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A User's Guide to SERICPAC: A Computer Program for Calculating Electric-Utility Avoided Costs Rates

A Subcontract Report

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Prepared Under Subcontract No. XS-0-9275-1

SERI

Solar Energy Research Institute

A Division of Midwest Research Institute

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Golden, Colorado 80401

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SERI Technical Monitor: Theresa Flaim

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FOREWORD

SERICOST and SERICPAC are companion computer models for use in estimating technology-specific avoided cost rates for electric utility purchases from distributed power producers. SERICOST is a modified version of MARGINALCOST, the marginal cost estimation model developed by Charles Cicchetti, William Gillen, and Paul Smolensky. SERICOST calculates the electric utility's avoided cost by time period, independent of the type of technology used by the qualifying facility.

SERICPAC contains models that (1) simulate the performance of wind turbines, low-head hydro facilities, and several biomass systems, (2) accumulate production estimates by utility time period, and (3) take the output from SERICOST and combine it with the time-correlated production estimates to calculate weighted average annual rates. Thus, the models are designed to estimate rates for facilities when time-of-production metering is not feasible.

Many computer models are available for estimating avoided costs. For example, most generating utilities have production cost and capacity expansion models that they use regularly for planning purposes. These planning models could be used directly to estimate avoided cost rates. However, except for very large facilities, it would be prohibitively expensive to use these planning models to estimate separate avoided cost rates for each qualifying facility. The combined use of SERICOST and SERICPAC provides a method for taking the output from the more complex planning tools, and developing avoided cost rates for different types of technologies without having to rerun the planning models for every facility or technology type.

In addition, SERICOST and SERICPAC are designed for maximum flexibility, ease of use, and public accessibility. The models are flexible in that they can be used together or separately if the user wants to substitute a different technology performance or avoided cost model. In addition, the user can execute a single model within SERICPAC without having to run other models.

Although it is advisable to create some data files in advance, both SERICOST and SERICPAC are interactive and easy to operate. They also contain background information on avoided costs and the different technologies' performance characteristics. Finally, unlike many other models, both SERICOST and SERICPAC are fully documented and publicly available.

Volume I is the User's Guide to SERICPAC and also contains a full listing of the computer programs. Volume II is the User's Guide to SERICOST and contains a full listing of the computer program. These models are available through the National Energy Software Center, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439.

Theresa Flaim
Project Monitor

Approved for

SOLAR ENERGY RESEARCH INSTITUTE

Jack Stone, Manager
Photovoltaics and Wind Program Office

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Solar Electric Conversion Research Division

SUMMARY

Objectives

To develop computer models that can be used to estimate technology-specific avoided cost rates for electric utility purchases from qualifying distributed power producers, as required by Section 210 of the Public Utility Regulatory Policies Act of 1978.

Discussion

This report is Volume I of a two-volume report, and is the User's Guide to SERICPAC, the companion model to SERICOST. Used in combination, the two models calculate average annual avoided cost rates for wind turbines, low-head hydro facilities, and several biomass systems.

Volume II is the User's Guide to SERICOST. SERICOST is a modified version of MARGINALCOST, the marginal cost estimation model developed by Charles Cicchetti, William Gillen, and Paul Smolensky. SERICOST calculates the electric utility's avoided cost by time period, independent of the type of technology used by the qualifying facility.

Conclusions

The primary advantage of SERICOST and SERICPAC over other available models is that they can be used to estimate technology-specific avoided cost rates without having to rerun more complex utility planning models for every qualifying facility or technology type. If the qualifying facility is large enough to justify time-of-production (TOP) metering, then SERICOST alone can calculate appropriate rates. If TOP metering is infeasible, then the use of both models is recommended for calculating average annual rates.

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SECTION 1.0

INTRODUCTION

SERICPAC is a computer program intended for use in calculating the avoided costs rates for decentralized electric production. SERICPAC is a companion program to SERICOST, a program developed by Madison Consulting Group, Inc. to calculate the avoided costs of electric utilities. SERICPAC utilizes the results of SERICOST to determine the appropriate rates selling of electricity to electric utilities from qualifying facilities (QF's) as stipulated under Section 210 of the Public Utility Regulatory Policies Act (PURPA) of 1978.

The two computer programs are designed to work in tandem. The user first uses SERICOST to determine the avoided cost of a particular utility. Next, SERICPAC couples that cost structure with the performance characteristics of the particular qualifying facility. Together, these programs allow the user to determine the revenues that may be expected from sales by QF's to utilities, and rates for the electricity that is sold.

SERICPAC is designed to calculate the technology specific average avoided cost rates. The model was developed originally to handle facilities smaller than 100kW where the size did not warrant inclusion in a separate utility generation expansion analysis. The model is capable of determining appropriate rates for any size generation units. However, it may be appropriate for the utility to treat the larger facility in a manner similar to the way that the utility plans and cost accounts its own facilities. Figure 1.1 shows the overall logic of SERICPAC.

Figure 1-1. Overview of SERICPAC Methodology

SECTION 2.0

SERICPAC METHODOLOGY

This chapter introduces the user to the major programs of SERICPAC. In this chapter each of the programs is introduced and specific information regarding the use of the program is discussed. Detailed input requirements and operation characteristics are provided in Section 3.0, "The User's Guide to SERICPAC."

The theory involved in the SERICPAC methodology is based on previous work of the authors (see for example S. Feldman and R. Wirtshafter, On the Economics of Solar Energy: The Public Utility Interface). The electric production of QF's must be evaluated with respect to their impact on the utility loads and finances. Rates are determined that reflect the avoided cost to the utility from the existence of those QF's.

SERICPAC consists of four separable programs. The first program SIMULATE contains the simulation models of the QF's. DANDL (derate, load and integrate) converts the simulations into a more realistic measure of performance by including planned and forced outages. DANDL also allows the user the option of inputting an electric load. This option calculates the net sale of electricity to the utility as well as the total gross production of electricity. PMAIN then converts the electricity for sell back into utility periods, that are defined in SERICOST to represent differences in cost of service. The final program AVOIDC calculates technology specific avoided cost rates.

2.1 TECHNOLOGY SIMULATIONS (SIMULATE)

This program simulates the electrical production of the different technologies. The subroutines have been developed at the University of Pennsylvania Energy Center, SERI and independently (see Bibliography, and Appendices). There is also a provision for utilizing a users own simulation and entirely bypassing this routine. The different technologies that are contained in SIMULATE are:

- HYDRO - a run-of-the-river hydroelectric generation model
- WIND - a wind electric generation model
- CONFUI - a conventional fuels electricity generating model
- CONTOO - a constant production, based upon rated power model
- COMBUS - electricity production through direct combustion of biomass fuels
- BIOGAS - a methane production and electric generation model
- MUNI - a municipal waste electric generation model
- GASSIF - a producer gas production and generation model

2.1.1 Hydro-Electric Production (HYDRO)

The hydro model simulates a run-of-the-river, low-head hydro-electric system. One classification of types of hydro power is based upon the head size. The head size is the distance between the turbine and the surface of the water. For low-head applications the size of the head is generally no more than 20 meters. Run-of-the-river facilities do not include dams or ponding. To accomplish ponding using the above model, a transformation of stream-flow data is necessary.

The basic inputs to the simulation are characteristics regarding the river and its flow, and the turbine and its capacity. For most potential hydro-electric sites it is likely that some survey has been previously performed. The potential hydro-electric sites are most often supplied by data from the U. S. Geological Survey (USGS), the public utility, or from estimates of the Army Corps of Engineer's (U. S. Army Corps, 1979). The Corps' study is primarily a siting methodology which evaluates the electric power potential in a cost/benefit framework. Included in their analysis is a listing of potential sites by river or stream per state as well as an estimated head size, drainage area, and potential turbine capacity.

The U. S. Geological Survey has stream-flow gauging stations along the streams and rivers cited in the Corps' study. The stream-flow data, measured in cubic feet per second (CFS), is generally available by an hour-by-hour measurement, often times on computer tapes. Not all of the USGS regions have the stream-flow data in this form. The alternative is to input average daily flow data which is most readily accessible (365 records). This method is an alternative to entering 8760 hourly records.

Hydro-electric turbines can only operate within a small range of stream flow levels. If the flow is too low, generally 40-50% of turbine design capacity, there is insufficient power to rotate the turbine. If stream flow is too high water will cover the turbine, and prevent its operation. The simulation allows the user to input values for a minimum and maximum range for which the turbine will operate.

The model can simultaneously evaluate many hydro-electric sites built along a river. However, the model assumes that each turbine does not impact the downstream flow and therefore the model may slightly overestimate performance of successive downstream turbines.

In general the formula to calculate power production is (see Eq. 2-1):

$$PKW = CFS * PLEFF * HHDLOS * GRHEAD / 11.8 \quad (2-1)$$

where:

PKW	= electric power produced
CFS	= stream flow in cubic feet per second
PLEFF	= plant efficiency--the actual performance of the turbine divided by its rated capacity (defaulted at 0.88)

HHDL0S = height head loss as efficiency--the actual flow through head divided by the theoretical potential (defaulted at 0.95)
GRHEAD = gross head size--the distance between the surface of the water and the turbine

Output of the simulation is electric consumption in kW per hour. The model also determines average stream flow, average plant capacity and average spillage factor. Plant capacity is determined by dividing the simulated performance of the turbine by the rated performance of the turbine. Spillage factor is the percentage of water power not utilized by the turbine unit, either because of insufficient or excessive stream flow. For run-of-the-river plant capacities are normally around 70%, but will vary considerably depending on the stream flow, plant capacity size and minimum and maximum operation inputs.

2.1.2 Wind Energy Conversion Systems (WIND)

Wind energy conversion systems (WECS) were originally designed for agricultural applications. Commercial sized machines range from .1 to 15 kW. Large wind machines have been built with capacity size of 1-3 mW. Wind machines are classified as being either horizontal or vertical axis types. Components of the WECS include: a turbine assembly (includes blade, generator, etc.), a tower support, a battery pack, and, if necessary, an auxiliary engine.

The (WECS) simulation in the SERICPAC model is based upon recent research performed by Justus and Mikhail (1978), and a detailed WECS model developed at SERI by Percival and Harper (1981). Input parameters may cover a wide range of potential configurations and manufacturers' performance ratings. The model is designed to accept hourly or tri-hourly wind speeds and temperatures. Wind speed and direction as well as temperature are available from SOLMET and Typical Meteorological Year (TMY) tapes available from National Oceanic and Atmospheric Administration (NOAA), Asheville, N. C. (NOAA, 1978). Additional sources for input data can be supplied by local public utilities (see, for example, Paul Gipe, "Sources of Wind Data," Solar Age, May 1981).

Wind speed is normally an average hourly (or tri-hourly) value and does not account for instantaneous variation. Because wind energy is proportional to the cube of the wind speed, accuracy in predicting wind velocity is necessary. An average estimation of wind velocities from "measurement readings" will normally undervalue the wind power. Consequently, a probability distribution chosen for use is the Weibull density function. The critical parameters, K and C, are dependent upon the distribution of wind velocities and average velocity.

The cut-in velocity is the speed at which the windmill begins producing power. The cut-out velocity is the speed at which the windmill ceases to produce power for safety reasons. The rated power is the speed at which the windmill begins to produce at maximum (rated) power. The maximum power coefficient is the highest ratio of available wind power to shaft power attainable by the machine. The design velocity at the maximum power coefficient is the velocity at which the maximum power coefficient occurs.

Rotor diameter is the diameter of the circle described by the tip of the rotor. The anemometer recording height is the height of the recording station above the ground. Elevation above sea level is the height of the windmill site above sea level. Hub height is (for a horizontal windmill) hub height above ground. Clearance height is (for a vertical windmill) the height of the bottom of the rotor above the ground. Constant or variable RPM and horizontal or vertical axis must be specified. The height of the installation (for a vertical windmill) must be specified. The time interval at which data occurs is required.

The wind model operates on a probabilistic basis. The mean and standard deviation of observed wind speeds over a month period are used as parameters to generate a Weibull probability distribution of wind speeds. The range of speeds of operation of the windmill is then partitioned into several intervals. For each of these intervals the probability of a windspeed in that interval can be determined from the Weibull distribution, and power in that interval can be approximated as a function of the mean speed in the interval and the windmill's configuration (rotor area, efficiency). Below the cut-in and above the cut-out velocity there is no power production. Between the rated velocity and the cut-out velocity, power is equal to rated power. Total power production is then simply the sum of the products of interval probability times interval power. For a detailed description including equations, see Justus and Mikhail (1978).

2.1.3 Conventional Fuel Input (CONFUI)

Cogeneration is the simultaneous production of electrical or mechanical energy and useful thermal energy. The thermal energy is in the form of hot liquids or gases. The types of cogeneration systems available today are: dual purpose power plants, waste-heat utilization systems, certain types of district heating systems, and total energy systems.

The difference between a conventional energy system, and cogeneration system is that the conventional energy system produces either thermal or electrical energy, whereas the cogeneration system produces both. Recent interest in more efficient use of energy resources has been spurred by the 1973-74 oil embargo. Historically, there existed a wide use of cogeneration systems. The contribution of cogeneration applications, however, has declined over the past sixty years. In 1920, industrial fossil fuel electric power generation contributed 22% of total U.S. electricity production. In 1940, the percentage declined to 18%, by 1960 only 9% and in 1976 there was a 4% contribution (Williams, 1978, p. 315). The development of centralized electric plants is the primary cause of the movement away from industrial cogeneration.

The potential for industrial cogeneration in the 1985 planning horizon, has been studied by several sources: Dow Chemical Company (1975) for the National Science Foundation, Thermo Electron Corporation (1976) for the former Federal Energy Administration (FEA), Resource Planning Associates (RPA) (1977) for the former Energy Research and Development Administration (ERDA) and Synergic Resources Corporation (Limaye et al., 1980) for the Electric Power Research Institute. Estimates for 1985 cogeneration potential are also summarized in Williams (1978, pp. 331-333).

The choice of cogeneration system depends upon its application. Total energy systems are designed to provide electricity, heating, cooling, and waste-water treatment facilities to entire communities. Waste-heat utilization systems and dual purpose power plants are applied in the industrial and utility market sectors. District heating systems are forms of cogeneration where thermal energy discharged from an industrial or utility process is utilized by the residential sector as a form of home heating.

The cogeneration technologies available today in the industrial and utility sectors are: back pressure steam turbines (Rankine cycle) systems, gas turbines (Bryton cycle) systems, and diesel engines. Table 2.1 describes the equipment properties of the three systems. There are two methods for power generation available for each technology: topping and bottoming cycles. A topping cycle is a system which uses the fuel first to generate electricity, then uses the waste heat for industrial processes. A bottoming cycle uses the fuel input first to produce heat and/or steam for industrial processes, then utilizes the waste heat and pressure for electricity production (New England Energy Commission, 1978 , p. 121).

SERICPAC incorporates a simulation of topping diesel engine cogeneration system. A schematic of a typical diesel cogeneration system is seen in Figure 2.1.

There are two options for a simulation of the cogeneration system. One option is to simply assume operation of the system at its rated level. Fuel needs and heat produced may be determined ex post facto in this case. The rated level is the power input to the generator. The generator operates continuously for the entire year. Alternatively, the fuel inputs and the heat content may be used with the system efficiency to determine outputs to the generator. In essence, these approaches differ in the order of calculation.

The model assumes that the system operates at its rated level at all times of operation, and that a constant input of fuel with uniform heat value is always utilized. To adjust the output to account for outages, the user should use the DANDL program, Section 2.2 and 3.3.

The inputs to the model include: rated output of the engine, efficiency of the engine, heat content of the fuel, rate of fuel input, and generator efficiency.

The output is in kWh's and is calculated by multiplying the fuel heating value by the input rate and by efficiency losses. The result is the kW production of the system. Heat produced and fuel used are optional outputs.

2.1.4 Rated Power (CONTOO)

This model is a simple program which allows the user to specify only the rated capacity of the generic technology. CONTOO is considered an analytical tool rather than a simulation, because no technology specific input data is required. For instance, the user may be interested in determining the avoided cost rate of a diesel generator. Rather than using the Conventional

Table 2-1. Properties of the Equipment for Three Cogeneration Systems

Cogeneration System	Preferred Size (MW)	Fuel	Electrical Efficiency ^a %	Advantages	Disadvantages
Steam turbine	1-1200	Any fuel: oil, natural gas, coal wastes	10-30	Can use inexpensive fuel; useful for high heat needs relative to electricity needs. Useful in district heating.	Not useful at small sites; low electrical efficiency.
Gas turbine	1-100	#2 oil; #6 oil; ^b natural gas	20-30	Gives good electrical efficiency and high-pressure steam.	
Diesel	0.5-25	#2 oil; #6 oil; ^b natural gas	25-40	Most practical system for small sites.	Potential air problems caused by relatively large amounts of nitrogen oxide emissions.

SOURCE: Commonwealth of Massachusetts, 1978, p. 122

^aElectrical efficiency is the fraction of fuel energy input (in Btu) that is transformed into electricity.

^bRequires additional treatment to remove impurities.

Figure 2-1. Diesel Cogeneration

SOURCE: Commonwealth of Massachusetts, 1978, p. 129

Fuel (CONFUI) model where the user is required to specify fuel input rates and fuel heating values, the user needs only to know the rated capacity, in kW, of the generator to use CONT00. Scheduled and/or forced outages effect production patterns. These variations can be accounted for by a derating method. See DANDL, Section 2.2 and 3.3.

2.1.5 Direct Combustion of Biomass (COMBUS)

Biomass fuels can be converted into useful energy through direct combustion. A simulation model has been developed to predict electricity production from a constant biomass source, an "energy plantation" and/or direct combustion utilizing wood residues.

Biomass has in the past been burned primarily to produce steam for electric power generation and/or process heat. Steam generation is a well known technology. Recently research and development has focussed upon increasing efficiency, decreasing operating costs, minimizing pollution and adopting different fuel inputs (ADL, November 1979, p. VII-12).

Types of biomass firing systems available include: 1) fluidized bed combustion, 2) charcoal/oil slurry firing, 3) stoker firing, and 4) suspension firing. Fluidized bed and slurry firing technologies are relatively new and still under development. The stoker and suspension firing technologies are presently well developed and utilized for commercial and residential application.

The types of biomass fuels available are agricultural, industrial, forest products, commercial and residential wastes. An energy plantation could utilize fast growing biomass as fuel to a small generation facility. It is also possible that seasonal availability of some biomass types can affect dependability of electrical production.

There are five options available in using this simulation. Option 1 allows the user to input a constant biomass fuel source. Option 2 and 3 calculates the electric generation from a biomass plantation. Option 2 pelletizes the biomass and option 3 does not pelletize the biomass. Options 4 and 5 calculate the electric generation of wood residues. Option 4 pelletized the residue and option 5 does not. It is possible to select one or more options together.

For constant fuel input, the user needs only to know the amount of biomass fuel per hour. The "energy plantation" concept is based upon a planned, managed forest with a specified harvesting schedule. The harvesting schedule is designed such that wood is available on a continuous basis. Wood residues are a by-product of lumber manufacturing processes. Based upon physical form, "chippable residues," bark, and shavings are classified as residues.

Because wood fuel has a low energy density, pelletizing may be desirable because it increases the specific gravity. Pelletizing reduces shipping problems and produces a fuel which is clean, stable, readily marketable (SERI, February 1980, p. 51). Fuel inputs from either the "energy plantation" or from wood residues can be in pelletized or non-pelletized

form. In each of the five options, a uniform average annual heating value of wood is assumed for the biomass inputs.

Regardless of the form of biomass or its source, several factors are included in the simulation section. The heating value of the wood is essentially the thermal-energy released during combustion. There are three ways of defining the heating value: 1) gross heating value, 2) higher heating value, and 3) net heating value.

The gross heating value (GHV) incorporates a factor for removing the moisture content from the wood. The equation is (see Eq. 2-2):

$$\text{GHV} = \text{HHV} (1 - \text{moisture content}) \quad (2-2)$$

The moisture content (MC) is the percent moisture based upon the wet weight of wood. The higher heating value (HHV), which is the input value required for the simulation, generally ranges from 7900 to 10000 Btu/lb. It is the total thermal energy available from oven dried wood. A list of typical higher heating values can be seen in Table 2.2.

The net heating value accounts for the negative heating effect of water. This is the real energy available for processing. The net consumption of energy is decreased by 1200 Btu/lb. for every pound of water. The moisture must be superheated to 400°F and zero pounds of pressure per square inch in order to be released. Vaporizing and superheating occur in the furnace. The formula for net heating value is (see Eq. 2-3):

$$\text{NHV} = \text{HHV} (1 - \text{MC}/100) - \text{MC}/100 \times 1200 \quad (2-3)$$

In all five options the biomass is used to fire an electric generator. The output of the simulation is the average rate of electric power production expressed in kW. The simulation section assumes that the generator runs continuously throughout each day of the year. Outages whether planned or forced are handled in the DANDL Section of SERICPAC, Section 2.2 and 3.3.

2.1.6 Methane Production and Generation (BIOGAS)

A second technology which converts biomass into usable energy is anaerobic digestion.

The principles of methane production from decomposing organic matter have been applied for centuries. Initial development applications and experience have been in the less developed countries, primarily in Asia. Recent interest in biogas technology has been prompted by the rapidly rising cost of conventional fuels (National Academy of Sciences, 1977, Part I, Chapter 1).

There are several direct benefits of using organic wastes for anaerobic digestion rather than as fuel for direct combustion or as fertilizer. They include: 1) energy production which can be more efficiently stored, 2) a stabilized residue (sludge) which retains its original value as a fertilizer and 3) conventional fuel savings which result from producing an equivalent

**Table 2-2. Typical Higher Heating Values
of Some Wood and Fossil Fuels^a**

Fuel Type	Higher Heating Values (HHV) (Btu/lb)
Southern pine bark	8,900
Hardwood whole tree chips	8,600
Wood pellets	8,600
Bituminous coal	14,000
#2 Heating Oil	19,400
#6 Heating Oil	18,300
La. natural gas	21,800

SOURCE: Levi and O'Grady, 1980, p.33.

^aAn average HHV for wood of 8,500 Btu/lb is used in this text.

amount of nitrogen fertilizer from synthetic processes. Indirect benefits include reduced health hazards due to partial sterilization of pathogens during the bioconversion process.

All biomass materials are composed of three principal components: cellulose, lignen, and hemicellulose. Anaerobic bacteria reduce complex raw materials to simple organic compounds. Acids are produced at the end of the reduction stage. Methonogenic bacteria use these acids and produce methane and carbon dioxide (National Academy of Sciences, 1977, Part I, Chapter 2). The basic procedure for methane production includes the following steps: collection and transportation of biomass materials, processing biomass, digestion and product outputs (National Academy of Sciences, 1977, p. 61).

Methane has a heating value of 500 to 700 Btu/ft³. The gaseous outputs of the process is 70-50% methane and 30-50% carbon dioxide. Methane can be easily burned for cooking, lighting, heating, and refrigeration or as a fuel for an internal combustion engine. Applications for automobiles, however, are rather limited.

Seasonal variation in input fuels influence production rates unless biomass storage is available. In this analysis methane output is considered relatively constant due to crop residue storage (National Academy of Sciences, 1977, p. 61-71).

The biogas simulation predicts methane generation in terms of million cubic feet and equivalent kWh. We have adopted a computer model from Dynatech R/D (Ashare et al., 1979). It has eight components, each simulating the interaction of physical and biological elements of methane generation. The principles of anaerobic digestion which were discussed earlier are relied upon in the simulation. The eight components include:

1. Feed Composition--calculates biochemical characteristics of the feed (input);
2. Storage--determines number of required units for safe storage;
3. Shredding--finds amount of work necessary to shred biomass;
4. Holding-Mixing--finds energy requirement for this process;
5. Pretreatment--prepares biomass for digestion. Also calculates energy requirements;
6. Digestion--option for batch, continuous stir, and plug flow digestion process. Gas production and heat requirements are calculated;
7. Dewatering--water removal; and
8. Gas Purification--removal of impurities to improve quality. The energy requirements from each section are summed, and subtracted from gross production to determine net available energy.

One of the major strengths of this model is its flexibility with regard to input data. Agricultural residues, animal manure, and human refuse can be accepted for use by this model. The biomass input quantity can be easily entered through the interactive input section of the SIMULATE program. The configuration of the methane generation system will vary as the size of the farm varies. The system capabilities are additionally a function of the type of input.

Biological and chemical parameters will change as physical inputs vary. For example, digester retention time will fall as feedstock size decreases for crop residues (Ashare et al., 1979, p. 150). Additionally, the percentage of biodegradability of volatile solids changes with type of crop residue.

Another strength of biogas simulation model is the ability to consider virtually infinite system configurations. The biogas systems available for simulation include batch, continuous stir, and plug flow methods. Each of these systems are able to be simulated using the same input list.

Both the continuous stirred tank reactor (CSTR) and the plug flow reactor promote continuous digestion. The major difference between the CSTR and plug flow systems is particle residence time in the reactor. Each particle in the plug flow has the same residence time, whereas the CSTR digester has a wide distribution of residence times. The application of both of these techniques to utilize crop residues has been primarily on a small scale basis (Ashare et al., 1979, p. 65-66).

Batch digester designs have been applied to methane production from crop residues and biomass with high solids content, such as food processing wastes and other agricultural residues. Methane production from sanitary landfills are an application of batch designs. There are four stages of gas production in a landfill. The final process yields 50-70% methane. Various pretreatment options increase production rates. "Controlled landfill" methods have recently attracted considerable attention to the relative economic success of gas extraction from existing sites. Dynatech's study indicates "controlled landfill" batch reactors are more economically attractive to the small scale farm user than conventional CSTR because batch reactors require less labor input and less capital costs (Ashare et al., 1979, pp. 145-149).

The same flexibility is available for dairy farms and poultry farm gasification. The output of the system is then used immediately to power an internal combustion engine, which then runs an electric generator. The mathematics of digester reaction are based upon the so-called first order kinetics of chemical reaction engineering theory. The essence of the entire model is founded upon the following reaction rates (see Eq. 2-4, 2-5, and 2-6):

CSTR

$$G = A * CBO * K \div (1-kt) \quad (2-4)$$

Plug Flow

$$G = A * CBO * K \exp (-Kt) \quad (2-5)$$

Batch

$$G = A * CBO * (1 - \exp -Kt) \quad (2-6)$$

- G - volume of gas produced per reactor volume per day (VVD)
- CBO - inlet concentration of biodegradable volatile solids
- K - first order reaction rate constant
- t - hydraulic retention time (reactor volume/inlet volumetric flow rate)
- A - volume of gas produced per mass converted

There are a variety of system processes available to the user. The options simulated are storage, shredding (physical pretreatment), holding and/or mixing, chemical/thermal pretreatment, heat exchange, dewatering, and gas purification. The input lists default values and work requirements are listed in the users' guide. A brief description of the components follows.

The size of the site specific storage unit(s) can be included in the input section of the simulation program. Additionally the density in the storage can be interactively entered. Because crop residues are a seasonal product, storage is necessary; especially for the CSTR digesters.

In regions where large amounts of wastes are available for methane production, the digester may receive the wastes directly. If such a design is implemented, equilibrating/mixing chambers can be installed to heat the waste before entering the digester and as a result maintain better control of the composition of feedstock. In such situations, where digester inputs are not directly utilized, storage facilities are necessary (National Academy of Sciences, 1977, p. 42).

Pretreatment is a method by which the biomass material is processed so that it will break down more rapidly during anaerobic digestion and yield higher methane output. There are several methods available: chemical, physical, and temperature. Generally, an economic analysis is performed to determine whether the economic benefits of additional gas production outweigh the costs of pretreatment.

The forms of pretreatment offered in the simulation are in the forms of physical and chemical pretreatment. The chemical pretreatment utilized in the analysis is a pretreatment conversion of 50% with an addition of sodium hydroxide with a 4-hour retention time at 115°C and 5% loss of input biodegradable volatile solids (Ashare et al., 1979, pp. 153-55). See Table 2.3 for the effect of pretreatment of residue digestion.

The model also allows three additional options. A heat exchanger can be included to recover sensible heat from the digester effluent stream (Ashare et al., 1979, p. 96). Dewatering can be included in order to utilize digester effluents in a more concentrated form, and to provide recycled water (Ashare & Wilson, 1979, p. 131). Finally, gas purification can be

Table 2-3. Effect of Pretreatment on Residue Digestion^a

	Corn Stover	Rice Straw	Wheat Straw
Small scale			
Annual gas production (MM Btu)	2.68×10^3	3.2×10^3	2.4×10^3
Unit gas cost (\$/MM Btu)	12.81	12.36	12.76
Intermedite scale			
Annual gas production (MM Btu)	4.56×10^5	5.47×10^5	4.10×10^5
Unit gas cost (\$/MM Btu)	5.29	5.18	5.15
Large scale			
Annual gas production (MM Btu)	4.56×10^6	5.47×10^6	4.10×10^6
Unit gas cost (\$/MM Btu)	4.33	4.38	4.15

SOURCE: Ashare et al., 1979, p. 154.

^aPretreatment conditions:

NaOH requirements = 5% of feed solids

conversion = 50% of nonbiodegradable solids

temperature = 115°C

retention time = 4 hours

utilized in large-scale applications for the cleaning and compression of the gas before pipeline delivery.

As mentioned above, the user has the option available to vary the system configuration. System capabilities include small, medium and large systems. The output of the model is an average rate of electric power production for the smoothly operating system.

2.1.7 Municipal Waste Electric Generation (MUNI)

A subset of the anaerobic digestion model is a simulation of methane production from municipal solid wastes (MSW) and subsequent transformation to electricity. Municipal solid wastes can produce methane from either anaerobic digestion processes, or through extraction from landfills. The model that has been developed for the SERICPAC methodology is specifically designed to predict methane production from the anaerobic digestion of MSW.

For methane production from MSW, there are four necessary components to the process: pretreatment, digestion, product recovery, and residue treatment. Figure 2.2 illustrates a flow diagram of the process. Pretreatment separates inorganic matter and materials, as well as enhancing the biodegradability of the substrate, the material prepared for digestion. The digestion process produces methane (CH_4) and carbon dioxide (CO_2). The product recovery stage separates the CO_2 from the CH_4 providing "pipeline quality" methane for commercial distribution or electricity generation. Residue treatment removes undigested materials including water (dewatering). The residue can be disposed of either through a landfill, an incinerator, or can be used as a soil conditioner. The conceptual design widely accepted for methane production from MSW was prepared by Kisert et al. (1975) (see also Scaramelli, 1979, p. 251). Figure 2.3 illustrates this design. It is discussed in greater detail below.

The inputs to the system first pass through size reduction equipment. This stage efficiently separates organic materials from inorganic matter found in the MSW, and causes the feed to become more soluble for digestion. There are both wet and dry separation systems for removing grit, glass, and metals in order to increase the feedstock concentration of digestible matter. The dry separation process is flexible in terms of selecting a water content of the feed to the digesters. The wet separation handles low solid concentrations in aqueous slurries, requiring a dewatering stage.

Nutrients from the sewage sludge are added to the organic feedstock, together with control chemicals. Ferrous salts and lime are also added for pH and hydrogen sulfide control. Raw water or recycled filtrate can be added to the substrate in order to facilitate pumping the slurry.

Primary research on anaerobic digestion from MSW has been completed at the Illinois University at Urbana by Quindry et al. (1976), and Brown et al. (1976). The digestion conversion occurs in two stages: Solids are first digested by enzymatic action, and then soluble products are fermented in a series of reactions producing CH_4 and CO_2 . The resultant product is composed of two streams. One stream is the gaseous output, the other, a slurry stream containing undigested organic matter.

Figure 2-2. Processes in the Anaerobic Digestion of Municipal Solid Waste

Figure 2-3. Anaerobic Digestion Process for Solid Waste Utilization

SOURCE: Kispert et al., 1975

The gaseous output of the digestion process contains both CO_2 and CH_4 . Acid gases are also represented, and require removal in order to prepare "pipeline quality" methane. A chemical (monoethanolamine) is utilized as an absorbant, removing CO_2 and hydrogen sulfide. The chemical is recirculated and regenerated. Additionally, the methane is dried using a dehydration process. If the gas is used off-site, it is normally pressurized.

For effluent handling and disposal, the water and nondigestible matter must be removed at a rate equal to the rate of feed input. Therefore during a steady state operation of waste digestion, the system must be bled continuously. Normally, the substrate is well stirred to maintain homogeneous slurry composition. The slurry is then removed by separating the solids from the liquids. The liquid can either be recycled or returned to the sewage treatment plant. The solids can be incinerated, sent to a landfill, or utilized as a soil conditioner (Scaramelli, 1979, pp. 251-55).

The computer simulation of the generalized design has been adapted from Kispert et al. (1974). Their model was prepared with the objective of sizing equipment at the lowest cost. Performance inputs are aligned with the laws of conservation of mass, the first and second laws of thermodynamics and the rate equations which define the size of the equipment in terms of the driving forces and resistances (Kispert et al., 1974, pp. 16-17).

His model has been simplified for computational ease. The underlying assumption for methane production is a ratio of 1000 tons per day of MSW yielding 140.9×10^6 Btu per day. A human population of 571,400 is necessary to support a flow rate of 1000 tons per day. It is assumed that a per capita refuse generation rate is 3.5 lb/capita/day (Quindry et al., 1976, p. 5). It is also assumed that the input rate is constant and that there is a uniform Btu content of fuel input. The efficiency of the generator can be interactively entered as an input. The output is constant electricity production measured in kW per hour.

2.1.8 Producers Gas Production and Generation (GASSIF)

Air gasification to obtain producer's gas is one of several technologies designed for utilizing biomass fuels as an energy source. Of the four gasification processes, air gasification is one of the least complicated forms of gasification. Carbon monoxide is a low Btu gas, having a Btu content of 100-150 Btu/Standard Cubic Foot (SCF). There are two types of air gasifiers, updraft (counter-flow) and downdraft (co-flow). The distinction is based upon where the injection of both air, heat and the biomass enters the system.

In the updraft systems, air is drawn up through a fixed bed of biomass on a grate located at the bottom of a shaft furnace. Combustion and char gasification occur on the grates supporting the biomass. High temperatures are encountered and the resultant gases rise. Carbon dioxide (CO_2) and water (H_2O) are reduced to carbon monoxide (CO) and hydrogen (H_2). As these gases rise to the lower temperature zones (200-500°C) they meet the biomass descending from the top of the shaft and pyrolyze. The gases continue to rise and contact more wet incoming biomass, which subsequently dries due to

the high temperatures. The gas exits at a lower temperature, saturated with pyrolysis oils and tars.

If the gas temperature cools below a specified temperature, chemicals, tars and oils will condense in the pyrolysis zone. A "close-couple" mode is utilized to prevent this condensation. This method more efficiently produces the gas and leaves no residues.

In the downdraft gasifier, air is injected through tuyeres (a pipe or nozzle) between the char zone and the zone of pyrolysis. Heat from the char zone pyrolyzes the biomass above. Oil vapors also pass through the bed of hot charcoals where they are "cracked" to simplified gases and chars. Figures 2.4 and 2.5 illustrate both the up and downdraft reactors.

If the temperature is too high, endothermic reactions occur thereby cooling the gases. When the temperatures are too low, exothermic reactions occur keeping the gases hot (SERI, July 1979, p. 19, and SERI, April 1980, p. 15).

Our gasification simulation model is based upon research completed at the University of California, Davis, and by SERI (SERI, July 1979; SERI, April 1980; and Levy and O'Grady, 1980). GASSIF is a computer model based upon important relationships discussed in these works. The model is straightforward. There are two options available to the user. The program can model a "pure biomass" system or a "dual" system. The distinction between the two systems is that the "dual" system uses a gaseous mixture of fuels in the combustion process.

The principle inputs to the simulation are the system configuration, the residue loading rate, the moisture content of the biomass, the higher heating value of biomass, estimated operation time per day, and several mechanical efficiencies. A more complete list is available in Section 3.

The assumptions utilized in the simulation include uniform biomass heat content. The net heating value multiplied by the residue loading rate (corrected for tons to pounds and years to days) yields available energy before gasification process.

Producers' gas has a low Btu value (100-150 Btu/scf) and is primarily carbon monoxide. The gas is used immediately to power an internal combustion engine, which runs a generator.

The efficiency for all processes, is constant throughout the model. The power output of the engine is then adjusted by the generator efficiency to determine net kWh produced.

The sole output of this model is the average rate of electricity power production for the smoothly operating system.

