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MARKET PENETRATION MODEL (MPM)
USER'S GUIDE

January 4, 1979

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USER'S GUIDE

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ABSTRACT

This document describes a computer program which calculates the most probable Solar Total Energy System (STES) market penetration and forecasts of energy displacement by geographic location (50 states) and by industrial application (140 industries) for seven time periods (from 1985 to 2015 in five year increments). The program is written in Fortran for the FTN compiler on The Aerospace Corporation's CDC 7600 computer. It consists of approximately 750 cards, including comments.

This document contains a description of the program, its inputs and its outputs. Examples of program input and output as well as a sample deck structure are provided. A source listing appears in the appendix.

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1. Introduction

STES performance analyses conducted by The Aerospace Corporation have resulted in the development of relationships between the equivalent cost ratio (ECR) and fuel displacement (FD) of a STES application and the characteristics of that application, including the effects of insolation and fuel price. These relationships have been used to develop dynamic, quantitative mathematical models of market penetration. Two computerized models have been developed: STES Applications Model (SAM), which provides ECR and FD vs. time as a function of industry and location, and a Market Penetration Model (MPM), which uses the outputs of SAM coupled with forecasts of energy demand and costs to calculate probable market penetration.

The basic building blocks of SAM and MPM and their interrelationships are shown in Figure 1-1. Census data on application characteristics, energy use, and size are combined in SAM with state-wide insolation data to estimate performance for each industry and location. Levelized costs of STES and fuel price forecasts are then combined with energy demand forecasts to develop the potential STES market.

MPM takes the output of SAM and modifies it to account for suitability and new vs. replacement growth characteristics. The result is an effective STES market which users could adopt, provided the STES economics were favorable, i.e., equivalent cost ratios are less than unity. MPM treats the ECR for each application and location as a distribution. The ECR distributions are obtained using a Monte Carlo technique involving unique distributions of size, insolation, fuel costs and interest rates. Each distribution is modified by technical and financial risk factors, and the program then computes the percentage of firms having favorable ECR's. The resulting market penetration percentages are combined with the effective market computed previously to yield total market penetration as a function of industry, location and time. MPM also reports fuel displacement by fuel type as a function of industry location and time. The details of MPM are discussed in the paragraphs below.

Although the initial data base and mathematical relationships developed in these models are for industrial users, the SAM and MPM are capable of handling residential and commercial applications as well. Data can be summed by both location and industry type to evaluate total market potential at 5-year intervals from 1985 through 2015.

Figure 1-1. STES Application and Market Penetration Models

2. MPM Description

The Market Penetration Model has been designed to perform three basic tasks. The first is to define an effective market for STES by state and industry, based on the potential market calculated by SAM. The second task is to estimate STES market penetration, while the third is to apply these estimates to the effective market forecast to evaluate future energy savings by fuel type.

The potential market calculated by SAM represents the maximum energy savings possible, assuming an optimum STES was designed and utilized for all applications. As a practical matter, however, the high costs and difficulties associated with retrofit preclude the installation of STES in most existing structures, and it is therefore assumed that the effective STES market will only apply to new structures. There are two components to this market. The first component is annual energy growth, which is calculated for each industry and state by a linear interpolation of the five-year energy demand data available as input to MPM (c.f. Section 3.2). It is assumed that this growth is fully attributed to an increase in the number of users within that state and industry. The second component is that due to replacement of pre-existing structures with new structures, and can be computed as a fraction of the total energy consumption in a given year.

In addition to the considerations noted above which tend to restrict the STES market to new structures, there exist additional factors, such as unavailability of land within an acceptable price range upon which to locate STES and limitations in exposure to sunlight, which could further limit the adoption of STES. For these reasons the potential market for STES as calculated by SAM must be scaled down by a constant multiplicative suitability factor to produce the final effective market for STES. The mathematical relationship of effective market is given in Section 2.2 equation (2-10).

The ECR's developed by SAM are nominal values for a given industry, subgroup, state and year. In order to calculate percent market penetration, distributions about these nominal values must be developed. The decision rule used in the simulation is that those applications having ECR's less than unity

will adopt STES, subject to biases due to financial and technical risk factors. The data flow for these calculations is shown in Figure 2-1. The development of ECR distributions and the quantification of the financial and technical risk factors are discussed in the paragraphs below.

The components of an ECR distribution are shown in the first box of Figure 2-1. Data on size distribution from the 1972 Census of Manufacturers were combined with energy use data from the 1974 Survey of Manufacturers to obtain energy use per size class for each of twenty industrial groups. The size distribution data from the 1972 Census of Manufacturers also permitted a determination of the median STES size required for each subgroup. ECR multiplicative factors were calculated to account for the distribution of capital costs vs. STES size, and as normalized cost relative to the median. The results are shown in Table 2-1, where ECR_m is the median correction factor for 1985. ECR_m is a correction factor for the median size of an industry (see Table 2-8 in Ref. 3) to account for its difference from the cost and size used in the STES optimization. (see Table 2-7 in Ref. 3) The distribution of ECR/ECR_m in Table 2-1 allows further correction within a given industry due to different plant size variations from its median size. Percent energy distribution in Table 2-1 indicates the percent of energy consumed by a particular size of structures in an industry group. For example, Table 2-1 indicates that 3.7% of the energy consumed by the food industry group was consumed by structures with more than 2500 employees. In calculating % energy distributions, no data were readily available on energy consumption as a function of size of establishment, so the number of man-hours spent in production was used as a proxy for energy consumption within each particular industry group.

The ECR of a given industry (as obtained from interpolation of appropriate optimization polynomials in SAM) when multiplied by ECR_m results in the ECR median value for that industry.

The second component contributing to an ECR distribution is the insolation variations within a given state. This was assumed to be a uniform distribution with values shown in Table 2-2. The 50 states were grouped into seven groups as shown in Figure 2-2. This (along with the grouping of the 140

industries into 20 industry groups) reduced a potential matrix of 7000 (50 states times 140 industries) to a more manageable matrix of 140 (7 state groups times 20 industry groups). A third ECR distribution component is the variation in energy price occurring within a state. Review of current energy price data indicated that a normal distribution was appropriate with a standard deviation of $\pm 12\%$. (See Ref. 1, page VI-27 and Appendix B) The final component is the variation in annualized charge rate (ACR), which was also assumed to be normally distributed with a standard deviation of $\pm 8\%$. (See Ref. 1, page VI-27 and Appendix B)

A Monte Carlo simulation was used to combine these distributions to obtain 140 joint distributions of an ECR multiplicative factor. As shown in Figure 2-1, the ECR median value for a given industry subgroup, state and time period is combined with the appropriate distribution from the Monte Carlo simulation to yield a Technical Equivalent Cost Ratio (TECR) distribution. Sample TECR distributions are shown in Figure 2-3.

The Financial Risk Factor (FRF) introduces a shift in the median of the ECR distribution which accounts for the negative aspects of making annualized payments for STES which are initially higher than the current costs of the displaced conventional energy, (i.e., negative cash flow) even though they are lower than the annualized conventional energy costs.

The difference between the annualized cost of the solar system for the decision year, and the actual cost in that year of the energy it would displace can be computed as a percentage of the cost of the conventional energy. The financial risk factor is taken to be proportional to this percentage. Further details are given in Ref. 1 and 2.

The Technical Risk Factor (TRF) introduces a shift in the median of the ECR distribution to compensate for the risk which an investor associates with the uncertainties in expected performance, operating costs and lifetime of a relatively unproven technical system such as a STES. The magnitude of the TRF is tempered or reduced by two major factors. The first of these is experience, where the later the decision year for a STES purchase relative to the time it was first introduced on the market, the less will be the technical risk. The second factor is the energy intensiveness of the industry, where

those industries which are highly energy intensive are more vulnerable to possible fuel curtailments or rapid escalation of conventional energy prices, and would thus require less of a risk premium to invest in STES. The amount of fuel displaced by STES is also a factor in the investment decision, since an industry which can only displace a small percentage of its conventional fuel by STES will not be as motivated to adopt the new system. Further details are given in Ref. 1 and 2.

As shown in the block diagram of Figure 2-1, the TRF and the distributions of the FRF are added to the distributions of the Technical ECR's to yield an adjusted ECR, i.e.,

$$AECR = TECR + FRF + TRF$$

The distribution of Adjusted Equivalent Cost Ratios about a typical value for each user subgroup, state, and year permits the computation of the percent of users having perceived AECE exceeding any given value. A potential user will adopt STES if he perceives the cost of STES to be just a fraction lower than the cost of conventional energy if all costs are taken into account. The Adjusted Equivalent Cost Ratio takes all known anticipated costs of both STES and conventional energy into account. Thus, all users who perceive the AECE to be less than 1 will adopt STES instead of the conventional alternatives. The Percent Cumulative Population of STES (PCPS) is calculated corresponding to where $AECE = 1$ via equation (2-6). Finally, the PCPS is used to calculate the Percent Cumulative Energy Market (PCEM) via equation (2-7). By this method the percent market penetration for each user and state is calculated for each time period.

The final step in the market penetration calculation is to develop absolute values of energy displacement by STES. This is accomplished by multiplying PCEM calculated in equation (2-7) by the effective market (EMARKT) calculated in equation (2-1). The result is a matrix of energy savings by fuel type for each industry, state, and time period which is aggregated by fuel type to yield national energy savings due to STES in equations (2-12) to (2-16).

Figure 2-1. Development of Percent Market Penetration

SIC	Industry	Variable	Distribution by Employment Class							
			2500+	1000-2499	500-999	250-499	100-249	50-99	20-49	10-19
20	Food ($ECR_m=2.31$)	% Size	0.1	0.5	1.9	5.5	16.2	19.4	32.8	23.7
		% Energy	3.7	0.0	22.9	20.8	25.7	13.4	10.2	3.4
		ECR/ECR_m	.64	-	.71	.82	.90	.99	1.09	1.22
21	Tobacco ($ECR_m=2.23$)	% Size	3.4	4.0	7.5	13.8	23.6	13.2	23.0	11.5
		% Energy	47.1	15.4	12.2	10.8	9.9	2.4	1.8	0.4
		ECR/ECR_m	.66	.74	.83	.90	.97	1.07	1.19	1.43
22	Textiles ($ECR_m=2.30$)	% Size	0.2	2.0	6.0	12.0	20.0	17.6	25.6	16.6
		% Energy	5.1	16.4	23.8	24.5	17.9	6.7	4.3	1.1
		ECR/ECR_m	0.62	0.70	0.77	0.83	1.01	0.99	1.10	1.27
23	Apparel ($ECR_m=3.2$)	% Size	0.3	0.0	1.4	5.5	14.7	20.6	34.2	23.3
		% Energy	0.0	5.8	10.8	22.9	27.8	16.7	12.5	3.6
		ECR/ECR_m	0.56	0.63	0.68	0.74	0.82	0.95	1.17	-
24	Wood ($ECR_m=2.48$)	% Size	0.2	0.0	0.5	2.4	12.1	16.7	32.4	35.6
		% Energy	0.0	3.8	6.1	14.4	31.9	19.8	16.2	7.8
		ECR/ECR_m	-	0.67	0.72	0.77	0.85	0.93	1.04	1.19
25	Furniture ($ECR_m=2.79$)	% Size	0.1	0.5	2.0	4.9	14.1	17.7	33.4	27.2
		% Energy	3.0	8.3	15.6	0.0	44.2	13.5	11.3	.4
		ECR/ECR_m	0.59	0.66	0.71	-	0.79	0.94	1.09	1.36
26	Paper ($ECR_m=1.83$)	% Size	1.3	1.0	3.4	7.2	25.7	19.7	27.6	15.1
		% Energy	0.0	15.9	18.1	18.2	29.7	10.3	6.4	1.5
		ECR/ECR_m	-	0.72	0.79	0.86	0.94	1.03	1.13	1.23
27	Printing ($ECR_m=3.0$)	% Size	0.7	0.0	1.2	2.8	8.3	13.6	34.8	38.6
		% Energy	0.0	15.8	11.3	13.0	19.4	14.6	17.0	8.8
		ECR/ECR_m	-	0.60	0.68	0.74	0.80	0.89	1.03	1.27

