.9411
65	28.6574	28.5062	31.0426
66	27.7751	31.2608	31.1441
67	30.5052	30.8973	31.2456
68	33.5952	30.9160	31.3472
69	30.4256	32.4075	31.4487
70	34.1176	35.4814	31.5502
71	33.5952	36.4136	31.6517
72	35.9239	32.6384	31.7533
73	25.4879	29.5992	31.8548
74	33.5952	26.1561	31.9563
75	23.0381	27.5700	32.0578
76	30.8270	27.9987	32.1594
77	30.1453	26.5764	32.2609
78	31.3495	32.8649	32.3624
79	31.9896	33.1259	32.4639
80	37.0865	33.0467	32.5655
81	32.9931	34.5246	32.6670
82	36.8477	37.1041	32.7685
83	36.2837	38.2969	32.8700
84	35.0796	33.5125	32.9716
85		31.5179	33.0731
86		29.7048	33.1746
87		29.4005	33.2761
88		28.9877	33.3777
89		29.2190	33.4792
90		31.9342	33.5807
91		32.6365	33.6822
92		34.7039	33.7838
93		34.3345	33.8853
94		36.4759	33.9868
95		38.2480	34.0883
96		35.5722	34.1899

PROJECTION COMPARISONS

FY 75 USE **** 277.277

FY 81 USE **** 384.723

CHANGE **** 38.8%

PROJECTED FY 81 USE *****	380.376	388.958
CHANGE FROM FY 75 *****	37.2%	40.3%
PROJECTED FY 82 USE *****	392.735	403.578
CHANGE FROM FY 75 *****	41.6%	45.6%

SUMMARY OF PROJECTIONS

NRMC OAKLAND

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	16.3113	*******	17.6000
2	16.2986	*******	17.6321
3	16.2986	*******	17.6643
4	17.1008	*******	17.6964
5	15.0252	*******	17.7286
6	14.5668	*******	17.7607
7	14.3758	*******	17.7929
8	16.9480	*******	17.8250
9	16.2731	*******	17.8572
10	18.0812	*******	17.8893
11	16.3495	*******	17.9215
12	15.1271	*******	17.9536
13	15.1271	*******	17.9858
14	21.1881	17.3317	18.0179
15	19.1126	16.2168	18.0501
16	18.5524	16.9611	18.0822
17	18.0812	16.7291	18.1144
18	18.5396	17.5027	18.1465
19	18.5778	17.9669	18.1787
20	19.2527	18.4515	18.2108
21	17.9411	17.9945	18.2430
22	17.7756	19.8961	18.2751
23	19.4309	19.3192	18.3073
24	18.9089	17.1880	18.3395
25	19.0871	18.2008	18.3716
26	18.9725	20.0867	18.4038
27	19.0235	16.8067	18.4359
28	15.5218	18.2039	18.4681
29	17.4191	16.5759	18.5002
30	20.0676	17.2913	18.5324
31	19.2527	18.9022	18.5645
32	17.8266	19.7560	18.5967
33	17.8138	17.7050	18.6288
34	21.1499	19.7995	18.6610
35	21.3664	20.7525	18.6931
36	18.0939	18.6539	18.7253
37	18.3613	18.5938	18.7574
38	20.7552	20.3614	18.7896
39	16.6678	18.2390	18.8217
40	18.0812	18.1880	18.8539
41	17.8266	17.2402	18.8860
42	17.1772	18.5837	18.9182
43	20.3987	18.9817	18.9503
44	18.2977	18.8576	18.9825
45	19.8257	18.9013	19.0146
46	23.1873	21.0648	19.0468
47	21.5956	20.7630	19.0789
48	20.9971	20.4173	19.1111
49	21.1754	19.7958	19.1432
50	19.3036	21.1049	19.1754
51	16.8079	19.9595	19.2076
52	17.3172	17.4234	19.2397
53	15.0762	17.1992	19.2719
54	20.9971	19.5800	19.3040
55	19.2527	18.8602	19.3362
56	18.4250	19.4405	19.3683
57	21.7611	20.2433	19.4005

58	20.0803	20.3417	19.4326
59	22.2195	21.8951	19.4648
60	21.2900	20.5582	19.4969
61	20.4428	18.6062	19.5291
62	20.7285	22.9356	19.5612
63	18.8407	19.1283	19.5934
64	19.8467	17.3645	19.6255
65	21.5730	20.2856	19.6577
66	18.9276	20.8131	19.6898
67	19.1636	19.5530	19.7220
68	20.2317	20.8500	19.7541
69	18.4060	19.6846	19.7863
70	19.6852	21.3778	19.8184
71	24.0569	22.1702	19.8506
72	17.4000	19.8105	19.8827
73	20.2565	20.2411	19.9149
74	18.7786	21.3974	19.9470
75	19.5983	17.0698	19.9792
76	18.8531	19.9234	20.0113
77	18.5426	18.5450	20.0435
78	19.3499	19.2441	20.0757
79	18.9525	20.7885	20.1078
80	20.2938	19.1682	20.1400
81	16.8163	19.7187	20.1721
82	20.5546	21.5441	20.2043
83	19.2629	20.9062	20.2364
84	20.4552	18.7461	20.2686
85		20.9411	20.3007
86		20.0963	20.3329
87		18.8915	20.3650
88		19.3262	20.3972
89		17.9989	20.4293
90		20.0712	20.4615
91		19.9775	20.4936
92		19.1778	20.5258
93		20.2595	20.5579
94		21.0886	20.5901
95		21.7286	20.6222
96		20.6440	20.6544

PROJECTION COMPARISONS

FY 75 USE	****	192.755	
FY 81 USE	****	231.714	
CHANGE	****	20.2%	
PROJECTED FY81 USE	****	237.292	241.101
CHANGE FROM FY 75	****	23.1%	25.1%
PROJECTED FY 82 USE	****	240.201	245.730
CHANGE FROM FY 75	****	24.6%	27.5%

SUMMARY OF PROJECTIONS

NRMC ORLANDO

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	26.9198	*******	17.9708
2	18.7122	20.4879	18.1796
3	14.5519	16.4957	18.3884
4	14.6085	15.1286	18.5973
5	16.0849	15.9250	18.8061
6	15.5377	15.8549	19.0149
7	17.3962	18.9352	19.2237
8	19.4245	19.3330	19.4326
9	22.4858	21.1864	19.6414
10	25.7170	25.1207	19.8502
11	25.3302	26.0730	20.0590
12	26.8113	27.2828	20.2679
13	24.5094	26.4921	20.4767
14	23.0330	18.7565	20.6855
15	15.8679	17.9819	20.8943
16	19.5849	16.7518	21.1032
17	17.1792	19.1236	21.3120
18	17.3962	16.7188	21.5208
19	26.9198	20.2695	21.7296
20	25.6038	23.4166	21.9385
21	26.4245	28.1669	22.1473
22	30.6934	27.3551	22.3561
23	33.3773	29.4803	22.5650
24	36.6038	31.8404	22.7738
25	33.3302	33.1696	22.9826
26	23.2547	27.3194	23.1914
27	20.6273	20.6988	23.4003
28	18.5519	21.1338	23.6091
29	17.8915	21.2193	23.8179
30	15.6462	18.8302	24.0267
31	22.8679	24.7551	24.2356
32	22.1604	23.9682	24.4444
33	26.4811	25.9212	24.6532
34	30.4198	29.5925	24.8620
35	29.6557	32.2964	25.0709
36	33.9764	32.9594	25.2797
37	30.6934	31.3585	25.4885
38	24.4575	24.2681	25.6973
39	20.9009	21.5738	25.9062
40	18.2170	20.1627	26.1150
41	19.5330	19.4520	26.3238
42	16.1934	17.5801	26.5326
43	16.5755	24.3317	26.7415
44	23.9104	19.8190	26.9503
45	32.6651	25.6726	27.1591
46	33.1557	32.9608	27.3680
47	34.1981	33.6451	27.5768
48	36.6038	34.2117	27.7856
49	31.1321	33.3748	27.9944
50	25.2783	25.3921	28.2032
51	29.0000	22.5314	28.4121
52	20.5755	23.2939	28.6209
53	19.2594	23.3960	28.8297
54	18.0000	17.2686	29.0386
55	18.8679	20.9572	29.2474
56	32.0755	24.6047	29.4562
57	30.1509	34.2234	29.6650

58	30.8066	33.4291	29.8739
59	34.8019	32.6800	30.0827
60	35.1273	35.1836	30.2915
61	32.1179	33.6738	30.5003
62	29.0000	25.4636	30.7092
63	25.3349	29.2618	30.9180
64	16.8538	21.1040	31.1268
65	21.1226	19.6816	31.3356
66	18.2217	17.7539	31.5445
67	23.3632	22.2578	31.7533
68	25.8255	29.5962	31.9621
69	29.2736	30.1809	32.1709
70	32.5566	29.5342	32.3798
71	35.7311	34.9149	32.5886
72	33.7075	36.0256	32.7974
73	40.8726	31.8256	33.0063
74	43.5000	31.2841	33.2151
75	28.3443	35.8436	33.4239
76	30.5849	23.5215	33.6327
77	29.6038	26.5284	33.8416
78	36.9340	25.6466	34.0504
79	44.3773	34.8895	34.2592
80	36.1698	40.0963	34.4680
81	39.6698	40.6823	34.6768
82	30.5849	37.5106	34.8857
83	48.6981	39.6830	35.0945
84	36.3868	42.2706	35.3033
85		44.2338	35.5122
86		42.7805	35.7210
87		33.8866	35.9298
88		34.2675	36.1386
89		32.9387	36.3475
90		37.5728	36.5563
91		41.4543	36.7651
92		40.1612	36.9739
93		41.6831	37.1828
94		38.8001	37.3916
95		48.4722	37.6004
96		42.6358	37.8092

PROJECTION COMPARISONS

FY 75 USE **** 243.580

FY 81 USE **** 445.726

CHANGE **** 83.0%

PROJECTED FY 81 USE ******	409.782	409.857
CHANGE FROM FY 75 ******	68.2%	68.3%
PROJECTED FY 82 USE ******	478.886	439.928
CHANGE FROM FY 75 ******	96.6%	80.6%

SUMMARY OF PROJECTIONS

NRMC PHILADELPHIA

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	8.1567	*******	10.3036
2	8.5236	*******	10.3099
3	8.4107	*******	10.3163
4	7.6910	*******	10.3226
5	8.1567	*******	10.3289
6	8.6647	*******	10.3352
7	7.8603	*******	10.3415
8	10.8662	*******	10.3478
9	12.6584	*******	10.3541
10	16.2146	*******	10.3604
11	16.5250	*******	10.3667
12	11.9810	*******	10.3730
13	10.7674	9.9182	10.3793
14	9.9207	9.5628	10.3856
15	9.6808	8.9978	10.3919
16	8.4248	8.7888	10.3982
17	8.7917	8.9535	10.4045
18	9.0740	8.5402	10.4108
19	10.4146	8.9765	10.4171
20	10.1888	9.9617	10.4234
21	14.8740	12.8080	10.4298
22	14.5353	15.4982	10.4361
23	15.0997	15.7655	10.4424
24	13.2088	12.9978	10.4487
25	9.4363	9.2248	10.4550
26	9.6316	9.3822	10.4613
27	8.3394	8.7724	10.4676
28	8.2342	8.5085	10.4739
29	9.3611	8.4910	10.4802
30	8.3995	8.3162	10.4865
31	9.1808	8.9095	10.4928
32	10.5632	10.0872	10.4991
33	13.5233	12.5613	10.5054
34	14.9658	15.4924	10.5117
35	15.3264	15.6001	10.5180
36	12.5767	12.7105	10.5243
37	8.4295	9.4492	10.5306
38	9.3611	9.3933	10.5369
39	7.8886	8.5431	10.5433
40	7.6031	8.1682	10.5496
41	8.1290	8.2451	10.5559
42	8.8843	8.1362	10.5622
43	9.1361	8.7026	10.5685
44	9.7836	9.9600	10.5748
45	14.7832	12.8906	10.5811
46	13.9200	15.1354	10.5874
47	18.1463	15.6698	10.5937
48	13.8660	12.6537	10.6000
49	9.8195	10.0186	10.6063
50	10.8267	10.1936	10.6126
51	9.3879	9.2149	10.6189
52	9.6577	8.8508	10.6252
53	8.9383	9.0810	10.6315
54	7.4456	9.0059	10.6378
55	9.6037	9.3989	10.6441
56	9.9814	9.9332	10.6504
57	11.0065	12.8918	10.6568

58	13.6143	15.0966	10.6631
59	13.7401	14.7708	10.6694
60	12.4093	11.9375	10.6757
61	9.2081	8.4455	10.6820
62	9.3339	8.9592	10.6883
63	8.4707	8.4426	10.6946
64	8.9383	8.2185	10.7009
65	8.3988	8.5709	10.7072
66	8.1650	8.7137	10.7135
67	8.8663	9.1561	10.7198
68	9.3699	9.9614	10.7261
69	10.7367	13.0820	10.7324
70	16.2939	14.6823	10.7387
71	14.8552	14.8831	10.7450
72	13.7941	12.6842	10.7513
73	9.2980	9.1958	10.7576
74	8.1650	9.8330	10.7639
75	9.2620	8.9018	10.7703
76	8.4527	8.1612	10.7766
77	8.9563	8.5037	10.7829
78	8.0211	8.3304	10.7892
79	7.0319	9.2453	10.7955
80	8.9203	10.0393	10.8018
81	12.8589	12.2763	10.8081
82	16.1680	14.0184	10.8144
83	12.8769	14.9681	10.8207
84	11.7798	13.0949	10.8270
85		9.0106	10.8333
86		9.0094	10.8396
87		8.2751	10.8459
88		8.2393	10.8522
89		8.3859	10.8585
90		8.1628	10.8648
91		8.9487	10.8711
92		9.8097	10.8774
93		12.4318	10.8838
94		14.9380	10.8901
95		15.2020	10.8964
96		12.9014	10.9027

PROJECTION COMPARISONS

FY 75 USE **** 125.709

FY 81 USE **** 121.791

CHANGE **** -3.1%

PROJECTED FY 81 USE *****	126.568	129.508
CHANGE FROM FY 75 *****	0.7%	3.0%
PROJECTED FY 82 USE *****	125.315	130.416
CHANGE FROM FY 75 *****	-0.3%	3.7%

SUMMARY OF PROJECTIONS

NRMC PORTSMOUTH

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	18.0563	16.7895	16.7949
2	14.5347	14.6170	16.8117
3	11.5787	13.5766	16.8286
4	12.0375	12.4636	16.8455
5	13.8304	13.6492	16.8624
6	12.4857	13.0947	16.8793
7	11.3332	14.6848	16.8962
8	18.5685	15.9539	16.9130
9	21.6419	23.2986	16.9299
10	25.5477	24.6729	16.9468
11	24.2031	24.8403	16.9637
12	22.9866	24.1545	16.9806
13	17.2879	16.3513	16.9975
14	16.4556	15.0267	17.0143
15	13.8304	13.1449	17.0312
16	12.8059	12.8954	17.0481
17	13.1901	13.4329	17.0650
18	13.9584	12.8593	17.0819
19	15.0469	13.9702	17.0988
20	15.6232	16.9214	17.1156
21	22.4103	22.6417	17.1325
22	23.3067	24.3003	17.1494
23	22.9866	25.1748	17.1663
24	22.3463	23.2602	17.1832
25	16.1994	17.0588	17.2001
26	14.0865	15.0520	17.2169
27	12.3577	13.3323	17.2338
28	12.5498	12.7052	17.2507
29	12.9339	13.6898	17.2676
30	14.3106	13.1207	17.2845
31	15.4951	14.2706	17.3014
32	17.8642	16.7364	17.3183
33	21.7700	22.6978	17.3351
34	25.9319	24.1133	17.3520
35	25.2916	24.5278	17.3689
36	24.4379	23.5876	17.3858
37	15.3030	16.5825	17.4027
38	16.2635	14.8367	17.4196
39	14.3426	12.8708	17.4364
40	13.1260	13.2158	17.4533
41	14.8548	13.1674	17.4702
42	13.6383	13.4832	17.4871
43	14.0224	14.4193	17.5040
44	15.3030	16.5818	17.5209
45	23.2427	22.4370	17.5378
46	24.9074	24.5214	17.5546
47	26.2521	25.0380	17.5715
48	26.8390	23.3701	17.5884
49	16.5836	16.9222	17.6053
50	16.7757	14.9570	17.6222
51	13.5102	13.1123	17.6391
52	14.0865	12.9941	17.6559
53	13.6596	13.5010	17.6728
54	12.2296	13.6023	17.6897
55	14.5987	13.9895	17.7066
56	17.2879	16.5872	17.7235
57	21.1937	22.7992	17.7404