001043

Figure 2-4. Updraft Gasifier

SOURCE: Levy & O'Grady, Feb. 1980, pp. 91 & 92

001042

Figure 2-5. General Diagram of Downgrade Gasifier

SOURCE: Levy and O'Grady, Feb. 1980, pp. 91 & 92.

2.2 DERATE, LOAD, INTEGRATE (DANDL)

According to PURPA, the buyback rates set by the utilities should distinguish among technologies based on the cost that is avoided as a result of the existence of the QF's produced power. The rates may vary depending upon the time of day, week and month because utility costs of production vary over these time periods. Two components of utility costs, energy and capacity must be distinguished as to the relationship between QF production and avoided cost rates. The utility avoids energy costs by not having to produce the electricity that is provided by the QF. The avoided energy costs are determined by subtracting the QF's sell-back from the total utility load and calculating the energy savings. The utility also may save money if the QF production and sale coincides with its peak demand. For this to occur, it is necessary that the production is not only available, but that the production is sufficiently reliable to allow the utility to forego other opportunities to meet demand.

Determination of capacity savings is a more complex issue. It centers on determining not only the potential reduction in capacity requirements, but the benefits to the utility of foregoing construction of that capacity. For purposes of this discussion, we will divide these two components into availability and reliability issues, respectively.

Availability concerns the prediction of the performance of the QF and the production of electricity sold back to the utility. It is the average amount of production that the utility should expect and incorporate into its dispatching plans. Availability must account for variation in production based on variations in input fuel availability, and also variations in the amount of electricity used internally by the QF, and, therefore, not available for sell back. In order for the production to be compatible with the utilities dispatch, it must also account for outages caused by breakdown or routine maintenance. DANDL is written to specifically provide a diversified utility production that is comparable to its own facilities. DANDL derates the maximum outputs to adjust them from individual performance without outages to a diversified production (an amount of production that would be the average performance of a large number of similar systems).

Avoided Capacity Cost and Reliability is best handled through the Capacity Adjustment Factor discussed in Section 2 of SERICOST the companion to this text. The avoided capacity cost should indicate the benefits of reductions in capacity requirements. If the utility cannot be certain that the QF will exist then an adjustment to the avoided capacity cost is warranted. These considerations are independent of availability which measures how the QF performs. The DANDL program specifies an average annual diversified production which accounts for variations in weather and operation. The avoided cost benefits in \$/kW and the measure of reliability are taken into account in the SERICOST program.

To summarize more clearly how DANDL works, the following description is provided. The output from the SIMULATE program is the maximum performance of facility assuming that the facility is available all year long. While the

simulations do account for variation in the availability of the input resource such as wind, solar insolation and water, the models do not account for breakdown or maintenance. In addition, not all of the produced power will be sold to the utility; some will be utilized by the QF itself. The utility that is forced to buy power from the QF must plan for the receipt of this power in the future and build and operate its own facilities to match the availability of QF's sell back electricity.

This program, DANDL, converts the maximum output into a diversified sell-back production for the utility. Using criteria similar to that used by utilities in analyzing the availability of their own systems, DANDL derates the maximum output and subtracts the user's own load. The product of this program is an average decentralized production for which utilities can anticipate and plan accordingly. It also represents the sell-back production on which the impact on the utility and the subsequent rates can be determined.

DANDL allows the user to derate the maximum output in several manners. These methods are similar to those employed by the utilities in production planning and capacity expansion. The user can specify periods when the unit will be under maintenance, the user can specify a derating factor that reduces production by a fraction equivalent to an unscheduled forced outage probability, or the user can utilize both options together. It is important to note that virtually no data is available for forced outage rates of small power producers. One solution is to use the forced outage rate of the utility's own equipment, until actual data is collected from the QF systems. Derating can be implemented on a yearly, monthly or daily basis. The user's guide Section 3.2 will provide further information regarding its use.

The second part of DANDL integrates the QF's power requirements with its power production. The calculated electric energy from the simulation model can be subtracted from the QF's known load, which is input by the user for each hour or on an average daily/monthly basis. The QF's power demand can be entered interactively or may be read in from file.

There are two options available to integrate the QF's power produced with the QF's power requirements. They are simultaneous buy/sell and net power. PURPA and the FERC rulings specify that simultaneous buy/sell options are to be permitted. Simultaneous buy/sell is when a QF purchases its entire power requirements from the utility and sells all its production to the utility separately, receiving a rate of the avoided costs. Net power, the amount of production that is not used internally, is the second of the two options available in the load integration section.

As mentioned earlier the integrate section of DANDL standardizes the output from SIMULATE main program. Performance Analysis (PMAIN) program converts the DANDL output into production by utility period, and is the subject of the next part of this text.

2.3 PERFORMANCE ANALYSIS (PMAIN)

The performance analysis section of the methodology is rather straightforward. Utility cost (especially at the margin) are influenced by the mix, as well as the number of qualifying facilities. Conventional utility planning models estimate capacity requirements based upon load forecasts. The technology simulation module predicted hour-by-hour performance. This output was derated to reflect an average diversified production and then integrated with the QF's own demand requirements. This is essentially the output of the DANDL program. The inputs to PMAIN are: the derated performance which is aggregated into one 24 hour period monthly and the utility period definitions. Through the interactive input section, the user can selectively change the input variables. The user's guide outlines the procedure in Section 3.3.

PMAIN takes the output from DANDL and divides the output into aggregate production by utility periods. The periods represent the major divisions in utility cost of production. These utility periods were identified in SERICOST and must be identically specified in PMAIN.

2.4 AVOIDED COST (AVOIDC)

The final section to the SERICPAC methodology is the calculation of avoided cost rates. As discussed earlier, rates to QF's are supposed to be based upon those costs the public utility avoids as a result of purchasing electric energy from the QF. The purpose of SERICPAC is to methodically calculate the buy-back rate to the QF, based upon avoided costs.

There are two conceptual elements to the calculation; the cost structure of the utility, and the performance of decentralized power source. SERICPAC combines the output of the performance analysis with the avoided costs derived in SERICOST.

Avoided costs represent the opportunity costs of resources available to produce electric power. SERICOST determines the cost of the electricity the utility avoids as a result of purchasing electricity during different periods. The results from SERICOST are to be entered in this section of the methodology.

The avoided cost data per time period is combined with the performance of the QF. The performance analysis, calculated in PMAIN, is in the form of aggregated hour performance by utility time period. It is based upon the results from the SIMULATE and DANDL sections of the methodology. The performance analysis can be considered in terms of electricity sold and produced by the QF.

The output of AVOIDC is the weighted average avoided cost rate for that technology. If time of use rates are desired, then the rates from SERICOST are the appropriate rates.

The formula to calculate the weighted average avoided cost is as follows (see Eq. 2-7):

$$ACR = \frac{\sum_{i=1}^n (kWh_i) (AC_i)}{\sum_{i=1}^n kWh_i} \quad (2-7)$$

where:

ACR = weighted avoided cost rate.
 kWh = the kilowatt hours sold back to the utility in period i.
 AC = the utility avoided cost in period i from SERICOST.
 n = the number of utility periods specified in SERICOST.
 i = avoided cost period.

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SECTION 3.0

SERICPAC USER GUIDE*

3.1 INTRODUCTION

The SERICPAC methodology is designed to calculate the avoided cost rates for various decentralized technologies. SERICPAC is designed to be compatible with SERICOST a program to calculate the avoided costs of a utility. The program is flexible enough to accommodate other utility costing models or technology simulation programs.

SERICPAC is composed of four main sections. The sections include:

<u>Section Number</u>	<u>Title</u>	<u>Description</u>
3.2	SIMULATE:	This program contains eight different simulations of decentralized technologies.
3.3	DANDL:	This section allows the user to account for the availability of qualifying facility production. Simultaneous buy/sell or net energy options are available to the user.
3.4	PMAIN:	This program takes the net or gross production and breaks it up into utility time periods.
3.5	AVOIDC:	The avoided cost rates are calculated and displayed.

3.1.1 Symbols Used in Guide

- An underlined word, phrase, sentence(s) indicates a computer-response. It should be carefully distinguished from section headings, which are also underlined but preceded by chapter numbers.
- "input"--to be provided by user is between quotes.
- (cr)--a carriage return is required or actuated. When (cr) is preceded by an input quote (described above), the user should enter the input then depress carriage return.
- ϕ --signifies a blank space.
- *Headings/Subheadings*--headings and subheadings used for clarification purposes will be bracketed by asterisks.

*The user should consult Appendix A in order to operationalize the SERICPAC computer model.

3.2 TECHNOLOGY SIMULATION (SIMULATE)

There are two very important sections in the SIMULATE main program:

Technology Simulation--There are eight technology models which simulate their performance, individually, given the inputs to the model and/or configuration chosen. Section 3.2.2.

Interactive Input Option--The user is able to inspect, change, save input files, and read previously saved input files. The user is also able to execute the simulation. Section 3.2.1.

It is suggested that the user review technology descriptions (found in Section 2) and input requirements to the technology simulations (found in Section 3.2.2) before attempting to execute the SIMULATE main program. A flow diagram of how SIMULATE operates is presented in Figure 3.1.

To activate the technology simulation main program, the user should type "SIMULATE" (cr).

The following appears at the terminal:

Do you want printout to terminal? (Y/N)
(If NO, Printout to file)

"Y"(cr) - The output of the simulation module will appear at the terminal. It will be stored in the file SYSSIMUL.DAT. The prompt proceeds to the Main Branchpoint.

"N"(cr) - The technology simulation output is stored in SYSSIMUL.PRN and unavailable for viewing at the terminal. The prompt proceeds to the Main Branchpoint.

SIMULATION TO EXECUTE-
>>H:W:C:G:M:R:B:P:?:E:

This is the main branchpoint for the SIMULATE main program. If the user is unfamiliar with the branchpoint, a question mark "?"(cr) should be entered. The prompt returns.

This is the simulation section-

Energy systems may be modeled by the appropriate module.

Available modules and commands include:

H(ydro) - Hydropower simulation.

W(ind) - Wind production simulation.

G(assif) - Producers gas simulation.

C(onfui) - Level performance, for example for either direct combustion, based on fuel rate and heat content.

R(ated) - Level performance for any constant output process, based in rated level. This is a useful tool for analysis of a technology with a constant rated output.

B(iogas) - Biogas power production simulation.

Figure 3-1. Flowchart of the SIMULATE Main Program

M(uni) - Municipal waste simulation.

P(lantat) - Combustion - Energy plantation simulation.

E(nd) - Terminate simulation section.

*Note that there is an interactive input to each section, with default values and prompting. It is therefore not necessary to know all variables or to memorize their order.

SIMULATION TO EXECUTE-

>>H:W:C:G:M:R:B:P:?:E:

The user should select a technology to simulate and enter the appropriate letter, followed by (cr).

If a response other than the one allowed is entered, the following is returned to the terminal:

ENTER ONE OF THE FOLLOWING: "H" "W" "C" "G" "M" "R" "B" "P" "?" "E"

>>H:W:C:G:M:R:B:P:?:E:

3.2.1 Interactive Options

Once the user has selected and entered a technology to simulate, the following branchpoint appears:

Interactive Input Option:

>>L:R:?:C:I:O:D:E:

If the user is unfamiliar with this branchpoint, "?" (cr) should be entered.

The following should appear on terminal: This is the interactive input section. Available commands include:

L(list) Lists technology input variables. If you respond to the following prompt with a positive number, that line will be listed. If the number is less than zero, all lines will be listed. Entry of a zero causes you to be prompted for a range to list.

C(hange) Changes in variables. You will be prompted for the number of the variable to change and the new value.

R(un) Returns to simulation module to execute with variables as specified in this section.

I(nput) Sets data from a previously "output" file.

O(utput) Saves current data to file, suitable for later "input."

D(efault) Resets to defaults. This is done automatically on the first run for each simulation module.

E(nd) Aborts this section without proceeding with run.

After executing (cr) the program returns to the interactive option branchpoint, Section 3.2.1.

3.2.1.1 List

If the user wishes to list all of the input variables, "L"(cr) is entered and the following is returned to the terminal:

Number To List (0 for range, <0 for all):

Number to list implies the variable's position in the technology simulation input list. It is possible to have some or all of the variables listed at the terminal. For instance, the fifth through tenth variables can be displayed. In such a case "0" is entered. The prompt returns:

First Line Number: (cr)

The first variable line number "5" should be entered (cr). Prompt returns:

Last Line Number: (cr)

The last variable number "10" (cr) is to be entered.

Error message: *Invalid values for list range* indicates that either the user entered no responses or only one response, or that the first and last desired line were out of numerical order. If the user is unfamiliar with the input list, a negative number should be entered.

The user is returned to the interactive option branchpoint, Section 3.2.1.

3.2.1.2 Help

The directory assistance option is engaged by entering "?" (cr). The list of available interactive commands was previously listed in Section 3.2.1.

3.2.1.3 Change

The change option enables the user to change specific input variables. Upon entering "C" (cr), Number To Change appears at the terminal. The variable numbers are available either through the list of options or within the user guide description presented in the next section, 3.2.2.

After the user enters the appropriate number (cr), the prompt returns:

New Value:

If no value is entered for either or both request(s), the user is returned to the interactive input branchpoint, Section 3.2.1.

3.2.1.4 Output

It is possible to change the default values and save them for future use by writing them to a user specified file. Enter "0" (cr) prompt returns:

Name of output file (11 chars--no period):

Enter file name (cr).

Disk of Data File (A/B):

Enter appropriate disk "A" or "B" (see Appendix A).

File header (20 chars max):

The user should enter a file name of eleven characters immediately after the returned : with no periods and (cr). A descriptive heading to the file, of no more than twenty characters is a good idea. Spaces between words are not included as characters.

It is important to note that writing a file to an existing file will wipe out the existing file.

The user returns to Section 3.2.1, the interactive branchpoint whether titles have been entered or not.

3.2.1.5 Input

Previously saved files can be read into this section as inputs to the technology simulations, by entering "I" (cr). The prompt response:

Enter Information on Input File
Enter Disk of Data File (A/B):

The user should enter either "A" or "B."

Filename (11 Chars, no period: Blank to Escape):

The user should enter the proper filename.

File header (20 chars max):

The name of the input file must be 11 characters, with no periods and entered after the :. The file heading can be only 20 characters total. Spaces between words are not included as characters. A check is performed to determine whether the specified file is in the computer memory. If the test fails the following message appears:

File not Found

If the file is found, then another check is executed to evaluate whether the specified input file requested is for the technology initially chosen. The message:

File for wrong system type

appears if the condition occurs.

In the event of problems of data transfer, the message:

Premature end-of-file on channel number--

The user is returned to Section 3.2.1, the interactive input branchpoint when either the input was successfully completed or no entries were attempted.

3.2.1.6 End

"Q" (cr) allows the user to leave or quit the interactive input section without executing the model, returning to the main branchpoint.

3.2.1.7 Run

This option enables the user to execute the simulation with the input data changed or left as defaults.

The next section outlines the input data, options (if applicable) and output available per technology after "R" (cr) has been entered. It is very important to read this next section before attempting to execute any of the technology simulations.

3.2.2 Technology Options

It is highly recommended that the user review this section before attempting to execute any of the technology simulations. This section outlines the input data, simulation options (if applicable), and output available per technology, after the "R" (cr) has been entered while at the interactive branchpoint.

3.2.2.1 Technology Simulation User Guide Introduction

The general form of the next section (3.2.2.2--3.2.2.8) is as follows:

Introduction: Brief description of technology.

Requirements: Data requirements to the technology simulations are listed with the respective portions of sections 3.2.2.1 through 3.2.2.8. Access to vary, save, or create input files is available within section 3.2.1.1 through 3.2.1.7.

Default

Assumptions: These are the input variables to the simulation. Section 3.2.1 outlines the procedure to vary, save, recall, and/or default these input variables.

Additional

Assumptions: Some programs have options which are elaborated upon within this section.

Operation: Instructions for operation.

Error

Messages: Explanatory statements of any execution time errors.

Output: Example of simulation results displayed.

3.2.2.2 Data File In SIMULATE

In order to more accurately perform the technology simulations, weather data are required for some of the technology models. The following technologies require data files:

<u>Technology</u>	<u>Data</u>	<u>Format</u>
Hydro-Electric Production	1. River flow measured in cubic feet per second (CFS) for hourly, daily, or monthly gauge readings.	Variable read format option, defaults to G13.6.
Wind Energy Conversion Systems	1. Windspeed (meters/sec.) hourly or tri-hourly readings per day.	First Line is a descriptive header, one entry per subsequent line. The entry format is G13.7.
	2. Temperature (centigrade) Electric Production (Hydro)	Same as above.

3.2.3 Hydro-Electric Production (HYDRO)

Based upon Army Corp of Engineer model. See Section 2.1.1 for a further description.

Requirements:

Data Files

River flow measured in cubic feet per second (cfs) for either hourly, daily, or monthly gauge readings.

The file should be titled with 11 characters, containing no periods. The first line should be a header, and one input per line thereafter. There is a variable read format option, which defaults to G13.6.

Default Assumptions:

<u>Variable Numbers</u>	<u>Default Values</u>
1. Plant efficiency (%).....	.88000
2. Height head efficiency (%).....	.95000
3. Minimum operational level (% of capacity).....	.400000
4. Number of dam sites.....	1.000000
5. Data flag (1-hourly, 2-daily, 3-monthly).....	1.000000

Additional Assumptions:

*Frequency of flow measurements (hourly, daily, monthly)

*For each site:

Gross head size--measured in feet

Plant capacity--measured in kW

Sample Inputs

Upon selecting "R" (cr) the computer responds:

End data set section
Disk of data file (A/B)

The user should respond with the appropriate letter (cr). The prompt returns:

Filename (11 chars, no period: blank to escape)

A file name of the data file containing flow data is to be entered; eleven characters and no periods.

Is the first record of the file a label header?
("Yes" should be the default condition)
(N,Y)

"N" (cr) - no header exists

"Y" (cr) - default condition; one line description exists.
It is returned to the screen.

Header: (SAMPLE HEADER NAME)

The prompt returns:

Do you wish to use the default data format:
(G13.6)
(N,Y):

This is the variable format option:

"Y" (cr) - defaults format to (G13.6)

"N" (cr) - the following question follows:

Enter new format (including parens: blank to escape):

User should enter appropriate FORTRAN data field descriptor (cr). An example is "(2X, F15.2)." No entry (cr) causes the user to return to Main Branchpoint, Section 3.2.

The prompt returns with the additional assumption section.

Name of Site:

The user is asked to provide the name (20 characters or less) of the first site (if more than one site is selected) (cr).

Plant Capacity-kW-(G):

The appropriate plant capacity (in kW) is entered with a decimal point (cr).

Gross Head Size-Ft:

The appropriate gross head size (in ft.) is entered with a decimal point (cr).

The preceding series of three questions (Name of Site, Plant Capacity, and Gross Head Size) is iterated as many times as specified by input variable #4. Variable #4 defaults to 1..

Sample Out and Error Messages:

After the final gross head is entered:

Running...

A running message is displayed. Check messages are displayed:

```
Hour 1000
Hour 2000
|
Hour 8000
```

This indicates the number of hours the simulation has performed. If input data is daily rather than hourly, then day--is displayed.

If the prompt returns:

This program has no provision for century by century data. We are returning you to the main program--clean up your act.

Then the user should compare value #5 from the input list with stream flow data entered from file. It is important to determine whether the elements of the input file match the specifications indicated by variable #5.

Other error messages are self-explanatory.

The output form of the simulation for three sites is as follows:

```

*****
*   THE AVERAGE STREAM FLOW FOR THE GAUGE SITE IS 343.417 CFS   *
*****
* SITE TEST1                                                    *
* PLANT FACTOR 100.0000                                         *
* SPILLAGE FACTOR 97.1187                                       *
* TOTAL KWH 276.000                                             *
* SITE TEST 2                                                    *
* PLANT FACTOR 100.0000                                         *
* SPILLAGE FACTOR 93.3455                                       *
* TOTAL KWH 408.000                                             *
* SITE TEST 3                                                    *
* PLANT FACTOR 100.0000                                         *
* SPILLAGE FACTOR 97.4614                                       *
* TOTAL KWH 252.000                                             *
*****

```

3.2.2.4 Wind Energy Conversion Systems (WIND).

Introduction: WECS model designed to accept hourly or tri-hourly wind speed data. Further description Section 2.1.3.

Requirements: *Data Files*

Two data files are required:

<u>File</u>	<u>Format</u>
Wind speed (m/sec)	First line header, one entry per subsequent line.
Temperature (centigrade)	Same as above.

The program is designed to accept this input data for hourly or tri-hourly wind and temperature readings.

The title of the respective file is to be 11 characters (with no periods). The header can be 20 characters maximum. Spaces are not included as characters.

Default Assumptions:

<u>Variable Numbers</u>	<u>Default Values</u>
1. CUT IN VELOCITY (M/S).....	4.50000
2. CUT OUT VELOCITY (M/S).....	18.0000
3. RATED VELOCITY (M/S).....	11.6000
4. DESIGN VELOCITY AT MAX. POWER COEFF (M/S).....	7.40000
5. RATED POWER (WATTS).....	65000.0
6. MAXIMUM POWER COEFFICIENT (FRACTION).....	.410000
7. ROTOR DIAMETER (M).....	19.5000
8. ANEMOMETER RECORDING HEIGHT (M).....	6.10000
9. ELEVATION ABOVE SEA LEVEL (M).....	177.000
10. HUB HEIGHT IF HORIZONTAL AXIS (M).....	22.9000
11. CLEARANCE HEIGHT IF VERTICAL AXIS (M).....	0.00000

12. CONSTANT (=0) OR VARIABLE (= 1) RPM.....	0.00000
13. HORIZONTAL (=0) OR VERTICAL(=1) AXIS.....	0.00000
14. HEIGHT OF WECS IF VERTICAL AXIS (M).....	0.00000
15. TIME INCREMENT OF WIND SPEED DATA (HOURS).....	3.00000

Operation:

There are two sets of interactive questions; the first is directed towards wind speed, the second towards temperature.

Upon entering "R" (cr) at the interactive option branchpoint, Section 3.2.1, the prompt returns:

Enter data for wind file (meters/sec)-
Disk of data file (A/B):

The user should enter the appropriate response "A" or "B" (cr):

Filename (11 chars, no period: blank to escape):

An eleven character file name for the wind speed data is to be entered (cr). No entry (cr) returns the user to the SIMULATE Branchpoint, Section 3.2.

Is the first record of the file a label header?
("Yes" should be the default condition)
(N,Y):

"N" (cr) - prompt returns to the next section
 "Y" (cr) - a copy of the header is displayed.

Header: (Sample Header)

Do you wish to use the default data format?
(G13.6)
(N,Y):

"Y" (cr) - prompt returns to the next question
 "N" (cr) - the user views:

Enter new format (including parens: blank to escape):

The appropriate field descriptor is to be entered, reflecting the formatting of the data file. No entry (cr) allows the user to return to SIMULATE branchpoint, Section 3.2. The prompt returns:

Is the data in meters/second?
(N,Y):

"Y" (cr) - the user is returned to the next question
 "N" (cr) - prompt returns:

Data may be adjusted by the formula:
Final data = (Rawdata+addfactor)*multfactor

The raw data is the input file. The input file eventually is to be in units of meters/sec.

Enter factor to add to raw data:

Enter appropriate factor (cr) including a decimal point. If no factor is to be added to the raw data, then "0." should be entered (cr).

Enter factor to multiply data by after addition:

Enter appropriate factor (cr) including decimal point. If the raw data is not to be multiplied by a factor, then "1." (cr) is to be entered.

Data can be either hourly or in the form of hour/month mean & standard deviation.

Is the data hourly? ("No" indicates mean & SD)

"Y" (cr) - hourly (or daily) inputs are specified

"N" (cr) - a file containing previously calculated means and standard deviation had been entered.

The second input file to be retrieved is temperature data.

Enter data for temperature file (deg C)-
Disk of data file (A/B):

Enter appropriate disk "A" or "B" (cr).

Filename (11 chars, no period: blank to escape):

Enter temperature file name, eleven characters and no period (cr).

Is the first record of the file a label header?
("Yes" should be the default condition)
(N,Y):

"N" (cr) - prompt returns with next question

"Y" (cr) - user views the temperature file header

Header: (Sample Header)

Do you wish to use the default data format?
(G13.6)

"Y" (cr) - prompt returns with the next question

"N" (cr) - prompt returns:

Enter new format (including parens: blank to escape):

User should enter appropriate field descriptor for the temperature data file (cr). No entry (cr) returns the user to the SIMULATE Branchpoint, Section 3.2.

Is the data in centigrade?
(N,Y):

"N" (cr) - temperature data is converted from fahrenheit
into centigrade.

"Y" (cr) - temperature data is in centigrade and will be
directly utilized.

Error Messages:

All error messages will be self-explanatory.

Sample Output
(See following page)

Sample Output

Output from the simulation appears as follows:

```
*****
*   WIND SIMULATION OUTPUT:                                     *
*                                                                 *
*   INPUTS:                                                       *
*   1.  CUT IN VELOCITY (M/S)..... 4.50000                      *
*   2.  CUT OUT VELOCITY (M/S)..... 18.0000                      *
*   3.  RATED VELOCITY (M/S)..... 11.6000                       *
*   4.  DESIGN VELOCITY AT MAX. POWER COEFF (M/S)..... 7.40000   *
*   5.  RATED POWER (WATTS)..... 65000.0                        *
*   6.  MAXIMUM POWER COEFFICIENT (FRACTION)..... .410000        *
*   7.  ROTOR DIAMETER (M)..... 19.5000                         *
*   8.  ANEMOMETER RECORDING HEIGHT (M)..... 6.10000            *
*   9.  ELEVATION ABOVE SEA LEVEL (M)..... 177.000              *
*  10.  HUB HEIGHT IF HORIZONTAL AXIS (M)..... 22.9000           *
*  11.  CLEARANCE HEIGHT IF VERTICAL AXIS (M)..... 0.00000       *
*  12.  CONSTANT (=0) OR VARIABLE (= 1) RPM..... 0.00000        *
*  13.  HORIZONTAL (=0) OR VERTICAL(=1) AXIS..... 0.00000        *
*  14.  HEIGHT OF WECS IF VERTICAL AXIS (M)..... 0.00000        *
*  15.  TIME INCREMENT OF WIND SPEED DATA (HOURS)..... 3.00000  *
*   *****                                                    *
*   *   MONTH      TOTAL POWER(KWH)    AVERAGE POWER(KWH)      *
*   *               PER MONTH           PER MONTH               *
*   *   1          12284.2              16.5110                 *
*   *   2          6606.22              9.83069                  *
*   *   3          12021.8              16.1583                  *
*   *   4          10549.2              14.6516                  *
*   *   5          7090.90              9.53078                  *
*   *   6          7576.63              10.5231                  *
*   *   7          4148.99              5.57660                  *
*   *   8          3996.22              5.37126                  *
*   *   9          5307.23              7.37116                  *
*   *  10          8340.11              11.2098                  *
*   *  11          8207.74              11.3996                  *
*   *  12          8646.78              11.6220                  *
*   *                                                                 *
*   *   TOTAL POWER OUTPUT =                94775.9 KWH/YR      *
*   *   AVERAGE POWER OUTPUT =              10.8192 KW          *
*   *   AVERAGE ANNUAL CAPACITY FACTOR =    16.6449 %          *
*   *   *****                                                    *
*   *                                                                 *
*****
```

The user is returned to the SIMULATE Branchpoint, Section 3.2.

3.2.2.5 Conventional Fuel Input (CONFUI)

Introduction: Conventional fossil fuel engine. Description in Section 2.1.3.

Requirements: The user does not have to provide data files.

Default Assumptions:

<u>Variable Numbers</u>	<u>Default Values</u>
1. Fuel Heating Value (Btu/Gal).....	150000.
2. Fuel Input Rate (Gal/Hr).....	1.20000
3. Efficiency of Power Plant (%).....	.700000

Additional Assumptions: None.

Operation: From Interactive Input Branchpoint, Section 3.2.1, enter "R" (cr).

Error Messages: Self-explanatory.

Sample Output

```
*****
*   OUTPUT FROM CONVENTIONAL FUELS POWER PRODUCTION   *
*                                                       *
*   INPUTS:                                             *
*       1. FUEL HEATING VALUE (BTU/GAL)..... 150000.   *
*       2. FUEL INPUT RATE (GAL/HR)..... 1.20000       *
*       3. EFFICIENCY OF POWER PLANT(%)..... .700000   *
*                                                       *
*   *****                                           *
*   *   POWER PRODUCTION = 36.928 KW/HR               *   *
*   *****                                           *
*                                                       *
*****
```

3.2.2.6 Rated Power (CONTOO)

Introduction: Analytical tool to describe technology with constant production. Further description section 2.1.4.

Requirements: No additional data files required.

Default Assumptions:

1. Rated Level of Constant Production (kW)..... 100.0000

Additional Assumptions: None.

Operation: From Interactive Input Branchpoint, section 3.2.1, enter "R" (cr).

Error Messages: Self-explanatory.

Sample Output

[illegible]

3.2.2.7 Direct Combustion of Biomass (COMBUS)

Introduction: Direct combustion of biomass fuels. A wood plantation, or a constant source of fuels is assumed. See section 2.1.5 for further description.

Requirements: No additional data files are requested.

Default Assumptions:

Variable Number	Value
1. CONSTANT BIOMASS FUEL INPUT OPTION(YES=1)	1.000000
2. ENERGY PLANTATION PELLETIZED OPTN(YES=1)	1.000000
3. ENERGY PLANT.NON-PELLETIZED OPTN(YES=1)..	1.000000
4. WOOD RESIDUE PELLETIZED OPTION(YES=1)....	1.000000
5. WOOD RESIDUE NON-PELLETIZED OPTION(YES=1)	1.000000
6. FUELWOOD YIELD (GREEN TONS/HECTARE/YEAR)	10.8700
7. AREA PLANTED (HECTARES).....	50.0000
8. HIGHER HEATING VALUE OF FUELWOOD(BTU/LB).	8500.00
9. PELLETIZED FOR PLANTATION (%).....	50.0000
10. PERCENT OF BIOMASS WHICH IS MOISTURE (%).	40.0000
11. MOISTURE CONTENT AFTER PELLETIZATION (%)..	10.00000
12. FUELWOOD AFTER PELLET (% RECOVERED).....	90.0000
13. WOOD RESIDUE PRODUCTION (GREEN TONS/YR)..	500.000
14. HIGHER HEATING VALUE WOOD RESIDUE (BTU/LB)	8500.00
15. PELLETIZED FOR RESIDUES (%).....	50.0000
16. PERCENT OF RESIDUE WHICH IS MOISTURE (%).	40.0000
17. MOISTURE CONTENT AFTER PELLET-RESIDUE(%).	10.00000
18. FUELWOOD AFTER PELLET-RESIDUE(% RECOVER).	90.0000
19. HEAT RATE ELECTRIC POWER PLANT (BTU./KWH)	11600.0
20. CONSTANT BIOMASS FUEL INPUT (TONS/HR)...	3.00000
21. PERCENT OF BIOMASS FUEL THAT IS MOISTURE.	40.0000
22. HIGHER HEATING VALUE BIOMASS FUEL (BTU/LB)	8500.00
23. BTU RATIO STEAM/ELECTRICITY.....	1.000000

Additional Assumptions: None.

Operation: From Interactive Input Branchpoint, Section 3.2.1 enter "R" (cr).

Error Messages: Self explanatory.

Sample Output

```

*****
*
* OUTPUT FROM ENERGY PLANTATION POWER PRODUCTION
*
* INPUTS:
*   1.  CONSTANT BIOMASS FUEL INPUT OPTION(YES=1)                1.000000
*   2.  ENERGY PLANTATION PELLETIZED OPTN(YES=1)                1.000000
*   3.  ENERGY PLANT.NON-PELLETIZED OPTN(YES=1)..              1.000000
*   4.  WOOD RESIDUE PELLETIZED OPTION(YES=1)....               1.000000
*   5.  WOOD RESIDUE NON-PELLETIZED OPTION(YES=1)                1.000000
*   6.  FUELWOOD YIELD (GREEN TONS/HECTARE/YEAR).                10.8700
*   7.  AREA PLANTED (HECTARES).....                           50.0000
*   8.  HIGHER HEATING VALUE OF FUELWOOD(BTU/LB).                8500.00
*   9.  PELLETIZED FOR PLANTATION (%).....                      50.0000
*  10.  PERCENT OF BIOMASS WHICH IS MOISTURE (%).                40.0000
*  11.  MOISTURE CONTENT AFTER PELLETIZATION (%).                10.00000
*  12.  FUELWOOD AFTER PELLET (% RECOVERED).....                90.0000
*  13.  WOOD RESIDUE PRODUCTION (GREEN TONS/YR)..                500.000
*  14.  HIGHER HEATING VALUE WOOD RESIDUE (BTU/LB)                8500.00
*  15.  PELLETIZED FOR RESIDUES (%).....                        50.0000
*  16.  PERCENT OF RESIDUE WHICH IS MOISTURE (%).                40.0000
*  17.  MOISTURE CONTENT AFTER PELLET-RESIDUE(%)..              10.00000
*  18.  FUELWOOD AFTER PELLET-RESIDUE(% RECOVER).                90.0000
*  19.  HEAT RATE ELECTRIC POWER PLANT (BTU//KWH)                11600.0
*  20.  CONSTANT BIOMASS FUEL INPUT (TONS/HRS)...                3.00000
*  21.  PERCENT OF BIOMASS FUEL THAT IS MOISTURE.                40.0000
*  22.  HIGHER HEATING VALUE BIOMASS FUEL (BTU/LB)                8500.00
*  23.  BTU RATIO STEAM/ELECTRICITY.....                       1.000000
*
*   *****
*   *   POWER PRODUCTION   =  134.3866882   KW/HR
*   *****
*
*****

```

Additional Assumptions: The following options are available for direct combustion technologies:

1. Constant biomass fuel input--the following variables require appropriate values.

Variable Number	Variable Title
8	Higher Heating Value of Fuelwood (Btu/lb)
10	% of Biomass which is Moisture
18	Heat Rate Electric Power Plant (Btu/kWh)
19	Tons of Biomass Per Hour

2. Energy Plantation--Pelletized Biomass. The following variables require appropriate values:

<u>Variable Number</u>	<u>Variable Title</u>
6	Fuelwood Yield (Green Tons/Hectare/Year)
7	Area Planted (Hectare)
8	Higher Heating Value of Fuelwood (Btu/lb)
9	Pelletized for Plantation (%)
10	% of Biomass which is Moisture (%)
11	Moisture content after Pelletization (%)
12	Fuelwood after Pellet (% RECOVERED)
19	Hect Rate Electric Power (Btu/kWh)

3. Energy Plantation--Non-pelletized Biomass.

The following variables require appropriate values:

<u>Variable Number</u>	<u>Variable Title</u>
6	Fuelwood Yield (Green Tons/Hectare/Year)
7	Area Planted (Hectare)
8	Higher Heating Value of Fuelwood (Btu/lb)
10	% of Biomass which is Moisture
19	Heat Rate Electric Power (Btu/kWh)

4. Biomass Residues--Pelletized.

The following variables require appropriate values:

<u>Variable Number</u>	<u>Variable Title</u>
13	Biomass Residue Production (Green Tons/Yr)
14	Higher Heating Value Biomass Residue (Btu/lb)
15	Pelletized for Residues (%)
16	% Residues which is Moisture
17	Moisture Content after Pellet.--Residue (%)
18	Biomass after Pellet.--Residue (% Recover)
19	Heat Rate Electric Power Plant (Btu/kWh)

5. Biomass Residues--Non-pelletized.

The following variables require appropriate values:

<u>Variable Number</u>	<u>Variable Title</u>
13	Biomass Residue Production (Green Tons/Yr)
14	Higher Heating Value Residues (Btu/lb)
16	% Residues which is Moisture
19	Heat Rate Electric Power Plant (Btu/kWh)

NOTE: The user can use any combination (including all five) of the options available, by choosing a value of "1" in variables 1--5.

3.2.2.8 Methane Production and Generation (BIOGAS)

Introduction: Methane production through anaerobic digestion of biomass materials. See section 2.1.6 for further explanation.

Requirements: No additional data files required.

Default Assumptions: See Additional Assumptions to clarify input of variable numbers 44-51.

