PN-ABN-822
81809

MONTE CARLO PRODUCTION COST SIMULATION MODEL SIMPLIFIED OPERATIONG GUIDE

Prepared for:

EGYPTIAN ELECTRICITY AUTHORITY
Cairo, Egypt

HBI Reference No. 90-9215

Prepared by:

RCG/HAGLER, BAILLY, INC.
1530 Wilson Boulevard
Suite 900
Arlington, Virginia 22209-2406
(703) 351-0300

January 1992

CONTENTS

CHAPTER 1. INTRODUCTION 1

CHAPTER 2. OBJECTIVE OF THE MODEL 2

CHAPTER 3. ONE-STEP OPERATION 3

CHAPTER 4. MACRO COMMAND 4

CHAPTER 5. REQUIRED INPUT FILES 5

CHAPTER 6. READING THE OUTPUT 11

This simplified guide is intended for the reader interested in the conceptual and practical aspects of the operation of the model MCPCSM. This document avoids the description of any technical details of the programs and the input data that are not strictly necessary to understand the general operation of the model and the preparation of data for the specific case of the Egypt Electricity Pricing Study.

Nevertheless, the computer disc included with this guide has a directory called "SOURCE" which contains all the source files necessary to study the detailed algorithms, modify the programs and re-compile them. These additional source files contain sufficient information for users interested in more detailed knowledge of the model and the use for different applications.

The model is compiled to run in any IBM compatible personal computer using DOS operating system.

The model uses information on the power system and the load to calculate the marginal cost of the system by hour of the day, by day of the week, and by month. Normally, this level of detail is not necessary and the marginal cost is still calculated by hour of the day, but only for two or three categories of types of days and months, representative of peculiar load patterns.

The marginal hourly cost of the system is the additional cost involved in meeting a small increment of the hourly load.

In the computer disc included with this guide are all the files necessary to run the model and replicate the results of the Egypt Electricity Pricing Study. The only requisite to run the models and obtain those results is to invoke the command *MARCO* and then press the *ENTER* key every time the model pauses for input.

After the model stops running, the file MARCO.OUT will contain the total hourly marginal costs as well as the individual hourly components of that marginal cost which are: (1) the marginal hourly production cost, (2) the marginal hourly cost of unserved energy and (3) the marginal hourly cost of system losses.

TESTING THE MODEL

At the beginning of the operation, the model will ask if the default files are to be used. Pressing *ENTER* every time causes the model to use the default data files that correspond to those files used in the Electricity Pricing Study.

To test the operation of the model without going through the lengthy run used in the Electricity Pricing Study, a file called MCMSYS.TEST is included. When the model asks if MCMSYS.DAT should be used, the user can enter MCMSYS.TEST and then the entire model will run in a few seconds. Of course, using MCMSYS.TEST results in values of MARCO.OUT different than those used in the study.

The command *MARCO* causes the computer to perform the operations illustrated in Figure 1 and described as follows:

- Execute the production cost model MCPCSM using input files MCMSYS.DAT, MCMDEM.DAT, MCMHYD.DAT, MCMTRA.DAT and MCMMAN.DAT
- Produce the output files MCMOUT.OUT, MCMTEM.OUT and MCMVEC.OUT
- Copy the contents of file MCMVEC.OUT to a file TRA.MCM
- Use the file TRA.MCM together with files TRA.HRL and TRA.INP as input to the transfer model TRA.
- Execute the transfer model TRA and produce the final output file MARCO.OUT

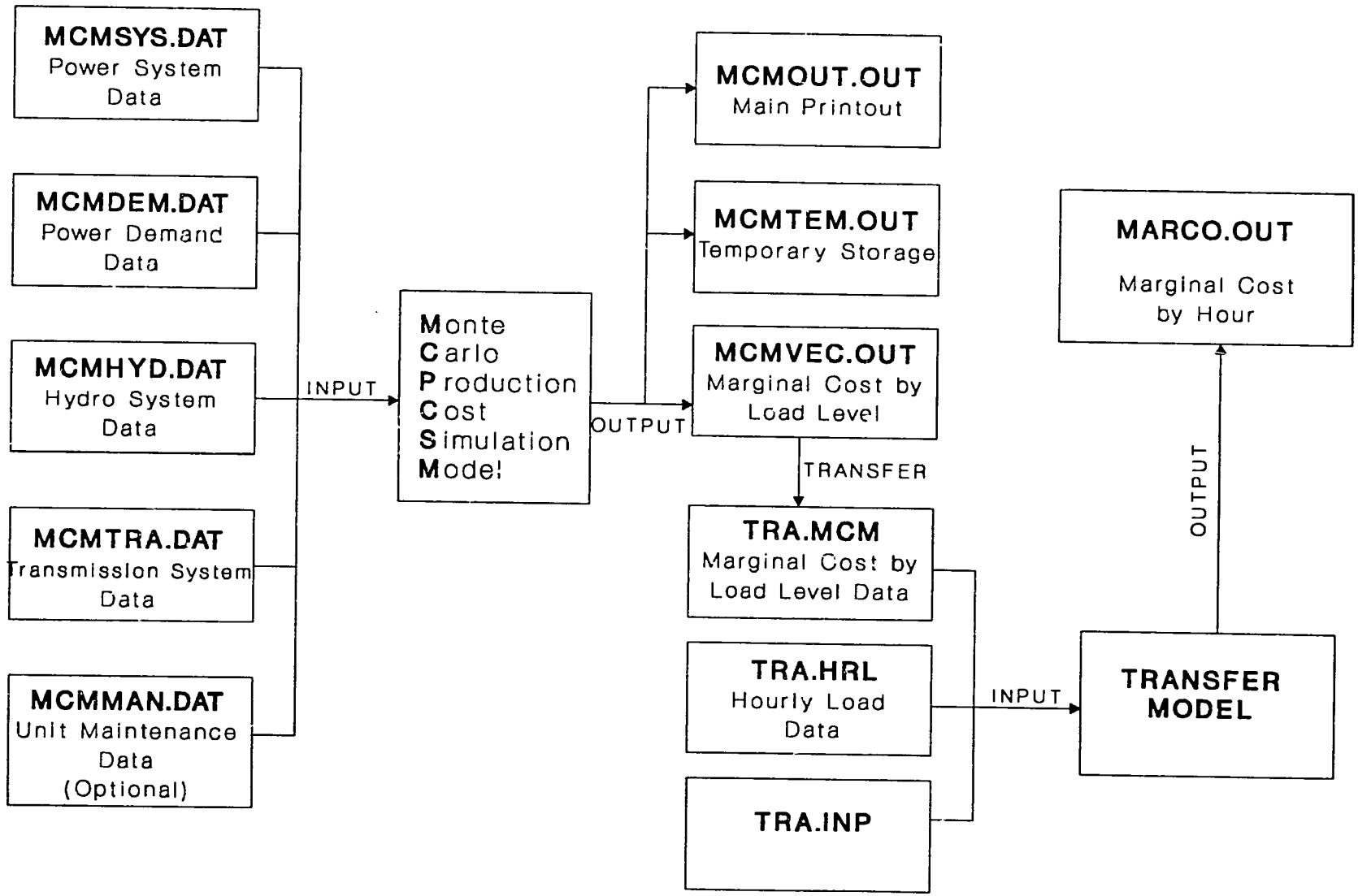
Based on this procedure, before invoking *MARCO*, the user must have the two programs MCPCSN.EXE and TRA.EXE, as well as the following input files:

