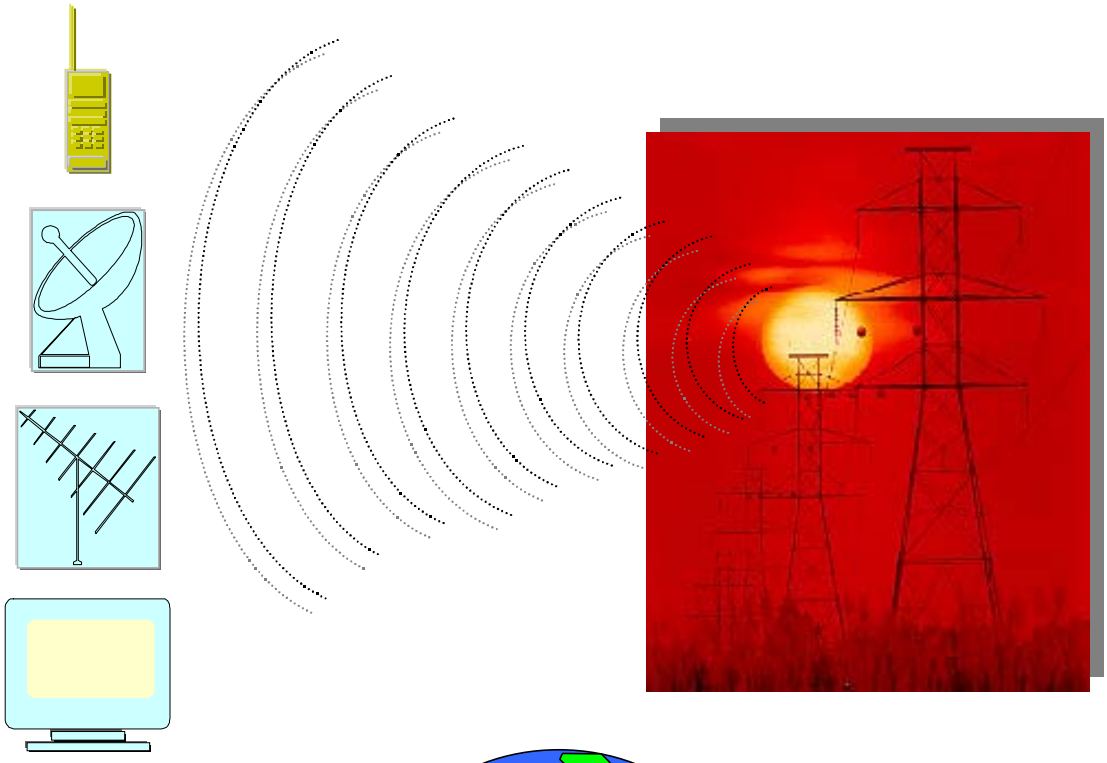
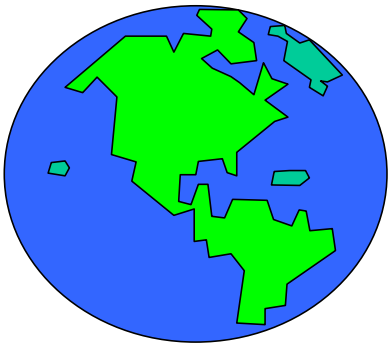
SMS User 's Guide
Models & Algorithms





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USER ’s GUIDE

1. Background:

The power industry today has undergone drastic and irreversible changes. From a monopolistic environment a decade ago when electricity was generated and distributed to consumers who had virtually no say in the prices, electricity is now traded in a competitive market just like other commodities; and consumers today can select and buy electricity from marketers of their choice.

Because electricity cannot be stored in a large quantity, it must be generated to meet the instantaneous demand. The spot market clearing prices of electricity market sometimes can behave quite unpredictably. Quite often, spot market price volatility is attributed to the capacity adequacy and demand conditions of a Control Area. In addition, the underlying transmission network within a Control Area and between adjacent Control Areas can result in price disparity between regions. Limitations of a transmission network often prevent power flow from inexpensive to more expensive regions. As a result, more expensive resource must be dispatched to meet the local demand resulting in higher market clearing price in that region. The challenge is to devise a dispatch algorithm, which maximizes the utilization and value of available resources based on the offer prices to satisfy the demands in different regions while respecting the transmission limitations.

The deregulated electric industry clearly requires a new tool to assist energy traders, asset managers, and system operators. make important decisions in their daily activities. Factors such as generation outages, transmission congestion, volatile fuel costs, load growth and environmental issues/cost must be taken into consideration in forecasting the electricity price.

Furthermore, for some investors who plan for long-term asset acquisitions or divestiture it is important to understand the location impact of the asset on the prices and how it affects their return of the investment. A new tool must be able to simulate the market conditions over a period of 5-10 years with hourly resolution in order to examine in details all possibilities before making such an important decision. In this case the location of the generators in the transmission grid is of paramount importance. The electricity price difference between the two locations is a signal of transmission congestion and it is also a measure of the transmission right value.

SMS Suite, when subscribed with the appropriate Control Areas, is the tool that was developed for these purposes. It is capable of performing network analysis and forecasting electricity spot market prices. It provides also short-term and long-term values of generating assets located anywhere in the Northeastern power network. SMS incorporates variables such as fuel costs, transmission outages, generation outages, weather uncertainty and planned and forced outage rates in order to provide comprehensive answers to some of the difficult questions related to portfolio management and trading decisions. This user's guide will introduce users to various features designed in the SMS Suite and how to use them.

An overview of the SMS input and output relationship is as shown in Figure 1.

2. An Overview of SMS Input-Output Relationship

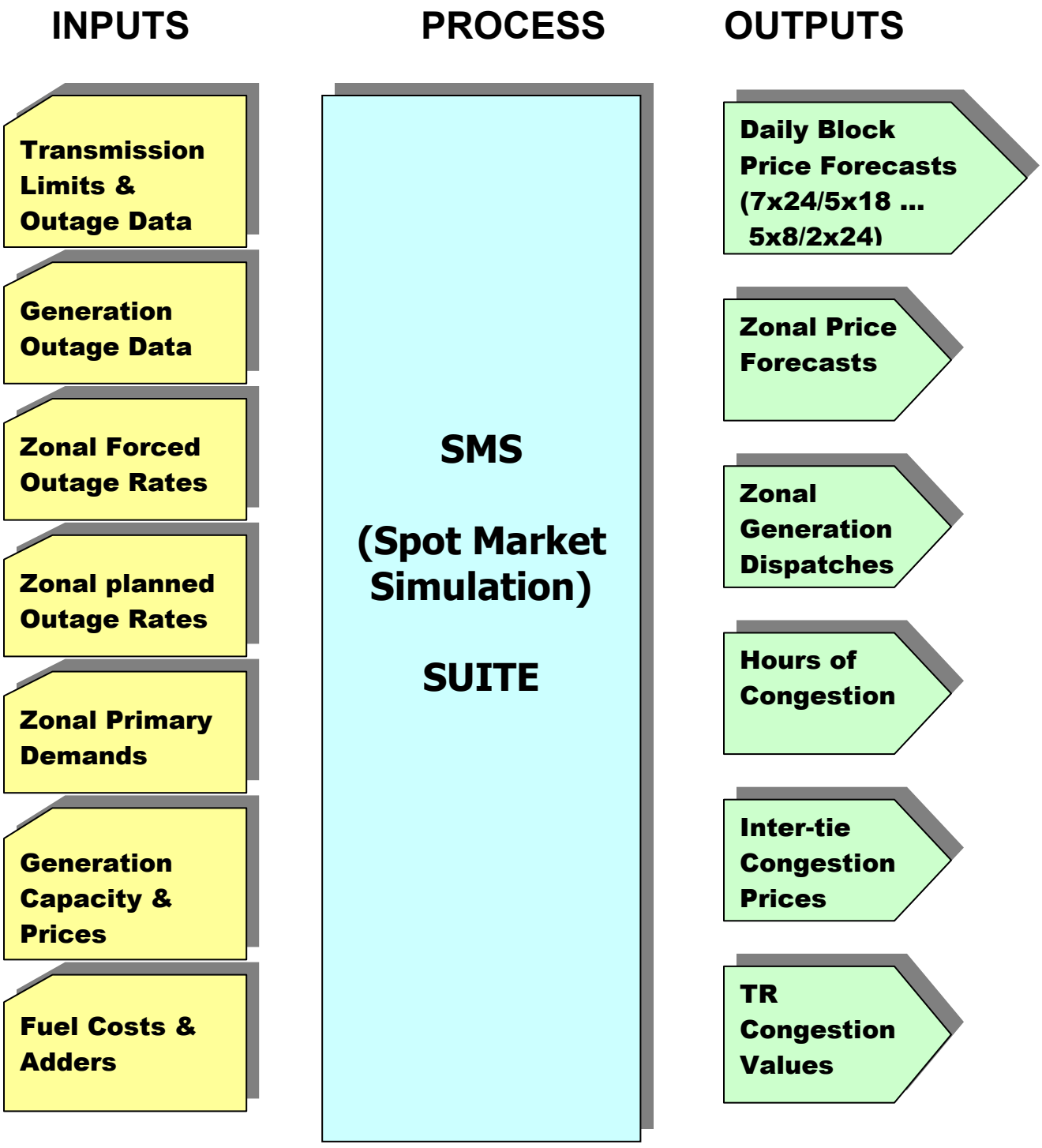


Figure 1: SMS Suite Input Output Relationship

3. How To Activate the SMS Suite

MS Suite is developed based on Matlab[1] technology to take advantage of many convenient features such as userfriendliness, rich mathematical algorithms, speed and variety of sophisticated computational platforms. However, users do not need to know Matlab in order to run SMS, although some basic knowledge of Matlab would help them navigate through the inputs and outputs to get the desired answer more quickly.

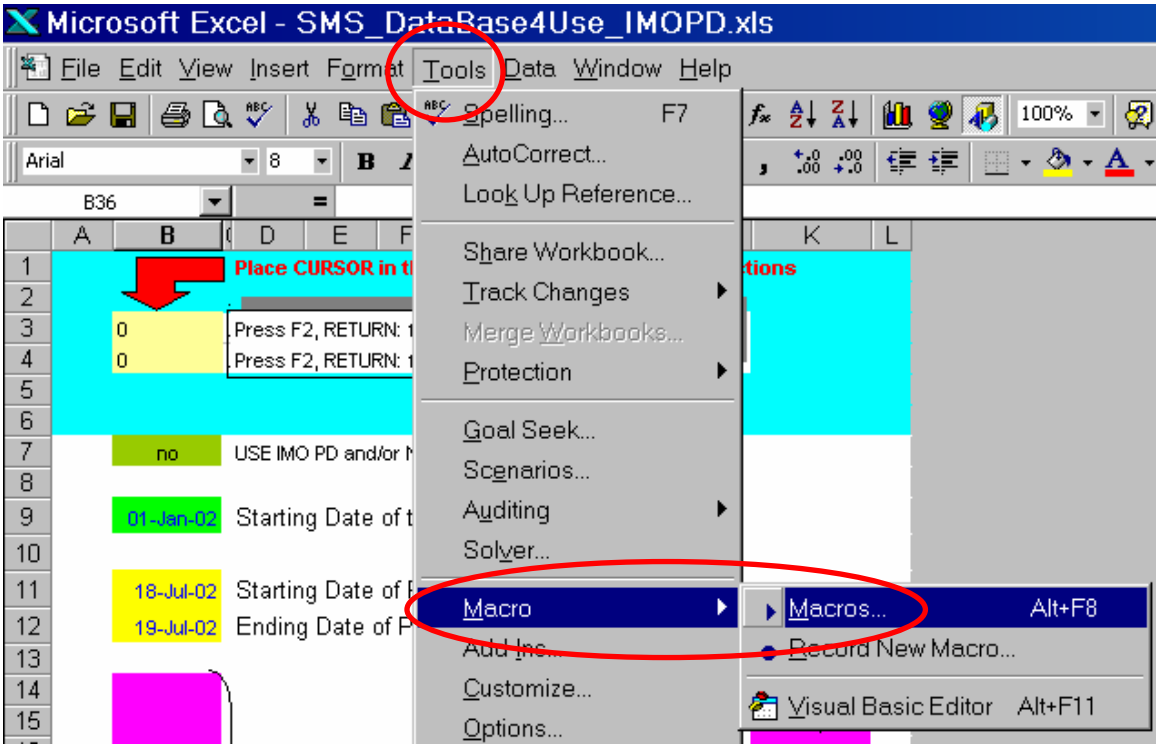
Input and output data flows in SMS are handled through the EXCEL interfaces.

To run SMS Suite, users must go to the directory where a working copy of the user-interface template (an EXCEL[2] worksheet) is installed and follow the following steps:

1. Activate the MS EXCEL workbook named SMS_Database4Use_IMOPD

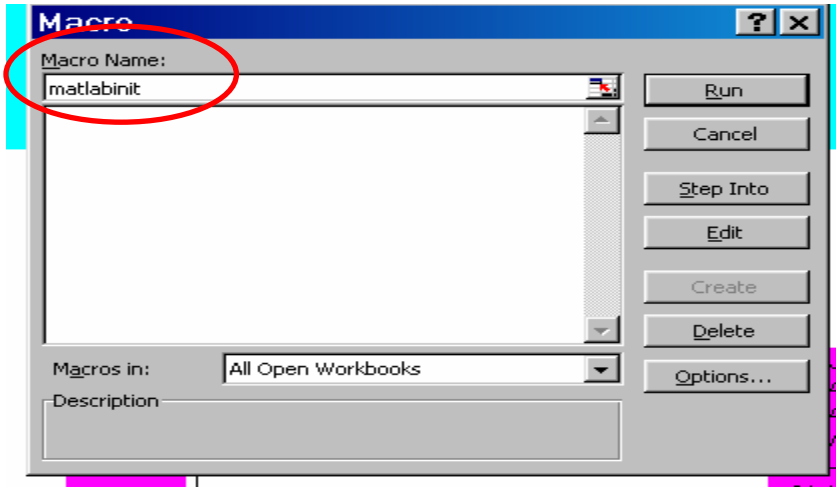
2. Activate Matlab,

   - by first going to the **Tools bar** Menu and selecting Macro as shown in the picture below:

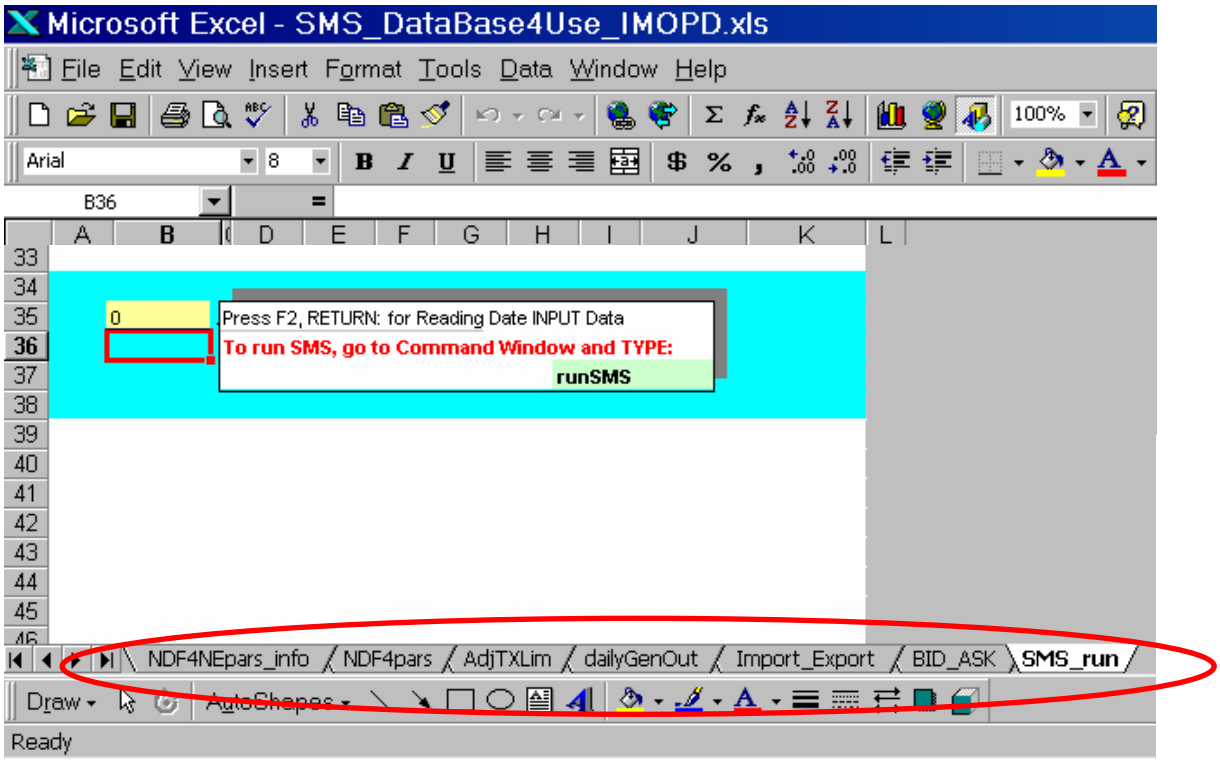


[1] A Mathworks product: see Mathworks website: www.mathworks.com
[2] A Microsoft product: see Microsoft Website: www.microsoft.com

- Click on **Macros** and then type 'matlabinit' (**matlab init**ialize) in the space provided for the Macro Name as in the picture below



Now everything is ready for you to run the SMS application. You must, however, prepare the input case for your particular study before submitting it to a SMS run. The following sections will guide you through the process of data preparations.