<u>Variable Numbers</u>	<u>Default Values</u>
1. NUMBER OF PROCESS STEPS.....	8.00000
2. ACTIVATION ENERGY (CAL/MOLE).....	15180.0
3. RATIO OF MANURE SOLIDS TO RESIDUE SOLIDS.....	.100000
4. FRACTION OF SOLIDS IN MANURE.....	.120000
5. FRACTION OF VOL. SOLIDS IN MANURE.....	.800000
6. FRACTION OF BIODEG. VOL. SOL. IN MANURE.....	.600000
7. HEAT CAP. DIGESTER (SLURRY)(BTU/LB.DEG-F).....	.000000
8. HEAT TRANS. COEF. HEAT XCHNG(BTU/HR-FT ² -).....	80.0000
9. AMBIENT TEMP (DEG. C).....	0.00000
10. CU.FT. METHANE/LB. CONVERTED.....	6.60000
11. FRAC. SOLIDS IN DEWATERED SOL. STREAM.....	.300000
12. MAXIMUM CAPACITY SHREDDER (TONS/HR).....	25.0000
13. SHREDDER WORK (HP/TONS/HR).....	15.0000
14. STORAGE MAX. CAPACITY(CU.FT.).....	300000.
15. HEAT XCHNG MAX. CAPACITY(CU.FT.).....	0000.00
16. HOLDING/MIXING MAX. CAPACITY(CU.FT.).....	300000.
17. PRETREATMENT MAX. CAPACITY(CU.FT.).....	5469.00
18. DEWATERING MAX. CAPACITY (TON/HR).....	0.00000
19. DEWATERING WORK (HP/TON/HR).....	0.00000
20. EFFICIENCY OF DEWATERER(%).....	0.00000
21. GAS PURIFICATION WORK (HP/MM SCFD).....	300.000
22. DENSITY STORAGE (CU.FT.).....	88.0000
23. RATE EQUATION CONSTANT(1/DAYS).....	.300000E+10
24. FRACTION LOSS PRETREATMENT.....	.500000E-01
25. EFFICIENCY OF PRETREATMENT.....	.500000
26. PRETREATMENT WORK.....	.200000
27. RETENTION TIME PRETREATMENT.....	4.00000
28. RETENTION TIME STORAGE(DAYS).....	360.000
29. RETENTION TIME HOLDING TANK (DAYS).....	.000000
30. HOLD/MIX TANK WORK (HP/CU.FT.).....	.200000E-03
31. DENSITY HOLD/MIX TANK(LB./CU.FT.).....	64.0000
32. DENSITY PRETREATMENT (LB./CU.FT.).....	64.0000
33. AMOUNT OF CHEM. REQ. PER SOLID FEED(%).....	.500000
34. FRACTION SOLID IN HOLDING MIX.....	.100000
35. FRACTION SOLIDS PRETREATMENT.....	.100000
36. FRACTION SOLIDS IN DIGES. FEED.....	.100000
37. RETENTION TIME DIGESTER (DAYS).....	0.00000
38. DIGESTER WORK MAX CAPACITY (CU.FT.).....	00000.0
39. DIGESTER WORK (HP/CU.FT.).....	.200000E-03
40. DIGESTER DENSITY (LB./CU.FT.).....	64.0000
41. BATCH LOADING TIME (DAYS).....	30.0000
42. DIGESTER TEMP. (DEG-C).....	60.0000

43.	PRETREATMENT TEMP.(DEG-C).....	115.000
44.	<1 SHREDDER NOT USED.....	1.000000
45.	<0 NO HOLDING;=0HOLDING, NO MIX; >0 HOLD/M.....	1.000000
46.	<1 NO PRETREATMENT.....	1.000000
47.	<1 NO STORAGE.....	1.000000
48.	<1 NO HEAT EXCHANGER.....	1.000000
49.	<0 CSTR; =0 PLUG FLOW; >0 BATCH.....	-1.000000
50.	<1 NO DEWATERER.....	0. 0000
51.	<1 NO GAS PURIFICATION.....	1.000000
52.	FEEDSTOCK RATE (TONS SOL./DAY).....	200.000
53.	FRACTION SOLIDS IN FEED.....	.500000
54.	FRACTION VOL. SOLIDS IN FEED.....	.950000
55.	FRACTION BIODEGR. VOL. SOLIDS IN FEED.....	.360000

Additional Assumptions:

Variable Number	Description	Variable Name	Option	NORMATIVE BASE CASE		
				SM.	MED.	LARGE
44	SHREDDER	INSHR	EQ. OR LT. ZERO NOT USED	Y	Y	Y
45	HOLDING/ MIXING	INHLD	LT.ZERO; NOT USED EQ.ZERO; HOLDING, NO MIXING	Y Y	Y Y	Y Y
46	PRETREATMENT	INPRT	EQ. OR LT. ZERO; NO USED	N	N	N
47	STORAGE	INSTR	Same as Above	Y	Y	Y
48	HEAT EXCHANGER	INHEX	Same as Above	Y	Y	Y
49	DIGESTER TYPE	INDIG	EQ. ZERO PLUG FLOW LT. CSTR GT. BATCH	C C	C C	C C
50	DEWATERING	INDWT	EQ. OR LT. ZERO; NOT USED	N	N	N
51	GAS PURIFICATION	INPGU	EQ. OR LT. ZERO; NOT USED	N	N	N

Error Messages: Self-Explanatory.

Sample Output and Operation:

Upon entering "R" (cr) in the interactive input section, the user views:

Enter system header-one line-

An appropriate descriptive statement should be entered (cr). An example of a header is:

"Test of biogas system simulation"

The output is in the form of:

```
*****
*   TEST OF BIOGAS SYSTEM SIMULATION   *
*****
```

SYSTEM PERFORMANCE

FEED COMPOSITION

TOTAL SOLIDS	200.000	TONS/D
SOLIDS FRACTION IN FEED	.500000	
VOLATILE SOLIDS FRACTION IN SOLIDS	.950000	
BIODEGR. VOL. SOL. FRACT. IN SOL.	.360000	

STORAGE

NUMBER OF UNITS	6.0000	
CAPACITY PER UNIT	272727.	CU.FT.

SHREDDING

NUMBER OF UNITS	1.00000	
CAPACITY PER UNIT	.1667E+02	TONS/HR
POWER REQUIREMENT	.2500E+03	HP

HOLDING-MIXING

NUMBER OF UNITS	1.00000	
CAPACITY PER UNIT	.6250E+05	CU.FT.
POWER REQUIREMENT	.1250E+02	HP

PRETREATMENT

RATIO OF CHEMICAL TO FEED	.50000E-01	
CONVERSION EFFICIENCY	.500000	
NUMBER OF UNITS	2.0000	
CAPACITY PER UNIT	.5469E+04	CU.FT.
CHEMICAL REQUIREMENT	.1000E+02	TONS/HR
POWER REQUIREMENT	.2187E+04	HP

DIGESTION

CSTR

NUMBER OF UNITS	8.0000	
CAPACITY PER UNIT	.9023E+05	CU.FT.
DIGESTER TEMPERATURE	60.00	C
RETENTION TIME	10.00000	DAYS
CONVERSION EFFICIENCY	.767378	
POWER REQUIREMENT	.1444E+03	HP

GAS PRODUCTION

1.90639	VVD
.1376E+04	MM BTU/D

HEAT EXCHANGER

NUMBER OF UNITS	3.00000	
HEAT EXCHANGER AREA	.6893E+04	SQ.FT.

TOTAL HEAT REQUIREMENT

.0000E+01 MM BTU/D

DEWATERING-NONE USED

GAS PURIFICATION

CAPACITY PER UNIT

.2294E+07 CU.FT./D

TOTAL WORK REQUIREMENTS 3282.46 HP

TOTAL ELECTRICITY PRODUCED = 3361.12 KW/HR

TOTAL ENERGY USED = 2448.72 KW/HR

NET ENERGY PRODUCED = 912.406 KW/HR

3.2.2.9 Municipal Waste Electric Generation (MUNI)

Introduction: Methane production via anaerobic digestion of municipal wastes. Further description can be found in section 2.1.7.

Requirements: No additional data files are required.

Default Assumptions:

1. WASTE USED (TONS PER DAY).....	1000.000
2. EFFICIENCY OF GENERATOR.....	.200000

Additional Assumptions: None.

Operation: From Interactive Branchpoint option, section .2, enter "R" (cr).

Error Messages: Self-explanatory.

Sample Output:

```
*****
*
*  OUTPUT FROM MUNICIPAL WASTE POWER PRODUCTION
*
*  INPUTS:
*    1. WASTE USED (TONS PER DAY)..... 1000.000
*    2. EFFICIENCY OF GENERATOR..... .200000
*    *****
*    *  POWER PRODUCTION = 344.1285706 KW/HR
*    *****
*
*****
```

3.2.2.10 Producers' Gas Production and Generation (GASSIF)

Introduction: Producers' gas simulation model. Further description section 2.1.8.

Requirements: No additional data files required.

Default Assumptions:

1. RESIDUAL LOADING RATE (TONS/DAY).....	4.10959
2. HOURS OF OPERATION PER DAY.....	24.0000
3. HIGHER HEATING VALUE OF BIOMASS (BTU/LB).....	8500.00
4. MOISTURE CONTENT OF BIOMASS (%).....	.400000
5. CONVENTIONAL FUEL NET HEAT VALUE(BTU/LB).....	0.0000
6. CONVENTIONAL FUEL RATE (LITERS/HOURS).....	0.00000
7. DENSITY OF CONVENTIONAL FUEL (LBS/LITER).....	0.00000
8. EFFICIENCY OF GASIFICATION SYSTEM (%).....	.650000
9. EFFICIENCY OF ENGINE (%).....	.300000
10. EFFICIENCY OF GENERATOR (%).....	.900000

Additional Assumptions:

If a pure system is to be utilized variable number 6 is to be changed to zero. When a dual system is utilized, the conventional fuel rate is to be adjusted accordingly. See section 3.2.1.3 in order to complete these changes.

Operation: From Interactive option Branchpoint, Section 3.2.1 enter "R" (or).

Error Messages: Self-explanatory.

Sample Output:

```
*****
*
* OUTPUT FROM PRODUCERS' GAS POWER PRODUCTION
*
* 1. RESIDUAL LOADING RATE (TONS/DAY)..... 4.10959
* 2. HOURS OF OPERATION PER DAY..... 24.0000
* 3. HIGHER HEATING VALUE OF BIOMASS (BTU/LB)..... 8500.00
* 4. MOISTURE CONTENT OF BIOMASS (%)..... .400000
* 5. CONVENTIONAL FUEL NET HEAT VALUE(BTU/LB)..... 0.00000
* 6. CONVENTIONAL FUEL RATE (LITERS/HOURS)..... 0.00000
* 7. DENSITY OF CONVENTIONAL FUEL (LBS/LITER)..... 0.00000
* 8. EFFICIENCY OF GASIFICATION SYSTEM (%)..... .650000
* 9. EFFICIENCY OF ENGINE (%)..... .300000
* 10. EFFICIENCY OF GENERATOR (%)..... .900000
*
* *****
* * POWER PRODUCTION = 81.382 KW/HR *
* *****
*
*****
```

3.2.3 Exit Simulate Main Program

Upon completing the selected technology simulation, the user is returned to the Main Branchpoint. The user cannot perform a second technology simulation at this point without destroying the results of the existing simulation.

Entering "E" (cr) causes the user to exit the SIMULATE program. The prompt returns:

Simulation section ended stop

and the user is returned to the main system.

3.2.3.1 Output Descriptions

Printouts, available for inspection, of the completed simulations are stored in SYSSIMUL.PRN. SYSSIMUL.DAT. is the data file which also stores the results of the simulation, but is only available to transfer to the DANDL main program.

3.3 DANDL: DERATE, INTEGRATE, AND LOAD

3.3.1 Introduction

The DANDL, derate, integrate, and load main program is responsible for simulating availability of technology performance as well as integrating the QF's load with the derated technology performance.

Requirements for DANDL Operation:

Mode System

Whether the technology performance will be supplied by the user or default to the performance file of the simulation section

Determine which data files have headers as a first line

The DANDL main program has three primary functions:

1. It enables the user to enter the Qualifying Facility's (QF) power requirements (referred to as load) either interactively or via a data file (see section 3.3.4).
2. DANDL integrates the QF load with its power production by hourly periods.
3. The program enables the user to account for QF forced and scheduled outages.

The first option in the DANDL program is to integrate the QF production with the QF power demands (load) by hourly periods. When this integration occurs, the sell back to the utility is termed net energy. The simultaneous buy-sell option occurs when the QF sells its produced electricity to the utility without deducting its load. The Load Integration procedure begins in section 3.3.3. If the net energy option is chosen, then the user should be prepared to enter the QF load patterns and be familiar with the mode system which is discussed in section 3.3.2. Section 3.3.4.1 allows the user to interactively enter the QF load. This interactive option enables the

input of the QF load as a constant hourly load or by varying load by time of day (TOD) periods only. Section 3.3.4.2 enables the user to enter other QF load patterns by establishing a data file.

The derate option, section 3.3.5 allows the user to account for scheduled and forced outages of small power producers. Section 2.2 conceptually describes the derating process. In section 3.3.5, the user is able to derate QF production on a flat, monthly, and/or hourly basis. An example, the derating process could be applied to a diesel generator. If its rated capacity is 100 kW but average production is only 80 kW, then the user would utilize the flat derate option (section 3.3.5.1), entering "80" or ".8." If, for example during the months of July and August, the generator is serviced and can only supply 10 kW of demand, then the user should enter "10" or ".1" for July and August and "100" or "1" for the remaining months (see section 3.3.5.2). The hourly derate option, section 3.3.5.3 allows the user to derate production for each hourly period (24 hours).

The DANDL program allows the user to enter technology performance from a simulation other than those contained in SERICPAC. To enter these technology simulations, see section 3.3.6. The general output format is found within section 3.3.7.

3.3.2 The Mode System: Discussion

This section 3.3.2 is only important if user wishes to input a user load or the results of a simulation not contained in SIMULATE

Both the operating characteristics and the inputs to each simulated technology differ. As a result, output patterns of production will vary. The mode system is a method of differentiating types of QF production. There are four modes. The mode system distinguishes those simulations which have constant production such as a diesel generator, from those technologies which vary by TOD and/or month. The mode system is a computational tool used by the program to insure consistency and accuracy. It also alerts those users who wish to insert the results of their own technology simulations to the existing formats available to complete the package. Knowledge of the mode system is necessary in order to respond to sections 3.3.4 and 3.3.6 portions of the DANDL integrate programs. A description of each mode is listed below.

- Mode 1 - Constant hourly production of power producers such as diesel engines, and direct combustion typify mode 1 production. "1" is to be entered for mode 1 options.
- Mode 2 - Technology performance aggregated in mode 2 varies by time of day (TOD), but there is no monthly variation. Power production is aggregated as an average output (kW) per hour, per month.
- Mode 3 - Hour-by-hour aggregation in mode 3 is similar to mode 2, except that there is variation in monthly output.

Mode 10 - Reflects hour-by-hour production with no aggregation by month. The technologies which receive input data on an hourly basis, such as WECS, and Hydro-electric typically utilize inputs in mode 10.

3.3.3 DANDL Operation

After typing "DANDL" (cr). The prompt returns:

Derating and load integration section

This section derates performance on a flat basis, an hourly basis, and/or a monthly basis. It also integrates loads with this performance to determine net energy bought, sold, and produced.

Do you wish to have a user load integrated?

("Yes" should be used for net sellback determination)

(N/Y):

The user must determine whether the QF's load is to be integrated with his/her production. For the simultaneous buy/sell option, the appropriate response is "N." For the net power option, the user should select "Y."

If the response is:

Yes - see section 3.3.4

No - see section 3.3.5

Error Message:

If a stray response is entered the following is returned:

Please enter N or Y for NO or YES

(N/Y):

3.3.4 Integrate

A positive response to section 3.3.3 returns the prompt with:

Do you wish to enter the load from the terminal?

("NO" will result in disk read prompts)

(N/Y):

Yes - See section 3.3.4.1

No - See section 3.3.4.2

3.3.4.1 Interactive User Load

"Y" provides the user with the opportunity to interactively enter the QF's load (in decimal fraction, or as whole number with decimal points) for either mode 1 or mode 2 technology performance. Note: The QF production is transferred through an internal file.

Mode 1 - constant one number production (in kW)
Mode 2 - varies by TOD but not by month

Loads with mode 3 or 4 specification should be stored on file. The prompt returns:

Mode for load data (1 or 2 only)?

Enter appropriate mode number then (cr).

"1" - constant hourly production
"2" - varies by (TOD), but not by month

"1" - Prompt returns.

Enter User Load for hour 1 (kWh):

The response should be one whole number with a decimal point, in kWh per hour. Section 3.3, derating procedure are the following sequence of questions:

"2" - Prompt returns.

Enter user load for hour 1:

Enter user load for hour 2:

Enter user load for hour 3:

Enter user load for hour 24:

All responses appropriately placed with decimal points follow : with (cr).

From either a mode 1 or mode 2 response the program proceeds to the derate option, section 3.3.5.

3.3.4.2 Disk Read Prompts

Enter load data file information-
disk of data file (A/B):

The user should enter either "A" or "B."

File name (11 Chars, No period):

The user should type an appropriate filename. An example filename would be "file1111.dat."

Is the first record of the file a label header?
(Yes should be the default condition) (N,Y):

A header is assumed to be the first line of the data file. If no, the program will read the first entry as data.

Do you wish use the default data format?
(G13.6)
(N,Y):

If the user responds no, then all user entered formats require proper G or F FORTRAN field descriptors and parenthesis. If the user enters "Y," then the program continues to section 3.3.5.

3.3.5 Derate

This section accounts for forced and schedule outages. The conceptual description is within Section 2.2.

3.3.5.1 Flat Basis

Derate on a flat basis?
(N,Y):

"N" (cr) - a negative response will return the prompt with the next question.

"Y" (cr) - an affirmative response asks:

Derate factor (0.0 F 1.0):

The response can be, for exmaple 75.0 or .75. Remember, the derate section is estimating the available production. Example, production will be 75% of rated capacity.

The prompt will return:

3.3.5.2 Hourly Basis

Derate on an hourly basis?
(N,Y):

"N" (cr) prompt will return with the next section

"Y" (cr) asks the following:

Enter factor for each hour (0.0 F 1.0)

Hour 1:

Hour 2:

Hour 3:

Hour 4:

Hour 5:

Hour 6:

Hour 7:

Hour 8:

Hour 24:

There is (cr) after each colon. The number entered is the percentage of the hour during which production is available. The number can be entered as whole number with a decimal point or as a decimal fraction. This choice of entry style does not have to be consistent.

example: 75.0 or .75

The prompt returns the next question.

3.3.5.3 Monthly Basis

Derate on a monthly basis?
(N,Y):

"N" (cr) A negative response begins the computational section. Interactive options continue in section 3.3.6.

"Y" (cr) The following inputs are required:

Entering factor for each month (0.0<F<1.0)

Month 1:

Month 2:

Month 3:

Month 4:

Month 10:

Month 11:

Month 12:

After each : the percentage of available production, per month is entered as a whole number with a decimal point or as a decimal fraction.

Example: 75. or .75

3.3.6 Entering Technology Simulation

Are you using the default performance file from
the simulation section?
(N,Y):

"Y" (cr) - executes the derate, integrate, and load analysis.
An example of the output with the default factors appear in section 3.3.7.

"N" (cr) - Requires the following information:

*File name (11 characters, no periods) of the technology performance.

*Mode number for input files.

If the user enters "N" (cr), the prompt returns:

Is the performance data in kilowatt hours?
(N,Y):

"Y" (cr) - user will skip the next question

"N" (cr) - the prompt returns;

Enter conversion factor:

The conversion factor is available to translate energy units, i.e., B.T.U., S.C.F., etc. of the alternate technology performance file to kilowatt hours (kWh). The decimal point is very important to include in any of the conversion factors. The prompt returns:

Enter performance data file information-
disk of data file (A/B):

The user should enter either "A" or "B." The prompt returns:

Filename (11 chars, no period):

The alternative performance input file name should be entered. The user should be prepared to answer the following question:

Is the first record of the file a label header?
("Yes" should be the default condition).
(N,Y):

"Y" (cr) - HEADER: X X X X X The header of the file is returned. The prompt returns.

"N" (cr) - skips to the next question.

Do you wish to use the default data format:
(G13.6)
(N,Y):

"Y" (cr) - skips the next question

"N" (cr) - prompt returns

Enter new format (including parens):

The user should enter the appropriate FORTRAN field descriptors, including parentheses. The prompt returns:

Does the file have a mode as its first record?
(N,Y):

As discussed in section 3.3.2, the mode system represents the hourly aggregation of inputs and/or output.

"Y" (cr) - the program begins execution

"N" (cr) - prompt returns.

The user should be prepared to respond to:

Enter mode the data file is in (1-3 or 10):

The user should enter either "1," or "2," or "3," or "10." If there are uncertainties, then the user should reread section 3.3.2 and/or check the specified technology performance input file for proper mode number.

When all of the above entries are successfully completed, the program begins execution. The following should appear at the terminal:

Running....

If there are errors the appropriate message will appear at this point. Error messages are self explanatory.

Otherwise the prompt returns:

Output to terminal? ("No" will send it to file)
(N,Y):

"N" (cr) - Printout in file "DERALOAD.PRN"
Derating and load integration section concluded.

"Y" (cr) - Printout proceeds.

3.3.7 Output

```
*****
*
*   DERATING AND LOAD INTEGRATION SECTION
*
*   LEVEL DERATE:   1.00000
*
*   HOURLY DERATE (HOUR & FACTOR)
*   1  1.000  2  1.000  3  1.000  4  1.000  5  1.000  6  1.000
*   7  1.000  8  1.000  9  1.000 10  1.000 11  1.000 12  1.000
*  13  1.000 14  1.000 15  1.000 16  1.000 17  1.000 18  1.000
*  19  1.000 20  1.000 21  1.000 22  1.000 23  1.000 24  1.000
*
*   MONTHLY DERATE (MONTH & FACTOR)
*   1  1.000  2  1.000  3  1.000  4  1.000  5  1.000  6  1.000
*   7  1.000  8  1.000  9  1.000 10  1.000 11  1.000 12  1.000
*
*   PERFORMANCE MODE:      1
*   LOAD MODE:              1
*   OUTPUT MODE:            3
*   RECORDS WRITTEN:       288
*
*****
```

Derating and load integration section concluded
Stop

3.4 PMAIN: PERFORMANCE ANALYSIS

3.4.1 Introduction

The performance analysis is designed to aggregate the output from the DANDL main program, into utility time periods, i.e., peak, intermediate, off-peak.

In order to successfully execute this program the following information is necessary:

Requirements: Utility time periods (Read SERICOST, Section 3.2.5 and 3.2.16)

- hours during which time period occurs
- number of holidays per month
- months during which time period occurs

Input file from DANDL

3.4.2 Main Branchpoint

The performance analysis requires the output from DANDL as well as utility time periods. This section is designed to provide interactive ability for the user to enter the utility specific time periods.

There are five input sections to this main program. DANDL output is contained in DERALOAD.DAT. The user need not be concerned with transferring this file to PMAIN. The five input sections include:

1. Number of holidays per month
2. Utility title
3. System title
4. Print parameters
5. Period definition

In order to begin the performance analysis, the user should enter "PMAIN" (cr). The prompt returns:

Main Branchpoint
>>D:L:C:R:?:E:V:I:O:

If a stray response is entered the following appears:

Enter one of the following: "D" "L" "C" "R" "?" "E" "V" "I" "O"
>>D:L:R:?:E:V:I:O:

If the user is unfamiliar with the branchpoint, he/she should type a question mark "?" (cr). A directory assistance message is presented:

This is the performance analysis section--
Data may be defaulted, read from file, or specified by the user.

Available commands are:

D(efault) - Set data to default values,
L(ist) - List existing value or values,
C(hange) - Change existing value,
R(un) - Get raw data & execute performance analysis,
E(nd) - Terminate this section without performing a new
performance analysis or getting more raw data,
V(ars) - List #'s of variables for list or change purposes,
I(nput) - Read a previously written data setup from file,
O(utput) - Write the current data setup to file.

3.4.2.1 Interactive Options of the PMAIN Branchpoint

3.4.2.2 Variable List

In order to view the input section titles the user should enter "V" (cr).

Variables:

1 - # holidays/month
2 - utility title
3 - system title
4 - print parameters
5 - period definition

3.4.2.3 List

"L" (cr) enables the user to list the variables in all five input sections of PMAIN. Upon entering "L" the user should see:

Section # to list (0 for all):

If the user is uncertain of sections or input variables available, zero is the recommended response. "0" (cr) returns: (The user does not have to enter actual dates.)

SECTION # 1	
MONTH	#-HOLIDAYS
1	1
2	0
3	0
4	0
5	1
6	0
7	1
8	0
9	1
10	0
11	1
12	1

SECTION # 2
UTILITY DESCRIPTION:
ENTER UTILITY HERE

SECTION #3
SYSTEM DESCRIPTION:
ENTER TECHNOLOGY HERE

SECTION #4
PERFORMANCE ANALYSIS PRINT - YES
PRINTOUT TO TERMINAL (IF NO THEN TO FILE)- NO

SECTION #5
PERIOD DEFINITION SECTION
OF PERIODS = 2

PERIOD DEFINITION

	<u>MONTHS</u>	<u>HOURS</u>	<u>WEEKDAYS</u>	<u>WEEKENDS</u>	<u>HOLIDAYS</u>
PERIOD 1 PEAK	1 - 12	9 - 22	YES	NO	NO
PERIOD 2 OFFPEAK	1 - 12	1 - 8	YES	NO	NO
PERIOD 2 OFFPEAK	1 - 12	23 - 24	YES	NO	NO
PERIOD 2 OFFPEAK	1 - 12	1 - 24	NO	YES	YES

Entering one of the five section numbers will list the specified portion of the input list.

NOTES: Only one number can be entered. The message: STOP will occur when a number greater than 5 is entered. The user will exit from the program and return to the main system, not the PMAIN Branchpoint.

3.4.2.4 Change

The option enables the user to change the default values in all input sections (Sections 1-5).

Requirements: User should be familiar with both the input section numbers and the input variables.

Upon entering the letter "C" (cr), the user views:

Section # to change:

The appropriate section number should be entered. No decimal points. For a list of the section numbers, the user should refer to section 3.4.2.2.

NOTE: A number greater than 5 or multiple entries will cause the user to exit the program and return to the main system, not the PMAIN Branchpoint.

If the user is unfamiliar with the section titles and corresponding variables, "0" (cr) or (cr) will display all input section and variables.

Section 1 Holidays/Month

If the user wishes to change Section 1, a "1" (cr) should be entered.

The prompt returns:

For month #, Enter # of holidays
Month 1:

After : the user should enter the appropriate number of holidays in January. The number entered is the number of days in the month considered holidays by the utility. After each (cr) the next month will appear at the terminal until month 12, December. The main branchpoint (Section 3.4.2) is returned after the (cr) of month 12.

Section 2 Utility Title

Entering 2 (cr) to section # to change: The prompt returns:

Utility title (80 chars max):

The user should enter the title of the appropriate facility or utility being evaluated. It is used as heading and does not influence the computations. (cr) returns user to the PMAIN Branchpoint, section 3.4.2.

Section 3 System Description

Upon entering "3" (cr), the following prompt returns:

System title (80 chars max, 5 lines required):

Five lines (any or all of which may be blank) must be entered. These lines describe the qualifying facility.

Section 4 Print Option

If "4" were entered in section # to change, the prompt returns:

Would you like the performance analysis printed
to either the terminal or file?
(N,Y):

"N" (cr) - no records of the performance analysis are stored in printout files. Output is however stored in the data file PERFTOTS. DAT. The user is returned to the PMAIN Branchpoint, Section 3.4.2.

"Y" (cr) - the following question is returned:

Print output to terminal? (Answer no for print to file):
(N,Y):

"N" (cr) - printouts available in default file PERFANAL.PRN.
"Y" (cr) - the output from the performance analysis is
available at the terminal.

Yes or No the prompt returns to the PMAIN Branchpoint, section 3.4.2.

Section 5 Period Definition

The DANDL program passes the aggregated hourly QF performance to PMAIN. The period definition section is the heart of PMAIN. Within this section, the user is required to identify time of day (TOD) periods which are consistent with those of the electric utility. These utility periods must also agree with the information required in SERICOST Input Format sections 4 through 9, and Sections 3.2.5 and 3.2.16 of SERICOST.

In order to perform period definition, the following must be known: the number of periods, their titles, the months included in each period, the hours included in each period, and whether weekdays, weekends, and holidays are included in each period. An example is given below, followed by further comments. This example defines the following:

Peak period: Weekdays 8 AM - 10 PM, all months
Offpeak periods: Weekdays 10 PM - 8 AM, weekends and
holidays all day, all months.

Main Branchpoint
>>?:V:L:C:D:O:I:E:R:
Section # to change: 5

"C" indicates the desire to change a section from the main branchpoint in PMAIN: "5" indicates that section 5, the period definition section, is to be changed.

Period Definition
Periods: 2

Periods are blocks of time such as peak, offpeak, and shoulder. These periods are utility-defined. "2" above indicates that two utility periods are being used.

Title for Period # 1: PEAK
Title for Period # 2: OFFPEAK

Thus period #1 corresponds to the utility peak period and is labelled accordingly, and period #2 is the offpeak period. "Peak" and "offpeak" are merely user labels, and have no effect on the running of the program.

More Entries?
(N,Y): Y

The "more entries?" prompt will be made after each block of time has been defined. This prompt should be answered "Y" until all periods have been

defined, and then answered "N" to terminate the period definition section.

Period # : 1

This prompts the user to indicate which period the following data pertain to. Here, the data are for period 1.

First Month: 1
Last Month: 12

The second number must be greater than or equal to the first. Month numbers must be in the range 1-12, corresponding to January-December.

Error Message:

If entries are not sequential or outside the bounds of 1 through 12 the following error message appears:

Month Read Help
You must enter two months between 1 and 12, with the
second later in the year than the first, would you like
to end "E," change the month definition "C," or read this
period from the start (not the whole section, just the
period you're doing "R"?

>>E:C:R:

The user can respond according to necessary changes. If the user has experienced no difficulty, the program continues.

All months between the two numbers are included; that is the months fall in a contiguous block. Here, period 1 includes at least part of every month in the year. If period 1 were only January-April and September-December, then there would have to be two definitions for period 1 made, one with months 1-4 and one with months 9-12.

This brings up an important point: several definitions may be (and often are) made for the same period. All definitions made for a period are included. Entries for period definitions must contain only one contiguous block of time (e.g., May-September, 9 AM - 2 PM), but many periods, especially those that run across midnight or New Year's Day, consist of two or more contiguous blocks (e.g., Sept. - April, 11 PM - 7 AM would be four blocks: Sept. - Dec., 11 PM - 12 PM; Sept. - Dec., 12 PM - 7 AM; Jan. - April, 11 PM - 12 PM; Jan. - April, 12 PM - 7 AM). Therefore, several passes through the "more entries?" loop should be made when needed, one for each contiguous block. Since all dates/times between months/hours specified are included, care must be taken to include only those dates/times falling in the period being specified.

First Hour: 9
Last Hour: 22

All hours between the two numbers are included. Hours must fall in the range 1-24, corresponding to 1 AM to 12 PM. The second number must not be

less than the first.

Error Message:

If sequence or range of entries is incorrect, the following error message is provided:

Hour Read Help

You must enter two hours between 1 and 24, with the second later in the day than the first, would you like to end "E," change the hour definition "C," or redo this period from the start (not the whole section, just the period you're doing "R"?

>>E:C:R:

The user can respond accordingly to necessary changes.

The hour number refers to the hour period ending at the time specified: hence "1" means 12 PM - 1 AM, and "13" means 12 noon to 1 PM. Otherwise, hours are very much like months, in that they must be defined in contiguous blocks and several definitions should be made if the period does not cover contiguous times.

Are Weekdays Included?

(N,Y): Y

Are Weekends Included?

(N,Y): N

Are Holidays Included?

(N,Y): N

Part of the utility period definition is whether the period includes weekdays, weekends, and holidays. Holidays are as specified in input section 1 (See beginning Section 3.4.2.4).

An important point here is that different period definitions for the same period should not overlap. Thus, if a period is weekdays 1-5 and weekends 1-24, the definition for hours 1-5 should say "N" for weekends included, even though the period does include weekends. This is because the second period definition will say hours 1-24, "Y" for weekends included, which covers all hours of all weekends. The first definition is needed only for weekday times. This can perhaps best be seen by visualizing the two contiguous blocks that make up this period. If both blocks include weekends, weekend hours 1-5 are defined twice. It is important that the user check to make certain that all times and dates are defined once--and only once.

We have now completed the definition of period 1, the peak period. This was a simple definition, consisting as it did of only one block. Now we define period 2, offpeak, which consists of three blocks: weekdays 1 AM - 8 AM, weekdays 11 PM - 12 PM, and weekends and holidays all day.

More Entries?

(N,Y): Y

Period #: 2

First Month: 1

Last Month: 12

First Hour: 1

Last Hour: 8

Are Weekdays Included?

(N,Y):Y

Are Weekends Included?

(N,Y):N

Are Holidays Included?

(N,Y):N

This sequence includes hours 1-8, weekdays, for all months of the year in period 2. The first of the three blocks of period 2 has been defined.

More Entries?

(N,Y):Y

Period #: 2

First Month: 1

Last Month: 12

First Hour: 23

Last Hour: 24

Are Weekdays Included?

(N,Y):Y

Are Weekends Included?

(N,Y):N

Are Holidays Included?

(N,Y):N

This sequence includes hours 23-24, weekdays, for all months of the year in period 2. The second of the three blocks of period 2 has been defined.

More Entries?

(N,Y):Y

Period #: 2

First Month: 1

Last Month: 12

First Hour: 1

Last Hour: 24

Are Weekdays Included?

(N,Y):N

Are Weekends Included?

(N,Y):Y

Are Holidays Included?

(N,Y):Y

This sequence includes all weekend and holiday times in period 2. Period 2 has now been defined as weekdays 1-8 and 23-24 all year, and weekends and holidays all day, for all months of the year.

Periods 1 and 2 have now been defined to include all times of the year, and include them only once. The period definition section is now complete.

More Entries?

(N,Y):N

No more entries are to be made, and "N" returns the user to the main branchpoint (section 3.4.2).

Main Branchpoint

>>?:V:L:C:D:O:I:E:R:

Note that incremental alterations to the definitions cannot be made: that is to say that the previous definitions are erased when changes are made, so an entire set of definitions must be made every time the period definitions are changed. Also, since all definitions are remembered, do not attempt to correct an incorrect definition by reentering it without returning to the main branchpoint and starting over, as this will result in doubly-defined times.

3.4.2.5 Default

"D" (cr) sets the default input values for the performance analysis. They can be viewed by selecting L(ist) cr or C(hange) (cr). When the user enters "D," they are returned to the PMAIN Branchpoint, Section 3.4.2.

3.4.2.6 Output

This option is relevant for those users who have changed a default file and wish to save it for future use.

"O" (cr) returns the prompt with:

Enter information on output file
Disk of data file A/B):

The disk for which this file is designated should be entered, either "A" or "B" (cr).

Enter header line:

The following questions appear at the terminal:

Filename (11 chars, no period: blank to escape):

The user should enter a filename of eleven characters, with no periods. If the user does not want to save an input, (cr) is entered and the user is returned to the PMAIN Branchpoint.

3.4.2.7 Input

"I" (cr), allows the user to input a file created in 3.4.2.6. The prompt returns:

Enter information on input file
Disk of data file (A/B):

The proper disk letter should be entered, either "A" or "B" (cr).

Filename (11 chars, no period: blank to escape):

An eleven letter file name with no period should be entered (cr). In the event the user does not wish to execute the input command (cr) should be entered, returning the user to the PMAIN Branchpoint.

3.4.2.8 End

The selection of "E" (cr) causes the PMAIN program to be terminated without performing a new performance analysis or getting more raw data.

The prompt returns:

Performance analysis section aborted
Stop

3.4.2.9 Run

In order to execute the performance analysis, "R" (cr) is to be entered.

If an error occurs, then a statement appears. It indicates the probable cause of the error.