MCMSYS.DAT
MCMDEM.DAT
MCMHYD.DAT
MCMTRA.DAT
MCMMAN.DAT

TRA.HRL
TRA.INP

In the following sections the reader will learn about the information that is contained in these files, but only that which may need to be modified for use of the model for a similar application.

OPERATION OF THE COMMAND MARCO



4a

The production cost model MCPCSM uses five input files and produces three output files. A copy of each of these files, exactly as they are in the disc, is included in an appendix at the end of this guide and the reader would benefit by referring to them while reading the description. The input files will be described first.

FILE MCMSYS.DAT

This file contains (1) the general information needed to control the model and (2) the data on the characteristics of the thermal generating units. There are many controls including the ability to obtain more detailed output for program "debugging" and follow up. However, a description of each of them would require also a detailed description of the mathematical algorithms which might confuse the reader and is not necessary for the practical use of the model.

The description will only refer to those lines and the values in each that could be changed in future runs of the model for the same application.

Lines 1 and 2

Line 1, Fields 1 to 3	These values control the creation of output files.
Line 1, Fields 4 to 9	These values are switches that control features not present in the current version of the model. It is common programming practice to leave additional control slots for possible expansion of the logic.
Line 1, Fields 10 to 14	These values identify the hydro plants for which detailed output is being requested. Up to 5 plants can be identified.
Line 1, Fields 15 to 19	These values identify thermal plants for which detailed output is being requested. Up to 5 plants can be identified.

Line 1, Field 20	The seed for a random number generation algorithm.

Line 2 contains 20 values that are exclusively dedicated to control the tracking of specific pieces of the logic for debugging purposes. They are only useful to the programmer during initial testing of the model's logic.

Lines 3 to 7

These lines contain the title of the run and can be modified at will if the length of the lines is preserved.

Line 8

Field 2 (value = 3)	the number of hydroelectric plants, and should be altered only if additional hydroelectric plants are added.
Field 3 (value = 37)	the number of thermal plants, and should also be altered if thermal plants are added or deleted from the list.

Line 9

Field 2 (value = 2750)	must be equal to or greater than the total hydroelectric capacity.

Lines 10 to 12

A new hydroelectric project can be included by simply adding a line and then changing the number of hydroelectric plants in line 8. Some of the data values are not used by the model in this application and several others should be left untouched. Taking as an example the plant Aswan I, the data elements that should be modified in the event of a new plant are as follows:

Field 1 (value = 1)	the correlative number of the hydro plant
Field 3 (value = aswan I)	plant title
Field 4 (value = 9)	number of turbogenerator sets
Field 5 (value = 345.)	total installed capacity in MW
Field 6 (value = 100.)	base load in MW

Field 10 (value = 4)	the size of the regulating reservoir in GWh
Field 11 (value = 0)	use 0 for any new plant in the Nile

After all hydro plants there should be a line with the single value 999

Lines 14 to 50

Thermal plants can be modified, retired or added by changing, deleting or adding lines and then changing the number of thermal plants in line 8. The following is a guide to the values that can be modified, using plant Cairo West St as an example. All other values should be left as they are or copied from any other plant since they are not executed by the model.

Field 1 (value = 1)	the correlative number of thermal plant
Field 3 (value = cairo we st)	plant title
Field 4 (value = 4)	number of individual units
Field 5 (value = 350.)	installed capacity in MW
Field 6 (value = 327.)	actual maximum continuous rating in MW
Field 7 (value = 0.114)	forced outage rate
Field 8 (value = 1)	use 1 for steam, 2 for combustion turbines, 3 for combined cycle.
Field 9 (value = 17.52)	fuel cost ($/Mwh)
Field 16 (value = 28.)	use 28. for steam plants and 14. for all others

After all thermal plants there should be a line with the single value 999[1]

[1] In the description of file MCMSYS.DAT, the fields 10 to 15 of lines 14 to 50 correspond to input data that are not relevant to the purposes for which the model was used, either because such data are not applicable to the EEA system or because those data were included in post-processing of the results. In any case, the fields correspond to the following concepts:

Field 10	Fixed O&M costs
Field 11	Variable O&M costs
Field 12	A penalty factor for plants operating beyond normal range
Field 13	Minimum normal plant factor
Field 14	Maximum normal plant factor
Field 15	Maintenance category

FILE MCMDEM.DAT

This file contains data to characterize the load on the power system for one year. For the application of the Electricity Pricing Study, the load for the year July 1991 to June 1992 is used and is described by two typical days of each month, one day corresponds to Fridays and the other is representative of Saturday to Thursday.