58	22.2182	24.4671	17.7572
59	23.3707	24.7041	17.7741
60	24.8434	24.1197	17.7910
61	16.1354	16.7643	17.8079
62	15.3030	15.6085	17.8248
63	13.1901	13.2315	17.8417
64	12.6138	13.1908	17.8585
65	14.9189	13.6501	17.8754
66	12.1656	13.3144	17.8923
67	13.3822	14.4553	17.9092
68	15.9433	16.3183	17.9261
69	21.3218	22.5081	17.9430
70	24.3312	23.9995	17.9598
71	28.4291	24.7775	17.9767
72	23.2808	24.5819	17.9936
73	16.2481	16.5473	18.0105
74	12.1254	14.7883	18.0274
75	14.6111	13.5270	18.0443
76	12.9136	12.6718	18.0611
77	12.7317	14.7138	18.0780
78	12.1861	12.3865	18.0949
79	16.1874	14.4567	18.1118
80	15.2780	16.5482	18.1287
81	26.5547	22.3488	18.1456
82	24.8571	23.9476	18.1624
83	23.2808	26.0551	18.1793
84	20.6739	22.9899	18.1962
85		16.4451	18.2131
86		14.6189	18.2300
87		14.1712	18.2469
88		12.7650	18.2637
89		13.9838	18.2806
90		12.6326	18.2975
91		14.7822	18.3144
92		16.1121	18.3313
93		23.1043	18.3482
94		24.1303	18.3651
95		25.0319	18.3819
96		23.2605	18.3988

PROJECTION COMPARISONS

FY 75 USE **** 206.804

FY 81 USE **** 207.648

CHANGE **** 0.4%

PROJECTED FY 81 USE *****	210.981	217.240
CHANGE FROM FY 75 *****	2.0%	5.0%
PROJECTED FY 82 USE *****	211.038	219.671
CHANGE FROM FY 75 *****	2.0%	6.2%

SUMMARY OF PROJECTIONS

NRMC SAN DIEGO

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	12.0453	*********	10.2508
2	11.4203	*********	10.2624
3	8.2208	*********	10.2741
4	8.6009	*********	10.2857
5	10.5080	*********	10.2974
6	8.2144	*********	10.3090
7	10.0831	*********	10.3207
8	9.9771	*********	10.3323
9	10.7683	*********	10.3440
10	10.9679	*********	10.3557
11	11.9191	*********	10.3673
12	11.9255	*********	10.3790
13	11.1410	11.5565	10.3906
14	10.6152	10.9347	10.4023
15	10.5092	9.1523	10.4139
16	9.8704	9.4878	10.4256
17	11.4071	10.9700	10.4372
18	8.7328	8.4528	10.4489
19	10.1164	10.4610	10.4605
20	9.9037	9.8235	10.4722
21	11.1806	10.8797	10.4838
22	11.2873	11.4044	10.4955
23	11.3933	11.4577	10.5071
24	11.0745	11.9299	10.5188
25	10.3360	11.4408	10.5304
26	10.5424	10.6648	10.5421
27	10.8758	9.5787	10.5537
28	10.3799	9.6876	10.5654
29	11.8833	10.9771	10.5771
30	10.1282	8.6903	10.5887
31	10.5984	10.5720	10.6004
32	10.7259	9.7821	10.6120
33	11.1038	11.1323	10.6237
34	11.1587	11.3432	10.6353
35	12.1031	11.2913	10.6470
36	12.4573	11.9968	10.6586
37	11.5685	11.1946	10.6703
38	11.4030	10.6188	10.6819
39	10.5373	10.4148	10.6936
40	10.2307	9.7223	10.7052
41	10.8046	11.2754	10.7169
42	9.2469	9.2029	10.7285
43	10.5373	10.1702	10.7402
44	10.8046	10.3715	10.7518
45	11.2849	11.1724	10.7635
46	10.5217	11.0698	10.7752
47	12.2212	11.6911	10.7868
48	12.2374	11.9619	10.7985
49	10.6947	11.1265	10.8101
50	11.7571	10.7259	10.8218
51	10.7422	10.7861	10.8334
52	10.5061	10.1292	10.8451
53	10.3955	11.1234	10.8567
54	10.2700	9.4489	10.8684
55	10.4586	10.5080	10.8800
56	10.5156	10.5479	10.8917
57	11.6391	11.0819	10.9033

58	11.1357	11.1290	10.9150
59	11.6316	11.9693	10.9266
60	11.6472	11.8467	10.9383
61	13.0163	11.0075	10.9499
62	11.2062	11.6987	10.9616
63	11.2693	10.5566	10.9732
64	10.5929	10.3357	10.9849
65	11.0570	11.3264	10.9966
66	10.8127	9.4614	11.0082
67	10.3331	10.8308	11.0199
68	10.8914	10.6940	11.0315
69	10.4511	11.0484	11.0432
70	10.6791	11.1235	11.0548
71	11.8914	11.7526	11.0665
72	12.7802	11.9838	11.0781
73	11.1594	11.9210	11.0898
74	11.2381	11.0422	11.1014
75	11.9227	11.0532	11.1131
76	11.3799	11.0082	11.1247
77	10.3881	10.6627	11.1364
78	10.7028	10.2466	11.1480
79	10.9627	10.7195	11.1597
80	10.3487	10.7212	11.1713
81	10.7815	11.0016	11.1830
82	12.8589	10.8826	11.1947
83	12.3005	12.3402	11.2063
84	12.3080	12.1652	11.2180
85		11.5324	11.2296
86		11.6437	11.2413
87		11.3239	11.2529
88		10.8928	11.2646
89		10.7836	11.2762
90		10.5658	11.2879
91		10.6436	11.2995
92		10.7411	11.3112
93		10.8590	11.3228
94		11.5163	11.3345
95		12.0529	11.3461
96		12.3352	11.3578

PROJECTION COMPARISONS

FY 75 USE **** 124.651

FY 81 USE **** 136.351

CHANGE **** 9.4%

PROJECTED FY 81 USE	******	133.765	133.846
CHANGE FROM FY 75	******	7.3%	7.4%
PROJECTED FY 82 USE	******	134.890	135.524
CHANGE FROM FY 75	******	8.2%	8.7%

SUMMARY OF PROJECTIONS

NRMC STUDY GROUP

MONTH	ACTUAL MBTU/KSF	TIME SERIES MBTU/KSF	TREND MBTU/KSF
1	16.0855	*******	15.7327
2	15.0318	15.0518	15.7587
3	13.5591	14.1348	15.7847
4	14.4436	13.9621	15.8107
5	14.2591	13.9564	15.8368
6	14.1153	14.0939	15.8628
7	14.3101	15.0449	15.8888
8	16.1351	15.6392	15.9148
9	17.3502	18.2575	15.9408
10	19.7231	18.8657	15.9669
11	19.4111	19.9734	15.9929
12	17.7595	18.6120	16.0189
13	16.7473	16.0433	16.0449
14	16.1953	15.4341	16.0710
15	14.9899	14.5391	16.0970
16	14.5984	14.7411	16.1230
17	14.5148	14.3782	16.1490
18	14.5214	14.5961	16.1750
19	15.5964	15.3567	16.2011
20	15.6172	16.4616	16.2271
21	18.2138	18.2543	16.2531
22	18.8085	19.7019	16.2791
23	18.7384	19.7885	16.3051
24	18.6712	18.6109	16.3312
25	16.2065	16.5114	16.3572
26	15.5170	15.4774	16.3832
27	14.7072	14.5680	16.4092
28	14.0230	14.6304	16.4353
29	14.5855	14.1876	16.4613
30	14.6307	14.5491	16.4873
31	15.7764	15.3189	16.5133
32	16.7574	16.3359	16.5394
33	18.2900	18.5741	16.5654
34	20.0127	19.5941	16.5914
35	20.4480	20.1649	16.6174
36	19.6841	19.2693	16.6434
37	16.6320	17.1034	16.6695
38	16.0053	16.0300	16.6955
39	14.7222	15.1711	16.7215
40	14.7480	14.9197	16.7475
41	14.5081	14.8661	16.7735
42	14.4005	14.8389	16.7996
43	15.2030	15.6809	16.8256
44	16.7535	16.4436	16.8516
45	19.1387	18.7108	16.8776
46	19.9736	20.0114	16.9037
47	21.3555	20.3174	16.9297
48	20.9813	19.8270	16.9557
49	16.9873	17.5813	16.9817
50	15.9464	16.4296	17.0078
51	14.8510	15.4230	17.0338
52	14.7143	15.2184	17.0598
53	13.8935	15.0313	17.0858
54	14.4213	14.7827	17.1118
55	15.3146	15.7625	17.1379
56	16.5931	16.5816	17.1639
57	18.7258	18.8132	17.1899

58	19.2451	19.9297	17.2159
59	20.0002	20.2691	17.2420
60	19.4747	19.5270	17.2680
61	17.4246	16.8574	17.2940
62	15.9169	16.2086	17.3200
63	14.8327	14.9635	17.3460
64	14.6609	14.9586	17.3721
65	15.3565	14.6136	17.3981
66	14.2605	15.0582	17.4241
67	15.1969	15.5170	17.4501
68	17.3386	16.6529	17.4762
69	17.5405	18.9939	17.5022
70	20.1880	19.4592	17.5282
71	21.1862	20.6061	17.5542
72	20.0119	19.7881	17.5802
73	17.0782	17.2866	17.6063
74	16.0461	16.2304	17.6323
75	15.7261	15.1859	17.6583
76	15.7464	15.2989	17.6843
77	15.0018	15.2460	17.7104
78	15.6896	15.0566	17.7364
79	16.9606	16.2298	17.7624
80	17.1617	17.5163	17.7884
81	20.4526	19.1299	17.8144
82	21.2952	20.9941	17.8405
83	20.9255	21.4269	17.8665
84	19.9337	20.5066	17.8925
85		17.7835	17.9185
86		16.9069	17.9445
87		15.9526	17.9706
88		15.8998	17.9966
89		15.7038	18.0226
90		15.7643	18.0486
91		16.7215	18.0747
92		17.7577	18.1007
93		19.8128	18.1267
94		21.0590	18.1527
95		21.5333	18.1788
96		20.6973	18.2048

PROJECTION COMPARISONS

FY 75 USE **** 192.184

FY 81 USE **** 212.017

CHANGE **** 10.3%

PROJECTED FY 81 USE *****	210.108	212.992
CHANGE FROM FY 75 *****	9.3%	10.8%
PROJECTED FY 82 USE *****	215.592	216.740
CHANGE FROM FY 75 *****	12.2%	12.8%

APPENDIX D

DATA SUMMARY

SUMMARY OF DATA FOR NRMC CAMP LEJEUNE
(Month 1 = Oct 1974)

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	4199	660	6.36	61.50	141.	42.	8.99
2	5081	660	7.70	55.20	306.	20.	1.72
3	3561	660	5.40	49.90	459.	0.	5.14
4	5254	660	7.96	51.10	425.	1.	4.38
5	3897	660	5.90	51.50	378.	7.	2.95
6	3781	660	5.73	52.50	383.	3.	1.89
7	4767	660	7.22	55.90	289.	20.	4.37
8	4767	660	7.22	69.10	26.	160.	4.05
9	7586	660	11.49	76.50	0.	353.	4.40
10	10556	660	15.99	77.60	0.	398.	6.69
11	11240	660	17.03	80.20	0.	479.	1.91
12	5707	660	8.65	76.20	0.	345.	5.21
13	6391	660	9.68	68.30	32.	142.	4.04
14	5510	660	8.35	59.00	206.	32.	3.71
15	4141	660	6.27	48.70	498.	0.	4.87
16	4663	660	7.07	43.70	653.	0.	3.22
17	4512	660	6.84	51.70	379.	0.	1.42
18	4512	660	6.84	57.30	244.	11.	2.73
19	4802	660	7.28	60.00	190.	48.	0.59
20	5881	660	8.91	67.20	52.	127.	5.20
21	8178	660	12.39	73.60	4.	268.	4.71
22	9593	660	14.53	77.70	0.	401.	4.31
23	8746	660	13.25	75.90	0.	344.	11.73
24	7876	660	11.93	71.80	1.	214.	8.58
25	6774	660	10.26	62.20	135.	53.	4.62
26	4628	660	7.01	49.90	448.	0.	3.08
27	4500	660	6.82	46.50	566.	0.	6.90
28	4732	660	7.17	35.80	900.	0.	4.53
29	4500	660	6.82	44.30	575.	1.	1.64
30	4303	660	6.52	55.20	309.	10.	4.01
31	5753	660	8.72	62.90	104.	49.	1.89
32	6275	660	9.51	69.60	27.	177.	1.81
33	8410	660	12.74	74.60	0.	295.	3.07
34	10973	660	16.63	80.80	0.	499.	2.48
35	9964	660	15.10	79.50	0.	453.	2.74
36	9987	660	15.13	77.30	0.	374.	2.70
37	6032	660	9.14	63.40	103.	57.	9.13
38	5823	660	8.82	59.40	196.	37.	12.00
39	4303	660	6.52	48.80	504.	6.	5.99
40	5417	660	8.21	42.00	704.	0.	7.61
41	4628	660	7.01	35.70	813.	0.	2.85
42	3723	660	5.64	50.10	455.	0.	5.70
43	4292	660	6.50	60.20	152.	13.	5.73
44	4918	660	7.45	65.10	60.	68.	6.04
45	9175	660	13.90	73.80	0.	271.	0.38
46	9546	660	14.46	78.00	0.	411.	4.47
47	10730	660	16.26	80.60	0.	493.	1.04
48	9546	660	14.46	76.30	0.	345.	0.73

49	4686	660	7.10	63.50	90.	48.	3.15
50	5800	660	8.79	61.30	123.	21.	6.77
51	5139	660	7.79	51.20	426.	7.	3.32
52	4501	660	6.82	45.40	601.	0.	9.72
53	5116	660	7.75	41.00	563.	0.	4.67
54	4443	660	6.73	50.70	439.	2.	2.96
55	5208	660	7.89	58.90	198.	23.	2.68
56	6496	660	9.84	67.60	32.	121.	0.66
57	7389	660	11.20	71.60	0.	203.	4.04
58	8503	660	12.88	77.40	0.	394.	6.30
59	9651	660	14.62	77.90	0.	407.	3.33
60	9466	660	14.34	75.20	0.	313.	12.78
61	6078	660	9.21	63.40	112.	69.	2.04
62	5058	660	7.66	58.60	208.	24.	8.46
63	4791	660	7.26	49.10	487.	0.	5.19
64	4710	660	7.14	45.80	587.	0.	7.76
65	4942	660	7.49	39.00	750.	0.	2.38
66	4594	660	6.96	49.30	477.	0.	8.94
67	5545	660	8.40	61.10	145.	35.	4.03
68	10243	660	15.52	68.60	33.	153.	0.87
69	7285	660	11.04	73.10	0.	252.	5.49
70	9698	660	14.69	79.30	0.	449.	3.47
71	10196	660	15.45	79.10	0.	445.	1.48
72	10022	660	15.18	76.00	0.	335.	5.09
73	5649	660	8.56	62.20	132.	54.	2.58
74	5232	660	7.93	52.00	385.	3.	5.29
75	4791	660	7.26	47.10	549.	0.	4.48
76	5382	660	8.15	36.20	0.	0.	1.75
77	5116	660	7.75	46.10	0.	0.	1.99
78	4721	660	7.15	45.40	1.	1.	2.36
79	5359	660	8.12	62.60	45.	45.	1.84
80	6334	660	9.60	65.40	104.	104.	4.90
81	10185	660	15.43	78.30	406.	406.	3.91
82	9698	660	14.69	78.60	429.	429.	9.32
83	10022	660	15.18	76.50	361.	361.	11.34
84	10022	660	15.18	71.50	218.	218.	1.31