There are 7 worksheets in the **SMS_Database4Use_IMOPD** workbook; they contain the database that will be used to simulate the spot market price forecasts and transmission right evaluation by the SMS suite. The description of each of these worksheets is listed in the following.

1. **NDF4NEpars_info**: this worksheet contains the processed data of the Northeast transmission network into zones of interest as defined by IMO/ISO. The data in this worksheet should not be changed unless there is a change in the transmission network topologies. This worksheet also contains critical planning flowgates' limits.

2. **NDF4pars:** this worksheet contains the operational data for all the phase angle regulators (phase shifters) of the northeast interconnection. All phase angles of the phase shifters are assumed fixed. Users, however, can make changes to a particular phase shifter operation/angle if they have such knowledge.

3. **AdjTXLim:** this worksheet contains flowgates limits and facilities. Adjust these limits to reflect prevailing conditions.

4. **dailyGenOut:** this worksheet contains generating laminations in each zone and facilities that allow the capacity to be adjusted to reflect the availability.

5. **Import_Export:** this worksheet is used to control the import-export amount of power through each control area during the SMS runs.

6. **BID_ASK:** this worksheet contains information about the zonal generating capacity and offer that are categorized into laminations for fuel types and running cost plus a variety of adders.

7. **SMS_run:** this template prepares the input read and other information like holidays, control of specific period to be forecasted etc.

Except for the transmission network topologies that are assumed unchanged, therefore, data in the **NDF4Nepars_info** worksheet will not be modified. The network topologies are considered undergone a major change if there is an expansion due to additions of components such as new transmission lines, new high voltage transformers, or new phase shifters that will have a new major yet unknown impact on the transmission system operations and reliability. Minor changes such as element outages (lines or transformers) for maintenance purposes (whose impacts on the system are known) will be taken into consideration by making appropriate changes in the **AdjTXLim** worksheet. In the following sections we will describe how to prepare input data as required for SMS runs.

4. How To Prepare Input Data for a SMS Run

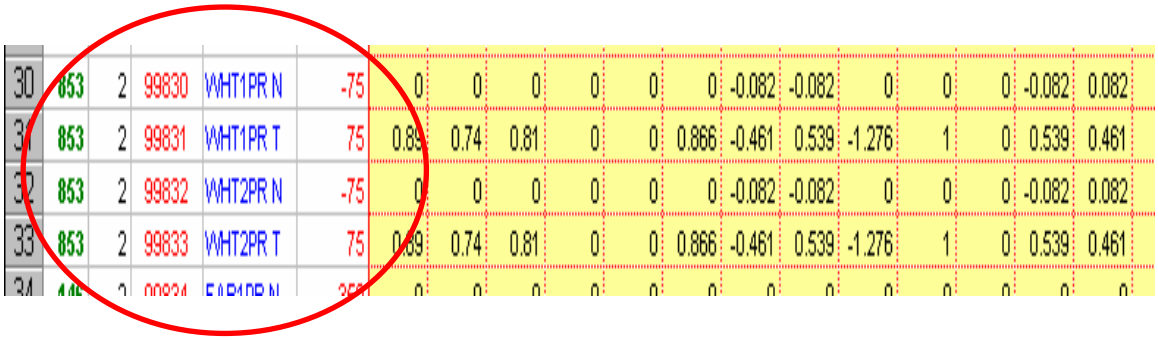
Before any price forecasts run using SMS, a natural question comes to mind is whether there are any changes in the transmission network that might affect the spot prices. Any change in the flowgate's control devices such as phase shifters (**NDF4pars** worksheet) or change in the flowgate's security limits (**AdjTXLim** worksheet) due to some transmission line outages during the period of study will likely affect the power flows and hence the spot prices of electricity. If users have knowledge of such changes, then they must make appropriate modifications to reflect these changes or the results will not be accurate.

a) Phase Angle Regulator (Phase Shifter) Adjustment:

The default operating conditions of the existing phase shifters are described in the **NDF4pars** worksheet that is partially shown as below

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1					NDF4pars	TEM	LHE	EWFE	D501P	P502X	FN_S	QFW	BLIP	FETT	MH-ON	ONT-MI	ONT-MI	ONT-NY	NTxONT
2					Preflow	178	148	162	0	0	173	264	460	-250	200	0	459	-263	0
3	Area	Type	OrigBN	BusNAM	Pars(MW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
4	13	2	99800	LND PR N	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	13	2	99801	LND PR T	-98	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	13	2	99802	NFM PR N	-351	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	13	2	99803	NFM PR T	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	13	2	99804	NFS PR N	-351	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	13	2	99805	NFS PR N	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	13	2	99806	WA1 PR T	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	13	2	99807	WA1 PR N	1	0	0	0	0	0	0	0.259	0.259	0	0	0	0.259	-0.259	0
12	13	2	99808	WA2 PR T	-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	13	2	99809	WA2 PR N	30	0	0	0	0	0	0	0.259	0.259	0	0	0	0.259	-0.259	0
14	13	2	99810	WA3 PR T	-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	13	2	99811	WA3 PR N	26	0	0	0	0	0	0	0.259	0.259	0	0	0	0.259	-0.259	0
16	852	2	99816	MN7 PR N	-110	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
17	852	2	99817	MN7 PR T	110	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
18	852	2	99818	IFLSPR N	0	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
19	852	2	99819	IFLSPR T	0	0.89	0.741	0.81	0	0	0.866	-0.461	0.539	-1.276	0	-1	0.539	0.461	0
20	853	2	99820	BDX PR N	100	0	0	0	0	0	0	-0.081	-0.081	0	0	0	-0.081	0.081	0
21	853	2	99821	BDX PR T	-100	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
22	853	2	99822	MCP1PR N	-57	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
23	853	2	99823	MCP1PR T	58	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
24	853	2	99824	MCP2PR N	-57	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
25	853	2	99825	MCP2PR T	57	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
26	853	2	99826	SCT PR N	-47	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
27	853	2	99827	SCT PR T	47	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
28	853	2	99828	SHE PR N	-67	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
29	853	2	99829	SHE PR T	67	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
30	853	2	99830	WHT1PR N	-100	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
31	853	2	99831	WHT1PR T	100	0.89	0.74	0.81	0	0	0.866	-0.461	0.539	-1.276	1	0	0.539	0.461	0
32	853	2	99832	WHT2PR N	-100	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082	0
33	853	2	99833	WHT2PR T	100	0.89	0.74	0.81	0	0	0.866	-0.461	0.539	-1.276	1	0	0.539	0.461	0

The flowgate that monitors the power flow between Ontario and Manitoba is controlled by the pairs of phase shifters at the White Shell buses as seen in the red circle in the above picture. The model of a phase shifter is described in Part II: Models & Algorithms. For each phase shifter a pair of generators (one positive, one negative) is used. The flow in this flowgate is regulated to around 200MW. Therefore, we can observe there exist 2 pairs or four generators to represent the two phase shifters along this flowgate. To adjust the phase shifter so that it will operate and therefore control the flow in this flowgate at a different value than 200 MW one must adjust to outputs of these generators. The diagram below illustrate the case where the phase shifters are adjusted to control the flow in the flowgate at a value of 150 MW,



30	853	2	99830	WHT1PR N	-75	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082
31	853	2	99831	WHT1PR T	75	0.89	0.74	0.81	0	0	0.866	-0.461	0.539	-1.276	1	0	0.539	0.461
32	853	2	99832	WHT2PR N	-75	0	0	0	0	0	0	-0.082	-0.082	0	0	0	-0.082	0.082
33	853	2	99833	WHT2PR T	75	0.89	0.74	0.81	0	0	0.866	-0.461	0.539	-1.276	1	0	0.539	0.461
34						0	0	0	0	0	0	0	0	0	0	0	0	0

Note that although in the above example each generator is assumed to contribute 75 MW to make up the total of 150 MW as specified, it may not necessary be the case. If one has a precise knowledge of the actual setting that is used to control the flowgate's flow, then this setting must be used for the phase shifters.

b) Transmission Limit Adjustment & Transmission Outage Data:

At any given moment, there are always flows in all the branches of an electrical transmission network unless they are completely taken out of service. To operate the power system reliably, one must observe the amount of flow in some lines or a set of lines that are being identified as critical flow-gates to make sure that the flow should not exceed the pre-established limits called security limits in these flow-gates.

What is a Flowgate ?

Flow-gate is a circuit or a group of circuits through which amount of power flow must be monitored and controlled to ensure a safe operation of the power system.

Flow-Gates' Definitions

The Ontario-Michigan flow-gate definition consists of the following circuits:

OH-MECS:

Bus NAME	kV	Bus NAME	kV	Cct. ID	Metered
LAMB L4D	345	19SC67	345	1	T
LAMB L51	345	19SC67	345	1	F
J5D PS	230	19WTRMN	230	1	F
SCOTT	220	19BUNCE	230	1	T

This flow-gate contains four circuits. Consider the first circuit as specified in the first row: the first bus name is an Ontario bus of the circuit (line), next is the voltage level of this circuit, 345 kV; the second bus name is a Michigan bus of the circuit, the voltage level (345 kV), and the circuit identification (Cct. ID). Each circuit of this flow-gate will have a meter for monitoring the flow. The last column indicates where the meter is located. For this circuit, the meter is at the 'TO' bus (T). The symbol 'F' means the meter is located at the 'FROM' bus.

A complete set of flow-gate definitions is shown in the Appendix A.

The template for use to modify transmission limits and transmission outage data is as shown in the EXCEL worksheet named **AdjTXLim** that is partially shown as below

					1	2	3	4	5	6	7	8	9	10
	No	Interface	LoLIMIT	UpLIMIT	5/18/02	5/19/02	5/20/02	5/21/02	5/22/02	5/23/02	5/24/02	5/25/02	5/26/02	5/27/02
	1	TEM	-350	325	0	0	0	0	0	0	0	0	0	0
	2	LHE	-250	230	0	0	0	0	0	0	0	0	0	0
	3	EWFE	-350	325	0	0	0	0	0	0	0	0	0	0
	4	D501P	-1500	1500	0	0	0	0	0	0	0	0	0	0
	5	P502X	-1500	1500	0	0	0	0	0	0	0	0	0	0
	6	FN_S	-1800	1265	0	0	0	0	0	0	0	0	0	0
	7	QFW	-1600	2650	0	0	0	0	0	0	0	0	0	0
	8	BLIP	-2500	4500	0	0	0	0	0	0	0	0	0	0
	9	FETT	-5000	5750	0	0	0	0	0	0	0	0	0	0
	10	MH-ONT	-200	300	0	0	0	0	0	0	0	0	0	0
	11	ONT-MPL	-150	175	0	0	0	0	0	0	0	0	0	0
→	12	ONT-MECS	-2214	2344	0	0	0	0	0	0	0	0	0	0
	13	ONT-NYPP	-1525	2350	0	0	0	0	0	0	0	0	0	0
	14	NTxONT_STL	-200	400	0	0	0	0	0	0	0	0	0	0
	15	NY_CxE	-3100	2980	0	0	0	0	0	0	0	0	0	0

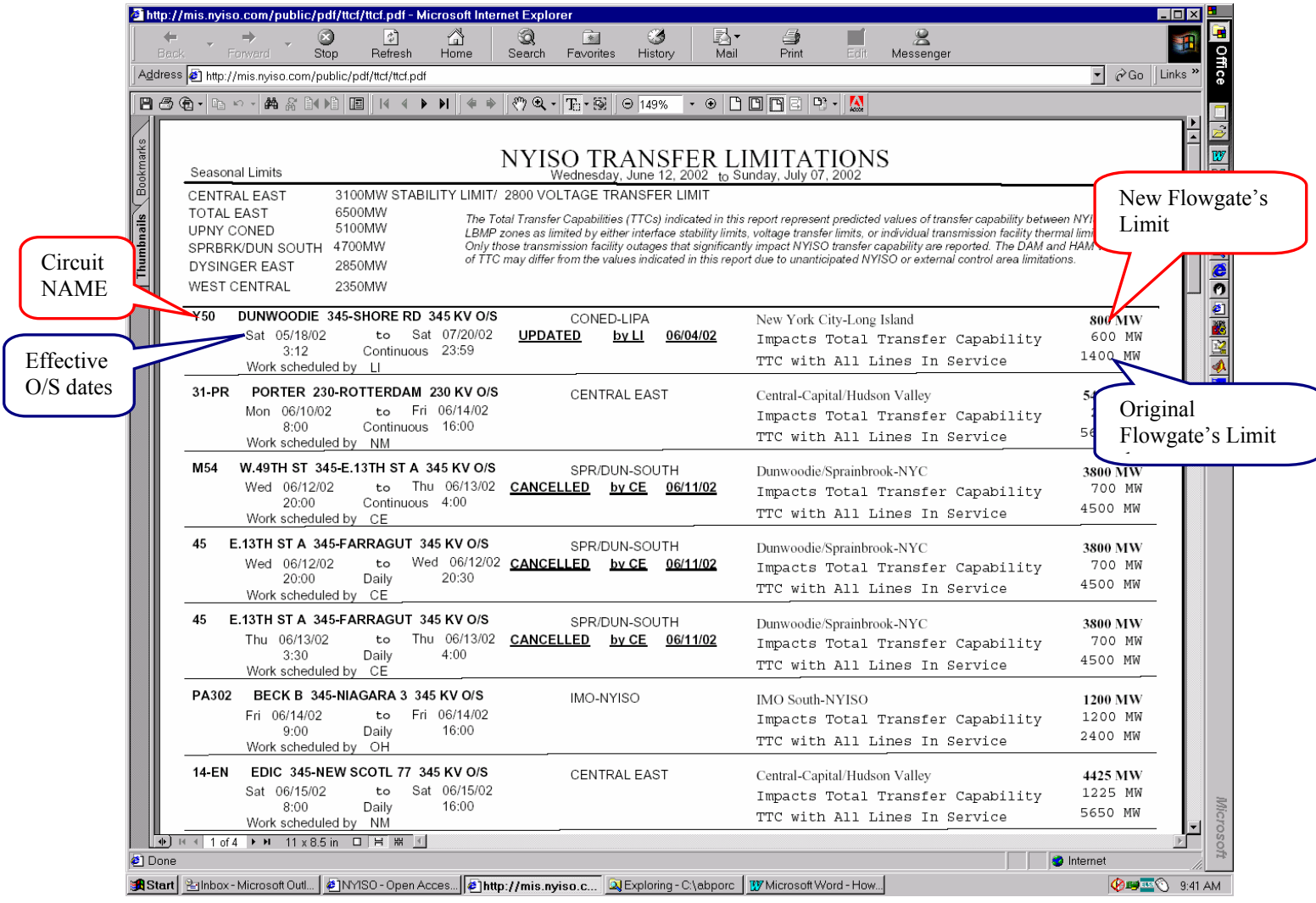
For each flow-gate, there is a limit for the amount of power flow in one direction and a limit for the flow in the opposite direction. These limits are not necessarily the same due to operating conditions in different areas.