Running....appears if there are no errors

Aggregate hours/month raw data input completed
End performance data section

If no printout was requested in the print option (section 4 of 3.4.2.3), the following appears:

End performance analysis section.
Printout is in file "PERFANAL.PRN"
Stop

If a terminal printout was specified the output will be in this form (see Section 3.4.3):

3.4.3 Output

The following page shows a sample output from the PMAIN program.

```

*****
*                                     *
*                                     * PERFORMANCE ANALYSIS *
*                                     *
*****
* UTILITY TITLE GOES HERE
*****
*
*****
* TECHNOLOGY GOES HERE
*
*
*****
*
* PERIOD DEFINITION
*
* MONTHS      HOURS      WEEKDAYS      WEEKENDS      HOLIDAYS
* PERIOD 1 PEAK      1 - 12      9 - 22      YES      NO      NO
* PERIOD 2 OFFPEAK   1 - 12      1 - 8      YES      NO      NO
*                   1 - 12      23 - 24     YES      NO      NO
*                   1 - 12      1 - 24      NO      YES      YES
*
* ELECTRIC USE SUMMARY
*
* BOUGHT      SOLD      PRODUCED      NET
*
* PEAK W/ALT.EN.SYSTEM      0.0      132534.7      1 .7      -132534.7
* W/O ALT.EN.SYSTEM      0.0      0.0      0.0      0.0
*
* OFFPEAK W/ALT.EN.SYSTEM      0.0      190865.1      190865.1      -190865.1
* W/O ALT.EN.SYSTEM      0.0      0.0      0.0      0.0
*
* -----
* TOTAL W/ALT.EN.SYSTEM      0.0      323399.8      323399.8      -323399.8
* TOTAL W/O ALT.EN.SYSTEM      0.0      0.0      0.0      0.0
*
*****

```

PRINTOUT IS IN FILE "B:PERFANAL.PRN"****

END PERFORMANCE ANALYSIS SECTION

Note: W/O ALT.EN.SYSTEM refers to electric requirements of firm without installation of QF. If no user's load is entered then zero's will appear in all column's and the net W/ALT.EN.SYSTEM will be negative reflecting incremental production.

3.5 AVOIDC: AVOIDED COST CALCULATION

3.5.1 Introduction

This is the final main program of the SERICPAC Methodology. The output of this program is an avoided cost (\$/kWh). It represents the marginal cost of electricity which the utility would have had to incur had a QF not contributed to the grid. The QF's contribution, in SERICPAC, has been adjusted for seasonal, daily and hourly (when applicable) variations in production, availability, and the QF's power demand (net power vs. simultaneous buy/sell). The avoided cost calculated in this section includes these factors.

3.5.2 Requirements

To initiate execution of this section the user should have:

- * Marginal cost data from SERICOST (or equivalent) per utility time period according to identical time period definitions
- * Performance analysis completed. File available in PERFTOTS.DAT.

3.5.3 Operation

To begin execution type AVOIDC (cr) prompt returns:

```
*Avoided cost section*
Enter marginal cost data per kilowatt-hour for
each period
Marginal cost, period ($/kWh):
```

Period indicates the first period specified in the PMAIN. The user should enter the appropriate value calculated in SERICOST. Because the units are \$/kWh, a decimal point is required (cr).

The previous message returns for as many time periods specified in PMAIN (Performance Analysis) input section 5.

For each period the proper marginal cost is entered with a decimal point. Then the user enters (cr).

When marginal costs for all periods have been entered, the prompt returns.

```
Do you want calculations based on gross production?
("No" means net sellback will be used)
(N,Y):
```

"N" (cr) - The QF's power demand (load) will be subtracted from the total power production to determine net sellback.

"Y" (cr) - Gross power production will be included in avoided cost calculations. This calculation assumes simultaneous purchase and sale. See section 3.3.3 for further clarification.

3.5.4 Output

The output from AVOIDC will be in the following form:

```
*****
*
*      Period      Marginal      Total Avoided
*      Costs      Costs by QF
*
*-----*
*      PEAK        0.100 $/kWh      13253.50 $
*
*      OFFPEAK     0.100 $/kWh      10986.50 $
*
*      *****
*      * AVOIDED COST = 0.1000 $/KWH *
*      *****
*
*****
```

The prompt returns:

Do you wish this output to file as well?
(N,Y):

"N" (cr) - user is returned to the operating system, not any Branchpoint

"Y" (cr) - prompt returns

Output in file "AVOIDC.PRN."
Stop

User is returned to the operating system, not any Branchpoint.

SECTION 4.0

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APPENDIX A: NOTES ON DISK FILE ACCESS

SERICPAC was developed on a Vector Graphics VIP (VG-VIP), a 56k RAM micro-computer built around a Z80 processor. Disk storage is on 2 300k floppy disk drives (designated "A" and "B" drives); therefore, the file OPEN routine in a FORTRAN program must specify which disk drive the file is on. On most machines supporting FORTRAN, the user has access to only one disk drive, and this specification is not made. As SERICPAC is currently constructed, FOPEN asks for the disk drive the file is on. On most machines, this question should be removed. The format of the VG-VIP FORTRAN OPEN routine is called by:

```
CALL OPEN (LUN,filename,drive)
```

where:

LUN - logical unit #, either an integer variable or
 an integer constant

filename - 11-character ASC11 literal constant or array
 variable, with no period and all 11 characters
 specified. The CP/M equivalent filename is
 filename.ext, such as TEST0001.DAT, which would
 be specified in CALL OPEN as 'TEST0001DAT'.

drive - 0 - currently selected drive is used
 1 - Drive A is used
 2 - Drive B is used

The drive specifier should be removed on most machines. Filename format will likely be different. Also, there are frequently other parameters in the statement which vary from machine to machine. Those should be added on an installation-dependent basis.

There are several FORTRAN statements which perform disk-related operations which may be machine-specific. These include: ENDFILE (which closes a file), CALL OPEN, and random-access READ and WRITE statements. These are marked so that they might easily be found: They are immediately preceded by the line:

C (FILEMARK). Any filenames in write formats are also marked in this way.

For use on a different computer, it may be necessary (depending on system conventions) to replace ENDFILE with CLOSE or CALL CLOSE, CALL OPEN with OPEN (and almost certainly with different arguments), and to change filenames to match the system conventions.

Random access on the VG-VIP is done as follows: READ (LUN, FORMAT #, REC=n) varlist, where n is the record to be read. Records are always 128 bytes long, automatically blank-filled if needed. Different systems have a variety of ways to point to the record and the different record lengths. There is no associated variable that is automatically incremented on the VG-VIP.

FOPEN is the subroutine in which user-specified files are always opened. Thus changing this routine to match the system should accomplish much of the necessary alteration. CALL FOPEN is always preceded by C (FILEMARK). Program-specified file opens are done with CALL OPEN and are scattered through SERICPAC, but are primarily concentrated in the main programs (SIMUL, DANDL, PMAIN, AVOIDC). Each routine is marked at the top as to whether it has file-access statements:

```
C (NO FILEACCESS)  and
C (FILEACCESS)
```

are fairly self-explanatory.

```
C (FILEACCESS)
```

indicates the presence of one of the following:

```
ENDFILE, CALL OPEN, random-access, filename, or CALL FOPEN.
```

Some computers (IBM computers, for example) specify file management prior to execution of the program rather than under program control. In this case the OPENS and CLOSEs would have to be replaced with operating system specifications. Such changes would have to be made by someone with a thorough knowledge of both the operating system and FORTRAN; there is no easy prescription for this conversion.

A variable format is an I/O format specifier which may be changed under program control, so as to vary as the user desires. This might be used to input data that may be in any of a number of forms. SERICPAC uses variable formats. All variable formats are preceded by the line:

```
C (VARIABLE FORMAT)
```

Usually this line also contains a functional description of how the variable format is used.

Variable formats are stored in arrays, with successive array locations containing successive characters in the format. SERICPAC for the VG-VIP uses INTEGER*2 arrays. This means that each array location contains 2 characters. A CDC machine stores 6 characters in each integer array location. This should not cause difficulties if the extra spaces are blank-filled; since no literal strings are used in variable formats, blanks should be ignored.

Note that VG-VIP FORTRAN defaults for variable types are LOGICAL*1, INTEGER*2, AND REAL*4. These are used in SERICPAC. Machines using INTEGER*4 or larger integers, or REAL*8 or larger reals, should also run SERICPAC with no difficulty.

Note that NTR and NTW are the terminal read and write LUN's, respectively. On the VG-VIP they are both 1. These are set in the BLOCKDATAs (SBLOCK, DBLOCK, PBLOCK, and ABLOCK).

APPENDIX B: SOURCE CODE SERICPAC

```

1:      PROGRAM SIMUL
2: C [FILEACCESS]
3: C SIMUL SERVE TO CALL THE VARIOUS SIMULATION SUBROUTINES,
4: C AND OPEN THE FILES FOR PRINTOUTS AND DATA.
5:      INTEGER ICHAR(11)
6:      LOGICAL FIRST
7:      COMMON/RESET/FIRST(15)
8:      COMMON/IO/NTR,NTW,ND(20)
9:      DATA ICHAR/' ','H','W','C','G','M','R','B','P','?','E'/
10: C
11: C
12: C
13:      DO 10 I=1,15
14: 10   FIRST(I)=.TRUE.
15: C
16: C
17: C [FILEMARK]
18:      CALL OPEN(ND(20),'PROMPTS1DAT',0)
19: C
20: C
21: C [FILEMARK]
22:      CALL OPEN(ND(19),'SYSSIMULDAT',2)
23: C
24: C
25:      WRITE(NTW,1005)
26:      IF(NOYES(1).EQ.0)GO TO 50
27: C
28:      ND(18)=NTW
29:      GO TO 100
30: C [FILEMARK]
31: 50   CALL OPEN(ND(18),'SIMULLOGPRN',2)
32: C
33: 100  WRITE(NTW,1001)
34:      K=IPARSE(ICHAR,11)
35:      GO TO(900,110,120,130,140,150,160,170,180,990,200),K
36: C
37: 110  CALL HYDRO
38:      GO TO 100
39: C
40: 120  CALL WIND
41:      GO TO 100
42: C
43: C
44: 130  CALL CONFUI
45:      GO TO 100
46: C
47: 140  CALL GASSIF
48:      GO TO 100
49: C
50: 150  CALL MUNI
51:      GO TO 100
52: C
53: C
54: 160  CALL CONTOD
55:      GO TO 100
56: C
57: 170  CALL BIOGAS
58:      GO TO 100
59: C
60: 180  CALL COMBUS

```



```

61:      GO TO 100
62: C                                     END
63: 200  WRITE(NTW,1003)
64: C                                     NOTIFY IF PRINTOUT IN FILE
65:      IF(ND(18).NE.NTW)WRITE(NTW,1006)
66:      STOP
67: C                                     NO RECOGNIZABLE CHARACTER PRINTED
68: C                                     SO NOTIFY HELP AVAILABLE
69: 900  WRITE(NTW,1004)
70:      GO TO 100
71: C                                     HELP
72: 990  WRITE(NTW,1002)
73:      GO TO 100
74: 1001  FORMAT('OSIMULATION TO EXECUTE-')
75: 1002  FORMAT('OTHIS IS THE SIMULATION SECTION-')
76:      * ' ENERGY SYSTEMS MAY BE MODELED BY THE APPROPRIATE MODULE.'
77:      * ' AVAILABLE MODULES AND COMMANDS INCLUDE:'
78:      * 5X,'H(YDRO) -HYDROPOWER SIMULATION.'
79:      * 5X,'W(IND) -WIND PRODUCTION SIMULATION.'
80:      * 5X,'G(ASIFY) -PRODUCERS GAS SIMULATION.'
81:      * 5X,'C(ONVEN) -LEVEL PERFORMANCE, FOR EXAMPLE FOR EITHER'
82:      * 16X,'DIRECT COMBUSTION OR INTERNAL COMBUSTION, BASED ON'
83:      * 16X,'FUEL RATE AND HEAT CONTENT.'
84:      * 5X,'R(ATED) -LEVEL PERFORMANCE FOR ANY'
85:      * 16X,'CONSTANT OUTPUT PROCESS, BASED ON RATED LEVEL.'
86:      * 16X,'THIS IS A USEFUL TOOL FOR ANALYSIS OF A TECHNOLOGY'
87:      * 16X,'WITH A CONSTANT RATED OUTPUT.'
88:      * 5X,'B(IOGAS) -BIOGAS SIMULATION.'
89:      * 5X,'M(UNI) -MUNICIPAL WASTE SIMULATION.'
90:      * 5X,'P(LANTAT)-ENERGY PLANTATION SIMULATION.'
91:      * 5X,'E(ND) -TERMINATE SIMULATION SECTION.'
92:      * /5X,'*NOTE* THAT THERE IS AN INTERACTIVE INPUT TO EACH'
93:      * 12X,'SECTION, WITH DEFAULT VALUES AND PROMPTING.'
94:      * 12X,'IT IS THEREFORE NOT NECESSARY TO KNOW ALL VARIABLES'
95:      * 12X,'OR TO MEMORIZE THEIR ORDER.')
96: C [FILEMARK] (SYSTEM SPECIFIC FILENAME)
97: 1003  FORMAT('OSIMULATION SECTION ENDED')
98: 1004  FORMAT('O*TYPE ? FOR HELP*')
99: 1005  FORMAT('ODO YOU WANT PRINTOUTS TO GO TO THE TERMINAL?')
100:      * ('NO" WILL SEND PRINTOUTS TO FILE')
101: C [FILEMARK]
102: 1006  FORMAT(' PRINTOUT IS IN FILE "SIMULLOG.PRN"')
103:      END