SUMMARY OF DATA FOR NRMC CHARLESTON

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	10022	456	21.98	61.80	136.	46.	0.40
2	10242	456	22.46	55.50	299.	18.	3.78
3	9500	456	20.83	51.00	432.	3.	3.00
4	12412	456	27.22	53.80	350.	8.	4.92
5	9314	456	20.43	54.70	294.	13.	3.54
6	10463	456	22.95	56.90	273.	26.	4.54
7	10625	456	23.30	62.30	152.	74.	3.74
8	11901	456	26.10	75.10	0.	318.	5.06
9	12667	456	27.78	78.50	0.	414.	5.96
10	11890	456	26.07	79.20	0.	449.	9.34
11	14697	456	32.23	81.50	0.	516.	7.18
12	11542	456	25.31	76.80	0.	361.	5.16
13	12748	456	27.96	69.00	40.	171.	1.97
14	10474	456	22.97	59.30	221.	58.	1.43
15	9349	456	20.50	49.70	466.	0.	3.35
16	9778	456	21.44	44.80	524.	2.	1.62
17	8352	456	18.32	55.90	265.	9.	0.95
18	8630	456	18.93	62.30	146.	73.	2.33
19	9036	456	19.82	64.00	94.	70.	0.62
20	10590	456	23.22	70.30	15.	187.	8.87
21	10730	456	23.53	75.80	3.	329.	5.59
22	11797	456	25.87	81.00	0.	502.	4.48
23	11228	456	24.62	77.20	0.	384.	5.22
24	12783	456	28.03	73.90	0.	274.	6.03
25	9767	456	21.42	61.40	159.	52.	4.10
26	9338	456	20.48	50.90	418.	2.	3.57
27	9082	456	19.92	48.80	501.	1.	5.12
28	8363	456	18.34	38.70	808.	0.	2.72
29	8328	456	18.26	46.30	516.	1.	1.38
30	8201	456	17.98	60.60	186.	54.	5.31
31	9465	456	20.76	66.40	58.	107.	0.45
32	9407	456	20.63	72.80	17.	263.	4.66
33	11379	456	24.95	81.20	0.	493.	2.12
34	11368	456	24.93	83.80	0.	588.	3.86
35	11785	456	25.84	81.40	0.	518.	8.13
36	12446	456	27.29	78.70	0.	417.	2.48
37	9848	456	21.60	63.50	112.	71.	2.49
38	9198	456	20.17	61.30	175.	71.	1.76
39	10045	456	22.03	55.00	459.	1.	5.88
40	10347	456	22.69	43.50	663.	0.	4.31
41	7632	456	16.74	42.70	616.	0.	1.82
42	7899	456	17.32	55.20	309.	13.	3.25
43	8363	456	18.34	66.50	52.	106.	1.97
44	9686	456	21.24	72.00	18.	242.	4.68
45	12296	456	26.96	78.60	0.	414.	3.42
46	11576	456	25.39	81.10	0.	505.	6.19
47	11832	456	25.95	81.30	0.	514.	4.01
48	11681	456	25.62	77.40	0.	378.	5.06
49	10104	456	22.16	65.70	57.	86.	0.18
50	9512	456	20.86	63.30	83.	40.	1.87
51	9953	456	21.83	52.70	399.	21.	4.13
52	9477	456	20.78	45.40	602.	0.	3.43
53	7401	456	16.23	46.80	505.	2.	3.04
54	7400	456	16.23	57.40	241.	9.	3.01
55	7459	456	16.36	64.90	70.	71.	3.81
56	10220	456	22.41	72.40	2.	241.	8.09
57	10637	456	23.33	75.90	0.	335.	2.23
58	9303	456	20.40	82.00	0.	533.	8.35
59	11704	456	25.67	81.40	0.	514.	0.88
60	13734	456	30.12	76.50	0.	354.	15.36

61	10243	456	22.46	66.00	68.	105.	3.87
62	9698	456	21.27	59.40	203.	40.	3.29
63	8839	456	19.38	48.70	500.	0.	2.62
64	9361	456	20.53	48.70	495.	0.	3.99
65	8387	456	18.39	45.90	555.	9.	1.25
66	8828	456	19.36	54.60	321.	7.	7.99
67	10162	456	22.29	64.30	82.	69.	3.43
68	11124	456	24.39	71.40	17.	221.	5.85
69	10231	456	22.44	78.40	0.	407.	3.15
70	12957	456	28.41	82.40	0.	549.	6.97
71	12250	456	26.86	82.10	0.	539.	0.73
72	11658	456	25.57	79.80	0.	451.	2.60
73	11704	456	25.67	65.00	80.	87.	1.52
74	10173	456	22.31	55.40	287.	5.	2.19
75	10034	456	22.00	47.50	537.	1.	1.25
76	9593	456	21.04	41.60	719.	0.	0.93
77	8688	456	19.05	50.80	393.	0.	2.23
78	9802	456	21.50	54.30	333.	9.	2.38
79	10695	456	23.45	67.50	55.	138.	1.87
80	9883	456	21.67	70.80	16.	199.	4.02
81	10718	456	23.50	82.70	0.	539.	6.04
82	13595	456	29.81	83.50	0.	582.	12.66
83	11791	456	25.86	80.30	0.	481.	9.30
84	10950	456	24.01	74.80	3.	307.	1.27

SUMMARY OF DATA FOR NRMC CORPUS CHRISTI

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	9604	264	36.38	74.00	4.	289.	3.57
2	9558	264	36.20	64.20	117.	97.	1.76
3	9558	264	36.20	57.50	260.	32.	0.83
4	10509	264	39.81	59.70	227.	70.	1.94
5	10231	264	38.75	60.10	167.	135.	0.42
6	10486	264	39.72	67.20	77.	154.	0.05
7	8120	264	30.76	75.00	10.	319.	0.08
8	7899	264	29.92	80.50	0.	486.	1.67
9	7273	264	27.55	83.40	0.	557.	1.31
10	10521	264	39.85	84.50	0.	608.	4.05
11	8560	264	32.42	83.30	0.	573.	4.84
12	9036	264	34.23	79.00	0.	422.	6.70
13	9048	264	34.27	74.40	4.	300.	2.02
14	8154	264	30.89	66.50	107.	161.	0.90
15	8363	264	31.68	58.50	247.	52.	1.21
16	8120	264	30.76	56.70	275.	25.	0.15
17	8224	264	31.15	64.40	94.	84.	0.0
18	8386	264	31.77	68.80	45.	170.	0.15
19	6933	264	26.26	73.50	1.	265.	3.68
20	8746	264	33.13	74.40	0.	299.	5.95
21	8514	264	32.25	81.60	0.	505.	0.76
22	9686	264	36.69	81.20	0.	510.	11.92
23	9442	264	35.77	83.00	0.	563.	0.86
24	8816	264	33.39	81.40	0.	498.	2.54
25	8259	264	31.28	67.30	59.	136.	6.81
26	7690	264	29.13	57.30	253.	31.	4.27
27	7377	264	27.94	54.80	311.	3.	2.30
28	6855	264	25.97	50.30	455.	4.	3.11
29	7203	264	27.28	58.60	192.	18.	1.72
30	8618	264	32.64	66.00	65.	104.	0.96
31	8874	264	33.61	71.50	6.	206.	6.00
32	8746	264	33.13	78.80	0.	435.	1.96
33	8352	264	31.64	82.90	0.	545.	3.56
34	8642	264	32.73	84.60	0.	616.	1.15
35	9442	264	35.77	86.70	0.	677.	0.39
36	8792	264	33.30	85.50	0.	621.	0.87
37	8143	264	30.84	75.70	4.	342.	4.73
38	7714	264	29.22	67.50	56.	136.	1.74
39	7377	264	27.94	61.90	160.	71.	0.06
40	7690	264	29.13	49.20	502.	18.	2.01
41	7424	264	28.12	51.70	382.	16.	0.84
42	8618	264	32.64	63.90	101.	74.	0.03
43	8456	264	32.03	72.30	17.	243.	2.20
44	9291	264	35.19	81.00	0.	502.	1.68
45	8433	264	31.94	83.50	0.	561.	12.04
46	8943	264	33.87	85.50	0.	647.	3.92
47	10451	264	39.59	84.90	0.	622.	0.81
48	10509	264	39.81	81.90	0.	511.	10.83
49	8572	264	32.47	73.20	1.	264.	2.46
50	8097	264	30.67	68.80	57.	177.	0.50
51	6856	264	25.97	59.10	236.	56.	1.82
52	6102	264	23.11	51.30	445.	26.	3.93
53	5475	264	20.74	57.00	256.	39.	0.83
54	6983	235	29.71	67.90	38.	140.	1.55
55	9187	235	39.09	74.30	1.	289.	3.69
56	10046	235	42.75	76.60	0.	366.	4.28
57	11381	235	48.43	81.70	0.	507.	3.23
58	12319	235	52.42	85.50	0.	639.	3.52
59	12064	235	51.34	84.90	0.	624.	2.53
60	9906	235	42.15	78.80	0.	421.	13.77

61	9303	235	39.59	75.40	6.	333.	0.41
62	6600	235	28.09	63.30	131.	89.	0.28
63	5290	235	22.51	58.80	233.	47.	1.02
64	6032	235	25.67	60.00	195.	45.	1.24
65	5359	235	22.80	58.10	247.	52.	1.01
66	7099	235	30.21	67.60	74.	159.	0.31
67	7134	235	30.36	69.40	30.	166.	0.34
68	10173	235	43.29	77.80	0.	405.	2.82
69	11182	235	47.58	83.80	0.	573.	10.03
70	12632	235	53.75	85.80	0.	649.	1.47
71	10695	235	45.51	83.20	0.	570.	14.79
72	10904	235	46.40	82.40	0.	530.	6.01
73	8433	235	35.89	71.30	43.	247.	1.18
74	6218	235	26.46	59.90	204.	56.	3.16
75	5591	235	23.79	57.70	254.	34.	0.33
76	5301	235	22.56	46.10	294.	4.	2.55
77	5672	235	24.14	49.00	221.	41.	1.91
78	7633	235	32.48	54.20	90.	57.	2.37
79	8526	235	36.28	74.40	0.	288.	0.98
80	9129	235	38.85	77.00	0.	378.	8.64
81	10312	235	43.88	76.30	0.	535.	3.02
82	10336	235	43.98	83.40	0.	580.	5.98
83	10776	235	45.86	83.70	0.	589.	5.79
84	10011	235	42.60	80.70	0.	476.	0.49

SUMMARY OF DATA FOR NRMC GREAT LAKES

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	10695	1201	8.91	52.80	384.	12.	1.88
2	9774	1201	8.14	40.60	724.	0.	2.47
3	10695	1201	8.91	30.20	1072.	0.	2.12
4	11032	1201	9.19	26.20	1160.	0.	3.69
5	9709	1201	8.08	26.20	1078.	0.	2.48
6	11008	1201	9.17	34.10	951.	0.	2.02
7	10498	1201	8.74	43.30	543.	0.	5.50
8	11635	1201	9.69	62.30	152.	76.	3.02
9	12621	1201	10.51	70.50	30.	203.	5.07
10	12853	1201	10.70	75.50	1.	332.	2.19
11	12632	1201	10.52	76.30	0.	358.	7.37
12	12725	1201	10.60	61.40	147.	46.	0.80
13	10753	1201	8.95	55.80	303.	24.	1.90
14	8978	1201	7.48	47.20	531.	1.	2.53
15	11484	1201	9.56	31.50	1033.	0.	3.05
16	10022	1201	8.34	19.90	1392.	0.	0.85
17	9442	1201	7.86	35.20	859.	0.	1.87
18	10881	1201	9.06	42.80	581.	0.	5.91
19	12018	1201	10.01	52.30	411.	36.	4.05
20	11438	1201	9.52	55.90	285.	6.	4.03
21	14546	1201	12.11	70.10	170.	178.	2.93
22	12215	1201	10.17	74.00	0.	286.	1.44
23	11855	1201	9.87	70.80	9.	196.	1.29
24	12076	1201	10.05	62.70	119.	56.	1.49
25	11902	1201	9.91	48.30	522.	8.	1.41
26	12795	1201	10.65	32.40	973.	0.	0.65
27	10208	1201	8.50	19.40	1408.	0.	0.64
28	11426	1201	9.51	10.70	1579.	0.	0.55
29	11336	1201	9.44	26.90	1060.	0.	0.71
30	10950	1201	9.12	44.90	616.	0.	3.67
31	10080	1201	8.39	55.00	332.	39.	2.62
32	11670	1201	9.72	67.20	115.	191.	1.88
33	11507	1201	9.58	69.30	41.	178.	5.12
34	12122	1201	10.09	77.50	8.	395.	1.18
35	13839	1201	11.52	71.90	8.	229.	5.39
36	11855	1201	9.87	66.00	42.	76.	6.07
37	10939	1201	9.11	51.50	413.	0.	1.36
38	10428	1201	8.68	40.00	741.	0.	2.05
39	10416	1201	8.67	24.20	1254.	0.	1.96
40	11368	1201	9.47	15.70	1521.	0.	1.48
41	10811	1201	9.00	16.80	1346.	0.	0.43
42	9871	1201	8.22	31.90	1020.	0.	1.16
43	9981	1201	8.31	47.50	518.	0.	3.94
44	11286	1201	9.40	58.30	264.	60.	2.80
45	14152	1201	11.78	67.60	46.	132.	6.36
46	15532	1201	12.93	72.00	1.	227.	4.61
47	15706	1201	13.08	72.40	4.	243.	1.96
48	17145	1201	14.28	68.80	59.	181.	6.88
49	12690	1201	10.57	51.40	418.	2.	1.08
50	10811	1201	9.00	40.80	718.	0.	2.24
51	12447	1201	10.36	25.80	1206.	0.	4.41
52	12389	1201	10.32	12.50	1522.	0.	2.81
53	13062	1201	10.88	16.20	1350.	0.	1.02
54	11554	1201	9.62	36.40	879.	0.	4.49
55	12772	1201	10.63	45.50	580.	2.	4.92
56	12064	1201	10.04	59.30	233.	61.	2.58
57	15486	1201	12.89	69.20	30.	164.	4.63
58	15393	1201	12.82	72.00	16.	241.	2.19
59	14198	1201	11.82	71.00	19.	213.	7.57
60	13166	1201	10.96	66.10	62.	99.	0.02

61	13073	1201	10.89	53.30	382.	26.	1.49
62	13085	1201	10.89	40.60	722.	0.	2.80
63	12714	1201	10.59	33.70	1967.	0.	2.58
64	11530	1201	9.60	23.40	1281.	0.	1.04
65	13073	1201	10.89	21.50	1254.	0.	1.24
66	10231	1201	8.52	32.60	995.	0.	1.96
67	11554	1201	9.62	46.50	558.	10.	3.41
68	11936	1201	9.94	59.70	198.	43.	3.22
69	11646	1201	9.70	65.30	83.	101.	3.42
70	12841	1201	10.69	75.70	0.	338.	3.56
71	13618	1201	11.34	75.70	3.	342.	8.54
72	12864	1201	10.71	66.00	71.	107.	5.65
73	11333	1201	9.44	48.40	511.	2.	2.09
74	12621	1201	10.51	39.90	746.	0.	1.10
75	10707	1046	10.24	28.00	1140.	0.	3.43
76	12516	1046	11.97	22.60	1308.	0.	0.10
77	10997	1046	10.51	28.00	1031.	0.	2.35
78	10730	1046	10.26	37.60	846.	0.	0.63
79	11507	1046	11.00	51.80	397.	9.	6.14
80	11983	1046	11.46	55.30	313.	20.	5.85
81	13665	1046	13.06	69.80	6.	157.	4.46
82	14593	1046	13.95	72.50	8.	248.	4.50
83	13607	1046	13.01	71.20	6.	204.	6.60
84	12911	1046	12.34	61.70	135.	44.	3.25

