PUBLIC

WESM Manual

Market Network Model
Issue 0.0

Abstract	This document covers the development, validation, approval, publication and revision of the WESM market network model

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Related Document

Document ID	Document Title
	WESM Rules
	Philippine Grid Code
	WESM IT Infrastructure Vol.2:Technical Requirements
	Price Determination Methodology

Distribution List

Copy Number	Organization	Name of Recipient

Table of Contents

1.0 Introduction

1.1 About this Manual

This manual consolidates the market procedures and associated forms, standards, and policies that define the *market network model* to be used in the operation of the Wholesale Electricity Spot Market (WESM). The Market Network Model (MNM) documentation provides more detailed descriptions of the requirements for the network model than is specified in the "WESM Rules". Where there is a discrepancy between the requirements in this document and the "WESM Rules", the "WESM Rules" shall prevail. Standards and policies referenced or appended shall provide a supporting framework.

1.2 Purpose

This document aim to:

1.2.1 Provide the methodology and criteria for the development of the MNM that shall represent fairly, and in a manner that facilitate the consistent and reliable operation of the power system.

1.2.2 Provide the manner of approval of the MNM.

1.2.3 Provide the manner by which the MNM shall be published.

1.2.4 Provide the timetable for revising the MNM.

1.2.5 Define the responsibilities of the Market Operator (MO), System Operator (SO) and Trading Participants in developing and maintaining the MNM.

1.3 Scope

This document covers the basic procedures and policies for the development, validation, approval, maintenance, publication and revision the Market Network Model of the Philippine power system.

1.4 Intended Audience

This manual is intended for use of the MO, SO and Trading Participants and their representatives and other parties, as appropriate.

1.5 Conventions

The standard conventions to be followed in this *manual* are as follows:

1.5.1 The word 'shall' denotes a mandatory requirement;

1.5.2 Terms and acronyms used in this *manual* including all Parts thereto that are italicized have the meanings ascribed thereto in "WESM Rules";

1.5.3 Double quotation marks are used to indicate titles of publications, legislation, forms and other documents.

1.5.4 Any procedure-specific convention(s) shall be identified within the specific document itself.

1.6 Background

As stipulated in Section 3.2 of WESM Rules, the MO shall maintain and publish a market network model that shall be used for the purpose of central scheduling and dispatch, pricing and settlement. The MNM shall be developed by the MO in consultation with electric power industry participants prior to commencement of the spot market and shall be subject to approval by the Philippine Electricity Market Board (PEM Board).

Pursuant to Section 3.2, this Manual - the "Market Network Model" - has been established by the MO, in consultation with the Technical Working Group/Market Operations Sub-Committee, in accordance with specific provisions of the WESM Rules, and is a subsidiary document of the WESM Rules. This document contains the requirements, obligations, assumptions and approximations required to develop the MNM to be used for the Philippine WESM.

The MNM is a core component of the Market Dispatch Optimization Model (MDOM) described in the WESM Price Determination Methodology (PDM) and approved (conditionally) by the Energy Regulatory Commission (ERC).

2.0 Definition of Terms

2.1 Full Network Model – the network model representing all the nodes, lines and equipment in the Transmission System including, to a certain extent, parts of the Sub-Transmission System that materially affects the operation and control of the power system.

2.2 Transmission Lines – the power system lines directly under the control of the SO.

2.3 Sub transmission Lines – the power system lines directly under the control of power distributors and cooperatives.

2.4 Generator Interconnection Lines - lines connecting generating plants to the transmission system.

2.5 Node – also known as "Bus". They are transshipment points, injection or withdrawal points of power in the grid.

2.6 Substation – physical representation of nodes in the power system. They may be composed of several nodes corresponding to the low voltage and high voltage busses.

2.7 Load flow – the process for calculating currents, voltages, and real and reactive power flows at every node in a given power system condition.

Other terms used in this document shall conform to the definition of terms under the WESM Rules and the Philippine Grid Code (PGC).

3.0 Responsibilities

3.1 The MO shall be responsible for the development, validation, maintenance, publication and revision of this document in coordination with Trading Participants and the SO.

3.2 The SO shall provide the necessary information and references for subsequent revisions and validation of this document.

3.3 Trading participants shall provide the necessary information and references for subsequent revisions and validation of this document.

3.4 The PEM Board shall be responsible for the approval of this document and subsequent revisions and issuances.

4.0 Market Network Model Development

4.1 Definition

The MNM is a mathematical representation of the *power system*, which will be used for the purpose of determining *dispatch schedules* and *energy prices*, and preparing *market projections*. It contains information on the technical characteristics of the transmission network, the connectivity, capacities and limitations of each network element. It also represents the node assignments and size of each generator and load. The node assignments indicate where each generator injects power to the transmission network and where each load draws power from the transmission network. The MNM also identifies the Market Trading Nodes on which the transactions for Trading Participants shall be referenced.

The components of the MNM interacts with one another in accordance with dispatch schedule of the generation units, customer demand and the physical laws that govern the operation of the network components. These interactions are complex by nature but should be balanced to maintain the reliable and secure operation of the power system by the SO, and fair and economic market dispatch and nodal prices by the MO.

4.2 Criteria for the Market Network Model

The following outlines the criteria necessary to develop and maintain the MNM as provided in the WESM Rules:

4.2.1 Representation of the physical Transmission System of the Luzon, Visayas and Mindanao grids using an alternating current (AC) and direct current (DC) load flow full network model.

4.2.2 Use network data that accurately reflects the conditions prevailing on the network, including losses, constraints and contingencies, at any trading interval.

4.2.3 Provide necessary simplifications based on the current best international industry practice.

4.2.4 Include the representation of the sub-transmission system that may be required for the secure and reliable operation of the power system and that may impact on the formulation of dispatch schedule and nodal prices.

4.2.5 The MNM shall have adequate detail to be able to capture the dynamism of the power system and shall be robust enough to reflect the dynamic behavior of the power system for the efficient and viable technical performance of the Market Management System (MMS) and the Energy Management System (EMS).

4.3 MNM Components and Modeling

The components of the MNM are:

4.3.1 Market Trading Nodes (MTN) – Nodes or bus in the AC or DC load flow model designated as the reckoning node for Trading Participant bids or offers and corresponding settlement. It will be the high voltage bus of the network system and is associated with either or both generator and customer.

MTN shall be modeled as the trading point of Generator or Load where the appropriate metering point can be associated. Where the MTN and the metering point are of different location, site-specific loss adjustment provided in the WESM metering manual shall apply.

4.3.2 Generator plant/unit representations – numerical representation of generating units and its characteristics corresponding to power injection to the network.

Generating units shall be modeled as positive power injection with linear monotonically increasing cost function.