Again, let consider the ONT-MECS flow-gate as marked by the arrow in the above table. The maximum allowable power flow from Ontario to Michigan is 2344 MW whereas the maximum flow from Michigan to Ontario is 2214 MW (-2214 is used to indicate the flow

in the opposite direction). These limits can be modified by directly changing the values of the appropriate cells.

The flow-gates' limits could be varied during the course of the day or week or month due to system conditions. The new limits will be posted by the ISO/IMO as required by market rules to inform the market participants of system changes so that they could take appropriate measures to mitigate the risk created by these changes. These limit changes for various interfaces during days or weeks or months into the future could be captured in the dispatches using the EXCEL table shown above. In the following section, we will demonstrate how SMS utilizes transmission outage information reported daily by the New York ISO prior to its energy dispatch and price forecast runs.

The New York ISO, for example, posts daily transmission limits for various flow-gates throughout the state. A sample of this posting is as shown below.



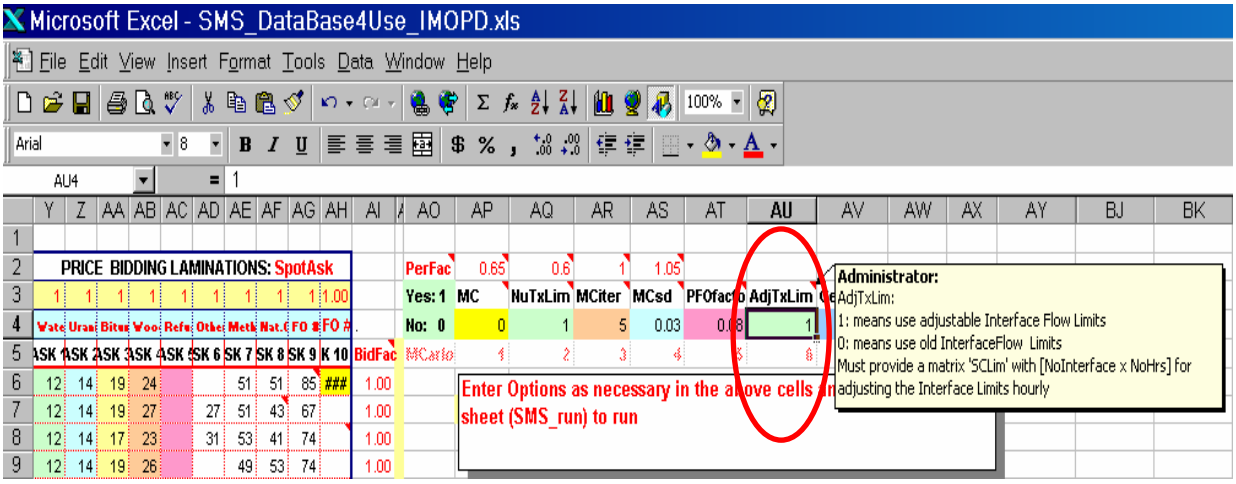
How to use this information:

The first row is the circuit name that connects a bus named DUNWOODIE 345 to the SHORE RD 345KV. The second row shows the effective out-of-service dates. It indicates that between May 18, 2002 to July 20, 2002, the circuit named DUNWOODIE 345 _SHORE RD 345KV is out of service (O/S), therefore, the flow-gate between CONED and LIPA whose original limit of 1400MW is to be reduced by 600 MW. This information is entered into the **AdjTXLim worksheet** as shown in the following:

					1	2	3	4	5	6	7	8	9	10
	No	Interface	LoLIMIT	UpLIMIT	5/18/02	5/19/02	5/20/02	5/21/02	5/22/02	5/23/02	5/24/02	5/25/02	5/26/02	5/27/02
	28	NYCxLILCO	-500	250	0	0	0	0	0	0	0	0	0	0
→	29	WSCHExLILC	-800	1400	-600	-600	-600	-600	-600	-600	-600	-600	-600	-600
	30	NPXxLILCO	-100	100	0	0	0	0	0	0	0	0	0	0
	31	PJM_WxCAP	-1500	1500	0	0	0	0	0	0	0	0	0	0
	32	PJM_ExNYC	-1000	1000	0	0	0	0	0	0	0	0	0	0
	33	PJM_WxNIAG	-550	550	0	0	0	0	0	0	0	0	0	0
	34	PJM_WxCENT	-1100	1100	0	0	0	0	0	0	0	0	0	0
	35	HQxADIR	-2350	2350	0	0	0	0	0	0	0	0	0	0
	36	NEPOOLxNY	-1375	1300	0	0	0	0	0	0	0	0	0	0

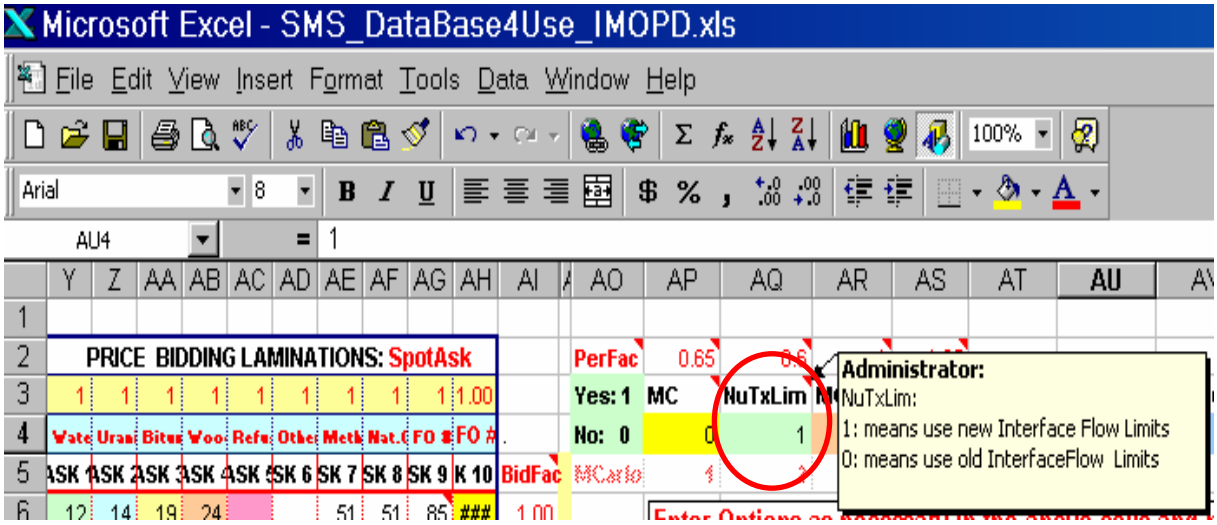
For each day from 5/18/02 to 5/27/02 (10 days used in the table for illustration purposes), The limit on the interface is reduced by 600MW. Thus, the flow from Weschester to Long Island must be kept at 800MW maximum, and the reverse flow from Long Island to Weschester must be controlled at 200MW maximum. SMS will use these new limits when it dispatches power to serve the load demands. Similarly, other flow-gates' limits must be updated to achieve correct results.

In order for the new daily limit change reported in this worksheet to take effect, one must set the **AdjTxLim** parameter in the **BID_ASK worksheet** to 1 as shown below



Note also that this **AdjTXLim** worksheet contains the flowgates' limit in one direction as defined in the column named **UpLIMIT** (positive direction) and the limits in the reverse direction as in the column named **LoLIMIT** (negative direction). These are operational limits as compared to the planning limits shown in the **NDF4NEpars_info** worksheet.

To use the planning limits, one must set the **NuTxLimit** parameter in the **BID_ASK worksheet** to 0, and to use the operational limits set it to 1 (see the below figure).



For comparison, the two sets of limit (planning limits and operational limits) for the defined critical flowgates are also shown in the following page.

From the NDF4NEPARS_info worksheet

From the AdjTXLim worksheet

Planning Flowgates' Limits

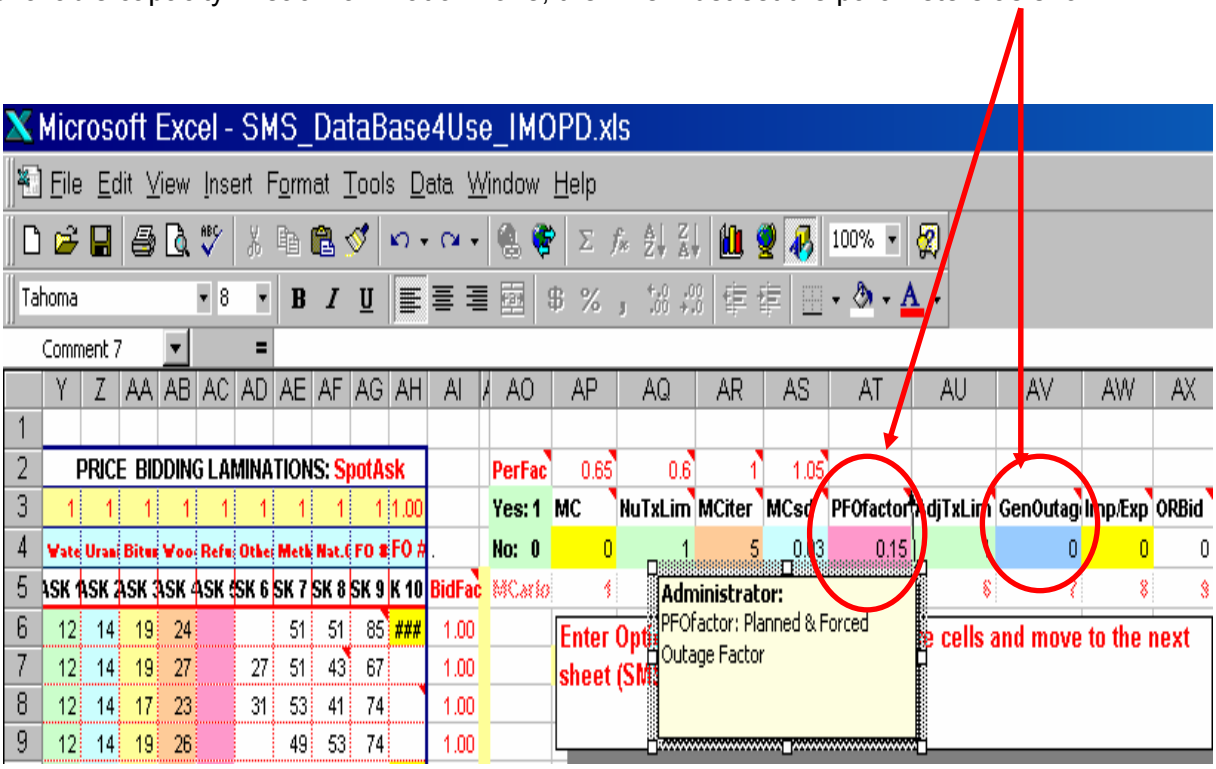
No	Interface	LoLIMIT	UpLIMIT
1	TEM	-350	325
2	LHE	-250	230
3	EWFE	-350	325
4	D501P	-1500	1500
5	P502X	-1500	1500
6	FN_S	-1800	1265
7	QFW	-1600	1650
8	BLIP	-1500	3500
9	FETT	-5000	5750
10	MH-ONT	-200	300
11	ONT-MPL	-150	175
12	ONT-MECS	-2214	2344
13	ONT-NYPP	-1525	2350
14	NTxONT_STL	-200	400
15	NY_CxE	-3100	3100
16	NY_WxC	-2350	2350
17	NYxPJM	-3600	3600
18	PJM-WEST	-5750	5750
19	PJM-CENT	-4500	4500
20	PJM-EAST	-7000	7000
21	FRONT-GENE	-2750	2750
22	GENExCENT	-2200	2200
23	ADIRxCENT	-2050	2050
24	CENxCAP_HD	-4650	4650
25	CAPxNE	-1200	1200
26	CAPxWSCHE	-4225	4225
27	WSCHExNYC	-4175	4175
28	NYCxLILCO	-975	975
29	WSCHExLILC	-1175	1175
30	NPXxLILCO	-200	200
31	PJM_WxCAP	-1150	1150
32	PJM_ExNYC	-1000	1000
33	PJM_WxNIAG	-1100	1100
34	PJM_WxCENT	-1300	1300
35	HQxADIR	-2350	2350
36	NEPOOLxNY	-1375	1300
37	PJM-APS	-1500	4000
38	PJM-CEI	-700	700
39	PJM-VP	-2000	2000
40	APS_WxE	-5000	5000
41	ADIR-VERMN	-125	150
42	NYxONT_NIA	-1975	1325
43	DECO_CONS	-5324	5324
44	DECO_AEP	-3380	3380
45	CONS_AEP	-4450	4450
46	CONS_CIN	-60	60

Operational Flowgates' Limits

No	Interface	oLIMIT	pLIMIT
1	TEM	-350	325
2	LHE	-250	230
3	EWFE	-350	325
4	D501P	-1500	1500
5	P502X	-1500	1500
6	FN_S	-1800	1265
7	QFW	-1600	1650
8	BLIP	-1500	3500
9	FETT	-5000	5750
10	MH-ONT	-200	300
11	ONT-MPL	-150	175
12	ONT-MECS	-2214	2344
13	ONT-NYPP	-1525	2350
14	NTxONT_STL	-200	400
15	NY_CxE	-3100	3100
16	NY_WxC	-2350	2350
17	NYxPJM	-3600	3600
18	PJM-WEST	-5750	5750
19	PJM-CENT	-4500	4500
20	PJM-EAST	-7000	7000
21	FRONT-GENE	-2000	2600
22	GENExCENT	-1300	1770
23	ADIRxCENT	-1500	2500
24	CENxCAP_HD	-4650	4650
25	CAPxNE	-1200	1200
26	CAPxWSCHE	-4225	4225
27	WSCHExNYC	-2000	3700
28	NYCxLILCO	-500	250
29	WSCHExLILC	-500	1300
30	NPXxLILCO	-100	100
31	PJM_WxCAP	-1500	1500
32	PJM_ExNYC	-1000	1000
33	PJM_WxNIAG	-550	550
34	PJM_WxCENT	-1100	1100
35	HQxADIR	-2350	2350
36	NEPOOLxNY	-1375	1300
37	PJM-APS	-1500	4000
38	PJM-CEI	-700	700
39	PJM-VP	-2000	2000
40	APS_WxE	-5000	5000
41	ADIR-VERMN	-125	150
42	NYxONT_NIA	-1975	1325
43	DECO_CONS	-5324	5324
44	DECO_AEP	-3380	3380
45	CONS_AEP	-4450	4450
46	CONS_CIN	-60	60

c) Daily Generator Outage Data:

Due to the proprietary nature of generator outage data, SMS uses the combined planned and forced outage rates (PFOfactors) for all areas of interest represented in the model. This PFO rate is used as the standard deviation in a Random Normal distribution whose mean value is set to zeros. The set of random numbers generated by this distribution is used to offset the available capacity of generation in each zone so that the overall net capacity achieved the desired level. To use this approach users must set the **GenOutage** Parameter in the **BID_ASK** worksheet to 0 and the **PFOfactors** to the combined planned and forced outage rates (in fraction). For instance, if the combined planned and forced outage rate is around 15 percent of available capacity in each lamination/zone, then we must set the parameters as shown

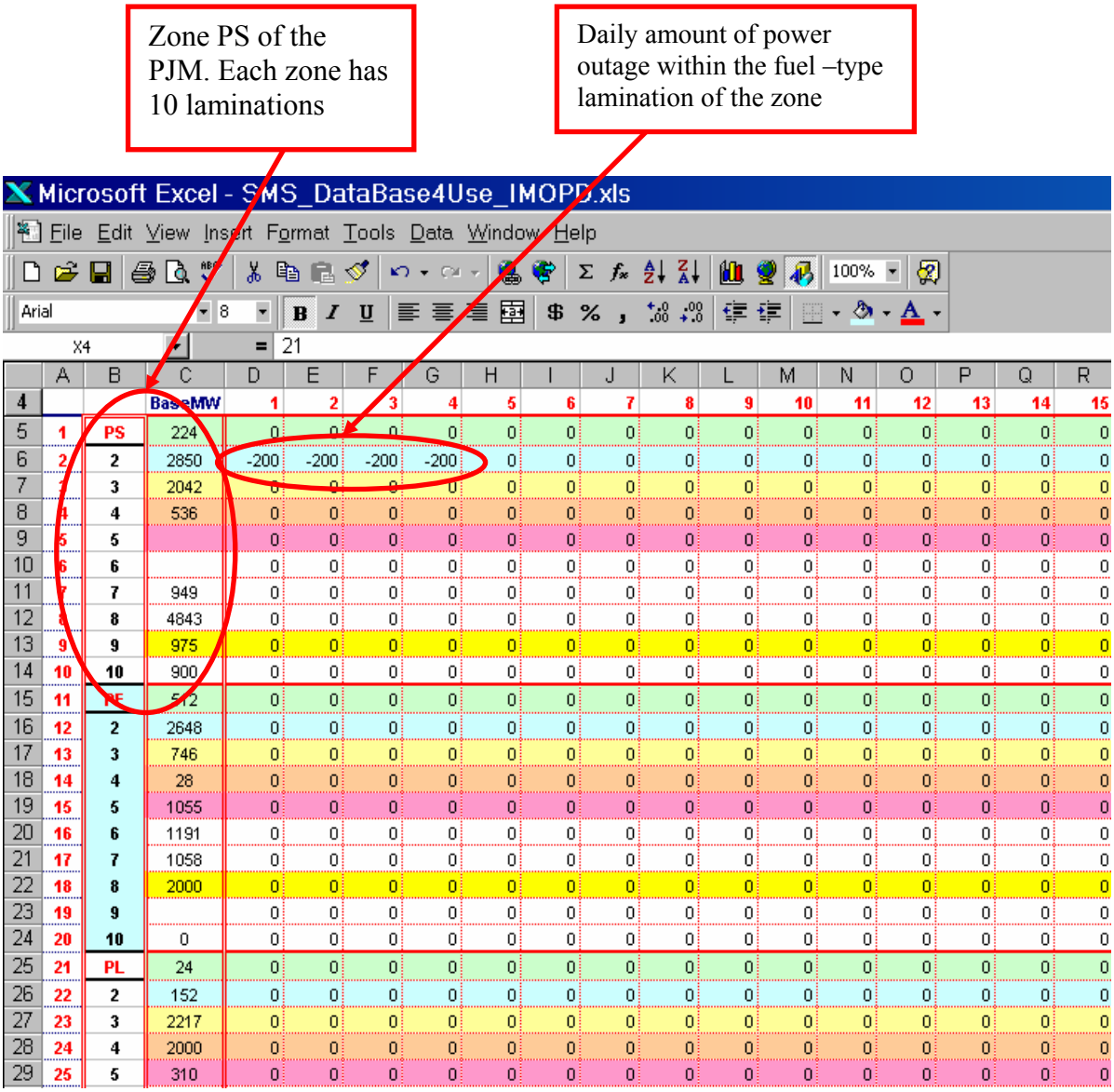


If, however, users have precise knowledge of generation outage for each zone, then this info can be entered manually in the provided **dailyGenOut** worksheet as shown partially in the following diagram.

Each zone in the SMS program contains 10 cells. These cells are also called laminations which are used to classified the type of generations exists in each zone.

Note that each zone shown in the diagram is exactly the transpose of each zone energy lamination described in the **BID_ASK** worksheet. The reason for the transpose is so that daily outages for each zone lamination can be accommodated.

Suppose, there is approximately 200 MW out of a total capacity of 2850 MW of nuclear power in Zone PS of the PJM market to be out of service for the next 4 days, the information can be entered into the **dailyGenOut** worksheet as shown in the diagram.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
4			BaseMW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5	1	PS	224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	2	2	2850	-200	-200	-200	-200	0	0	0	0	0	0	0	0	0	0	0
7	3	3	2042	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	4	4	536	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	5	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	6	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	7	7	949	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	8	8	4843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	9	9	975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	10	10	900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	11	PE	512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	12	2	2648	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	13	3	746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	14	4	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	15	5	1055	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	16	6	1191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	17	7	1058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	18	8	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	19	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	21	PL	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	22	2	152	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	23	3	2217	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	24	4	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	25	5	310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

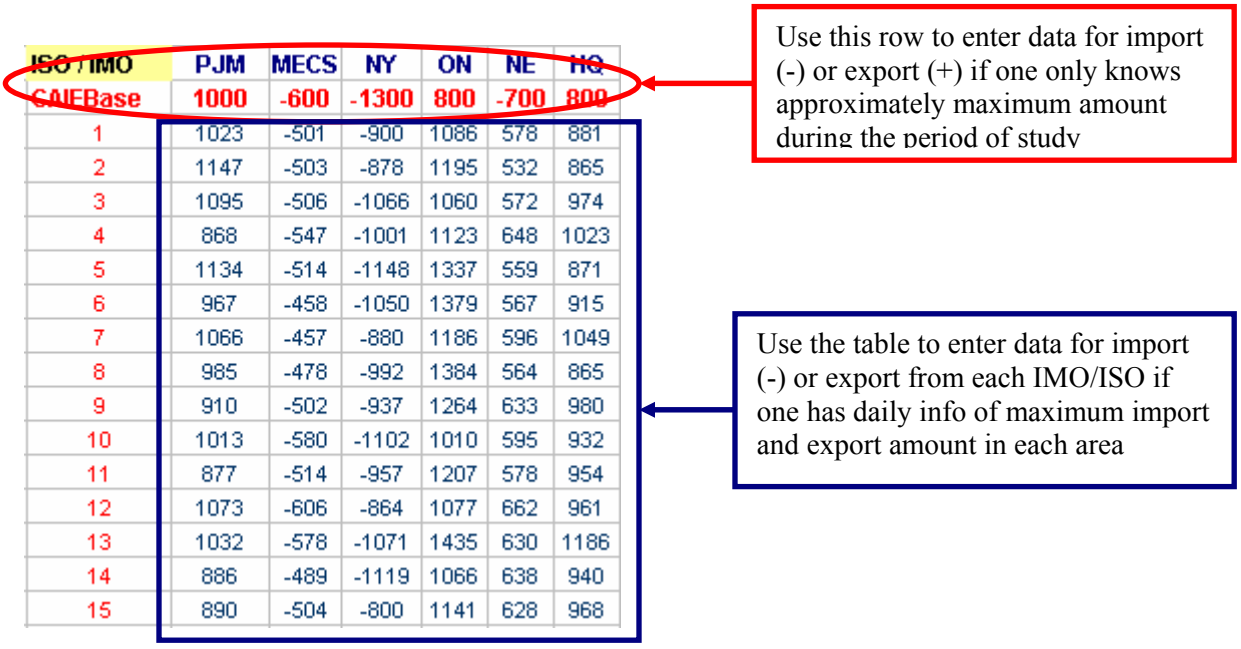
Another way to incorporate outages is to reduce the amount of MW available in the **BID_ASK** worksheet by moving the generation capacity to a much high price lamination. Usually the last lamination in each zone is set aside for this purpose. Due to high its high price, it will not normally dispatched. Hence, by moving generation capacity to this lamination one is essentially increasing the outage rate for that zone.

d) Import-Export Adjustment

Optimal power dispatches will result in power flowing from a cheaper zone to a more expensive zone to meet load demands. In practice, free movement of power based on price offer alone is not realistic. Other factors such as dispatch coordination, security and system reliability must also be considered during the dispatches.

Within the authority of an ISO/ IMO it makes sense to assume that normal economic dispatch takes place with some minor adjustment for security reasons. However, power exchange between IMO and ISO or ISO and ISO must be coordinated to ensure proper dispatches. So unless power traders are actively involved in moving surplus cheap power to supply more expensive demand regions, free power movement based on offer price simply does not occur.

In SMS program, import and export feature is facilitated in a worksheet named **Import_Export** as shown below



ISO / IMO	PJM	MECS	NY	ON	NE	HQ
CAIEBase	1000	-600	-1300	800	-700	800
1	1023	-501	-900	1086	578	881
2	1147	-503	-878	1195	532	865
3	1095	-506	-1066	1060	572	974
4	868	-547	-1001	1123	648	1023
5	1134	-514	-1148	1337	559	871
6	967	-458	-1050	1379	567	915
7	1066	-457	-880	1186	596	1049
8	985	-478	-992	1384	564	865
9	910	-502	-937	1264	633	980
10	1013	-580	-1102	1010	595	932
11	877	-514	-957	1207	578	954
12	1073	-606	-864	1077	662	961
13	1032	-578	-1071	1435	630	1186
14	886	-489	-1119	1066	638	940
15	890	-504	-800	1141	628	968

In the example shown, during the period of forecast, one would expect that at any hour PJM could export a maximum of 1000 MW, MECS imports a maximum 600 MW, NY could buy up to 1300MW, Ontario could sell up to 800 MW, New England could buy up to 700MW and HQ could sell up to 800 MW.

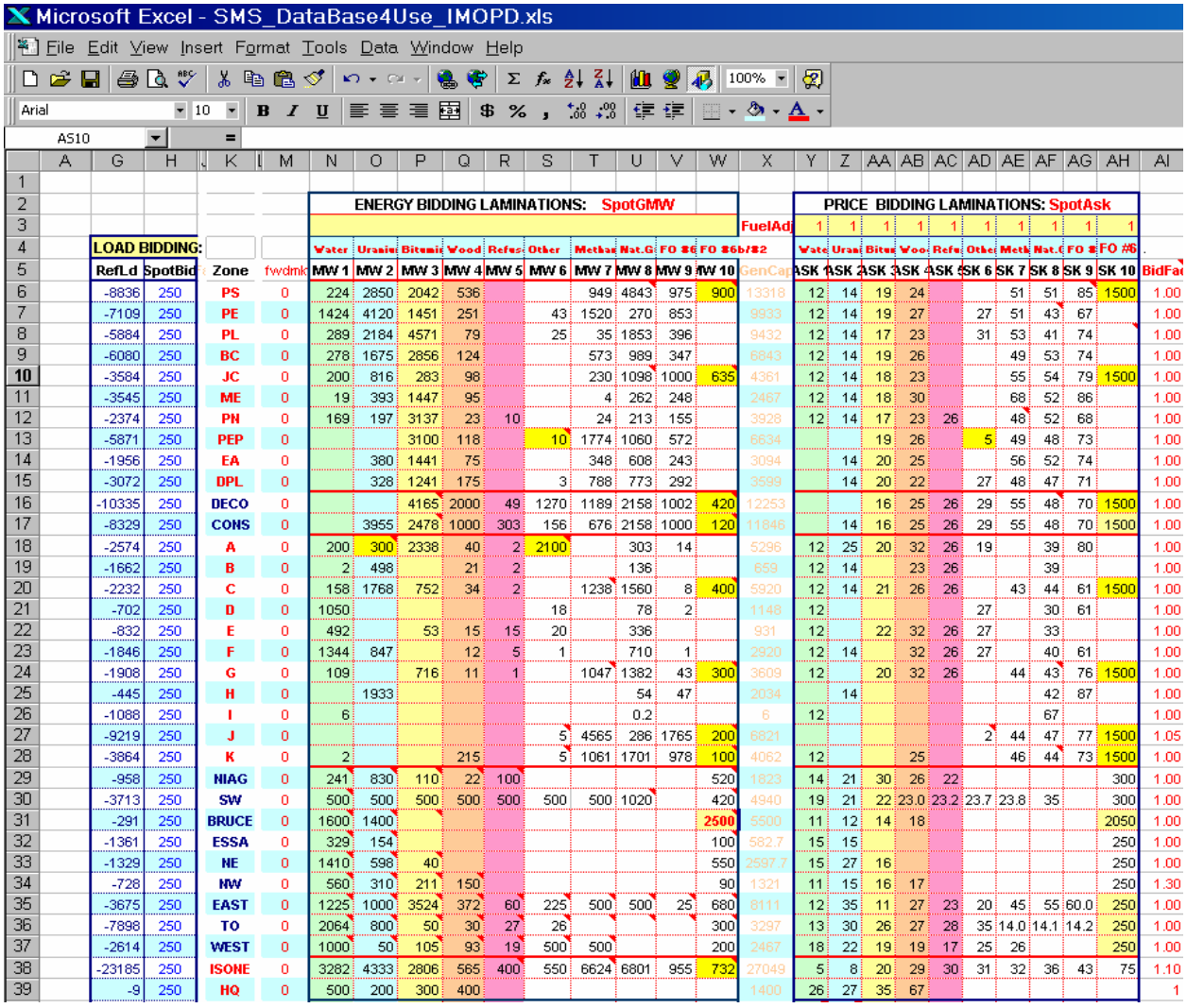
The table format is designed for a forecast period of 15 days ahead; however, it could be easily extend to any number of days with some minor change.

e) BID and ASK Modifications:

One of the challenges in forecasting spot market price is the lack of data concerning bidding strategies. Because of the proprietary nature of how generators offer their energy to the daily or hourly spot markets, one must establish some reasonable criteria based on the public domain information related to the generation characteristics in each IMO/ISO in order to forecast the spot market prices for electricity.

Public domain information such as fuel type, heat rates, and operating characteristics is available for most generators. This information together with the historical price data in various control areas and ISO/IMO published price data can be used to construct a bidding strategy for generators.