Table 2-1. Energy and Size Distribution by Industry Group

SIC	Industry	Variable	Distribution by Employment Class							
			2500+	1000-2499	500-999	250-499	100-249	50-99	20-49	10-19
28	Chemical ($ECR_m=1.7$)	% Size	0.6	1.8	3.0	5.7	12.5	16.5	33.0	26.9
		% Energy	15.4	20.7	15.7	0.0	30.0	0.0	15.6	2.6
		ECR/ECR_m	0.68	0.75	0.83	-	0.89	-	1.08	1.29
29	Petroleum ($ECR_m=1.8$)	% Size	0.5	1.7	3.5	5.6	14.5	14.2	30.2	29.8
		% Energy	11.7	18.0	18.9	14.5	19.9	7.1	6.8	3.0
		ECR/ECR_m	0.62	0.68	0.73	0.81	0.86	0.96	1.04	1.15
30	Rubber ($ECR_m=2.7$)	% Size	0.2	1.3	1.9	4.8	16.0	19.7	32.9	23.2
		% Energy	8.2	17.0	11.9	15.1	23.0	12.6	9.4	2.8
		ECR/ECR_m	0.54	0.59	0.64	0.70	0.76	0.84	0.93	1.06
31	Leather ($ECR_m=2.7$)	% Size	0.3	0.0	3.2	15.0	19.9	17.4	26.7	17.6
		% Energy	0.0	3.3	19.1	59.6	83.0	92.2	98.3	100.0
		ECR/ECR_m	-	0.71	0.78	0.83	0.93	1.04	1.26	1.70
32	Stone, Clay Glass ($ECR_m=2.29$)	% Size	0.1	0.6	1.6	3.2	10.1	13.3	36.3	34.8
		% Energy	3.8	10.6	16.4	15.5	21.5	12.5	13.8	5.8
		ECR/ECR_m	0.61	0.66	0.71	0.78	0.84	0.92	1.04	1.14
33	PRI Metals ($ECR_m=1.84$)	% Size	1.5	2.5	4.4	8.9	18.0	17.9	28.0	18.7
		% Energy	35.3	15.8	12.8	13.4	12.4	5.4	3.8	1.1
		ECR/ECR_m	0.72	0.72	0.79	0.84	0.92	1.02	1.10	1.21
34	Fabric Metals ($ECR_m=2.52$)	% Size	0.2	0.6	1.7	4.2	12.2	16.5	35.5	29.2
		% Energy	10.0	9.0	12.6	16.5	21.6	13.2	12.6	6.6
		ECR/ECR_m	0.60	0.67	0.73	0.79	0.87	0.95	1.06	1.24
35	Machinery ($ECR_m=2.52$)	% Size	0.4	1.2	2.3	3.9	9.4	12.8	32.1	37.9
		% Energy	16.0	16.6	14.7	13.3	14.2	9.1	10.4	5.7
		ECR/ECR_m	0.58	0.66	0.72	0.78	0.84	0.93	1.03	1.22
36	El. El. EQ. ($ECR_m=2.46$)	% Size	1.4	3.0	5.2	8.7	16.9	17.1	27.3	20.3
		% Energy	26.9	19.7	16.5	14.0	12.3	5.5	3.8	1.2
		ECR/ECR_m	0.63	0.71	0.77	0.83	0.91	1.01	1.14	1.37

Table 2-1. Energy and Size Distribution by Industry Group (continued)

<u>SIC</u>	<u>Industry</u>	<u>Variable</u>	<u>Distribution by Employment Class</u>							
			<u>2500+</u>	<u>1000-2499</u>	<u>500-999</u>	<u>250-499</u>	<u>100-249</u>	<u>50-99</u>	<u>20-49</u>	<u>10-19</u>
37	Trans. ($ECR_m=2.08$)	% Size	3.5	2.8	4.0	7.0	14.1	16.9	28.7	22.9
		% Energy	60.0	11.8	7.7	7.1	6.4	3.5	2.5	0.9
		ECR/ECR_m	0.71	0.82	0.90	0.96	1.06	1.15	1.34	1.50
38	Inst. ($ECR_m=2.65$)	% Size	0.5	2.1	3.7	5.9	14.4	14.9	30.6	28.0
		% Energy	17.6	20.8	16.7	14.1	14.9	7.1	6.3	2.5
		ECR/ECR_m	0.58	0.68	0.74	0.79	0.87	0.96	1.10	1.36
39	Misc. ($ECR_m=2.63$)	% Size	0.0	0.5	1.2	3.8	10.4	15.0	33.4	35.8
		% Energy	0.0	0.0	23.5	18.5	22.9	0.0	28.6	6.6
		ECR/ECR_m	-	-	0.70	0.82	0.91	-	1.03	1.48

Table 2-1. Energy and Size Distribution by Industry Group (continued)

Figure 2-2. Correspondence of States and State Groups

<u>State Group</u>	<u>States</u>
1	Alaska, Delaware, Hawaii, Rhode Island
2	Vermont, Massachusetts, Connecticut, New Jersey, Pennsylvania, Indiana, Maryland, West Virginia, Florida, Alabama
3	Maine, Michigan, Wisconsin, North Dakota, Iowa, Virginia, North Carolina, South Carolina, Georgia, Mississippi, Utah
4	New Hampshire, New York, Missouri, Kansas, Arkansas, New Mexico, Arizona, Nevada
5	Ohio, Illinois, Minnesota, South Dakota, Nebraska, Kentucky, Tennessee, Louisiana, Oklahoma, Wyoming, Colorado
6	California
7	Texas, Montana, Idaho, Washington, Oregon

Figure 2-3. Sample TECR Multiplicative Factor Distributions

INDUSTRIAL GROUP NUMBER= 20

STATE GROUP NUMBER= 1 NUMBER OF SAMPLES= 348

TECR= .530 .658 .786 .913 1.041 1.169 1.297 1.424 1.552 1.680 1.808
D(TECR)= 0.000 .003 .069 .264 .494 .747 .897 .951 .989 .994 .997

STATE GROUP NUMBER= 2 NUMBER OF SAMPLES= 320

TECR= .575 .683 .790 .898 1.006 1.113 1.221 1.329 1.436 1.544 1.652
D(TECR)= 0.000 .019 .069 .188 .397 .578 .763 .900 .950 .994 1.000

STATE GROUP NUMBER= 3 NUMBER OF SAMPLES= 510

TECR= .632 .746 .860 .974 1.087 1.201 1.315 1.429 1.542 1.656 1.770
D(TECR)= 0.000 .047 .180 .392 .622 .755 .882 .961 .988 .998 .998

STATE GROUP NUMBER= 4 NUMBER OF SAMPLES= 206

TECR= .612 .707 .802 .897 .993 1.088 1.183 1.278 1.373 1.468 1.564
D(TECR)= 0.000 .039 .097 .252 .408 .563 .743 .840 .913 .981 .995

STATE GROUP NUMBER= 5 NUMBER OF SAMPLES= 532

TECR= .494 .622 .751 .879 1.007 1.135 1.263 1.392 1.520 1.648 1.776
D(TECR)= 0.000 .017 .081 .241 .472 .686 .840 .944 .989 .998 .998

STATE GROUP NUMBER= 6 NUMBER OF SAMPLES= 332

TECR= .513 .631 .749 .867 .985 1.104 1.222 1.340 1.458 1.576 1.695
D(TECR)= 0.000 .030 .096 .232 .404 .630 .752 .889 .967 .988 .997

STATE GROUP NUMBER= 7 NUMBER OF SAMPLES= 206

TECR= .558 .703 .847 .992 1.137 1.282 1.427 1.571 1.716 1.861 2.006
D(TECR)= 0.000 .068 .204 .451 .641 .811 .942 .971 .985 .995 .995

Table 2-2. Variation of Average Daily Direct Insolation and ECR with Location

<u>State</u>	<u>I_s</u>	<u>ΔI_s</u>	<u>ΔECR ECR</u>	<u>State</u>	<u>I_s</u>	<u>ΔI_s</u>	<u>ΔECR ECR</u>
Alabama	4.0	0.25	0.046	Nebraska	5.5	0.5	0.091
Alaska	3.6	0	0	Nevada	6.5	0.5	0.084
Arizona	7.5	0.50	0.069	New Hampshire	3.6	0.4	0.074
Arkansas	4.8	0.40	0.074	New Jersey	3.9	0.2	0.038
California	6.5	1.0	0.168	New Mexico	6.5	0.5	0.084
Colorado	6.0	0.5	0.088	New York	3.8	0.4	0.074
Connecticut	3.9	0.1	0.019	North Carolina	3.7	0.3	0.055
Delaware	3.8	0	0	North Dakota	5.0	0.3	0.056
Florida	4.1	0.2	0.037	Ohio	4.0	0.5	0.093
Georgia	4.0	0.3	0.056	Oklahoma	5.5	0.5	0.091
Hawaii	6.7	0	0	Oregon	3.7	1.0	0.184
Idaho	5.1	1.0	0.185	Pennsylvania	3.7	0.2	0.037
Illinois	4.1	0.5	0.093	Rhode Island	4.0	0	0
Indiana	4.3	0.2	0.037	South Carolina	4.0	0.3	0.056
Iowa	4.7	0.3	0.056	South Dakota	5.0	0.5	0.093
Kansas	5.6	0.4	0.073	Tennessee	4.0	0.5	0.093
Kentucky	4.0	0.5	0.093	Texas	5.0	1.0	0.186
Louisiana	4.0	0.5	0.093	Utah	5.8	0.3	0.054
Maine	3.7	0.3	0.055	Vermont	3.6	0.2	0.037
Maryland	3.6	0.2	0.037	Virginia	3.6	0.3	0.056
Massachusetts	4.0	0.2	0.037	Washington	3.2	1.2	0.218
Michigan	3.7	0.3	0.055	West Virginia	3.5	0.2	0.037
Minnesota	4.5	0.5	0.093	Wisconsin	4.0	0.3	0.056
Mississippi	4.3	0.3	0.056	Wyoming	5.5	0.5	0.091
Missouri	5.0	0.4	0.074	Puerto Rico	6.3	0	0
Montana	5.0	1.0	0.185				

2.1 MPM Structure and Functions

MPM has a simple structure - it consists of one main program.

It contains, via DATA statements, tables providing the names of 50 states and 140 industries, the correspondence between the Sherman Clark ordering of states and alphabetical order, the correspondence between the 50 states and the 7 groups of states, the energy intensiveness values of the 20 industry groups, the 3-digit SIC codes for the 140 industries, the 8 cumulative percent size distribution values for the 20 industry groups, the 8 cumulative percent energy distribution values for the 20 industry groups, the T/E ratios for the 140 industries and default values for the variables in NAMELIST.

Although much of the data used by the program is stored in the program via these data statements, a considerable amount of data is read into memory during program execution from tapes.

The 140 Monte Carlo Distributions of ECR multipliers are read in from tape 1.

The energy demand values for 140 industries and 7 time periods are read in from tape 2 and stored in Large Core Memory (LCM). These energy demand values are read in as trillions of Btus and converted in the program to Btus.

The thermal and electric fuel mix fractions, the costs for thermal and electric energy, and the levelized costs of thermal and electric energy for 50 states and 7 time periods are read in from tape 3. The levelized electric energy costs are read in as Mills/KWH and converted in the program to cents/MBtu. The levelized thermal energy costs are converted from dollars/MBtu to cents/MBtu.

The NAMELIST data is read in from tape 5 - the input stream.

When all of the above data has been read in, the program enters its main processing loop. This is the time period loop. For each of the seven time periods, the following calculations are performed.

Tape 4 - the SAM output file is read in. Each record on this file describes a particular industry in a particular state.

For each record, i.e. industry within a state, the following calculations are performed. The appropriate distribution is accessed and used to compute the TECR distribution. The appropriate costs of thermal and electric energy and the levelized costs of thermal and electric energy are accessed and used to compute the financial risk factor distribution. The appropriate energy intensiveness value is accessed and used to calculate the technical risk factor. The TECR distribution, the financial risk factor distribution and the technical risk factor are combined to form the adjusted equivalent cost ratio distribution. The adjusted equivalent cost ratio distribution is used to determine the percent cumulative population of STES which in turn is used to calculate the percent cumulative energy market. The effective market for STES is calculated. The percent cumulative energy market and the effective market for STES are used to compute the market penetration of this industry in this state. The appropriate fuel mix fractions are accessed and used to compute the amount and type of fuels displaced by market penetration. The fuel mix fractions for an industry varies from state to state and is based upon the Sherman Clark projections of industrial fuel mix consumption by 50 states and 7 time periods. See Reference 4. The amount and type of fuels displaced by market penetration are accumulated by industry, state and nationally.

When an end-of-file is encountered on tape 4 and all of the industries in all of the states are processed, then the 4 standard reports for this time period are generated and control returns to the beginning of the time period loop and the calculations are repeated for the next time period.

Note that the fuel displacement outputs which are calculated for each time period represent market penetration rates, i.e., they correspond to the fuel displacement of those firms which adopt STES in that given year. The cumulative national fuel displacement by STES presented in Reference (2) was obtained by graphical integration of the MPM output data. A routine for performing this integration automatically has recently been developed by Aerospace, but was not available for inclusion in this User's Guide.

