Manual No. 002

Business Practices Manual

Energy and Operating Reserve Markets

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Revision History

Doc Number	Description	Author	Effective Date
BPM-002-r23	Annual review completed. This revision contains updates for Electric Storage Resource.	B. Peters H. Zheng S. Li Y. Ma	SEP-30-2022
BPM-002-r22	Annual review completed. This revision contains updates for Short Term Reserve [effective on Dec. 7, 2021] and Emergency Pricing Enhancement [effective on Sep.1, 2021].	B. Peters M. Flagg J. Li Y. Ma	OCT-15-2021
BPM-002-r21	Annual review completed. This revision contains updates for Energy Offer Cap and Automatic Generation Control enhancement for Fast Ramping Resources.	Y. Ma M. Kandukuri J. Li P. Addepalle	OCT-15-2020
BPM-002-r20	Annual review completed. This revision contains updates for reserve procurement enhancements	P. Addepalle M. Mattox	OCT-15-2019
BPM-002-r19	Annual review completed. This revision contains updates for Coordinated Transaction Scheduling (CTS) between MISO and PJM. It also includes various correction of provisions that are no longer in practice.	P. Addepalle M. Kandukuri A. Hartman	OCT-15-2018
BPM-002-r18	Annual review completed. This revision contains updates from MISO's internal Tariff review and implementation of some Emergency pricing enhancements, Change of RGD references to GBAO per Operation reorganization. It also includes various corrections of provisions that are no longer in practice; Updated Pricing logic; Updated attachment D and corrected typographical errors.	P. Addepalle, A. Hartman, S. Li B. Borissov	SEP-23-2017
BPM-002-r17	Address changes in DA/FRAC Market Timing related to FERC order 809	Y. Jiang	NOV-05-2016
BPM-002-r16	Annual Review completed. Reflect changes associated with Emergency and LMR pricing and Real Time Offer Override Enhancement and expand on Day Ahead market extension and reopening; added details on Ramp Up/Down impact on SCED algorithm; revised Demand Response max contribution to SPIN and off line supplemental;	R. Merring	OCT-01-2016

	added guidance on registration of Regulation, Spin and Supplemental qualified resources		
BPM-002-r15	Annual Review completed. This revision describes changes to accommodate MISO's implementation of Ramp Capability Product, a new Ancillary Service. This update also includes clarifications on Bi-Directional EAR, the transition to webTrans and load modeling procedures.	K. Spontak	MAR-17-2016
BPM-002-r14	Annual Review completed. This revision describes changes to accommodate MISO's implementation of the Extended LMP process, Demand Response Enhancement process, Bi-Direction EAR process, the Sub-Regional Power Balance Constraint, control mode response based on behavior for Real Time ancillary services, behavior for partial generation resources associated with external schedules, the switch in Day Ahead from Nodal Power Balance to Global Power Balance and the update to weighting factors for ARR Zones compared to load zones.	K. Spontak J. Li C. Wang K. Trotter P. Caro-Ochoa S. Duggirala R. Merring	MAR-01-2015
BPM-002-r13	This revision describes changes to accommodate MISO's compliance to FERC Order 755 regarding Regulation Mileage, and changes to accommodate Transmission Constraint Demand Curve Tariff changes. It also includes various corrections and language improvements. Annual review completed.	M. Keyser A. Hartman Y. Ma K. Spontak	FEB-04-2014
BPM-002-r12	This revision describes changes for the Look-Ahead commitment process, changes to accommodate FERC Order 719 and 745 (on Demand Response and Aggregators of Retail Customers), changes for Reg+Spin Demand Curves, and changes to eliminate gaming opportunities from the Day-Ahead market and other forward processes. Also, validations that exist in the Market Portal (MUI) are described, descriptions of how transmission constraint marginal value limits are determined, and various corrections and language improvements are included. Annual review completed.	M. Keyser	FEB-06-2013
BPM-002-r11	This revision describes Reserve Procurement changes, new rules for Resource Supplemental Reserve Testing and Capping, inclusion of notification deadline language, and various	M. Keyser	JAN-13—2012