4.3.3 Load representations – numerical representation of the customer demand corresponding to power withdrawal from the network.

Loads shall be modeled as constant power withdrawal points.

4.3.4 Transmission and Sub-transmission lines – numerical representation of the “wires” connecting the different nodes.

Transmission lines shall be modeled as constant lumped impedance and shunt capacitance. Thermal and Contingency limits shall be based on the Grid Management Committee (GMC) specifications .

4.3.5 Transshipment node – Node in the network model that has neither generator nor customer associated to it.

Transhipment nodes shall be modeled as a Node or Bus that connects lines and equipment together.

4.3.6 Power Transformer – equipment used to transform the voltage from one level to another.

Transformers shall be modeled as impedance and including no-load loss and nominal and off-nominal turns ratio including step-size. Two-winding transformers shall be modeled as two-winding transformers and three-winding transformers shall be modeled as three-winding transformers.

4.3.7 Shunt and Series Devices– Network elements used to ensure the reliability and security of the power system.

Shunt devices shall be modeled as MVAR injection to the power system and identified whether this is Fixed, Regulating or Static Var Compensator (SVC). Its nominal real and reactive power shall be indicated including upper limit and lower limit voltage control range. Series devices shall be modeled as series resistance.

4.3.8 Power Circuit Breakers – Network switch to enable the system operator to connect and disconnect the transmission lines and other network elements from the network.

Power circuit breakers maybe neglected in the load flow model. However, this shall be reflected as switch points indicated in the breaker oriented model or single line diagram.

4.3.9 Metering Point – location of the revenue metering point in the MNM.

Metering point shall be indicated in the Bus or node to which it is located by a data flag. This shall be indicated also in the bus oriented or breaker oriented single line diagram.

4.4 MNM Development Strategy

4.4.1 The MNM shall be developed in stages to provide for transparency in development to all Trading Participants.

4.4.2 Stage 1 - Prior to the Market Trials, preliminary data will be submitted by the SO, Network Service Provider (NSP) and intending Trading Participants to the MO.

4.4.3 Stage 2 – Prior to commercial operation. The MO shall officially contact the intending Trading Participants on the data requirements regarding the MNM should it be necessary.

4.4.4 The SO, NSP and intending Trading Participants shall officially transmit all information provided to the MO.

4.5 Development of the MNM prior to Market Trial

4.5.1 **Input Data**

The following are the basic input data for the development of the MNM:

4.5.1.1 Topology of the network

4.5.1.2 Impedances and thermal limits of lines and other system components

4.5.1.3 Loss function of lines and other system components expressed as quadratic functions.

4.5.1.4 Limits on the lines and other system components that include:

- Thermal limits under normal operations
- Thermal overload limits of specific duration
- Contingency limits

4.5.1.5 Limits on the voltage of the HVDC equipment.

4.5.1.6 Generator parameters

4.5.1.7 Load profile of customer loads

Appendix 1 lists an overview of an AC loadflow representation of power system components and its equivalent mathematical model that may be included in the MNM and provided by the NSP.

4.5.2 Submission and Data Format

4.5.2.1 The SO shall provide the MO with full network data utilized in the EMS as Indicated in Appendix 5.

4.5.2.2 Each NSP shall submit to the MO standing network and period-specific data relating to all network elements that are under that NSP's control. NSP shall submit the data as indicated in Appendix 5.

4.5.2.3 Generation Companies connected to the grid shall submit to MO the generator data as indicated in Appendix 5.

4.5.2.4 Bulk Power/Directly connected Customers intending to be Trading Participants shall submit information as indicated in Appendix 5.

4.5.2.5 All data shall be officially transmitted in electronic and hardcopy formats to the MO.

4.5.2.6 Submission of data on MNM prior to market trial shall form part of a pre-registration process.

4.5.3 Data Accuracy

4.5.3.1 The SO, NSPs and Trading Participants shall be responsible for the accuracy of information submitted. Where applicable, reference document shall be provided in support of the information provided

4.5.4 Data Security and Confidentiality

4.5.4.1 The MO shall treat all design data as confidential information and maintain the information in a secure manner.

4.5.4.2 The MO shall treat bus oriented single line diagrams as non-confidential to intending Trading Participants.

4.5.4.3 Acquisition of MNM bus oriented single line diagram by intending Trading Participants shall be through the MO for a corresponding fee to be set by the PEM Board.

4.5.4.4 Design data may be acquired from the plant or equipment owner, if amenable, for a corresponding fee to be set by the PEM Board.

4.5.4.5 Data classification shall be developed by the MO, SO and Trading Participants to facilitate the setting of fee by the PEM Board.

4.5.5 General Procedure for MNM Development Prior to Market Trial (Interim MNM)

The general procedure shall be as follows:

4.5.5.1 MO to develop MNM from SO and NSP standing data.

4.5.5.2 MO to identify MTNs and associated Trading Participant.

4.5.5.3 Publish Bus Oriented Single Line Diagram, MTN and participant matrix through the WESM website.

4.5.5.4 MO, SO and intending participants shall coordinate on the level of detail of the MNM.

4.5.5.5 Trading Participants shall officially confirm the associated MTN to the MO and SO.

4.5.5.6 Market Trials shall utilize the interim MNM.

4.5.6 MNM Approval Process

4.5.6.1 The MO, SO and intending Trading Participants shall officially concur to the MNM to be used in the Market Trials.

4.5.6.2 The MO shall officially endorse the interim MNM to the WESM Technical Working Group.

4.5.6.3 The WESM Technical Working Group shall submit the MNM to the PEM Board and the ERC.

4.5.7 Development Timeline

The initial development phase and revisions of the MNM shall be implemented in accordance with the timeline and procedures detailed in Appendix 2, 2A. Appendix 3 shows the procedural workflow.

4.6 MNM to be used in the Commercial Operation

4.6.1 Input Data

4.6.1.1 Prior to commercial operation, the MO shall provide a complete list of necessary data for the MNM to be submitted by the SO, Meter Service Provider (MSP) and Trading Participant, which may include among others:

4.6.1.1.1 One-year historical hourly customer load profile.

4.6.1.1.2 One year (short term) to three-year (medium term) expansion plan.

4.6.1.2 Prior to the commercial operation, the MO shall publish through the WESM website (www.wesm.ph) the modeling procedures to be adopted and approved by the GMC.

4.6.1.3 The MO shall publish in the WESM website the necessary forms to be filled up by the Trading Participant.

4.6.1.4 The MO shall publish the list of reference documents to be used by the Trading Participants in confirming their data submitted to MO.

4.6.1.5 Trading Participants shall officially confirm if they no longer wish to change the data submitted prior to Market Trials.