2.2 MPM Equations

The following notations are used in MPM:

ECR	is the equivalent cost ratio.
Y	is the distribution of the ECR multiplicative factors to account for the distribution of capital costs vs. STES size, normalized relative to the median size for each industry.
R	is the T/E ratio for displaced energy for this industry in this state
$\bar{C}_T$	is the levelized cost of thermal energy
$\bar{C}_E$	is the levelized cost of electrical energy
C_T	is the cost of thermal energy in first year of STES operation
C_E	is the cost of electrical energy in first year of STES operation
K	is the financial risk constant multiplier
t_0	is the decision year
N	is the life of the STES system (nominally 30 years)
FD	is the fuel displacement
FDMAX	is the maximum fuel displacement used in the simulation (.80)
EI	is the energy intensiveness
TRFMAX	is the maximum technical risk factor used in the simulation (.10)
DY	is the cumulative probability distribution function of the ECR multiplicative factor Y.
PE	contains the 8 cumulative percent energy distribution values for industry group IG.
PS	contains the 8 cumulative percent size distribution values for industry group IG.
EMI	is the annual energy demand
SUITF	is the STES suitability factor for land availability
RPLMTF	is the replacement factor of pre-existing industry structures
TED	is the thermal to electric demand ratio
TFDT	is the percent of fuel displacement for thermal energy
TFDE	is the percent of fuel displacement for electrical energy
FMT	contains the thermal fuel mix fractions
FME	contains the electric fuel mix fractions

The equations used in MPM are discussed below:

The TECR distribution for 11 size classes is calculated by:

$$TECR(L) = ECR \cdot Y(IG, IS, L) \quad (2-1)$$

where: L is a subscript which takes on the values 1 to 11.

IG identifies the industry group (one of twenty) of which this industry is a member.

IS identifies the state group (one of seven) of which this state is a member.

For a partial printout of the TECR distributions, see figure 2-3.

The Financial Risk Factor distribution of 11 size classes is calculated by:

$$FRFM = (\bar{C}_T(JJ, NT) \cdot R + \bar{C}_E(JJ, NT)) / (\bar{C}_T(JJ, NT) \cdot R + \bar{C}_E(JJ, NT)) \quad (2-2)$$

$$FRF(M) = \begin{cases} K \cdot (TECR(M) \cdot FRFM) - 1 & ; \text{ otherwise} \\ 0 & ; \text{ } TECR(M) \cdot FRFM < 1 \end{cases} \quad (2-3)$$

where: M is a subscript which takes on the values 1 to 11

JJ identifies the state

NT identifies the time period

C_T is the composite cost of thermal energy read in from Tape 3 as described in Section 3.3.

C_E is the composite cost of electric energy read in from Tape 3 as described in Section 3.3.

The Technical Risk Factor is calculated by:

$$TRF = TRFMAX \cdot (1 - EI(IG) \cdot FD/FD_{MAX}) \cdot (1 - \frac{t_o - 1985}{N}) \quad (2-4)$$

The Adjusted Equivalent Cost Ratio distribution of 11 values is calculated by:

$$AECR(M) = TECR(M) + FRF(M) + TRF \quad (2-5)$$

The percent cumulative population of STES corresponding to where $AECR=1$ is calculated by:

$$PCPS = \begin{cases} 0 & ; AECR(1) \geq 1 \\ \frac{DY(IG,IS,MM) + (DY(IG,IS,M) - DY(IG,IS,MM)) \cdot (1 - AECR(M)) / (AECR(M) - AECR(MM)) \cdot 100}{100} & ; \text{otherwise} \\ 100. & ; AECR(11) \geq 1 \end{cases} \quad (2-6)$$

where: $MM = M-1$

M is an integer ≤ 11 such that $AECR(M) > 1$ and $AECR(MM) \leq 1$

DY is the cumulative probability distribution of the ECR multiplicative factor values input from Tape 1 as described in Section 3.1.

The Percent Cumulative Energy Market is calculated by:

$$PCEM = \begin{cases} 0 & ; PCPS < PS(IG,1) \text{ or } PCPS \leq 1 \\ \frac{PE(IG,IM) + (PE(IG,I) - PE(IG,IM)) \cdot (PCPS - PS(IG,IM)) / (PS(IG,I) - PS(IG,IM))}{100} & ; \text{otherwise} \\ 100 & ; PCPS \geq PS(IG,8) \end{cases} \quad (2-7)$$

where: $IM = I-1$

I is an integer ≤ 8 such that $PCPS < PS(IG,I)$ and $PCPS \geq PS(IG,IM)$

The annual growth of energy demand is calculated by:

$$MARKGR = \begin{cases} (EMI(II,JJ,2) - EMI(II,JJ,1))/5 & ; NT = 1 \\ EMI(II,JJ,NT) - EMI(II,JJ,NT-1))/5 & ; \text{otherwise} \end{cases} \quad (2-8)$$

where: NT identifies the time period
 II identifies the industry
 JJ identifies the state

The adjusted energy demand (as described on page V-20 in Ref. 1) is calculated by:

$$AEMI = \begin{cases} EMI(II, JJ, 1) & ; \quad NT < 6 \\ EMI(II, JJ, N-4); & NT \geq 6 \end{cases} \quad (2-9)$$

The total effective STES market potential is calculated by:

$$EMARKT = SUITF \cdot (MARKGR + AEMI \cdot RPLMTF) \quad (2-10)$$

The market potential for total energy is calculated by:

$$MARKPL = EMARKT \cdot PCEM / 100 \quad (2-11)$$

The market potential for electric energy is:

$$MARKPE = MARKPL / (1 + TED(II)) \quad (2-12)$$

The market potential for thermal energy is:

$$MARKPT = MARKPL - MARKPE \quad (2-13)$$

The total market penetration is:

$$MARKPN = (TFDT \cdot MARKPT + TFDE \cdot MARKPE) / 100 \quad (2-14)$$

The amount of thermal fuel displaced by fuel type is calculated by:

$$AFDT(I) = TFDT \cdot FMT(JJ, NT, I) \cdot MARKPT / 100 \quad (2-15)$$

where: I takes on the values 1 to 4 representing fuel types natural gas, coal, oil and other

The amount of electric fuel displaced by fuel type is calculated by:

$$AFDE(I) = TFDE \cdot FME(JJ, NT, I) \cdot MARKPE / 100 \quad (2-16)$$

where: I takes on the values 1 to 6 representing the fuel types natural gas, oil, coal, nuclear, hydro and other

2.3 MPM Requirements and Limitations

MPM was written in Fortran for the FTN compiler on The Aerospace Corporation's CDC 7600 computer. It consists of just one main routine and approximately 750 cards, including comments.

The program requires 16,491 words of small core memory (SCM) and 49,000 words of large core memory (LCM).

To run one case of seven time periods (1985-2015) through MPM requires approximately 20 seconds. This accounts for approximately 5 computing units (CUs) which currently cost \$1.30/CU so that it costs approximately \$6.50 per case to run MPM.

Because the program was written for the FTN compiler for a CDC 7600 computer, it has certain non-ANSI Fortran features, including: a PROGRAM statement, 7-character variable names, a LEVEL 2 statement indicating storage in LCM, and non-ANSI format DATA statements.

3. MPM Inputs

The MPM program has five input files: Tape 1 - Monte Carlo Distributions, Tape 2 - Industrial Energy Demand Data, Tape 3 - Fuel Mixes, Composite Fuel Costs and Levelized Fuel Costs, Tape 4 - SAM Output Data and Tape 5 - The Input Stream. These files are described in the following sections.

3.1 Tape 1 - Monte Carlo Distributions

This tape contains the distributions of the ECR multipliers for 140 combinations of 20 industrial and 7 state group scenarios. A discussion of how these distributions were created appears in Section 2. The tape has 140 records; each record contains the following information:

1. industry group identification (with values of 20 to 39) in integer format
2. state group identification (with values of 1 to 7) in integer format
3. 11 Y values in floating point format
4. 11 DY values in floating point format

The tape is unformatted and contains no end-of-file mark.

3.2 Tape 2 - Industrial Energy Demand Data

This tape contains the energy demand values for each of the 50 states and 140 industries for 7 time periods. The units are trillions of Btus. Each record contains the energy demand values for 50 states. The first record contains the energy demand values for industry 1, time period 1. The second record is for industry 2, time period 1. . . . The 140th record is for industry 140, time period 1. The next 140 records are for time period 2., etc. The last 140 records for time period 7. The data is unformatted.

This tape is also used as input for the SAM data generation program and is described in Reference 3.

3.3 Tape 3 - Fuel Mixes, Composite Fuel Costs and Levelized Fuel Costs

This tape contains three sets of information all on one file.

The first set of information contains thermal and electric fuel mix fractions for 6 types of electric fuels and 4 types of thermal fuels for 50 states and for 7 time periods.

Each record contains the following information:

<u>word</u>	<u>contents</u>
1	fraction electric natural gas
2	fraction electric coal
3	fraction electric nuclear
4	fraction electric hydro
5	fraction electric other
6	fraction electric oil
7	fraction thermal natural gas
8	fraction thermal coal
9	fraction thermal oil
10	fraction thermal other

The first 50 records contain the fuel mix fractions for the 50 states (Sherman Clark ordering) for time period 1 (1985). The data for the remaining 6 time periods follows.

The second set of data contains the composite thermal and electric fuel costs for the 50 states for the 7 time periods. The data is given in units of cents/MBtu and follows the states sequence of Sherman Clark data:

Each record contains the following information:

<u>word</u>	<u>contents</u>
1	alphanumeric state identification
2	composite fuel cost for first time period. (the odd records contain thermal fuel costs and the even records contain electric fuel costs)
3	composite fuel cost for second time period
.	
.	
.	
8	composite fuel cost for seventh time period

The third set of data contains the levelized electric and thermal fuel costs for the 50 states for the 7 time periods. The data is in the following units: electric costs are in mills/KWH; thermal costs are in dollars/MBtu. The states are in Sherman Clark order. The data is unformatted.

Each record contains the following information:

<u>word</u>	<u>contents</u>
1	alphanumeric state identification
2	levelized fuel costs for first time period. (The odd records contain electric fuel costs and the even records contain thermal fuel costs)
.	
.	
.	
8	levelized fuel costs for seventh time period

The first set of data on this tape is also used as input for the SAM data generation program and is described in Reference 3.

3.4 Tape 4 - SAM Output Data

This tape contains the data output by either SAMDGP or SAMRGP. (The two programs generate tapes with the same format.)

Each record contains the following information:

<u>word</u>	<u>contents</u>
1	state identification
2	industry identification
3	ECR
4	FD
5	total thermal fuel displaced
6	total electric fuel displaced
7	amount of thermal natural gas displaced
8	amount of thermal oil displaced
9	amount of thermal coal displaced
10	amount of thermal other displaced
11	amount of electric natural gas displaced
12	amount of electric oil displaced
13	amount of electric coal displaced
14	amount of electric nuclear displaced
15	amount of electric hydro displaced
16	amount of electric other displaced
17	R

There are approximately 2000 records on this tape. Each record describes one industry in one state. The data is unformatted.

3.5 Tape 5 - The Input Stream

The MPM program uses NAMELIST data. The data for a case is organized into one NAMELIST group with the group name IN.

At present there are only four input variables in IN. The names of the input variables along with brief descriptions and default values follows:

ECRM ECR Multiplier
(default = 1.0)

KK Financial Risk Constant Multiplier
(default = .25)

TRFMAX Maximum Technical Risk Constant Multiplier
(default = .1)

IPRINT special print option flag
If IPRINT = 0, no special print is generated
If IPRINT = 1, a report is printed on the output file which contains, for each industry in each state in which there is some market penetration, the amount of market penetration and fuel displacement by fuel type. In other words, this report gives on the intra-state industry level, the information which is presented on the state-wide and national industry levels in the standard reports.
Warning: This option results in 100,000 to 200,000 lines of print! Use with Extreme Caution!

Note: Other variables could be added to IN if it becomes desirable to do so. For example, if the default value for SUITF, the STES suitability factor for load availability, is no longer acceptable, then SUITF could be added to IN and alternate values could then be assigned via NAMELIST.

4. MPM Outputs

In addition to the printback of the NAMELIST input, MPM has five types of printed output:

1. market penetration and fuel displacement by state
2. market penetration and fuel displacement summary for all states
3. market penetration and fuel displacement by application
4. market penetration and fuel displacement summary for all applications
5. market penetration and fuel displacement by applications within states

All of the outputs are generated for each of the seven time periods. The first four types of outputs are automatically generated, while the fifth is an optional printout.

4.1 Market Penetration and Fuel Displacement by State

This output report records for each state the amount of fuel that could be displaced by STES in the year indicated. A sample partial report appears in Figure 4-1. The states are listed in alphabetical order. Fuel displacement is given by fuel type for thermal, electric and total energy. The thermal energy fuel types are natural gas, oil, coal and other. The electric and total energy fuel types are natural gas, oil, coal, nuclear, hydroelectricity and other. Market Penetration, which is the total fuel displacement for all fuel types, is also given. Everything is in Btus.