	corrections and language improvements, including corrections to MCP formulations for the inclusion of Demand Response Resource Type I clearing Spinning Reserves.		
BPM-002-r10	This revision contains changes to accommodate Dispatchable Intermittent Resources. In addition, details about the Real-Time Congestion Management Procedure has been added; various clean-up and grammar edits have been made; MISO rebranding included.	M. Keyser A. Hartman	JUN-29-2011
BPM-002-r9	This revision contains the following changes: timing changes associated with moving the Day-Ahead clearing forward by one hour; references to dispatch bands have been removed; Quick-Start Resource language has been added and clarified; Outage language has been updated for clarity, and to accommodate the new Outage Scheduling application; various clean-up and grammar edits have been made.	M. Keyser A. Hartman	OCT-21-2010
BPM-002-r8	This revision contains constraint details for DA and RAC Ramp Capability Constraints. Several corrections are made to other areas, including DRRI's clearing Spinning Reserves.	M. Keyser	JUL-07-2010
BPM-002-r7	This revision contains changes to accommodate clearing of Spinning Reserves on DRR-Type I Resources	M. Keyser	MAR-11-2010
BPM-002-r6	This revision contains clerical changes only, to reflect the change in identification of this document, from "MO-BPM-001-rxxx" to "BPM-002-rxxx". Also, the Issue Date has been removed from this Revision History.	M. Keyser	JAN-12-2010
BPM-002-r5	This primary reason for this revision is to incorporate Stored Energy Resources, a new resource type. During this revision, other corrections and language improvements were made. Noteworthy changes are to the table of contents and references; all links have been corrected. Also, changes have been made to the language regarding the clearing and deployment of Regulating Reserves, to increase precision. Editing Note: For ease of reading, each Attachment being published along with this r5 revision is being named	M. Keyser	OCT-27-2009

	"r5", even if no changes have been made to that Attachment.		
BPM-002-r4	This revision updates pricing sections to more accurately reflect Market rules. In addition, several other minor corrections have been made as well.	B. Borissov	OCT-02-2009
BPM-002-r3	This revision removes references to the DNR Regulation Must-Offer requirement that existed during the first 180 days of the market. It also describes new rules regarding Interchange Scheduling	M. Keyser	JAN-06-2009
BPM-002-r2	This revision reflects changes to align the document with the final as-built design of the Energy and Operating Reserves Market to the extent possible at the time of edit. Typographical and grammatical corrections have also been made.	M. Keyser	JAN-06-2009
BPM-002-r1	This new Energy and Operating Reserve Market BPM was created by combining the current Energy Markets BPM and Energy Markets Instruments BPM and then revising this combined BPM to reflect the September 14, 2007 filing, subsequent September 19, 2007 Errata filing and March 26, 2008 30-Day Compliance Filing of the Open Access Transmission and Energy Markets Tariff for the MISO, Inc. (EMT) relating to implementation of the Day-Ahead and Real-Time Energy and Ancillary Services Markets and integration of proposed changes to the Balancing Authority Agreement.	M. Tackett	JAN-06-2009

Contents

List of Attachments

Attachment A – Market Optimization Techniques – (provided in separate document)

Attachment B – Day-Ahead Energy and Operating Reserve Market Software Formulations and Business Logic – (provided in separate document)

Attachment C – Reliability Assessment Commitment Software Formulations and Business Logic – (provided in separate document)

Attachment D – Real-Time Energy and Operating Reserve Market Software Formulations and Business Logic – (provided in separate document)

List of Exhibits:

1. Introduction

This introduction to the *Business Practices Manual ("BPM") for Energy and Operating Reserve Markets* includes basic information about this BPM and the other MISO BPMs. The first section (Section 1.1) of this Introduction provides information about the MISO BPMs in general. The second section (Section 1.2) is an introduction to this BPM in particular. The third section (Section 1.3) identifies other documents in addition to the BPMs, which can be used by the reader as references when reading this BPM.

1.1 Purpose of the MISO Business Practices Manuals

The BPMs developed by MISO provide background information, guidelines, business rules, and processes established by MISO for the operation and administration of the MISO markets, provision of transmission reliability services, and compliance with the MISO settlements, billing, and accounting requirements. A complete list of MISO BPMs is available for reference through MISO's website.

1.2 Purpose of this Business Practices Manual

This BPM for *Energy and Operating Reserve Markets* covers the rules, design, and operational elements of MISO's Day-Ahead Energy and Operating Reserve Market and Real-Time Energy and Operating Reserve Market. MISO uses simultaneously co-optimized Security Constrained Unit Commitment ("SCUC"), Security Constrained Economic Dispatch ("SCED") and SCED-Pricing algorithms to clear and dispatch the Energy and Operating Reserve Markets. To understand how these algorithms perform their optimization function, a series of Attachments have been developed to assist in the understanding of some basic optimization concepts and the optimization formulations used within the applicable algorithms as follows:

- Attachment A to the BPM for *Energy and Operating Reserve Markets* outlines some basic optimization concepts and provides a high level description of the SCED and SCUC algorithms that are utilized by MISO to achieve its objectives;
- Attachment B provides additional detail regarding how the Day-Ahead Energy and Operating Reserve Market SCUC, SCED and SCED-Pricing algorithms were formulated and the business logic that is applied to clear the Day-Ahead Energy and Operating Reserve Market;
- Attachment C provides additional detail regarding how the SCUC algorithms were formulated for use in the multi-day RAC, forward RAC and intra-day RAC processes;

- Attachment D provides additional detail regarding how the SCED and SCED-Pricing algorithms were formulated for use in the Real-Time operating hour to calculate Dispatch Targets for Energy and Operating Reserve; and

This BPM conforms and complies with MISO's Tariff, the reliability standards, policies, principles and guidelines of the North American Electric Reliability Corporation ("NERC"), also known as the Electric Reliability Organization ("ERO"), operating policies, and the applicable Regional Entities, and is designed to facilitate administration of efficient Energy and Operating Reserve Markets.

This BPM benefits readers who want answers to the following questions:

- What are the roles of MISO and the Market Participants ("MPs") in the Energy and Operating Reserve Markets?
- What are the basic concepts that one needs to know to interact with the Energy and Operating Reserve Markets?
- What MP activities must be performed to engage in the Energy and Operating Reserve Markets?

1.3 References

Other reference information related to this BPM includes:

- Agreement of Transmission Facilities Owners to Organize the Midcontinent Independent System Operator, Inc., a Delaware Non-Stock Corporation (referred to as "T.O. Agreement" or "TOA")
- BPM-001 Market Registration BPM
- BPM-004 FTR-ARR BPM
- BPM-005 Market Settlements BPM
- BPM-007 Physical Scheduling BPM
- BPM-008 Outage Operations BPM
- BPM-009 Market Monitoring and Mitigation Business Practice Manual
- BPM-010 Network and Commercial Models BPM
- BPM-011 Resource Adequacy BPM
- BPM-025 Forecast Engineering BPM
- BPM-026 Demand Response BPM
- BPM-030 Pseudo-Tie BPM
- Market User Interface – API Specification

- MS-OP-031 Post Operating Processor Calculation Guide in the Market Settlements BPM
- Tariff for Midcontinent Independent System Operator, Inc.
- Coordination Policy Manual

2. Energy and Operating Reserve Markets Overview

This section presents a high level description of the Day-Ahead and Real-Time Energy and Operating Reserve Markets. The intent is to explain the basics, including the following:

- Energy and Operating Reserve Markets operation and Settlements
- Roles and Responsibilities of the entities that interact with the Energy and Operating Reserve Markets
- Market models and terminology
- Day-Ahead and Real-Time computer system components
- Market operation tools

2.1 Energy and Operating Reserve Markets Operation and Settlements

MISO operates two Energy and Operating Reserve Markets:

- ***Day-Ahead Energy and Operating Reserve Market*** – The Day-Ahead Energy and Operating Reserve Market is a forward market in which Energy, Operating Reserve and other reserve products, including the Ramp Capability Product and Short-Term Reserve, are cleared on a simultaneously co-optimized basis for each hour of the next Operating Day using Security-Constrained Unit Commitment ("SCUC"), Security-Constrained Economic Dispatch ("SCED") and SCED-Pricing computer programs to satisfy the Energy demand Bids, Operating Reserve requirements and other reserve requirements of the Day-Ahead Energy and Operating Reserve Market. The results of the Day-Ahead Energy and Operating Reserve Market clearing include hourly Ex Ante and Ex Post LMP values for Energy demand and supply, hourly Ex Ante and Ex Post Market Clearing Price ("MCP") values for Regulating Reserve, Spinning Reserve, Supplemental Reserve supply, Short-Term Reserve, Up Ramp Capability and Down Ramp Capability and hourly Energy demand schedules, hourly Energy supply schedules for each Resource, hourly Regulating Reserve, Spinning Reserve and Supplemental Reserve supply, hourly Up Ramp Capability and Down Ramp Capability schedules, and hourly Short-Term Reserve schedules for each qualified Resource. See Section 7. of this BPM for details of the Day-Ahead Energy and Operating Reserve Market.
- ***Real-Time Energy and Operating Reserve Market*** – The Real-Time Energy and Operating Reserve Market is a market in which Energy, Operating Reserve and other