SUMMARY OF DATA FOR NRMC JACKSONVILLE

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	9164	341	26.87	66.20	38.	84.	0.34
2	8340	341	24.46	60.30	181.	47.	1.03
3	7273	341	21.33	55.00	321.	18.	1.73
4	7238	341	21.23	58.60	223.	31.	3.48
5	7598	341	22.28	60.90	153.	42.	2.58
6	8410	341	24.66	60.50	193.	59.	2.46
7	9442	341	27.69	66.40	59.	109.	5.78
8	10602	341	31.09	75.50	0.	334.	7.00
9	10416	341	30.55	80.90	0.	482.	5.21
10	9268	341	27.18	80.00	0.	474.	6.36
11	8676	341	25.44	81.20	0.	508.	6.23
12	9338	341	27.38	78.40	0.	406.	5.24
13	9372	341	27.48	72.20	11.	238.	3.63
14	8584	341	25.17	62.20	176.	99.	0.39
15	7667	341	22.48	52.70	373.	2.	1.79
16	7516	341	22.04	48.70	498.	0.	2.29
17	7076	341	20.75	58.00	210.	16.	1.05
18	8247	341	24.18	65.00	79.	85.	0.34
19	8004	341	23.47	65.30	43.	60.	0.63
20	7458	341	21.87	71.40	9.	213.	10.02
21	10208	341	29.94	76.40	0.	350.	4.26
22	9198	341	26.97	81.80	0.	528.	5.41
23	10347	341	30.34	79.70	0.	462.	6.37
24	10242	341	30.04	76.80	0.	360.	8.56
25	9291	341	27.25	64.70	87.	85.	1.63
26	9894	341	29.01	54.30	327.	13.	2.43
27	8514	341	24.97	52.80	376.	7.	4.81
28	8584	341	25.17	44.00	643.	0.	2.96
29	5927	341	17.38	50.00	414.	1.	3.24
30	6565	341	19.25	65.00	102.	107.	1.03
31	9442	341	27.69	67.00	46.	115.	1.76
32	10022	341	29.39	73.00	0.	255.	3.07
33	9546	341	27.99	81.30	0.	499.	2.65
34	9303	341	27.28	82.70	0.	559.	1.97
35	9941	341	29.15	81.90	0.	531.	7.26
36	9720	341	28.50	80.10	0.	462.	7.45
37	8955	341	26.26	66.10	70.	110.	1.68
38	8700	341	25.51	62.50	135.	68.	3.11
39	8514	341	24.97	53.30	366.	10.	3.38
40	7540	341	22.11	48.60	508.	5.	4.64
41	7725	341	22.65	47.50	484.	0.	4.17
42	8224	341	24.12	58.70	221.	31.	2.83
43	8062	341	23.64	68.30	22.	131.	2.24
44	13316	341	39.05	74.80	1.	311.	9.18
45	7006	341	20.55	79.50	0.	441.	2.62
46	7795	341	22.86	81.80	0.	527.	6.67
47	7772	341	22.79	80.80	0.	497.	2.39
48	6855	341	20.10	77.80	0.	390.	4.40
49	6832	341	20.04	67.80	46.	140.	1.26
50	5243	341	15.38	64.60	68.	62.	0.80
51	5580	341	16.36	55.10	324.	24.	1.84
52	6658	341	19.52	47.90	525.	1.	6.28
53	5626	341	16.50	52.00	371.	13.	3.75
54	6102	341	17.89	60.80	160.	36.	1.00
55	6624	341	19.43	68.60	13.	131.	4.18
56	5904	341	17.31	73.00	3.	259.	7.54
57	6276	341	18.40	77.10	0.	369.	5.91
58	7053	341	20.68	82.00	0.	532.	4.67
59	6948	341	20.38	80.40	0.	484.	4.78
60	6600	341	19.35	79.30	0.	436.	17.75

61	7262	341	21.30	69.30	19.	158.	0.25
62	6566	341	19.26	62.00	144.	61.	3.64
63	6299	341	18.47	54.30	331.	3.	2.01
64	6960	341	20.41	53.30	356.	1.	2.61
65	6020	341	17.65	51.20	406.	15.	1.06
66	7343	424	17.32	62.40	134.	63.	6.83
67	8016	424	18.91	68.10	24.	122.	3.91
68	8967	424	21.15	75.20	0.	322.	3.01
69	10684	424	25.20	80.20	0.	466.	4.59
70	10811	424	25.50	83.70	0.	585.	5.29
71	10370	424	24.46	83.10	0.	568.	3.97
72	10881	424	25.66	80.90	0.	483.	3.03
73	9524	424	22.46	68.50	26.	143.	2.69
74	8607	424	20.30	61.30	146.	41.	2.32
75	8062	424	19.01	52.70	379.	3.	0.21
76	7853	424	18.52	46.50	570.	0.	0.92
77	6751	424	15.92	55.40	273.	6.	4.53
78	8607	424	20.30	59.10	202.	23.	5.41
79	8445	424	19.92	70.40	9.	177.	0.32
80	8804	424	20.76	72.50	6.	245.	1.48
81	13398	424	31.60	83.30	0.	557.	3.31
82	8538	424	20.14	84.40	0.	608.	2.46
83	11612	424	27.39	80.80	0.	497.	6.47
84	10452	424	24.65	76.00	1.	336.	1.22

SUMMARY OF DATA FOR NRMC LONG BEACH

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	17237	426	40.46	66.70	27.	87.	0.58
2	15868	426	37.25	63.20	87.	40.	0.03
3	15800	426	37.09	54.10	331.	0.	5.21
4	15741	426	36.95	56.70	254.	6.	0.09
5	14952	426	35.10	58.40	180.	0.	4.44
6	15718	426	36.90	56.80	246.	0.	3.60
7	16286	426	38.23	57.20	227.	0.	1.49
8	17110	426	40.16	63.40	63.	22.	0.01
9	16124	426	37.85	66.80	2.	62.	0.0
10	20787	426	48.80	72.80	0.	248.	0.0
11	17864	426	41.93	72.70	0.	243.	0.0
12	18815	426	44.17	74.20	0.	282.	0.0
13	17875	426	41.96	66.70	28.	90.	0.25
14	18954	426	44.49	60.60	145.	18.	0.13
15	15822	426	37.14	57.20	239.	3.	0.21
16	16344	426	38.37	60.10	177.	34.	0.0
17	15439	426	36.24	59.30	161.	0.	2.40
18	15381	426	36.11	59.90	165.	17.	0.66
19	16831	426	39.51	59.60	165.	8.	1.18
20	14476	426	33.98	66.30	8.	56.	0.01
21	15938	426	37.41	72.00	1.	215.	0.14
22	17376	426	40.79	73.60	0.	271.	0.0
23	15590	426	36.60	74.20	0.	295.	0.03
24	17400	426	40.85	74.30	0.	286.	1.45
25	15845	426	37.19	72.30	0.	232.	0.07
26	15509	426	36.41	66.20	42.	85.	0.98
27	14564	426	34.19	59.00	180.	0.	0.43
28	13850	426	32.51	57.70	224.	6.	1.80
29	15393	426	36.13	59.40	157.	4.	0.35
30	12852	426	30.17	55.50	285.	0.	1.35
31	13212	426	31.01	62.80	74.	14.	0.0
32	14221	426	33.38	63.20	72.	26.	2.32
33	15288	426	35.89	68.90	1.	124.	0.0
34	15520	426	36.43	74.20	0.	295.	0.0
35	15033	426	35.29	76.30	0.	360.	2.03
36	16680	426	39.15	71.60	0.	207.	0.02
37	15892	426	37.31	70.40	4.	180.	0.0
38	14662	426	34.42	66.40	35.	83.	0.0
39	13456	426	31.59	61.20	125.	13.	3.03
40	13978	426	32.81	56.20	265.	0.	7.62
41	12794	426	30.03	56.90	223.	0.	8.60
42	13525	426	31.75	64.00	88.	65.	6.17
43	13780	426	32.35	61.40	104.	2.	0.80
44	13838	426	32.48	68.90	12.	138.	0.0
45	15138	426	35.54	69.90	5.	162.	0.0
46	15520	426	36.43	72.60	0.	240.	0.0
47	16286	426	38.23	73.00	0.	254.	0.0
48	16286	426	38.23	74.20	0.	284.	1.04
49	17852	426	41.91	69.70	4.	155.	0.02
50	14001	426	32.87	58.40	201.	11.	2.00
51	12009	426	28.19	52.60	376.	0.	1.42
52	13375	426	31.40	53.70	344.	0.	8.41
53	13108	426	30.77	55.20	268.	0.	2.25
54	12528	426	29.41	59.40	177.	10.	4.07
55	12946	426	30.39	64.20	41.	25.	0.0
56	13526	426	31.75	65.70	30.	61.	0.0
57	13920	426	32.68	72.10	1.	220.	0.0
58	16634	426	39.05	72.00	0.	226.	0.0
59	14639	426	34.36	73.50	0.	272.	0.0
60	15764	436	36.16	74.90	0.	302.	0.0

61	15718	436	36.05	66.40	21.	72.	0.37
62	12621	436	28.95	59.80	147.	1.	0.23
63	12888	436	29.56	58.60	204.	14.	0.28
64	12679	436	29.08	58.50	195.	0.	7.17
65	13769	436	31.58	60.90	116.	4.	9.40
66	12748	436	29.24	58.00	209.	0.	2.86
67	12806	436	29.37	62.60	99.	33.	0.29
68	13676	436	31.37	62.50	82.	10.	0.10
69	12528	436	28.73	68.90	11.	132.	0.0
70	15788	436	36.21	74.10	0.	289.	0.0
71	15718	436	36.05	74.40	0.	299.	0.0
72	17806	436	40.84	70.30	0.	167.	0.0
73	15880	436	36.42	67.90	14.	109.	0.0
74	15126	436	34.69	61.70	103.	7.	0.0
75	14686	436	33.68	59.20	185.	8.	1.54
76	14628	436	33.55	58.40	197.	0.	1.85
77	14164	436	32.49	59.70	156.	15.	1.55
78	13479	436	30.92	58.60	189.	0.	3.41
79	14825	436	34.00	63.00	89.	37.	0.32
80	14570	436	33.42	66.70	8.	66.	0.0
81	16182	436	37.11	75.10	0.	309.	0.0
82	18479	436	42.38	75.80	0.	340.	0.0
83	16774	436	38.47	76.00	0.	350.	0.0
84	17876	436	41.00	73.20	0.	251.	0.07

SUMMARY OF DATA FOR NRMC MEMPHIS

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	7064	324	21.80	62.40	121.	46.	2.67
2	6588	324	20.33	53.30	367.	23.	4.96
3	6391	324	19.73	45.20	607.	0.	5.03
4	6751	324	20.84	45.90	591.	8.	4.65
5	7598	324	23.45	46.20	521.	0.	5.53
6	7795	324	24.06	49.90	463.	3.	12.08
7	8004	324	24.70	61.90	180.	93.	4.98
8	6322	324	19.51	73.50	2.	272.	8.72
9	7586	324	23.41	78.80	0.	421.	2.42
10	8595	324	26.53	81.10	0.	507.	2.26
11	9372	324	28.93	81.20	0.	510.	2.03
12	7772	324	23.99	70.90	40.	224.	2.62
13	9245	324	28.53	65.80	90.	121.	2.69
14	7424	324	22.91	53.80	352.	23.	7.77
15	7714	324	23.81	44.10	643.	2.	2.93
16	7772	324	23.99	39.50	783.	0.	2.85
17	8004	324	24.70	53.80	326.	7.	4.41
18	8201	324	25.31	58.50	238.	44.	7.68
19	8943	324	27.60	63.60	100.	64.	2.41
20	7748	324	23.91	65.60	58.	84.	4.73
21	7725	324	23.84	76.40	0.	349.	4.06
22	9361	324	28.89	81.50	0.	519.	3.82
23	9048	324	27.93	78.90	0.	438.	0.86
24	9094	324	28.07	73.00	0.	247.	5.40
25	6890	324	21.27	58.90	231.	48.	5.66
26	7110	324	21.94	45.50	581.	0.	1.83
27	7690	324	23.73	41.90	708.	0.	1.79
28	6797	324	20.98	30.70	1056.	0.	2.57
29	7400	324	22.84	45.10	547.	0.	1.99
30	8862	324	27.35	58.60	212.	23.	4.13
31	9465	324	29.21	66.90	61.	123.	5.42
32	11542	324	35.62	76.40	4.	362.	0.83
33	11866	324	36.62	81.90	0.	516.	3.38
34	12829	324	39.60	84.70	0.	619.	3.41
35	13282	324	40.99	82.60	0.	551.	1.62
36	12191	324	37.63	79.00	0.	426.	6.43
37	11948	324	36.88	62.20	123.	41.	2.02
38	7760	324	23.95	55.10	313.	20.	6.01
39	8723	324	26.92	44.10	640.	0.	3.39
40	7980	324	24.63	32.70	995.	0.	8.13
41	8178	324	25.24	35.00	835.	0.	1.31
42	10092	324	31.15	50.30	454.	6.	4.05
43	9941	324	30.68	66.30	74.	122.	2.14
44	11101	324	34.26	70.90	47.	235.	8.14
45	10509	324	32.44	79.80	0.	452.	4.45
46	11182	324	34.51	83.80	0.	590.	3.89
47	12910	324	39.85	80.90	0.	501.	9.65
48	12806	324	39.52	77.70	0.	387.	1.52
49	9164	324	28.28	62.50	116.	46.	1.82
50	8630	324	26.64	57.70	230.	18.	5.56
51	8804	324	27.17	44.00	643.	0.	13.12
52	8062	324	24.88	30.90	1049.	0.	5.98
53	7621	324	23.52	38.50	734.	0.	5.66
54	9779	324	30.18	54.30	345.	19.	6.60
55	8874	324	27.39	63.00	121.	68.	11.47
56	9709	324	29.97	70.00	23.	184.	7.78
57	10684	324	32.98	77.90	0.	394.	4.93
58	10046	324	31.01	82.60	0.	553.	3.12
59	11206	324	34.59	80.90	0.	499.	5.92
60	7111	289	24.61	73.40	0.	259.	4.49

61	8630	289	29.86	65.80	76.	108.	2.60
62	8549	289	29.58	50.70	426.	4.	7.42
63	8016	289	27.74	45.40	598.	0.	4.92
64	8375	289	28.98	43.20	669.	0.	3.23
65	8282	289	28.66	39.50	733.	0.	1.12
66	8027	289	27.78	49.40	478.	0.	10.86
67	8816	289	30.51	60.90	156.	40.	7.53
68	9709	289	33.60	72.50	7.	249.	4.43
69	8793	289	30.43	80.90	0.	480.	5.75
70	9860	289	34.12	88.80	0.	744.	4.73
71	9709	289	33.60	87.20	0.	695.	1.23
72	10382	289	35.92	80.50	5.	476.	5.32
73	7366	289	25.49	62.70	146.	80.	3.14
74	9709	289	33.60	53.30	362.	18.	5.23
75	6658	289	23.04	45.90	586.	2.	1.86
76	8909	289	30.83	40.90	739.	0.	1.38
77	8712	289	30.15	47.30	492.	5.	3.66
78	9060	289	31.35	54.30	342.	20.	4.98
79	9245	289	31.99	70.20	18.	181.	3.67
80	10718	289	37.09	70.00	23.	184.	7.06
81	9535	289	32.99	82.50	0.	532.	2.93
82	10649	289	36.85	84.60	0.	614.	1.71
83	10486	289	36.28	81.80	0.	527.	4.21
84	10138	289	35.08	74.00	9.	285.	0.61