4.2 Market Penetration and Fuel Displacement Summary for All States

This output report records the 50 state total amount of fuel that could be displaced by STES in the year indicated. A sample report appears in Figure 4-2. Fuel displacement is given by fuel type for thermal, electric and total energy. The thermal energy fuel types are natural gas, oil, coal and other. The electric and total energy fuel types are natural gas, oil, coal, nuclear, hydroelectricity and other. The market penetration, or fuel displacement for all fuel types, is given for thermal, electric and total energy. Everything is in Btus.

4.3 Market Penetration and Fuel Displacement by Application

This output report records, for each of the 140 applications, the amount of fuel that could be displaced by STES in the year indicated. A sample partial report appears in Figure 4-3. The applications are listed by 3-digit SIC code (increasing order). Fuel displacement is given by fuel type for thermal, electric and total energy. The thermal energy fuel types are natural gas, oil, coal and other. The electric and total energy fuel types are natural gas, oil, coal, nuclear, hydroelectricity and other. Market Penetration, the total fuel displacement for all fuel types, is also given. Everything is in Btus.

4.4 Market Penetration and Fuel Displacement Summary for All Applications

This output report records the 140 application total amount of fuel that could be displaced by STES in the year indicated. A sample report appears in Figure 4-4. Fuel displacement is given by fuel type for thermal, electric and total energy. The thermal energy fuel types are natural gas, oil, coal and other. The electric and total energy fuel types are natural gas, oil, coal, nuclear, hydroelectricity and other. The market penetration, or fuel displacement for all fuel types, is given for thermal, electric and total energy. Everything is in Btus.

4.5 Market Penetration and Fuel Displacement by Applications Within States

This optional output report records, for each application in each state, the amount of fuel that could be displaced by STES in the year indicated. A sample partial report appears in Figure 4-5. Only applications with some market penetration are listed. The report is ordered by application with states appearing in alphabetical order when an application has market penetration in more than one state. Fuel displacement is given by fuel type for thermal, electric and total energy. The thermal energy fuel types are natural gas, oil, coal and other. The electric and total energy fuel types are natural gas, oil, coal, nuclear, hydroelectricity and other. Market Penetration, the total fuel displacement for all fuel types, is also given. Everything is in Btus.

This report is an optional report because of the large volume of output it generates. One can expect anywhere between 100,000 and 200,000 lines of output, depending on the input parameter values, when this option is selected.

This report is selected by setting the NAMELIST print flag IPRINT = 1. (c.f. Section 3.1).

Warning: Use this report with extreme caution!

Figure 4-1. Sample (Partial) Market Penetration and Fuel Displacement by State Report

MARKET PENETRATION AND FUEL DISPLACEMENT BY STATE IN 1990

STATE	MARKET PENETRATION	FUEL DISPLACEMENT						
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER	
ALABAMA		THERMAL	0.	0.	0.	0.	0.	0.
	0.	ELECTRIC	0.	0.	0.	0.	0.	0.
		TOTAL	0.	0.	0.	0.	0.	0.
ALASKA		THERMAL	0.	0.	0.	0.	0.	0.
	0.	ELECTRIC	0.	0.	0.	0.	0.	0.
		TOTAL	0.	0.	0.	0.	0.	0.
ARIZONA		THERMAL	.30E+11	.60E+11	.23E+11			.57E+09
	.13E+12	ELECTRIC	0.	.10E+10	.57E+10	.23E+10	.23E+10	0.
		TOTAL	.30E+11	.61E+11	.29E+11	.23E+10	.23E+10	.57E+09
ARKANSAS		THERMAL	0.	0.	0.	0.	0.	0.
	0.	ELECTRIC	0.	0.	0.	0.	0.	0.
		TOTAL	0.	0.	0.	0.	0.	0.
CALIFORNIA		THERMAL	.71E+13	.74E+12	.18E+12			.18E+13
	.11E+14	ELECTRIC	0.	.28E+12	.14E+12	.19E+12	.11E+12	.32E+11
		TOTAL	.71E+13	.10E+13	.32E+12	.19E+12	.11E+12	.19E+13
COLORADO		THERMAL	0.	0.	0.	0.	0.	0.
	0.	ELECTRIC	0.	0.	0.	0.	0.	0.
		TOTAL	0.	0.	0.	0.	0.	0.
CONNECTICUT		THERMAL	.52E+10	.27E+12	.26E+11			.91E+10
	.34E+12	ELECTRIC	0.	.64E+10	.12E+11	.10E+11	.23E+09	0.
		TOTAL	.52E+10	.27E+12	.38E+11	.10E+11	.23E+09	.91E+10
DELAWARE		THERMAL	.16E+11	.61E+11	.12E+11			.60E+11
	.15E+12	ELECTRIC	0.	.18E+10	.39E+10	0.	0.	0.
		TOTAL	.16E+11	.62E+11	.16E+11	0.	0.	.60E+11

Figure 4-2. Sample Market Penetration and Fuel Displacement Summary Report for all States

MARKET PENETRATION AND FUEL DISPLACEMENT SUMMARY FOR ALL STATES IN 1990

	TOTAL	NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
THERMAL	.37E+14	.19E+14	.95E+13	.30E+13			.50E+13
ELECTRIC	.20E+13	0.	.57E+12	.77E+12	.51E+12	.13E+12	.32E+11
TOTAL	.39E+14	.19E+14	.10E+14	.38E+13	.51E+12	.13E+12	.51E+13

Figure 4-3. Sample (Partial) Market Penetration and Fuel Displacement by Application Report

MARKET PENETRATION AND FUEL DISPLACEMENT BY INDUSTRY IN 1990

HEAT PRODUCTS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.39E+11	.40E+10	.96E+09		.10E+11
	.60E+11	ELECTRIC	0.	.24E+10	.12E+10	.17E+10	.27E+09
		TOTAL	.39E+11	.65E+10	.22E+10	.17E+10	.10E+11
DAIRY PRODUCTS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.32E+11	.33E+10	.79E+09		.83E+10
	.48E+11	ELECTRIC	0.	.13E+10	.66E+09	.90E+09	.15E+09
		TOTAL	.32E+11	.47E+10	.15E+10	.90E+09	.85E+10
PRESERVED FRUITS AND VEGETABLE	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.30E+12	.54E+11	.73E+10		.86E+11
	.47E+12	ELECTRIC	0.	.84E+10	.33E+10	.45E+10	.75E+09
		TOTAL	.30E+12	.63E+11	.11E+11	.45E+10	.87E+11
GRAIN MILL PRODUCTS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.76E+11	.79E+10	.19E+10		.20E+11
	.11E+12	ELECTRIC	0.	.22E+10	.11E+10	.15E+10	.25E+09
		TOTAL	.76E+11	.10E+11	.30E+10	.15E+10	.20E+11
BAKERY PRODUCTS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.33E+11	.35E+10	.82E+09		.86E+10
	.49E+11	ELECTRIC	0.	.11E+10	.54E+09	.74E+09	.12E+09
		TOTAL	.33E+11	.45E+10	.14E+10	.74E+09	.87E+10
SUGAR, CONFECTIONERY PRODUCTS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.37E+12	.19E+12	.80E+10		.15E+12
	.77E+12	ELECTRIC	0.	.35E+11	.71E+10	.98E+10	.10E+10
		TOTAL	.37E+12	.22E+12	.15E+11	.98E+10	.15E+12
FATS AND OILS	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.64E+11	.66E+10	.16E+10		.16E+11
	.91E+11	ELECTRIC	0.	.10E+10	.51E+09	.70E+09	.11E+09
		TOTAL	.64E+11	.76E+10	.21E+10	.70E+09	.17E+11
BEVERAGES	MARKET PENETRATION	FUEL DISPLACEMENT					
		NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
		THERMAL	.79E+11	.82E+10	.20E+10		.21E+11
	.12E+12	ELECTRIC	0.	.19E+10	.94E+09	.13E+10	.21E+09
		TOTAL	.79E+11	.10E+11	.29E+10	.13E+10	.21E+11

Figure 4-4. Sample Market Penetration and Fuel Displacement Summary Report for all Industries.

MARKET PENETRATION AND FUEL DISPLACEMENT SUMMARY FOR ALL INDUSTRIES IN 1990

	TOTAL	NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
THERMAL	.37E+14	.19E+14	.95E+13	.30E+13			.50E+13
ELECTRIC	.20E+13	0.	.57E+12	.77E+12	.51E+12	.13E+12	.32E+11
TOTAL	.39E+14	.19E+14	.10E+14	.38E+13	.51E+12	.13E+12	.51E+13

Figure 4-5. Sample (Partial) Market Penetration and Fuel Displacement by Application Within States Report

1990

MEAT PRODUCTS		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.39E+11	.40E+10	.96E+09			.10E+11
		.60E+11	ELECTRIC	0.	.24E+10	.12E+10	.17E+10	.91E+09	.27E+09
			TOTAL	.39E+11	.65E+10	.22E+10	.17E+10	.91E+09	.10E+11
DAIRY PRODUCTS		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.32E+11	.33E+10	.79E+09			.83E+10
		.48E+11	ELECTRIC	0.	.13E+10	.66E+09	.90E+09	.49E+09	.15E+09
			TOTAL	.32E+11	.47E+10	.15E+10	.90E+09	.49E+09	.85E+10
PRESERVED FRUITS AND VEGETABLE		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.29E+12	.30E+11	.73E+10			.76E+11
		.43E+12	ELECTRIC	0.	.66E+10	.33E+10	.45E+10	.25E+10	.74E+09
			TOTAL	.29E+12	.37E+11	.11E+11	.45E+10	.25E+10	.77E+11
PRESERVED FRUITS AND VEGETABLE		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
HAWAII			THERMAL	.64E+10	.24E+11	0.			.10E+11
		.42E+11	ELECTRIC	0.	.18E+10	0.	0.	.38E+07	.15E+08
			TOTAL	.64E+10	.26E+11	0.	0.	.38E+07	.10E+11
GRAIN MILL PRODUCTS		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.76E+11	.79E+10	.19E+10			.20E+11
		.11E+12	ELECTRIC	0.	.22E+10	.11E+10	.15E+10	.82E+09	.25E+09
			TOTAL	.76E+11	.10E+11	.30E+10	.15E+10	.82E+09	.20E+11
BAKERY PRODUCTS		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.33E+11	.35E+10	.82E+09			.86E+10
		.49E+11	ELECTRIC	0.	.11E+10	.54E+09	.74E+09	.40E+09	.12E+09
			TOTAL	.33E+11	.45E+10	.14E+10	.74E+09	.40E+09	.87E+10
SUGAR, CONFECTIONERY PRODUCTS		MARKET PENETRATION		FUEL DISPLACEMENT					
				NATURAL GAS	OIL	COAL	NUCLEAR	HYDRO	OTHER
CALIFORNIA			THERMAL	.33E+12	.34E+11	.80E+10			.84E+11
		.49E+12	ELECTRIC	0.	.14E+11	.71E+10	.98E+10	.53E+10	.16E+10
			TOTAL	.33E+12	.48E+11	.15E+11	.98E+10	.53E+10	.86E+11

5. MPM Deck Structure and Control Cards

Although each facility may have unique peculiarities which result in some differences in the control cards, a sample deck structure with the control cards used at The Aerospace Corporation is shown in Figure 5-1.

As shown in Figure 5-1, there are two control cards, the \$PGMR4 card and the \$PARAM cards, which appear at the front of every batch submitted job at The Aerospace Corporation. These two cards identify the job, the programmer, the account number to which the computing charges are applied, the number of tapes and the amount of time requested by the job. Although these cards may be unique to the Aerospace Corporation in format, other facilities have cards which perform similar functions which can be substituted in their place.

A STAGE card is required for each tape that is requested by the job. MPM requests four tapes. The first STAGE card requests that the operators mount tape number 21506 and assign it the logical file name of TAPE 1. This tape contains the Monte Carlo distributions. The second STAGE card requests that tape number 10467 be assigned to TAPE 2. This tape contains the industrial energy demand data. The third STAGE card requests that tape number 11140 be assigned to TAPE 3. This tape contains the fuel mixes, the composite fuel costs and the levelized fuel costs. The fourth STAGE card requests that tape number 15306 be assigned to TAPE 4. This tape contains the SAM output data. Refer to Section 3 for a complete discussion of the contents and formats of these tapes. The T parameter on the STAGE cards specifies the size of the LCM buffer to be one sector - the smallest unit that can be requested. This helps to minimize the total LCM storage requested by the job.

The FTN card calls the FTN compiler to compile the source deck and create the object module LGO. OPT is an optimization parameter requesting maximum optimization. R is an optional parameter request for a long symbolic reference map.

The LOAD(LGO) card, the NOGO(X) card and the X(PL=100000) card form, a load sequence which generates an absolute core image of the program on a separate file (called X) and then executes that file. This sequence replaces the LGO card and eliminates the need for some LCM space for buffers. PL=100000 is an optional parameter which sets the print limit at 100,000 lines.