In this simplified guide, it is assumed that the user will not change the basic structure (i.e., 12 months and 2 typical days) but may wish to change the actual load data.

Line 1

The first line is a title and can be changed at will

Line 2

This line should not be modified

Lines 3 and 4

Lines 3 and 4 correspond to the two typical days of month 1. The fields will be described with reference to Line 3 as an example. The same description applies to any of the lines below it.

Field 1 (value = 1)	month number (in this case is July)
Field 2 (value = 1)	typical day number, use 2 for Fridays and 1 for all others
Field 3 (value = 26)	number of typical days in the month
Field 4 (value = 5714.0)	peak load of the typical day in MW
Field 5 (value = 3550.0)	minimum load of the typical day MW
Field 6 (value = 105494.0)	energy load of the typical day in MWH

Field 2 corresponds to the subsystem number in the case that the analysis is made by splitting the system into several weakly linked subsystems.

FILE MCMHYD.DAT

This file contains the capacity and energy available from each hydroelectric plant for each month. It should only be modified in the event that a new plant is added or if additional hydrologic information warrants it.

Line 1

Should not be modified

Line 2

Field 1 (value = 1)	plant number
Fields 2 to 13	monthly capacity in MW

Line 5

Field 1 (value = 1)	plant number
Fields 2 to 13	monthly energy in GWh

FILES MCMTRA.DAT AND MCMMAN.DAT

These files should not be modified for the type of application anticipated in the preparation of this guide.

The file MCMTRA.DAT contains specifications regarding the reliability of the transmission system that, for the purposes of this application, is considered to be fully reliable.

File MCMMAN.DAT is not used in this application and is an empty file. However, the file must exist in order for the model MCPCSM to run.

FILE TRA.HRL

This file contains 24 lines and each line contains 24 values corresponding to the hourly load during a typical day. In the printout of this file in Appendix 1, it appears that the file has 48

lines. This is only because the paper is not wide enough and then each line "wraps around" to a new line below it. A computer screen would show 24 values in each line.

The first 12 lines (actual computer screen lines) correspond to the hourly loads for the typical day representative of Saturdays to Thursdays of each of the 12 months. The next 12 lines correspond to the hourly loads of 12 months for the typical days representative of Fridays of each of the 12 months.

When modifying this file, it is important to note that the information in this file must be consistent with the information in file MCMDEM.DAT. For instance:

- The highest value in Line 1 (typical day 1, month 1) of TRA.HRL is 5714, which is the peak load in Line 2 (month 1 typical day 1) of MCMDEM.DAT.
- The lowest value in Line 1 of TRA.HRL is 3550, which is the minimum load of the week.
- The sum of all the values in the first line of TRA.HRL is 114756. This value is larger than the value 105494 in the corresponding line of MCMDEM.DAT because 105494 is the actual energy content of typical day 1 of month 1, whereas 114756 is the sum of all peak values of each hour and thus overestimates the actual energy load.

FILE TRA.INP

This file should not be modified except perhaps for the last value (value = 55), which is the assumed cost of unserved energy in $/MWh.

Line 1 Variable 1	Number of typical days per period
Line 1 Variable 2	Number of periods
Line 2 Variable 1	Reference load for computation of system losses
Line 2 Variable 2	Corresponding losses to the reference load
Line 3 Variable 1	Unserved energy cost.

There are intermediate outputs such as MCMVEC.OUT and MCMOUT.OUT. These files, in particular MCMOUT.OUT, can be useful as a reference for the data used in the analysis, but the reader needs only be concerned about the final output in file MARCO.OUT.

This file is self-explanatory and the reader can verify that the different cost components (i.e., production cost, cost of losses and cost of unserved energy) add up, for every hour, to the total marginal cost of that hour.