4.6.2 Submission and Data Format

4.6.2.1 The MNM data shall be provided by the Trading Participants through the market registration process.

4.6.3 Data Accuracy

4.6.3.1 The SO and all Trading Participants shall provide reference documents to the MO on the data submitted.

4.6.3.2 Reference documents shall be documents required by the MO for submission as part of the participant registration process.

4.6.4 Data Security and Confidentiality

4.6.4.1 The MO shall treat all design data and reference documents as confidential information and shall maintain the information in a secure manner.

4.6.4.2 The MO shall treat bus oriented single line diagrams as non-confidential and may show the diagram to interested participants.

4.6.4.3 Acquisition of MNM bus oriented single line diagram shall be through the MO for a corresponding fee set by the PEM Board.

4.6.4.4 Design data shall be acquired from the plant or equipment owner, if amenable, for a corresponding fee set by the PEM Board.

4.6.5 **Timetable of Data Submission**

4.6.5.1 The MO shall publish the time table of the registration process including the submission of necessary data for the MNM in the WESM website prior to commercial operation.

4.6.6 **General Procedure for MNM Development for Market Commercial Operation**

The general procedure shall be as follows:

4.6.6.1 MO to publish draft MNM to be used in the commercial operation of the WESM in the website via bus oriented single line diagram.

4.6.6.2 Trading Participants to officially submit data changes if necessary.

4.6.6.3 MO to publish final MNM Bus Oriented Single Line Diagram, MTNs and participant matrix through the WESM website.

4.6.6.4 MO, SO and intending participants shall coordinate on the finalization of the MNM.

4.6.7 **MNM Approval Process**

4.6.7.1 The MO, SO and intending Trading Participants shall officially concur to the MNM to be used in the commercial operation of the market trials.

4.6.7.2 The MO shall officially endorse the interim MNM to the WESM-Technical Working Group.

4.6.7.3 The WESM Technical Working Group shall endorse the MNM to the PEM Board for approval.

4.6.7.4 The PEM Board shall issue confirmatory resolution to the MNM to be used in the commercial operation of the WESM. Appendix 4 shows the procedural workflow.

5.0 MNM Maintenance

5.1 The MO shall prepare a document containing all the parameters used in the MNM.

5.2 The MNM document shall be maintained in hardcopy and electronic file in a format required by the MMS.

5.3 The MO shall likewise prepare and maintain the following in hardcopy and electronic formats:

5.3.1 Bus Oriented Single Line Diagram

5.3.2 Breaker Oriented Single Line Diagram

5.3.3 Load flow Single Line Diagram

5.3.4 Load flow save case in PSS/E format

5.4 The MO shall provide an efficient data retrieval and maintenance process for the documents.

5.5 The MO shall ensure that the MNM used in the MMS is the same as the approved MNM by the PEM Board.

6.0 MNM Publication

6.1 Prior to Commercial Operation

The MO shall, in consultation with the SO and Trading Participants, finalize and establish the level of the MNM data in electronic format that shall be published and made available to the Trading Participants through the WESM website.

6.2 Participant Access

Access to published MNM data shall be through a secure connection between the MO and Trading Participants.

6.3 Data Payment Process

MNM data that were established to have corresponding fee by the MO and the SO, subject to approval of the PEM Board, shall be payable to the MO and credited to the account of the data supplier (e.g., MO, SO, Trading Participant). Payment procedures shall be developed by MO for such purposes.

6.4 Data Treatment

MNM data with associated fees shall be treated by the buyer as confidential information and shall not be provided to a third party without due consent from the MO, SO or Data Owner. Penalty for violations shall be set by the PEM Board.

6.5 Manner of Publication

6.5.1 The MO shall regularly publish the MNM every October of every year.

6.5.2 Any changes or revision initiated by the MO or SO shall trigger the publication of the revised and approved MNM.

6.5.3 The MNM publication shall include MNM corresponding to a one year power system outlook.

6.5.4 All publication by the MO regarding the MNM shall be in an uneditable electronic format.

7.0 Alterations and Revisions to the MNM

Alterations ad revisions on the MNM shall be made as a result of the following:

7.1 Real-time reconfiguration.

Real time reconfiguration will take the meaning of reconfiguration of any part of the transmission system that may affect the dispatch within any trading interval. These revisions shall be made automatically to the MMS model based on the inputs and data provided by the EMS. This shall include, but may not be limited to, the following:

7.1.1 Change in Transmission and Sub-transmission Network topology

7.1.2 Line, Generator and Customer Load outage,

7.1.3 Reconfiguration as initiated by the SO to maintain system security and reliability.

7.1.4 Particular changes in the MNM configuration shall be published in accordance with MNM publication.

7.2 Network Development

Network development shall take the meaning of any reconfiguration of any part of the transmission or sub-transmission system that may affect the dispatch that are permanent in nature. This shall include the following:

7.2.1 Installation of new lines and equipment

7.2.2 Line/network connectivity switching

7.2.3 Line upgrading

7.2.4 Transformer upgrading

7.2.5 Transformer Relocation

7.2.6 Installation of new substation

7.2.7 Replacement Network element parameter change

7.3 Particular change to the MNM in any trading interval shall be published in the WESM website in a manner recommended by the MO and approved by the PEM Board.

7.4 Long term changes or revisions to the network system shall be captured in the regular publication of the MNM.

7.5 Responsibilities

The SO, NSPs and Trading Participants shall provide the MO documents pertaining to their one year power system outlook that could trigger any change to the MNM topology and connectivity or parameter.

8.0 Market Trading Node

8.1 Background

Each node in the MNM, in physical terms, represents a power substation onto which energy is injected or withdrawn through power transformers or switching equipment. The transformers and switching equipment connect the transmission network operated by the SO and generating equipment, distribution network operated by NSPs and load customers.

8.2 Definition

Market Trading Node (MTN) is a node in the MNM that lies at the boundary between the network operated by the SO and any apparatus, network or equipment used to generate, convey or control the conveyance of energy and operated by a person other than the SO. The MTN is associated with a Trading Participant that is required to pay for energy withdrawn, or will be paid for energy injected to the system.

8.3 Classification

8.3.1 MTN's can be classified as either Generator Node or Customer Node. Generator nodes are nodes that represent a registered generating unit or generating system directly connected to a network operated by the SO. It is a node where power is injected into the transmission network. Customer nodes are also nodes that represent a registered customer. It is the node where power is withdrawn by the customer.

8.3.2 There may be conditions wherein a customer and a generator are both connected to a MTN. In such a case, then that node will both be considered as a generator node and a customer node. Each Trading Participant associated to a MTN that has both generator or customer shall also have separate metering installation capable of measuring all relevant flows in the MTN.