SUMMARY OF DATA FOR NRMC OAKLAND

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	14860	911	16.31	62.00	117.	30.	0.93
2	14848	911	16.30	53.80	329.	0.	0.50
3	14848	911	16.30	48.60	499.	0.	2.36
4	15579	911	17.10	47.40	540.	0.	2.60
5	13688	911	15.03	50.90	387.	0.	3.94
6	13270	911	14.57	51.40	415.	0.	5.91
7	13096	911	14.38	50.60	424.	0.	1.66
8	15440	911	16.95	58.40	220.	21.	0.02
9	14825	911	16.27	59.80	151.	4.	0.04
10	16472	911	18.08	61.80	109.	15.	0.13
11	14894	911	16.35	63.00	75.	19.	0.21
12	13781	911	15.13	61.40	120.	19.	0.0
13	13781	911	15.13	58.80	188.	25.	2.21
14	19302	911	21.19	52.20	377.	0.	0.26
15	17412	911	19.11	49.30	480.	0.	0.21
16	16901	911	18.55	48.50	504.	0.	0.37
17	16472	911	18.08	50.50	415.	0.	2.13
18	16890	911	18.54	51.00	427.	0.	1.22
19	16924	911	18.58	53.30	344.	0.	0.92
20	17539	911	19.25	58.30	222.	21.	0.0
21	16344	911	17.94	63.20	136.	88.	0.01
22	16194	911	17.78	62.50	72.	4.	0.0
23	17702	911	19.43	64.30	38.	23.	0.66
24	17226	911	18.91	63.30	79.	33.	0.30
25	17388	911	19.09	61.30	127.	23.	0.34
26	17284	911	18.97	57.00	231.	0.	1.37
27	17330	911	19.02	48.80	494.	0.	2.70
28	14140	911	15.52	47.00	549.	0.	2.22
29	15869	911	17.42	53.20	326.	0.	1.04
30	18282	911	20.07	50.90	432.	0.	2.01
31	17539	911	19.25	55.50	278.	0.	0.0
32	16240	911	17.83	55.80	278.	0.	0.41
33	16228	911	17.81	60.40	141.	10.	0.0
34	19268	911	21.15	62.40	103.	30.	0.35
35	19465	911	21.37	64.10	48.	26.	0.0
36	16484	911	18.09	63.50	55.	17.	0.47
37	16727	911	18.36	60.50	139.	5.	0.15
38	18908	911	20.75	55.30	284.	0.	2.20
39	15184	911	16.67	52.30	385.	0.	3.69
40	16472	911	18.08	52.50	381.	0.	8.90
41	16240	911	17.83	52.80	335.	0.	4.92
42	15648	911	17.18	57.00	238.	0.	4.90
43	18583	911	20.40	54.90	295.	0.	4.50
44	16669	911	18.30	60.40	161.	24.	0.02
45	18061	911	19.83	60.40	135.	0.	0.0
46	21124	911	23.19	61.40	111.	7.	0.0
47	19674	911	21.60	63.20	65.	18.	0.0
48	19128	911	21.00	65.80	32.	62.	0.26
49	19291	911	21.18	61.10	143.	33.	0.0
50	17586	911	19.30	52.50	371.	0.	1.67
51	15312	911	16.81	46.00	581.	0.	0.64
52	15776	911	17.32	47.50	536.	0.	6.61
53	13734	911	15.08	50.30	406.	0.	5.87
54	19128	911	21.00	54.50	319.	0.	2.74
55	17539	911	19.25	55.50	277.	0.	0.69
56	16785	911	18.42	60.40	148.	11.	0.13
57	19824	911	21.76	61.00	132.	19.	0.0
58	18293	911	20.08	63.80	55.	25.	0.09
59	20242	911	22.22	63.70	56.	21.	0.0
60	19395	911	21.29	67.30	13.	88.	0.0

61	19094	934	20.44	62.60	85.	18.	2.20
62	19360	934	20.73	54.10	320.	0.	1.94
63	17597	934	18.84	50.90	431.	0.	4.30
64	18537	934	19.85	50.50	441.	0.	4.85
65	20149	934	21.57	54.40	298.	0.	7.62
66	17678	934	18.93	53.00	366.	0.	2.65
67	17899	934	19.16	55.90	269.	0.	0.90
68	18896	934	20.23	56.30	261.	0.	0.24
69	17191	934	18.41	59.90	155.	10.	0.03
70	18386	934	19.69	63.00	76.	22.	0.10
71	22469	934	24.06	61.50	109.	7.	0.0
72	16252	934	17.40	63.20	74.	30.	0.0
73	18920	934	20.26	61.20	145.	33.	0.10
74	17539	934	18.78	55.60	275.	1.	0.12
75	18305	934	19.60	50.70	436.	0.	1.73
76	17609	934	18.85	62.20	424.	0.	5.93
77	17319	934	18.54	65.50	301.	0.	2.21
78	18073	934	19.35	64.50	358.	0.	3.60
79	17702	934	18.95	68.00	279.	17.	0.24
80	18954	934	20.29	68.10	180.	0.	0.07
81	15706	934	16.82	68.10	53.	61.	0.0
82	19198	934	20.55	64.10	112.	17.	0.0
83	17992	934	19.26	64.90	65.	7.	0.0
84	19105	934	20.46	64.60	71.	7.	0.28

SUMMARY OF DATA FOR NRMC ORLANDO

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	5707	212	26.92	72.60	0.	241.	0.48
2	3967	212	18.71	67.60	40.	125.	0.31
3	3085	212	14.55	60.90	153.	43.	1.62
4	3097	212	14.61	65.80	73.	105.	0.98
5	3410	212	16.08	67.60	44.	121.	1.49
6	3294	212	15.54	67.40	57.	141.	1.10
7	3688	212	17.40	72.40	10.	237.	1.36
8	4118	212	19.42	79.10	0.	442.	7.52
9	4767	212	22.49	80.80	0.	481.	9.70
10	5452	212	25.72	80.50	0.	489.	9.26
11	5370	212	25.33	82.30	0.	541.	4.75
12	5684	212	26.81	80.70	0.	479.	4.97
13	5196	212	24.51	76.60	0.	366.	4.74
14	4883	212	23.03	67.40	85.	167.	0.66
15	3364	212	15.87	60.20	174.	32.	0.51
16	4152	212	19.58	56.50	278.	18.	0.37
17	3642	212	17.18	63.70	104.	75.	0.83
18	3688	212	17.40	70.40	18.	194.	1.72
19	5707	212	26.92	71.30	1.	196.	2.16
20	5428	212	25.60	76.80	0.	374.	10.36
21	5602	212	26.42	79.70	0.	449.	9.93
22	6507	212	30.69	82.40	0.	549.	7.05
23	7076	212	33.38	81.90	0.	529.	3.25
24	7760	212	36.60	80.50	0.	474.	5.87
25	7066	212	33.33	72.60	4.	247.	0.74
26	4930	212	23.25	63.00	118.	65.	2.03
27	4373	212	20.63	60.10	197.	49.	2.77
28	3933	212	18.55	50.60	440.	1.	1.81
29	3793	212	17.89	57.40	218.	13.	1.76
30	3317	212	15.65	69.70	41.	192.	1.82
31	4848	212	22.87	70.60	8.	182.	0.14
32	4698	212	22.16	75.20	0.	324.	1.47
33	5614	212	26.48	82.60	0.	534.	4.47
34	6449	212	30.42	82.00	0.	537.	6.61
35	6287	212	29.66	81.50	0.	521.	6.28
36	7203	212	33.98	82.60	0.	536.	7.03
37	6507	212	30.69	72.90	6.	257.	0.43
38	5185	212	24.46	69.60	38.	185.	2.60
39	4431	212	20.90	61.00	179.	62.	3.70
40	3862	212	18.22	56.80	275.	26.	2.49
41	4141	212	19.53	55.80	255.	3.	5.49
42	3433	212	16.19	66.30	71.	116.	2.14
43	3514	212	16.58	73.40	0.	259.	0.61
44	5069	212	23.91	79.30	0.	449.	3.16
45	6925	212	32.67	82.90	0.	541.	10.00
46	7029	212	33.16	83.60	0.	550.	11.92
47	7250	212	34.20	82.60	0.	553.	5.13
48	7760	212	36.60	81.70	0.	508.	4.31
49	6600	212	31.13	75.00	0.	321.	1.51
50	5359	212	25.28	72.30	0.	225.	0.18
51	6148	212	29.00	66.80	56.	115.	3.69
52	4362	212	20.58	58.20	230.	26.	6.48
53	4083	212	19.26	58.40	214.	31.	1.45
54	3816	212	18.00	64.60	71.	65.	3.24
55	4000	212	18.87	73.40	0.	260.	1.08
56	6800	212	32.08	75.40	0.	330.	7.66
57	6392	212	30.15	80.70	0.	479.	4.00
58	6531	212	30.81	83.30	0.	575.	7.95
59	7378	212	34.80	82.40	0.	546.	5.88
60	7447	212	35.13	81.30	0.	498.	9.19

61	6809	212	32.12	74.40	0.	299.	0.43
62	6148	212	29.00	68.30	47.	153.	1.93
63	5371	212	25.33	62.60	119.	53.	0.94
64	3573	212	16.85	60.50	161.	27.	2.45
65	4478	212	21.12	57.20	245.	25.	1.64
66	3863	212	18.22	68.20	61.	169.	1.51
67	4953	212	23.36	70.40	4.	172.	4.07
68	5475	212	25.83	76.40	0.	362.	6.96
69	6206	212	29.27	80.10	0.	459.	5.25
70	6902	212	32.56	83.60	0.	586.	5.14
71	7575	212	35.73	83.60	0.	582.	2.92
72	7146	212	33.71	81.70	0.	508.	3.70
73	8665	212	40.87	75.40	1.	331.	0.55
74	9222	212	43.50	67.10	67.	138.	6.55
75	6009	212	28.34	59.00	190.	12.	0.47
76	6484	212	30.58	51.30	416.	0.	0.21
77	6276	212	29.60	61.70	119.	34.	4.36
78	7830	212	36.93	64.00	76.	52.	1.85
79	9408	212	44.38	73.10	1.	253.	0.18
80	7668	212	36.17	76.70	0.	372.	2.02
81	8410	212	39.67	83.20	0.	552.	12.49
82	6484	212	30.58	84.10	0.	602.	3.53
83	10324	212	48.70	82.90	0.	559.	5.60
84	7714	212	36.39	80.00	0.	458.	8.26

SUMMARY OF DATA FOR NRMC PORTSMOUTH

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	19627	1087	18.06	58.70	213.	26.	1.23
2	15799	1087	14.53	53.50	371.	32.	1.22
3	12586	1087	11.58	46.00	584.	0.	3.81
4	13085	1087	12.04	46.00	584.	2.	4.18
5	15034	1087	13.83	45.40	547.	3.	4.18
6	13572	1087	12.49	47.40	541.	0.	5.72
7	12319	1087	11.33	52.70	382.	22.	4.19
8	20184	1087	18.57	68.30	47.	157.	3.37
9	23525	1087	21.64	77.00	0.	366.	1.16
10	27770	1087	25.55	78.60	0.	429.	13.73
11	26309	1087	24.20	79.60	0.	460.	0.74
12	24986	1087	22.99	72.30	6.	233.	4.82
13	18792	1087	17.29	63.40	98.	55.	3.19
14	17887	1087	16.46	55.70	290.	17.	1.63
15	15034	1087	13.83	43.20	671.	0.	3.62
16	13920	1087	12.81	38.90	804.	1.	2.51
17	14338	1087	13.19	49.90	443.	13.	1.50
18	15173	1087	13.96	53.40	362.	11.	2.21
19	16356	1087	15.05	61.90	186.	102.	0.99
20	16982	1087	15.62	66.30	62.	110.	3.74
21	24360	1087	22.41	75.90	6.	337.	1.59
22	25334	1087	23.31	78.20	0.	417.	5.19
23	24986	1087	22.99	75.90	0.	347.	2.62
24	24290	1087	22.35	71.10	0.	193.	3.51
25	17609	1087	16.20	57.70	245.	27.	2.90
26	15312	1087	14.09	45.90	566.	0.	2.38
27	13433	1087	12.36	41.40	726.	0.	3.22
28	13642	1087	12.55	29.20	1104.	0.	3.33
29	14059	1087	12.93	41.50	657.	4.	2.23
30	15556	1087	14.31	54.70	330.	16.	4.05
31	16843	1087	15.50	61.90	150.	66.	2.20
32	19418	1087	17.86	68.20	40.	145.	3.86
33	23664	1087	21.77	74.30	1.	289.	2.41
34	28188	1087	25.93	81.40	0.	515.	2.70
35	27492	1087	25.29	81.00	0.	502.	4.57
36	26564	1087	24.44	76.30	0.	347.	3.00
37	16634	1087	15.30	60.50	158.	24.	6.09
38	17678	1087	16.26	54.80	321.	22.	5.41
39	15590	1087	14.34	43.50	661.	0.	3.92
40	14268	1087	13.13	37.00	860.	0.	6.32
41	16147	1087	14.85	32.60	902.	0.	1.91
42	14825	1087	13.64	46.10	580.	0.	7.80
43	15242	1087	14.02	57.20	235.	9.	2.90
44	16634	1087	15.30	65.60	72.	96.	5.64
45	25265	1087	23.24	74.10	3.	286.	7.84
46	27074	1087	24.91	76.10	0.	352.	4.19
47	28536	1087	26.25	80.50	0.	487.	1.66
48	29174	1087	26.84	73.20	3.	257.	1.17
49	18026	1087	16.58	60.80	162.	36.	1.50
50	18235	1087	16.78	56.00	268.	3.	4.40
51	14686	1087	13.51	45.30	614.	9.	2.31
52	15312	1087	14.09	39.40	787.	0.	6.47
53	14848	1087	13.66	33.30	879.	0.	5.01
54	13294	1087	12.23	49.10	499.	11.	5.13
55	15869	1087	14.60	58.10	213.	13.	7.00
56	18792	1087	17.29	66.70	52.	112.	10.12
57	23038	1087	21.19	70.40	5.	171.	2.97
58	24151	1087	22.22	77.10	0.	385.	4.69
59	25404	1087	23.37	78.50	0.	426.	1.79
60	27005	1087	24.84	72.80	0.	239.	13.80

61	17539	1087	16.14	60.40	190.	54.	1.74
62	16634	1087	15.30	56.40	272.	22.	5.26
63	14338	1087	13.19	44.90	616.	0.	0.98
64	13711	1087	12.61	40.30	759.	0.	4.54
65	16217	1087	14.92	34.70	872.	0.	2.91
66	13224	1087	12.17	46.50	564.	0.	4.40
67	14546	1087	13.38	58.60	196.	11.	3.25
68	17330	1087	15.94	67.80	58.	153.	5.17
69	23177	1087	21.32	73.90	2.	274.	1.39
70	26448	1087	24.33	80.90	0.	499.	1.85
71	30902	1087	28.43	80.90	0.	497.	4.54
72	26726	1148	23.28	76.10	11.	351.	1.47
73	18653	1148	16.25	60.40	181.	45.	4.21
74	13920	1148	12.13	49.90	449.	1.	2.01
75	16774	1148	14.61	42.30	699.	1.	2.64
76	14825	1148	12.91	32.70	994.	0.	1.05
77	14616	1148	12.73	43.10	610.	0.	2.26
78	13990	1148	12.19	45.40	605.	0.	1.88
79	18583	1148	16.19	61.20	159.	51.	2.26
80	17539	1148	15.28	65.10	96.	103.	2.75
81	30485	1148	26.55	78.30	0.	407.	5.00
82	28536	1148	24.86	79.80	0.	468.	5.10
83	26726	1148	23.28	75.10	0.	320.	6.87
84	23734	1148	20.67	70.70	12.	189.	3.18

SUMMARY OF DATA FOR NRMC PHILADELPHIA

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	6705	822	8.16	54.80	313.	5.	1.93
2	7006	822	8.52	48.50	500.	12.	0.81
3	6914	822	8.41	39.40	786.	0.	4.04
4	6322	822	7.69	37.30	852.	0.	4.00
5	6705	822	8.16	35.80	812.	0.	2.91
6	7122	822	8.66	41.20	732.	0.	4.68
7	6461	822	7.86	48.70	483.	0.	2.97
8	8932	822	10.87	66.60	66.	121.	4.99
9	10405	822	12.66	72.20	4.	224.	7.57
10	13328	822	16.21	76.60	0.	366.	6.32
11	13584	822	16.53	77.10	0.	380.	2.21
12	9848	822	11.98	66.60	45.	98.	7.21
13	8851	822	10.77	61.20	152.	42.	3.24
14	8155	822	9.92	52.70	372.	12.	3.14
15	7958	822	9.68	36.90	866.	0.	2.89
16	6925	822	8.42	28.70	1120.	0.	4.50
17	7227	822	8.79	40.90	692.	0.	1.66
18	7459	822	9.07	46.30	572.	0.	2.38
19	8561	822	10.41	56.60	307.	64.	2.06
20	8375	822	10.19	62.70	119.	58.	4.35
21	12226	822	14.87	75.20	13.	326.	3.42
22	11948	822	14.54	75.30	0.	326.	4.04
23	12412	822	15.10	74.80	2.	315.	2.17
24	10858	822	13.21	67.30	42.	115.	2.44
25	7285	772	9.44	52.50	387.	7.	4.30
26	7436	772	9.63	39.90	743.	0.	0.32
27	6438	772	8.34	30.30	1069.	0.	1.63
28	6357	772	8.23	20.00	1390.	0.	2.61
29	7227	772	9.36	33.60	873.	0.	1.33
30	6484	772	8.40	48.80	505.	10.	4.19
31	7088	772	9.18	57.20	258.	32.	5.59
32	8155	772	10.56	65.80	73.	104.	0.70
33	10440	772	13.52	68.60	36.	150.	5.33
34	11554	772	14.97	77.80	0.	402.	1.47
35	11832	772	15.33	76.20	0.	355.	8.70
36	9709	772	12.58	69.90	24.	175.	3.44
37	6508	772	8.43	54.30	328.	3.	3.11
38	7227	772	9.36	46.40	558.	6.	7.76
39	6090	772	7.89	32.60	998.	0.	5.19
40	5870	772	7.60	28.00	1139.	0.	8.86
41	6276	772	8.13	24.70	1121.	0.	1.35
42	5730	645	8.88	39.00	797.	0.	4.31
43	5893	645	9.14	50.60	423.	0.	1.76
44	6310	645	9.78	61.40	161.	57.	6.01
45	9535	645	14.78	72.60	10.	244.	1.75
46	8978	645	13.92	75.60	5.	338.	5.27
47	11704	645	18.15	79.20	0.	447.	6.04
48	8944	645	13.87	68.50	41.	153.	1.59
49	6334	645	9.82	55.50	296.	8.	1.20
50	6983	645	10.83	47.90	507.	0.	2.20
51	6055	645	9.39	38.60	811.	0.	5.61
52	6229	645	9.66	32.50	999.	0.	8.74
53	5765	645	8.94	23.00	1170.	0.	6.44
54	4802	645	7.45	47.00	556.	6.	2.43
55	6194	645	9.60	52.30	378.	5.	4.08
56	6438	645	9.98	66.40	38.	90.	3.98
57	7099	645	11.01	69.10	17.	146.	4.34
58	8781	645	13.61	76.20	4.	357.	3.95
59	8862	645	13.74	75.50	7.	339.	5.95
60	8004	645	12.41	68.50	28.	137.	4.89