FILE PRINTOUTS

MCMSYS.DAT
MCMDEM.DAT
MCMHYD.DAT
MCMTRA.DAT
TRA.HRL
TRA.INP

MARCO.OUT

INPUT FILE

MCMSYS.DAT

POWER SYSTEM DATA

```
  0  1  1  0  0  0  0  0  0  1  2  3  0  0  1 15 22 30 32  0
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
*****************************************************************************
*  EGYPT - EEA ELECTRICITY PRICING STUDY - RCG/HAGLER, BAILLY INC.          *
*  EEA SYSTEM AS PLANNED FOR 1991-1992  Gas 1.560 $/mbtu   Sollar 3.93 $/mbtu *
*                          FILE DATE: APRIL 6, 1991                         *
*****************************************************************************
  300    3   37    1    1    1   12    24.    52      0.     0.    .75    .25
  1  2750.
  1  1.00
 1 1 aswan I       9  345.  100. 0.01  527.  0.01   4. 2  0.  0.  0.  0. 1 20. 1
 2 1 aswan II      4  300.  100. 0.01  458.  0.01   4. 2  0.  0.  0.  0. 1 20. 1
 3 1 high dam     12 2100.    0. 0.01 3206.  0.01  50. 2  1.  0.  0.  0. 1 20. 1
999
 1 1 cairo we st   4  350.  327. .114 1 17.52 1708.   0.2  1.0 0.0 1.0 1  28. 0
 2 1 cairo so st   4  255.  238. .040 1 22.61 1253.   0.2  1.0 0.0 1.0 1  28. 0
 3 1 cairo no st   2  100.   94. .306 1 24.70  285.   0.2  1.0 0.0 1.0 1  28. 0
 4 1 el tebbin s   3   45.   42. .266 1 24.31  222.   0.2  1.0 0.0 1.0 1  28. 0
 5 1 new talkha s  3   90.   84. .236 1 23.65  427.   0.2  1.0 0.0 1.0 1  28. 0
 6 1 old talkha s  3   38.   36. .236 1 23.65  171.   0.2  1.0 0.0 1.0 1  28. 0
 7 1 new daman  s  3  195.  182. .538 1 19.34  683.   0.2  1.0 0.0 1.0 1  28. 0
 8 1 old daman  s  2   30.   28. .538 1 19.34  114.   0.2  1.0 0.0 1.0 1  28. 0
 9 1 kafra (st)    4  440.  411. .242 1 17.64 1822.   0.2  1.0 0.0 1.0 1  28. 0
10 1 suif (st)     4  113.  106. .510 1 19.67  524.   0.2  1.0 0.0 1.0 1  28. 0
11 1 suez (st)     4  100.   94. .672 1 19.67  455.   0.2  1.0 0.0 1.0 1  28. 0
12 1 assiut (st)   3   90.   84. .081 1 19.12  410.   0.2  1.0 0.0 1.0 1  28. 0
13 1 abu kir (st)  4  600.  561. .184 1 14.97 3189.   0.2  1.0 0.0 1.0 1  28. 0
14 1 abu solta  s  4  600.  561. .164 1 14.70 3189.   0.2  1.0 0.0 1.0 1  28. 0
15 1 shoubrah st   4 1296. 1211. .048 1 15.23 6833.   0.2  1.0 0.0 1.0 1  28. 0
16 1 attaka (st)   2  600.  561. .186 1 13.13 3132.   0.2  1.0 0.0 1.0 1  28. 0
17 1 daman 4 (st)  1  300.  280. .080 1 15.15  512.   0.2  1.0 0.0 1.0 1  28. 0
18 1 cairo so 3 s  1  100.   94. .080 1 16.94  190.   0.2  1.0 0.0 1.0 1  28. 0
19 1 attaka 3 st   1  300.  280. .080 1 15.15 1480.   0.2  1.0 0.0 1.0 1  28. 0
20 1 suez 5 st     1   90.   84. .080 1 16.94  441.   0.2  1.0 0.0 1.0 1  28. 0
21 1 talkha 4 s    1  200.  187. .080 1 16.05  379.   0.2  1.0 0.0 1.0 1  28. 0
22 1 abu kir 5 s   1  300.  280. .080 1 15.15  512.   0.2  1.0 0.0 1.0 1  28. 0
23 1 talkha (cc)   2  260.  252. .100 3 15.15  436.   0.2  1.0 0.0 1.0 1  14. 0
24 1 demietta cc   6 1050. 1019. .100 3 15.15 1760.   0.2  1.0 0.0 1.0 1  14. 0
25 1 helwan (gt)   5  100.   99. .088 2 25.16  248.   0.2  1.0 0.0 1.0 1  14. 0
```

26	1	el tebbin g	2	46.	45.	.292	2	27.06	99.	0.2	1.0	0.0	1.0	1	14.	0
27	1	cairo ea gt	2	46.	45.	.280	2	24.64	89.	0.2	1.0	0.0	1.0	1	14.	0
28	1	ismailia g	1	20.	19.	.030	2	51.70	40.	0.2	1.0	0.0	1.0	1	14.	0
29	1	port said gt	2	60.	59.	.046	2	23.39	79.	0.2	1.0	0.0	1.0	1	14.	0
30	1	mahmoudia g	12	392.	388.	.072	2	23.33	754.	0.2	1.0	0.0	1.0	1	14.	0
31	1	shabab (gt)	3	100.	99.	.162	2	23.13	186.	0.2	1.0	0.0	1.0	1	14.	0
32	1	suif (gt)	7	225.	223.	.210	2	26.86	382.	0.2	1.0	0.0	1.0	1	14.	0
33	1	damanhour gt	4	100.	99.	.014	2	22.09	198.	0.2	1.0	0.0	1.0	1	14.	0
34	1	wadi hof gt	3	100.	99.	.060	2	27.06	201.	0.2	1.0	0.0	1.0	1	14.	0
35	1	cairo so 3 g	2	100.	99.	.110	2	22.29	248.	0.2	1.0	0.0	1.0	1	14.	0
36	1	heliop 4+5 g	2	20.	19.	.110	2	22.33	25.	0.2	1.0	0.0	1.0	1	14.	0
37	1	assiut 4 st	1	300.	280.	.080	1	15.15	1470.	0.2	1.0	0.0	1.0	1	28.	0

999

INPUT FILE

MCMDEM.DAT

DEMAND DATA

DEMAND DATA FOR JUL91-JUN92

2	1	1	1	1 1	2 1	
	1	1	26	5714.0	3550.0	105494.0
	1	2	5	5532.0	3548.0	100775.0
	2	1	27	5690.0	3571.0	104540.0
	2	2	4	5532.0	3486.0	100042.0
	3	1	26	5786.0	3701.0	106105.0
	3	2	4	5539.0	3544.0	100990.0
	4	1	26	5758.0	3610.0	103952.0
	4	2	5	5489.0	3539.0	98520.0
	5	1	26	5781.0	3573.0	104803.0
	5	2	4	5587.0	3608.0	102187.0
	6	1	27	5830.0	3573.0	106763.0
	6	2	4	5663.0	3579.0	102461.0
	7	1	26	5712.0	3482.0	105049.0
	7	2	5	5535.0	3575.0	101604.0
	8	1	25	5727.0	3469.0	104497.0
	8	2	4	5540.0	3584.0	102670.0
	9	1	27	5757.0	3543.0	104269.0
	9	2	4	5532.0	3615.0	100751.0
	10	1	25	5682.0	3605.0	104179.0
	10	2	5	5560.0	3510.0	102372.0
	11	1	27	5575.0	3499.0	103108.0
	11	2	4	5387.0	3479.0	100785.0
	12	1	26	5612.0	3621.0	105082.0
	12	2	4	5457.0	3508.0	99375.0