8.4 Criteria for the Definition of MTN

The following are the general criteria for the definition of MTN:

8.4.1 MTN shall be defined for each node in the MNM that lies at the boundary between a network operated by the SO and any apparatus, network or equipment used to generate, convey or control the conveyance of energy and operated by a person other than the SO.

8.4.2 Each MTN defined shall have a metering installation that conforms to WESM requirements and capable of measuring relevant flows of energy into, or out of, the power system operated by the SO at the market trading node.

8.4.3 Each MTN shall be associated with a Trading Participant registered with the Energy Regulatory Commission (ERC) and is a member of the Philippine Electricity Market Corporation (PEMC).

8.4.4 MTN shall be defined in a manner that calculation of relevant power flows and locational marginal prices shall not result to cross-subsidization of the Trading Participant.

8.4.5 Whenever possible, the MTN shall be defined at the high voltage side of the main power network, as follows:

8.4.5.1 Luzon Grid – 500 kV, 230 kV

8.4.5.2 Visayas Grid – 138 kV, 69 kV

8.4.5.3 Mindanao Grid – 138 kV

8.4.6 If the interface of the network operated by the SO and the apparatus, network or equipment operated by the Trading Participant lies at the end of a radial transmission line or power transformer serving solely the Trading Participant, the MTN shall be defined at the take-off point of the radial transmission line or the power transformer from the main power network. Locational marginal prices shall be calculated at the MTN and dispatch of energy supplied or withdrawn by the Trading Participant shall be adjusted to account for the energy losses along the radial transmission line or power transformer. These energy losses shall be for the account of the Trading Participant.

8.4.7 If the Trading Participant interconnects to two or more transmission nodes, the MTN for that Trading Participant shall be the high voltage side of its step-up transformer.

8.4.8 If the Trading Participant is a dispatchable generator connected to a distribution system, then the associated Trading Node represented in the MNM shall be its MTN. If the associated node for the dispatchable generator is not represented in the MNM, then the nearest node represented in the MNM shall be its MTN.

8.5 Generator MTN

A MTN is considered a generator node if energy is supplied into that node and the direction of the power flow is from the apparatus or equipment (i.e. generator) operated by the Trading Participant to the network operated by the SO. During the submission of offers to supply electricity, the participant generator shall specify the location of the connection point and the relevant market network node. The information that should be submitted by the generators in their energy supply and reserve offers are enumerated in Appendix A of the WESM rules.

8.6 Customer MTN

A customer node is the point where energy is withdrawn by the WESM participant and the direction of the power flow is from the network operated by the SO to the energy consuming apparatus or equipment (i.e. load) owned by or connected to the customer trading participant. The information required from the customers during their submission of demand bids or reserve offers in the case of dispatchable loads are listed in Appendix A of the WESM rules.

8.7 Procedure for MTN Identification

8.7.1 During registration process, Trading Participants shall submit data requirements specified by the MO.

8.7.2 The MO and the SO, in coordination with the Trading Participant, shall determine if the node is associated to Generator or Customer.

8.7.3 The MO shall validate the Trading Participant node based on the MTN criteria.

8.7.4 The MO shall formally inform the Trading Participant and the SO of the MTN assignment.

8.7.5 Trading Participant shall officially concur to the MTN assignment.

9.0 Auditing of MNM

During Market Trials and prior to the commencement of the final WESM, an independent auditor elected by the PEM Board shall verify the correctness and applicability of the MNM.

10.0 Regulatory Filing

In compliance with the application of the WESM PDM, the MNM shall be provided to, and in a format sufficient for the ERC to conduct the approval process of the PDM.

11.0 Dispute Resolution

Any Trading Participant question or dispute thereto arising from the application of the MNM shall be forwarded to the Dispute Resolution committee.

12.0 Continuing Obligations and Responsibilities

The MO, SO, NSPs, MSPs and Trading Participants shall continuously coordinate with the MO on the aspect of maintenance, revision, publication and other necessary action regarding the MNM based on the WESM Timetable.

Appendix 1. AC Load flow power system components and its equivalent mathematical model shall include, but not limited to:

A. Topology of the Network

i. Bus Number (designated by NSP) (any number from 1-99000)
ii. Bus Name (designated by NSP, corresponding to substation name)
iii. Bus Voltage (in kilovolts)
iv. Transmission Line Name and Circuit Number (designated by NSP)
v. Transmission Line Name (designated by NSP)
vi. Transmission “From Bus”
vii. Transmission Line “To bus”
viii. Transformer Name and Circuit Number (designated by NSP)
ix. Transformer Name (designated by NSP)
x. Transformer “From Bus”
xi. Transformer “To bus”
xii. Transmission Line owner (NSP name)
xiii. Generator Station Identification
xiv. Generator Bus name
xv. Generator Unit Number/Identification
xvi. Generator Interconnection Bus Name
xvii. Load Name
xviii. Load Unit Number
xix. Load Interconnection Bus Name
xx. Zone/Area Identification Name (Control Area designated by NSP)
xxi. Zone/Area ID Number (designated by NSP) (any number from 1-99000)
xxii. Switched Shunt (capacitor, reactor) Name
xxiii. Switched Shunt (capacitor, reactor) associated Bus name
xxiv. HVDC Link Circuit Number

B. Impedances, Thermal Limits, Loss Functions

i. Transmission Line Circuit Branch resistance, R
ii. Transmission Line Circuit Branch reactance, X
iii. Transmission Line Circuit Total Branch susceptance, B
iV. Transmission Line Circuit Thermal limit under Normal Operation, MVA
v. Transmission Line Circuit Thermal overload limit of specific duration, MVA
vi. Transmission Line Circuit Thermal contingency limit , MVA
vii. Transformer off-nominal turns ratio
viii. Transformer Voltage, kV
ix. Transformer resistance, R
x. Transformer reactance, X
xi. Transformer impedance, Z
xii. Transformer no-load loss, Watts
xiii. Transformer phase shift angle, Degrees
xiv. Transformer Winding number
xv. Transformer Thermal limit under Normal Operation, MVA
xvi. Transformer Thermal overload limit of specific duration, MVA
xvii. Transformer Thermal contingency limit , MVA
xviii. Switched Shunt (capacitor, reactor) Admittance, MVAR
xix. Switched Shunt (capacitor, reactor) control mode, (fixed, discrete, continuous)

C. Limits on the voltage of the HVDC Equipment

i. HVDC Link resistance, R
ii. HVDC Bus Voltage, kV
iii. HVDC Power Transfer Rating,MW