61	5939	645	9.21	54.90	324.	16.	3.84
62	6020	645	9.33	50.10	439.	1.	2.48
63	5464	645	8.47	38.20	823.	0.	1.67
64	5765	645	8.94	31.80	1021.	0.	2.27
65	5417	645	8.40	29.70	1016.	0.	0.96
66	5266	645	8.16	40.20	753.	0.	7.01
67	5719	645	8.87	54.70	301.	0.	4.79
68	6044	645	9.37	65.40	72.	89.	3.22
69	6925	645	10.74	70.60	17.	194.	1.73
70	10510	645	16.29	78.50	0.	428.	6.58
71	9582	645	14.86	80.00	0.	470.	0.80
72	8897	645	13.79	72.20	22.	244.	2.79
73	5997	645	9.30	54.90	320.	10.	5.03
74	5266	645	8.16	43.20	546.	0.	2.85
75	5974	645	9.26	32.50	999.	0.	0.77
76	5452	645	8.45	25.30	1222.	0.	0.50
77	5777	645	8.96	37.90	752.	0.	2.94
78	5174	645	8.02	40.00	768.	0.	1.61
79	4536	645	7.03	54.70	309.	9.	3.60
80	5754	645	8.92	62.60	129.	62.	4.53
81	8294	645	12.86	72.00	4.	224.	4.40
82	10428	645	16.17	76.90	0.	373.	4.54
83	8306	645	12.88	74.90	0.	315.	5.11
84	7598	645	11.78	66.80	58.	119.	2.83

SUMMARY OF DATA FOR NRMC SAN DIEGO

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	21007	1744	12.05	66.80	14.	75.	1.03
2	19917	1744	11.42	62.20	97.	19.	0.14
3	14337	1744	8.22	56.30	265.	0.	2.20
4	15000	1744	8.60	56.10	273.	0.	0.49
5	18326	1744	10.51	56.40	237.	0.	0.96
6	14326	1744	8.21	57.50	225.	0.	3.79
7	17585	1744	10.08	58.70	182.	0.	2.00
8	17400	1744	9.98	62.20	83.	1.	0.01
9	18780	1744	10.77	65.00	10.	18.	0.02
10	19128	1744	10.97	69.40	0.	142.	0.0
11	20787	1744	11.92	68.90	0.	124.	0.0
12	20798	1744	11.93	71.50	0.	201.	0.0
13	19430	1744	11.14	65.90	19.	54.	0.09
14	18513	1744	10.62	60.40	141.	8.	0.64
15	18328	1744	10.51	56.90	246.	0.	0.37
16	17214	1744	9.87	58.90	196.	14.	0.0
17	19894	1744	11.41	59.60	150.	0.	5.40
18	15230	1744	8.73	60.30	148.	10.	0.99
19	17643	1744	10.12	61.00	115.	3.	1.33
20	17272	1744	9.90	65.20	16.	31.	0.27
21	19499	1744	11.18	69.70	0.	147.	0.02
22	19685	1744	11.29	71.10	0.	196.	0.02
23	19870	1744	11.39	72.40	0.	240.	0.01
24	19314	1744	11.07	73.80	0.	269.	1.00
25	18026	1744	10.34	71.20	0.	200.	0.38
26	18386	1744	10.54	66.80	39.	102.	0.75
27	16031	1474	10.88	60.70	129.	0.	1.06
28	15300	1474	10.38	60.30	143.	5.	2.36
29	17516	1474	11.88	61.70	94.	9.	0.06
30	14929	1474	10.13	57.50	224.	0.	0.61
31	15622	1474	10.60	61.40	103.	2.	0.01
32	15810	1474	10.73	61.90	88.	1.	1.79
33	16367	1474	11.10	65.80	3.	34.	0.03
34	16448	1474	11.16	71.60	0.	212.	0.0
35	17840	1474	12.10	73.10	0.	258.	2.13
36	18362	1474	12.46	72.20	0.	224.	0.0
37	17052	1474	11.57	68.90	0.	128.	0.50
38	16808	1474	11.40	64.90	37.	40.	0.05
39	15532	1474	10.54	63.30	55.	8.	1.67
40	15080	1474	10.23	61.00	117.	1.	5.95
41	15926	1474	10.80	60.90	117.	7.	2.64
42	13630	1474	9.25	64.30	52.	38.	5.00
43	15532	1474	10.54	63.40	43.	4.	0.73
44	15926	1474	10.80	68.20	8.	115.	0.04
45	16634	1474	11.28	71.30	0.	194.	0.0
46	15509	1474	10.52	71.60	0.	213.	0.0
47	18014	1474	12.22	72.90	0.	251.	0.0
48	18038	1474	12.24	74.00	0.	276.	0.72
49	15764	1474	10.69	70.10	0.	166.	0.05
50	17330	1474	11.76	61.70	102.	11.	2.09
51	15834	1474	10.74	55.20	297.	0.	2.19
52	15486	1474	10.51	56.90	244.	0.	5.82
53	15323	1474	10.40	56.90	219.	0.	0.85
54	15138	1474	10.27	60.10	153.	10.	3.71
55	15416	1474	10.46	63.40	45.	6.	0.02
56	15500	1474	10.52	65.60	20.	46.	0.09
57	17156	1474	11.64	70.20	6.	169.	0.01
58	16414	1474	11.14	71.80	0.	216.	0.09
59	17145	1474	11.63	73.90	0.	283.	0.01
60	17168	1474	11.65	76.30	0.	348.	0.0

61	19186	1474	13.02	68.70	4.	124.	0.73
62	16518	1474	11.21	62.40	75.	5.	0.27
63	16611	1474	11.27	60.60	136.	8.	0.02
64	15614	1474	10.59	61.10	117.	2.	5.58
65	16298	1474	11.06	63.50	50.	13.	4.47
66	15938	1474	10.81	61.50	104.	3.	2.71
67	15231	1474	10.33	63.90	61.	35.	1.18
68	16054	1474	10.89	63.80	43.	15.	0.65
69	15405	1474	10.45	68.50	1.	110.	0.01
70	15741	1474	10.68	72.90	0.	253.	0.0
71	17528	1474	11.89	74.20	0.	289.	0.0
72	18838	1474	12.78	70.40	0.	170.	0.0
73	16449	1474	11.16	67.30	6.	86.	0.05
74	16565	1474	11.24	62.70	75.	15.	0.0
75	17574	1474	11.92	60.80	133.	7.	0.31
76	16774	1474	11.38	61.30	113.	7.	1.48
77	15312	1474	10.39	62.20	101.	29.	2.26
78	15776	1474	10.70	61.10	116.	0.	3.74
79	16159	1474	10.96	64.40	40.	26.	0.22
80	15254	1474	10.35	67.30	1.	81.	0.04
81	15892	1474	10.78	72.90	0.	244.	0.0
82	18954	1474	12.86	75.60	0.	335.	0.0
83	18131	1474	12.30	75.80	0.	343.	0.0
84	18142	1474	12.31	73.70	0.	265.	0.03

SUMMARY OF DATA FOR NRMC STUDY GROUP

MONTH	MBTU	KSF	MBTU/KSF	AVG TEMP	HDD	CDD	PRECIP
1	135891	8448	16.09	63.36	1508.	983.	24.03
2	126989	8448	15.03	56.49	3418.	433.	18.73
3	114547	8448	13.56	49.51	5769.	96.	37.09
4	122019	8448	14.44	50.38	5552.	231.	35.40
5	120461	8448	14.26	51.17	4798.	321.	35.42
6	119246	8448	14.12	53.57	4556.	386.	47.84
7	120892	8448	14.31	58.76	3041.	874.	38.12
8	136309	8448	16.14	69.50	659.	2410.	45.44
9	146575	8448	17.35	74.18	197.	3585.	42.86
10	166621	8448	19.72	76.47	110.	4457.	60.33
11	163985	8448	19.41	77.27	75.	4711.	37.47
12	150033	8448	17.76	72.45	358.	3116.	42.73
13	141481	8448	16.75	66.51	965.	1628.	29.97
14	136818	8448	16.20	58.08	3003.	596.	23.19
15	126635	8448	14.99	49.07	5936.	91.	25.01
16	123327	8448	14.60	45.41	7304.	94.	18.73
17	122621	8448	14.51	53.57	4098.	204.	23.62
18	122677	8448	14.52	58.00	3125.	615.	28.32
19	131758	8448	15.60	61.87	1957.	916.	20.62
20	131934	8448	15.62	66.70	846.	1566.	57.53
21	153871	8448	18.21	74.13	333.	3541.	37.42
22	158894	8448	18.81	76.69	72.	4509.	47.68
23	158302	8448	18.74	75.75	49.	4136.	35.07
24	157735	8448	18.67	72.49	241.	3019.	47.17
25	136102	8398	16.21	62.53	1956.	1118.	32.96
26	130311	8398	15.52	52.42	4739.	298.	23.66
27	119540	8128	14.71	47.04	6565.	60.	33.37
28	113979	8128	14.02	39.58	9391.	16.	30.57
29	118551	8128	14.59	48.17	5629.	51.	17.45
30	118918	8128	14.63	57.28	3307.	516.	33.14
31	128231	8128	15.78	63.26	1478.	935.	26.08
32	136204	8128	16.76	68.99	714.	2283.	24.76
33	148661	8128	18.29	74.32	223.	3667.	32.14
34	162663	8128	20.01	78.62	111.	5267.	25.18
35	166202	8128	20.45	78.02	56.	4981.	49.24
36	159993	8128	19.68	75.22	121.	3882.	39.96
37	135185	8128	16.63	64.16	1460.	1218.	31.69
38	130091	8128	16.01	58.60	2889.	668.	44.69
39	119662	8128	14.72	50.10	5786.	171.	41.86
40	119871	8128	14.75	43.60	7930.	50.	68.32
41	117922	8128	14.51	42.76	7429.	26.	36.33
42	115218	8001	14.40	53.90	4386.	343.	47.34
43	121639	8001	15.20	61.83	1935.	889.	29.52
44	134045	8001	16.75	68.82	804.	2297.	47.39
45	153129	8001	19.14	74.50	199.	3698.	48.86
46	159809	8001	19.97	76.93	117.	4607.	51.13
47	170865	8001	21.36	77.69	69.	4880.	32.69
48	167872	8001	20.98	74.77	135.	3732.	38.51
49	135915	8001	16.99	64.69	1333.	1305.	14.23
50	127587	8001	15.95	58.77	2728.	568.	30.28
51	118822	8001	14.85	49.37	5969.	232.	44.50
52	117729	8001	14.71	43.47	7984.	53.	74.68
53	111162	8001	13.89	44.05	7045.	85.	40.84
54	114967	7972	14.42	55.18	3877.	308.	40.93
55	122088	7972	15.31	61.84	1937.	893.	43.62
56	132280	7972	16.59	68.26	581.	1882.	52.91
57	149282	7972	18.73	73.07	191.	3176.	36.29
58	153422	7972	19.25	77.14	75.	4676.	44.92
59	159442	7972	20.00	77.00	82.	4628.	38.64
60	154766	7947	19.47	74.20	103.	3494.	92.05

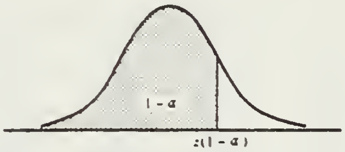
61	138874	7970	17.42	65.05	1287.	1382.	19.97
62	126858	7970	15.92	57.14	3134.	400.	38.00
63	118217	7970	14.83	50.48	6445.	125.	26.53
64	116848	7970	14.66	48.09	6277.	75.	46.73
65	122391	7970	15.36	46.30	6542.	118.	35.06
66	114840	8053	14.26	53.61	4546.	401.	58.03
67	122381	8053	15.20	61.37	1925.	693.	37.13
68	139628	8053	17.34	68.12	771.	2022.	36.54
69	141253	8053	17.54	73.63	269.	3458.	40.84
70	162574	8053	20.19	79.06	76.	5391.	39.16
71	170613	8053	21.19	78.75	112.	5303.	39.00
72	162377	8114	20.01	74.96	183.	3852.	35.66
73	138573	8114	17.08	63.77	1605.	1227.	23.14
74	130198	8114	16.05	55.17	3745.	285.	30.82
75	125164	7959	15.73	48.62	6087.	68.	19.02
76	125325	7959	15.75	43.76	6996.	11.	18.65
77	119399	7959	15.00	50.56	4449.	130.	32.25
78	124874	7959	15.69	53.21	3926.	162.	34.22
79	134989	7959	16.96	65.11	1401.	1231.	21.64
80	136590	7959	17.16	68.12	876.	1814.	41.36
81	162782	7959	20.45	76.87	469.	4523.	45.56
82	169488	7959	21.30	78.61	549.	5196.	49.80
83	166547	7959	20.93	76.99	432.	4553.	61.29
84	158653	7959	19.93	72.31	507.	2955.	22.80

APPENDIX ?