```

```

1:      SUBROUTINE HYDRO
2: C [FILEACCESS]
3: C   THIS SUBROUTINE CALCULATES THE POWER OUTPUT OF HYDRO-ELECTRIC
4: C   FACILITY.
5:      REAL PKW(20),GRHEAD(20),CAPKW(20),XIN(6),
6:      *SUMSPF(20),SUMPKW(20),TOTY(24)
7: C [VARIABLE FORMAT] (DIMENSIONED)
8:      INTEGER KMT(12),JMT(12),IFMT(10),IFORMD(10),IHRS(3)
9:      REAL*8 NAME(10)
10:     COMMON/IO/NTR,NTW,ND(20)
11:     EQUIVALENCE (PLEFF,XIN(1)),(HHDLOS,XIN(2)),(CAPMIN,XIN(3)),
12:     *(CAPMAX,XIN(4))
13:     DATA KMT/31,59,90,120,151,181,212,243,273,304,334,365/
14:     DATA JMT/31,28,31,30,31,30,31,31,30,31,30,31/
15: C [VARIABLE FORMAT] (DEFAULT DEFINED)
16:     DATA IFORMD/('G','13','6','')',6*' '/'
17:     DATA IHRS/8760,365,12/
18:     DATA LXIN/6/,MODE/3/,MODNUM/6/
19: C                                     SET I/O CHANNELS
20:     NFW=ND(19)
21:     NFR=ND(7)
22:     NW=ND(18)
23: C                                     GET RUN PARAMETERS
24:     CALL DATSET(MODNUM,XIN,IRET)
25:     IF (IRET.EQ.0)RETURN
26:     WRITE(NFW,1002)MODE,MODNUM
27:     NSITE=XIN(5)
28:     IVAL=XIN(6)
29: C                                     INITIALIZE THE VARIABLES
30:     DO 5 I=1,10
31: C [VARIABLE FORMAT]
32: 5      IFMT(I)=IFORMD(I)
33:     TOTTL=0.0
34:     DO 10 I=1,24
35: 10      TOTY(I)=0.0
36:     DO 20 I=1,20
37: 20      SUMSPF(I)=0.0
38:     SUMPKW(I)=0.0
39:     SUMCFS=0.0
40: C
41: C                                     GET INPUT DATA CHANNEL SET
42:     WRITE(NTW,1001)
43: C [FILEMARK] [VARIABLE FORMAT] (PASSED PARAMETER)
44:     CALL FOPEN(NFR,IFMT,-1,1,IRET2,0,CNVHYD,ADDHYD)
45:     IF (IRET2.EQ.0)RETURN
46: C                                     CHECK MODE OF DATA-HOURLY,
47: C                                     DAILY, OR MONTHLY
48:     IF (IVAL.GT.0.AND.IVAL.LT.4)GO TO 50
49: C                                     INVALID DATA SELECTION #
50:     WRITE(NTW,1014)
51: C [FILEMARK]
52:     ENDFILE NFR
53:     RETURN
54: C                                     SET COUNTER VALUES FOR THE DO LOOPS
55: 50      IMM=IHRS(IVAL)
56:     RMM=IMM
57:     DO 80 I=1,NSITE
58:     WRITE(NTW,1010)
59:     READ(NTR,1007)NAME(I)
60:     WRITE(NTW,1008)

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61:      READ(NTR,1006)CAPKW(I)
62:      WRITE(NTW,1009)
63:      READ(NTR,1006)GRHEAD(I)
64: 80    CONTINUE
65:      WRITE(NTW,1005)
66:      DO 200 I=1,IMM
67:      IF(MOD(I,1000).EQ.0)WRITE(NTW,1020)I
68: C [VARIABLE FORMAT]
69:      READ(NFR,IFMT)CFS
70:      CFS=(CFS+ADDHYD)*CNVHYD
71:      TOTPKW=0.0
72:      SUMCFS=SUMCFS+CFS
73:      DO 90 ISITE=1,NSITE
74:      SPILL=0.0
75:      PKW(ISITE)=PLEFF*HHDL0S*CFS*GRHEAD(ISITE)/11.8
76:      IF(PKW(ISITE).GE.CAPKW(ISITE))SPILL=PKW(ISITE)-CAPKW(ISITE)
77:      IF(PKW(ISITE).GE.CAPKW(ISITE))PKW(ISITE)=CAPKW(ISITE)
78:      CAPMN=CAPMIN*CAPKW(ISITE)
79:      CAPMX=CAPMAX*CAPKW(ISITE)
80:      IF(PKW(ISITE).LE.CAPMN.OR.PKW(ISITE).GT.CAPMX)PKW(ISITE)=0.0
81:      SUMPKW(ISITE)=SUMPKW(ISITE)+PKW(ISITE)
82:      TOTPKW=TOTPKW+PKW(ISITE)
83: 90    SUMSPF(ISITE)=SPILL/PLEFF/HHDL0S/GRHEAD(ISITE)*11.8+SUMSPF(ISITE)
84: C
85: C                                     COMBINE VALUES INTO A 24 HR
86: C                                     LOAD CURVE FOR EACH MONTH
87: C
88:      GO TO(97,93,91),IVAL
89: C                                     FOR MONTH BY MONTH
90: 91    DO 92    IMX=1,24
91: 92    WRITE(NFW,1006)TOTPKW
92:      GO TO 199
93: C                                     FOR DAY BY DAY
94: 93    TOTTL=TOTTL+TOTPKW
95:      DO 94    IMT=1,12
96:      IF(I.LT.KMT(IMT))GO TO 199
97:      IF(I.EQ.KMT(IMT))GO TO 95
98: 94    CONTINUE
99: 95    TOTTL=TOTTL/JMT(IMT)
100:      DO 96    IMX=1,24
101: 96    WRITE(NFW,1006)TOTTL
102:      TOTTL=0.0
103:      GO TO 199
104: C                                     FOR HOUR BY HOUR
105: 97    IL=MOD(I,24)
106:      TOTY(IL)=TOTY(IL)+TOTPKW
107:      IF(IL.NE.0)GO TO 199
108:      ILM=I/24
109:      DO 98    IMT=1,12
110:      IF(ILM.LT.KMT(IMT))GO TO 199
111:      IF(ILM.EQ.KMT(IMT))GO TO 99
112: 98    CONTINUE
113: 99    DO 100   IMX=1,24
114:      TOTY(IMX)=TOTY(IMX)/JMT(IMT)
115:      WRITE(NFW,1006)TOTY(IMX)
116: 100   TOTY(IMX)=0.0
117: 199   CONTINUE
118: 200   CONTINUE
119: C [FILEMARK]
120:      ENDFILE NFR

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121: C          CALCULATE AVE STREAM FLOW
122:          SUMCFS=SUMCFS/RMM
123: C          OUTPUT RESULTS
124: C          INITIALIZE PRINTOUT ROUTINE
125:          CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
126:          WRITE(NW,1015)
127:          CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
128:          WRITE(NW,1016)SUMCFS
129: C          CALCULATE & PRINT PLANT FACTOR,
130: C          SPILLAGE FACTOR,TOTAL KWH
131:          DO 211 I=1,NSITE
132:          AVPLF=SUMPKW(I)/CAPKW(I)/RMM*100.0
133:          SUMSPF(I)=SUMSPF(I)/SUMCFS*100.0/RMM
134: 211        WRITE(NW,1019)NAME(I),AVPLF,SUMSPF(I),SUMPKW(I)
135:          CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
136:          RETURN
137: C
138: 1001        FORMAT('ENTER DATA ON HYDRO DATA FILE(CU FT/SEC)-')
139: 1002        FORMAT(2I3)
140: 1005        FORMAT('ORUNNING...')
141: 1006        FORMAT(2G13.6)
142: 1007        FORMAT(A8)
143: 1008        FORMAT(' PLANT CAPACITY(KW): ')
144: 1009        FORMAT(' GROSS HEAD(FT.): ')
145: 1010        FORMAT(' NAME OF SITE: ')
146: 1011        FORMAT(' IS THE GAUGING DATA ENTERED ON AN HOUR BY HOUR BASIS?')
147: 1012        FORMAT(' IS THE GAUGING DATA ENTERED ON A DAY BY DAY BASIS?')
148: 1013        FORMAT(' IS THE GAUGING DATA ENTERED ON A MONTH BY MONTH BASIS?')
149: 1014        FORMAT(' THIS PROGRAM HAS NO PROVISION FOR CENTURY BY CENTURY ',
150:          *'DATA.'/' WE ARE RETURNING YOU TO THE MAIN PROGRAM--CLEAN UP ',
151:          *'YOUR ACT.')

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1:      SUBROUTINE WIND
2: C [FILEACCESS]
3: C WIND POWER PROGRAM FOR VECTOR GRAPHICS.
4: C AGGREGATE MONTHLY HOUR MEAN & STANDARD DEVIATION OF WIND
5: C   ARE INPUTS; ALSO MEAN MONTHLY AIR TEMPERATURE.
6: C
7: C MONTH -MONTH OF YEAR
8: C I      -DO LOOP VAR
9: C XIN     -ARRAY USED TO PASS INFO BACK FROM DATSET
10: C STEP   -TIME IN HOURS BETWEEN WIND DATA POINTS (ISTEP IS INTEGER FORM)
11: C I HOUR  -HOUR OF DAY
12: C J      -INDEX FOR VELOCITY INTERVAL OPERATED ON
13: C IVCO    -CUTOUT VELOCITY+1, HIGHEST INTERVAL WANTED IN ARRAYS
14: C IRET    -ERROR RETURN FROM SUBROUTINES
15: C NTR     -TERMINAL READ #
16: C NTW     -TERMINAL WRITE #
17: C ND      -ARRAY W/DISK CHANNEL #'S
18: C NF1     -WIND DATA READ #
19: C NF2     -TEMPERATURE DATA READ #
20: C NW      -PRINTOUT WRITE #
21: C NFW     -DATA OUTPUT #
22: C MODE    -MODE OF OUTPUT DATA
23: C IFMT    -VARIABLE FORMAT USED TO READ WIND DATA
24: C IFMT2   -VARIABLE FORMAT USED TO READ TEMP DATA
25: C IFORMD  -DEFAULT FORMAT FOR IFMT,IFMT2
26: C LXIN    -# PARAMS INPUT IN DATSET
27: C WFLAG   -TRUE IF HOUR BY HOUR WIND DATA, FALSE IF MEAN & SD HOUR/MONTH
28: C WKO     -WEIBULL PARAM "K" AT ANEMOM HEIGHT
29: C WK      -WEIBULL PARAM "K" ADJUSTED TO HUB HEIGHT
30: C WCO     -WEIBULL PARAM "C" AT ANEMOM HEIGHT
31: C WC      -WEIBULL PARAM "C" ADJ TO HUB HEIGHT
32: C CFAVG   -AVG CAP FACTOR FOR YEAR
33: C PAVG    -AVERAGE POWER PROD/HOUR FOR THE YEAR
34: C DAIR0   -DENSITY OF AIR(KG/M3)
35: C DAIR    -MEAN MONTHLY AIR DENSITY FOR THIS SITE
36: C PYEAR   -TOTAL POWER PROD/YEAR
37: C MODNUM  -WIND MODULE INDEX # AMONG SIMULATIONS
38: C NUMVAR  -# OF PARAM TO VARY( IF ANY )
39: C IVFLG   -1 IF ANOTHER PARM VALUE TO DO WHEN VARYING
40: C H1      -ELEVATION OF CENTER OF WINDMILL ABOVE SEA LEVEL
41: C HEIGHT  -HEIGHT OF CENTER OF WINDMILL
42: C AXIS    -0:HORIZ AXIS,1:VERT AXIS
43: C HGHT    -IF VERT AXIS, HEIGHT OF WEC
44: C HCLR    -CLEARANCE BETWEEN ROTOR & GROUND
45: C ELEV    -ELEVATION ABOVE SEA LEVEL
46: C ADDTMP  -ADD TO INPUT TEMP TO CONVERT TO DEG FAR IF NECESSARY
47: C CNVTMP  -MULT BY (INPUT TEMP+ADDTMP) TO CONV TO DEG FAR IF NEC
48: C HO      -HEIGHT OF ANEMOM ABOVE GROUND
49: C TEMP    -MEAN MONTHLY TEMP
50: C PMON    -TOTAL POWER PRODUCED/MONTH
51: C RPMUX   -0:CONSTANT RPM,1:VARIABLE RPM
52: C DIAM    -DIAMETER OF ROTOR
53: C CSAREA  -CROSSECTIONAL AREA SUBTENDE BY ROTOR
54: C APMON   -AVG POWER/HR FOR THE MONTH
55: C PTOI    -AVG POWER FOR GIVEN TIME OF DAY
56: C PVEL    -POWER AT A GIVEN VELOCITY
57: C VAUG    -AVERAGE VELOCITY IN AN INTERVAL
58: C VR      -LOWEST VELO WHERE RATED POWER IS PRODUCED(RATED VELOCITY)
59: C CPR     -POWER COEFFICIENT AT RATED VELO
60: C VCO     -CUTOUT VELO

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61: C CPM      -MAX POWER COEFF
62: C VM      -VELO WHICH PRODUCES CPM (DESIGN VELOCITY)
63: C
64:      REAL XIN(15),PMON(12),APMON(12),DAY(12),PVEL(100),VAUG(100)
65:      REAL PROB(100),VOBAR(24),SD(24)
66:      INTEGER MONTH,I,ISTEP,IHOUR,J,IVCO,NTR,NTW,ND,NF1,NF2,NW,IRET,NFW
67: C [VARIABLE FORMAT] (DIMENSIONED)
68:      INTEGER MODE,IFMT(10),IFMT2(10),IFORMD(10),LXIN,MODNUM,NUMVAR
69:      INTEGER IVFLG
70:      LOGICAL WFLAG
71: C
72:      COMMON/IO/NTR,NTW,ND(20)
73: C
74:      EQUIVALENCE (VCI,XIN(1)),(VCO,XIN(2)),(VR,XIN(3)),(VM,XIN(4)),
75:      *(PR,XIN(5)),(CPM,XIN(6)),(DIAM,XIN(7)),(H0,XIN(8)),(ELEV,XIN(9)),
76:      *(HEIGHT,XIN(10)),(HCLR,XIN(11)),(RPMGX,XIN(12)),(AXIS,XIN(13)),
77:      *(HGHT,XIN(14)),(STEP,XIN(15))
78: C
79: C [VARIABLE FORMAT] (DEFAULT DEFINED)
80:      DATA IFORMD/'G','13','6','')',6*' '/'
81:      DATA PI/3.141592/,MODE/3/,LXIN/15/,DAIRO/1.225/
82:      DATA DAY/31.,28.,31.,30.,31.,30.,31.,31.,30.,31.,30.,31./
83:      DATA MODNUM/5/
84: C                      SET DATA CHANNELS
85:      NW=ND(18)
86:      NFW=ND(19)
87:      NF1=ND(9)
88:      NF2=ND(8)
89: C                      SET PARMS
90:      CALL DATSET(MODNUM,XIN,IRET)
91: C                      RETURN NO RUN IF ERROR
92:      IF(IRET.EQ.0)RETURN
93:      WRITE(NFW,1013)MODE,MODNUM
94: C                      DEFAULT VAR FORMATS
95:      DO 10 I=1,10
96: C [VARIABLE FORMAT]
97:      IFMT(I)=IFORMD(I)
98: C [VARIABLE FORMAT]
99:      IFMT2(I)=IFORMD(I)
100: C                      GET DATA FILES:WIND DATA
101:      WRITE(NTW,1009)
102: C                      FIND WIND FILE NAME,OPEN,SET FORMAT...
103: C [FILEMARK] [VARIABLE FORMAT] (PASSED PARAMETER)
104:      CALL FOPEN(NF1,IFMT,-1,1,IRET,0,CHVWIND,ADDWIND)
105: C                      RETURN NO RUN IF ERROR
106:      IF(IRET.EQ.0)RETURN
107: C                      SEE IF READING PREPARED MEAN/SD
108: C                      FILE (FALSE) OR RAW HOURLY DATA
109: C                      (TRUE)
110:      WFLAG=.TRUE.
111:      WRITE(NTW,1001)
112:      IF(NOYES(1).EQ.0)WFLAG=.FALSE.
113: C                      TEMPERATURE DATA
114:      WRITE(NTW,1008)
115: C                      FIND TEMP FILE NAME,OPEN,SET FORMAT...
116: C [FILEMARK] [VARIABLE FORMAT] (PASSED PARAMETER)
117:      CALL FOPEN(NF2,IFMT2,-1,1,IRET,1,CHVTMP,ADDTMP)
118:      IF(IRET.EQ.0)RETURN
119: C                      INITIALIZE
120:      PYEAR=0.0

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121:      IF(AXIS)30,30,20
122: 20    HEIGHT=(HGHT/2.0)+HCLR
123: 30    H1=HEIGHT+ELEV
124: C      NOTIFY EXECUTION IN PROGRESS
125:      WRITE(NTW,1011)
126: C
127: C      MAIN LOOP TO SIMULATE BY MONTH
128: C
129:      DO 500 MONTH=1,12
130:      PMON(MONTH)=0.0
131: C [VARIABLE FORMAT]
132:      READ(NF2,IFMT2)TEMP
133: C      MONTHLY MEAN TEMP
134:      TEMP=(TEMP+ADDTMP)*CNVTMP
135: C      MONTHLY MEAN AIR DENSITY
136:      DAIR=DAIRO*(EXP((-1.0)*H1/8435.0)-(TEMP-15.0)/288.0)
137:      ISTEP=STEP
138: C      SKIP RAW DATA READ IF PREPARED
139: C      FILE
140:      IF(.NOT.WFLAG)GO TO 40
141: C      GET MEANS AND STANDARD DEVS
142: C      FOR EACH OF THE 24 HOURS
143: C      FOR THIS MONTH
144: C [VARIABLE FORMAT] (PASSED PARAMETER)
145:      CALL MONIN(VOBAR,SD,NTW,NF1,IFMT,DAY(MONTH),ISTEP,CHVWND,ADDWND)
146: C
147: C      PERFORM CALCS FOR EACH OF THE 24 HOURS (CUMULATIVE
148: C TOP OF HOUR LOOP      FOR THE MONTH) FOR WHICH THERE IS DATA,
149: C      AS INDICATED BY ISTEP
150: C
151: 40    DO 450 IHOURL=1,24,ISTEP
152: C      READ MEAN & SD IF PREPARED FILE
153:      IF(WFLAG)GO TO 45
154: C [VARIABLE FORMAT]
155:      READ(NF1,IFMT,END=991)VOBAR(IHOURL),SD(IHOURL)
156: C      CALCULATION OF WEIBULL
157: C      PARAMETERS K&C
158: 45    WK0=(SD(IHOURL)/VOBAR(IHOURL))**(-1.086)
159:      WC0=(VOBAR(IHOURL)/GAMMA(1+1/WK0))*1.025
160:      ALPHA=(0.37-0.088*ALOG(WC0))/(1.0-0.088*ALOG(H0/10.0))
161:      WK=WK0*(1.0-0.088*ALOG(H0/10.0))/(1.0-0.088*ALOG(HEIGHT/10.0))
162:      WC=WC0*(HEIGHT/H0)**ALPHA
163: C      CALCULATION OF WIND SPEED
164: C      FREQUENCY DISTRIBUTION
165:      IVCO=VCO+1
166:      DO 50 J=1,IVCO
167:      AJ=J-1
168:      PROB(J)=EXP(-((AJ/WC)**WK))-EXP(-(((AJ+1.0)/WC)**WK))
169:      VAVG(J)=AJ+0.5
170: 50    CONTINUE
171: C      CALCULATION OF INCREMENTAL POWER
172: 100    IF(RPMDX) 110,110,220
173: C      CONSTANT RPM
174: 110    IF(AXIS) 115,115,130
175: C      HORIZ AXIS
176: 115    CSAREA=PI*(DIAM/2.0)**2.0
177:      GO TO 150
178: C      VERT AXIS
179: 130    CSAREA=(2.0/3.0)*DIAM*HEIGHT
180: C      CONSTANT RPM MACHINE

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181: 150   CPR=PR/(.5*DAIR*CSAREA*VR**3.0)
182:       Z1=(VM/VR)-1.0
183:       Z2=(VM/VCI)-1.0
184:       Z3=(Z1**2.0)*((Z2**2.0)*(Z1-Z2))
185: C       Z4=A,Z5=B(FROM JUSTUS & MIKHAIL)
186:       Z4=((Z1**3.0)-((1.0-CPR/CPM)*Z2**3.0))/Z3
187:       Z5=((Z2**2.0*(1.0-CPR/CPM))-Z1**2.0)/Z3
188:       Z6=(VM/VR)/(1.0-(2.0*Z4/3.0*Z5))
189: C       CONSTRAINT ON ABOVE CALCS
190:       IF(1.0.LE.Z6.AND.(VCI/VR).GE.Z6)GO TO 990
191:       DO 200 J=1,IVCO
192:       IF(PROB(J).LE.0.0001)GO TO 190
193:       IF(VAVG(J).LT.VCI) GO TO 190
194:       IF(VAVG(J).GT.VR) GO TO 180
195:       PVEL(J)=PR*(CPM/CPR)*(VAVG(J)/VR)**3.0*(1.0-
196: $Z4*(VM/VAVG(J)-1.0)**2.0-Z5*(VM/VAVG(J)-1.0)**3.0)
197:       GO TO 199
198: 180     PVEL(J)=PR
199:       GO TO 199
200: 190     PVEL(J)=0.0
201: 199     IF(PVEL(J).LT.0.0)PVEL(J)=0.0
202: 200     CONTINUE
203:       GO TO 310
204: C       VARIABLE RPM MACHINE
205: 220     IF(AXIS) 225,225,230
206: 225     CSAREA=(PI*DIAM**2.0)/4.0
207:       GO TO 240
208: 230     CSAREA=(2.0/3.0)*DIAM*HEIGHT
209: 240     DEL=.1*(VR-VCI)
210:       C4=DEL/VR
211:       C5=VCI/VR
212:       C3=(C4+C5)**2.0*((2.0*C4-C5)/(C4**2.0))
213:       C2=3.0*(C4+C5)**2.0-(2.0*C3*(C4+C5))
214:       C1=(-1.)*C2*C5-(C3*(C5**2.0))
215:       DO 300 J=1,IVCO
216:       IF(PROB(J).LT.0.0001)GO TO 290
217:       IF(VAVG(J).LT.VCI) GO TO 290
218:       IF(VAVG(J).GE.VR) GO TO 280
219:       IF(VAVG(J).GT.(VCI+DEL)) GO TO 270
220:       PVEL(J)=PR*(C1+C2*(VAVG(J)/VR)+(C3*(VAVG(J)/VR)**2.0))
221:       GO TO 299
222: 270     PVEL(J)=PR*(VAVG(J)/VR)**3.0
223:       GO TO 299
224: 280     PVEL(J)=PR
225:       GO TO 299
226: 290     PVEL(J)=0.0
227: 299     IF(PVEL(J).LT.0.0)PVEL(J)=0.0
228: 300     CONTINUE
229: C       CALCS OF TIME OF DAY POWER
230: 310     PTOD=0.0
231: C
232:       DO 320 J=1,IVCO
233: C       SKIP VIRTUALLY ZERO OUTPUT
234:       IF(PROB(J).LT.0.0001)GO TO 320
235: C       POWER=[SUMM](POWER AT SPEED*PROB OF SPEED)
236:       PTOD=PTOD+PROB(J)*PVEL(J)
237: 320     CONTINUE
238: C       TOTAL PROD IN INTERVAL,CONV WATTS->KWH
239:       PTOD=PTOD/1000.0
240: C       END OF CALCS-OUTPUT SAME FOR ALL HOURS/1 STEP

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241:      DO 390 I=1,ISTEP
242:      WRITE(NFW,1005)PTOD
243: 390    CONTINUE
244:      PMON(MONTH)=PMON(MONTH)+PTOD*STEP
245: 450    CONTINUE
246: C          END OF HOUR LOOP
247: C          AVG POWER=ONE DAY OF POWER/24 HOURS PER DAY
248:      APMON(MONTH)=PMON(MONTH)/24.0
249: C          EXPAND AVG DAY TO WHOLE MONTH
250:      PMON(MONTH)=PMON(MONTH)*DAY(MONTH)
251:      PYEAR=PYEAR+PMON(MONTH)
252: C          NOTIFY USER OF PROGRESS
253:      WRITE(NTW,1007)MONTH
254: 500    CONTINUE
255: C          END OF MONTH LOOP
256: C          INITIALIZE GENERAL PRINTOUT
257:      CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
258:      WRITE(NW,1010)
259:      CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
260: C          PRINT MONTHLY RESULTS
261:      WRITE(NW,1003)
262:      DO 600 J=1,12
263:      WRITE(NW,1006)J,PMON(J),APMON(J)
264: 600    CONTINUE
265:      PAVG=PYEAR/8760.0
266:      CFAVG=PAVG/(PR/1000.0)*100.0
267:      WRITE(NW,1002)PYEAR,PAVG,CFAVG
268: C          FINISH PRINTOUT
269:      CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
270: C [FILEMARK]
271:      ENDFILE NF1
272: C [FILEMARK]
273:      ENDFILE NF2
274:      RETURN
275: C          VIOLATED CONSTRAINT ON Z6
276: 990    WRITE(NTW,1004)
277:      STOP
278: C          PREMATURE END-OF-FILE
279: 991    WRITE(NTW,1012)
280:      STOP
281: C
282: 1001   FORMAT(' DATA CAN BE EITHER HOURLY OR IN THE FORM OF'/
283:      *' HOUR/MONTH MEAN & STANDARD DEVIATION'/
284:      *' IS THE DATA HOURLY? ("NO" INDICATES MEAN & SD)')
285: 1002   FORMAT(' *',5X,'*',58X,'*',5X,'*'/
286:      *' *',5X,'* ANNUAL POWER OUTPUT = ',G13.6,' KWH/YR',
287:      *11X,'*',5X,'*'/
288:      *' *',5X,'* AVERAGE POWER OUTPUT = ',G13.6,' KW',15X,'*',5X,'*'/
289:      *' *',5X,'* AVERAGE CAPACITY FACTOR = ',G13.6,' %',16X,'*',5X,'*')
290: 1003   FORMAT(' *',5X,'* MONTH TOTAL POWER AVERAGE POWER',22X,'*',
291:      *5X,'*')
292: 1004   FORMAT('0***CONSTRAINT OF Z6 IS VIOLATED***'/)
293: 1005   FORMAT(2G13.6)
294: 1006   FORMAT(' *',5X,'*',16,2G14.6,24X,'*',5X,'*')
295: 1007   FORMAT(' MONTH:',I3)
296: 1008   FORMAT(' ENTER DATA FOR TEMPERATURE FILE(DEG C)-')
297: 1009   FORMAT(' ENTER DATA FOR WIND FILE(METERS/SEC)-')
298: 1010   FORMAT(' * WIND SIMULATION OUTPUT:',45X,'*')
299: 1011   FORMAT('ORUNNING...')
300: 1012   FORMAT('0***ERROR IN WIND DATA FILE READ',12X,'***'/)

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301: *' ***PROBABLE CAUSE: INSUFFICIENT DATA POINTS***'
302: 1013 FORMAT(2I3)
303: END

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1:      SUBROUTINE MONIN(VBAR,SD,NTW,NFR,IFMT,DAYMO,ISTEP,CNVWND,ADDWND)
2: C [NO FILEACCESS]
3: C [VARIABLE FORMAT] (PASSED PARAMETER)
4: C MONIN INPUTS A MONTH OF HOURLY WIND DATA AND TURNS IT INTO MEANS
5: C AND STANDARD DEVIATIONS FOR EACH OF THE 24 HOURS TO FEED TO
6: C THE WIND SIMULATION.
7: C [VARIABLE FORMAT] (DIMENSIONED)
8:      INTEGER HOUR,DAYIN,NFR,ISTEP,I,IFMT(10),NTW
9:      REAL VTOT(24),VSQRT(24),VBAR(24),SD(24),DAYMO,CNVWND,ADDWND,VELOC
10: C
11: C                               INITIALIZE ARRAYS
12:      DO 10 HOUR=1,24,ISTEP
13:      VTOT(HOUR)=0.0
14: 10  VSQRT(HOUR)=0.0
15: C                               LOOP THROUGH DAYS
16:      I=DAYMO
17:      DO 40 DAYIN=1,I
18: C                               LOOP THROUGH HOURS AT INTERVAL
19: C                               SPECIFIED
20:      DO 20 HOUR=1,24,ISTEP
21: C                               GET WIND DATA AND CONVERT TO
22: C                               METERS/SECOND
23: C [VARIABLE FORMAT]
24:      READ(NFR,IFMT,END=999)VELOC
25:      VELOC=(VELOC+ADDWND)*CNVWND
26: C                               ADD TO SUM & SUM OF SQUARES
27:      VTOT(HOUR)=VTOT(HOUR)+VELOC
28:      VSQRT(HOUR)=VSQRT(HOUR)+VELOC**2
29: 20  CONTINUE
30: 40  CONTINUE
31: C                               CALCULATE MEAN AND STANDARD
32: C                               DEVIATION FOR EACH HOUR VELOCITY
33:      DO 50 HOUR=1,24,ISTEP
34:      VBAR(HOUR)=(VTOT(HOUR)/DAYMO)
35:      SD(HOUR)=(((VSQRT(HOUR)-DAYMO*VBAR(HOUR)**2)/
36:      $(DAYMO-1.0))*0.5)*0.447
37:      VBAR(HOUR)=VBAR(HOUR)*0.447
38: 50  CONTINUE
39:      RETURN
40: C                               PREMATURE END-OF-FILE FOUND
41: 999  WRITE(NTW,1001)
42:      STOP
43: C
44: 1001 FORMAT('O***ERROR IN WIND DATA FILE READ',12X,'***'/
45:      *' ***PROBABLE CAUSE: INSUFFICIENT DATA POINTS***')
46:      END

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1:      SUBROUTINE CONFUI
2: C [NO FILEACCESS]
3: C   THIS IS A GENERAL PROGRAM TO DETERMINE THE POWER OUTPUT
4: C   OF AN ELECTRICAL GENERATING SYSTEM USING CONVENTIONAL
5: C   FUEL
6:      REAL XIN(3)
7:      COMMON/IO/NTR,NTW,ND(20)
8:      EQUIVALENCE (FHV,XIN(1)),(FR,XIN(2)),(EFFP,XIN(3))
9:      DATA LXIN/3/,MODNUM/1/,MODE/3/
10: C                                     ASSIGN IO CHANNELS
11:      NFW=ND(19)
12:      NW=ND(18)
13: C                                     GET INPUT VALUES
14:      CALL DATSET(MODNUM,XIN,IRET)
15:      IF(IRET.EQ.0)RETURN
16:      WRITE(NFW,1002)MODE,MODNUM
17: C                                     START PRINTOUT
18:      CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
19:      WRITE(NW,1001)
20:      CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
21: C                                     EXECUTE
22:      PGF=FHV*FR*EFFP/3413.0
23:      WRITE(NW,1004)PGF
24:      CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
25:      CALL VARSET(NFW,PGF)
26:      RETURN
27: 1001  FORMAT(' * OUTPUT FROM CONVENTIONAL FUELS POWER PRODUCTION',
28:            *21X,'*')
29: 1002  FORMAT(2I3)
30: 1004  FORMAT(' *      * POWER PRODUCTION =',F20.3,' KWH/HR',12X,
31:            *'*      *')
32:      END
33: C
34: C
35: C
36:      SUBROUTINE GASSIF
37: C [NO FILEACCESS]
38: C PROGRAM TO DETERMINE PERFORMANCE OF GASSIFICATION PROCESS
39: C USING BIOMASS
40:      REAL XIN(10),MC,NHV
41:      COMMON/IO/NTR,NTW,ND(20)
42:      EQUIVALENCE (RRTY,XIN(1)),(HPD,XIN(2)),(HHV,XIN(3)),
43:      *(MC,XIN(4)),(CNHH,XIN(5)),(CFR,XIN(6)),(CFD,XIN(7)),
44:      *(EFFG,XIN(8)),(EFFE,XIN(9)),(EFFK,XIN(10))
45:      DATA LXIN/10/,MODNUM/4/,MODE/3/
46: C                                     SET I/O CHANNELS
47:      NFW=ND(19)
48:      NW=ND(18)
49: C                                     GET INPUTS
50:      CALL DATSET(MODNUM,XIN,IRET)
51:      IF(IRET.EQ.0)RETURN
52:      WRITE(NFW,1002)MODE,MODNUM
53: C                                     START PRINTOUT
54:      CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
55:      WRITE(NW,1001)
56:      CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
57: C                                     EXECUTE
58:      NHV=HHV*(1-MC)-MC*1200.0
59:      THR=NHV*RRTY*2000.*(HPD/24.)/24.
60:      APEG=THR*EFFG

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61: CAPEG=CNHH*CFR*CFD
62: AEBF=CAPEG+APEG
63: PG=AEBF/3412.0*EFFE*EFFK
64: C PRINTOUT
65: WRITE(NW,1004)PG
66: CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
67: C PERFORMANCE DATA TO FILE
68: CALL VARSET(NFW,PG)
69: RETURN
70: 1001 FORMAT(' * OUTPUT FROM PRODUCERS' GAS POWER PRODUCTION',25X,'*')
71: 1002 FORMAT(2I3)
72: 1004 FORMAT(' * POWER PRODUCTION =',F20.3,' KWH/HR',12X,
73: '* * ')
74: END
75: C
76: C
77: C
78: SUBROUTINE CONTOO
79: C [NO FILEACCESS]
80: C THIS IS A GENERAL PROGRAM TO DETERMINE THE POWER OUTPUT
81: C OF AN ELECTRICAL GENERATING SYSTEM USING CONVENTIONAL
82: C FUEL BASED ON A RATED PERFORMANCE.
83: REAL XIN(2)
84: COMMON/IO/NTR,NTW,ND(20)
85: EQUIVALENCE (PROD,XIN(1)),(EFF,XIN(2))
86: DATA LXIN/2/,MODNUM/8/,MODE/3/
87: C ASSIGN IO CHANNELS
88: NFW=ND(19)
89: NW=ND(18)
90: C GET INPUT VALUES
91: CALL DATSET(MODNUM,XIN,IRET)
92: IF(IRET,EQ.0)RETURN
93: WRITE(NFW,1002)MODE,MODNUM
94: C START PRINTOUT
95: CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
96: WRITE(NW,1001)
97: CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
98: WRITE(NW,1004)PROD
99: CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
100: CALL VARSET(NFW,PROD)
101: RETURN
102: 1001 FORMAT(' * OUTPUT FROM RATED LEVEL POWER PRODUCTION',
103: '*28X,'*')
104: 1002 FORMAT(2I3)
105: 1004 FORMAT(' * POWER PRODUCTION =',F20.3,' KWH/HR',12X,
106: '* * ')
107: END
108: C
109: C
110: C
111: SUBROUTINE MUNI
112: C [NO FILEACCESS]
113: C MUNICIPAL WASTE SIMULATION.
114: C LXIN -LENGTH OF XIN
115: C XIN -INPUT ARRAY PASSED TO DATSET FOR INPUT VALUES
116: C TPD -TONS/DAY
117: C EFF -EFFICIENCY OF CONVERSION TO ELECTRICITY
118: REAL XIN(3),NETKW,FTPD,BTUHR,TPD,EFF
119: INTEGER NW,LXIN
120: COMMON/IO/NTR,NTW,ND(20)

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121:      EQUIVALENCE (TPD,XIN(1)),(EFF,XIN(2)),(BTULB,XIN(3))
122:      DATA LXIN/3/,MODNUM/7/,MODE/3/
123: C          ASSIGN IO CHANNELS
124:      NFW=ND(19)
125:      NW=ND(18)
126: C          GET INPUT VALUES
127:      CALL DATSET(MODNUM,XIN,IRET)
128:      IF(IRET,EQ.0)RETURN
129:      WRITE(NFW,1002)MODE,MODNUM
130: C          EXECUTE
131:      FTPD=TPD/1000.0
132:      BTUHR=FTPD*140.9E6/24.0
133:      NETKW=(BTUHR/3412.0)*EFF
134:      CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
135:      WRITE(NW,1001)
136:      CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
137:      WRITE(NW,1004)NETKW
138:      CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
139:      CALL VARSET(NFW,NETKW)
140:      RETURN
141: 1001  FORMAT(' *  OUTPUT FROM MUNICIPAL WASTE POWER PRODUCTION',
142:            *24X,'*')
143: 1002  FORMAT(2I3)
144: 1004  FORMAT(' *',5X,'* POWER PRODUCTION =' ,G20.10,' KWH/HR',12X,'*',
145:            *5X,'*')
146:      END
147: C
148: C
149: C
150:      SUBROUTINE COMBUS
151: C [NO FILEACCESS]
152: C PROGRAM DOES DIRECT COMBUSTION OF BIOMASS, FIVE OPTIONS AVAILABLE
153: C   OPTION 1: CONSTANT FUEL SOURCE
154: C   OPTION 2: ENERGY PLANTATION PELLETIZED
155: C   OPTION 3: ENERGY PLANTANTION NON-PELLETIZED
156: C   OPTION 4: WOOD RESIDUES PELLETIZED
157: C   OPTION 5: WOOD RESIDUES NON-PELLETIZED
158: C ANY NUMBER OF OPTIONS CAN BE SELECTED TOGETHER
159:      REAL TAH(5),XIN(22),J(5)
160:      COMMON/IO/NTR,NTW,ND(20)
161:      EQUIVALENCE (J(1),XIN(1)),(FYH,XIN(6)),(HEC,XIN(7)),(HHVP,XIN(8)),
162:      *(PPP,XIN(9)),(C1P,XIN(10)),(C2P,XIN(11)),(AWPP,XIN(12)),
163:      *(WRP,XIN(13)),(HHVR,XIN(14)),(PPR,XIN(15)),(C1R,XIN(16)),
164:      *(C2R,XIN(17)),(AWPR,XIN(18)),(HR,XIN(19)),(TON,XIN(20)),
165:      *(CP,XIN(21)),(HHVC,XIN(22))
166:      DATA LXIN/22/,MODNUM/2/,MODE/3/
167: C
168:      NFW=ND(19)
169:      NW=ND(18)
170: C
171:      CALL DATSET(MODNUM,XIN,IRET)
172:      IF(IRET,EQ.0)RETURN
173:      WRITE(NFW,1002)MODE,MODNUM
174: C          CONVERT % TO FRAC IF NEEDED
175:      IF(PPP.GT.1.0)PPP=PPP/100.0
176:      IF(CP.GT.1.0)CP=CP/100.0
177:      IF(C1P.GT.1.0)C1P=C1P/100.0
178:      IF(C2P.GT.1.0)C2P=C2P/100.0
179:      IF(AWPP.GT.1.0)AWPP=AWPP/100.0
180:      IF(PPR.GT.1.0)PPR=PPR/100.0

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181: IF(C1R.GT.1.0)C1R=C1R/100.0
182: IF(C2R.GT.1.0)C2R=C2R/100.0
183: IF(AWPR.GT.1.0)AWPR=AWPR/100.0
184: DO 1 I=1,5
185: 1 TAH(I)=0.0
186: C CONSTANT INPUT
187: IF(J(1).NE.1.0)GO TO 5
188: TAH(1)=(HHVC*(1-CP)-CP*1200.)*TON*2000.*8760,
189: C ENERGY PLANTATION : PELLETIZED
190: 5 IF(J(2).NE.1.0)GO TO 10
191: TWPP = FYH*HEC*PPP
192: TPP = TWPP*AWPP
193: WBPP = C1P*TWPP
194: WAPP = (C2P*(1.0-C1P)*TWPP)/(1.0-C2P)
195: TWEP = WBPP-WAPP
196: BTUVP = TWEP*2000.0*1700.0
197: WHP = TPP*150.0
198: HVPP = HHVP*(1.0-C2P)-C2P*1200.0
199: TAH(2) = TPP*2000.0*HVPP-BTUVP-WHP
200: C ENERGY PLANTATION : NON-PELLETIZED
201: 10 IF(J(3).NE.1.0)GOTO 15
202: IF(J(2).EQ.1.0)PPP=0.0
203: TWNP = FYH*HEC*(1.0-PPP)
204: HVNP = HHVP*(1.0-C1P)-C1P*1200.0
205: TAH(3) = TWNP*2000.0*HVNP
206: C WOOD RESIDUES: PELLETIZED
207: 15 IF(J(4).NE.1.0)GO TO 20
208: TWPR = WRP*PPR
209: TPR = TWPR*AWPR
210: WBPR = C1R*TWPR
211: WAPR = (C2R*(1.0-C1R)*TWPR)/(1.0-C2R)
212: TWER = WBPR-WAPR
213: BTUVR = TWER*2000.0*1700.0
214: WHR = TPR*150.0
215: HVPR = HHVR*(1.0-C2R)-C2R*1200.0
216: TAH(4) = TPR*2000.0*HVPR-BTUVR-WHR
217: C WOOD RESIDUES : NON-PELLETIZED
218: 20 IF(J(5).NE.1.0)GOTO 25
219: IF(J(4).EQ.1.0)PPR=0.0
220: TWZNR = WRP*(1.0-PPR)
221: HVZNR = HHVR*(1.0-C1R)-C1R*1200.0
222: TAH(5) = TWZNR*HVZNR*2000.0
223: C AGGREGATE OUTPUT
224: 25 TAD=0.0
225: DO 30 I=1,5
226: TAD = TAD+TAH(I)
227: 30 CONTINUE
228: PROD = TAD/HR/8760.0
229: CALL GENOUT(1,XIN,LXIN,NW,MODNUM)
230: WRITE(NW,1001)
231: CALL GENOUT(2,XIN,LXIN,NW,MODNUM)
232: WRITE(NW,1004)PROD
233: CALL GENOUT(3,XIN,LXIN,NW,MODNUM)
234: CALL VARSET(NFW,PROD)
235: RETURN
236: 1001 FORMAT(' * OUTPUT FROM BIOMASS COMBUSTION POWER PRODUCTION',
237: *22X,'*')
238: 1002 FORMAT(2I3)
239: 1004 FORMAT(' *',5X,'* POWER PRODUCTION =',G20.10,' KWH/HR',12X,'*',
240: *5X,'*')

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1:      SUBROUTINE BIOGAS
2: C [NO FILEACCESS]
3: C THIS PROGRAM IS A SIMULATION OF ANAEROBIC DIGESTION OUTPUT
4: C THE OUTPUT OF THIS SIMULATION IS MMBTU-- CONVERTED TO KWH.
5: C GENERATOR EFFICIENCY IS ASSUMED TO BE 30%
6: C
7: C THIS MODEL WAS ADOPTED FROM RESEARCH PERFORMED FOR SERI,
8: C BY DYNATECH R/D COMPANY IN 1979.
9: C
10: C KK IS THE # OF PIECES OF EQUIPMENT
11: C K IS THE NUMBER TIMES THE PROGRAM WILL BE RUN.
12: C
13: C
14: C
15: C THE FIRST STEP IS TO DIMENSION THE ARRAYS AND ASSIGN VALUES
16: C
17: C
18: C THE VARIABLE FS5 IS ASSUMED TO BE 30%,
19: C ACCORDING TO ED ASHARE OF DYNATECH.
20: C
21: C
22:      INTEGER BUF(36)
23:      REAL XIN(55)
24:      DIMENSION TNMBR(10),WK(10),ACP(10)
25:      COMMON/KWPROD/ELNET
26:      COMMON/IO/NTR,NTW,ND(20)
27:      EQUIVALENCE (EA,XIN(2)),(FMAN,XIN(3)),(FSH,XIN(4)),(FVSM,XIN(5)),
28:      *(FBVSM,XIN(6)),(CF,XIN(7)),(HTC,XIN(8)),(TA,XIN(9)),(A,XIN(10)),
29:      *(FS5,XIN(11)),(SHRMC,XIN(12)),(SHRUK,XIN(13)),(STRMC,XIN(14)),
30:      *(HEXMC,XIN(15)),(HLMC,XIN(16)),(PRTMC,XIN(17)),(DWTMC,XIN(18)),
31:      *(DWTWK,XIN(19)),(EDWT,XIN(20)),(GPUWK,XIN(21)),(INSTR,XIN(22)),
32:      *(RKO,XIN(23)),(ELPRT,XIN(24)),(EPRT,XIN(25)),(PRTWK,XIN(26)),
33:      *(HRTPR,XIN(27)),(HRTST,XIN(28)),(HRTHL,XIN(29)),(HLDWK,XIN(30)),
34:      *(INSHL,XIN(31)),(INSPR,XIN(32)),(CHEM,XIN(33)),(FS1,XIN(34)),
35:      *(FS2,XIN(35)),(FS3,XIN(36)),(HRTDG,XIN(37)),(DIGMC,XIN(38)),
36:      *(DIGWK,XIN(39)),(INSDG,XIN(40)),(BLDT,XIN(41)),(TC,XIN(42)),
37:      *(TMPPR,XIN(43)),(FD,XIN(52)),(FSF,XIN(53)),(FVSF,XIN(54)),
38:      *(FBVSF,XIN(55))
39:      DATA MODNUM/3/,LXIN/55/,MODE/3/
40: C                                SET I/O CHANNELS
41:      NFW=ND(19)
42:      NW=ND(18)
43: C
44:      CALL DATSET(MODNUM,XIN,IRET)
45:      IF(IRET.EQ.0)RETURN
46:      WRITE(NFW,1004)MODE,MODNUM
47: C                                INITIALIZE DUMMY VARIABLES FOR
48: C                                SYSTEM CONFIGURATION
49:      KK=XIN(1)+.01
50:      INSHR=XIN(44)+SIGN(.01,XIN(44))
51:      INHLD=XIN(45)+SIGN(.01,XIN(45))
52:      INPRT=XIN(46)+SIGN(.01,XIN(46))
53:      INSTR=XIN(47)+SIGN(.01,XIN(47))
54:      INHEX=XIN(48)+SIGN(.01,XIN(48))
55:      INDIG=XIN(49)+SIGN(.01,XIN(49))
56:      INDWT=XIN(50)+SIGN(.01,XIN(50))
57:      INGPU=XIN(51)+SIGN(.01,XIN(51))
58:      STF=1.0
59:      WRITE(NTW,4001)
60:      READ(NTR,4002)BUF

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61:      WRITE(NTW,4000)
62: C
63:      DO 77 J=1,KK
64: 77      ACP(J)=1.0E-8
65: C
66: C *****FEED COMPOSITION*****
67: C
68: C  INDIG IS THE INDICATOR VARIABLE WHICH DETERMINES THE SIZING AND OPER
69: C  ATIONAL MODE OF THE DIGESTER SYSTEM. IT IS UTILIZED LATER IN THE PGM
70: C  WHEN INDIG IS =0:PLUG FLOW IS USED <0:CSTR IS USED >0 :BATCH IS
71: C  USED.
72: C
73:      TSF=FD
74:      TNDO=365.*STF
75:      IF (INDIG)1,1,2
76: 2      TSF=TSF*365./BLDT
77:      TNDO=BLDT
78: 1      TFF=TSF/FSF
79:      TVSF=TSF*FVSF
80:      TBVSF=TVSF*FBVSF
81:      TAF=TSF-TVSF
82:      TWF=TFF-TSF
83: C
84: C *****STORAGE*****
85: C
86: C  INSTR IS THE INDICATOR VARIABLE WHICH DETERMINES THE TYPE AND SIZING
87: C  OF THE STORAGE .
88: C
89:      IF(INSTR)11,11,12
90: 12      NSTR=TSF*2000.*HRTST/(DNSTR*STRMC)
91:      TNMBR(1)=1.+NSTR
92:      ACP(1)=TSF*2000.*HRTST/(DNSTR*TNMBR(1))
93:      GO TO 13
94: 11      TNMBR(1)=0.
95: 13      WK(1)=0.
96: C
97: C *****SHREDDING*****
98: C
99: C
100: C  INSHR IS THE INDICATOR VARIABLE;=OR<0 NOT USED
101: C
102:      IF(INSHR)15,15,16
103: 16      NSHR=TFF/(SHRMC*24.)
104:      TNMBR(2)=1.+NSHR
105:      ACP(2)=TFF/(TNMBR(2)*24.)
106:      WK(2)=TNMBR(2)*ACP(2)*SHRWK
107:      GO TO 20
108: 15      TNMBR(2)=0.
109:      WK(2)=0.
110: C
111: C
112: C *****HOLDING/MIXING*****
113: C
114: C
115: C  INHLD IS THE INDICATOR VARIABLE:<0 MEANSNOT USED;=0 MEANS NO MIX
116: C  BUT HOLDING.
117: C
118: 20      IF (INHLD)21,21,22
119: 22      TF1=TSF/FS1
120:      WH=TF1-TFF

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121:      IF(WH)23,23,24
122: 23    WH=0.0
123:      F21=FSF
124: 24    NHLD=TF1*2000.*HRTHL/(INSHL*HLDMC)
125:      TNMBR(3)=1.+NHLD
126:      ACP(3)=TF1*2000.*HRTHL/(INSHL * TNMBR(3))
127:      IF(INHLD) 25,25,26
128: 26    WK(3)=TNMBR(3)*ACP(3)*HLDWK
129:      GO TO 27
130: 25    WK(3)=0.
131:      GO TO 27
132: 21    TF1=TFF
133:      FS1=FSF
134:      WH=0
135:      TNMBR(3)=0.
136:      WK(3)=0
137: 27    TW1=TWf+WH
138: C
139: C
140: C *****PRETREATMENT(CHEM./THERMAL)*****
141: C
142: C
143: C INPRT IS THE PRETREATMENT VARIABLE; WHEN IT IS 0 OR<0 THEN IT IS
144: C NOT USED. THESE ASSIGNMENTS ARE CONSIDERED WHEN DETERMINING THE SYST
145: C CONFIGURATION.
146: C
147:      IF(INPRT)31,31,32
148: 32    TGBVS=(TVSF-TBVSF)*EPRT
149:      TCHEM=CHEM*TSF
150:      TLBVS=TBVSF*ELPRT
151:      TBVS2=TBVSF+TGBVS-TLBVS
152:      TS2=TSF+TCHEM
153:      TA2=TAF+TCHEM
154:      TVS2=TVSF
155:      TF2=TS2/FS2
156:      WP=TF2-TF1-TCHEM
157:      IF(WP)33,33,34
158: 33    WP=0.
159:      FS2=FS1
160:      TF2=TS2/FS2
161: 34    TW2=TW1+WP
162:      NPRT=TF2*2000.*HRTPR/(INSPR*24.*PRTMC)
163:      TNMBR(4)=1.+NPRT
164:      ACP(4)=TF2*2000.*HRTPR/(INSPR*24.*TNMBR(4))
165:      WK(4)=TNMBR(4)*ACP(4)*PRTWK
166:      GO TO 39
167: 31    TCHEM=0.
168:      TBVS2=TBVSF
169:      TS2=TSF
170:      TA2=TAF
171:      TF2=TF1
172:      TVS2=TVSF
173:      TWS=TW1
174:      WP=0.
175:      FS2=FS1
176:      TNMBR(4)=0.
177:      WK(4)=0.
178:      PRTHT=0.
179:      TMPPR=TA
180: 39    CONTINUE

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181: C
182: C
183: C *****DIGESTION*****
184: C
185: C
186: C *****RATE CONSTANT*****
187: C
188: IF(RK0,LE,0)GO TO 9942
189: RK=RK0*EXP(-EA/(1.987*(TC+273.16)))
190: GO TO 9943
191: 9942 RK=RK0*(-1.0)
192: 9943 TMS=TS2*FMAN
193: TS3=TMS+TS2
194: TVS3=TVS2+TMS*FBVSM
195: TBVS3=TBVS2+TMS*FVSM*FBVSM
196: TA3=TA2+TMS*(1.-FVSM)
197: TF3=TS3/FS3
198: TMW=TMS*(1.-FSM)/FSM
199: WDIG=TF3-TF2-TMS/FSM
200: IF (WDIG)44,44,45
201: 44 WDIG=0,
202: TF3=TF2+TMS/FSM
203: FS3=TS3/TF3
204: 45 TW3=TW2+WDIG+TMW
205: CBI=TBVS3 /TF3*DNSDG
206: IF (INDIG)51,51,59
207: C
208: C
209: C *****CONTINUOUS STIR DIGESTER*****
210: C
211: C
212: 51 CBE=CBI/(1.+RK*HRTDG)
213: GO TO 55
214: 52 CBE=CBI*EXP(-RK*HRTDG)
215: 55 TVD=TF3*2000.*HRTDG/DNSDG
216: GO TO 58
217: C
218: C
219: C *****BATCH DIGESTION *****
220: C
221: C
222: 59 CBE=CBI*EXP(-RK*HRTDG)
223: TVD=TF3*2000.*BLDT/DNSDG
224: 58 NDIG=TVD/DIGMC
225: TNMBR(5)=1.+NDIG
226: ACP(5)=TVD/TNMBR(5)
227: WK(5)=TNMBR(5)*ACP(5)*DIGWK
228: FCONV=(CBI-CBE)/CBI
229: C
230: C
231: C *****GAS PRODUCTION*****
232: C
233: C
234: IF (INDIG)53,53,54
235: 53 GPD=A*(CBI-CBE)/HRTDG
236: DGP=GPD*TVD
237: GO TO 40
238: 54 RGP=TBVS3*2000.*A*BLDT*FCONV
239: DGP=RGP/HRTDG
240: GPD=DGP/TVD

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241: C
242: C
243: C *****DIGESTER HEAT EXCHANGER*****
244: C
245: C
246: 40 IF( INHEX )41,41,42
247: 42 TPEX=( TC-TA)*0.1 +TA
248: XX=1.2756*EXP( -5220./( TC+233.16))
249: H2OEV=DGP*XX/( 1.-XX)*0.0474
250: TF4=TF3-( H2OEV/2000.+( CBI-CBE )/DNSIG*TF3)
251: TPF=TF4*( TC-TPEX)/TF2+TA
252: TAHEX=TF4*2000.*CF*( TC-TPEX)/(( TPEX-TA)*HTC*24.)
253: NHEX=TAHEX/HEXMC
254: TNMBR( 6)=1.+NHEX
255: ACP( 6)=TAHEX/ TNMBR( 6)
256: GO TO 43
257: 41 TNMBR( 6)=0.
258: TPEX=TC
259: TPF=TA
260: 43 WK( 6)=0.
261: C
262: C
263: C *****HEAT REQUIREMENT*****
264: C
265: C
266: 56 IF ( INPRT.EQ.1 )PRJHT=TF2*3600.*CF*( TMPPR-TPF )
267: HGAS=DGP*( TC-TA)*0.0723
268: HEVAP=H2OEV*( 1025.+0.805*( TC-TA))
269: HEFF=TF4*CF*( TPEX-TA)*3600.
270: HRXN=DGP*61.6
271: HLOSS=( ACP( 5)**( 2./3. ))*TNMBR( 5)*( TC-TA)*96.63
272: HREQ=HGAS+HEVAP+HEFF+HLOSS-HRXN
273: IF( INDIG.LE.0 ) HREQ=HGAS+HEVAP+HLOSS-HRXN
274: IF( HREQ.LE.0 ) HREQ=0
275: TBVS4=TRVS3*( 1.-FCONV )
276: TVS4=TVS3-( TBVS3 -TVBS4 )
277: TW4=TW3-H2OEV/2000.
278: TS4=TF4-TW4
279: TA4=TS4-TVS4
280: C
281: C *****DEWATERING*****
282: C
283: IF( INDWT )71,71,72
284: 72 NDWT=TF4/( DWTMC*24. )
285: ACP( 7)=TF4/( 24.*TNMBR( 7))
286: WK( 7)=TNMBR( 7)*DWTWK
287: TW5=TS4*EDWT
288: TW5=TS5/FS5*( 1.-FS5)
289: TF5=TS5+TW5
290: GO TO 73
291: 71 TNMBR( 7)=0.
292: WK( 7)=0.
293: TS5=0.
294: TW5=0.
295: TF5=0.
296: 73 TS6=TS4-TS6
297: TF6=TF4-TF5
298: TW6=TW4-TW5
299: C
300: C *****GAS PURIFICATION*****

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301: C
302: IF( INGPU ) 81,81,82
303: 82 ACP( 8 )=DGP/0.6
304: TNMBR( 8 )=1.
305: WK( 8 )=ACP( 8 )*GPUWK/1.E6
306: GO TO 88
307: 81 TNMBR( 8 )=0.
308: WK( 8 )=0.
309: 88 CONTINUE
310: DGPM=DGP/1000.
311: HREQM=HREQ/1.E6
312: WRITE( NW,4003 )BUF
313: WRITE( NW,1001 )FD,FSF,FVSF,FBVSF
314: IF ( INSTR )701,701,702
315: 701 WRITE( NW,1501 )
316: GO TO 803
317: 702 WRITE( NW,1502 )TNMBR( 1 ),ACP( 1 )
318: 803 IF ( INSHR )800,800,801
319: 800 WRITE( NW,1002 )
320: GO TO 805
321: 801 WRITE( NW,1003 )TNMBR( 2 ),ACP( 2 ),WK( 2 )
322: 805 IF ( INHLD )820,821,822
323: 820 WRITE ( NW,1008 )
324: GO TO 829
325: 821 WRITE( NW,1009 )
326: GO TO 825
327: 822 WRITE( NW,1010 )
328: 825 WRITE( NW,1011 )TNMBR( 3 ),ACP( 3 ),WK( 3 )
329: 829 IF( INPRT )810,810,811
330: 810 WRITE( NW,1006 )
331: GO TO 815
332: 811 WRITE( NW,1007 )CHEM,EPRT,TNMBR( 4 ),ACP( 4 ),TCHEM,WK( 4 )
333: 815 WRITE( NW,1012 )
334: IF( INDIG )831,833,838
335: 831 WRITE( NW,1013 )
336: GO TO 835
337: 833 WRITE( NW,1014 )
338: GO TO 835
339: 838 WRITE( NW,1015 )
340: 835 WRITE( NW,1016 )TNMBR( 5 ),ACP( 5 ),TC,HRTDG,FCONV,WK( 5 ),GPD,DGPM
341: IF( INHEX )841,841,842
342: 842 WRITE( NW,1017 )TNMBR( 6 ),ACP( 6 )
343: 841 WRITE( NW,1018 )HREQM
344: IF( INDWT )850,850,851
345: 850 WRITE( NW,1019 )
346: GO TO 852
347: 851 WRITE( NW,1020 )TNMBR( 7 ),ACP( 7 ),WK( 7 )
348: 852 IF( INGPU )860,860,861
349: 860 WRITE( NW,1021 )
350: GO TO 862
351: 861 WRITE( NW,1022 )ACP( 8 )
352: 862 CONTINUE
353: C
354: C
355: C *****WORK REQUIREMENTS*****
356: C
357: C
358: TWK=0
359: IF ( INDIG.LT.1 )GO TO 130
360: WK( 8 )=WK( 8 )*HRTDG/TNDO

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361:      HREQ=HREQ*HRTDG/TNDO
362: 130   DO 120 J=1,KK
363: 120   TWK=TWK+WK(J)
364:      WRITE(NW,2000)TWK
365: C *****CALL SUBROUTINE TO CALCULATE NET ELECTRICAL OUTPUT*****
366:      EFFGEN=.2
367:      CALL KWOUT(DGPM,TWK,EFFGEN,ELPROD,ELWK)
368:      WRITE(NW,3000)ELPROD,ELWK,ELNET
369:      CALL VARSET(NFW,ELNET)
370:      RETURN
371: C
372: C *****
373: C
374: 1001   FORMAT(1H1///24X,'SYSTEM PERFORMANCE'//1X,'FEED COMPOSITION'//9X,
375:      *'TOTAL SOLIDS',24X,G13.6,'TONS/D'//9X,'SOLIDS FRACTION',
376:      *'IN FEED',14X,G13.6/9X,'VOLATILE SOLIDS FRACTION IN SOLIDS',3X,G13.
377:      *.6/9X,'BIODEGR. VOL. SOL. FRACT. IN SOL. ',G13.6//)
378: 1002   FORMAT(/1X , 'SHREDDING-NONE USED' )
379: 1003   FORMAT(/1X,'SHREDDING'//9X,'NUMBER OF UNITS',20X,G12.5/9X,'CAPACITY
380:      *PER UNIT',13X,E10.4,'TONS/HR'//9X,'POWER REQUIREMENT'
381:      *,20X,E11.4,'HP' )
382: 1004   FORMAT(2I3)
383: 1006   FORMAT(/1X,'PRETREATMENT-NONE USED' )
384: 1007   FORMAT(/1X,'PRETREATMENT'//9X,'RATIO OF CHEMICAL TO FEED',13X
385:      *,G12.5/9X,'CONVERSION EFFICIENCY',16X,G13.6/9X,'NUMBER OF UNITS',
386:      *20X,G12.5/9X,'CAPACITY PER UNIT',13X,E10.4,'CU.FT.'//9X,
387:      *'CHEMICAL REQUIREMENT',10X,E10.4,'TONS/HR'//9X,'POWER ',
388:      *'REQUIREMENT',20X,E11.4,'HP' )
389: 1008   FORMAT(/1X,'HOLDING-NONE USED' )
390: 1009   FORMAT(/1X,'HOLDING-NO MIXING' )
391: 1010   FORMAT(/1X,'HOLDING-MIXING' )
392: 1011   FORMAT(/9X,'NUMBER OF UNITS',20X,G12.5/9X,'CAPACITY PER UNIT',13X,
393:      *E10.4,'CU.FT.'//9X,'POWER REQUIREMENT',20X,E11.4,'HP' )
394: 1012   FORMAT(/1X,'DIGESTION' )
395: 1013   FORMAT(/5X,'CSTR' )
396: 1014   FORMAT(/5X,'PLUG FLOW' )
397: 1015   FORMAT(/5X,'BATCH' )
398: 1016   FORMAT(9X,'NUMBER OF UNITS',20X,G12.5/9X,'CAPACITY PER UNIT',13X,
399:      * E10.4,'CU.FT. '//9X,'DIGESTER TEMPERATURE',16X,G11.4,'C'//9X,
400:      *'RETENTION TIME',21X,G13.6,'DAYS'//9X,'CONVERSION EFFICIENCY',16X,
401:      *G13.6/9X,'POWER REQUIREMENT',20X,E11.4,'HP'//
402:      */5X,'GAS PRODUCTION',26X,G13.6,' VVB'/41X,E11.4,'MM BTU/D' )
403: 1017   FORMAT( 5X,'HEAT EXCHANGER'// 9X,'NUMBER OF UNITS',20X,G13.6/9X,
404:      *'HEAT EXCHANGER AREA',10X,E11.4,'SQ.FT. ' )
405: 1018   FORMAT(/5X,'TOTAL HEAT REQUIREMENT',12X,E10.4,' MM BTU/D' )
406: 1019   FORMAT(/1X,'DEWATERING-NONE USED' )
407: 1020   FORMAT(/1X,'DEWATERING'//9X,'NUMBER OF UNITS',20X,G13.6/9X,
408:      *'CAPACITY PER UNIT',13X,E10.4,' TONS/HR '//9X,'POWER ',
409:      *'REQUIREMENT',20X,E11.4,'HP' )
410: 1021   FORMAT(/1X,'GAS PURIFICATION-NONE USED' )
411: 1022   FORMAT(1X,'GAS PURIFICATION'//9X,'CAPACITY PER UNIT',13X,E10.4,
412:      *' CU.FT./D' )
413: 1501   FORMAT(/1X,'STORAGE-NONE USED' )
414: 1502   FORMAT(/1X,'STORAGE'//9X,'NUMBER OF UNITS',20X,G12.5/9X,'CAPACITY'
415:      *,',PER UNIT',14X,G13.6,' CU.FT.' )
416: 2000   FORMAT(/1X,'TOTAL WORK REQUIREMENTS ',G13.6,' HP' )
417: 3000   FORMAT(/5X,' TOTAL ELECTRICITY PRODUCED = ',G13.6,' KWH/HR'//
418:      *      5X,' TOTAL ENERGY USED           = ',G13.6,' KWH/HR'//
419:      *      5X,' NET ENERGY PRODUCED          = ',G13.6,' KWH/HR'//)
420: 4000   FORMAT('ORUNNING...')

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421: 4001  FORMAT(' ENTER SYSTEM HEADER-ONE LINE-'/)
422: 4002  FORMAT(36A2)
423: 4003  FORMAT('1',76('*'))/' * ',36A2,' *'/' ',76('*'))
424:      END
425:      SUBROUTINE KWOUT(DGPM,TWK,EFFGEN,ELPROD,ELWK)
426: C [NO FILEACCESS]
427:      COMMON/KWPROD/ELNET
428:      BTUDAY=DGPM*1000000.0
429:      AKWHPD=BTUDAY/3412.0*EFFGEN
430:      ELPROD=AKWHPD/24.0
431:      ELWK=TWK*.746
432:      ELNET=ELPROD-ELWK
433:      RETURN
434:      END

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```

1:      SUBROUTINE DATSET(IOPT1,XIN,IRET)
2: C [FILEACCESS]
3: C DATSET DEFAULTS VALUES FROM DISK FOR THE SELECTED OPTION, THEN ALLOWS
4: C INSPECTION OR CHANGE OF THOSE VARIABLES. OTHER VARIABLE LISTS MAY BE
5: C DEFAULTED FROM A DISK FILE & SUCH A FILE MAY BE WRITTEN FOR THE
6: C CURRENT LIST.
7: C IOPT<0 THEN PRINTS LIST TO CHANNEL # SPEC IN IRET
8: C IRET IS 1 FOR NORMAL COMPLETION, 0 FOR ABORTED RUN.
9: C IOPT>100 THEN GETS FOR MODULE (IOPT-100) DECSRIPTOR # (IRET)
10: C      IRET NOT SET IN THIS OPT
11:      REAL XIN(1)
12:      INTEGER IOPT,INDEX(15),ICHAR(9),BUF(20)
13:      LOGICAL FIRST,IRBUF
14:      COMMON/IO/NTR,NTW,ND(20)
15:      COMMON/RESET/FIRST(15)
16:      DATA ICHAR/' ','L','R','?','C','I','O','D','E'/
17:      DATA NINDEX/11/
18: C                                     >100 THEN RETURN SPEC DESCRIPTOR
19: C                                     THIS OPT NEEDS REC IN IRET,
20: C                                     XIN AT LEAST 10 LONG (DESC HERE)
21:      IOPT=IOPT1
22:      IRBUF=.FALSE.
23:      IF(IABS(IOPT).LE.100)GO TO 5
24:      IRBUF=.TRUE.
25:      IOPT=IOPT-100
26: C                                     -1 THEN PRINT TO FILE SPEC IN IRET
27: 5      IOPT=IOPT
28:      IOPT=IABS(IOPT)
29:      ICHAN=IRET
30: C      IOFFST FOR # REC IN FILE DESIRED IF IOPT>100
31:      IOFFST=IRET
32:      ITEMP=NTW
33: C      CHECK FOR INVALID OPT #
34:      IF(IOPT.LT.1.OR.IOPT.GT.NINDEX)GO TO 990
35: C
36:      NF=ND(20)
37:      NFILE=ND(10)
38: C      GET LENGTHS
39: C      THE FIRST RECORD OF THE DEFAULTS
40: C      FILE HAS THE LENGTH OF EACH
41: C      MODULES INFORMATION IN TERMS
42: C      OF RECORDS OF DATA (EG. IF
43: C      XIN IS FIVE ELEMENTS LONG FOR
44: C      THE MODULE CALLING WITH IOPT=2,
45: C      THEN THE SECOND ELEMENT ON THE
46: C      FIRST LINE WILL BE FIVE
47: C [RANDOM ACCESS]
48:      READ(NF,1020,REC=1)(INDEX(I),I=1,NINDEX)
49: C      GET DEFAULTS
50:      IF1=0
51:      IRET=1
52:      IPOPT=1
53:      IF(IOPT.EQ.1)GO TO 20
54:      IOPTT=IOPT-1
55:      DO 10 I=1,IPOPTT
56:      IPOPT=IPOPT+INDEX(I)
57: 10      CONTINUE
58: 20      IND=INDEX(IOPT)
59:      IF(.NOT.IRBUF)GO TO 25
60: C      GET BUF DESIRED AND RETURN

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61:      IPOINT=IPOPT+IOFFST
62:      READ(NF,1012,REC=IPOINT)(XIN(I),I=1,10)
63:      RETURN
64: C
65: 25      IF(.NOT.FIRST(IOPT))GO TO 100
66:      FIRST(IOPT)=.FALSE.
67: 30      DO 50 I=1,IND
68:      IPOINT=IPOPT+I
69: C [RANDOM ACCESS]
70:      READ(NF,1005,REC=IPOINT)XIN(I)
71: 50      CONTINUE
72: C                                MAINBRANCH
73: 100     WRITE(NTW,1001)
74:      K=IPARSE(ICHAR,9)
75:      GO TO(900,200,300,400,500,600,700,30,800),K
76: C                                LIST
77: 200     WRITE(NTW,1002)
78:      READ(NTR,1020)NLIST
79:      IF(NLIST)210,220,230
80: 210     I1=1
81:      I2=INDEX(IOPT)
82:      GO TO 240
83: 220     WRITE(NTW,1017)
84:      READ(NTR,1020)I1
85:      WRITE(NTW,1022)
86:      READ(NTR,1020)I2
87:      IF(I1.LT.1.OR.I2.LT.I1.OR.I2.GT.INDEX(IOPT))GO TO 920
88:      GO TO 240
89: 230     I1=NLIST
90:      I2=NLIST
91: 240     DO 280 I=I1,I2
92:      IPOINT=IPOPT+I
93: C [RANDOM ACCESS]
94:      READ(NF,1003,REC=IPOINT)BUF
95:      WRITE(NTW,1004)I,BUF,XIN(I)
96: 280     CONTINUE
97: C                                IF PRINT AT END, THEN DONE
98:      IF(IF1.EQ.1)GO TO 310
99:      GO TO 100
100: C                                RETURN
101: 300     WRITE(NTW,1006)
102:      IF(IDOUT.GT.0)RETURN
103: C                                PRINT TO OUTPUT CHANNEL
104:      NTW=ICHAN
105:      WRITE(ICHAN,1011)
106:      IF1=1
107:      GO TO 210
108: C                                RESTORE CHANNEL TO NORMAL
109: 310     NTW=ITEMP
110:      RETURN
111: C                                HELP
112: 400     WRITE(NTW,2001)
113:      GO TO 100
114: C                                CHANGE
115: 500     WRITE(NTW,1007)
116:      READ(NTR,1020)NCHNG
117:      IF(NCHNG.EQ.0)GOTO 100
118:      IF(NCHNG.LT.1.OR.NCHNG.GT.IND)GOTO 500
119:      WRITE(NTW,1008)
120:      READ(NTR,1021)XIN(NCHNG)

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121:      GO TO 100
122: C
123: 600  WRITE(NTW,1025)
124: C [FILEMARK]
125:      CALL FOPEN(NFILE,BUF,1,0,IRET2,-1,DUM1,DUM2)
126:      IF(IRET2.EQ.0)GO TO 100
127: C [FILEMARK]
128:      READ(NFILE,1020,END=930)NOPT
129:      IF(IOPT.NE.NOPT)GO TO 910
130:      IND=INDEX(IOPT)
131:      DO 650 I=1,IND
132: C [FILEMARK]
133:      READ(NFILE,1026,END=930)XIN(I)
134: 650  CONTINUE
135: C [FILEMARK]
136:      ENDFILE NFILE
137:      GO TO 100
138: C
139: 700  WRITE(NTW,1009)
140: C [FILEMARK]
141:      CALL FOPEN(NFILE,BUF,0,0,IRET2,-1,DUM1,DUM2)
142:      IF(IRET2.EQ.0)GO TO 100
143: C
144:      WRITE(NTW,1010)
145:      READ(NTR,1003)BUF
146:      WRITE(NFILE,1003)BUF
147:      WRITE(NFILE,1020)IOPT
148:      IND=INDEX(IOPT)
149:      DO 750 I=1,IND
150:      WRITE(NFILE,1026)XIN(I)
151: 750  CONTINUE
152: C [FILEMARK]
153:      ENDFILE NFILE
154:      GO TO 100
155: C
156: 800  IRET=0
157:      RETURN
158: C
159: 900  WRITE(NTW,1015)
160:      GO TO 100
161: 910  WRITE(NTW,1016)
162:      GO TO 100
163: 920  WRITE(NTW,1018)
164:      GO TO 100
165: 930  WRITE(NTW,1019)
166:      GO TO 100
167: C
168: 990  WRITE(NTW,1027)
169:      STOP
170: C
171: 1001 FORMAT(' INTERACTIVE INPUT OPTION: ')
172: 1002 FORMAT(' # TO LIST (0 FOR RANGE,<0 FOR ALL): ')
173: 1003 FORMAT(20A2)
174: 1004 FORMAT(' ',I2,' ',20A2,1X,G13.6)
175: 1005 FORMAT(40X,G30.23)
176: 1006 FORMAT(' *END DATA SET SECTION*//')
177: 1007 FORMAT(' # TO CHANGE (0 TO ESCAPE): ')
178: 1008 FORMAT(' NEW VALUE: ')
179: 1009 FORMAT(' OENTER INFORMATION ON OUTPUT FILE-')
180: 1010 FORMAT(' FILE HEADER: ')

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181: 1011  FORMAT(//1',12X,'ASSUMPTIONS FOR THE ANALYSIS'/13X,28(' '))
182: 1012  FORMAT(10A4)
183: 1015  FORMAT(' *TYPE ? FOR HELP*')
184: 1016  FORMAT(' *FILE FOR WRONG SYSTEM TYPE*')
185: 1017  FORMAT(' FIRST LINE #: ')
186: 1018  FORMAT(' *INVALID VALUES FOR LIST RANGE*')
187: 1019  FORMAT('O***PREMATURE END-OF-FILE***')
188: 1020  FORMAT(15I3)
189: 1021  FORMAT(G30.23)
190: 1022  FORMAT(' LAST LINE #: ')
191: 1024  FORMAT(11A1)
192: 1025  FORMAT('OENTER INFORMATION ON INPUT FILE-')
193: 1026  FORMAT(G13.6)
194: 1027  FORMAT('O***ERROR IN IOPT CALL TO DATSET',19X,'***'/
195:      *' ***PROBABLE CAUSE: NINDEX NOT INCREASED WHEN A NEW***'/
196:      *' ***',7X,'MODULE WAS ADDED',24X,'***')
197: 2001  FORMAT('OTHIS IS THE INTERACTIVE INPUT SECTION.'/
198:      *' AVAILABLE COMMANDS INCLUDE:.'/
199:      *5X,'L(IST) -LISTS VARIABLES. IF YOU RESPOND TO THE '//
200:      *10X,'FOLLOWING PROMPT WITH A POSITIVE #, THAT LINE WILL BE '//
201:      *10X,'LISTED. IF THE NUMBER IS LESS THAN ZERO, ALL LINES WILL '//
202:      *10X,'BE LISTED. ENTRY OF A ZERO CAUSES YOU TO BE PROMPTED '//
203:      *10X,'FOR A RANGE TO LIST.'/
204:      *5X,'C(HANGE) -CHANGES VARIABLES. YOU WILL BE PROMPTED FOR '//
205:      *10X,'THE # OF THE VARIABLE TO CHANGE AND THE NEW VALUE.'/
206:      *5X,'R(UN) -RETURNS TO SIMULATION MODULE TO EXECUTE WITH '//
207:      *10X,'VARIABLES AS SPECIFIED IN THIS SECTION.'/
208:      *5X,'I(NTPUT) -SETS DATA FROM A PREVIOUSLY "OUTPUT" FILE '//
209:      *5X,'O(UTPUT) -SAVES CURRENT DATA TO FILE, SUITABLE FOR',
210:      *' LATER "INPUT".'/
211:      *5X,'D(EFAULT)-RESETS TO DEFAULTS. THIS IS DONE '//
212:      *10X,'AUTOMATICALLY ON THE FIRST RUN FOR EACH SIMULATION'//
213:      *10X,'MODULE.'/
214:      *5X,'E(ND) -ABORTS THIS SECTION WITHOUT PROCEEDING WITH RUN'//
215:      END

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1:      BLOCKDATA SBLOCK
2: C [FILEACCESS]
3: C BLOCKDATA FOR SIMULATION SECTION OF CPAC MODEL
4:      LOGICAL FIRST
5:      INTEGER ND,NTR,NTW
6:      COMMON/RESET/FIRST(10)
7:      COMMON/IO/NTR,NTW,ND(20)
8: C
9: C FIRST -FLAG TO DATSET AS TO WHETHER IT HAS ALREADY BEEN CALLED BY
10: C      A GIVEN MODULE.
11: C NTR   -CHANNEL # FOR TERMINAL READ.
12: C NTW   -CHANNEL # FOR TERMINAL WRITE.
13: C ND    -CHANNEL #'S FOR FILE ACCESSES
14: C
15: C [FILEMARK] TERMINAL IN/OUT CHANNEL #'S
16:      DATA NTR,NTW/1,1/
17:      DATA ND/4*1,8,9,9,8,9,9,5*1,2,6,7,4,5/
18:      END

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1:      INTEGER FUNCTION IPARSE(IRAY,LEN)
2: C [NO FILEACCESS]
3: C IPARSE DETERMINES WHICH OF A PASSED ARRAY OF CHARACTERS IS ENTERED
4: C AS A RESPONSE. IF CORRECT ENTRY FAILS TWICE, A SPECIAL CODE OF 1
5: C (NUMERIC ONE) IS RETURNED; ELSE THE POSITION OF THE ENTERED CHARACTER
6: C IS RETURNED. THUS THE FIRST CHARACTER OF THE PASSED ARRAY SHOULD BE
7: C BLANK, AS IT IS A DUMMY. IF LEN IS NEGATIVE, NO PROMPT IS MADE, &
8: C NO SECOND INPUT IS ALLOWED.
9: C
10: C ILEN -ABSOLUTE VALUE OF LEN
11: C IFLAG-MARKS FOR SECOND FAILURE
12: C IRAY -PASSED CHARACTER ARRAY
13: C LEN --# OF CHARACTERS TO BE SEARCHED IN ARRAY
14: C IN   -USER RESPONSE
15: C
16:      INTEGER LEN,IRAY(LEN),IN,J,ILEN
17:      LOGICAL IFLAG
18:      COMMON/IO/NTR,NTW,ND(20)
19: C
20:      IFLAG=.FALSE.
21:      IF(LEN.LT.0)IFLAG=.TRUE.
22:      ILEN=IABS(LEN)
23: C                                PROMPT
24: 100  IF(LEN.LT.0)GO TO 150
25:      WRITE(NTW,1001)(IRAY(J),J=2,ILEN)
26: 150  READ(NTR,1002)IN
27: C                                LOOP TO SEARCH FOR INPUT CHAR
28:      DO 200 IPARSE=2,ILEN
29:      IF(IRAY(IPARSE).EQ.IN)RETURN
30: 200  CONTINUE
31: C                                NO MATCH AT ALL
32: C                                CHECK FOR SECOND FAILURE
33:      IPARSE=1
34:      IF(IFLAG)RETURN
35:      IFLAG=.TRUE.
36:      WRITE(NTW,1003)(IRAY(J),J=2,ILEN)
37:      GO TO 100
38: 1001  FORMAT(' >> ',10(A1,':'))
39: 1002  FORMAT(A1)
40: 1003  FORMAT(' ENTER ONE OF THE FOLLOWING: ',10(' ',A1,' '))
41:      END
42: C
43: C
44: C
45:      FUNCTION GAMMA(K0)
46: C [NO FILEACCESS]
47: C STATISTICAL FUNCTION FOR WIND SIMULATION
48:      REAL G(101),K0,P,AMUL,PP
49:      INTEGER I
50:      DATA G /1.0,.9943,.9888,.9836,.9784,.9735,.9687,.9642,.9597,.9555,
51:      * .9514,.9474,.9436,.9399,.9364,.9330,.9298,.9267,.9237,.9209,
52:      * .9182,.9156,.9131,.9108,.9085,.9064,.9044,.9025,.9007,.8990,
53:      * .8976,.8960,.8946,.8934,.8922,.8912,.8902,.8893,.8885,.8879,
54:      * .8873,.8868,.8864,.8860,.8858,.8857,.8856,.8856,.8858,.8860,
55:      * .8862,.8866,.8870,.8876,.8882,.8889,.8896,.8905,.8914,.8924,
56:      * .8935,.8947,.8959,.8972,.8986,.9001,.9012,.9033,.9050,.9068,
57:      * .9084,.9106,.9126,.9147,.9168,.9191,.9214,.9238,.9262,.9288,
58:      * .9314,.9341,.9369,.9397,.9426,.9456,.9487,.9518,.9551,.9584,
59:      * .9618,.9652,.9688,.9724,.9761,.9799,.9838,.9876,.9917,.9958,
60:      * 1.0/