\$PGMR4	}	Aerospace Peculiar
\$PARAM		
STAGE(TAPE1,VSN=21506,T)		
STAGE(TAPE2,VSN=10467,T)		
STAGE(TAPE3,VSN=11140,T)		
STAGE(TAPE4,VSN=15306,T)		
FTN(OPT,R)		
LOAD(LGO)		
NOGO(X)		
X(PL=100000)		
7 ₈₉		
SOURCE DECK		
7 ₈₉		
NAMELIST DATA		
6 ₇₈₉		

Figure 5-1. Sample MPM Deck Structure and Control Cards

6. Bibliography

1. Solar Total Energy Systems Second Technical Progress Report, The Aerospace Corporation, ATR-77(7692-01)-2, 1 December 1977.
2. Solar Total Energy System Final Technical Summary Report, Volume I, Solar Total Energy Systems Market Penetration, The Aerospace Corporation, ATR-78(7692-01)-1, 31 March 1978.
3. STES Applications Model (SAM) User's Guide, The Aerospace Corporation, ATR-78(7748)-02, September 1978.
4. Solar Total Energy Systems Final Technical Summary Report, Volume II, Energy Use and Price Forecasts, Prepared for The Aerospace Corporation by Sherman H. Clark Associates, ATR-78(7692-01)-1, 31 March 1978.

Appendix - MPM Source Listing

```

1      PROGRAM MPM (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE1,TAPE2,
      *    TAPE3,TAPE4)
      C
      C      MPM - MARKET PENETRATION MODEL
5      C      DEVELOPED MAR 1978 BY BRUCE TIMMER
      C      OF THE SYSTEMS SIMULATION AND ANALYSIS DEPARTMENT
      C      OF THE AEROSPACE CORPORATION.
      C
      REAL MARKGR,MARKPN,KK,MARKPE,MARKPT
10     DIMENSION Y(20,7,11),OY(20,7,11),JSG(50),CBART(50,7),CBARE(50,7)
      *    ,CT(50,7),CE(50,7),EI(20),FMT(50,7,4),FME(50,7,6)
      *    ,INDCODE(140),TECR(11),FRF(11),FILE(7),AECR(11),PS(20,8)
      *    ,PE(20,8),AFDT(4),AFDE(6)
      *    ,STFDS(50,4),STFDI(140,4)
15     *    ,SUMS(50),SUMI(140)
      *    ,SEFDS(50,6),SEFDI(140,6)
      *    ,STFDN(4),SEFDN(6),STFDNS(4),SEFDNS(6)
      *    ,SFDS(50,6),SFDI(140,6)
      *    ,APP(3,140)
20     *    ,ISTA(50)
      *    ,TED(140)
      *    ,STFDN(6),STFDNS(6)
      *    ,AFDS(6)
      C
      C      EMI IS ARRAY OF ENERGY DEMANDS FOR 140 INDUSTRIES, 50 STATES,
25     C      AND 7 TIME PERIODS. EMI IS STORED IN LCM.
      C
      COMMON EMI(140,50,7)
      LEVEL 2, EMI
30     C
      C      LOC IS TABLE CONTAINING NAMES FOR 50 STATES.
      C
      DOUBLE LOC(50)
      DATA (LOC(ILOC),ILOC=1,36,1)
35     1/20HALABAMA      ,      20HALASKA      ,
      2 20HARIZONA      ,      20HARKANSAS     ,
      3 20HCALIFORNIA    ,      20HCOLORADO    ,
      4 20HCONNECTICUT   ,      20HDELAWARE    ,
40     5 20HFLORIDA      ,      20HGEORGIA     ,
      6 20HHAWAII        ,      20HIDAHO      ,
      7 20HILLINOIS      ,      20HINDIANA    ,
      8 20HIOWA          ,      20HKANSAS     ,
      9 20HKENTUCKY      ,      20HLOUISIANA   ,
45     A 20HMAINE        ,      20HMARYLAND    ,
      B 20HMASSACHUSETTS ,      20HMICHIGAN   ,
      C 20HMINNESOTA     ,      20HMISSISSIPPI ,
      D 20HMISSCURI      ,      20HMONTANA    ,
      E 20HNEBRASKA      ,      20HNEVADA     ,
50     F 20HNEW HAMPSHIRE ,      20HNEW JERSEY  ,
      G 20HNEW MEXICO    ,      20HNEW YORK   ,
      H 20HNORTH CAROLINA ,      20HNORTH DAKOTA ,
      I 20HOHIO          ,      20HOKLAHOMA   /
      DATA (LOC(ILOC),ILOC=37,50,1)

```

55	1/20HOREGON	,	20HPENNSYLVANIA	,	00000054
	2 20HRHODE ISLAND	,	20HSOUTH CAROLINA	,	00000055
	3 20HSOUTH DAKOTA	,	20HTENNESSEE	,	00000056
	4 20HTEXAS	,	20HUTAH	,	00000057
	5 20HVERMONT	,	20HVIRGINIA	,	00000058
	6 20HWASHINGTON	,	20HWEST VIRGINIA	,	00000059
60	7 20HWISCONSIN	,	20HWYOMING	/	00000060
					00000061
					00000062
					00000063
					00000064
65	2 DATA (APP(IA),IA=1,60,3) / 30HMEAT PRODUCTS	,			00000065
	3 30HDAIRY PRODUCTS	,			00000066
	4 30HPRESERVED FRUITS AND VEGETABLE	,			00000067
	5 30HGRAIN MILL PRODUCTS	,			00000068
	6 30HBAKERY PRODUCTS	,			00000069
70	7 30HSUGAR, CONFECTIONERY PRODUCTS	,			00000070
	8 30HFATS AND OILS	,			00000071
	9 30HBEVERAGES	,			00000072
	A 30HMISC. FOODS, KINDRED PRODUCTS	,			00000073
	1 30HCIGARETTES	,			00000074
75	2 30HCIGARS	,			00000075
	3 30HCHEWING AND SMOKING TOBACCO	,			00000076
	4 30HTOBACCO STEMMING AND REDRYING	,			00000077
	5 30HWEAVING MILLS, COTTON	,			00000078
	6 30HWEAVING MILLS, MANMADE FIBER	,			00000079
80	7 30HWEAVING, FINISHING MILLS, WOOL	,			00000080
	8 30HNARROW FABRIC MILLS	,			00000081
	9 30HKNITTING MILLS	,			00000082
	A 30HTEXTILE FINISHING, EXCEPT WOOL	,			00000083
	DATA (APP(IA),IA=61,120,3) / 30HYARN AND THREAD MILLS	,			00000084
85	2 30HFLOOR COVERING MILLS	/			00000085
	3 30HMISCELLANEOUS TEXTILE GOODS	,			00000086
	4 30HMEN>S AND BOYS> SUITS AND COAT	,			00000087
	5 30HMEN>S AND BOYS> FURNISHINGS	,			00000088
	6 30HWOMEN>S AND MISSES> OUTERWEAR	,			00000089
90	7 30HWOMEN>S, CHILDREN>S UNDERGARMS	,			00000090
	8 30HHATS, CAPS, AND MILLINERY	,			00000091
	9 30HCHILDREN>S OUTERWEAR	,			00000092
	A 30HMISC. APPAREL AND ACCESSORIES	,			00000093
	1 30HMISC. FABRICATED TEXTILE PRODS	,			00000094
95	2 30HLOGGING CAMPS, LOG CONTRACTORS	,			00000095
	3 30HSAWMILLS AND PLANING MILLS	,			00000096
	4 30HMTLWORK, PLYWOOD, STRUC. MEMB	,			00000097
	5 30HWOOD CONTAINERS	,			00000098
	6 30HWOOD BUILDINGS AND MOBILE HOME	,			00000099
100	7 30HMISCELLANEOUS WOOD PRODUCTS	,			00000100
	8 30HHOUSEHOLD FURNITURE	,			00000101
	9 30HOFFICE FURNITURE	,			00000102
	A 30HPUBLIC BLDG., RELATED FURNITUR	,			00000103
	DATA (APP(IA),IA=121,180,3) / 30HMISC. FURNITURE AND FIXTURES	,			00000104
105	2 30HPARTITIONS AND FIXTURES	/			00000105
	3 30HPULPMILLS	,			00000106
	3 30HPAPERMILLS, EXC. BUILDING PAPE	,			00000106

	4	30HPAPERBOARD MILLS	, 00000107
	5	30HMISC. CONVERTED PAPER PRODUCTS,	00000108
	6	30HPAPERBOARD CONTAINERS AND BOXE,	00000109
110	7	30HBUILDING PAPER AND BOARD MILLS,	00000110
	8	30HNEWSPAPERS	, 00000111
	9	30HPERIODICALS	, 00000112
	A	30HBOOKS	, 00000113
	1	30HMISCELLANEOUS PUBLISHING	, 00000114
115	2	30HCOMMERCIAL PRINTING	, 00000115
	3	30HMANIFOLD BUSINESS FORMS	, 00000116
	4	30HGREETING CARD PUBLISHING	, 00000117
	5	30HBLANKBOOKS AND BOOKBINDING	, 00000118
	6	30HFRINTING TRADE SERVICES	, 00000119
120	7	30HINDUSTRIAL INORGANIC CHEMICALS,	00000120
	8	30HPLASTICS MATERIALS, SYNTHETICS,	00000121
	9	30HDRUGS	, 00000122
	A	30HSOAP, CLEANERS, TOILET GOODS /	00000123
		DATA (APP(IA),IA=181,240,3) /30HPAINTS AND ALLIED PRODUCTS	, 00000124
125	2	30HINDUSTRIAL ORGANIC CHEMICALS	, 00000125
	3	30HAGRICULTURAL CHEMICALS	, 00000126
	4	30HMISCELLANEOUS CHEMICAL PRODUCT,	00000127
	5	30HPETROLEUM REFINING	, 00000128
	6	30HPAVING AND ROOFING MATERIALS	, 00000129
130	7	30HMISC. PETROLEUM, COAL PRODUCTS,	00000130
	8	30HTIRES AND INNER TUBES	, 00000131
	9	30HRUBBER AND PLASTICS FOOTWEAR	, 00000132
	A	30HRUBBER, PLASTICS HOSE, BELTING,	00000133
	1	30HFABRICATED RUBBER PRODUCTS, NE,	00000134
135	2	30HMISCELLANEOUS PLASTICS PRODUCT,	00000135
	3	30HLEATHER TANNING AND FINISHING	, 00000136
	4	30HBOOT, SHOE CUT STOCK, FINDINGS,	00000137
	5	30HFOOTWEAR, EXCEPT RUBBER	, 00000138
	6	30HLEATHER GLOVES AND MITTENS	, 00000139
140	7	30HLUGGAGE	, 00000140
	8	30HWOMEN'S HANDBAGS AND PURSES	, 00000141
	9	30HFLAT GLASS	, 00000142
	A	30HGLASS, PRESSED OR BLOWN	/ 00000143
		DATA (APP(IA),IA=241,300,3) /30HPRODUCTS OF PURCHASED GLASS	, 00000144
145	2	30HCEMENT, HYDRAULIC	, 00000145
	3	30HSTRUCTURAL CLAY PRODUCTS	, 00000146
	4	30HPOTTERY AND RELATED PRODUCTS	, 00000147
	5	30HCONCRETE, GYPSUM, PLASTER PROD,	00000148
	6	30HCUT STONE AND STONE PRODUCTS	, 00000149
150	7	30HMISC. NONMETALLIC MINERAL PROD,	00000150
	8	30HBLAST FURNACE, BASIC STEEL PRO,	00000151
	9	30HIRON AND STEEL FOUNDRIES	, 00000152
	A	30HPRIMARY NONFERROUS METALS	, 00000153
	1	30HSECONDARY NONFERROUS METALS	, 00000154
155	2	30HNONFERROUS ROLLING AND DRAWING,	00000155
	3	30HNONFERROUS FOUNDRIES	, 00000156
	4	30HMISC. PRIMARY METAL PRODUCTS	, 00000157
	5	30HMETAL CANS, SHIPPING CONTAINER,	00000158
	6	30HCUTLERY, HANDTOOLS AND HARDWAR,	00000159