STATISTICAL TABLES

A. CUMULATIVE PROBABILITIES OF STANDARD NORMAL DISTRIBUTION

Entry is area $1 - \alpha$ under the standard normal curve from $-\infty$ to $z(1 - \alpha)$

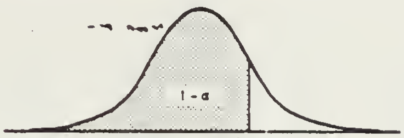


z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Source: Neter, John and Wasserman, William, Applied Linear Statistical Models Irwin, 1974

B. PERCENTILES OF THE t-DISTRIBUTION

Entry is $t(1-\alpha;\nu)$ where $P\{t(\nu) \leq t(1-\alpha;\nu)\} = 1-\alpha$



ν	$1-\alpha$ .55	.60	.65	.70	.75	.80	.85
1	0.158	0.325	0.510	0.727	1.000	1.376	1.963
2	0.142	0.289	0.445	0.617	0.816	1.061	1.386
3	0.137	0.277	0.424	0.584	0.765	0.978	1.250
4	0.134	0.271	0.414	0.569	0.741	0.941	1.190
5	0.132	0.267	0.408	0.559	0.727	0.920	1.156
6	0.131	0.265	0.404	0.553	0.718	0.906	1.134
7	0.130	0.263	0.402	0.549	0.711	0.896	1.119
8	0.130	0.262	0.399	0.546	0.706	0.889	1.108
9	0.129	0.261	0.398	0.543	0.703	0.883	1.100
10	0.129	0.260	0.397	0.542	0.700	0.879	1.093
11	0.129	0.260	0.396	0.540	0.697	0.876	1.088
12	0.128	0.259	0.395	0.539	0.695	0.873	1.083
13	0.128	0.259	0.394	0.538	0.694	0.870	1.079
14	0.128	0.258	0.393	0.537	0.692	0.868	1.076
15	0.128	0.258	0.393	0.536	0.691	0.866	1.074
16	0.128	0.258	0.392	0.535	0.690	0.865	1.071
17	0.128	0.257	0.392	0.534	0.689	0.863	1.069
18	0.127	0.257	0.392	0.534	0.688	0.862	1.067
19	0.127	0.257	0.391	0.533	0.688	0.861	1.066
20	0.127	0.257	0.391	0.533	0.687	0.860	1.064
21	0.127	0.257	0.391	0.532	0.686	0.859	1.063
22	0.127	0.256	0.390	0.532	0.686	0.858	1.061
23	0.127	0.256	0.390	0.532	0.685	0.858	1.060
24	0.127	0.256	0.390	0.531	0.685	0.857	1.059
25	0.127	0.256	0.390	0.531	0.684	0.856	1.058
26	0.127	0.256	0.390	0.531	0.684	0.856	1.058
27	0.127	0.256	0.389	0.531	0.684	0.855	1.057
28	0.127	0.256	0.389	0.530	0.683	0.855	1.056
29	0.127	0.256	0.389	0.530	0.683	0.854	1.055
30	0.127	0.256	0.389	0.530	0.683	0.854	1.055
40	0.126	0.255	0.388	0.529	0.681	0.851	1.050
60	0.126	0.254	0.387	0.527	0.679	0.848	1.046
120	0.126	0.254	0.386	0.526	0.677	0.845	1.041
∞	0.126	0.253	0.385	0.524	0.674	0.842	1.036

Source: Neter, John and Wasserman, William, <u>Applied Linear Statistical Models</u> Irwin, 1974

C. PERCENTILES OF THE F-DISTRIBUTION

		ν_1								
ν_2	$1-\alpha$	1	2	3	4	5	6	7	8	9
1	.50	1.00	1.50	1.71	1.82	1.89	1.94	1.98	2.00	2.03
	.90	39.9	49.5	53.6	55.8	57.2	58.2	58.9	59.4	59.9
	.95	161	200	216	225	230	234	237	239	241
	.975	648	800	864	900	922	937	948	957	963
	.99	4,052	5,000	5,403	5,625	5,764	5,859	5,928	5,981	6,022
	.995	16,211	20,000	21,615	22,500	23,056	23,437	23,715	23,925	24,091
	.999	405,280	500,000	540,380	562,500	576,400	585,940	592,870	598,140	602,280
2	.50	0.667	1.00	1.13	1.21	1.25	1.28	1.30	1.32	1.33
	.90	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38
	.95	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4
	.975	38.5	39.0	39.2	39.2	39.3	39.3	39.4	39.4	39.4
	.99	98.5	99.0	99.2	99.2	99.3	99.3	99.4	99.4	99.4
	.995	199	199	199	199	199	199	199	199	199
	.999	998.5	999.0	999.2	999.2	999.3	999.3	999.4	999.4	999.4
3	.50	0.585	0.881	1.00	1.06	1.10	1.13	1.15	1.16	1.17
	.90	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24
	.95	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
	.975	17.4	16.0	15.4	15.1	14.9	14.7	14.6	14.5	14.5
	.99	34.1	30.8	29.5	28.7	28.2	27.9	27.7	27.5	27.3
	.995	55.6	49.8	47.5	46.2	45.4	44.8	44.4	44.1	43.9
	.999	167.0	148.5	141.1	137.1	134.6	132.8	131.6	130.6	129.9
4	.50	0.549	0.828	0.941	1.00	1.04	1.06	1.08	1.09	1.10
	.90	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94
	.95	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
	.975	12.2	10.6	9.98	9.60	9.36	9.20	9.07	8.98	8.90
	.99	21.2	18.0	16.7	16.0	15.5	15.2	15.0	14.8	14.7
	.995	31.3	26.3	24.3	23.2	22.5	22.0	21.6	21.4	21.1
	.999	74.1	61.2	56.2	53.4	51.7	50.5	49.7	49.0	48.5
5	.50	0.528	0.799	0.907	0.965	1.00	1.02	1.04	1.05	1.06
	.90	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32
	.95	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
	.975	10.0	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68
	.99	16.3	13.3	12.1	11.4	11.0	10.7	10.5	10.3	10.2
	.995	22.8	18.3	16.5	15.6	14.9	14.5	14.2	14.0	13.8
	.999	47.2	37.1	33.2	31.1	29.8	28.8	28.2	27.6	27.2
6	.50	0.515	0.780	0.886	0.942	0.977	1.00	1.02	1.03	1.04
	.90	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96
	.95	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
	.975	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52
	.99	13.7	10.9	9.78	9.15	8.75	8.47	8.26	8.10	7.98
	.995	18.6	14.5	12.9	12.0	11.5	11.1	10.8	10.6	10.4
	.999	35.5	27.0	23.7	21.9	20.8	20.0	19.5	19.0	18.7
7	.50	0.506	0.767	0.871	0.926	0.960	0.983	1.00	1.01	1.02
	.90	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72
	.95	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
	.975	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82
	.99	12.2	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72
	.995	16.2	12.4	10.9	10.1	9.52	9.16	8.89	8.68	8.51
	.999	29.2	21.7	18.8	17.2	16.2	15.5	15.0	14.6	14.3

PERCENTILES OF THE F DISTRIBUTION

ν_2	$1-\alpha$	ν_1 = 10	12	15	20	24	30	60	120	∞
1	.50	2.04	2.07	2.09	2.12	2.13	2.15	2.17	2.18	2.20
	.90	60.2	60.7	61.2	61.7	62.0	62.3	62.8	63.1	63.3
	.95	242	244	246	248	249	250	252	253	254
	.975	969	977	985	993	997	1,001	1,010	1,014	1,018
	.99	6,056	6,106	6,157	6,209	6,235	6,261	6,313	6,339	6,366
	.995	24,224	24,426	24,630	24,836	24,940	25,044	25,253	25,359	25,464
	.999	605,620	610,670	615,760	620,910	623,500	626,100	631,340	633,970	636,620
2	.50	1.34	1.36	1.38	1.39	1.40	1.41	1.43	1.43	1.44
	.90	9.39	9.41	9.42	9.44	9.45	9.46	9.47	9.48	9.49
	.95	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5
	.975	39.4	39.4	39.4	39.4	39.5	39.5	39.5	39.5	39.5
	.99	99.4	99.4	99.4	99.4	99.5	99.5	99.5	99.5	99.5
	.995	199	199	199	199	199	199	199	199	200
	.999	999.4	999.4	999.4	999.4	999.5	999.5	999.5	999.5	999.5
3	.50	1.18	1.20	1.21	1.23	1.23	1.24	1.25	1.26	1.27
	.90	5.23	5.22	5.20	5.18	5.18	5.17	5.15	5.14	5.13
	.95	8.79	8.74	8.70	8.66	8.64	8.62	8.57	8.55	8.53
	.975	14.4	14.3	14.3	14.2	14.1	14.1	14.0	13.9	13.9
	.99	27.2	27.1	26.9	26.7	26.6	26.5	26.3	26.2	26.1
	.995	43.7	43.4	43.1	42.8	42.6	42.5	42.1	42.0	41.8
	.999	129.2	128.3	127.4	126.4	125.9	125.4	124.5	124.0	123.5
4	.50	1.11	1.13	1.14	1.15	1.16	1.16	1.18	1.18	1.19
	.90	3.92	3.90	3.87	3.84	3.83	3.82	3.79	3.78	3.76
	.95	5.96	5.91	5.86	5.80	5.77	5.75	5.69	5.66	5.63
	.975	8.84	8.75	8.66	8.56	8.51	8.46	8.36	8.31	8.26
	.99	14.5	14.4	14.2	14.0	13.9	13.8	13.7	13.6	13.5
	.995	21.0	20.7	20.4	20.2	20.0	19.9	19.6	19.5	19.3
	.999	48.1	47.4	46.8	46.1	45.8	45.4	44.7	44.4	44.1
5	.50	1.07	1.09	1.10	1.11	1.12	1.12	1.14	1.14	1.15
	.90	3.30	3.27	3.24	3.21	3.19	3.17	3.14	3.12	3.11
	.95	4.74	4.68	4.62	4.56	4.53	4.50	4.43	4.40	4.37
	.975	6.62	6.52	6.43	6.33	6.28	6.23	6.12	6.07	6.02
	.99	10.1	9.89	9.72	9.55	9.47	9.38	9.20	9.11	9.02
	.995	13.6	13.4	13.1	12.9	12.8	12.7	12.4	12.3	12.1
	.999	26.9	26.4	25.9	25.4	25.1	24.9	24.3	24.1	23.8
6	.50	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.12
	.90	2.94	2.90	2.87	2.84	2.82	2.80	2.76	2.74	2.72
	.95	4.06	4.00	3.94	3.87	3.84	3.81	3.74	3.70	3.67
	.975	5.46	5.37	5.27	5.17	5.12	5.07	4.96	4.90	4.85
	.99	7.87	7.72	7.56	7.40	7.31	7.23	7.06	6.97	6.88
	.995	10.2	10.0	9.81	9.59	9.47	9.36	9.12	9.00	8.88
	.999	18.4	18.0	17.6	17.1	16.9	16.7	16.2	16.0	15.7
7	.50	1.03	1.04	1.05	1.07	1.07	1.08	1.09	1.10	1.10
	.90	2.70	2.67	2.63	2.59	2.58	2.56	2.51	2.49	2.47
	.95	3.64	3.57	3.51	3.44	3.41	3.38	3.30	3.27	3.23
	.975	4.76	4.67	4.57	4.47	4.42	4.36	4.25	4.20	4.14
	.99	6.62	6.47	6.31	6.16	6.07	5.99	5.82	5.74	5.65
	.995	8.38	8.18	7.97	7.75	7.65	7.53	7.31	7.19	7.08
	.999	14.1	13.7	13.3	12.9	12.7	12.5	12.1	11.9	11.7

ν_2	$1-\alpha$	ν_1 = 1	2	3	4	5	6	7	8	9
8	.50	0.499	0.757	0.860	0.915	0.948	0.971	0.988	1.00	1.01
	.90	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56
	.95	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
	.975	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36
	.99	11.3	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91
	.995	14.7	11.0	9.60	8.81	8.30	7.95	7.69	7.50	7.34
	.999	25.4	18.5	15.8	14.4	13.5	12.9	12.4	12.0	11.8
9	.50	0.494	0.749	0.852	0.906	0.939	0.962	0.978	0.990	1.00
	.90	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44
	.95	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
	.975	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03
	.99	10.6	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35
	.995	13.6	10.1	8.72	7.96	7.47	7.13	6.88	6.69	6.54
	.999	22.9	16.4	13.9	12.6	11.7	11.1	10.7	10.4	10.1
10	.50	0.490	0.743	0.845	0.899	0.932	0.954	0.971	0.983	0.992
	.90	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35
	.95	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
	.975	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78
	.99	10.0	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94
	.995	12.8	9.43	8.08	7.34	6.87	6.54	6.30	6.12	5.97
	.999	21.0	14.9	12.6	11.3	10.5	9.93	9.52	9.20	8.96
12	.50	0.484	0.735	0.835	0.888	0.921	0.943	0.959	0.972	0.981
	.90	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21
	.95	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
	.975	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44
	.99	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39
	.995	11.8	8.51	7.23	6.52	6.07	5.76	5.52	5.35	5.20
	.999	18.6	13.0	10.8	9.63	8.89	8.38	8.00	7.71	7.48
15	.50	0.478	0.726	0.826	0.878	0.911	0.933	0.949	0.960	0.970
	.90	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09
	.95	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
	.975	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12
	.99	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89
	.995	10.8	7.70	6.48	5.80	5.37	5.07	4.85	4.67	4.54
	.999	16.6	11.3	9.34	8.25	7.57	7.09	6.74	6.47	6.26
20	.50	0.472	0.718	0.816	0.868	0.900	0.922	0.938	0.950	0.959
	.90	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96
	.95	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
	.975	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84
	.99	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46
	.995	9.94	6.99	5.82	5.17	4.76	4.47	4.26	4.09	3.96
	.999	14.8	9.95	8.10	7.10	6.46	6.02	5.69	5.44	5.24
24	.50	0.469	0.714	0.812	0.863	0.895	0.917	0.932	0.944	0.953
	.90	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91
	.95	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
	.975	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70
	.99	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26
	.995	9.55	6.66	5.52	4.89	4.49	4.20	3.99	3.83	3.69
	.999	14.0	9.34	7.55	6.59	5.98	5.55	5.23	4.99	4.80

PERCENTILES OF THE F DISTRIBUTION

ν_2	$1-\alpha$	ν_1 = 10	12	15	20	24	30	60	120	∞
8	.50	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.08	1.09
	.90	2.54	2.50	2.46	2.42	2.40	2.38	2.34	2.32	2.29
	.95	3.35	3.28	3.22	3.15	3.12	3.08	3.01	2.97	2.93
	.975	4.30	4.20	4.10	4.00	3.95	3.89	3.78	3.73	3.67
	.99	5.81	5.67	5.52	5.36	5.28	5.20	5.03	4.95	4.86
	.995	7.21	7.01	6.81	6.61	6.50	6.40	6.18	6.06	5.95
	.999	11.5	11.2	10.8	10.5	10.3	10.1	9.73	9.53	9.33
9	.50	1.01	1.02	1.03	1.04	1.05	1.05	1.07	1.07	1.08
	.90	2.42	2.38	2.34	2.30	2.28	2.25	2.21	2.18	2.16
	.95	3.14	3.07	3.01	2.94	2.90	2.86	2.79	2.75	2.71
	.975	3.96	3.87	3.77	3.67	3.61	3.56	3.45	3.39	3.33
	.99	5.26	5.11	4.96	4.81	4.73	4.65	4.48	4.40	4.31
	.995	6.42	6.23	6.03	5.83	5.73	5.62	5.41	5.30	5.19
	.999	9.89	9.57	9.24	8.90	8.72	8.55	8.19	8.00	7.81
10	.50	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.06	1.07
	.90	2.32	2.28	2.24	2.20	2.18	2.16	2.11	2.08	2.06
	.95	2.98	2.91	2.84	2.77	2.74	2.70	2.62	2.58	2.54
	.975	3.72	3.62	3.52	3.42	3.37	3.31	3.20	3.14	3.08
	.99	4.85	4.71	4.56	4.41	4.33	4.25	4.08	4.00	3.91
	.995	5.85	5.66	5.47	5.27	5.17	5.07	4.86	4.75	4.64
	.999	8.75	8.45	8.13	7.80	7.64	7.47	7.12	6.94	6.76
12	.50	0.989	1.00	1.01	1.02	1.03	1.03	1.05	1.05	1.06
	.90	2.19	2.15	2.10	2.06	2.04	2.01	1.96	1.93	1.90
	.95	2.75	2.69	2.62	2.54	2.51	2.47	2.38	2.34	2.30
	.975	3.37	3.28	3.18	3.07	3.02	2.96	2.85	2.79	2.72
	.99	4.30	4.16	4.01	3.86	3.78	3.70	3.54	3.45	3.36
	.995	5.09	4.91	4.72	4.53	4.43	4.33	4.12	4.01	3.90
	.999	7.29	7.00	6.71	6.40	6.25	6.09	5.76	5.59	5.42
15	.50	0.977	0.989	1.00	1.01	1.02	1.02	1.03	1.04	1.05
	.90	2.06	2.02	1.97	1.92	1.90	1.87	1.82	1.79	1.76
	.95	2.54	2.48	2.40	2.33	2.29	2.25	2.16	2.11	2.07
	.975	3.06	2.96	2.86	2.76	2.70	2.64	2.52	2.46	2.40
	.99	3.80	3.67	3.52	3.37	3.29	3.21	3.05	2.96	2.87
	.995	4.42	4.25	4.07	3.88	3.79	3.69	3.48	3.37	3.26
	.999	6.08	5.81	5.54	5.25	5.10	4.95	4.64	4.48	4.31
20	.50	0.966	0.977	0.989	1.00	1.01	1.01	1.02	1.03	1.03
	.90	1.94	1.89	1.84	1.79	1.77	1.74	1.68	1.64	1.61
	.95	2.35	2.28	2.20	2.12	2.08	2.04	1.95	1.90	1.84
	.975	2.77	2.68	2.57	2.46	2.41	2.35	2.22	2.16	2.09
	.99	3.37	3.23	3.09	2.94	2.86	2.78	2.61	2.52	2.42
	.995	3.85	3.68	3.50	3.32	3.22	3.12	2.92	2.81	2.69
	.999	5.08	4.82	4.56	4.29	4.15	4.00	3.70	3.54	3.38
24	.50	0.961	0.972	0.983	0.994	1.00	1.01	1.02	1.02	1.03
	.90	1.88	1.83	1.78	1.73	1.70	1.67	1.61	1.57	1.53
	.95	2.25	2.18	2.11	2.03	1.98	1.94	1.84	1.79	1.73
	.975	2.64	2.54	2.44	2.33	2.27	2.21	2.08	2.01	1.94
	.99	3.17	3.03	2.89	2.74	2.66	2.58	2.40	2.31	2.21
	.995	3.59	3.42	3.25	3.06	2.97	2.87	2.66	2.55	2.43
	.999	4.64	4.39	4.14	3.87	3.74	3.59	3.29	3.14	2.97