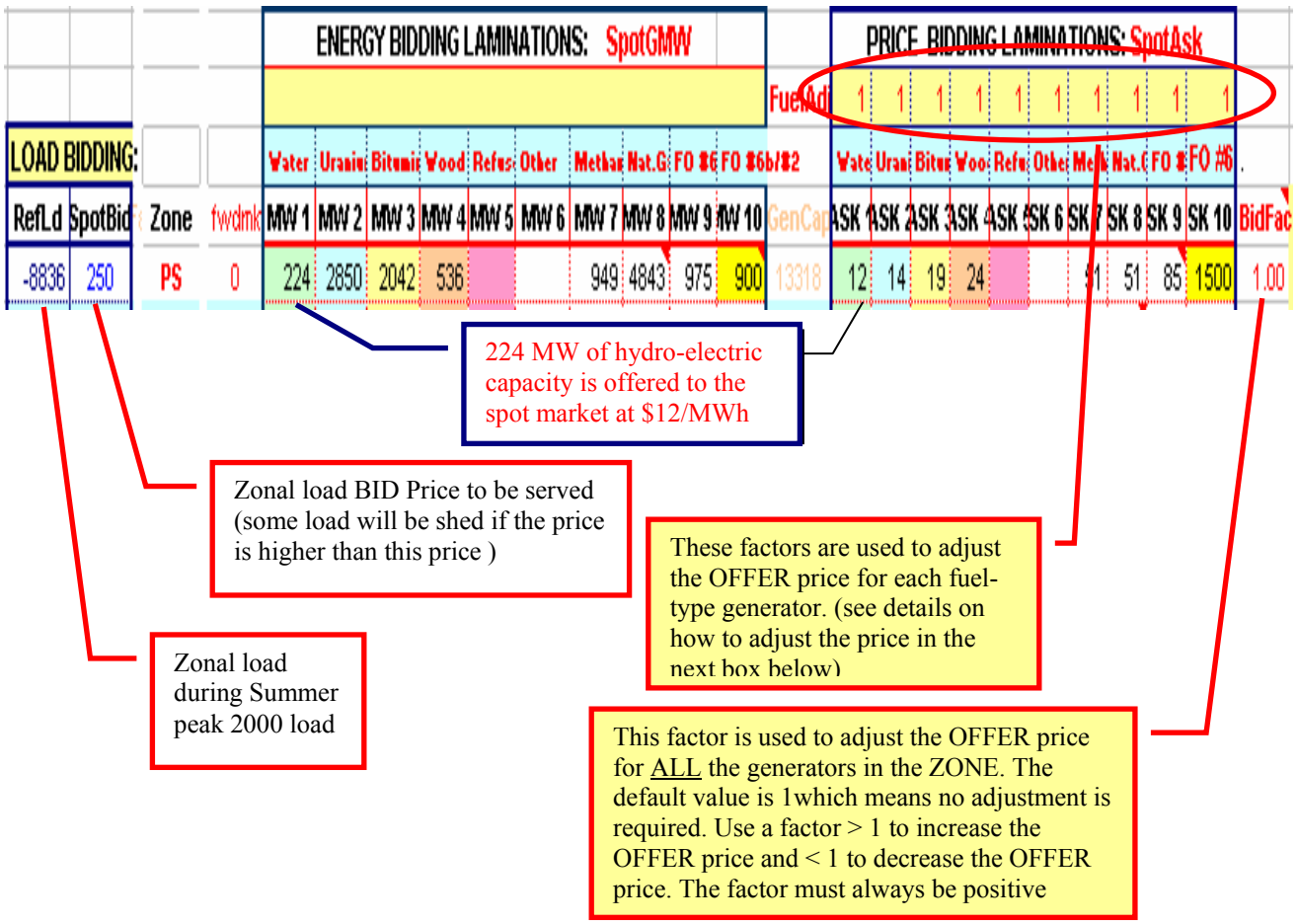
The BID_ASK worksheet shows generator data categorized into fuel type, capacity and the estimated cost per MWh for all generators across the Northeast interconnection.



Except for Ontario IMO market where the amount of generating capacity is not classified according to the fuel-type but rather by station, The US generating capacity is listed by fuel type. The order of fuel-type shown is:

1. Water or Hydro-electric type
2. Uranium or Nuclear type
3. Bituminous or Coal-fired type
4. Wood
5. Refuse or Waste
6. Others (Anything else that is not of the type listed)
7. Methane Gas
8. Natural Gas
9. Fuel Oil #6
10. Fuel Oil #2 or mixed type

Corresponding to the table of "Energy Bidding Laminations" is the "Price Bidding Laminations" table. The entries in one table are mapped one-to-one in the corresponding table. For ease of discussion, let us consider the very first row of the table shown in the BID_ASK worksheet as shown below:



As shown in the above diagram, the worksheet contains information about the zonal generating capacity and offer that are categorized into laminations for fuel types and running cost that also includes a variety of adders to account for actual cost plus profit.

SMS suite also allows dispatchable load BIDS. That is, the load can specify up to what price it is willing to pay for the power it consumes every hour. If it happens that the spot market price for some hour is higher than its bid price, some dispatchable load could be shed from the total load to achieve the desired price. This feature is very useful for implementing the demand management strategy to avoid rotating blackout, especially during the energy shortage period.

Although the load reference for each zone is reported in the table, it should not be taken as though the energy consumption is fixed for each zone during the study period. This reference serves as sanity check for the zonal load forecasts and "**Fwdmkt**" modeling that will be discussed shortly. The SMS program requires that hourly zonal load must be supplied for the entire period of the study. This data is read into the program in a separate input file to be discussed later.

The SMS program also provides bidding flexibility for fuel-type base for the entire region. The factors in the very top row of the Price Bidding Lamination table are to be used for the fuel-type based OFFER adjustment, and the factors in the far right column are used for zonal energy OFFER price adjustment. These factors must always be positive.

To increase the OFFER price one must use a factor that is greater than 1 and to decrease the price use a factor that is less than 1. The factor of value 1 is the reference for the OFFER prices as shown in the "Price Bidding Lamination" table.

One final feature from this worksheet that is also worth mentioning here is the "**Fwdmkt"**. The fourth column from the left that was labeled "**Fwdmkt**" is used to signal whether the generators in a particular zone should be used as "forward" market or not. That is, if the zone is considered as "**Fwdmkt**" either because we do not have sufficient data for generators in that zone or it is far away and therefore is not of interest, but activities in this zone will have some impact in the network power flow. Therefore we must find a way to incorporate the effect of these zonal activities. By assigning this zone to the "**Fwdmkt**" type, one basically assumes that the zone has enough supply to satisfy its own load (here summer peak load is used as a reference) and simulates the impact of the power flow in other flowgates of interest as a result. In doing this one at least capture some power flow impact in other critical flowgates in a conservative way rather than not capturing the effect at all that might result in erroneous congestion estimate.

To include a particular zone in the spot market dispatch, one therefore must assign 0 to the corresponding row of the "**Fwdmkt** " column. And the generating data of the zone must be supplied together with the OFFER prices in both "Energy Bidding Laminations" and "Price Bidding Laminations" tables for proper dispatches. On the other hand, if the zone is to be excluded from the spot market dispatch, then a 1 must the entered in the appropriate row. No information about generation needs to be provided.

f) How to Prepare Primary Demand Input:

Before showing how to run the SMS program, let us consider how the primary demand input should be prepared. Hourly primary demand for each zone must be prepared and arranged in the order as shown in the template below:

Two zones for Michigan:

1. Detroit Edison
2. Consumer Power

Eleven zones for New York ISO:

1. A 2. B 3. C
4. D 5. E 6. F
7. G 8. H 9. I
10. J (New York City)
11. K (Long Island)

Nine zones for Ontario IMO:

1. NIAG 2. SW 3. BRUCE
4. ESSA 5. NE 6. NW
7. EAST 8. TO 9. WEST

Hrs	DECO	CONS	A	B	C	D	E	F	G	H	I	J	K	NIAG	SW	BRUCE	ESSA	NE	NW	EAST	TO	WEST
1																						
2																						
3																						
4																						
5																						
6																						
7																						
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The primary demand input may contain as many hours as users want for their price forecast simulation. The SMS Suite does not restrict the size of the primary demand input.

The best way to load the primary demand input into SMS Suite is through Excel Link. Once the data has been prepared in the specified format in an EXCEL worksheet, it can be read in using the Excel Link command **putmatrix**:

1. Select by highlighting the primary demand input to be read into the SMS Suite

2. Click on the **putmatrix** button shown in the EXCEL sheet that is linked to Matlab Excel Link

3. Give the input matrix a name

Note:

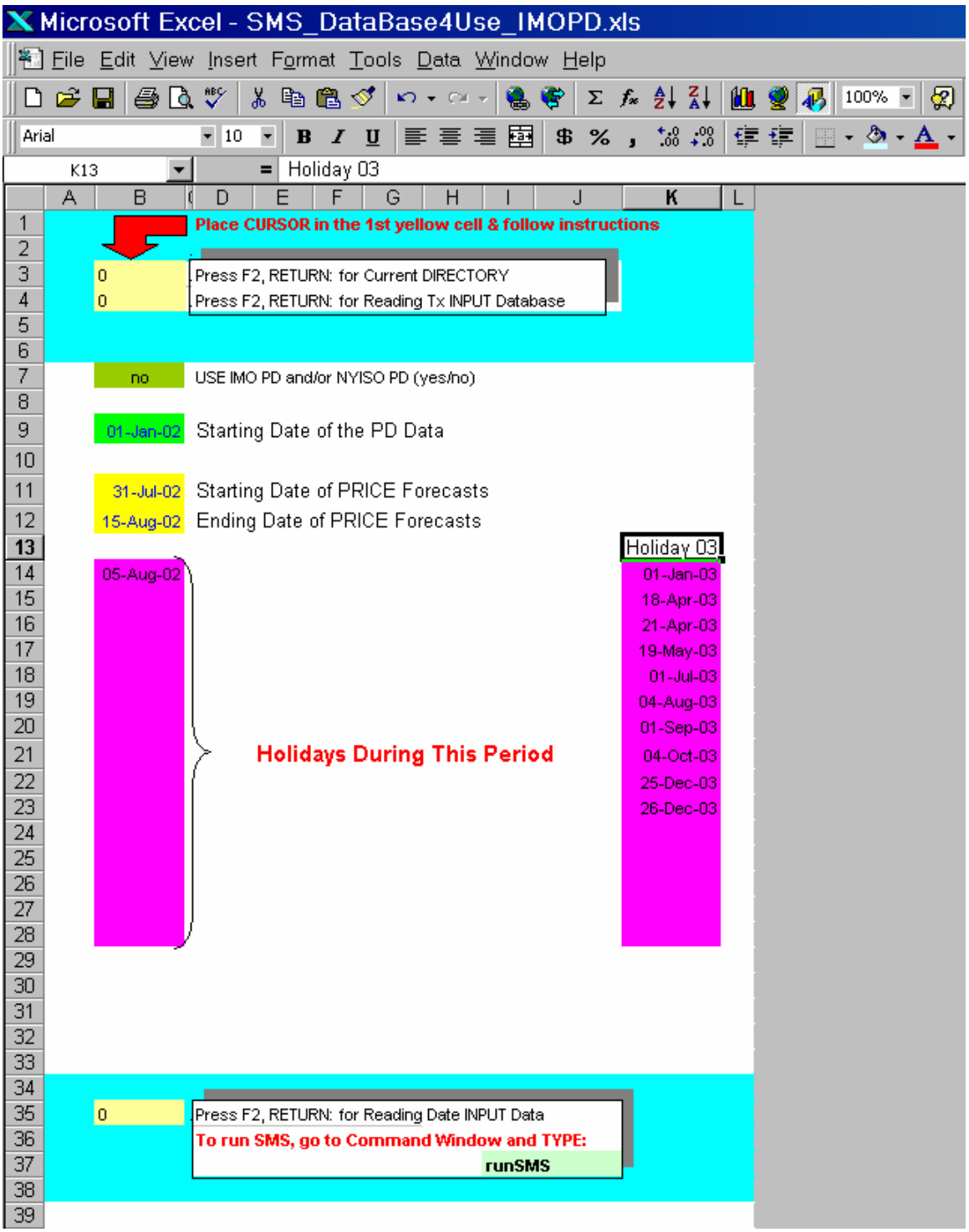
1. If you plan to use the primary demand input many more times in the future runs it is best to save it in a file otherwise it will be lost as you end the SMS run session.

2. When subscribed, the SMS also models PJM, New England ISO for accurate representation of power flow, the primary demands for these control areas will be provided in a default database to be used in conjunction with other primary demands prepared by users. This feature will be discussed in the next section.

3. At any time, users could replace previous primary demand forecasts by more accurate and recent sources based on the weather actual such as IMO or NY ISO forecasts. The next section will show how this can be done.

g) Run_SMS:

Finally, the **Run_SMS** worksheet is to read into the SMS program all the changes that have been made so far. Here one must also specify the primary demand forecasts that are required as inputs to the program, and whether there is any holiday during the period of study, if so, specify them, and then run the study using the SMS program.



Although the steps are self-explanatory, let us go through the example shown in details.

Once the SMS Suite has been activated with Excel link ready, the steps to be taken to run the SMS program is as follows:

1. Put the cursor in the first yellow cell and press F2 to locate the default directory that is the home of all the input-output data.

2. Press F2 with the cursor in the next yellow cell to read network database together with all the changes made.

3. Decide whether IMO Primary Demand (PD) forecast should be used or the in-house PD forecast is the choice. In the example shown here, it is assumed that the in-house PD forecast is supplied for the entire year 2002. Thus, the starting date of the PD forecast is Jan. 1, 2002. One can easily change this date according to the PD forecast prepared for the study.

4. Record the starting date and ending date for the study period.

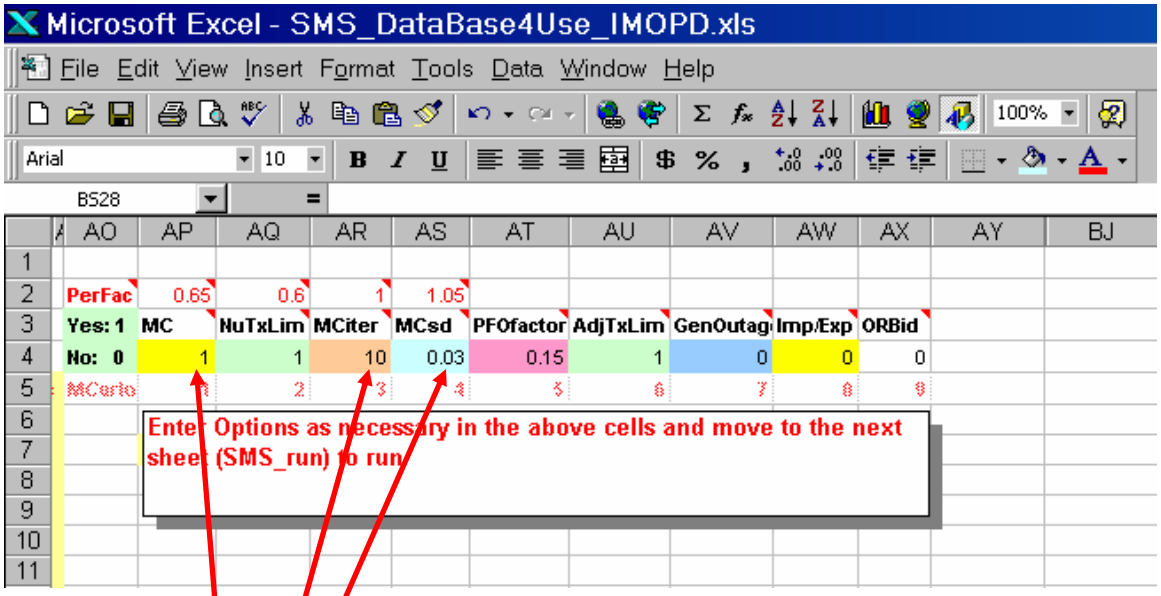
5. Record any holidays that might fall between the study periods. This is useful for the program to decide on-peak, off-peak and weekend prices. Also because US and Canada may have different holidays during the course of a month or a year, it is important that the data be input manually to avoid confusion and error.