D. Generator parameters

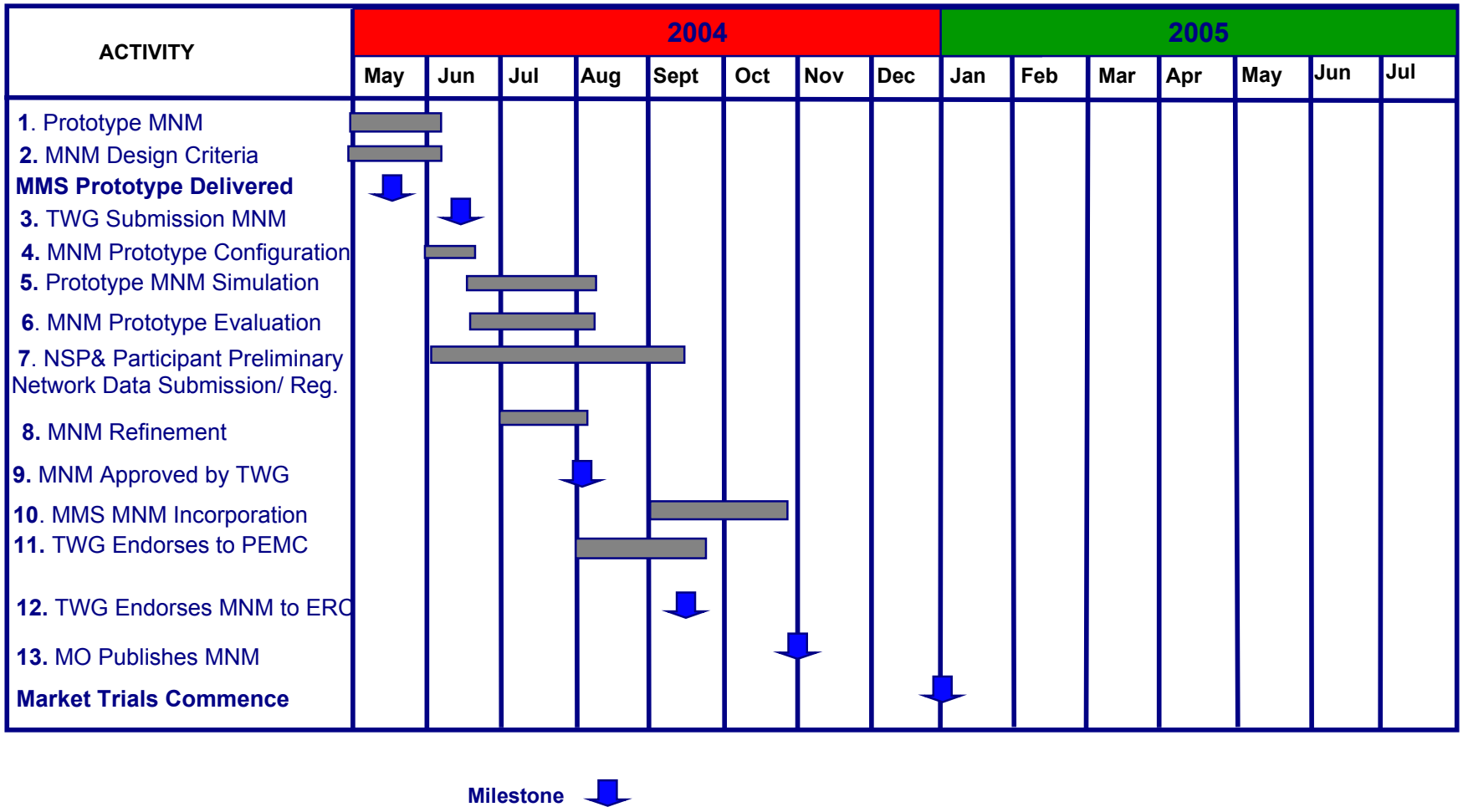
i. Generator real power output MW.
ii. Generator reactive power output, MVAR

iii. Maximum generator reactive power output, MVAR
iv. Minimum generator reactive power output; MVAR
v. Regulated voltage setpoint, per unit voltage.
vi. Transient Impedance
vii. Sub-Transient Impedance
viii. Step-Up Transformer Impedance
ix. Step-Up Transformer Off-nominal Turn Ratio
x. Generator Ramp rates

E. Load profile of customer loads

i. Zone/ Area to which the load is connected
ii. Bus Number where load is connected
iiI. Real power component of constant MVA load, MW
iv. Reactive power component of constant MVA load; MVAR