PERCENTILES OF THE F DISTRIBUTION

		ν_1								
ν_2	$1-\alpha$	1	2	3	4	5	6	7	8	9
30	.50	0.466	0.709	0.807	0.858	0.890	0.912	0.927	0.939	0.948
	.90	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85
	.95	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
	.975	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57
	.99	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07
	.995	9.18	6.35	5.24	4.62	4.23	3.95	3.74	3.58	3.45
	.999	13.3	8.77	7.05	6.12	5.53	5.12	4.82	4.58	4.39
60	.50	0.461	0.701	0.798	0.849	0.880	0.901	0.917	0.928	0.937
	.90	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74
	.95	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
	.975	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33
	.99	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72
	.995	8.49	5.80	4.73	4.14	3.76	3.49	3.29	3.13	3.01
	.999	12.0	7.77	6.17	5.31	4.76	4.37	4.09	3.86	3.69
120	.50	0.458	0.697	0.793	0.844	0.875	0.896	0.912	0.923	0.932
	.90	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68
	.95	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96
	.975	5.15	3.80	3.23	2.89	2.67	2.52	2.39	2.30	2.22
	.99	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56
	.995	8.18	5.54	4.50	3.92	3.55	3.28	3.09	2.93	2.81
	.999	11.4	7.32	5.78	4.95	4.42	4.04	3.77	3.55	3.38
∞	.50	0.455	0.693	0.789	0.839	0.870	0.891	0.907	0.918	0.927
	.90	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63
	.95	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88
	.975	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11
	.99	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41
	.995	7.88	5.30	4.28	3.72	3.35	3.09	2.90	2.74	2.62
	.999	10.8	6.91	5.42	4.62	4.10	3.74	3.47	3.27	3.10

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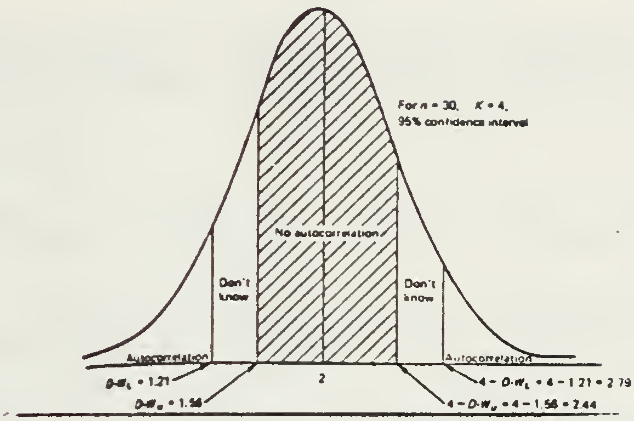
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200
25	4.24	3.38	2.99	2.76	2.60	2.49	2.41	2.34	2.28	2.24	2.20	2.16	2.11	2.06	2.00	1.96	1.92	1.87	1.84	1.80	1.77	1.74
	7.77	*5.57*	*4.68*	*4.18*	*3.86*	*3.63*	*3.46*	*3.32*	*3.21*	*3.13*	*3.05*	*2.99*	*2.89*	*2.81*	*2.70*	*2.62*	*2.54*	*2.45*	*2.40*	*2.32*	*2.29*	*2.23*
25	4.22	3.37	2.89	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15	2.10	2.05	1.99	1.95	1.90	1.85	1.82	1.78	1.76	1.72
	7.72	*5.53*	*4.64*	*4.14*	*3.82*	*3.59*	*3.42*	*3.29*	*3.17*	*3.09*	*3.02*	*2.96*	*2.86*	*2.77*	*2.66*	*2.58*	*2.50*	*2.41*	*2.36*	*2.28*	*2.25*	*2.19*
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.30	2.25	2.20	2.16	2.13	2.08	2.03	1.97	1.93	1.88	1.84	1.80	1.76	1.74	1.71
	7.68	*5.49*	*4.60*	*4.11*	*3.79*	*3.56*	*3.39*	*3.26*	*3.14*	*3.06*	*2.98*	*2.93*	*2.83*	*2.74*	*2.63*	*2.55*	*2.47*	*2.38*	*2.33*	*2.25*	*2.21*	*2.16*
28	4.20	3.34	2.95	2.71	2.56	2.44	2.36	2.29	2.24	2.19	2.15	2.12	2.06	2.02	1.96	1.91	1.87	1.81	1.78	1.75	1.72	1.69
	7.64	*5.45*	*4.57*	*4.07*	*3.76*	*3.53*	*3.36*	*3.23*	*3.11*	*3.03*	*2.95*	*2.90*	*2.80*	*2.71*	*2.60*	*2.52*	*2.44*	*2.35*	*2.30*	*2.22*	*2.18*	*2.13*
29	4.18	3.33	2.93	2.70	2.54	2.43	2.35	2.28	2.22	2.18	2.14	2.10	2.05	2.00	1.94	1.90	1.85	1.80	1.77	1.73	1.71	1.68
	7.60	*5.52*	*4.54*	*4.04*	*3.73*	*3.50*	*3.33*	*3.20*	*3.08*	*3.00*	*2.92*	*2.87*	*2.77*	*2.68*	*2.57*	*2.49*	*2.41*	*2.32*	*2.27*	*2.19*	*2.15*	*2.10*
30	4.17	3.32	2.92	2.69	2.53	2.42	2.34	2.27	2.21	2.16	2.12	2.09	2.04	1.99	1.93	1.89	1.84	1.79	1.76	1.72	1.69	1.66
	7.56	*5.39*	*4.51*	*4.02*	*3.70*	*3.47*	*3.30*	*3.17*	*3.06*	*2.98*	*2.00*	*2.84*	*2.74*	*2.66*	*2.55*	*2.47*	*2.38*	*2.29*	*2.24*	*2.16*	*2.13*	*2.07*
32	4.15	3.30	2.90	2.67	2.51	2.40	2.32	2.25	2.19	2.14	2.10	2.07	2.02	1.97	1.91	1.86	1.82	1.76	1.74	1.69	1.67	1.64
	7.50	*5.34*	*4.46*	*3.97*	*3.66*	*3.42*	*3.25*	*3.12*	*3.01*	*2.94*	*2.86*	*2.80*	*2.70*	*2.62*	*2.51*	*2.42*	*2.34*	*2.25*	*2.20*	*2.12*	*2.08*	*2.02*
34	4.13	3.28	2.88	2.65	2.49	2.38	2.30	2.23	2.17	2.12	2.08	2.05	2.00	1.95	1.89	1.84	1.80	1.74	1.71	1.67	1.64	1.61
	7.44	*5.29*	*4.42*	*3.93*	*3.61*	*3.38*	*3.21*	*3.08*	*2.97*	*2.89*	*2.82*	*2.76*	*2.66*	*2.58*	*2.47*	*2.38*	*2.30*	*2.21*	*2.15*	*2.08*	*2.04*	*1.98*
36	4.11	3.26	2.86	2.63	2.48	2.36	2.28	2.21	2.15	2.10	2.06	2.03	1.89	1.93	1.87	1.82	1.78	1.72	1.69	1.65	1.62	1.59
	7.39	*5.25*	*4.38*	*3.89*	*3.58*	*3.35*	*3.18*	*3.04*	*2.94*	*2.86*	*2.78*	*2.72*	*2.62*	*2.54*	*2.43*	*2.35*	*2.26*	*2.17*	*2.12*	*2.04*	*2.00*	*1.94*
38	4.10	3.25	2.85	2.62	2.46	2.35	2.26	2.19	2.14	2.09	2.05	2.02	1.96	1.92	1.85	1.80	1.76	1.71	1.67	1.63	1.60	1.57
	7.35	*5.21*	*4.34*	*3.86*	*3.54*	*3.32*	*3.15*	*3.02*	*2.91*	*2.82*	*2.75*	*2.69*	*2.59*	*2.51*	*2.40*	*2.32*	*2.22*	*2.14*	*2.08*	*2.00*	*1.97*	*1.90*
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.07	2.04	2.00	1.95	1.90	1.84	1.79	1.74	1.69	1.66	1.61	1.59	1.55
	7.31	*5.18*	*4.31*	*3.83*	*3.51*	*3.29*	*3.12*	*2.99*	*2.88*	*2.80*	*2.73*	*2.66*	*2.56*	*2.49*	*2.37*	*2.29*	*2.20*	*2.11*	*2.05*	*1.97*	*1.94*	*1.88*
42	4.07	3.22	2.83	2.59	2.44	2.32	2.24	2.17	2.11	2.06	2.02	1.99	1.94	1.89	1.82	1.78	1.73	1.68	1.64	1.60	1.57	1.54
	7.27	*5.15*	*4.29*	*3.80*	*3.49*	*3.26*	*3.10*	*2.96*	*2.86*	*2.77*	*2.70*	*2.64*	*2.54*	*2.46*	*2.35*	*2.26*	*2.17*	*2.08*	*2.02*	*1.94*	*1.91*	*1.85*
44	4.06	3.21	2.82	2.58	2.43	2.31	2.23	2.16	2.10	2.05	2.01	1.98	1.92	1.88	1.81	1.76	1.72	1.66	1.63	1.58	1.56	1.52
	7.24	*5.12*	*4.26*	*3.78*	*3.46*	*3.24*	*3.07*	*2.94*	*2.84*	*2.75*	*2.68*	*2.62*	*2.52*	*2.44*	*2.32*	*2.24*	*2.15*	*2.06*	*2.00*	*1.92*	*1.88*	*1.82*
46	4.05	3.20	2.81	2.57	2.42	2.30	2.22	2.14	2.09	2.04	2.00	1.97	1.91	1.87	1.80	1.75	1.71	1.65	1.62	1.57	1.54	1.51
	7.21	*5.10*	*4.24*	*3.76*	*3.44*	*3.22*	*3.05*	*2.92*	*2.82*	*2.73*	*2.66*	*2.60*	*2.50*	*2.42*	*2.30*	*2.22*	*2.13*	*2.04*	*1.98*	*1.90*	*1.86*	*1.80*

Source: Neter, John and Wasserman, William, Applied Linear Statistical Models Irwin, 1974

D. DURBIN-WATSON TEST BOUNDS



5 Percent Significance Points of d_l and d_u (two tailed test)

	k = 1		k = 2		k = 3		k = 4		k = 5	
n	d_l	d_u	d_l	d_u	d_l	d_u	d_l	d_u	d_l	d_u
15	.95	1.23	83	1.40	.71	1.61	59	1.84	48	2 09
16	.98	1.24	86	1 40	.75	1.59	.64	1 80	53	2 03
17	1 01	1 25	90	1 40	.79	1 58	68	1.77	57	1 98
18	1.03	1.26	93	1 40	.82	1 56	72	1.74	62	1 93
19	1 06	1.28	96	1 41	86	1 55	76	1 73	66	1 90
20	1.08	1.28	99	1 41	89	1.55	.79	1 72	70	1 87
21	1.10	1.30	1.01	1 41	92	1.54	83	1.69	73	1 84
22	1.12	1.31	1 04	1.42	95	1.54	86	1 68	.77	1 82
23	1.14	1 32	1.06	1 42	97	1 54	89	1 67	80	1 80
24	1.16	1.33	1 08	1 43	1 00	1.54	91	1 66	83	1.79
25	1.18	1.34	1.10	1.43	1.02	1.54	94	1 65	86	1 77
26	1.19	1.35	1 12	1 44	1.04	1 54	.96	1 65	88	1.76
27	1.21	1.36	1.13	1 44	1.06	1 54	99	1.64	91	1 75
28	1.22	1.37	1.15	1 45	1.08	1 54	1 01	1.84	93	1 74
29	1.24	1.38	1.17	1 45	1.10	1.54	1.03	1 63	96	1 73
30	1.25	1.38	1.18	1 46	1.12	1.54	1 05	1 63	.98	1 73
31	1.26	1.39	1 20	1 47	1.13	1 55	1.07	1 63	1 00	1.72
32	1.27	1 40	1.21	1 47	1.15	1.55	1.08	1.63	1.02	1.71
33	1.28	1.41	1.22	1.48	1.16	1.55	1 10	1 63	1.04	1.71
34	1.29	1.41	1 24	1 48	1.17	1.55	1.12	1.63	1 06	1 70
35	1.30	1.42	1.25	1 48	1.19	1.55	1.13	1.63	1 07	1.70
36	1.31	1.43	1.26	1 49	1.20	1.56	1.15	1 63	1 09	1 70
37	1.32	1.43	1 27	1 49	1.21	1 56	1.16	1 62	1.10	1 70
38	1.33	1.44	1 28	1.50	1.23	1.56	1.17	1.62	1.12	1.70
39	1.34	1.44	1.29	1.50	1.24	1.56	1.19	1.63	1.13	1 69
40	1.35	1.45	1.30	1.51	1.25	1.57	1.20	1 63	1.15	1.69
45	1.39	1.48	1 34	1.53	1 30	1.58	1.25	1 63	1.21	1 69
50	1 42	1 50	1.38	1.54	1 34	1 59	1:30	1 64	1 26	1 69
55	1.45	1.52	1.41	1.56	1.37	1.60	1.33	1.64	1.30	1 69
60	1.47	1.54	1.44	1 57	1.40	1.61	1 37	1.65	1 33	1 69
65	1.49	1.55	1.48	1.59	1 43	1.63	1.40	1.66	1 36	1 69
70	1.51	1.57	1 48	1 60	1.45	1.63	1.42	1 66	1.39	1 70
75	1 53	1.58	1 50	1.61	1.47	1 64	1.45	1 67	1.42	1 70
80	1.54	1.59	1 52	1 63	1.49	1 65	1.47	1.67	1 44	1.70
85	1.56	1.60	1.53	1.63	1.51	1 66	1.49	1.68	1 46	1.71
90	1.57	1.61	1.55	1.64	1.53	1 66	1.50	1.69	1.48	1.71
95	1.58	1.62	1 56	1 65	1.54	1 67	1.52	1 69	1 50	1.71
100	1.59	1.63	1.57	1.65	1 55	1.67	1.53	1.70	1.51	1.72

Source: Makradakis, Spyros and Wheelwright, Steven C., <u>Forecasting: Methods and Applications</u>, Wiley, 1978

LIST OF REFERENCES

1. Gwartney, James D. and Stroup, Richard C., *Economics: Public and Private Choice*, p.658 Prentice-Hall, 1980.

2. Ibid., p.658

3. Department of Commerce. *Total Energy Management* p.2 December 1975.

4. Gwartney, James D. and Stroup, Richard C., *Economics: Public and Private Choice*, p.658 Prentice-Hall, 1980.

5. Department of Energy. *Energy Management in the Federal Government: Annual Report to the President of the United States, Fiscal Year 1978*, p.8, 1979

6. Department of Energy. *Federal Government Energy Management: Annual Report FY 80*, p.8-3, 1981

7. Department of Commerce. *Total Energy Management*, p.1, December 1975.

8. Department of Commerce. *Total Energy Management*, pp.1-2, December 1975.

9. Lakhani, Hyder Ali G. "Forecasting the Cost of Energy in the Industrial Sector" *Energy*, v.6 p.14, January 1980.

10. Makridakis, Spyros and Wheelwright, Steven C., *Forecasting: Methods and Applications*, p.5, Wiley, 1978

11. Ibid., p. 327

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