6. Move the cursor to the next yellow cell and press F2 to record input data about holidays and/or the source of PD forecast.

7. Go to the Matlab command window and run the SMS Suite by issuing the command "**runSMS**."

   However, before issuing this command to execute the program, users may want to decide whether simple simulation run or Monte Carlo simulation run is indeed the choice. To make this choice, you must go back to the **BID_ASK** worksheet, and under the parameter **MC** (stands for Monte Carlo) enter the desired option: 1 to run Monte Carlo and 0 to make a simple (non-Monte Carlo) simulation run. Further to this choice, one must also enter what level of uncertainty in the PD forecast and the number of iterations required for each hour one wish to entertain. Suppose the PD uncertainty is around 3 % and 10 iterations are needed, then enter in the parameter beneath the cell labeled **MCsd** (stands for Monte Carlo Standard Deviation) the value 0.03, and beneath the parameter cell labeled **MCiter** enter 10. See the diagram below.

Note: One must go back to the second yellow cell at the top to read in these changes before issuing the "runSMS" command to run the SMS Suite.



These cells are to be used for Monte Carlo Simulation run:

1. MC = 1: Yes , use MC, MC = 0: No MC.
2. Mciter = 10, use 10 iterations for each hour, used only when MC = 1.
3. MCsd = 0.03, PD uncertainty is around 3 %, used only when MC = 1.

4. SMS OUTPUTS

When subscribed with the appropriate modules, the output of SMS program includes three main sets of power market forecasts: spot market price forecasts, flowgates' flows and transmission right and/TCC value. In the following sections, each of these output feature will be presented in details:

a) Spot Market Price Forecasts:

The spot market price forecasts are processed into 4 main blocks (categories) to help users best utilize the SMS output results. They are

- **7x24 Price Block**: Contains simple and weighted average daily prices
- **5x16 Price Block**: Contains simple and weighted average daily prices for the weekdays' hours 7:00 – 22:00
- **5x8 Price Block**: Contains simple and weighted average daily prices for the weekdays' hours 1:00 – 6:00 and 23:00 – 24:00
- **2x24 Price Block:** Contains simple and weighted average daily price for the weekends and holidays

There are two ways to obtain these results from a SMS run. The easiest way is to point the cursor at the yellow cell in the first row of the **SMSSpotPrices** output worksheet and press **F2.** Using this approach users will have all the results printed all at once in the pre-arranged SMS output worksheet.

0 Place Cursor in the yellow cell and press F2 for Price Results

7x24 Price Block				5x16 Price Block				5x8 Price Block				2x24 Price Block			
MCP7x24	MCPs $C	MCPw $C	DailyPD GWh	MCP5x16	MCPs $C	MCPw $C	DailyPD GWh	MCP5x8	MCPs $C	MCPw $C	DailyPD GWh	MCP2x24	MCPs $C	MCPw $C	DailyPD
15-Jul-02	63.8	65.1	443	15-Jul-02	79.5	81.5	321	15-Jul-02	32.2	32.3	122	20-Jul-02	36.7	37.2	384
16-Jul-02	60.7	62.3	415	16-Jul-02	75.5	77.9	298	16-Jul-02	31.0	31.1	117	21-Jul-02	35.0	35.4	376
17-Jul-02	64.6	66.7	414	17-Jul-02	80.1	83.1	297	17-Jul-02	33.5	33.8	116	27-Jul-02	37.1	37.6	412
18-Jul-02	79.7	80.5	418	18-Jul-02	101.9	102.9	302	18-Jul-02	35.4	35.6	116	28-Jul-02	32.1	32.3	372
19-Jul-02	58.8	60.0	422	19-Jul-02	71.6	73.2	305	19-Jul-02	33.2	33.5	117	3-Aug-02	33.0	33.3	384
20-Jul-02	36.7	37.2	384	22-Jul-02	70.7	72.4	293	22-Jul-02	31.0	31.1	115	4-Aug-02	31.9	32.2	367
21-Jul-02	35.0	35.4	376	23-Jul-02	69.9	71.6	303	23-Jul-02	32.2	32.4	116	10-Aug-02	39.3	40.0	405
22-Jul-02	57.4	58.7	408	24-Jul-02	74.6	75.4	327	24-Jul-02	34.2	34.4	125	11-Aug-02	35.1	35.7	365
23-Jul-02	57.4	58.5	419	25-Jul-02	71.7	72.2	313	25-Jul-02	31.7	31.8	120	5-Aug-02	39.8	40.8	376
24-Jul-02	61.2	61.7	452	26-Jul-02	66.6	67.4	325	26-Jul-02	31.1	31.2	124				
25-Jul-02	58.4	58.7	433	29-Jul-02	89.0	89.8	324	29-Jul-02	32.5	32.5	122				
26-Jul-02	54.8	55.3	449	30-Jul-02	89.9	93.3	329	30-Jul-02	34.7	35.1	125				
27-Jul-02	37.1	37.6	412	31-Jul-02	74.0	76.3	292	31-Jul-02	33.0	33.2	115				
28-Jul-02	32.1	32.3	372	1-Aug-02	88.2	90.2	309	1-Aug-02	36.0	36.3	118				
29-Jul-02	70.1	70.7	446	2-Aug-02	82.0	84.8	316	2-Aug-02	34.8	35.2	121				

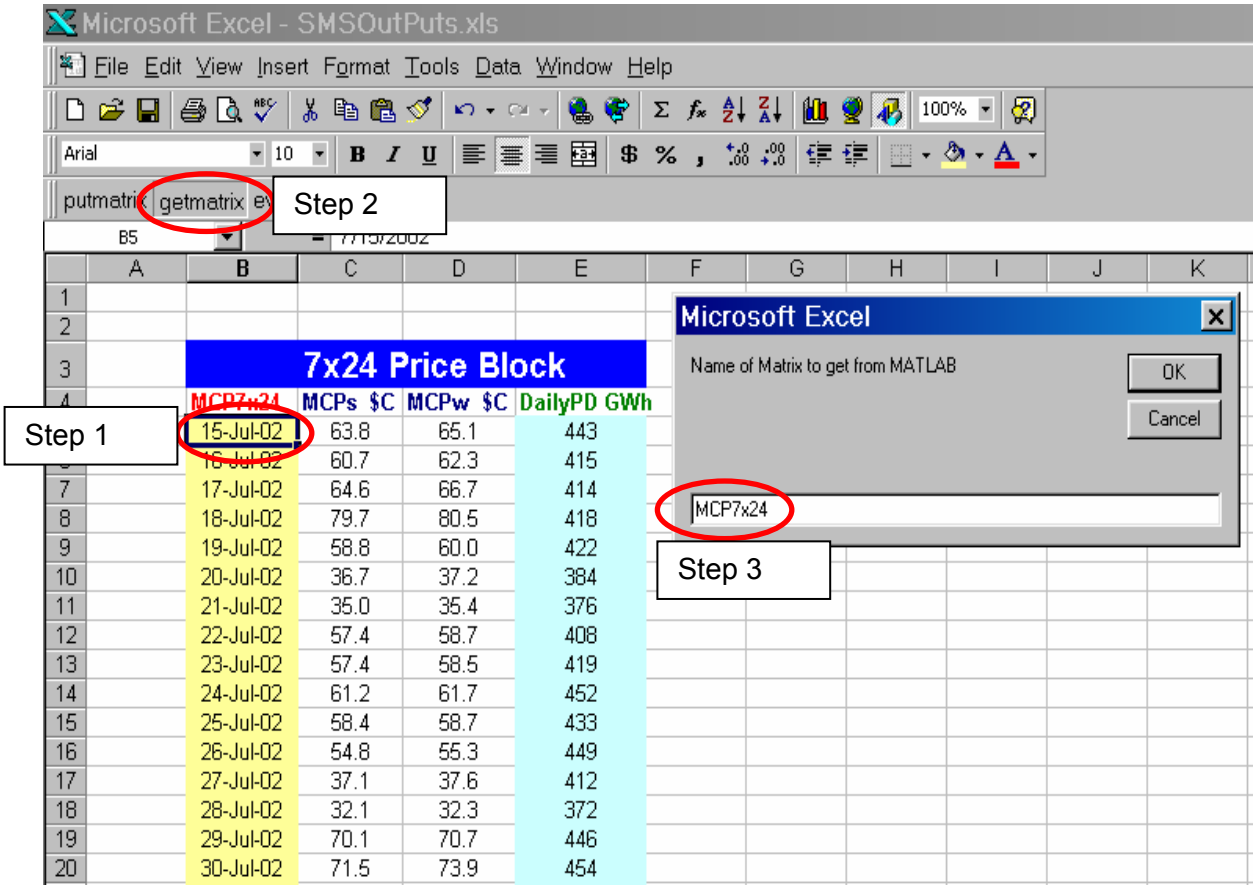
This is the CIVIC holiday during the period from July 15 - August 15, 2002

Sometimes, users would also like the flexibility to store the desired price output in a place other than the pre-arranged worksheet. To accommodate this desire, SMS allows users to select individual price blocks and store at any location of their choice. The names for each individual price block are:

- **7x24 Price Block:** MCP7x24
- **5x16 Price Block:** MCP5x16
- **5x8 Price Block:** MCP5x8
- **2x24 Price Block:** MCP2x24

To store a particular price block at a desire location of an EXCEL worksheet, all one has to do is to follow the steps:

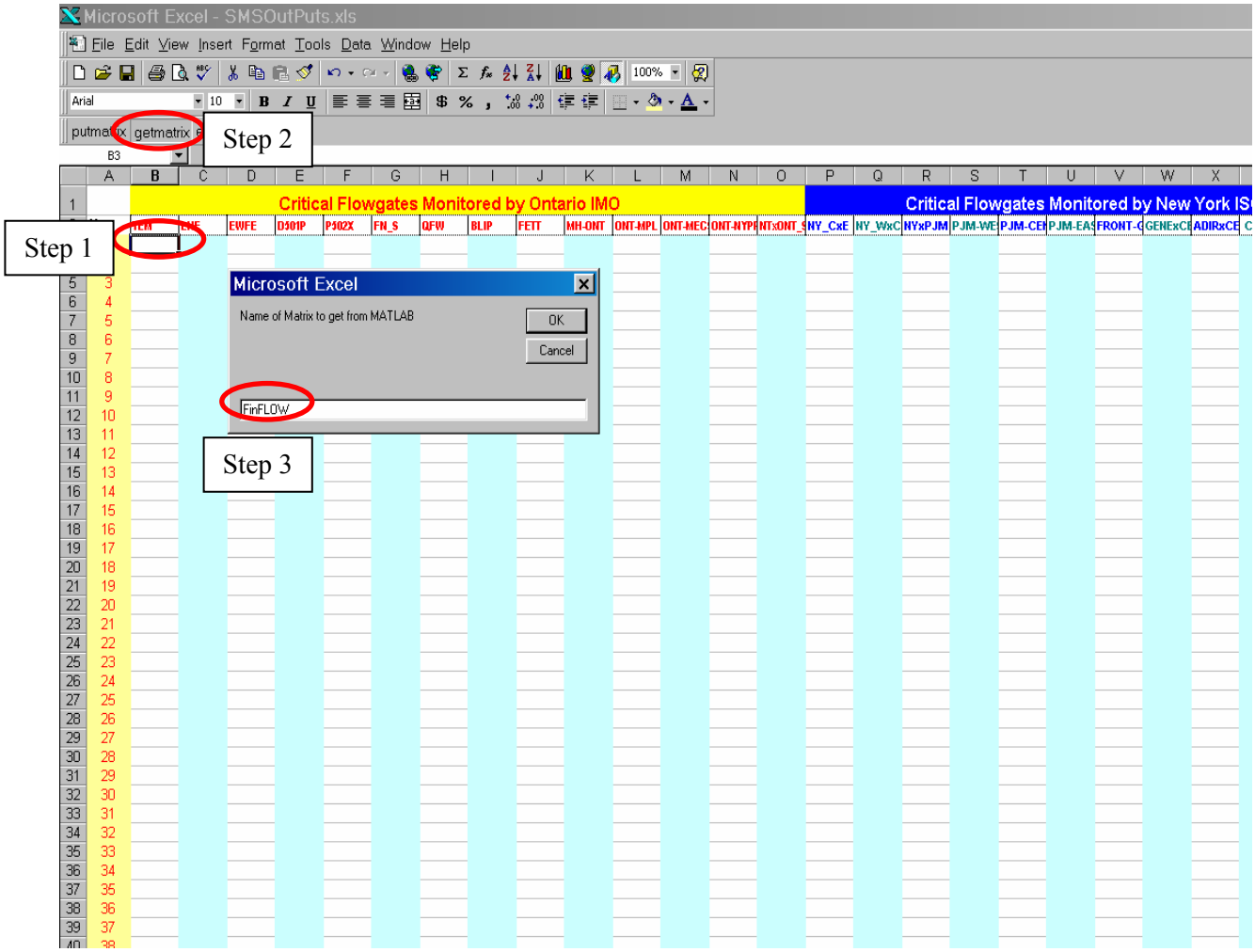
- Go to the location where the data is to be stored and,
- Click on the **getmatrix** button
- Enter the name of the price block to be stored in the menu and hit Enter or the OK button on the MENU



b) Flowgate 's Flows:

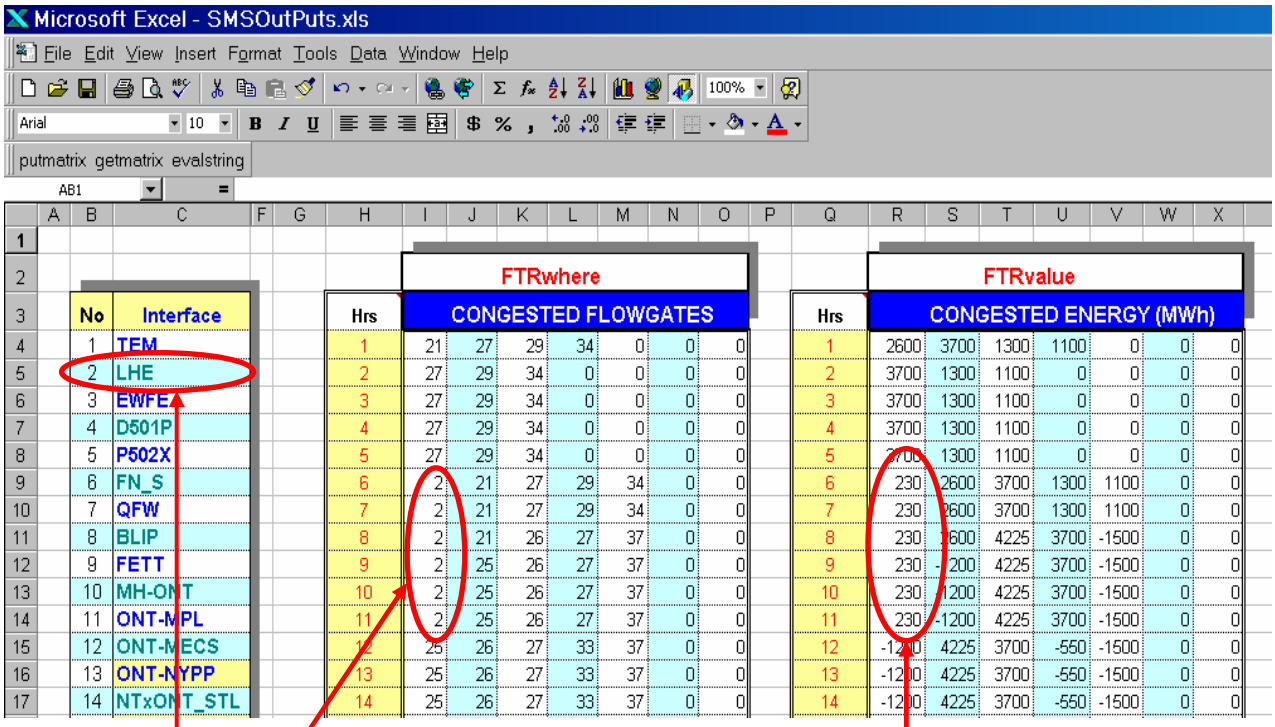
All critical flowgates as observed by IMO/ISO are defined in Appendix A. The flowgate 's flow results can be obtained by place the cursor at the desired location and follow the same steps as shown in the last section:

- Go to the location where the data is to be stored and,
- Click on the **getmatrix** button
- Enter the name **FinFLOW** (for flowgates' flows) in the menu and hit Enter or the OK button on the MENU



c) Congested Flowgates & FTR Values:

SMS program also determines hourly what flowgates are being congested and what amount of power flows in each of the congested flowgates. These features are useful for determining the values of the Financial Transmission Rights (FTR) administered the IMO or the Transmission Congestion Contract managed by the New York ISO. The sample picture below shows typical results obtained after each SMS run.