PROGRAM, MPM

76/76 OPT=2

FTN 4.6+428b

09/13/78 14.08.55\$

160	7	30HPLUMBING, HEATING, EXCEPT ELEC,	00000160
	8	30HFABRICATED STRUC. METAL PRODS ,	00000161
	9	30HSCREW MACHINE PROD., BOLTS, ET,	00000162
	A	30HMETAL FORGINGS AND STAMPINGS /	00000163
		DATA (APP(IA),IA=301,360,3) /30HMETAL SERVICES, NEC	00000164
165	2	30HORDNANCE AND ACCESSORIES, NEC ,	00000165
	3	30HMISC. FABRICATED METAL PRODUCT,	00000166
	4	30HENGINES AND TURBINES ,	00000167
	5	30HFARM AND GARDEN MACHINERY ,	00000168
	6	30HCONSTRUCTION, RELATED MACHINER,	00000169
170	7	30HMETALWORKING MACHINERY ,	00000170
	8	30HSPECIAL INDUSTRY MACHINERY ,	00000171
	9	30HGENERAL INDUSTRIAL MACHINERY ,	00000172
	A	30HOFFICE AND COMPUTING MACHINES ,	00000173
	1	30HREFRIGERATION AND SERVICE MACH,	00000174
175	2	30HMISC. MACHINERY, EXC. ELEC ,	00000175
	3	30HELECTRIC DISTRIBUTING EQUIPMEN,	00000176
	4	30HELECTRICAL INDUSTRIAL APPARATU,	00000177
	5	30HHOUSEHOLD APPLIANCES ,	00000178
	6	30HELEC. LIGHTING, WIRING EQUIP ,	00000179
180	7	30HRADIO, TV RECEIVING EQUIPMENT ,	00000180
	8	30HCOMMUNICATION EQUIPMENT ,	00000181
	9	30HELECTRONIC COMPONENTS, ACCESS ,	00000182
	A	30HMISC. ELEC. EQUIPMENT, SUPPLIE/	00000183
		DATA (APP(IA),IA=361,420,3) /30HMOTOR VEHICLES AND EQUIPMENT ,	00000184
185	2	30HAIRCRAFT AND PARTS ,	00000185
	3	30HSHIP, BOAT BUILDING, REPAIRING,	00000186
	4	30HRAILROAD EQUIPMENT ,	00000187
	5	30HMOTORCYCLES, BICYCLES, PARTS ,	00000188
	6	30HGUIDED MISSILES, SPACE VEHICLE,	00000189
190	7	30HTRANSPORTATION EQUIPMENT, NEC ,	00000190
	8	30HENGINEERING, SCIENTIFIC INSTRU,	00000191
	9	30HMEASURING, CONTROLLING DEVICES,	00000192
	A	30HOPTICAL INSTRUMENTS AND LENSES,	00000193
	1	30HMEDICAL INSTRUMENTS, SUPPLIES ,	00000194
195	2	30HOPHTHALMIC GOODS ,	00000195
	3	30HPHOTOGRAPHIC EQUIP., SUPPLIES ,	00000196
	4	30HWATCHES, CLOCKS, AND WATCHCASE,	00000197
	5	30HJEWELRY, SILVER AND PLATED WAR,	00000198
	6	30HMUSICAL INSTRUMENTS ,	00000199
200	7	30HTOYS AND SPORTING GOODS ,	00000200
	8	30HPENS, OFFICE AND ART GOODS ,	00000201
	9	30HCOSTUME JEWELRY AND NOTIONS ,	00000202
	A	30HMISCELLANEOUS MANUFACTURES /	00000203
	C		00000204
205	C	ISTA IS TABLE OF CORRESPONDENCE BETWEEN SHERMAN CLARK	00000205
	C	ORDERING OF STATES AND ALPHABETICAL ORDER.	00000206
	C		00000207
		DATA ISTA /7,19,21,29,39,45,30,32,38,13,14,22,35,49,15,16,23,25	00000208
	*	,27,34,41,8,9,10,20,33,40,46,48,17,42,1,24,36,4,18,43,3,6,12	00000209
210	*	,26,28,31,44,50,5,37,47,2,11/	00000210
	C		00000211
	C	JSG IS TABLE OF CORRESPONDENCE BETWEEN THE 50 STATES AND THE	00000212

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C      7 GROUPS OF STATES.                                00000213
C                                                                 00000214
215 DATA (JSG(I),I=1,50) /2,1,4,4,6,5,2,1,2,3,1,7,5,2,3,4,5,5,3,2,2, 00000215
*      3,5,3,4,7,5,4,4,2,4,4,3,3,5,5,7,2,1,3,5,5,7,3,2,3,7,2,3,5/ 00000216
C                                                                 00000217
C      KK IS FINANCIAL RISK CONSTANT MULTIPLIER.           00000218
C      TRFMAX IS MAXIMUM TECHNICAL RISK CONSTANT MULTIPLIER. 00000219
220 C      FDMAX IS MAXIMUM PERCENT FUEL DISPLACEMENT CONSTANT MULTIPLIER 00000220
C      NN IS LIFE OF STES PLANT (NN = NUMBER OF 5-YEAR TIME PERIODS 00000221
C      MINUS 1).                                           00000222
C      SUITF IS STES SUITABILITY FACTOR FOR LAND AVAILABILITY. 00000223
C      RPLMTF IS REPLACEMENT FACTOR OF PRE-EXISTING INDUSTRY 00000224
225 C      STRUCTURES.                                     00000225
C      ECRM IS ECR MULTIPLIER.                             00000226
C                                                                 00000227
C      DATA KK /.25/                                     00000228
*      ,TRFMAX /.1/                                       00000229
230 *      ,FDMAX /80./                                   00000230
*      ,NN /6/                                           00000231
*      ,SUITF /.9/                                       00000232
*      ,RPLMTF /.05/                                     00000233
*      ,ECRM /1.0/                                       00000234
235 *      ,IPRINT /0/                                    00000235
C                                                                 00000236
C      EI IS TABLE OF ENERGY INTENSIVENESS VALUES OF THE 20 00000237
C      INDUSTRY GROUPS.                                   00000238
C                                                                 00000239
240 C      DATA (EI(I),I=1,20) /.19,.08,.37,.12,.43,.19,.76,.14,.71,.52,.35 00000240
*      ,.18,1.0,.88,.24,.19,.17,.13,.17,.18/ 00000241
C                                                                 00000242
C      YEAR CONTAINS DEFAULT VALUE OF NAMELIST VARIABLE IDENTIFYING 00000243
C      YEAR OF INPUT DATA TO BE STUDIED.                 00000244
245 C      FILE IS ARRAY CONTAINING ALPHANUMERIC IDENTIFIERS OF YEARS 00000245
C      WITH DATA AVAILABLE TO BE STUDIED.                 00000246
C                                                                 00000247
C      DATA YEAR /10H1985      /,FILE /10H1985      , 00000248
*      10H1990      ,10H1995      ,10H2000      , 00000249
250 *      10H2005      ,10H2010      ,10H2015      / 00000250
C                                                                 00000251
C      INDCODE IS TABLE OF 3-DIGIT SIC CODES FOR THE 140 INDUSTRIES. 00000252
C                                                                 00000253
C      DATA INDCODE /                                     00000254
255 1 201, 202, 203, 204, 205, 206, 207, 208, 209, 211, 00000255
1 212, 213, 214, 221, 222, 223, 224, 225, 226, 227, 00000256
1 228, 229, 231, 232, 233, 234, 235, 236, 238, 239, 00000257
1 241, 242, 243, 244, 245, 249, 251, 252, 253, 254, 00000258
1 259, 261, 262, 263, 264, 265, 266, 271, 272, 273, 00000259
260 1 274, 275, 276, 277, 278, 279, 281, 282, 283, 284, 00000260
1 285, 286, 287, 289, 291, 295, 299, 301, 302, 304, 00000261
1 306, 307, 311, 313, 314, 315, 316, 317, 321, 322, 00000262
1 323, 324, 325, 326, 327, 328, 329, 331, 332, 333, 00000263
1 334, 335, 336, 339, 341, 342, 343, 344, 345, 346, 00000264
265 1 347, 348, 349, 351, 352, 353, 354, 355, 356, 357, 00000265

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1  358, 359, 361, 362, 363, 364, 365, 366, 367, 369, 00000266
1  371, 372, 373, 374, 375, 376, 379, 381, 382, 383, 00000267
1  384, 385, 386, 387, 391, 393, 394, 395, 396, 399/ 00000268
C
C      PS IS TABLE CONTAINING THE 8 CUMULATIVE PERCENT SIZE
C      DISTRIBUTION VALUES FOR THE 20 INDUSTRY GROUPS.
C
DATA (PS(1,J),J=1,8) / .1,.6,2.5,8.0,24.2,43.6,76.4,100./ 00000270
DATA (PS(2,J),J=1,8) / 3.4,7.4,14.9,28.7,52.3,65.5,88.5,100./ 00000271
275 DATA (PS(3,J),J=1,8) / .2,2.2,8.2,20.2,40.2,57.8,83.4,100./ 00000272
DATA (PS(4,J),J=1,8) / .3,.3,1.7,7.2,21.9,42.5,76.7,100./ 00000273
DATA (PS(5,J),J=1,8) / .20,.20,.7,3.1,15.2,31.9,64.3,100./ 00000274
DATA (PS(6,J),J=1,8) / .1,.6,2.6,7.5,21.6,39.3,72.7,100./ 00000275
280 DATA (PS(7,J),J=1,8) / 1.3,1.3,4.7,11.9,37.6,57.3,84.9,100./ 00000276
DATA (PS(8,J),J=1,8) / .7,.7,1.9,4.7,13.0,26.6,61.4,100./ 00000277
DATA (PS(9,J),J=1,8) / .6,2.4,5.4,11.1,23.6,40.1,73.1,100./ 00000278
DATA (PS(10,J),J=1,8) / .5,2.2,5.7,11.3,25.8,40.0,70.2,100./ 00000279
285 DATA (PS(11,J),J=1,8) / .2,1.5,3.4,8.2,24.2,43.9,76.8,100./ 00000280
DATA (PS(12,J),J=1,8) / .3,.3,3.5,18.5,38.4,55.8,82.5,100./ 00000281
DATA (PS(13,J),J=1,8) / .1,.7,2.3,5.5,15.6,28.9,65.2,100./ 00000282
DATA (PS(14,J),J=1,8) / 1.5,4.0,8.4,17.3,35.3,53.2,81.2,100./ 00000283
DATA (PS(15,J),J=1,8) / .2,.8,2.5,6.7,18.9,35.4,70.9,100./ 00000284
DATA (PS(16,J),J=1,8) / .4,1.6,3.9,7.8,17.2,30.0,62.1,100./ 00000285
290 DATA (PS(17,J),J=1,8) / 1.4,4.4,9.6,18.3,35.2,52.3,79.6,100./ 00000286
DATA (PS(18,J),J=1,8) / 3.5,6.3,10.3,17.3,31.4,48.3,77.0,100./ 00000287
DATA (PS(19,J),J=1,8) / .5,2.6,6.3,12.2,26.6,41.5,72.1,100./ 00000288
DATA (PS(20,J),J=1,8) / .0,.5,1.7,5.5,15.9,30.9,64.3,100./ 00000289
C
C      PE IS TABLE CONTAINING THE 8 CUMULATIVE PERCENT ENERGY
C      DISTRIBUTION VALUES FOR THE 20 INDUSTRY GROUPS.
C
DATA (PE(1,J),J=1,8) / 3.7,3.7,26.6,47.4,73.1,86.5,96.7,100./ 00000290
DATA (PE(2,J),J=1,8) / 47.1,62.5,74.7,85.5,95.4,97.8,99.6,100./ 00000291
300 DATA (PE(3,J),J=1,8) / 5.1,21.5,45.3,69.8,87.7,94.4,98.7,100./ 00000292
DATA (PE(4,J),J=1,8) / 0.0,5.8,16.6,39.5,67.3,84.0,96.5,100./ 00000293
DATA (PE(5,J),J=1,8) / 0.0,3.8,9.9,24.3,56.2,76.0,92.2,100./ 00000294
DATA (PE(6,J),J=1,8) / 3.0,11.3,26.9,26.9,71.1,84.6,95.9,100./ 00000295
305 DATA (PE(7,J),J=1,8) / 0.0,15.9,34.0,52.2,81.9,92.2,98.6,100./ 00000296
DATA (PE(8,J),J=1,8) / 0.0,15.8,27.1,40.1,59.5,74.1,91.1,100./ 00000297
DATA (PE(9,J),J=1,8) / 15.4,36.1,51.8,51.8,81.8,81.8,97.4,100./ 00000298
310 DATA (PE(10,J),J=1,8) / 11.7,29.7,48.6,63.1,83.0,90.1,95.9,100./ 00000299
DATA (PE(11,J),J=1,8) / 8.2,25.2,37.1,52.2,75.2,87.8,97.2,100./ 00000300
DATA (PE(12,J),J=1,8) / 0.0,3.3,19.1,59.6,83.0,92.2,98.3,100./ 00000301
315 DATA (PE(13,J),J=1,8) / 3.8,14.4,30.8,46.3,67.8,80.3,94.1,100./ 00000302
DATA (PE(14,J),J=1,8) / 35.3,51.1,63.9,77.3,89.7,95.1,98.9,100./ 00000303
DATA (PE(15,J),J=1,8) / 10.0,19.0,31.6,48.1,69.7,82.9,95.5,100./ 00000304
DATA (PE(16,J),J=1,8) / 16.0,32.6,47.3,60.6,74.8,83.9,94.3,100./ 00000305
DATA (PE(17,J),J=1,8) / 26.9,46.6,63.1,77.1,89.4,94.9,98.7,100./ 00000306
DATA (PE(18,J),J=1,8) / 60.0,71.8,79.5,86.6,93.0,96.5,99.0,100./ 00000307
DATA (PE(19,J),J=1,8) / 17.6,38.4,55.1,69.2,84.1,91.2,97.5,100./ 00000308
DATA (PE(20,J),J=1,8) / 0.0,0.0,23.5,42.0,64.9,64.9,93.5,100./ 00000309
C
C      TED IS TABLE CONTAINING T/E RATIOS FOR 140 APPLICATIONS.
C