reserve products, including the Ramp Capability Product and Short-Term Reserve, are cleared on a simultaneously co-optimized basis every five minutes using Security-Constrained Economic Dispatch ("SCED") computer programs to satisfy the forecasted Energy demand and Operating Reserve requirements of the Real-Time Energy and Operating Reserve Market based on actual system operating conditions, as described by MISO's State Estimator. The results of the Real-Time Energy and Operating Reserve Market clearing include five-minute Ex Ante LMPs for Energy demand and supply, five-minute Ex Ante MCP values for Regulating Reserve, Spinning Reserve, Supplemental Reserve supply, Short-Term Reserve, Up Ramp Capability and Down Ramp Capability, five-minute Dispatch Targets for each Resource for Energy, Regulating Reserve, Spinning Reserve and Supplemental Reserve, and clearing results for Up Ramp Capability, Down Ramp Capability, and Short-Term Reserve. The Real-Time Energy and Operating Reserve Market dispatch is supported by a Reliability Assessment Commitment ("RAC") process to ensure sufficient capacity is online to meet Real-Time operating conditions. See Section 6. of this BPM for details of the RAC processes and Section 8. of this BPM for details of the Real-Time Energy and Operating Reserve Market.

These Energy and Operating Reserve Markets operate in a coordinated sequence as summarized by the process/event overview timeline in Exhibit 2-1.

Separate accounting Settlements are performed for the Day-Ahead and Real-Time Energy and Operating Reserve Markets. See the BPM for *Market Settlements* for a detailed description.

LMP and MCP price calculations are described in detail in Section 5. of this BPM.

Real Time Ex Post Prices are calculated as part of Real Time Market Closure Activities as described in detail in Section 9. of this BPM.

Exhibit 2-1: Energy and Operating Reserve Markets – Timeline Overview

Beginning Day @ Time	Ending Day @ Time	Description of Processes and Events
Real-Time Energy and Operating Reserve Market RAC Pre Day-Ahead (See Section 6.)		
OD-7 @ 0000	OD-1 @ 2400	RAC Pre Day-Ahead Time Frame
Day-Ahead Energy and Operating Reserve Market Activities (See Section 7.)		
OD-7 @ 0000	OD-1 @ 1030 EPT	Prepare for Day-Ahead Energy and Operating Reserve Market
	OD-1 @ 1030 EPT	Close Day-Ahead Energy and Operating Reserve Market
	OD-1 @ 1330 EPT	Post the Day-Ahead Energy and Operating Reserve Market Awards Results and Ex-Ante LMPs and MCPs
OD-1 @ 1330 EPT	OD-1 @ 1630 EPT	Post the Day-Ahead Energy and Operating Reserve Market Ex-Post LMPs and MCPs
Real-Time Energy and Operating Reserve Market RAC Post Day-Ahead (See Section 6.)		
OD-1 @ 1330EPT	OD-1 @ 1430 EPT	Revise Offers for RAC Post Day-Ahead (with knowledge of Day-Ahead Energy and Operating Reserve Market results)
	OD-1 @ 1800EPT	Perform Post Day-Ahead RAC Process
OD-1 @ 1800 EPT	OD @ 0000	Notify Start-Up/Shut-Downs from Post Day-Ahead RAC Process
Real-Time Energy and Operating Reserve Market RAC Intraday (See Section 6.)		
OD-1@ 2000	OD @ 2400	RAC Intraday Time Frame
Real-Time Energy and Operating Reserve Market Activities (See Section 8.)		
OD-1 @ 2330	OD @ RT	Real-Time Energy and Operating Reserve Market Time Frame
	OD @ OH-30min	Close Real-Time Energy and Operating Reserve Market 30 minutes Prior to Top of Each OH
	OD @ RT-5min (Every 5 minutes)	Send UDS Dispatch Targets and post results
	OD @ RT-Continuous	Send Setpoint Instructions approximately every 4 seconds.
Energy Markets Closure Activities (See Section 9.)		
OD = Operating Day OH = Operating Hour (00 to 23) RT = Real-Time (target time for UDS Dispatch Targets) RAC = Reliability Assessment Commitment		UDS = Unit Dispatch System Note: All times are in EST unless noted otherwise.

2.2 Market Modeling Terminology

This section describes the models and terminology that MISO utilizes to coordinate the electric power system ("Network Model") with the Energy and Operating Reserve Markets ("Commercial Model"). Model coordination is crucial to the Settlement process so that credits and charges are accurately allocated to the MPs. The following subsections provide an overview of market modeling. See the BPM for *Network and Commercial Models* for a detailed description.

2.2.1 Network Model

The Network Model is a representation of the actual Transmission System within the MISO Balancing Authority Area, including all connection points modeled for generation and Load and including representations of other transmission systems within the Eastern Interconnection. This model has many purposes, including the analysis of the anticipated impact of physical Energy flow across the Transmission System.