```

```

61:      P=1.0+1.0/K0
62:      PP=P
63:      IF (PP.LT.1.0) GO TO 99
64:      AMUL=1.0
65: 10    IF (PP.LE.2.0) GO TO 20
66:      PP=PP-1.0
67:      AMUL=AMUL*PP
68:      GO TO 10
69: 20    I=(100.*(PP-1.0)+1.0)
70:      GAMMA=AMUL*G(I)
71:      RETURN
72: 99    WRITE(NW,1001)
73: 1001  FORMAT(/1X,'CONSTRAINTS ON K0 ARE VIOLATED')
74:      STOP *GAMMA
75:      END
76: C
77: C
78: C
79:      SUBROUTINE FOPEN(NFILE,IFMT,IHDR,IFORM,IRET,ITMP,CNV,ADD)
80: C [FILEACCESS]
81: C [VARIBALE FORMAT] (PASSED PARAMETER)
82: C
83: C *****
84: C *
85: C * THIS IS THE GENERAL USER-DEFINED FILE OPEN ROUTINE!!!
86: C * FILENAMES ARE 11 CHARS LONG, WITH NO PERIODS, AS IN
87: C * "TEST0001DAT", WHERE THE FIRST 8 CHARS ARE THEN FILENAME AND
88: C * THE LAST 3 ARE THE EXTENSION. THIS NAME IS THE SECOND ARGUMENT
89: C * TO THE FORTRAN OPEN ROUTINE. THE I/O CHANNEL # TO BE OPENED
90: C * IS THE FIRST ARG, AND THE DISK (0-LOGGED DISK, 1-DISK A, 2-DISK B,
91: C * AND SO ON) IS THE THIRD ARG, AS FOLLOWS:
92: C *      CALL OPEN(IOCHAN,FSPEC,DSPEC)
93: C * WHERE IOCHAN IS THE I/O CHANNEL, FSPEC IS THE 11-CHAR FILE
94: C * SPECIFIER, AND DSPEC IS AN INTEGER SPECIFYING THE DISK THE FILE IS
95: C * ON.
96: C * EXAMPLE: CALL OPEN(6,'TEST0001DAT',2) WOULD OPEN FILE
97: C * TEST0001.DAT ON DISK B ACCESSIBLE ON FORTRAN CHANNEL 6.
98: C * FOPEN MAY ALSO SET VARIABLE FORMATS, ASSUMING THEM TO BE ARRAYS OF
99: C * INTEGER*2 VARIABLES (AS ARE ALL INTEGERS IN THIS PROGRAM).
100: C * HEADER RECORDS MAY ALSO BE CHECKED FOR, AND CONVERSION FACTORS
101: C * MAY BE SPECIFIED.
102: C *
103: C *****
104: C
105: C FOPEN PROMPTS FOR DISK AND FILE FOR DATA. PROMPT MUST BE MADE IN
106: C CALLING ROUTINE.
107: C NFILE-FORTRAN UNIT # TO BE OPENED.
108: C IFMT -VARIABLE FORMAT TO BE USED TO READ THAT FILE (ALREADY
109: C      SET TO DEFAULT VALUE)
110: C IHDR -1,READ HEADER;0,DON'T;-1,ASK WHICH TO DO
111: C IFORM-1,GET FORMAT;0,DON'T
112: C IRET -1,SUCCESSFUL IN FOPEN;0,NOT
113: C ITMP -1,ASK IF DEGREES C;0,NOT A TEMPERATURE VALUE;-1 SKIP CONVERSION
114: C      SECTION ALTOGETHER
115: C CNV  -MULTIPLICATION FACTOR FOR INPUT
116: C ADD  -ADDITION FACTOR FOR INPUT [(INPUT+ADD)*CNV] IS PERFORMED
117: C
118: C [VARIABLE FORMAT] (DIMENSIONED)
119:      INTEGER NFILE,NTW,NTR,ND,IFMT(10),BLK
120:      LOGICAL FILE(40),DISK,CHRA,CHRB,IDISK,I,BLANK

```

```

121: COMMON/IO/NTR,NTW,ND(20)
122: DATA CHRA/'A'/,CHRB/'B'/,BLANK/' '/,BLK/' '/
123: C
124: IRET=1
125: K=0
126: C
127: 1 WRITE(NTW,1001)
128: READ(NTR,1002)DISK
129: IDISK=1
130: IF(DISK.EQ.CHRA)GOTO 10
131: IF(DISK.NE.CHRB)GOTO 1
132: IDISK=2
133: 10 WRITE(NTW,1003)
134: READ(NTR,1002)(FILE(I),I=1,11)
135: C IF BLANK FILENAME SPECIFIED,
136: C RETURN
137: DO 15 I=1,11
138: IF(FILE(I).NE.BLANK)GO TO 17
139: 15 CONTINUE
140: C BLANK FILENAME, SO END
141: C WITH UNSUCCESSFUL CODE
142: IRET=0
143: RETURN
144: C [FILEMARK]
145: 17 CALL OPEN(NFILE,FILE,IDISK)
146: C SKIP IF HEADER NOT SPECIFIED,
147: C OR READ, OR ASK WHAT TO DO
148: IF(IHDR)18,20,19
149: C ASK IF READ HEADER
150: 18 WRITE(NTW,1008)
151: IF(NOYES(1).EQ.0)GO TO 20
152: 19 READ(NFILE,1002,END=990)FILE
153: WRITE(NTW,1004)FILE
154: C ASK FORMAT ONLY IF SPECIFIED
155: 20 IF(IFORM)40,40,25
156: C GET DATA FORMAT
157: C [VARIABLE FORMAT] (WRITTEN OUT)
158: 25 WRITE(NTW,1006)IFMT
159: IF(NOYES(1).EQ.1)GO TO 40
160: WRITE(NTW,1009)
161: C [VARIABLE FORMAT] (READ IN)
162: READ(NTR,1007)IFMT
163: DO 30 I=1,10
164: C [VARIABLE FORMAT] (COMPARED)
165: IF(IFMT(I).NE.BLK)GO TO 40
166: 30 CONTINUE
167: C BLANK FORMAT-END UNSUCCESSFUL
168: IRET=0
169: RETURN
170: C CONVERSIONS
171: 40 ADD=0.0
172: CNV=1.0
173: IF(ITMP)900,60,45
174: C DO TEMPERATURE CONVERSION
175: 45 WRITE(NTW,1010)
176: IF(NOYES(1).EQ.1)GO TO 50
177: C IN FARENHEIT
178: ADD=(-32.0)

```

179: CNV=.555555
180: GO TO 900


```

181: C                                IN CENTIGRADE
182: 50    GO TO 900
183: C                                GENERAL CONVERSION
184: 60    WRITE(NTW,1014)
185:      IF(NOYES(1).EQ.1)GO TO 900
186:      WRITE(NTW,1011)
187:      READ(NTR,1012)ADD
188:      WRITE(NTW,1013)
189:      READ(NTR,1012)CNV
190: 900    RETURN
191: C                                ERROR MSG
192: 990    WRITE(NTW,1005)
193: C [FILEMARK]
194:      ENDFILE,NFILE
195:      K=K+1
196:      IF(K.EQ.1)GO TO 1
197:      IRET=0
198:      RETURN
199: C
200: 1001   FORMAT('ODISK OF DATA FILE(A/B): ')
201: 1002   FORMAT(40A1)
202: 1003   FORMAT(' FILENAME(11 CHARS,NO PERIOD: BLANK TO ESCAPE): ')
203: 1004   FORMAT(' HEADER: ',40A1/)
204: 1005   FORMAT('0***FILE NOT FOUND***')
205: 1006   FORMAT(' DO YOU WISH USE THE DEFAULT DATA FORMAT?'/
206:      *1X,10A2)
207: 1007   FORMAT(10A2)
208: 1008   FORMAT(' IS THE FIRST RECORD OF THE FILE A LABEL HEADER?'/
209:      *' ("YES" SHOULD BE THE DEFAULT CONDITION)')
210: 1009   FORMAT(' ENTER NEW FORMAT (INCLUDING PARENS: BLANK TO ESCAPE):'/)
211: 1010   FORMAT(' IS THE DATA IN CENTIGRADE? ("NO" FOR FARENHEIT)')
212: 1011   FORMAT(' DATA MAY BE ADJUSTED BY THE FORMULA:'/
213:      *' FINALDATA=(RAWDATA+ADDFACTOR)*MULTFACTOR'/
214:      *'0ENTER FACTOR TO ADD TO RAW DATA: ')
215: 1012   FORMAT(G13.6)
216: 1013   FORMAT(' ENTER FACTOR TO MULTIPLY DATA BY AFTER ADDITION: ')
217: 1014   FORMAT(' IS THE DATA IN THE PROPER UNITS? (AS SPECIFIED ABOVE)')
218:      END
219: C
220: C
221: C
222:      SUBROUTINE VARSET(NFW,PROD)
223: C [NO FILEACCESS]
224: C VARSET ALLOWS A DIURNAL OR MONTHLY VARIATION IN PRODUCTION
225: C LEVEL OF AN OTHERWISE CONSTANT PROCESS.
226: C IT OUTPUTS THE FACTOR BY HOUR
227: C AND/OR MONTH AS NEEDED.
228:      REAL HFAC(24),MFAC(12)
229:      COMMON/IO/NTR,NTW,NB(20)
230: C
231:      DO 600 I=1,12
232:      DO 600 J=1,24
233:      WRITE(NFW,1009)PROD
234: 600    CONTINUE
235:      RETURN
236: 1009   FORMAT(G13.6)
237:      END
238: C
239: C
240: C

```

```

241:      SUBROUTINE GENOUT(IOPT,XIN,NUM,NW,MODNUM)
242: C GENOUT DOES GENERALIZED OUTPUT FOR SIMULATION MODELS.
243: C IOPT -SPECIFIES OPTION FOR PRINT:
244: C      1) PRINT TOP LINES UP TO HEADER(HEADER PRINTED IN
245: C          CALLING ROUTINE)
246: C      2) PRINT INPUTS AND RIGHT UP TO OUTPUT(ALSO IN CALLING ROUTINE)
247: C      3) PRINT BOTTOM LINES AFTER OUTPUT
248: C XIN -INPUTS ARRAY USED TO CALL DATSET IN CALLING ROUTINE
249: C MODNUM-MODULE #
250: C NUM -# ELEMENTS IN XIN
251: C
252:      REAL XIN(1),BUF(10)
253: C
254: C          BRANCH TO EXECUTE OPTION
255:      GO TO(100,200,300),IOPT
256: C          TOP OF PRINTOUT
257: 100  WRITE(NW,1006)
258:      WRITE(NW,1001)
259:      WRITE(NW,1002)
260:      RETURN
261: C          PRINT INPUTS
262: 200  WRITE(NW,1002)
263:      WRITE(NW,1003)
264: C          LOOP THROUGH INPUTS
265:      DO 250 I=1,NUM
266:      MTEMP=MODNUM+100
267:      ITEMP=I
268:      CALL DATSET(MTEMP,BUF,ITEMP)
269: 250  WRITE(NW,1004)I,(BUF(J),J=1,10),XIN(I)
270:      WRITE(NW,1002)
271:      WRITE(NW,1005)
272:      RETURN
273: C          BOTTOM OF PRINTOUT
274: 300  WRITE(NW,1005)
275:      WRITE(NW,1002)
276:      WRITE(NW,1001)
277:      RETURN
278: C
279: 1001 FORMAT(' ',72('#'))
280: 1002 FORMAT(' *',70X,'#')
281: 1003 FORMAT(' * INPUTS:',61X,'#')
282: 1004 FORMAT(' *',7X,I3,' ')',10A4,G13.6,5X,'#')
283: 1005 FORMAT(' *',5X,60('#'),5X,'#')
284: 1006 FORMAT('1')
285:      END
286: C
287: C
288: C
289:      INTEGER FUNCTION NOYES(J)
290: C [NO FILEACCESS]
291: C NOYES RETURNS 0 IF THE ANSWER IS NO, 1 IF IT IS YES.
292: C THERE IS NO PROVISION FOR OTHER RESPONSES.
293: C IF J IS NEGATIVE, NO PROMPT IS MADE.
294: C
295:      INTEGER IC(2),IN,I,J
296:      COMMON/IO/NTR,NTW,ND(20)
297:      DATA IC/'N','Y'/
298: C
299: C          PROMPT
300: 50  IF(J.GE.0)WRITE(NTW,1001)

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```

301:      READ(NTR,1002)IN
302: C                                LOOP TO IDENTIFY INPUT CHAR
303:      DO 100 I=1,2
304:      NOYES=I-1
305:      IF(IC(I).EQ.IN)RETURN
306: 100   CONTINUE
307: C                                NO MATCH AT ALL
308:      WRITE(NTW,1003)
309: C                                IF NO PROMPT, TERMINATE(FILE READ ERROR)
310:      IF(J.LT.0)STOP
311:      GO TO 50
312: 1001  FORMAT(' (N,Y):')
313: 1002  FORMAT(A1)
314: 1003  FORMAT(' *PLEASE ENTER N OR Y FOR NO OR YES*')
315:      END

```

```

1:      PROGRAM DANDL
2: C [FILEACCESS]
3: C DANDL DERATES PERFORMANCE ON A LEVEL, HOURLY, AND MONTHLY BASIS. IT
4: C THEN INTEGRATES A SPECIFIED LOAD WITH THE PERFORMANCE TO DETERMINE
5: C NET ELECTRICITY BOUGHT, SOLD, AND PRODUCED.
6: C [VARIABLE FORMAT] (DIMENSIONED)
7:      INTEGER IFORMD(10),IFMT(10),IFMT2(10)
8:      REAL HOURP(24),HOURL(24),DHOURL(24),DDAILY(24),DMONTH(12),
9:      *DAYS(12),DLEVEL
10:     LOGICAL FLAGM(2),FLAGD(2),FLAGDK,FLAGUD
11:     COMMON/IO/NTR,NTW,ND(20)
12:     COMMON/DAT/MINMOD,MAXMOD
13:     DATA DAYS/31.0,28.0,31.0,30.0,31.0,30.0,31.0,31.0,
14:     *30.0,31.0,30.0,31.0/
15: C [VARIABLE FORMAT] (DEFINED DEFAULT)
16:     DATA IFORMD/'(1','G1','3.','6)','6*' '/'
17: C
18:     NPR=ND(1)
19:     NLR=ND(2)
20:     NFW=ND(3)
21:     NW=ND(4)
22:     K=1
23:     CNVPER=1.0
24:     ADDPER=0.0
25:     CNVLOA=1.0
26:     ADDLOA=0.0
27: C
28:     DO 98 I=1,20
29: C [VARIABLE FORMAT]
30:     IFMT2(I)=IFORMD(I)
31: C [VARIABLE FORMAT]
32: 98    IFMT(I)=IFORMD(I)
33:     WRITE(NTW,1001)
34: C
35: 99    WRITE(NTW,1034)
36:     IF(NDYES(1).EQ.1)GO TO 2
37: C
38:     FLAGDK=.FALSE.
39:     MODEL=1
40:     DO 1 I=1,24
41: 1     HOURL(I)=0.0
42:     GO TO 4
43: C
44: 2     WRITE(NTW,1035)
45:     IF(NDYES(1).EQ.0)GO TO 21
46: C
47:     FLAGDK=.FALSE.
48: 3     WRITE(NTW,1036)
49:     READ(NTW,1013)MODEL
50: C
51:     IF(MODEL.LT.1.OR.MODEL.GT.2)GO TO 3
52:     L=(MODEL-1)*23+1
53:     DO 19 I=1,L
54:     WRITE(NTW,1037)I
55:     READ(NTR,1021)HOURL(I)
56: 19    CONTINUE
57:     GO TO 4
58: C
59: 21    FLAGDK=.TRUE.
60:     WRITE(NTW,1002)