Appendix 2. MNM Development Procedural Timeline Prior to Market Trials



Appendix 2A. Procedural Steps for Market Network Development

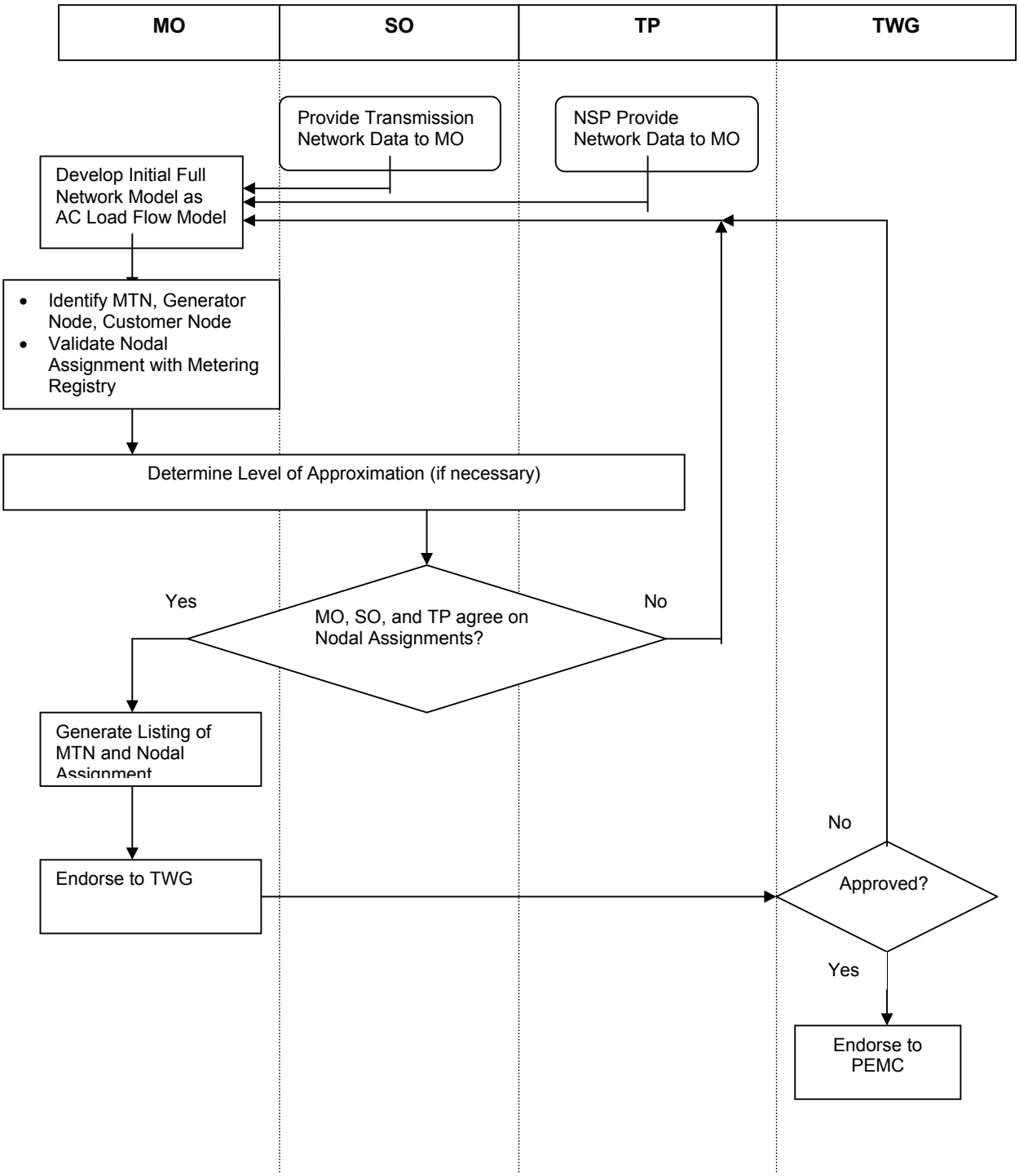
Ref.	Task Name	Task Detail	When	Resulting Information	Method	Completion Events
R.01	MMS Prototype MNM Development	1. MO to develop AC Load Flow Model for the Luzon, Visayas and Mindanao Grids from SO Network Planning Model Standing Data 2. MO to validate AC Load flow model using PSSE. 3. MO to validate AC Load Flow model from standing Generator and Customer Data and develop registry data file 4. MO to incorporate Load Flow model and registry data file to MMS Prototype	1-4. Prior to delivery of MMS Prototype	Prototype MNM		
R.02	MNM Design Criteria	1. MO Subcom to develop criteria for MNM and identify Market Trading Nodes and MNM level of details. 2. MO Subcom to generate Prototype Network Model and Trading node matrix. 3. MO Subcom to provide matrix data and single line diagram to SO Subcom. 4. MO and SO Subcom validates design criteria, MTN and level of detail of MNM.	1. Prior to Prototype delivery 2. During Task R.04 3. During Task R.04	Matrix of Generator Nodes and Customer Nodes and associated Market Trading Nodes		
R.03	TWG Submission of MNM Manual	1. MO Subcom submits to TWG the MNM SLD, Design Criteria and MTN Matrix for evaluation. 2. TWG provides preliminary evaluation to MNM 3. TWG approves initial MNM	1. After Task R.03.2 2. After Task R.03.1	Preliminary approval of MNM by TWG		

Ref.	Task Name	Task Detail	When	Resulting Information	Method	Completion Events
R.04	MNM Prototype Configuration	1. MO to incorporate MNM to MMS Prototype. 2. MO incorporates changes as per final TWG Directive on MNM	1. After Task R.01 2. After Task R.03			
R.05	Prototype Market Simulation	1. MO operates MMS Prototype with initial MNM	1.After Task R.04.	Market Simulation Results		
R.06	Prototype MNM Evaluation	1. MO checks MNM performance based on dispatch schedule and node prices and evaluates the MNM against the design criteria. 2. MO evaluates Prototype MNM performance considering Market Scenarios. 3. MO and MO/SO Subcom meet to discuss Market Outputs, analyses and MNM Performance.	1.During Task R.05 2.During Task R.05 3.During Task R.05			
R.07	SO& Participant Preliminary Network Data Submission/ Registration	1. NSP to provide transmission network Data to SO and MO. 2. SO incorporates NSP data to Transmission network and provide validation. 3. SO prepares traceability and auditing procedures for MNM. 4. SO provides Transmission Data and traceability and auditing documents to MO. 5. SO and NSP certifies network data included in the MNM	1. Simulataneous with Task R.04 2.During Task R.05 3.During Task R.05 4.During Task R.05 5.During Task R.05	Official Transmission Network Data. Determination of Transmission Line Capacity Procedures. Industry Reference Materials		