INPUT FILE

MCMHYD.DAT

HYDROELECTRIC PLANT DATA

18

** HYDROELECTRIC CAPABILITY AND ENERGY

1	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5	287.5
2	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0	225.0
3	1531.4	1729.2	1827.1	1892.4	1859.7	1827.1	1761.9	1729.2	1696.6	1696.6	1664.0	1631.4
1	141.7	132.3	101.6	92.1	85.0	85.0	66.1	85.0	99.2	99.2	122.8	153.5
2	158.7	148.1	113.7	103.2	95.2	95.2	74.1	95.2	111.1	111.1	137.6	171.9
3	633.4	643.6	439.3	490.4	434.2	416.8	311.6	459.7	551.7	556.8	710.0	996.1

19

INPUT FILE

MCMTRA.DAT

TRANSMISSION SYSTEM DATA

```
1  500.
1  1.0
2  500.
2  1.0
3 1925.
3  1.0
```

INPUT FILE

TRA.HRL

HOURLY LOAD DATA

	4150	3918	3803	3733	3651	3550	3565	3873	4164	4309	4364	4459	4490	4360
4303	4354	4395	4465	5023	5714	5644	5376	5103	4726	5714	3550			
	4188	3932	3799	3762	3691	3606	3571	3802	4065	4179	4269	4369	4420	4248
4230	4257	4252	4389	5369	5690	5530	5259	5008	4656	5690	3571			
	4120	3914	3807	3754	3739	3718	3701	3882	4121	4247	4302	4421	4469	4278
4255	4305	4327	4856	5786	5766	5517	5274	4953	4597	5786	3701			
	3930	3729	3641	3610	3647	3743	3805	3870	4009	4083	4174	4218	4198	4131
4108	4168	4339	5615	5758	5648	5381	5057	4789	4304	5758	3610			
	3850	3689	3577	3573	3645	3869	4004	4013	4112	4141	4170	4189	4171	4086
4098	4235	4731	5756	5781	5663	5438	5074	4701	4277	5781	3573			
	3887	3706	3614	3573	3652	3917	4182	4188	4247	4274	4264	4296	4297	4208
4203	4353	4934	5830	5825	5630	5447	5118	4774	4345	5830	3573			
	3801	3604	3503	3482	3544	3753	4058	4142	4255	4267	4211	4269	4267	4143
4194	4328	4579	5655	5712	5589	5447	5128	4758	4362	5712	3482			
	3783	3587	3505	3469	3557	3775	4093	4080	4213	4212	4190	4149	4272	4154
4151	4287	4426	5354	5727	5628	5514	5195	4815	4361	5727	3469			
	3936	3672	3569	3543	3645	3825	3993	4059	4170	4115	4099	4160	4241	4134
4134	4196	4287	4889	5757	5707	5528	5231	4877	4503	5757	3543			
	4342	4110	4003	3816	3662	3614	3605	3796	3971	4045	4000	4127	4139	4076
4060	4157	4138	4467	5418	5682	5592	5399	5137	4822	5682	3605			
	3865	3642	3524	3499	3557	3740	4005	4078	4149	4252	4178	4233	4133	4178
4119	4185	4199	4233	4573	5359	5575	5448	5288	5097	5575	3499			
	4330	3963	3812	3769	3746	3696	3621	3892	4201	4328	4401	4448	4479	4354
4323	4367	4363	4356	4347	4984	5612	5472	5256	4962	5612	3621			

	4358	3994	3858	3757	3706	3561	3548	3580	3716	3838	4010	4044	3961	4033
4054	4064	4055	4213	4662	5532	5477	5192	5012	4549	5532	3548			
	4213	3929	3847	3731	3718	3499	3486	3548	3669	3865	3978	3985	3946	3976
3951	4005	3995	4119	5235	5532	5370	5062	4842	4545	5532	3486			
	4274	3986	3844	3781	3749	3626	3544	3563	3739	3824	3922	3945	3974	4005
3934	3990	4024	4543	5530	5539	5359	5066	4789	4443	5539	3544			
	3990	3731	3657	3609	3624	3601	3550	3539	3700	3795	3934	3869	3862	3842
3865	3908	4001	4907	5489	5354	5197	4894	4521	4079	5489	3539			
	3967	3755	3608	3664	3718	3769	3771	3802	3956	4023	4097	4018	4006	4004
3948	4046	4578	5587	5548	5438	5282	4934	4531	4140	5587	3608			
	4076	3762	3635	3579	3592	3764	3806	3823	3936	4069	4103	4061	4010	4026
4060	4104	4509	5663	5571	5398	5278	4909	4547	4184	5663	3579			
	4040	3820	3643	3575	3586	3697	3765	3790	3891	4192	4262	4008	3869	3974
3925	4007	4251	5434	5535	5426	5305	4692	4663	4252	5535	3575			
	4104	3786	3649	3584	3625	3763	3787	3845	4013	4093	4147	4172	3966	4004
3968	4003	4419	5258	5540	5473	5358	5088	4772	4258	5540	3584			
	4105	3761	3683	3615	3721	3714	3673	3731	3892	4034	4118	4080	3913	3887
3951	3948	4055	4565	5532	5452	5343	5057	4664	4258	5532	3615			
	4456	4247	4063	3898	3659	3615	3510	3594	3794	3901	4008	4013	3930	3974
4009	4014	4031	4334	5331	5560	5451	5310	5010	4658	5560	3510			
	3922	3619	3536	3479	3503	3770	4046	4136	4266	4275	4245	4182	3903	3921
3971	3993	3957	3913	4354	5203	5013	5387	5211	4983	5387	3479			
	4545	4068	3872	3808	3791	3699	3516	3508	3576	3815	4001	4070	4036	3913
3915	4012	4056	4040	4003	4390	5457	5324	5122	4842	5457	3508			