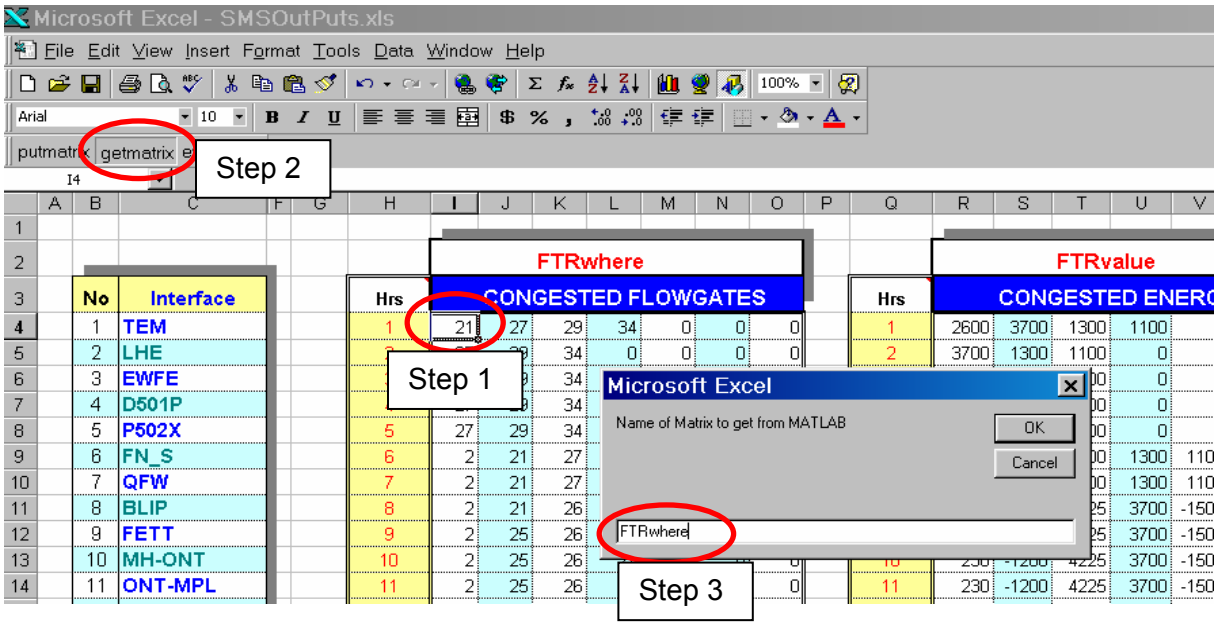


The numbers reported in the FTRwhere table on the right are the indices to the Interface (Flowgate) table on the left. Thus, **2** refers to **LHE** flowgate

The flowgate # 2 (or LHE) limit was reached at 230MW from hour 6 through hour 11 in this example.

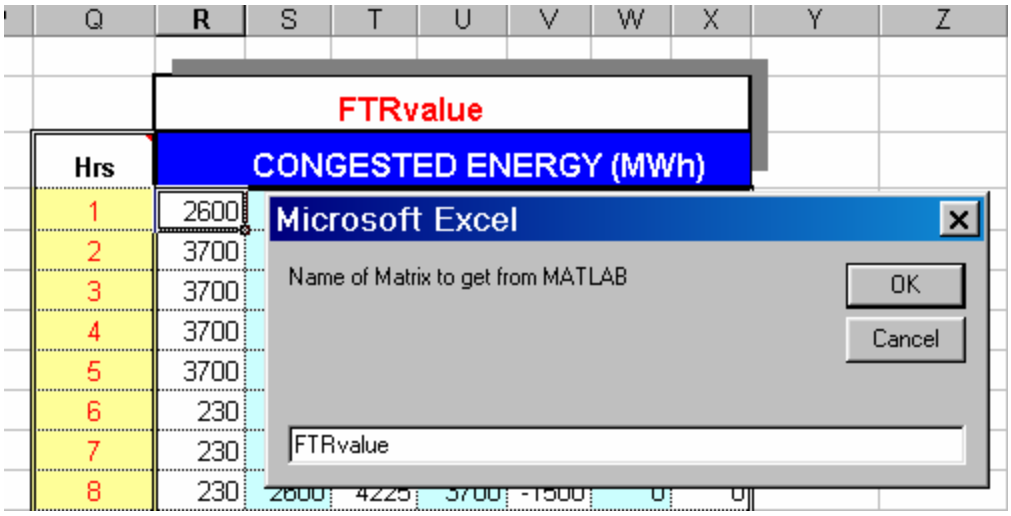
To obtain a report of hourly congested flowgates, do as follows:

- Place the cursor at the cell just immediate right of hour 1
- Click on the **getmatrix** button
- Then type **FTRwhere** on the appeared MENU



Similarly, to examine the value of the power flow in the congested flowgates, do the following steps:

- Place the cursor at the cell just immediate right of hour 1 of FTRvalue table
- Click on the **getmatrix** button
- Then type **FTRvalue** on the appeared MENU



APPENDIX A: FLOW-GATE DEFINITIONS

The following are the definitions of northeastern interconnection critical flowgates as defined by NERC NPCC and local IMO/ISO. The bus names and bus numbers are based on the NERC base-case loadflow.

FROM Bus NUMBER	TO Bus NUMBER	Low Tx. LIMIT	High Tx. LIMIT	FROM Bus NAME	TO Bus NAME	Circuit IDENTIFIER
% 1: TEM						
82275	82270	-350	325	MACKENZI 220	LAKEHEAD 220	CCT= 1
82275	82270	-350	325	MACKENZI 220	LAKEHEAD 220	CCT= 2
82429	82320	-350	325	MURILLO 118.05	BIRCH 118.05	CCT= 1
% 2: LHE						
82270	82280	-250	230	LAKEHEAD 220	MARATHON 220	CCT= 1
82270	82280	-250	230	LAKEHEAD 220	MARATHON 220	CCT= 2
% 3: EWFE						
82280	81970	-350	325	MARATHON 220	WAWA 220	CCT= 1
82280	81970	-350	325	MARATHON 220	WAWA 220	CCT= 2
% 4: D501P						
80081	80066	-1500	1500	PINARD 500	PORCUPIN 500	CTT= 1
% 5: P502X						
80066	80056	-1500	1500	PORCUPIN 500	HANMER 500	CCT= 1
% 6: FN_S						
80056	80046	-1800	1265	HANMER 500	ESSA 500	CCT= 1
80056	80046	-1800	1265	HANMER 500	ESSA 500	CCT= 2
81940	81160	-1800	1265	OTTO HOL 220	DES JOAC 220	CCT= 1
% 7: QFW						
81500	81597	-1600	1350	BECK2 DK 220	NEALJQ23 220	CCT= 1
81500	81595	-1600	1350	BECK2 DK 220	HANONJ24 220	CCT= 1
81500	81598	-1600	1350	BECK2 DK 220	NEALJQ25 220	CCT= 1
81500	81596	-1600	1350	BECK2 DK 220	HANONJ29 220	CCT= 1
81484	81615	-1600	1350	ALANJQ30 220	MIDDLEPT 220	CCT= 1
% 8: BLIP						
81570	82550	-1500	3500	DETWEILE 220	BUCHANAN 220	CCT= 1
81570	82550	-1500	3500	DETWEILE 220	BUCHANAN 220	CCT= 2
81615	82550	-1500	3500	MIDDLEPT 220	BUCHANAN 220	CCT= 1
82585	82550	-1500	3500	SALFDJ33 220	BUCHANAN 220	CCT= 1
82586	82550	-1500	3500	SALFDJ32 220	BUCHANAN 220	CCT= 1
80009	80121	-1500	3500	WILCJ562 500	LONGWOOD 500	CCT= 1
80010	80121	-1500	3500	WILCJ563 500	LONGWOOD 500	CCT= 1
80116	80121	-1500	3500	NANTICOK 500	LONGWOOD 500	CCT= 1

```
% 9: FETT
80101 80041 -5000 5750     MILTON   500    CLAIRVIL 500   CCT= 1
80101 80041 -5000 5750     MILTON   500    CLAIRVIL 500   CCT= 2
80099 80041 -5000 5750     MILTONH1 500    CLAIRVIL 500   CCT= 1
80100 80041 -5000 5750     MILTONH2 500    CLAIRVIL 500   CCT= 1
80251 80203 -5000 5750     ORANGEVL 220    ALLISJE8 220   CCT= 1
80251 80204 -5000 5750     ORANGEVL 220    ALLISJE9 220   CCT= 1
80731 80520 -5000 5750     TRAFALGA 220    ERINJR14 220   CCT= 1
80731 80521 -5000 5750     TRAFALGA 220    ERINJR17 220   CCT= 1
80731 80519 -5000 5750     TRAFALGA 220    ERINJR19 220   CCT= 1
80731 80518 -5000 5750     TRAFALGA 220    ERINJR21 220   CCT= 1

% 10: MH_ONT
63457 82260 -200  300    WHTSL1 4 220    KENORA   220   CCT= 1
63490 82260 -200  300    WHTSL2 4 220    KENORA   220   CCT= 1

% 11: ONT_MPL
82365 61484 -150  175    FT FRANC118.05  INTPHAS7 115   CCT= 1

% 12: ONT_MECS
82645 79002 -2214 2344     SCOTT    220    19BUNCEP 230   CCT= 1
82590 28805 -2214 2344     J5D PS   230    19WTRMN  230   CCT= 1
82695 28786 -2214 2344     LAMB L4D 345    19STCPP  345   CCT= 1
82696 28786 -2214 2344     LAMB L51 345    19STCPP  345   CCT= 1
(NERC_LF00)

% 13: ONT_NYPP
81256 79589 -2500 2500     STLAWL33 230    MOSES E  230   CCT= 1
81255 79589 -2500 2500     STLAWL34 230    MOSES E  230   CCT= 1
81508 79584 -2500 2500     BECK B   345    NIAG 345 345   CCT= 1
81509 79584 -2500 2500     BECK A   345    NIAG 345 345   CCT= 1
81516 79592 -2500 2500     PA27 REG 230    NIAGAR2W 230   CCT= 1
81515 76665 -2500 2500     BP76 REG 230    PACKARD2 230   CCT= 1

% 14:  NYxONT_STL
79589 81256 -450  450    MOSES E  230    STLAWL33 230   CCT= 1
79589 81255 -450  450    MOSES E  230    STLAWL34 230   CCT= 1

% 15: NY_CxE
79583 78703 -3100 3100     MARCY T1 345    N.SCOT99 345   CCT= 1
78450 78702 -3100 3100     EDIC     345    N.SCOT77 345   CCT= 1
78460 78980 -3100 3100     PORTER 2 230    ROTRDM.2 230   CCT= 1
78460 78980 -3100 3100     PORTER 2 230    ROTRDM.2 230   CCT= 2
78478 99892 -3100 3100    78460INGMS-CD 115  79136:INGHAM-E115 CCT=1->PAR:78478-
99892<-
75447 79136 -3100 3100     E.SPR115 115    INGHAM-E 115   CCT= 1
79602 70511 -3100 3100     PLAT T#3 115    GRAND IS 115   CCT= 1



% 16: NY_WxC
79801 77400 -2350 2350     PANNELL3 345    CLAY     345   CCT= 1
79801 77400 -2350 2350     PANNELL3 345    CLAY     345   CCT= 2
75417 75414 -2350 2350     STOLE230 230    MEYER230 230   CCT= 1
76510 76539 -2350 2350     ANDOVER1 115    NILE115  115   CCT= 99
79805 77433 -2350 2350     CLYDE199 115    CLTNCORN 115   CCT= 1
79875 77447 -2350 2350     FARMNGTN34.5    FRMGTN-4 115   CCT= 1
```

```
79875 77444 -2350 2350     FARMNGTN34.5    FARMGTN1 115   CCT= 1
77111 77110 -2350 2350     MORTIMER 115    LAWLER-1 115   CCT= 1
77111 77463 -2350 2350     MORTIMER 115    LAWLER-2 115   CCT= 1
79825 77447 -2350 2350     PANNELLI 115    FRMGTN-4 115   CCT= 1
79826 75892 -2350 2350     QUAKER   115    MACDN115 115   CCT= 1
79826 75893 -2350 2350     QUAKER   115    SLEIG115 115   CCT= 1
79805 75893 -2350 2350     CLYDE199 115    SLEIG115 115   CCT= 1
79810 75995 -2350 2350     STA 162  115    S.PER115 115   CCT= 1


% 17: NYxPJM
76501 361   -3600 3600     S RIPLEY 230    ERIE E   230   CCT= 1
76527 281   -3600 3600     FALCONER 115    WARREN   115   CCT= 1
75406 479   -3600 3600     STOLE345 345    HOMER CY 345   CCT= 1
75407 479   -3600 3600     WATRC345 345    HOMER CY 345   CCT= 1
75413 382   -3600 3600     HILSD230 230    E.TWANDA 230   CCT= 1
75486 383   -3600 3600     N.WAV115 115    E.SAYRE  115   CCT= 1
75457 387   -3600 3600     GOUDY115 115    LAUREL L 115   CCT= 1
74300 2     -3600 3600     RAMAPO 5 500    BRANCHBG 500   CCT= 1
79302 5028  -3600 3600     SMAHWAH1 345    WALDWICK 345   CCT= 1
79303 5028  -3600 3600     SMAHWAH2 345    WALDWICK 345   CCT= 1
74328 4989  -3600 3600     FARRGUT1 345    HUDSON1  345   CCT= 1
74329 5039  -3600 3600     FARRGUT2 345    HUDSON2  345   CCT= 1
74371 4996  -3600 3600     GOETHALS 230    LINDEN   230   CCT= 1


% 18: PJMxWEST
11    9     -5750 5750     KEYSTONE 500    JUNIATA  500   CCT= 1
5     9     -5750 5750     CONEM-GH 500    JUNIATA  500   CCT= 1
5     26    -5750 5750     CONEM-GH 500    HUNTERTN 500   CCT= 1
20105 3     -5750 5750     01DOUBS  500    BRIGHTON 500   CCT= 1


% 19: PJMxCEN
11    9     -4500 4500     KEYSTONE 500    JUNIATA  500   CCT= 1
5     9     -4500 4500     CONEM-GH 500    JUNIATA  500   CCT= 1
4     13    -4500 4500     CNASTONE 500    PEACHBTM 500   CCT= 1


% 20: PJMxEAST
23    1     -7000 7000     WESCOVLE 500    ALBURTIS 500   CCT= 1
9     1     -7000 7000     JUNIATA  500    ALBURTIS 500   CCT= 1
16    8     -7000 7000     3 MILE I 500    HOSENSAK 500   CCT= 1
13    24    -7000 7000     PEACHBTM 500    LIMERICK 500   CCT= 1
13    10    -7000 7000     PEACHBTM 500    KEENEY   500   CCT= 1

% 21: FRNT_GENE
75404 79800 -2750 2750     KINTI345 345    ROCH 345 345   CCT= 1
79584 79800 -2750 2750     NIAG 345 345    ROCH 345 345   CCT= 1
75417 75414 -2750 2750     STOLE230 230    MEYER230 230   CCT= 1
76702 77122 -2750 2750     LOCKPORT 115    SOUR-111 115   CCT= 1
76702 77101 -2750 2750     LOCKPORT 115    SHEL-113 115   CCT= 1
76702 77126 -2750 2750     LOCKPORT 115    TELRDTP2 115   CCT= 1
76702 77117 -2750 2750     LOCKPORT 115    OAKFLDTP 115   CCT= 1
76702 77115 -2750 2750     LOCKPORT 115    NAKR-108 115   CCT= 1
76702 77125 -2750 2750     LOCKPORT 115    TELRDTP1 115   CCT= 1
75994 75992 -2750 2750     PALMT115 115    BENET115 115   CCT= 1
```