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C
320 DATA TED / 3.6,4.5,6.7,5.6,5.2,12.7,8.6,6.4,4.2,5.1,1.0,5.0
* ,4.5,1.2,1.3,3.4,2.2,3.2,9.3,7.7,.9,2.8,2.8,1.8,2.0,1.1
* ,2.7,1.1,1.8,3.1,50.6,2.4,3.4,3.5,5.4,4.6,2.7,3.6,3.6,4.0
* ,4.9,3.6,3.5,4.8,2.8,3.4,8.6,1.3,0.7,2.1,2.1,2.7,1.6,1.1
* ,1.7,1.1,1.7,7.3,4.8,7.1,4.3,8.7,10.2,11.2,15.8,15.8,18.8
325 * ,4.3,2.4,5.2,3.9,2.0,11.3,1.9,1.3,4.4,2.0,1.2,14.5,9.4,4.5
* ,13.6,24.7,10.8,20.1,2.8,2.6,5.2,3.7,.6,14.1,3.4,4.8,5.7
* ,4.9,3.7,4.7,3.6,2.7,4.6,3.3,3.7,3.0,3.0,5.5,3.7,2.6,3.0
* ,3.0,1.1,3.5,3.2,2.0,2.1,3.6,2.8,2.2,1.3,1.2,2.1,3.5,2.0
* ,2.3,1.3,2.8,1.3,3.2,1.8,1.6,1.6,2.4,4.4,8.4,2.1,2.8,3.7
330 * ,2.5,2.6,1.9,3.5/
NAMELIST /IN/ ECRM, KK, TRFMAX, IPRINT.
C
C READ IN DISTRIBUTIONS OF ECR MULTIPLIERS ON TAPE 1.
C
335 DO 10 K=1,140
READ (1) IIG, ISG, (Y(IIG-19, ISG, I), I=1, 11), (DY(IIG-19, ISG, J)
* , J=1, 11)
10 CONTINUE
C
340 READ IN ENERGY DEMAND VALUES FROM TAPE 2 INTO LCM.
C
DO 40 K=1,7
DO 30 I=1,140
READ (2) (EMI(I, J, K), J=1, 50)
345 C
C CONVERT ENERGY DEMANDS FROM TRILLIONS OF BTUS TO BTUS.
C
DO 20 J=1,50
EMI(I, J, K)=EMI(I, J, K)*1.E12
350 20 CONTINUE
30 CONTINUE
40 CONTINUE
C
355 READ IN THERMAL AND ELECTRIC FUEL MIX FRACTIONS, COSTS OF
THERMAL AND ELECTRIC ENERGY, AND LEVELIZED COSTS OF THERMAL
AND ELECTRIC ENERGY FROM TAPE 3.
C
DO 60 K=1,7
DO 50 I=1,50
360 READ (3) FME(ISTA(I), K, 1), FME(ISTA(I), K, 3), FME(ISTA(I), K, 4)
* , FME(ISTA(I), K, 5), FME(ISTA(I), K, 6), FME(ISTA(I), K, 2)
* , FMT(ISTA(I), K, 1), FMT(ISTA(I), K, 3), FMT(ISTA(I), K, 2)
* , FMT(ISTA(I), K, 4)
50 CONTINUE
365 60 CONTINUE
DO 70 I=1,50
READ (3) DUM, (CT(ISTA(I), K), K=1, 7)
READ (3) DUM, (CE(ISTA(I), K), K=1, 7)
70 CONTINUE
370 DO 90 I=1,50
READ (3) DUM, (CBARE(ISTA(I), K), K=1, 7)

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      READ (3) DUM,(CBART(ISTA(I),K),K=1,7)                                00000372
C                                                                              00000373
C      CONVERT LEVELIZED ELECTRIC COST FROM MILLS/KWH TO CENTS/MBTU. 00000374
375 C      CONVERT LEVELIZED THERMAL COST FROM DOLLARS/MBTU TO CENTS/MBTU 00000375
C                                                                              00000376
      DO 80 K=1,7                                                            00000377
      CBARE(ISTA(I),K)=CBARE(ISTA(I),K)/.03413                            00000378
      CBART(ISTA(I),K)=CBART(ISTA(I),K)*100.                              00000379
380 80 CONTINUE                                                            00000380
      90 CONTINUE                                                            00000381
C                                                                              00000382
C      READ IN NAMELIST DATA FROM INPUT STREAM. IF EOF ENCOUNTERED, 00000383
C      TERMINATE EXECUTION.                                                00000384
385 C                                                                        00000385
      100 CONTINUE                                                            00000386
      READ (5,IN)                                                            00000387
      IF (EOF(5)) 110,120                                                  00000388
      110 CONTINUE                                                            00000389
390 STOP                                                                    00000390
      120 CONTINUE                                                            00000391
C                                                                              00000392
C      WRITE NAMELIST DATA ON OUTPUT FILE.                                00000393
C                                                                              00000394
395 C      WRITE (6,IN)                                                      00000395
C                                                                              00000396
C      REWIND TAPE 4 TO ALLOW MULTIPLE PASSES OVER TAPE.                 00000397
C                                                                              00000398
      REWIND 4                                                                00000399
400 C                                                                        0000400
C      REPEAT LOOP 650 FOR SEVEN TIME PERIODS.                            00000401
C                                                                              00000402
      DO 650 NT=1,7                                                          00000403
C                                                                              00000404
405 C      SET YEAR TO THIS TIME PERIOD.                                    00000405
C                                                                              00000406
      YEAR=FILE(NT)                                                          00000407
C                                                                              00000408
C      IF SPECIAL PRINT FLAG ON (IPRINT=1), THEN PRINT HEADER.          00000409
410 C                                                                        00000410
      IF (IPRINT .EQ. 1) WRITE (6,130) YEAR                                00000411
      130 FORMAT ('1H1,* MARKET PENETRATION AND FUEL DISPLACEMENT BY *, 00000412
      *      *INDUSTRIES WITHIN STATES IN *,A10,//////')                00000413
C                                                                              00000414
415 C      INITIALIZE MARKET PENETRATION SUMS TO ZERO.                    00000415
C                                                                              00000416
      DO 160 I=1,50                                                          00000417
      SUMS(I)=0.                                                            00000418
      DO 140 J=1,4                                                           00000419
      STFDS(I,J)=0.                                                         00000420
420 140 CONTINUE                                                            00000421
      DO 150 J=1,6                                                           00000422
      SEFDS(I,J)=0.                                                         00000423
      SFDS(I,J)=0.                                                         00000424

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425	150 CONTINUE	00000425
	160 CONTINUE	00000426
	DO 190 I=1,140	00000427
	SUMI(I)=0.	00000428
	DO 170 J=1,4	00000429
430	STFDI(I,J)=0.	00000430
	170 CONTINUE	00000431
	DO 180 J=1,6	00000432
	SEFDI(I,J)=0.	00000433
	SFDI(I,J)=0.	00000434
435	180 CONTINUE	00000435
	190 CONTINUE	00000436
	DO 200 I=1,4	00000437
	STFDH(I)=0.	00000438
	STFDHS(I)=0.	00000439
440	200 CONTINUE	00000440
	DO 210 I=1,6	00000441
	SEFDH(I)=0.	00000442
	SEFDHS(I)=0.	00000443
	210 CONTINUE	00000444
445	C	00000445
	C READ IN NEXT RECORD FROM SAMRGP OUTPUT FILE - TAPE 4.	00000446
	C	00000447
	220 CONTINUE	00000448
	READ (4) JJ,II,ECR,FD,TFDT,TFDE,(AFDT(M),M=1,4),(AFDE(L),L=1,6),R	00000449
450	IF (EOF(4)) 430,230	00000450
	230 CONTINUE	00000451
	C	00000452
	C MULTIPLY ECR BY ECR MULTIPLIER.	00000453
	C	00000454
455	ECR=ECR*ECRM	00000455
	C	00000456
	C DETERMINE INDUSTRY GROUP.	00000457
	C	00000458
	IG=INDCODE(II)/10-19	00000459
460	C	00000460
	C DETERMINE STATE GROUP.	00000461
	C	00000462
	IS=JSG(JJ)	00000463
	C	00000464
465	C ACCESS THE APPROPRIATE TECR MULTIPLICATIVE FACTOR DISTRIBUTION	00000465
	C AND COMPUTE THE TECR VECTOR.	00000466
	C	00000467
	DO 240 L=1,11	00000468
	TECR(L)=ECR*Y(IG,IS,L)	00000469
470	240 CONTINUE	00000470
	C	00000471
	C ACCESS THE APPROPRIATE CBART,CBARE,CT AND CE VALUES AND	00000472
	C COMPUTE THE FINANCIAL RISK FACTOR VECTOR FRF.	00000473
	C	00000474
475	FRFM=(CBART(JJ,NT)*R+CBARE(JJ,NT))/(CT(JJ,NT)*R+CE(JJ,NT))	00000475
	DO 250 M=1,11	00000476
	FRF(M)=KK*(TECR(M)*FRFM-1)	00000477

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      IF (FRF(M) .LT. 0.) FRF(M)=0.                                00000478
250 CONTINUE                                                    00000479
480 C                                                            00000480
      C ACCESS THE ENERGY INTENSIVENESS VALUE FOR THIS INDUSTRY GROUP 00000481
      C AND CALCULATE THE TECHNICAL RISK FACTOR, TRF.              00000482
      C                                                            00000483
      TRF=TRFMAX*(1.-EI(IG)*FD/FDMAX)*(1-(NT-1)/NN)              00000484
485 C                                                            00000485
      C COMPUTE THE ADJUSTED EQUIVALENT COST RATIO VECTOR, AECR.  00000486
      C                                                            00000487
      DO 260 M=1,11                                              00000488
      AECR(M)=TECR(M)+FRF(M)+TRF                                00000489
490 260 CONTINUE                                                00000490
      C                                                            00000491
      C DETERMINE THE PERCENT CUMULATIVE POPULATION OF STES - PCPS 00000492
      C CORRESPONDING TO WHERE AECR = 1.                          00000493
      C                                                            00000494
495 C                                                            00000495
      PCPS=0.0                                                  00000496
      DO 270 M=2,11                                              00000497
      IF (AECR(M) .GT. 1.) GO TO 280                            00000498
270 CONTINUE                                                    00000499
      PCPS=100.                                                  00000500
500 GO TO 290                                                    00000501
      280 CONTINUE                                              00000502
      MM=M-1                                                    00000503
      IF (AECR(1) .GE. 1.) GO TO 290                            00000504
      PCPS=DY(IG,IS,MM)+(DY(IG,IS,M)-DY(IG,IS,MM))*(1-AECR(MM))/ 00000505
505 * (AECR(M)-AECR(MM))                                       00000506
      PCPS=PCPS*100.                                           00000507
      C                                                            00000508
      C USE PCPS TO CALCULATE THE PERCENT CUMULATIVE ENERGY MARKET - 00000509
      C PCEM.                                                    00000510
510 C                                                            00000511
      290 CONTINUE                                              00000512
      IF (PCPS .GT. PS(IG,1) .A. PCPS .GT. 1.0) GO TO 300      00000513
      PCEM=0.                                                    00000514
      GO TO 330                                                  00000515
515 300 CONTINUE                                                00000516
      DO 310 I=2,8                                              00000517
      IF (PCPS .LT. PS(IG,I)) GO TO 320                        00000518
310 CONTINUE                                                    00000519
      PCEM=100.                                                  00000520
520 GO TO 330                                                    00000521
      320 CONTINUE                                              00000522
      IM=I-1                                                    00000523
      PCEM=PE(IG,IM)+(PE(IG,I)-PE(IG,IM))*(PCPS-PS(IG,IM))/ 00000524
      * (PS(IG,I)-PS(IG,IM))                                   00000525
525 330 CONTINUE                                                00000526
      C                                                            00000527
      C COMPUTE EFFECTIVE MARKET FOR STES - EMARKT.            00000528
      C                                                            00000529
      IF (NT .NE. 1) GO TO 340                                  00000530
530 MARKGR=(EMI(II,JJ,2)-EMI(II,JJ,1))/5.