INPUT FILE

TRA.INP

GENERAL TRANSFER PARAMETERS

```
2  12
6000. 600.
55.
```

26

OUTPUT FILE

MARCO.OUT

FINAL RESULTS

HOURLY MARGINAL PRODUCTION COST ($/MWH)

MO	DY	H: 1	2	3	4	5	6	7	8	9	10	11	12
		13	14	15	16	17	18	19	20	21	22	23	24
1	1	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30
		16.30	16.30	16.30	16.30	16.30	16.30	16.31	16.93	16.83	16.26	16.22	16.30
1	2	15.57	15.57	15.57	15.57	15.57	15.57	15.57	15.57	15.57	15.57	15.57	15.57
		15.57	15.57	15.57	15.57	15.57	15.57	15.57	16.08	16.04	15.75	15.61	15.57
2	1	16.07	16.07	16.07	16.07	16.07	16.07	16.07	16.07	16.07	16.07	16.07	16.07
		16.07	16.07	16.07	16.07	16.07	16.07	16.14	16.16	16.03	16.05	16.07	16.07
2	2	15.64	15.64	15.64	15.64	15.64	15.64	15.64	15.64	15.64	15.64	15.64	15.64
		15.64	15.64	15.64	15.64	15.64	15.64	15.90	16.41	16.19	15.66	15.64	15.64
3	1	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55
		16.55	16.55	16.55	16.55	16.55	16.55	16.97	16.85	16.55	16.55	16.55	16.55
3	2	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16
		18.16	18.16	18.16	18.16	18.16	18.16	18.21	18.21	18.16	18.16	18.16	18.16
4	1	16.77	16.77	16.77	16.77	16.77	16.77	16.77	16.77	16.77	16.77	16.77	16.77
		16.77	16.77	16.77	16.77	16.77	16.82	16.97	16.85	16.77	16.77	16.77	16.77
4	2	15.61	15.61	15.61	15.61	15.61	15.61	15.61	15.61	15.61	15.61	15.61	15.61
		15.61	15.61	15.61	15.61	15.61	15.61	15.62	15.61	15.61	15.61	15.61	15.61
5	1	17.51	17.51	17.51	17.51	17.51	17.51	17.51	17.51	17.51	17.51	17.51	17.51
		17.51	17.51	17.51	17.51	17.51	17.26	17.07	17.51	17.51	17.51	17.51	17.51
5	2	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93
		15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93	15.93
6	1	17.39	17.39	17.35	17.32	17.38	17.39	17.39	17.39	17.39	17.39	17.39	17.39
		17.39	17.39	17.39	17.39	17.39	17.41	17.41	17.39	17.39	17.39	17.39	17.39
6	2	17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36
		17.36	17.36	17.36	17.36	17.36	17.41	17.36	17.36	17.36	17.36	17.36	17.36

7	1	16.60	16.21	16.09	16.06	16.14	16.51	16.66	16.66	16.66	16.66	16.66	16.66
		16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66
7	2	17.25	17.25	17.23	17.12	17.13	17.25	17.25	17.25	17.25	17.25	17.25	17.25
		17.25	17.25	17.25	17.25	17.25	17.25	17.25	17.25	17.25	17.25	17.25	17.25
8	1	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48	16.48
		16.48	16.48	16.48	16.48	16.48	16.48	16.99	16.71	16.51	16.48	16.48	16.48
8	2	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10
		16.10	16.10	16.10	16.10	16.10	16.10	16.21	16.12	16.10	16.10	16.10	16.10
9	1	16.53	16.53	16.53	16.53	16.53	16.53	16.53	16.53	16.53	16.53	16.53	16.53
		16.53	16.53	16.53	16.53	16.53	16.53	17.48	17.32	16.90	16.53	16.53	16.53
9	2	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72
		15.72	15.72	15.72	15.72	15.72	15.72	16.06	15.93	15.81	15.72	15.72	15.72
10	1	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31
		17.31	17.31	17.31	17.31	17.31	17.31	17.49	18.13	17.84	17.49	17.31	17.31
10	2	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10	16.10
		16.10	16.10	16.10	16.10	16.10	16.10	16.27	16.56	16.45	16.23	16.10	16.10
11	1	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20
		16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.87	17.61	17.22	16.60	16.35
11	2	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78
		16.78	16.78	16.78	16.78	16.78	16.78	16.78	17.11	16.84	17.27	17.11	16.84
12	1	15.53	15.55	15.55	15.55	15.55	15.55	15.55	15.55	15.55	15.54	15.43	15.45
		15.46	15.48	15.55	15.45	15.46	15.48	15.49	15.55	15.88	15.92	15.70	15.54
12	2	15.67	15.45	15.45	15.45	15.45	15.45	15.45	15.45	15.45	15.45	15.45	15.45
		15.45	15.45	15.45	15.45	15.45	15.45	15.45	15.54	17.01	16.74	16.41	16.01

HOURLY MARGINAL COST OF SYSTEM LOSSES ($/MWH)