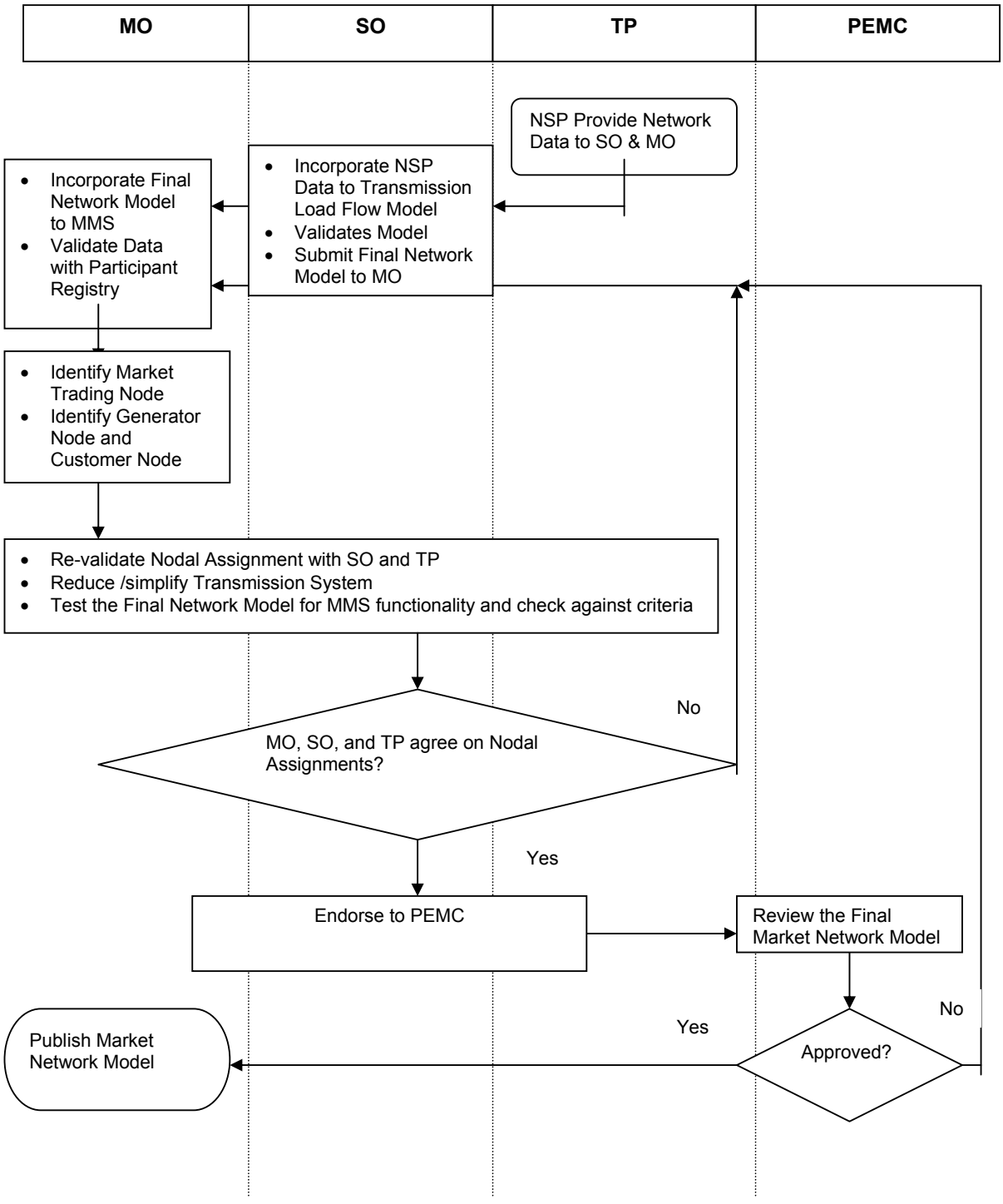
Ref.	Task Name	Task Detail	When	Resulting Information	Method	Completion Events
R.08	MNM Prototype Refinement	1. MO, SO and Trading Participants provide final stage evaluation to MNM	1. Prior to End of Task R.07.			
R.09	MNM Approved by TWG	1. MO Subcom endorses MNM, MTN designation to TWG. 2. TWG review and verify MNM Criteria and procedures. 3. TWG approves MNM Criteria and procedures.	1. After Tasks R.08			
R.10	MMS MNM Incorporation	1. MO incorporates NSP and preliminary participant data and network model to MMS.	1. After Tasks R.09			
R.11	TWG Endorses MNM to PEMC	1. TWG endorses MNM Criteria and Procedures to PEMC for approval.	1. After Task R.10			
R.12	TWG Endorses MNM to ERC	1. MO submit simulation results focused on MNM simultaneous with the PDM filing.	1. After Task R.11			

Ref.	Task Name	Task Detail	When	Resulting Information	Method	Completion Events
R.13	MO Publishes MNM	1. MO Publishes MNM Line Capacity and generic constraints through MO website. 2. MO provides electronic means for downloading NSP transmission model.	1. After Task R.14 and Prior to Market Trial	Market Trial MNM	Electronic Publication through Website	

Appendix 3. WORKFLOW- MARKET NETWORK MODEL DEVELOPMENT PRIOR TO MARKET TRIALS



Appendix 4. WORK FLOW - MARKET NETWORK MODEL DEVELOPMENT PRIOR to COMMERCIAL OPERATION



Appendix 5. DATA FOR SUBMISSION PRIOR TO MARKET TRIAL

1. The SO shall provide the MO with full network data utilized in the EMS in the following format.

   12.1 2004 PSS/E Base Case file for the Luzon- Visayas Grids – Peak Condition
   12.2 2004 PSS/E Base Case file for the Luzon- Visayas Grids – Off-Peak Condition
   12.3 Breaker Oriented Single Line Diagram –Large Format
   12.4 Bus Oriented Single Line Diagram – Large Format

2. Network Service Provider/Distributors/Cooperatives

   2.1 Network Diagram
   2.2 Distribution line data
   2.3 Transformer data
   2.4 Generator Connection Point (if Any)
   2.5 Customer Connection Point
   2.6 Protection equipment data
   2.7 Metering Points
   2.8 PSS/E Sav Case, if applicable
   2.9 Contact Person

3. Generators

   3.1 Generator Unit Type and Number
   3.2 Generator location
   3.3 Maximum Generator MW Output per Unit
   3.4 Minimum Generator MW Output per Unit
   3.5 Ramp Up Rate
   3.6 Ramp Down Rate
   3.7 Step-Up Transformer Configuration
   3.8 Step-Up Transformer Impedance
   3.9 Metering Installation
   3.10 Contact Person

4. Bulk Power/Directly connected Customers

   4.1 Load Rating, MW
   4.2 Location
   4.3 Connection points
   4.4 Metering Installation
   4.5 Contact Person

Addendum1. Procedures in the WESM Rules on Market Network Model.

Reference Chapter/Section	WESM Rules Provision	Remark
1. DETERMINATION OF MNM		
10.3.1.2	The composition of the *market network model* may be limited in scope during the operation of the *interim WESM*.	1. Procedure on Determination of MNM
3.2.1.2	The *market network model* shall represent fairly, and in a manner which will facilitate consistent and reliable operation of the power system: (a) The *transmission network* under the control of the *System Operator*, and (b) Such other aspects of the *power system* which, when *connected*, may be capable of materially affecting *dispatch* of *scheduled generating units* or pricing within the *spot market*.	1.MNM Characteristics/Scope 2. Identify aspect of power system that may affect the dispatch of gen. plants.
3.2.1.3	The *market network model* may contain such simplifications, approximations, equivalencies or adaptations as may facilitate the *dispatch*, pricing, or *settlement* processes.	1. MNM may contain simplifications to facilitate dispatch, pricing or settlement processes.
10.4.4.1.	Prior to the *spot market commencement date*, the *Market Operator*, in consultation with *WESM Participants* and the *System Operator* shall: (a) In accordance with clauses 3.2.1.2 and 3.2.1.3, recommend the composition of the *market network model*; (b) Seek approval of the *market network model* from the *PEM Board*; and (c) *Publish* details of the *market network model,* once approved.	1. MO/Subcom to recommend composition of MNM 2. MNM to be approved by PEM Board 3. MO to publish details of MNM **once approved.**
5.2.4.1	Consistent with the *Grid Code*, the *System Operator* is to maintain a register of data provided by *Trading Participants* and *Network Service Providers* for planning and design purposes. 5.2.4.2 The *System Operator* shall provide on a regular basis a copy of the register of data prepared under clause 5.2.4.1 to the *Market Operator* in a form specified by the *Market Operator*.	1. SO to provide TP and NSP planning & design data to MO, consistent with PGDC in a form specified by MO.