```

SET FORMAT TO DEFAULT FORMAT

SEE IF DESIRED TO ENTER LOAD

DEFAULT LOAD TO ZERO

SEE IF ENTERED FROM TERMINAL

YES, ENTER FROM TERMINAL

ONLY MODES 1 & 2

GET FROM FILE

```

61: C [FILEMARK] [VARIABLE FORMAT] (PASSED PARAMETER)
62:     CALL FOPEN(NLR,IFMT2,-1,1,IRET2,0,CNVLOA,ADDLOA)
63:     IF(IRET2.EQ.0)GO TO 99
64: 4     DO 5 I=1,24
65:     DDAILY(I)=1.0
66: 5     CONTINUE
67:     DO 6 I=1,12
68:     DMONTH(I)=1.0
69: 6     CONTINUE
70:     DLEVEL=1.0
71:     WRITE(NTW,1004)
72:     IF(NOYES(1).EQ.0)GOTO 10
73:     WRITE(NTW,1005)
74:     READ(NTR,1021)DLEVEL
75: 10    WRITE(NTW,1007)
76:     IF(NOYES(1).EQ.0)GOTO 20
77:     WRITE(NTW,1008)
78:     DO 15 I=1,24
79:     WRITE(NTW,1009)I
80:     READ(NTR,1021)DDAILY(I)
81: 15    CONTINUE
82: 20    WRITE(NTW,1010)
83:     IF(NOYES(1).EQ.0)GOTO 28
84:     WRITE(NTW,1011)
85:     DO 25 I=1,12
86:     WRITE(NTW,1012)I
87:     READ(NTR,1021)DMONTH(I)
88: 25    CONTINUE
89: C                                     CHECK TO SEE IF USER-DEFINED FILE
90: 28    FLAGSM=,TRUE,
91:     WRITE(NTW,1029)
92:     IF(NOYES(1).EQ.1)GO TO 35
93: 29    WRITE(NTW,1038)
94: C [FILEMARK] [VARIABLE FORMAT] (PASSED PARAMETER)
95:     CALL FOPEN(NPR,IFMT,-1,1,IRET2,0,CNVPER,ADDPER)
96:     IF(IRET2.EQ.0)GO TO 28
97:     WRITE(NTW,1039)
98:     FLAGSM=,FALSE,
99:     IF(NOYES(1).EQ.1)GO TO 40
100: 31    WRITE(NTW,1042)
101:     READ(NTR,1013)MODEP
102:     FLAGSM=,TRUE,
103: C                                     MARK AS USER-DEFINED FILE
104:     MODNUM=0
105: C                                     IF MODE 10, AGGREGATE INTO MODE 3
106: C                                     IN DEFAULT FILE AND PROCESS NOMALLY
107:     IF(MODEP.NE.10)GO TO 33
108: C [VARIABLE FORMAT] (PASSED PARAMETER)
109: 32    CALL MODE10(NPR,IFMT)
110:     CALL OPEN(NPR,'SYSSIMULDAT',2)
111:     READ(NPR,1013,END=991)MODEP
112:     GO TO 41
113: C                                     IF ILLEGAL MODE, ASK AGAIN
114: 33    IF(MODEP.LT.MINMOD.OR.MODEP.GT.MAXMOD)GO TO 31
115:     GO TO 45
116: C [FILEMARK]
117: 35    CALL OPEN(NPR,'SYSSIMULDAT',2)
118: 40    READ(NPR,1020,END=991)MODEP,MODNUM
119: 41    IF(FLAGSM)GO TO 42
120:     MODNUM=0

```

```

121: C                                CHECK TO SEE IF HOUR BY HOUR
122: 42    IF(MODEP.NE.10)GO TO 45
123: C                                YES, SO AGGREGATE INTO DEFAULT FILE
124: C [VARIABLE FORMAT] (PASSED PARAMETER)
125:     CALL MODE10(NPR,IFMT)
126:     CALL OPEN(NPR,'SYSSIMULDAT',2)
127:     READ(NPR,1013,END=991)MODEP
128:     GO TO 41
129: 45    IF(FLAGDK)READ(NLR,1013,END=992)MODEL
130: C                                OPEN DATA OUT FILE
131: C [FILEMARK]
132:     CALL OPEN(NFW,'LOADOUT1DAT',2)
133: C                                OUTPUT IS ALWAYS MODE 3
134:     MODE=3
135:     WRITE(NFW,1020)MODE,MODNUM
136: C                                LOOP TO HANDLE MULTIPLE RUNS
137:     FLAGM(1)=.TRUE.
138:     FLAGM(2)=.TRUE.
139:     FLAGD(1)=.TRUE.
140:     FLAGD(2)=.TRUE.
141: C                                NOTIFY THAT EXECUTION IS PROCEEDING
142:     WRITE(NTW,1045)
143: C                                INTEGRATE LOAD & PERFORMANCE, ONE AGGREGATE
144: C                                MONTH AT A TIME; DERATE LOAD FIRST
145: C
146: C                                GET PERFORMANCE
147:     DO 600 MONTH=1,12
148:     IF(.NOT.FLAGM(1))GOTO 200
149:     DO 100 I=1,24
150:     IF(.NOT.FLAGD(1))GOTO 50
151: C [VARIABLE FORMAT]
152:     READ(NPR,IFMT,END=993)HOURP(I)
153:     HOURP(I)=(HOURP(I)+ADDPER)*CNVPER
154:     IF(MODEP.LE.1)FLAGD(1)=.FALSE.
155:     GOTO 100
156: 50    HOURP(I)=HOURP(1)
157: 100   CONTINUE
158:     IF(MODEP.LE.2)FLAGM(1)=.FALSE.
159: C                                GET LOAD
160: 200   IF(.NOT.FLAGM(2))GOTO 400
161:     DO 300 I=1,24
162:     IF(.NOT.FLAGD(2))GOTO 250
163: C [VARIABLE FORMAT]
164:     IF(.NOT.FLAGDK)GO TO 220
165:     READ(NLR,IFMT2,END=994)HOURL(I)
166:     HOURL(I)=(HOURL(I)+ADDLOA)*CNVLOA
167: 220   IF(MODEL.LE.1)FLAGD(2)=.FALSE.
168:     GOTO 300
169: 250   HOURL(I)=HOURL(1)
170: 300   CONTINUE
171:     IF(MODEL.LE.2)FLAGM(2)=.FALSE.
172: C                                INTEGRATE
173: 400   DO 500 I=1,24
174:     DHOURP(I)=HOURP(I)*DLEVEL*DDAILY(I)*DMONTH(MONTH)
175:     BOUGHT=0.0
176:     SOLD=0.0
177:     ANET=(HOURL(I)-DHOURP(I))*DAYS(MONTH)
178:     DHOURP(I)=DHOURP(I)*DAYS(MONTH)
179:     IF(ANET)410,430,420
180: 410   SOLD=(-1.0)*ANET

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181:      GOTO 430
182: 420   BOUGHT=ANET
183: 430   WRITE(NFW,1022)I,BOUGHT,SOLD,DHOURP(I)
184:      K=K+1
185: 500   CONTINUE
186: 600   CONTINUE
187:      K=K-1
188: C                                     PRINT OUTPUT TO TERMINAL OR FILE
189:      NW=NTW
190:      WRITE(NTW,1016)
191:      IF(NYES(1),EQ,1)GO TO 700
192: C                                     OUTPUT TO FILE
193:      NW=ND(4)
194: C [FILEMARK]
195:      CALL OPEN(NW,'DERALOADPRN',2)
196: 700   WRITE(NW,1030)DLEVEL
197:      WRITE(NW,1031)(J,DBAILY(J),J=1,24)
198:      WRITE(NW,1032)(J,DMONTH(J),J=1,12)
199:      WRITE(NW,1015)MODEP,MODEL,MODE,K
200:      IF(NW,EQ,NTW)GO TO 710
201:      WRITE(NTW,1017)
202:      ENDFILE NW
203: 710   IF(FLAGDK)REWIND NLR
204:      STOP
205: C                                     ERROR MSGS ON UNEXPECTED END-OF-FILE
206: 991   WRITE(NTW,1018)
207:      WRITE(NTW,1019)
208:      STOP
209: 992   WRITE(NTW,1023)
210:      WRITE(NTW,1019)
211:      STOP
212: 993   IF(MONTH,EQ,1.AND,I,EQ,1)GO TO 991
213:      WRITE(NTW,1018)
214:      WRITE(NTW,1024)
215:      STOP
216: 994   IF(MONTH,EQ,1.AND,I,EQ,1)GO TO 992
217:      WRITE(NTW,1023)
218:      WRITE(NTW,1024)
219:      STOP
220: 1001  FORMAT('1'// DERATING & LOAD INTEGRATION SECTION//
221:      *' THIS SECTION DERATES PERFORMANCE ON A FLAT BASIS,//
222:      *' AN HOURLY BASIS, AND/OR A MONTHLY BASIS.//
223:      *' IT ALSO INTEGRATES LOAD WITH THIS PERFORMANCE TO//
224:      *' DETERMINE NET ENERGY BOUGHT, SOLD, AND PRODUCED.//)
225: 1002  FORMAT('ENTER LOAD DATA FILE INFORMATION (KWH) -')
226: 1004  FORMAT(' DERATE PERFORMANCE DATA ON A FLAT BASIS?')
227: 1005  FORMAT(' DERATE FACTOR (0.0<F<1.0): ')
228: 1007  FORMAT(' DERATE PERFORMANCE DATA ON AN HOURLY BASIS?')
229: 1008  FORMAT(' ENTER FACTOR FOR EACH HOUR (0.0<F<1.0)')
230: 1009  FORMAT(' HOUR',I3,' : ')
231: 1010  FORMAT(' DERATE PERFORMANCE DATA ON A MONTHLY BASIS?')
232: 1011  FORMAT(' ENTER FACTOR FOR EACH MONTH (0.0<F<1.0)')
233: 1012  FORMAT(' MONTH',I3,' : ')
234: 1013  FORMAT(I3)
235: 1015  FORMAT(' * PERFORMANCE MODE: ',I3,47X,'*//
236:      *      ' * LOAD MODE: ',7X,I3,47X,'*//
237:      *      ' * OUTPUT MODE: ',5X,I3,47X,'*//
238:      *      ' * RECORDS WRITTEN: ',I4,47X,'*//
239:      *      ' *,70X,'*// ',72(' *'))
240: 1016  FORMAT('OUTPUT TO TERMINAL? ("NO" WILL SEND IT TO FILE)')

```

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241: C [FILEMARK] (FILENAME)
242: 1017 FORMAT('OPRINTOUT IN FILE "DERALOAD.PRN"'/)
243: 1018 FORMAT('O***ERROR IN PERFORMANCE FILE READ ***')
244: 1019 FORMAT(' ***PROBABLE CAUSE: NONEXISTENT FILE***'/)
245: 1020 FORMAT(2I3)
246: 1021 FORMAT(G13.6)
247: 1022 FORMAT(I2,3G13.6)
248: 1023 FORMAT('O***ERROR IN LOAD FILE READ ***')
249: 1024 FORMAT(' ***PROBABLE CAUSE: INSUFFICIENT ***'/
250: * ' *** DATA POINTS IN FILE ***'/)
251: 1025 FORMAT(A1)
252: 1026 FORMAT('O***WARNING: EXCESS DATA POINTS AT ***'/
253: * ' *** END OF PERFORMANCE DATA FILE. ***'/
254: * ' *** RUN CONCLUDED NORMALLY ***'/)
255: 1027 FORMAT('O***WARNING: EXCESS DATA POINTS AT ***'/
256: * ' *** END OF LOAD DATA FILE. ***'/
257: * ' *** RUN CONCLUDED NORMALLY ***'/)
258: 1028 FORMAT('ODERATING AND LOAD INTEGRATION SECTION CONCLUDED'/)
259: 1029 FORMAT(' ARE YOU USING THE DEFAULT PERFORMANCE FILE FROM'/
260: * ' THE SIMULATION SECTION?')
261: 1030 FORMAT('1'/' ',72(' ')/' *',70X,'*'/
262: *' * DERATING AND LOAD INTEGRATION SECTION',31X,'*'/
263: *' *',70X,'*'/ ' * LEVEL DERATE: ',F10.5,41X,'*'/
264: *' *',70X,'*')
265: 1031 FORMAT(' *',5X,'HOURLY DERATE (HOUR & FACTOR)',36X,'*'/
266: *4(' *',3X,I2,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,3X,'*'/)
267: *', ' *',70X,'*')
268: 1032 FORMAT(' *',5X,'MONTHLY DERATE (MONTH & FACTOR )',33X,'*'/
269: *2(' *',3X,I2,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,I4,F7.3,3X,'*'/)
270: *', ' *',70X,'*')
271: 1034 FORMAT(' DO YOU WISH TO HAVE A USER LOAD INTEGRATED?'/
272: *' ("YES" SHOULD BE USED FOR NET SELLBACK DETERMINATION)')
273: 1035 FORMAT(' DO YOU WISH TO ENTER THE LOAD FROM THE TERMINAL?'/
274: *' ("NO" WILL RESULT IN DISK READ PROMPTS)')
275: 1036 FORMAT(' MODE FOR LOAD DATA (1 OR 2 ONLY)?')
276: 1037 FORMAT(' ENTER USER LOAD FOR HOUR',I3,'(KWH): ')
277: 1038 FORMAT(' ENTER PERFORMANCE DATA FILE INFORMATION (KWH/HOUR) -')
278: 1039 FORMAT(' DOES THE FILE HAVE A MODE AS ITS FIRST RECORD?')
279: 1042 FORMAT(' ENTER MODE THE DATA FILE IS IN (1-3 OR 10): ')
280: 1045 FORMAT('ORUNNING...')
281: END

```



```

1:      SUBROUTINE MODE10(NF,IFMT)
2: C [FILEACCESS]
3: C [VARIABLE FORMAT] (PASSED PARAMETER)
4: C MODE10 HANDLES MODE 10 (HOUR BY HOUR) DATA, AGGREGATING IT INTO
5: C AVERAGE HOUR FOR EACH HOUR OF EACH MONTH. NF IS THE CHANNEL #
6: C OF THE (ALREADY OPEN) FILE WITH THE PERFORMANCE DATA IN MODE TEN,
7: C SET SO THAT THE NEXT RECORD READ IS THE FIRST RECORD OF PERFORMANCE
8: C DATA. IT IS ALSO USED TO WRITE THE DEFAULT FILE OUT AFTERWARDS.
9: C IFMT IS THE FORMAT OF THE DATA.
10: C [VARIABLE FORMAT] (DIMENSIONED)
11:      INTEGER IFMT(20),NF
12:      INTEGER NDAYS(12)
13:      REAL PERF(12,24)
14:      COMMON/IO/NTR,NTW,ND(20)
15:      DATA NDAYS/31,28,31,30,31,30,31,31,30,31,30,31/
16: C
17:      DO 10 I=1,12
18:      DO 10 J=1,24
19: 10    PERF(I,J)=0.0
20:      DO 600 I=1,12
21:      II=NDAYS(I)
22:      DO 100 ID=1,II
23:      DO 90 J=1,24
24: C [VARIABLE FORMAT]
25:      READ(NF,IFMT,END=991)PERF(I,J)
26: 90    CONTINUE
27: 100   CONTINUE
28:      PERF(I,J)=PERF(I,J)/FLOAT(NDAYS(I))
29: 600   CONTINUE
30:      READ(NF,1001,END=700)I
31: C                                     NOTIFY EXCESS DATA POINTS
32:      WRITE(NTW,1002)
33: C [FILEMARK]
34: 700   ENDFILE NF
35: C [FILEMARK]
36:      CALL OPEN(NF,'SYSSIMULDAT',2)
37:      MODE=3
38:      WRITE(NF,1004)MODE
39:      DO 800 I=1,12
40:      DO 800 J=1,24
41: 800   WRITE(NF,1003)PERF(I,J)
42: C [FILEMARK]
43:      ENDFILE NF
44:      RETURN
45: C                                     ERROR IN FILE READ
46: 991   WRITE(NTW,1005)
47:      IF(I.EQ.1.AND.ID.EQ.1.AND.J.EQ.1)GO TO 992
48:      WRITE(NTW,1006)
49:      STOP
50: 992   WRITE(NTW,1007)
51:      STOP
52: 1001  FORMAT(A1)
53: 1002  FORMAT('O***WARNING: THERE ARE EXCESS DATA POINTS IN THE***'/
54:      *' *** PERFORMANCE DATA FILE. EXECUTION',10X,'***'/
55:      *' *** PROCEEDING NORMALLY.',23X,'***')
56: 1003  FORMAT(G13.6)
57: 1004  FORMAT(I3)
58: 1005  FORMAT('O***ERROR IN PERFORMANCE DATA FILE',14X,'***')
59: 1006  FORMAT(' ***PROBABLE CAUSE: INSUFFICIENT DATA POINTS. ***'/
60:      *' *** (8760 REQUIRED)',20X,'***')

```

61: 1007 FORMAT(' ***PROBABLE CAUSE: NON-EXISTENT DATA FILE ***')
62: END
63:

```

1:      BLOCKDATA DBLOCK
2: C [FILEACCESS]
3: C BLOCKDATA FOR DANDL
4:      INTEGER NTR,NTW,ND
5:      INTEGER MINMOD,MAXMOD
6:      COMMON/IO/NTR,NTW,ND(20)
7:      COMMON/DAT/MINMOD,MAXMOD
8: C NTR    -# FOR TERMINAL READ
9: C NTW    -# FOR TERMINAL WRITE
10: C ND(1) -# FOR PERFORMANCE DATA READ
11: C ND(2) -# FOR LOAD DATA READ
12: C ND(3) -# FOR OUTPUT DATA WRITE
13: C ND(4) -# FOR PRINTOUT WRITE
14: C MINMOD-MINIMUM LEGAL MODE # (DESCRIBES INPUT DATA FORMAT: CONSTANT
15: C      DATA, DIURNAL OR MONTHLY VARIATION, OR HOUR-BY-HOUR DATA)
16: C MAXMOD-MAXIMUM LEGAL MODE #
17: C [FILEMARK] TERMINAL IN/OUT CHANNEL #'S
18:      DATA NTR,NTW/1,1/
19:      DATA ND/6,7,8,9,16*1/
20:      DATA MINMOD,MAXMOD/1,3/
21:      END

```

```

1:      PROGRAM PMAIN
2: C [FILEACCESS]
3: C MAIN PROGRAM FOR PERFORMANCE ANALYSIS.
4:      COMMON/IO/NTR,NTW,ND(20)
5:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
6:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
7:      *SYSTTL(5,20),IPPRI,
8:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
9:      *TOT(10,10,5),CUMUL(10,5)
10: C
11:      NFR=ND(14)
12: C [FILEMARK]
13:      CALL OPEN(NFR,'LOADOUT1DAT',2)
14:      READ(NFR,1003)MODNUM,MODE
15:      N=ND(15)
16: C [FILEMARK]
17:      CALL OPEN(N,'PERFANALPRN',2)
18:      NFW=ND(1)
19: C [FILEMARK]
20:      CALL OPEN(NFW,'PERFTOTSDAT',2)
21:      WRITE(NFW,1003)MODNUM,MODE
22: C      PERFORMANCE ANALYSIS
23:      CALL DEFALT
24:      CALL PREAD
25: C      GET RAW DATA AND RUN
26:      WRITE(NTW,1004)
27: C      AGGREGATE HOURS/MONTH
28:      WRITE(NTW,1005)
29:      CALL PCALC
30:      CALL PASDAT(NFW)
31:      IF(IPPRI.EQ.1)CALL PPRINT
32:      IF(IPPRI.EQ.1.AND.ITERMP.EQ.0)WRITE(NTW,1002)
33:      WRITE(NTW,1001)
34:      STOP
35: 1001 FORMAT('OEND PERFORMANCE ANALYSIS SECTION.'/)
36: C [FILEMARK] (FILENAME)
37: 1002 FORMAT(' PRINTOUT IS IN FILE "PERFANAL.PRN"'/)
38: 1003 FORMAT(2I3)
39: 1004 FORMAT('ORUNNING...')
40: 1005 FORMAT(' AGGREGATE HOURS/MONTH RAW DATA INPUT COMPLETED')
41:      END

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1:      SUBROUTINE GOGET
2: C [NO FILEACCESS]
3: C GOGET TRANSFORMS RAW SIMULATION DATA, READ FROM FILE, INTO TIME-OF-
4: C USE AGGREGATED DATA, FOR ALL MONTHS, HOURS, AND INPUTS.
5: C FINISHED DATA IS IN TOT.
6: C
7: C TEMP  -MONTHLY TOTAL VALUES FOR INPUT FOR HOUR
8: C HOLD  -TEMP STORAGE FOR RECORD FROM FILE; IF TWO ELEMENTS, THE
9: C        PERFORMANCE VALUE IS ASSUMED TO BE LAST, WITH THE HOUR FIRST.
10: C
11:      REAL HOLD(3),TEMP1(24),TEMP2(24),TEMP3(24)
12:      REAL SHOLD(24)
13:      INTEGER MONTH,INPUT,I,J
14: C
15:      COMMON/IO/NTR,NTW,ND(20)
16:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
17:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
18:      *SYSTTL(5,20),IPPRI,
19:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
20:      *TOT(10,10,5),CUMUL(10,5)
21: C
22:      NDR=ND(14)
23: C          ZERO ARRAY
24:      DO 50 I=1,10
25:      DO 49 J=1,10
26:      DO 48 K=1,5
27:      TOT(I,J,K)=0.0
28: 48      CONTINUE
29: 49      CONTINUE
30: 50      CONTINUE
31: C          LOOP THROUGH EACH MONTH & INPUT
32:      DO 400 MONTH=1,12
33: C          GET CUMULATED HOURLY TOTALS FOR EACH HOUR
34: C          OF THE MONTH
35:      DO 200 I=1,24
36: C          GET ONE FILE RECORD
37:      READ(NDR,1001,END=991)(HOLD(J),J=1,NINPUT),SHOLD(I)
38: C          SAVE (ASSUMED IN KWH FROM DANDL)
39:      TEMP1(I)=HOLD(1)
40:      TEMP2(I)=HOLD(2)
41:      TEMP3(I)=HOLD(3)
42: 200      CONTINUE
43: C          ACCUMULATE BY PERIOD FOR EACH INPUT
44:      CALL SPLITS(MONTH,1,TEMP1,SHOLD)
45:      CALL SPLITS(MONTH,2,TEMP2,SHOLD)
46:      CALL SPLITS(MONTH,3,TEMP3,SHOLD)
47: 400      CONTINUE
48:      RETURN
49: C          ERROR IN FILE READ
50: 991      WRITE(NTW,1002)
51:      IF(MONTH.EQ.1.AND.I.EQ.1)GO TO 992
52:      WRITE(NTW,1006)
53:      STOP
54: 992      WRITE(NTW,1003)
55:      STOP
56: 1001      FORMAT(2X,6G13.6)
57: 1002      FORMAT(' ***ERROR IN PERFORMANCE FILE READ',7X,'***')
58: 1003      FORMAT(' ***PROBABLE CAUSE: NON-EXISTENT FILE ***')
59:      *' ***',9X,'FROM DANDL',18X,'***'
60: 1004      FORMAT(A1)

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61: 1006  FORMAT(' ***PROBABLE CAUSE: INSUFFICIENT DATA   ***' /
62:      *' ***',9X,'POINTS IN FILE',14X,'***' )
63:      END
64: C
65: C
66: C
67:      SUBROUTINE SPLITS(MONTH,INPUT,TEMP,SHOLD)
68: C [NO FILEACCESS]
69: C SPLITS AGGREGATES AN INPUT BY PERIOD(EG. PEAK, SHOULDER,...).
70: C INPUT MUST BE MONTHLY TOTALS FOR EACH OF 24 HOURS,
71: C IN ARRAY TEMP.
72: C
73: C MONTH -MONTH DATA IS FOR (1-12)
74: C INPUT -# OF INPUT BEING AGGREGATED
75: C TEMP -MONTHLY TOTAL VALUES FOR INPUT FOR HOUR
76: C
77:      REAL TEMP(24),FTEMP,SHOLD(24)
78:      INTEGER MONTH,INPUT,HOUR,PER
79: C
80:      COMMON/IO/NTR,NTW,NIX(20)
81:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
82:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
83:      *SYSTTL(5,20),IPPRI,
84:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
85:      *TOT(10,10,5),CUMUL(10,5)
86: C
87: C      LOOP ACCUMULATES HOUR-BY-HOUR
88:      DO 200 HOUR=1,24
89: C      LOOP ACCUMULATES BY PERIOD
90:      DO 100 PER=1,NPERS
91:      FTEMP=FACTOR(MONTH,HOUR,PER)
92: C      ACCUMULATE BY PERIOD FOR INPUT
93:      TTEMP=TEMP(HOUR)*FTEMP
94:      TOT(INPUT,PER,1)=TOT(INPUT,PER,1)+TTEMP
95: C      ACCUMULATE TOTAL FOR INPUT
96:      TOT(INPUT,NPERS1,1)=TOT(INPUT,NPERS1,1)+TTEMP
97: 100  CONTINUE
98: 200  CONTINUE
99:      RETURN
100:     END

```

```

1:      SUBROUTINE PCALC
2: C [NO FILEACCESS]
3: C PCALC DETERMINES PERFORMANCE VALUES FOR THE USER BOTH WITH & WITHOUT
4: C ALTERNATIVE ENERGY.
5: C
6:      INTEGER IB,IS,IP,I,J
7: C
8:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
9:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
10:     *SYSTTL(5,20),IPPRI,
11:     *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
12:     *TOT(10,10,5),CUMUL(10,5)
13: C
14: C                                ZERO PERIOD TOTAL FLOW
15:      DO 100 I=1,10
16:      DO 99 J=1,5
17:      CUMUL(I,J)=0.0
18: 99      CONTINUE
19: 100     CONTINUE
20: C                                LOOP CALCULATES TOTAL KWH FLOW; LESS THAN
21: C                                0 MEANS NET SELLBACK TO THE UTILITY
22:      DO 200 I=1,NPERS
23:      IB=IFLAG(1)
24:      IS=IFLAG(2)
25:      IP=IFLAG(3)
26:      CUMUL(I,1)=CUMUL(I,1)+TOT(IB,I,1)-TOT(IS,I,1)
27:      CUMUL(I,2)=CUMUL(I,2)+TOT(IB,I,1)-TOT(IS,I,1)+TOT(IP,I,1)
28:      CUMUL(NPERS1,1)=CUMUL(NPERS1,1)+TOT(IB,I,1)-TOT(IS,I,1)
29:      CUMUL(NPERS1,2)=CUMUL(NPERS1,2)+TOT(IB,I,1)-TOT(IS,I,1)
30:      *+TOT(IP,I,1)
31: 200     CONTINUE
32: C                                SET NON-ALT VALUES
33:      DO 300 I=1,NPERS1
34:      TOT(1,I,2)=CUMUL(I,2)
35:      TOT(2,I,2)=0.0
36:      TOT(3,I,2)=0.0
37: 300     CONTINUE
38:      RETURN
39:      END
40: C
41:      SUBROUTINE PASDAT(NFW)
42: C [NO FILEACCESS]
43: C PASDAT OUTPUTS DATA TO CHANNEL NFW FOR USE BY AVOIDC
44: C
45:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
46:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
47:      *SYSTTL(5,20),IPPRI,
48:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
49:      *TOT(10,10,5),CUMUL(10,5)
50: C
51: C                                WRITE DATA FILE FOR AVOIDC
52: C                                # PERIODS,INPUTS
53:      WRITE(NFW,1001)NPERS,NINPUT
54: C                                PERFORMANCE FOR EACH INPUT, PERIOD
55:      DO 400 I=1,NPERS1
56: 400     WRITE(NFW,1002)(TOT(J,I,1),J=1,NINPUT)
57: C                                PERIOD TITLES
58:      DO 500 I=1,NPERS
59: 500     WRITE(NFW,1003)(TITLE(I,J),J=1,2)
60:      RETURN

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61: 1001  FORMAT(2I3)
62: 1002  FORMAT(6G13.6)
63: 1003  FORMAT(2A4)
64:      END
65: C
66:      SUBROUTINE PPRINT
67: C [NO FILEACCESS]
68: C PPRINT OUTPUTS A PERFORMANCE ANALYSIS.
69: C
70: C NW      -OUTPUT UNIT
71: C IPREV  -INDICATES WHETHER NEW PERIOD IS BEING OUTPUT
72: C ITEMp  -TEMP STORAGE FOR PERIOD #
73: C YN     -CHARACTERS "YES" OR "NO" FOR PERIOD DEFINITION OUTPUT
74: C IYEAR  -YEAR OF EXECUTION
75: C IDAY   -DAY OF YEAR OF EXECUTION
76: C
77:      INTEGER NW,I,J,IPREV,ITEMp,IYEAR,IDAY
78:      REAL YN(2)
79: C
80:      COMMON/IO/NTR,NTW,ND(20)
81:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
82:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
83:      *SYSTTL(5,20),IPPRI,
84:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITEMp,
85:      *TOT(10,10,5),CUMUL(10,5)
86: C
87:      DATA YN/' NO ',' YES '/
88: C
89: C                      SELECT OUTPUT CHANNEL
90:      NW=NTW
91:      IF(ITEMp.EQ.0)NW=ND(15)
92: C                      BEGIN WRITE
93: C                      HEADER
94: 100  WRITE(NW,2004)
95:      WRITE(NW,2001)
96:      WRITE(NW,2002)
97:      WRITE(NW,1003)
98:      WRITE(NW,2002)
99:      WRITE(NW,2003)
100:     WRITE(NW,1004)UTLTTL
101:     WRITE(NW,2003)
102:     WRITE(NW,2002)
103:     WRITE(NW,2003)
104:     DO 200 I=1,5
105:     WRITE(NW,1004)(SYSTTL(I,J),J=1,20)
106: 200  CONTINUE
107:     WRITE(NW,2003)
108:     WRITE(NW,2002)
109:     WRITE(NW,2002)
110:     WRITE(NW,1005)
111:     WRITE(NW,2002)
112:     WRITE(NW,1006)
113:     IPREV=0
114:     DO 300 I=1,NPDAT
115:     ITEMp=IWH(I,4)
116:     I1=IWH(I,1)+1
117:     I2=IWH(I,2)+1
118:     I3=IWH(I,3)+1
119:     IF(IPREV.EQ.ITEMp)GO TO 250
120:     WRITE(NW,1007)ITEMp,(TITLE(ITEMp,J),J=1,2),(MSE(I,J),J=1,2),

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121:      *(IHSE(I,J),J=1,2),YN(I1),YN(I2),YN(I3)
122:      GO TO 290
123: 250   WRITE(NW,1008)(MSE(I,J),J=1,2),(IHSE(I,J),J=1,2),YN(I1),YN(I2),
124:      *YN(I3)
125: 290   IPREV=ITEMP
126: 300   CONTINUE
127:      WRITE(NW,2002)
128:      WRITE(NW,2002)
129:      WRITE(NW,1009)
130:      WRITE(NW,2002)
131:      WRITE(NW,1010)
132:      WRITE(NW,2002)
133:      DO 400 I=1,NPERS
134:      WRITE(NW,1011)(TITLE(I,J),J=1,2),(TOT(J,I,1),J=1,NINPUT),
135:      *CUMUL(I,1)
136:      WRITE(NW,1012)(TOT(J,I,2),J=1,NINPUT),CUMUL(I,2)
137:      WRITE(NW,2002)
138: 400   CONTINUE
139:      WRITE(NW,1013)
140:      WRITE(NW,1014)(TOT(J,NPERS1,1),J=1,NINPUT),CUMUL(NPERS1,1)
141:      WRITE(NW,1015)(TOT(J,NPERS1,2),J=1,NINPUT),CUMUL(NPERS1,2)
142:      WRITE(NW,2002)
143:      WRITE(NW,2002)
144:      WRITE(NW,2001)
145:      RETURN
146: 1003   FORMAT(1X,'*',31X,24(' '),15X,16X,'*'/
147:      *1X,'*',31X,'* PERFORMANCE ANALYSIS ',31X,'*'/
148:      *1X,'*',31X,24(' '),31X,'*')
149: 1004   FORMAT(1X,'*',1X,'*',20A4,'*',1X,'*')
150: 1005   FORMAT(1X,'*',34X,'PERIOD DEFINITION',35X,'*')
151: 1006   FORMAT(1X,'*',26X,'MONTHS      HOURS      ',
152:      *'WEEKDAYS WEEKENDS HOLIDAYS ',09X,'*')
153: 1007   FORMAT(1X,'*',06X,'PERIOD',I2,1X,2A4,1X,
154:      *2(I3,' - ',I3,1X),3(3X,A4,3X),12X,'*')
155: 1008   FORMAT(1X,'*',24X,
156:      *2(I3,' - ',I3,1X),3(3X,A4,3X),12X,'*')
157: 1009   FORMAT(1X,'*',33X,'ELECTRIC USE SUMMARY',33X,'*')
158: 1010   FORMAT(1X,'*',38X,'BOUGHT',6X,'SOLD',8X,'PRODUCED',4X,'NET',
159:      *09X,'*')
160: 1011   FORMAT(1X,'*',2X,2A4,1X,'W/ ALT. EN. SYSTEM',2X,
161:      *4F12.1,06X,'*')
162: 1012   FORMAT(1X,'*',11X,'W/O ALT. EN. SYSTEM',2X,4F12.1,06X,'*')
163: 1013   FORMAT(1X,'*',32X,' ',11(' - '),
164:      *' ',11(' - '),' ',11(' - '),11(' - '),06X,'*')
165: 1014   FORMAT(1X,'*',05X,'TOTAL',1X,'W/ ALT. EN. SYSTEM',2X,
166:      *4F12.1,06X,'*')
167: 1015   FORMAT(1X,'*',05X,'TOTAL',1X,'W/O ALT. EN. SYSTEM',2X,
168:      *4F12.1,06X,'*')
169: 2001   FORMAT(1X,88(' '))
170: 2002   FORMAT(1X,'*',86X,'*')
171: 2003   FORMAT(1X,'*',1X,84(' '),1X,'*')
172: 2004   FORMAT('1')
173:      END

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1:      SUBROUTINE PREAD
2: C [FILEACCESS]
3: C PREAD READS THE CONTROL DATA FOR INPUTTING PERFORMANCE DATA.
4: C
5: C ICHAR2-CHARACTER ARRAY FOR BRANCHPOINT DIALOGUE
6: C NFR      -# FOR FILE READ
7: C NFW      -# FOR FILE WRITE
8: C YN       -ARRAY FOR "NO" AND "YES" IN WRITES
9: C
10:      INTEGER ICHAR2(10),NFR,IDUM(20),
11:      *I,J,K,K1,I1,I2,I3,IPREV,ITEMP,KK1
12:      REAL YN(2)
13: C
14:      COMMON/IO/NTR,NTW,ND(20)
15:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
16:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
17:      *SYSTTL(5,20),IPPRI,
18:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
19:      *TOT(10,10,5),CUMUL(10,5)
20: C
21:      DATA ICHAR2/' ','?','V','L','C','D','O','I','E','R'/,
22:      *YN/' NO ','YES '/
23: C
24: C                                MAIN BRANCHPOINT
25: 5      WRITE(NTW,1011)
26:      K=IPARSE( ICHAR2,10)
27:      GO TO(950,950,700,200,400,100,850,800,999,600),K
28: C
29: C*****
30: C                                SET DEFAULTS
31: 100     CALL DEFALT
32:      GO TO 5
33: C
34: C*****
35: C                                LIST SECTION
36: C
37: 200     WRITE(NTW,1013)
38:      READ(NTR,1058)K1
39:      IF(K1.LT.0.OR.K1.GT.5)GO TO 5
40:      KK1=1
41:      IF(K1.EQ.0)GO TO 220
42:      KK1=K1
43:      GO TO(220,240,250,280,290),K1
44: C
45: C                                # HOLIDAYS/MONTH
46: 220     WRITE(NTW,1014)KK1
47:      WRITE(NTW,1019)
48:      DO 225 I=1,12
49:      WRITE(NTW,1020)I,NHS(I)
50: 225     CONTINUE
51:      IF(K1.NE.0)GO TO 5
52:      KK1=KK1+1
53: C
54: C                                UTILITY TITLE
55: 240     WRITE(NTW,1014)KK1
56:      WRITE(NTW,1022)UTLTTL
57:      IF(K1.NE.0)GO TO 5
58:      KK1=KK1+1
59: C
60: C                                SYSTEM TITLE
61: 250     WRITE(NTW,1014)KK1
62:      WRITE(NTW,1023)((SYSTTL(I,J),J=1,20),I=1,5)
63:      IF(K1.NE.0)GO TO 5

```