MO	DY	H: 1	2	3	4	5	6	7	8	9	10	11	12
		13	14	15	16	17	18	19	20	21	22	23	24
1	1	2.25	2.13	2.07	2.03	1.98	1.93	1.94	2.10	2.26	2.34	2.37	2.42
		2.44	2.37	2.34	2.37	2.39	2.43	2.73	3.22	3.17	2.91	2.76	2.57
1	2	2.26	2.07	2.00	1.95	1.92	1.85	1.84	1.86	1.93	1.99	2.08	2.10
		2.06	2.09	2.10	2.11	2.10	2.19	2.42	2.97	2.93	2.73	2.61	2.36
2	1	2.24	2.11	2.03	2.02	1.98	1.93	1.91	2.04	2.18	2.24	2.29	2.34
		2.37	2.28	2.27	2.28	2.28	2.35	2.89	3.07	2.95	2.81	2.68	2.49
2	2	2.20	2.05	2.01	1.95	1.94	1.82	1.82	1.85	1.91	2.01	2.07	2.08
		2.06	2.07	2.06	2.09	2.08	2.15	2.77	3.03	2.90	2.64	2.52	2.37
3	1	2.27	2.16	2.10	2.07	2.06	2.05	2.04	2.14	2.27	2.34	2.37	2.44
		2.47	2.36	2.35	2.37	2.39	2.68	3.27	3.24	3.04	2.91	2.73	2.54
3	2	2.59	2.41	2.33	2.29	2.27	2.19	2.15	2.16	2.26	2.31	2.37	2.39
		2.41	2.42	2.38	2.42	2.44	2.75	3.36	3.36	3.24	3.07	2.90	2.69
4	1	2.20	2.08	2.04	2.02	2.04	2.09	2.13	2.16	2.24	2.28	2.33	2.36
		2.35	2.31	2.30	2.33	2.43	3.15	3.26	3.17	3.01	2.83	2.68	2.41
4	2	2.08	1.94	1.90	1.88	1.89	1.87	1.85	1.84	1.93	1.97	2.05	2.01
		2.01	2.00	2.01	2.03	2.08	2.55	2.86	2.79	2.70	2.55	2.35	2.12
5	1	2.25	2.15	2.09	2.09	2.13	2.26	2.34	2.34	2.40	2.42	2.43	2.44
		2.43	2.38	2.39	2.47	2.76	3.31	3.29	3.31	3.17	2.96	2.74	2.50
5	2	2.11	1.99	1.92	1.95	1.97	2.00	2.00	2.02	2.10	2.14	2.18	2.13
		2.13	2.13	2.10	2.15	2.43	2.97	2.95	2.89	2.80	2.62	2.41	2.20
6	1	2.25	2.15	2.09	2.06	2.12	2.27	2.42	2.43	2.46	2.48	2.47	2.49
		2.49	2.44	2.44	2.52	2.86	3.38	3.38	3.26	3.16	2.97	2.77	2.52
6	2	2.36	2.18	2.10	2.07	2.08	2.18	2.20	2.21	2.28	2.35	2.37	2.35
		2.32	2.33	2.35	2.37	2.61	3.29	3.22	3.12	3.05	2.84	2.63	2.42

7	1	2.10	1.95	1.88	1.86	1.91	2.06	2.25	2.30	2.36	2.37	2.34	2.37
		2.37	2.30	2.33	2.40	2.54	3.14	3.17	3.10	3.02	2.85	2.64	2.42
7	2	2.32	2.20	2.09	2.04	2.05	2.13	2.16	2.18	2.24	2.41	2.45	2.30
		2.22	2.29	2.26	2.30	2.44	3.12	3.18	3.12	3.05	2.70	2.68	2.44
8	1	2.08	1.97	1.93	1.91	1.95	2.07	2.25	2.24	2.31	2.31	2.30	2.28
		2.35	2.28	2.28	2.35	2.43	2.94	3.24	3.13	3.04	2.85	2.65	2.40
8	2	2.20	2.03	1.96	1.92	1.95	2.02	2.03	2.06	2.15	2.20	2.23	2.24
		2.13	2.15	2.13	2.15	2.37	2.82	2.99	2.94	2.88	2.73	2.56	2.29
9	1	2.17	2.02	1.97	1.95	2.01	2.11	2.20	2.24	2.30	2.27	2.26	2.29
		2.34	2.28	2.28	2.31	2.36	2.69	3.35	3.30	3.11	2.88	2.69	2.48
9	2	2.15	1.97	1.93	1.89	1.95	1.95	1.92	1.96	2.04	2.11	2.16	2.14
		2.05	2.04	2.07	2.07	2.12	2.39	2.96	2.90	2.82	2.65	2.44	2.23
10	1	2.51	2.37	2.31	2.20	2.11	2.09	2.08	2.19	2.29	2.33	2.31	2.38
		2.39	2.35	2.34	2.40	2.39	2.58	3.16	3.43	3.33	3.15	2.96	2.78
10	2	2.39	2.28	2.18	2.09	1.96	1.94	1.88	1.93	2.04	2.09	2.15	2.15
		2.11	2.13	2.15	2.15	2.16	2.33	2.89	3.07	2.99	2.87	2.69	2.50
11	1	2.09	1.97	1.90	1.89	1.92	2.02	2.16	2.20	2.24	2.30	2.26	2.29
		2.23	2.26	2.22	2.26	2.27	2.29	2.47	3.01	3.27	3.13	2.93	2.78
11	2	2.19	2.02	1.98	1.95	1.96	2.11	2.26	2.31	2.39	2.39	2.37	2.34
		2.18	2.19	2.22	2.23	2.21	2.19	2.44	2.97	2.81	3.10	2.97	2.80
12	1	2.24	2.05	1.98	1.95	1.94	1.92	1.88	2.02	2.18	2.24	2.26	2.29
		2.31	2.25	2.24	2.25	2.25	2.25	2.25	2.58	2.97	2.90	2.75	2.57
12	2	2.37	2.10	1.99	1.96	1.95	1.90	1.81	1.81	1.84	1.96	2.06	2.10
		2.08	2.02	2.02	2.07	2.09	2.08	2.06	2.27	3.09	2.97	2.80	2.58

HOURLY MARGINAL COST OF UNSERVED LOAD ($/MWH)

MO	DY	H: 1	2	3	4	5	6	7	8	9	10	11	12
		13	14	15	16	17	18	19	20	21	22	23	24
1	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

7	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
9	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
9	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
12	1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
12	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

TOTAL HOURLY MARGINAL COST ($/MWH)