2. DETERMINATION OF MTN		
10.4.5.1.	Prior to the *spot market commencement date*, the *Market Operator* shall, in accordance with clauses 3.2.2.1, 3.2.2.2 and 3.2.2.3, determine the identity of each *market trading node* for trading and *settlement* purposes.	1. MO/Subcom to specifically identify MTN
	10.4.5.2. Prior to the *spot market commencement date*, the *Market Operator* shall publish a register of *market trading nodes* and of the *Trading Participant* responsible for each.	1. MO to publish register of MTN and associated TP
3. PUBLICATION OF MNM		
3.2.1.1	The *Market Operator* shall maintain and publish a *market network model*, which will be used for the purpose of central scheduling and dispatch, pricing and settlement.	**1. Maintenance of the MNM** **2. Publication of MNM**
3.2.2.4	The *Market Operator* shall maintain, *publish*, and continuously update a register of *market trading nodes*, defined in accordance with clause 3.2.2.1 so as to accurately reflect changes in the *market network model* and the *WESM Member* responsible for each *market trading node*.	
3.2.3.1	The *Market Operator* shall maintain and *publish* the *customer pricing zones* to be used for the settlement of energy for *Customers.*	**1. Procedure for maintaining Customer Pricing Zone** **2. Procedure for Publishing Customer Pricing Zones**
4. ALTERATION OF MNM		
3.2.1.4	Where appropriate, the *Market Operator* or the *System Operator* may recommend alterations to the *market network model*, so as to maintain: (a) The relationship between the *market network model* and the *transmission network*; and (b) Consistency with *market* requirements, in accordance with clauses 3.2.1.2 and 3.2.1.3.	**1. Procedure on Altering the MNM to be approved by PEM Board**
3.2.1.5	Any alteration recommended under clause 3.2.1.4 shall be approved by the *PEM Board*.	

3.2.1.6	The *Market Operator* shall continuously adapt or adjust the representation of the *market network model* to accurately reflect *power system* conditions, within the relevant *market* time frames, as advised by the *System Operator* under clause 3.5.3.	
3.2.3.4	The *Market Operator* shall, in consultation with *WESM Participants*, continuously review the procedures for determining the *market network model, market trading nodes*, and *customer pricing zones* set out in this chapter 3 and, to the extent the *Market Operator* considers it to be reasonably necessary to promote the WESM objectives, the *Market Operator* may recommend changes to these procedures in accordance with the rule change process set out in chapter 8.	*1.* ***MO/Participants shall continuosly review Procedures*** *for Determining MNM,MTN and CPZ's* *2. Based on the review MO can recommend* ***changes to Procedures in accord with Rules Change Process***
5. PROCEDURE ON DATA SUBMISSION		
3.5.2.1	Each *Network Service Provider* shall submit to the *System Operator standing network data* relating to all network elements which are under that *Network Service Provider's* control and included in the *market network model*, in accordance with clause 3.5.2.4 and the *Grid Code* and *Distribution Code*.	**1. Procedure on Data Submission By NSP to SO**
3.5.2.2	If there is any material long term change in the status or configuration of a *network* under the control of a *Network Services Provider,* the *standing network data* relevant to that *network* shall be revised by the relevant *Network Service Provider*, and submitted to the *System Operator*.	*1. Any Change in NSP Network Status shall be informed to SO*
3.5.2.3	Each *Network Service Provider* shall submit period-specific *network* data variations to the *System Operator* as soon as any material change in previously submitted *network data* becomes apparent with respect to the expected state of any of its *networks* in any *trading interval* of any *trading day* in the current *week-ahead market horizon*.	*1. NSP to submit period-specific network data variation to SO asap for* ***any period in the current Week-Ahead horizon.***
3.5.2.4	The *standing network data* and any variations to that data submitted in accordance with clause 3.5.2.3 shall be provided by *Network Service Providers* in a form which allows the *System*	*1. NSP standing network data and any variation shall be provide to SO in standard format specified by MO.*

	Operator to readily derive and verify the information specified in Appendix A2, as it may pertain to any *trading interval* of any *trading day* in the *week-ahead market horizon*.	
3.5.2.5	Each *Network Service Provider* shall immediately advise the *System Operator* of any circumstances which threaten a significant probability of material adverse change in the state of its *network* in any *trading interval*of any *trading day* in the current *week-ahead market horizon*	*1. NSP to advise SO asap for any material change in its* ***network in the current Week Ahead horizon***
3.5.3.1	The *System Operator* shall submit to the *Market Operator* standing network data relating to all network elements which are under the Network Service Provider's control and included in the market network model, in accordance with the *timetable*.	**1. Procedure on Data Submission By SO to MO**
	3.5.3.2 Where necessary, the *System Operator* shall, in accordance with the *timetable*, promptly advise the *Market Operator* to: (a) Vary the *market network model* representation employed for any *trading interval* in the current *week-ahead market horizon* to take account of information received from *Network Service Providers*; and (b) Apply, or vary, any *system security* constraints, *over-riding constraints* or *reserve requirements constraints* to be applied in any *trading interval* in the current *week-ahead market horizon* to take account of current, or projected, system conditions.	*1. SO to advise MO on any variation to MNM received from NSP and MO to reflect these advice to MNM in the WA horizon* *2. SO to advise MO to apply/vary system security constraints, over-riding constraints or reserve constraints in the current WA horizon*
	3.5.3.3 In determining whether it is reasonably necessary to advise the *Market Operator* under clause 3.5.3.2, the *System Operator* shall take into consideration its obligations with respect to maintaining *system security* in accordance with the *WESM Rules*, the *Act*, the *Grid Code* and *Distribution Code*, or any other relevant regulatory Instruments.	*1. System Security is a prerogative of SO subject to WESM Rules,PGDC, et.al.*
	3.5.3.4 In acting on such advice, the *Market Operator* shall take full account of its obligations to *WESM Members* with respect to maintaining the integrity of the market, and the *market network model*, as defined by the *WESM Rules*, the *Act*, or any other	*1. Market and MNM integrity is prerogative of MO as defined in WESM Rules, EPIRA etal*

	applicable regulatory instruments.	
	3.5.3.5 In accordance with the *timetable*, *a*ny revision under clause 3.5.3.2 to the system representation or constraints to be employed with respect to any market *trading interval* shall take effect the next time a *market dispatch optimization model* run is initiated.	***1. Timetable procedure on revising System Representation*** ***2. System representation changes shall take effect in the succeeding SCED.***
	3.5.3.6 The *System Operator* shall advise the *Market Operator* of any circumstances which threaten a significant probability of material adverse change in the state of the *network*, or system, in any *trading* *interval* of any *trading day* in the current *week-ahead market horizon.*	1. SO to advise MO on any circumstance for material adverse change in the state of the transmission system **in the current week ahead market horizon.**