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GO TO 350
340 CONTINUE
MARKGR=(EMI(II,JJ,NT)-EMI(II,JJ,NT-1))/5.
350 CONTINUE
535 AEMI=EMI(II,JJ,1)
IF (NT .GE. 6) AEMI=EMI(II,JJ,NT-4)
EMARKT=SUITF*(MARKGR+AEMI*RPLMTF)
C
C      COMPUTE AMOUNT OF THERMAL FUEL DISPLACED - AFT.
540 C
AFT=AFE=0.
DO 360 I=1,4
AFT=AFT+AFDT(I)
360 CONTINUE
545 C
C      COMPUTE AMOUNT OF ELECTRIC FUEL DISPLACED - AFE.
C
DO 370 I=1,6
AFE=AFE+AFDE(I)
550 370 CONTINUE
C
C      COMPUTE MARKET PENETRATION - MARKPN.
C
MARKPN=EMARKT*PCEM/100.
MARKPE=MARKPN/(1+TED(II))
555 MARKPT=MARKPN-MARKPE
MARKPN=(TFDT*MARKPT+TFDE*MARKPE)/100.
C
C      ACCUMULATE MARKET PENETRATION BY INDUSTRY AND BY STATE.
C
560 SUMI(II)=SUMI(II)+MARKPN
SUMS(JJ)=SUMS(JJ)+MARKPN
C
C      COMPUTE AMOUNT AND TYPE OF FUELS DISPLACED BY MARKET
565 C
C      PENETRATION.
C
DO 380 I=1,4
AFDT(I)=TFDT*FMT(JJ,NT,I)*MARKPT/100.
380 CONTINUE
570 DO 390 I=1,6
AFDE(I)=TFDE*FME(JJ,NT,I)*MARKPE/100.
390 CONTINUE
AFDS(1)=AFDT(1)+AFDE(1)
AFDS(2)=AFDT(2)+AFDE(2)
575 AFDS(3)=AFDT(3)+AFDE(3)
AFDS(4)= AFDE(4)
AFDS(5)= AFDE(5)
AFDS(6)=AFDT(4)+AFDE(6)
IF (MARKPN .NE. 0. .A. IPRINT .EQ. 1)
580 *WRITE (6,400) (APP(J,II),J=1,3),LOC(JJ),(AFDT(I),I=1,4),MARKPN,
* (AFDE(I),I=1,6),(AFDS(I),I=1,6)
400 FORMAT (/ ,1X,3A10,4X,6HMARKET,28X,17HFUEL DISPLACEMENT,/
* ,33X,11HPENETRATION,12X,11HNATURAL GAS,8X,3HOIL,7X,4HCOAL

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585      *      ,4X,7HNUCLEAR,6X,5HHYDRO,6X,5HOTHER,/      00000584
      *      ,1X,2A10,25X,7HTHERMAL,3X,3E11.2,22X,E11.2,/      00000585
      *      ,33X,E11.2,2X,8HELECTRIC,2X,6E11.2,/      00000586
      *      46X,5HTOTAL,5X,6E11.2,/)      00000587
C      00000588
C      ACCUMULATE AMOUNT AND TYPE OF FUELS DISPLACED BY MARKET      00000589
590      C      PENETRATION BY INDUSTRY AND BY STATE.      00000590
      C      00000591
      DO 410 I=1,4      00000592
      STFDI(II,I)=STFDI(II,I)+AFDT(I)      00000593
      STFDS(JJ,I)=STFDS(JJ,I)+AFDT(I)      00000594
595      410 CONTINUE      00000595
      DO 420 I=1,6      00000596
      SEFDI(II,I)=SEFDI(II,I)+AFDE(I)      00000597
      SEFDS(JJ,I)=SEFDS(JJ,I)+AFDE(I)      00000598
      420 CONTINUE      00000599
600      GO TO 220      00000600
      430 CONTINUE      00000601
C      00000602
C      ACCUMULATE AMOUNT AND TYPE OF FUELS DISPLACED BY MARKET      00000603
C      PENETRATION NATIONALLY.      00000604
605      C      00000605
      TTMP=0.      00000606
      TEMP=0.      00000607
      TTEMP=0.      00000608
      DO 460 I=1,140      00000609
      DO 440 J=1,4      00000610
      STFDN(J)=STFDN(J)+STFDI(I,J)      00000611
      440 CONTINUE      00000612
      DO 450 J=1,6      00000613
      SEFDN(J)=SEFDN(J)+SEFDI(I,J)      00000614
615      450 CONTINUE      00000615
      460 CONTINUE      00000616
      DO 470 I=1,4      00000617
      TTMP=TTMP+STFDN(I)      00000618
      470 CONTINUE      00000619
620      DO 480 I=1,6      00000620
      TEMP=TEMP+SEFDN(I)      00000621
      480 CONTINUE      00000622
      TTEMP=TTEMP+TEMP      00000623
      DO 490 J=1,3      00000624
      STEFDN(J)=STFDN(J)+SEFDN(J)      00000625
625      490 CONTINUE      00000626
      STEFDN(4)=SEFDN(4)      00000627
      STEFDN(5)=SEFDN(5)      00000628
      STEFDN(6)=STFDN(4)+SEFDN(6)      00000629
630      DO 520 I=1,50      00000630
      DO 500 J=1,4      00000631
      STFDNS(J)=STFDNS(J)+STFDS(I,J)      00000632
      500 CONTINUE      00000633
      DO 510 J=1,6      00000634
      SEFDNS(J)=SEFDNS(J)+SEFDS(I,J)      00000635
635      510 CONTINUE      00000636

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520 CONTINUE                                00000637
      TTMS=TEMPS-TTMS=0.                    00000638
      DO 530 I=1,4                          00000639
640      TTMS=TTMS+STFDS(I)                  00000640
530 CONTINUE                                00000641
      DO 540 I=1,6                          00000642
      TEMPS=TEMPS+SEFDS(I)                  00000643
645      540 CONTINUE                        00000644
      TTMS=TTMS+TEMPS                       00000645
      DO 550 J=1,3                          00000646
      SEFDS(J)=STFDS(J)+SEFDS(J)            00000647
550 CONTINUE                                00000648
      SEFDS(4)=SEFDS(4)                     00000649
650      SEFDS(5)=SEFDS(5)                   00000650
      SEFDS(6)=STFDS(4)+SEFDS(6)            00000651
      C                                     00000652
      C      FORM TOTAL FUEL DISPLACEMENTS (SUM OF THERMAL AND ELECTRIC) 00000653
      C      FOR EACH STATE.                00000654
655      C                                     00000655
      DO 560 I=1,50                          00000656
      SFDS(I,1)=STFDS(I,1)+SEFDS(I,1)        00000657
      SFDS(I,2)=STFDS(I,2)+SEFDS(I,2)        00000658
      SFDS(I,3)=STFDS(I,3)+SEFDS(I,3)        00000659
660      SFDS(I,4)=SEFDS(I,4)               00000660
      SFDS(I,5)=SEFDS(I,5)                   00000661
      SFDS(I,6)=STFDS(I,4)+SEFDS(I,6)        00000662
560 CONTINUE                                00000663
      C                                     00000664
665      C      FORM TOTAL FUEL DISPLACEMENTS FOR EACH INDUSTRY. 00000665
      C                                     00000666
      DO 570 I=1,140                          00000667
      SFDI(I,1)=STFDI(I,1)+SEFDI(I,1)        00000668
      SFDI(I,2)=STFDI(I,2)+SEFDI(I,2)        00000669
670      SFDI(I,3)=STFDI(I,3)+SEFDI(I,3)    00000670
      SFDI(I,4)=SEFDI(I,4)                   00000671
      SFDI(I,5)=SEFDI(I,5)                   00000672
      SFDI(I,6)=STFDI(I,4)+SEFDI(I,6)        00000673
570 CONTINUE                                00000674
      C                                     00000675
675      C      PRINT HEADER FOR STATES. 00000676
      C                                     00000677
      WRITE (6,575) YEAR                     00000678
575 FORMAT (1H1,* MARKET PENETRATION AND FUEL DISPLACEMENT BY STATE*, 00000679
680      * * IN *,A10,//////)               00000680
      C                                     00000681
      C      WRITE OUT STATE TOTALS FOR MARKET PENETRATION AND FUEL 00000682
      C      DISPLACEMENT.                  00000683
      C                                     00000684
685      DO 590 I=1,50                          00000685
      WRITE (6,580) LOC(I),(STFDS(I,J),J=1,4),SUMS(I) 00000686
      *      ,(SEFDS(I,K),K=1,6)             00000687
      *      ,(SFDS(I,L),L=1,6)              00000688
580 FORMAT(1X,2A10,14X,6HMARKET,28X,17HFUEL DISPLACEMENT, / 00000689

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690      *      ,33X,11HPENETRATION,12X,11HNATURAL GAS,8X,3HOIL,7X,4HCOAL      00000690
      *      ,4X,7HNUCLEAR,6X,5HHYDRO,6X,5HOTHER,/      00000691
      *      ,46X,7HTHERMAL,3X,3E11.2,22X,E11.2,/      00000692
      *      ,33X,E11.2,2X,8HELECTRIC,2X,6E11.2,/      00000693
      *      ,46X,5HTOTAL,5X,6E11.2/)      00000694
695      590 CONTINUE      00000695
      C      00000696
      C      WRITE OUT NATIONAL TOTALS FOR MARKET PENETRATION AND FUEL      00000697
      C      DISPLACEMENT.      00000698
      C      00000699
700      WRITE (6,600) YEAR,TTMP,(STFDN(J),J=1,4)      00000700
      *      ,TEMP,(SEFDN(J),J=1,6)      00000701
      *      ,TTEMP,(STFDN(J),J=1,6)      00000702
      600 FORMAT (1H1,* MARKET PENETRATION AND FUEL DISPLACEMENT *,      00000703
      *      *SUMMARY FOR ALL STATES IN *,A10,//////      00000704
705      *      ,18X,*TOTAL NATURAL GAS OIL COAL NUCLEAR*      00000705
      *      ,* HYDRO OTHER*,/* THERMAL*,3X,E11.2,3X,3E11.2      00000706
      *      ,22X,E11.2,/* ELECTRIC*,2X,E11.2,3X,6E11.2,/      00000707
      *      ,* TOTAL*,5X,E11.2,3X,6E11.2,/)      00000708
      WRITE (6,610)      00000709
710      610 FORMAT (1H1)      00000710
      C      00000711
      C      PRINT HEADER FOR INDUSTRIES.      00000712
      C      00000713
      WRITE (6,615) YEAR      00000714
715      615 FORMAT (1H1,* MARKET PENETRATION AND FUEL DISPLACEMENT *,      00000715
      *      *BY INDUSTRY IN *,A10,//////)      00000716
      C      00000717
      C      WRITE OUT INDUSTRY TOTALS FOR MARKET PENETRATION AND FUEL      00000718
      C      DISPLACEMENT.      00000719
      C      00000720
720      DO 630 I=1,140      00000721
      WRITE (6,620) (APP(J,I),J=1,3)      00000722
      *      ,(STFDI(I,J),J=1,4),SUMI(I),(SEFDI(I,K),K=1,6)      00000723
      *      ,(SFDI(I,L),L=1,6)      00000724
725      620 FORMAT (1X,3A10,4X,6HMARKET,28X,17HFUEL DISPLACEMENT,/      00000725
      *      ,33X,11HPENETRATION,12X,11HNATURAL GAS,8X,3HOIL,7X,4HCOAL      00000726
      *      ,4X,7HNUCLEAR,6X,5HHYDRO,6X,5HOTHER,/      00000727
      *      ,46X,7HTHERMAL,3X,3E11.2,22X,E11.2,/      00000728
      *      ,33X,E11.2,2X,8HELECTRIC,2X,6E11.2,/      00000729
730      *      ,46X,5HTOTAL,5X,6E11.2/)      00000730
      630 CONTINUE      00000731
      C      00000732
      C      WRITE OUT NATIONAL TOTALS FOR MARKET PENETRATION AND FUEL      00000733
      C      DISPLACEMENT.      00000734
      C      00000735
735      WRITE (6,640) YEAR,TTMPS,(STFDNS(J),J=1,4)      00000736
      *      ,TEMPS,(SEFDNS(J),J=1,6)      00000737
      *      ,TTEMPS,(STFDNS(J),J=1,6)      00000738
      640 FORMAT (1H1,* MARKET PENETRATION AND FUEL DISPLACEMENT *,      00000739
      *      *SUMMARY FOR ALL INDUSTRIES IN *,A10,//////      00000740
740      *      ,18X,*TOTAL NATURAL GAS OIL COAL NUCLEAR*      00000741
      *      ,* HYDRO OTHER*,/* THERMAL*,3X,E11.2,3X,3E11.2      00000742

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PROGRAM MPM

76/76 OPT=2

FTN 4.6+428B

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*      ,22X,E11.2,/,*  ELECTRIC*,2X,E11.2,3X,6E11.2,/
*      ,*  TOTAL*,5X,E11.2,3X,6E11.2,/)
      WRITE (6,610)
650  CONTINUE
      GO TO 100
      END
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