MO	DY	H: 1	2	3	4	5	6	7	8	9	10	11	12
		13	14	15	16	17	18	19	20	21	22	23	24
1	1	18.55	18.43	18.37	18.33	18.28	18.23	18.24	18.40	18.56	18.64	18.67	18.72
		18.74	18.67	18.64	18.67	18.69	18.73	19.04	20.15	20.00	19.17	18.98	18.87
1	2	17.83	17.64	17.57	17.52	17.49	17.42	17.41	17.43	17.50	17.56	17.65	17.67
		17.63	17.66	17.67	17.68	17.67	17.76	17.99	19.05	18.97	18.47	18.21	17.93
2	1	18.31	18.18	18.10	18.09	18.05	18.00	17.98	18.11	18.25	18.31	18.36	18.41
		18.44	18.35	18.34	18.35	18.35	18.42	19.03	19.23	18.98	18.86	18.75	18.56
2	2	17.84	17.69	17.65	17.59	17.58	17.46	17.46	17.49	17.55	17.65	17.71	17.72
		17.70	17.71	17.70	17.73	17.72	17.79	18.67	19.44	19.08	18.30	18.16	18.01
3	1	18.82	18.71	18.65	18.62	18.61	18.60	18.59	18.69	18.82	18.89	18.92	18.99
		19.02	18.91	18.90	18.92	18.94	19.23	20.24	20.09	19.59	19.46	19.28	19.09
3	2	20.75	20.57	20.49	20.45	20.43	20.35	20.31	20.32	20.42	20.47	20.53	20.55
		20.57	20.58	20.54	20.58	20.60	20.91	21.56	21.57	21.40	21.23	21.06	20.85
4	1	18.97	18.85	18.81	18.79	18.81	18.86	18.90	18.93	19.01	19.05	19.10	19.13
		19.12	19.08	19.07	19.10	19.20	19.96	20.23	20.03	19.78	19.60	19.45	19.18
4	2	17.69	17.55	17.51	17.49	17.50	17.48	17.46	17.45	17.54	17.58	17.66	17.62
		17.62	17.61	17.62	17.64	17.69	18.16	18.48	18.40	18.31	18.16	17.96	17.73
5	1	19.76	19.66	19.60	19.60	19.64	19.77	19.85	19.85	19.91	19.93	19.94	19.95
		19.94	19.89	19.90	19.98	20.27	20.58	20.36	20.32	20.68	20.47	20.25	20.01
5	2	18.04	17.92	17.85	17.88	17.90	17.93	17.93	17.95	18.03	18.07	18.11	18.06
		18.06	18.06	18.03	18.08	18.36	18.90	18.88	18.82	18.73	18.55	18.34	18.13
6	1	19.64	19.54	19.44	19.38	19.49	19.66	19.81	19.82	19.85	19.87	19.86	19.88
		19.88	19.83	19.83	19.91	20.25	20.79	20.79	20.65	20.55	20.36	20.16	19.91
6	2	19.72	19.54	19.46	19.43	19.44	19.54	19.56	19.57	19.64	19.71	19.73	19.71
		19.68	19.69	19.71	19.73	19.97	20.70	20.58	20.48	20.41	20.20	19.99	19.78

34

7	1	18.70	18.15	17.96	17.92	18.05	18.57	18.91	18.96	19.02	19.03	19.00	19.03
		19.03	18.96	18.99	19.06	19.20	19.80	19.83	19.76	19.68	19.51	19.30	19.08
7	2	19.57	19.45	19.32	19.16	19.18	19.38	19.41	19.43	19.49	19.66	19.70	19.55
		19.47	19.54	19.51	19.55	19.69	20.37	20.43	20.37	20.30	19.95	19.93	19.69
8	1	18.56	18.45	18.41	18.39	18.43	18.55	18.73	18.72	18.79	18.79	18.78	18.76
		18.83	18.76	18.76	18.83	18.91	19.42	20.23	19.85	19.55	19.33	19.13	18.88
8	2	18.30	18.13	18.06	18.02	18.05	18.12	18.13	18.16	18.25	18.30	18.33	18.34
		18.23	18.25	18.23	18.25	18.47	18.92	19.20	19.06	18.98	18.83	18.66	18.39
9	1	18.70	18.55	18.50	18.48	18.54	18.64	18.73	18.77	18.83	18.80	18.79	18.82
		18.87	18.81	18.81	18.84	18.89	19.22	20.83	20.62	20.02	19.41	19.22	19.01
9	2	17.87	17.69	17.65	17.61	17.67	17.67	17.64	17.68	17.76	17.83	17.88	17.86
		17.77	17.76	17.79	17.79	17.84	18.11	19.02	18.83	18.62	18.37	18.16	17.95
10	1	19.82	19.68	19.62	19.51	19.42	19.40	19.39	19.50	19.60	19.64	19.62	19.69
		19.70	19.66	19.65	19.71	19.70	19.89	20.64	21.56	21.17	20.64	20.27	20.09
10	2	18.49	18.38	18.28	18.19	18.06	18.04	17.98	18.03	18.14	18.19	18.25	18.25
		18.21	18.23	18.25	18.25	18.26	18.43	19.16	19.63	19.43	19.10	18.79	18.60
11	1	18.29	18.17	18.10	18.09	18.12	18.22	18.36	18.40	18.44	18.50	18.46	18.49
		18.43	18.46	18.42	18.46	18.47	18.49	18.67	19.89	20.88	20.35	19.53	19.12
11	2	18.97	18.80	18.76	18.73	18.74	18.89	19.04	19.09	19.17	19.17	19.15	19.12
		18.96	18.97	19.00	19.01	18.99	18.97	19.22	20.07	19.66	20.37	20.08	19.64
12	1	17.77	17.60	17.53	17.50	17.49	17.47	17.43	17.57	17.73	17.78	17.70	17.74
		17.76	17.73	17.79	17.70	17.71	17.72	17.74	18.13	18.85	18.82	18.45	18.12
12	2	18.04	17.55	17.44	17.41	17.40	17.35	17.26	17.26	17.29	17.41	17.51	17.55
		17.53	17.47	17.47	17.52	17.54	17.53	17.51	17.82	20.10	19.71	19.21	18.59