```

61:      KK1=KK1+1
62: C
63: 280  WRITE(NTW,1014)KK1
64:      WRITE(NTW,1049)YN(IPPRI+1)
65:      IF(IPPRI.EQ.0)GO TO 285
66:      WRITE(NTW,1059)YN(ITERMP+1)
67: 285  IF(K1.NE.0)GO TO 5
68:      KK1=KK1+1
69: C
70: 290  WRITE(NTW,1014)KK1
71:      WRITE(NTW,1029)
72:      WRITE(NTW,1032)NPERS
73:      WRITE(NTW,1033)
74:      WRITE(NTW,1034)
75:      WRITE(NTW,1033)
76:      WRITE(NTW,1035)
77:      IPREV=0
78:      DO 298 I=1,NPDAT
79:      ITEM=IWH(I,4)
80:      I1=IWH(I,1)+1
81:      I2=IWH(I,2)+1
82:      I3=IWH(I,3)+1
83:      IF(IPREV.EQ.ITEM)GO TO 295
84:      WRITE(NTW,1036)ITEM,(TITLE(ITEM,J),J=1,2),(MSE(I,J),J=1,2),
85:      *(IHSE(I,J),J=1,2),YN(I1),YN(I2),YN(I3)
86:      GO TO 296
87: 295  WRITE(NTW,1037)(MSE(I,J),J=1,2),(IHSE(I,J),J=1,2),
88:      *YN(I1),YN(I2),YN(I3)
89: 296  IPREV=ITEM
90: 298  CONTINUE
91:      IF(K1.NE.0)GO TO 5
92:      KK1=KK1+1
93:      GO TO 5
94: C
95: C*****
96: C
97: 400  WRITE(NTW,1038)
98:      READ(NTR,1058)K1
99:      IF(K1.LT.0.OR.K1.GT.5)GO TO 5
100:     IF(K1.EQ.0)GO TO 420
101:     GO TO(420,440,450,480,490),K1
102: C
103: 420  WRITE(NTW,1040)
104:     DO 425 I=1,12
105:     WRITE(NTW,1041)I
106:     READ(NTW,1058)NHS(I)
107: 425  CONTINUE
108:     IF(K1.NE.0)GO TO 5
109: C
110: 440  WRITE(NTW,1043)
111:     READ(NTR,1003)UTLTTL
112:     IF(K1.NE.0)GO TO 5
113: C
114: 450  WRITE(NTW,1044)
115:     DO 455 I=1,5
116:     READ(NTR,1003)(SYSTTL(I,J),J=1,20)
117: 455  CONTINUE
118:     IF(K1.NE.0)GO TO 5
119: C
120: 480  WRITE(NTW,1050)

```

PRINT OPTION

PERIOD DEFINITION

CHANGE

OF HOLIDAYS

UTILITY TITLE

SYSTEM TITLE

PRINT OPTION

```

121:      IPPRI=NOYES(1)
122:      IF(IPPRI.EQ.0)GO TO 485
123:      WRITE(NTW,1061)
124:      ITERMP=NOYES(1)
125: 485   IF(K1.NE.0)GO TO 5
126: C                                           PERIOD DEFINITION
127: 490   WRITE(NTW,1029)
128: C                                           # PERIODS
129:      WRITE(NTW,1052)
130:      READ(NTR,1058)NPERS
131:      NPERS1=NPERS+1
132: C                                           PERIOD TITLES
133:      DO 492 I=1,NPERS
134:      WRITE(NTW,1055)I
135:      READ(NTR,1003)(TITLE(I,J),J=1,2)
136: 492   CONTINUE
137: C                                           DEFINE PERIODS
138:      CALL MHREAD
139:      GO TO 5
140: C
141: C*****
142: C                                           GET RAW DATA AND RUN
143: 600   NR=ND(14)
144: C                                           READ HEADER OFF
145: C      READ(NR,1005,END=991)IDUM
146:      WRITE(NTW,1016)
147: C                                           AGGREGATE HOURS/MONTH
148:      CALL GOGET
149:      WRITE(NTW,1053)
150:      RETURN
151: C
152: C*****
153: C                                           LIST VARIABLE NUMBERS
154: 700   WRITE(NTW,1068)
155:      GO TO 5
156: C
157: C*****
158: C                                           INPUT PREVIOUSLY SAVED SETUP
159: C                                           FROM DISK
160: 800   WRITE(NTW,1065)
161:      NFR=ND(10)
162: C [FILEMARK]
163:      CALL FOPEN(NFR,IDUM,1,0,IRET2,-1,DUM1,DUM2)
164:      IF(IRET2.EQ.0)GO TO 5
165:      READ(NFR,1006,END=993)NHS,CNV,IPPRI,ITERMP,NPERS,NPDAT
166:      READ(NFR,1003)UTLTTL
167:      DO 810 I=1,5
168: 810   READ(NFR,1003,END=994)(SYSTTL(I,J),J=1,20)
169:      DO 812 I=1,NPERS
170: 812   READ(NFR,1003,END=994)(TITLE(I,J),J=1,2)
171:      DO 815 I=1,NPDAT
172:      READ(NFR,1058,END=994)(MSE(I,J),J=1,2)
173:      READ(NFR,1058,END=994)(IHSE(I,J),J=1,2)
174:      READ(NFR,1058,END=994)(IWH(I,J),J=1,4)
175: 815   CONTINUE
176: C [FILEMARK]
177:      ENDFILE NFR
178:      GO TO 5
179: C
180: C*****

```

```

181: C                                SAVE CURRENT SETUP TO DISK
182: 850    WRITE(NTW,1066)
183:        NFW=ND(10)
184: C [FILEMARK]
185:        CALL FOPEN(NFW,IDUM,0,0,IRET2,-1,DUM1,DUM2)
186:        IF(IRET2.EQ.0)GO TO 5
187: C                                GET HEADER
188:        WRITE(NTW,1069)
189:        READ(NTR,1005)IDUM
190:        WRITE(NFW,1005)IDUM
191:        WRITE(NFW,1006)NHS,CNV,IPPRI,ITERMP,NPERS,NPDAT
192:        WRITE(NFW,1003)UTLTTL
193:        DO 860 I=1,5
194: 860    WRITE(NFW,1003)(SYSTTL(I,J),J=1,20)
195:        DO 862 I=1,NPERS
196: 862    WRITE(NFW,1003)(TITLE(I,J),J=1,2)
197:        DO 865 I=1,NPDAT
198:        WRITE(NFW,1058)(MSE(I,J),J=1,2)
199:        WRITE(NFW,1058)(IHSE(I,J),J=1,2)
200:        WRITE(NFW,1058)(IWH(I,J),J=1,4)
201: 865    CONTINUE
202: C [FILEMARK]
203:        ENDFILE NFW
204:        GO TO 5
205: C
206: C*****
207: C                                HELP SECTION
208: 950    WRITE(NTW,1067)
209:        GO TO 5
210: C                                PREMATURE END OF FILE FOUND
211: 991    WRITE(NTW,1001)
212:        STOP
213: 993    WRITE(NTW,1008)
214:        WRITE(NTW,1009)
215: C [FILEMARK]
216:        ENDFILE NFR
217:        GO TO 5
218: 994    WRITE(NTW,1008)
219:        WRITE(NTW,1010)
220: C [FILEMARK]
221:        ENDFILE NFR
222:        GO TO 5
223: 999    WRITE(NTW,1002)
224:        STOP
225: C*****
226: 1001    FORMAT('O***ERROR IN PERFORMANCE DATA FILE READ ***'/
227:        *      ' ***PROBABLE CAUSE: NON-EXISTENT DEFAULT ***'/
228:        *      ' ***      PERFORMANCE DATA FILE      ***')
229: 1002    FORMAT('O PERFORMANCE ANALYSIS SECTION ABORTED'/)
230: 1003    FORMAT(20A4)
231: 1005    FORMAT(20A2)
232: 1006    FORMAT(12I2,G13.6,4I2)
233: 1008    FORMAT('O***ERROR IN INPUT FILE READ',15X,'***')
234: 1009    FORMAT(' ***PROBABLE CAUSE: NON-EXISTENT INPUT FILE***')
235: 1010    FORMAT(' ***PROBABLE CAUSE: INCOMPLETE INPUT FILE ***')
236: 1011    FORMAT(' MAIN BRANCHPOINT')
237: 1013    FORMAT(' SECTION # TO LIST (0 FOR ALL): ')
238: 1014    FORMAT('/' SECTION # ',I2)
239: 1016    FORMAT('ORUNNING...')
240: 1019    FORMAT(' MONTH #-HOLIDAYS')

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241: 1020  FORMAT(2X,I2,7X,I2)
242: 1022  FORMAT(' UTILITY DESCRIPTION: '// ',20A4)
243: 1023  FORMAT(' SYSTEM DESCRIPTION: '/5( '// ',20A4))
244: 1024  FORMAT(' # OF VARIABLES/RECORD = ',I1)
245: 1029  FORMAT(' PERIOD DEFINITION SECTION')
246: 1032  FORMAT(' # OF PERIODS = ',I2)
247: 1033  FORMAT(1X)
248: 1034  FORMAT(31X,'PERIOD DEFINITION')
249: 1035  FORMAT(23X,'MONTHS      HOURS      ',
250:      *'WEEKDAYS WEEKENDS HOLIDAYS')
251: 1036  FORMAT( 3X,'PERIOD',I2,1X,2A4,1X,2(I3,' - ',I3,1X),
252:      *3(3X,A4,3X))
253: 1037  FORMAT(21X,2(I3,' - ',I3,1X),3(3X,A4,3X))
254: 1038  FORMAT(' SECTION # TO CHANGE: ')
255: 1040  FORMAT(' FOR MONTH #, ENTER # OF HOLIDAYS')
256: 1041  FORMAT(' MONTH ',I2,'; ')
257: 1043  FORMAT(' UTILITY TITLE (80 CHARS MAX): '//)
258: 1044  FORMAT(' SYSTEM TITLE (80 CHARS MAX, 5 LINES REQUIRED): '//)
259: 1045  FORMAT(' # VARIABLES/RECORD: ')
260: 1049  FORMAT(' PERFORMANCE ANALYSIS PRINT - ',A4)
261: 1050  FORMAT(' WOULD YOU LIKE THE PERFORMANCE ANALYSIS PRINTED'/
262:      *' TO EITHER THE TERMINAL OR FILE?')
263: 1052  FORMAT(' # PERIODS: ')
264: 1053  FORMAT(' AGGREGATE HOURS/MONTH RAW DATA INPUT COMPLETED')
265: 1054  FORMAT(' ALTERNATE SEQUENTIAL HOURS/YEAR RAW DATA INPUT ',
266:      *'COMPLETED')
267: 1055  FORMAT(' TITLE FOR PERIOD # ',I2,';')
268: 1058  FORMAT(4I5)
269: 1059  FORMAT(' PRINTOUT TO TERMINAL (IF NO THEN TO FILE)- ',A4)
270: 1060  FORMAT(' PRINTOUT CHANNEL # ',I3)
271: 1061  FORMAT(' PRINT OUTPUT TO TERMINAL?',
272:      *' (ANSWER NO FOR PRINT TO FILE): ')
273: 1065  FORMAT(' ENTER INPUT FILE INFORMATION-')
274: 1066  FORMAT(' ENTER OUTPUT FILE INFORMATION-')
275: 1067  FORMAT(' OTHIS IS THE PERFORMANCE ANALYSIS SECTION-//
276:      *5X,'DATA MAY BE DEFAULTED, READ FROM FILE, OR SPECIFIED BY THE ',
277:      *'USER.'//5X,'AVAILABLE COMMANDS ARE: '//
278:      *10X,'(DEFAULT)-SET DATA TO DEFAULT VALUES.'//
279:      *10X,'L(IST) -LIST EXISTING VALUE OR VALUES.'//
280:      *10X,'C(HANGE) -CHANGE EXISTING VALUE OR VALUES.'//
281:      *10X,'R(UN) -GET RAW DATA & EXECUTE PERFORMANCE ANALYSIS.'//
282:      *10X,'E(ND) -TERMINATE THIS SECTION WITHUOT PERFORMING A NEW'//
283:      *21X,'PERFORMANCE ANALYSIS OR GETTING MORE RAW DATA.'//
284:      *10X,'V(ARS) -LIST #'S OF VARIABLES FOR LIST OR CHANGE',
285:      *1X,'PURPOSES.'//
286:      *10X,'I(NPUT) -READ A PREVIOUSLY WRITTEN DATA SETUP FROM FILE'//
287:      *10X,'O(UTPUT) -WRITE THE CURRENT DATA SETUP TO FILE'//)
288: 1068  FORMAT(' VARIABLES: '//
289:      *5X,'1-# HOLIDAYS/MONTH'//
290:      *5X,'2-UTILITY TITLE'//
291:      *5X,'3-SYSTEM TITLE'//
292:      *5X,'4-PRINT PARAMETERS'//
293:      *5X,'5-PERIOD DEFINITION')
294: 1069  FORMAT(' ENTER HEADER LINE: ')
295:      END

```

```

1:      REAL FUNCTION FACTOR(MONTH,HOUR,PER)
2: C [NO FILEACCESS]
3: C FACTOR RETURNS THE FRACTION OF THE (MONTH,HOUR) THAT FALLS IN PER.
4: C
5: C RATHOL-RATIO OF HOLIDAYS/TOTAL DAYS PER MONTH
6: C TEMP -TEMPORARY STORAGE FOR OVERALL PERIOD FACTOR
7: C PERMUL-MULTIPLIER TOACCOUNT FOR WEEKENDS & WEEKDAYS
8: C HOLMUL-MULTIPLIER TO ACCOUNT FOR HOLIDAY INCLUSION
9: C
10:      INTEGER I,K,HOUR,PER
11:      REAL PERMUL,HOLMUL,RATHOL,TEMP
12: C
13:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
14:      *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
15:      *SYSTTL(5,20),IPPRI,
16:      *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
17:      *TOT(10,10,5),CUMUL(10,5)
18: C
19: C              ZERO VALUE
20:      FACTOR=0.0
21: C              DO FOR ALL PERIOD DEFINITIONS
22:      DO 500 K=1,NPDAT
23: C              MAKE SURE THAT THIS PERIOD,
24: C              MONTH, HOUR IS REFERRED TO
25: C              BY THIS PERIOD UNIT-
26: C              ELSE SKIP
27:      IF(IWH(K,4),NE,PER,OR.
28:      *      MONTH.GT.MSE(K,2).OR.MONTH.LT.MSE(K,1).OR.
29:      *      HOUR.GT.IHSE(K,2).OR.HOUR.LT.IHSE(K,1))GO TO 500
30: C              CALCULATE FRACTION OF NON-
31: C              HOLIDAYS SPECIFIED
32:      PERMUL=(5.0/7.0)*FLOAT(IWH(K,1))+(2.0/7.0)*FLOAT(IWH(K,2))
33: C              FRACTION OF HOLIDAYS
34:      HOLMUL=FLOAT(IWH(K,3))
35: C              FRACTION OF DAYS THAT ARE HOLIDAY
36:      RATHOL=FLOAT(NHS(MONTH))/FLOAT(NDAYS(MONTH))
37: C              CALCULATE FRACTION OF MONTH,HOUR IN PERIOD
38:      TEMP=PERMUL*(1.0-RATHOL)+HOLMUL*RATHOL
39:      FACTOR=TEMP+FACTOR
40: 500      CONTINUE
41:      RETURN
42:      END

```

```

1:      BLOCKDATA FBLOCK
2: C [FILEACCESS]
3: C
4:      COMMON/IO/NTR,NTW,ND(20)
5: C NTR=# FOR TERMINAL READ (CONTROL DATA)
6: C NTW=# FOR TERMINAL WRITE
7: C NDR=# FOR DISK READ (RAW SIMULATION DATA)
8: C NDW=# FOR DISK WRITE
9: C
10:     COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
11:     *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
12:     *SYSTTL(5,20),IPPRI,
13:     *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
14:     *TOT(10,10,5),CUMUL(10,5)
15: C NINPUT=# OF INPUTS
16: C NPERS  -# OF PERIODS
17: C NPERS1 -# OF PERIODS + 1 (TOTAL POINTER)
18: C IFLAG -POINTER FOR SEQUENCE OF INPUTS ON DISK
19: C NHS   -# OF HOLIDAYS/MONTH
20: C NDAYS -# OF DAYS/MONTH
21: C TITLE -PERIOD TITLES
22: C UTLTTL-UTILITY DESCRIPTION
23: C SYSTTL-SYSTEM DESCRIPTION
24: C IPPRI -FLAG FOR PERFORMANCE LISTING: 1 - YES, LIST; 0 - NO, DON'T
25: C      LIST
26: C TOT-   FOR (INPUT,PERIOD), THE TOTAL OF THE SIMULATION DATA READ FROM
27: C      FILE
28: C
29:     DATA NDAYS/31,28,31,30,31,30,31,31,30,31,30,31/
30: C [FILEMARK] TERMINAL IN/OUT CHANNEL #'S
31:     DATA NTR,NTW/1,1/
32:     DATA ND/8,1,1,1,1,1,1,1,8,1,1,6,7,6,1,1,1,4/
33:     DATA NINPUT/3/
34:     DATA IFLAG/1,2,3,7*1/
35:     END

```



```

1: SUBROUTINE DEFALT
2: C [NO FILEACCESS]
3: C DEFALT SETS DEFAULT VALUES FOR PMAIN. THESE ARE THE VALUES SET
4: C AT THE BEGINNING OF EACH RUN.
5: C
6: INTEGER IHTMP(12),I,J,K,LMSE(10,2),LIHSE(10,2),LIWH(10,4)
7: REAL CHAR(8),BUF1(20),BUF2(20),BLANK4
8: C
9: COMMON/IO/NTR,NTW,ND(20)
10: COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
11: *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
12: *SYSTTL(5,20),IPPRI,
13: *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
14: *TOT(10,10,5),CUMUL(10,5)
15: C
16: DATA IHTMP/1,0,0,0,1,0,1,0,1,0,1,1/,
17: *CHAR/'PEAK',' ','OFFP','EAK ',' ',' ',' ',' ',' ',' ',
18: *BLANK4/' ',' ',' ',' ',' ',' ',' ',' ',' ',' ',
19: *BUF1/'UTIL','ITY ','TITL','E GO','ES H','ERE ',14* ' ',
20: *BUF2/'TECH','NOLO','GY G','OES ','HERE',15* ' ',
21: *LMSE/1,1,1,1,0,0,0,3*0,12,12,12,12,0,0,0,3*0/,
22: *LIHSE/9,1,23,1,0,0,0,3*0,22,8,24,24,0,0,0,3*0/,
23: *LIWH/3*1,7*0,3*0,1*1,6*0,3*0,1*1,6*0,1,2,2,2,0,0,0,3*0/
24: C
25: NINPUT=3
26: NPERS=2
27: NPERS1=NPERS+1
28: IFLAG(1)=1
29: IFLAG(2)=2
30: IFLAG(3)=3
31: DO 100 I=1,12
32: NHS(I)=IHTMP(I)
33: 100 CONTINUE
34: DO 200 I=1,NPERS
35: IX=(I-1)*2+1
36: IY=I*2
37: TITLE(I,1)=CHAR(IX)
38: TITLE(I,2)=CHAR(IY)
39: 200 CONTINUE
40: DO 300 I=1,20
41: UTLTTL(I)=BUF1(I)
42: 300 CONTINUE
43: DO 400 I=1,20
44: SYSTTL(I,I)=BUF2(I)
45: 400 CONTINUE
46: DO 500 I=2,5
47: DO 450 J=1,20
48: SYSTTL(I,J)=BLANK4
49: 450 CONTINUE
50: 500 CONTINUE
51: NPDAT=4
52: DO 650 I=1,10
53: DO 640 J=1,2
54: MSE(I,J)=LMSE(I,J)
55: IHSE(I,J)=LIHSE(I,J)
56: 640 CONTINUE
57: DO 645 J=1,4
58: IWH(I,J)=LIWH(I,J)
59: 645 CONTINUE
60: 650 CONTINUE

```

```

61:      DO 800 I=1,20
62: 800   CONTINUE
63:      IPPRI=1
64:      ITERMP=0
65:      RETURN
66:      END
67: C
68: C
69: C
70:      SUBROUTINE MHREAD
71: C [NO FILEACCESS]
72: C MHREAD INPUTS A NEW PERIOD CONFIGURATION.
73: C EXECUTION ENTAILS DETERMINING THE MONTHS, DAYS,
74: C AND HOURS WHICH CONSTITUTE ALL PERIODS, AND STORING THE DATA IN
75: C FACTOR, INDICATING WHAT FRACTION OF EACH MONTHLY TOTAL HOUR BELONGS
76: C IN THAT PERIOD.
77: C
78: C MSE(NPDAT,1) -FIRST SEQUENTIAL MONTH IN PERIOD
79: C MSE(NPDAT,2) -LAST SEQUENTIAL MONTH IN PERIOD
80: C IHSE(NPDAT,1)-FIRST SEQUENTIAL HOUR IN PERIOD
81: C IHSE(NPDAT,2)-LAST SEQUENTIAL HOUR IN PERIOD
82: C ICHAR -CHAR ARRAY USED FOR HELP DIALOGUE
83: C
84: C NOTE: ALL INFO ENTERED APPLIES TO ALL MONTHS & HOURS SPECIFIED. TO
85: C       VARY WITHIN ONE PERIOD, MHREAD SHOULD BE CALLED MORE THAN ONCE.
86: C
87:      INTEGER ICHAR(4),I,J,K
88: C
89:      COMMON/IO/NTR,NTW,ND(20)
90:      COMMON/DAT/NINPUT,NPERS,NPERS1,IFLAG(10),
91: *NHS(12),NDAYS(12),TITLE(10,2),UTLTTL(20),
92: *SYSTTL(5,20),IPPRI,
93: *NPDAT,MSE(10,2),IHSE(10,2),IWH(10,4),ITERMP,
94: *TOT(10,10,5),CUMUL(10,5)
95: C
96:      DATA ICHAR/' ','E','C','R'/
97: C
98:      NPDAT=0
99: C                                     TOP OFF LOOP FOR ONE DEFINITION
100: 100   WRITE(NTW,1009)
101:      IF(NYES(1),EQ.0)GO TO 500
102:      NPDAT=NPDAT+1
103:      WRITE(NTW,1010)
104:      READ(NTR,1012)IWH(NPDAT,4)
105: C                                     GET MONTH #'S
106: 150   WRITE(NTW,1001)
107:      READ(NTR,1012)MSE(NPDAT,1)
108:      WRITE(NTW,1002)
109:      READ(NTR,1012)MSE(NPDAT,2)
110:      IF(MSE(NPDAT,1).LT.1.OR.MSE(NPDAT,1).GT.MSE(NPDAT,2).OR.
111: *MSE(NPDAT,2).GT.12)GO TO 950
112: C                                     GET HOUR #'S
113: 200   WRITE(NTW,1003)
114:      READ(NTR,1012)IHSE(NPDAT,1)
115:      WRITE(NTW,1013)
116:      READ(NTR,1012)IHSE(NPDAT,2)
117:      IF(IHSE(NPDAT,1).LT.1.OR.IHSE(NPDAT,1).GT.IHSE(NPDAT,2).OR.
118: *IHSE(NPDAT,2).GT.24)GO TO 960
119: C                                     FACTOR FOR WEEKDAYS
120:      WRITE(NTW,1004)

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121:      IWH(NPDAT,1)=NOYES(1)
122: C      FACTOR FOR WEEKENDS
123:      WRITE(NTW,1005)
124:      IWH(NPDAT,2)=NOYES(1)
125: C      HOLIDAYS INCLUDED?
126:      WRITE(NTW,1006)
127:      IWH(NPDAT,3)=NOYES(1)
128: C      GET NEXT DEFINITION
129:      GO TO 100
130: 500    RETURN
131: C      ERROR HANDLER
132: C      MONTH INPUT HELP
133: 950    WRITE(NTW,1007)
134:      K=IPARSE(ICHAR,4)
135:      GO TO(950,990,150,100),K
136: C      HOUR INPUT HELP
137: 960    WRITE(NTW,1008)
138:      K=IPARSE(ICHAR,4)
139:      GO TO(960,990,200,100),K
140: C      NO CHANGES
141: 990    RETURN
142: 1001   FORMAT(' FIRST MONTH: ')
143: 1002   FORMAT(' LAST MONTH: ')
144: 1003   FORMAT(' FIRST HOUR: ')
145: 1004   FORMAT(' ARE WEEKDAYS INCLUDED? ')
146: 1005   FORMAT(' ARE WEEKENDS INCLUDED? ')
147: 1006   FORMAT(' ARE HOLIDAYS INCLUDED? ')
148: 1007   FORMAT(' *MONTH READ HELP*/
149:      *' YOU MUST ENTER TWO MONTHS BETWEEN 1 AND 12, WITH THE SECOND'
150:      *' LATER IN THE YEAR THAN THE FIRST. WOULD YOU LIKE TO END, '//
151:      *' CHANGE THE MONTH DEFINITION, OR REDO THIS PERIOD FROM THE'
152:      *' START (NOT THE WHOLE SECTION, JUST THE PERIOD YOU'RE DOING)?')
153: 1008   FORMAT(' *HOUR READ HELP*/
154:      *' YOU MUST ENTER TWO HOURS BETWEEN 1 AND 24, WITH THE SECOND'
155:      *' LATER IN THE DAY THAN THE FIRST. WOULD YOU LIKE TO END, '//
156:      *' CHANGE THE HOUR DEFINITION, OR REDO THIS PERIOD FROM THE'
157:      *' START (NOT THE WHOLE SECTION, JUST THE PERIOD YOU'RE DOING)?')
158: 1009   FORMAT(' MORE ENTRIES? ')
159: 1010   FORMAT(' PERIOD #: ')
160: 1012   FORMAT(I10)
161: 1013   FORMAT(' LAST HOUR: ')
162:      END

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1:      BLOCKDATA ABLOCK
2: C [FILEACCESS]
3: C THIS IS THE BLOCKDATA FOR AVOIDC
4:      COMMON/IO/NTR,NTW,ND(20)
5: C NTR- # FOR TERMINAL READ
6: C NTW- # FOR TERMINAL WRITE
7: C ND(1)-# FOR FILE READ
8: C ND(2)-# FOR FILE WRITE
9: C [FILEMARK] TERMINAL IN/OUT CHANNEL #'S
10:      DATA NTR,NTW/1,1/
11:      DATA ND/6,7,18*1/
12:      END
```

```

1:      PROGRAM AVOIDC
2: C [FILEACCESS]
3: C AVOIDC DETERMINES AVOIDED COSTS, BASED ON KWH PRODUCTION FIGURES
4: C BY PERIOD SUPPLIED FROM THE PERFORMANCE ANALYSIS SECTION VIA
5: C THE FILE 'PERFTOTS.DAT'. OUTPUT IS TO TERMINAL AND MAY BE TO
6: C FILE AS WELL (USER'S CHOICE).
7: C
8: C INPUT -THE # OF THE PRODUCTION VALUE USED (2=SOLD, 3=PRODUCED)
9: C NPERS -# OF PERIODS TO BE PASSED FROM PMAIN
10: C NPERS1-# OF PERIODS PLUS 1
11: C NINPUT-# OF INPUTS TO BE PASSED FROM PMAIN
12: C TOT -FOR EACH INPUT, TOTAL PERFORMANCE BY PERIOD (INPUT,PERIOD)
13: C COSTS -MARGINAL COSTS BY PERIOD
14: C CPKWH -COST PER KILOWATT-HOUR
15: C TCOST -TOTAL COST BY PERIOD
16: C TITLE -8 CHARACTER PERIOD TITLES
17: C I,J,K -DO LOOP INDICES
18: C NTR -# FOR TERMINAL READS
19: C NTW -# FOR TERMINAL WRITES
20: C NFR -# FOR FILE READS (DATA FROM PMAIN IN "PERFTOTS.DAT")
21: C NFW -CHANNEL # FOR FILE WRITES (IF OUTPUT DESIRED, IN "AVOIDEDC.PRN")
22: C ND -DUMMY ARRAY TO FILL COMMON REQUIRED BY SUBROUTINE NOYES
23: C
24:      REAL COSTS(10),CPKWH,TCOST(10),TOT(5,10),TITLE(10,2)
25:      INTEGER NPERS,NPERS1,I,J,K,INPUT,NTR,NTW,NFR,NFW,NINPUT,ND
26:      COMMON/IO/NTR,NTW,ND(20)
27:      NFR=ND(1)
28:      NFW=ND(2)
29: C
30: C                                     GET PERFORMANCE AND PERIOD DATA
31: C                                     PASSED FROM PMAIN
32: C [FILEMARK]
33:      CALL OPEN(NFR,'PERFTOTSDAT',2)
34:      READ(NFR,1009,END=997)MODE,MODNUM
35:      READ(NFR,1009,END=997)NPERS,NINPUT
36:      NPERS1=NPERS+1
37: C                                     GET PERFORMANCE BY INPUT AND PERIOD
38:      DO 10 J=1,NPERS1
39:      READ(NFR,1008,END=998)(TOT(I,J),I=1,NINPUT)
40: 10  CONTINUE
41: C                                     GET PERIOD TITLES
42:      DO 20 I=1,NPERS
43:      READ(NFR,1010,END=999)(TITLE(I,J),J=1,2)
44: 20  CONTINUE
45: C
46: C                                     INPUT COSTS/KWH/PERIOD
47:      WRITE(1,1001)
48:      DO 100 I=1,NPERS
49:      WRITE(NTW,1002)(TITLE(I,J),J=1,2)
50:      READ(NTR,1003)COSTS(I)
51: 100 CONTINUE
52: C                                     CALCULATE TOTAL COSTS
53:      DO 200 I=1,NPERS1
54:      TCOST(I)=0.0
55: 200 CONTINUE
56: C
57: C                                     ASK WHETHER GROSS OR NET PRODUCTION
58: C                                     IS TO BE USED
59:      WRITE(NTW,1004)
59:      INPUT=2+NOYES(1)
60: C                                     CALCULATE TOTAL COSTS BY PERIOD

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61: C                                AND OVERALL
62:      DO 300 I=1,NPERS
63:      TCOST(I)=TOT(INPUT,I)*COSTS(I)
64:      TCOST(NPERS1)=TCOST(NPERS1)+TCOST(I)
65: 300 CONTINUE
66: C                                CALCULATE AVERAGE AVOIDED COST
67: C                                FOR ALL PERIODS (SINGLE AVOIDED
68: C                                COST $)
69:      CPKWH=TCOST(NPERS1)/TOT(INPUT,NPERS1)
70: C
71: C                                START OUTPUTTING RESULTS
72:      WRITE(NTW,1005)
73:      DO 400 I=1,NPERS
74:      WRITE(NTW,1006)(TITLE(I,J),J=1,2),COSTS(I),TCOST(I)
75: 400 CONTINUE
76:      WRITE(NTW,1007)CPKWH
77: C                                CHECK IF OUTPUT TO FILE DESIRED
78:      WRITE(NTW,1015)
79:      IF(NOYES(1),NE.1)GO TO 990
80: C [FILEMARK]
81:      CALL OPEN(NFW,'AVOIDEDCPRN',2)
82: C                                OUTPUT TO FILE
83:      WRITE(NFW,1005)
84:      DO 500 I=1,NPERS
85:      WRITE(NFW,1006)(TITLE(I,J),J=1,2),COSTS(I),TCOST(I)
86: 500 CONTINUE
87:      WRITE(NFW,1007)CPKWH
88:      WRITE(NTW,1016)
89: 990 STOP
90: C                                ERROR IN DATA FILE READ
91: 997 WRITE(NTW,1011)
92:      WRITE(NTW,1012)
93:      STOP
94: 998 WRITE(NTW,1011)
95:      WRITE(NTW,1013)
96:      STOP
97: 999 WRITE(NTW,1011)
98:      WRITE(NTW,1014)
99:      STOP
100: C
101: 1001 FORMAT('O*****'/
102:      *      ' * AVOIDED COST SECTION *'/
103:      *      ' *****'/
104:      *      ' ENTER MARGINAL COST DATA PER KILOWATT-HOUR',
105:      *      ' FOR EACH PERIOD'/)
106: 1002 FORMAT(' MARGINAL COST, PERIOD ',2A4,' ($/KWH): ')
107: 1003 FORMAT(G15.8)
108: 1004 FORMAT(' DO YOU WANT CALCULATIONS BASED ON GROSS PRODUCTION?'/
109:      *      ' ("NO" MEANS NET SELLBACK WILL BE USED)')
110: 1005 FORMAT('1',48('*'))/' ',46X,'*'/
111:      *      ' ',16X,'MARGINAL',13X,'TOTAL',4X,'*'/
112:      *      ' ',4X,'PERIOD',7X,'COSTS',15X,'COSTS',4X,'*'/
113:      *      ' ',4X,38('--'),4X,'*')
114: 1006 FORMAT(' ',4X,2A4,F7.3,' $/KWH ',F16.2,1X,'$',2X,'*')
115: 1007 FORMAT(' ',46X,'*')/' ',7X,32('*'),7X,'*'/
116:      *      ' ',7X,'* AVOIDED COST =',F8.4,' $/KWH ',7X,'*'/
117:      *      ' ',7X,32('*'),7X,'*'/
118:      *      2(' ',46X,'*')/' ',48('*'))/
119: 1008 FORMAT(7G13.6)
120: 1009 FORMAT(2I3)

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121: 1010  FORMAT(2A4)
122: 1011  FORMAT('0***ERROR IN DATA FILE FROM PMAIN***')
123: 1012  FORMAT('0***PROBABLE CAUSE: NON-EXISTENT DATA FILE FROM PMAIN***')
124: 1013  FORMAT('0***PROBABLE CAUSE: PERFORMANCE DATA INCOMPLETE OR ***'/
125:      *      ' ***',9X,'INCONSISTENT WITH #PERIODS/INPUTS DATA***')
126: 1014  FORMAT('0***PROBABLE CAUSE: INCOMPLETE PERIOD TITLES***'/
127:      *      ' ***',9X,'OR INSUFFICIENT FILE LENGTH ***')
128: 1015  FORMAT('0DO YOU WISH THIS OUTPUT TO FILE AS WELL?')
129: C [FILEMARK]
130: 1016  FORMAT('0OUTPUT IN FILE "AVOIDEDC.PRN"/')
131:      END
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16. Abstract (Limit: 200 words) SERICPAC is a computer program developed to calculate average avoided cost rates for decentralized power producers and cogenerators that sell electricity to electric utilities. SERICPAC works in tandem with SERICOST, a program to calculate avoided costs, and determines the appropriate rates for buying and selling of electricity from electric utilities to qualifying facilities (QF) as stipulated under Section 210 of PURPA. SERICPAC contains simulation models for eight technologies including wind, hydro, biogas, and cogeneration. The simulations are converted in a diversified utility production which can be either gross production or net production, which accounts for an internal electricity usage by the QF. The program allows for adjustments to the production to be made for scheduled and forced outages. The program takes the production and divides it into cost periods defined in SERICOST. The final output of the model is a technology-specific average annual rate. The report contains a description of the technologies and the simulations as well as a complete user's guide to SERICPAC.			
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