% 22: GENE_CEN

```
79801 77400 -2350 2350     PANNELL3 345    CLAY     345   CCT= 1
79801 77400 -2350 2350     PANNELL3 345    CLAY     345   CCT= 2
75417 75414 -2350 2350     STOLE230 230    MEYER230 230   CCT= 1
77111 77110 -2350 2350     MORTIMER 115    LAWLER-1 115   CCT= 1
77111 77463 -2350 2350     MORTIMER 115    LAWLER-2 115   CCT= 1
79826 75893 -2350 2350     QUAKER   115    SLEIG115 115   CCT= 1
79825 77447 -2350 2350     PANNELLI 115    FRMGTN-4 115   CCT= 1
79810 75995 -2350 2350     STA 162  115    S.PER115 115   CCT= 1
79826 75892 -2350 2350     QUAKER   115    MACDN115 115   CCT= 1
75994 75992 -2350 2350     PALMT115 115    BENET115 115   CCT= 1
79805 75893 -2350 2350     CLYDE199 115    SLEIG115 115   CCT= 1
79805 77433 -2350 2350     CLYDE199 115    CLTNCORN 115   CCT= 1
79875 77444 -2350 2350     FARMNGTN34.5    FARMGTN1 115   CCT= 1
79875 77447 -2350 2350     FARMNGTN34.5    FRMGTN-4 115   CCT= 1
79946 77447 -2350 2350     S168    12.0    FRMGTN-4 115   CCT= 1
```

% 23: ADIR_CEN

```
79578 79577 -2000 2000     MASS 765 765    MARCY765 765   CCT= 1
78017 78002 -2000 2000     DENNISON 115    ANDRWS-4 115   CCT= 1
79590 79585 -2000 2000     MOSES W  230    ADRON B1 230   CCT= 1
79590 79586 -2000 2000     MOSES W  230    ADRON B2 230   CCT= 1
78017 78032 -2000 2000     DENNISON 115    LWRNCE-B 115   CCT= 1
78000 78010 -2000 2000     ALCOA-NM 115    BRADY    115   CCT= 1
78033 78041 -2000 2000     MALONE   115    NICHOLVL 115   CCT= 1
```

% 24: CENxCAP-HUD

```
78450 78702 -4650 4650     EDIC     345    N.SCOT77 345   CCT= 1
79583 78703 -4650 4650     MARCY T1 345    N.SCOT99 345   CCT= 1
78460 78980 -4650 4650     PORTER 2 230    ROTRDM.2 230   CCT= 1
78460 78980 -4650 4650     PORTER 2 230    ROTRDM.2 230   CCT= 2
75447 79136 -4650 4650     E.SPR115 115    INGHAM-E 115   CCT= 1
78478 99892 -4650 4650     78478:INGMS-CD115  79136:INGHAM-E115CCT=1->PAR:78478-
99892 <-
75403 79581 -4650 4650     FRASR345 345    GILB 345 345   CCT= 1
79304 74001 -4650 4650     SHOEMTAP 345    ROCK TAV 345   CCT= 1
75400 74001 -4650 4650     COOPC345 345    ROCK TAV 345   CCT= 2
```

% 25: CAPxNE

```
79135 70522 -1200 1200     HOOSICK  115    BNNINGTN 115   CCT= 1
79167 70525 -1200 1200     WHITEHAL 115    BLISSVIL 115   CCT= 1
78980 72385 -1200 1200     ROTRDM.2 230    BRSWAMP  230   CCT= 1
78700 72928 -1200 1200     ALPS345  345    MANY393  345   CCT= 1
74344 73117 -1200 1200     PLTVLLEY 345    CTNY398  345   CCT= 1
```

% 26: CAPxWSCHE

```
74002 74331 -5100 5100     ROSETON  345    FISHKILL 345   CCT= 1
74344 74341 -5100 5100     PLTVLLEY 345    MILLWOOD 345   CCT= 1
74344 74331 -5100 5100     PLTVLLEY 345    FISHKILL 345   CCT= 1
74344 74331 -5100 5100     PLTVLLEY 345    FISHKILL 345   CCT= 2
74344 74356 -5100 5100     PLTVLLEY 345    WOOD B   345   CCT= 1
74347 74312 -5100 5100     RAMAPO   345    BUCH N   345   CCT= 1
74340 74313 -5100 5100     LADENTWN 345    BUCH S   345   CCT= 1
74026 75762 -5100 5100     FISHKILL 115    SYLVN115 115   CCT= 1
74022 74331 -5100 5100     E FISH I 115    FISHKILL 345   CCT= 1
```

```
% 27: WSCHExNYC
74420 74533 -4175 4175     DUN NO1R 138    S CREEK  138   CCT= 1
74421 74533 -4175 4175     DUN NO2R 138    S CREEK  138   CCT= 1
74424 74435 -4175 4175     DUN SO1R 138    E179 ST  138   CCT= 1
74316 74345 -4175 4175     DUNWODIE 345    RAINEY   345   CCT= 3
74316 74345 -4175 4175     DUNWODIE 345    RAINEY   345   CCT= 4
74348 74351 -4175 4175     SPRBROOK 345    TREMONT  345   CCT= 1
74348 74354 -4175 4175     SPRBROOK 345    W 49 ST  345   CCT= 1
74348 74354 -4175 4175     SPRBROOK 345    W 49 ST  345   CCT= 2
75047 74505 -4175 4175     L SUCSPH 138    JAMAICA  138   CCT= 1
75067 74505 -4175 4175     V STRM P 138    JAMAICA  138   CCT= 1

% 28:  NYCxLILCO
74505 75047 -550  550    JAMAICA  138    L SUCSPH 138   CCT= 1
74505 75067 -550  550    JAMAICA  138    V STRM P 138   CCT= 1

% 29:  WSCHExLILCO
74316 75000 -625  625    DUNWODIE 345    SHORE RD 345   CCT= 1
74348 79607 -625  625    SPRBROOK 345    DVNPT NK 345   CCT= 1

% 30: NPXxLILCO
73166 75053 -150  175    NORHR138 138    NRTHPT P 138   CCT= 1


% 31: PJM_WxCAP
2     74300 -1150 1150     BRANCHBG 500    RAMAPO 5 500   CCT= 1

5028  79302 -1150 1150     WALDWICK 345    SMAHWAH1 345   CCT= 1

5028  79303 -1150 1150     WALDWICK 345    SMAHWAH2 345   CCT= 1


% 32: PJM_ExNYC
5039  74329 -400  400    HUDSON2  345    FARRGUT2 345   CCT= 1
4989  74328 -400  400    HUDSON1  345    FARRGUT1 345   CCT= 1
4996  74371 -400  400    LINDEN   230    GOETHALS 230   CCT= 1

% 33:  PJM_WxNIAG
479   75406 -1100 1100     HOMER CY 345    STOLE345 345   CCT= 1
281   76527 -1100 1100     WARREN   115    FALCONER 115   CCT= 1
361   76501 -1100 1100     ERIE E   230    S RIPLEY 230   CCT= 1

% 34: PJM_WxCEN
387   75457 -1300 1300     LAUREL L 115    GOUDY115 115   CCT= 1
383   75486 -1300 1300     E.SAYRE  115    N.WAV115 115   CCT= 1
382   75413 -1300 1300     E.TWANDA 230    HILSD230 230   CCT= 1
479   75407 -1300 1300     HOMER CY 345    WATRC345 345   CCT= 1

% 35: HQxADIR
84819 79578 -2350 2350     CHA-NY82 765    MASS 765 765   CCT= 1
89378 78017 -2350 2350     ROSEMT   115    DENNISON 115   CCT= 1  O/S
89379 78017 -2350 2350     ROSEMT-  115    DENNISON 115   CCT= 1  O/S
```

% 36: NEPOOLxNY

```
70511 79602 -1900 1900     GRAND IS 115    PLAT T#3 115   CCT= 1
70522 79135 -1900 1900     BNNINGTN 115    HOOSICK  115   CCT= 1
70525 79167 -1900 1900     BLISSVIL 115    WHITEHAL 115   CCT= 1
72385 78980 -1900 1900     BRSWAMP  230    ROTRDM.2 230   CCT= 1
72928 78700 -1900 1900     MANY393  345    ALPS345  345   CCT= 1
73117 74344 -1900 1900     CTNY398  345    PLTVLLEY 345   CCT= 1
73166 75053 -1900 1900     NORHR138 138    NRTHPT P 138   CCT= 1
```

% 37: PJMxAPS

```
3     20105 -1500 4000     BRIGHTON 500    01DOUBS  500   CCT= 1
11    20104 -1500 4000     KEYSTONE 500    01CABOT  500   CCT= 1
11    20116 -1500 4000     KEYSTONE 500    01YUKON  500   CCT= 1
473   20253 -1500 4000     BLAIRSVL 138    01SOCIAL 138   CCT= 1
571   20174 -1500 4000     BROOKVLE 138    01ELKO   138   CCT= 1
571   20224 -1500 4000     BROOKVLE 138    01N BETH 138   CCT= 1
375   370   -1500 4000     FARM VLY 115    TWOMILE  115   CCT= 1
283   20175 -1500 4000     FOREST   230    01ELKO   230   CCT= 1
472   20470 -1500 4000     GARRETT  115    01GARRET 115   CCT= 1
409   20220 -1500 4000     GROVER   230    01MOSHAN 230   CCT= 1
214   20248 -1500 4000     LEWISTWN 230    01SHINGL 230   CCT= 1
285   20151 -1500 4000     PINEY    115    01BURMA  115   CCT= 1
233   20188 -1500 4000     ROXBURY  138    01GREENE 138   CCT= 1
419   20220 -1500 4000     SHAWVL 1 230    01MOSHAN 230   CCT= 1
376   20234 -1500 4000     GOLD     115    01POTTER 115   CCT= 1
435   20175 -1500 4000     SHAWVL 2 230    01ELKO   230   CCT= 1
435   20248 -1500 4000     SHAWVL 2 230    01SHINGL 230   CCT= 1
1211  20463 -1500 4000     GERMANTN 138    01TANEY  138   CCT= 1
7002  20456 -1500 4000     STATIONH 230    01AQUEDT 230   CCT= 1
7002  20459 -1500 4000     STATIONH 230    01DOUBS  230   CCT= 1
```

% 38: PJMxCEI

```
302   21475 -700  700    ERIE W   345    02AT     345   CCT= 1
```

% 39: PJMxVP

```
19    14922 -2000 2000     BURCHES  500    8POSSUM  500   CCT= 1
7001  14072 -2000 2000     DICKERSN 230    6PL VIEW 230   CCT= 1
```

% 40: APS_WxE

```
20104 11    -5000 5000     01CABOT  500    KEYSTONE 500   CCT= 1
20116 11    -5000 5000     01YUKON  500    KEYSTONE 500   CCT= 1
20103 20101 -5000 5000     01BLACKO 500    01BEDNGT 500   CCT= 1
14917 20105 -5000 5000     8MT STM  500    01DOUBS  500   CCT= 1
```

% 41: ADIRxVER

```
79602 70511 -125  140    PLAT T#3 115    GRAND IS 115   CCT= 1
```

% 42: NYxONT_NIA

```
79584 81509 -1900 1900     NIAG 345 345    BECK A   345   CCT= 1
79584 81508 -1900 1900     NIAG 345 345    BECK B   345   CCT= 1
76665 81515 -1900 1900     PACKARD2 230    BP76 REG 230   CCT= 1
79592 81516 -1900 1900     NIAGAR2W 230    PA27 REG 230   CCT= 1
```

% 43: DECO_CONS

```
28727 28328 -3000 3000     19CUSTR  120    18WHTNGA 120   CCT= 1
28736 28262 -3000 3000     19GENOA  138    18LATSON 138   CCT= 1
```

```
28741 28247 -3000 3000     19HUNTC  120    18HMPHLD 120   CCT= 1
28745 28309 -3000 3000     19JEWEL  345    18THETFR 345   CCT= 1
28747 29321 -3000 3000     19LARK   138    18WSHTNJ 138   CCT= 1
28754 28285 -3000 3000     19MAJTC  345    18ONEIDJ 345   CCT= 1
28754 28314 -3000 3000     19MAJTC  345    18TOMPKN 345   CCT= 1
28774 28245 -3000 3000     19PONTC  345    18HAMPTO 345   CCT= 1
28815 28198 -3000 3000     19ATLAN  138    18ATLNTJ 138   CCT= 1

% 44: DECO_AEP
28750 21465 -2000 2000     19LULU   345    02ALLEN  345   CCT= 1
28754 21460 -2000 2000     19MAJTC  345    02LEMOY  345   CCT= 1
28761 21455 -2000 2000     19MON12  345    02BAY SH 345   CCT= 1

% 45: CONS_AEP
28197 22670 -2500 2500     18ARGENT 345    05ROB PK 345   CCT= 1
28197 22675 -2500 2500     18ARGENT 345    05TWIN B 345   CCT= 1
28289 22652 -2500 2500     18PALISA 345    05BENTON 345   CCT= 1
28289 22654 -2500 2500     18PALISA 345    05COOK   345   CCT= 1

% 46: CONS_CIN
28200 28017 -200  200      18BATAVI 138    17BRTNLK 138   CCT= 1
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