2.2.2 Commercial Model

The Commercial Model differs from the Network Model in that it describes the financial market relationships of the MPs and Asset Owners ("AOs"), and the commercial relationships among the elements of the Network Model. The hierarchy of relationships is as follows:

- MP Level
- AO Level
- Commercial Pricing Node ("CPNode") Level
- Elemental Pricing Node ("EPNode") Level

2.2.3 Elemental Pricing Nodes

The EPNode is the finest level of granularity in the Commercial Model. EPNodes represent selected single Buses in the Transmission System Network Model. EPNodes generally include all Buses where Energy is injected and/or withdrawn from the Transmissions System, as well as other commercially significant buses. MISO calculates the Ex Ante and Ex Post LMP of supplying and consuming Energy at each EPNode. Ex Ante and Ex Post MCPs are calculated directly at the CPNode level.

2.2.4 Aggregated Pricing Nodes

The Aggregated Pricing Node ("APNode") represents an aggregation of two or more EPNodes using predetermined weighting factors. For each APNode, the relationship of EPNodes to APNodes determines how Energy, Operating Reserve and other reserves at the APNode level

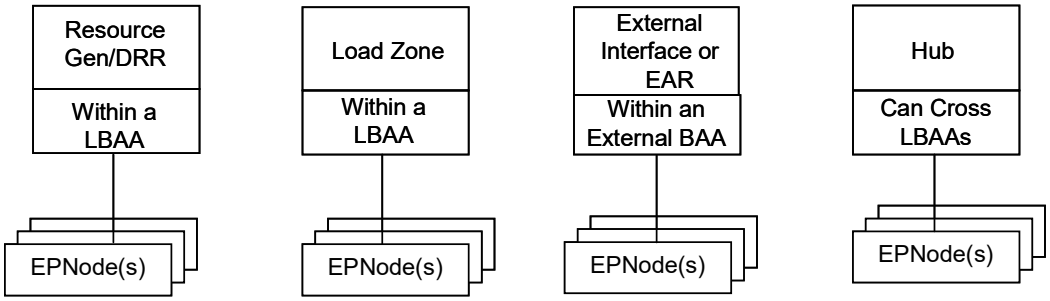
are allocated at the EPNode level and/or how prices at the EPNode level are weighted at the APNode level. This nodal relationship is maintained in MISO's Asset Registration System.

2.2.5 Commercial Pricing Nodes

The CPNode represents the next hierarchical level in the Commercial Model and consists of a single EPNode or APNode (i.e., an aggregation of one or more EPNodes). Energy supply and demand is financially settled at the CPNode level based on the appropriate CPNode LMP (Hourly Ex Post Day-Ahead or Hourly Ex Post Real Time) and CPNode energy injection or withdrawal level. Operating Reserve, Ramp Capability Product and Short-Term Reserve supply is financially settled at the Resource CPNode level based on the appropriate CPNode MCPs (Ex Post Day-Ahead MCPs or Ex Post Real Time MCPs). All LMPs and MCPs will be made available to the public.

There are four types of CPNodes: Resource, Load Zone, Hub, and Interface. Exhibit 2-2 illustrates the relationship between EPNodes and CPNodes.

Exhibit 2-2: CPNode Types



BAA = Balancing Authority Area
LBAA = Local Balancing Authority Area
DRR = Demand Response Resource Types I & II
EAR = External Asynchronous Resource

A Resource CPNode will be based on a single EPNode if the Resource output is injected at a single Bus or an APNode if the Resource output is injected at multiple Buses. For example, a Generation Resource with a single Generator or a Demand Response Resource - Type II hosted by a single Load on the Transmission System would contain a CPNode comprised of the single EPNode where the Generation Resource or Demand Response Resource - Type II injects energy.[1] On the other hand, a Combined Cycle Resource with multiple Generators connected to different electrical Buses or a Demand Response Resource - Type I representing an AC Compressor Control demand-side management program spread across many Loads could be represented by an APNode. Under this situation, the APNode weighting factors would be determined by the MP when the asset is registered and would need to be based on how the total energy injection from the Resource would be distributed among the multiple injection points to which the Resource connects.

A Load Zone CPNode will be based on a single EPNode if the Load Zone represents Load at a single Bus or an APNode if the Load Zone represents Load at multiple Buses. For Load Zone CPNodes that are APNodes, the weighting factors are generally based on actual Load measurements. For the Day-Ahead and Real-Time Markets, a common set of weighting factors are used for all 24 hours of the operating day and are based on the average of the 24 hourly State Estimator Loads associated with the day seven days prior to the Operating Day. On Quarterly Model updates, State Estimator Loads consistent with the new model may not be available, therefore, the weighting factors may be derived offline and applied for the first seven days after a new model is effective.

A Hub CPNode can be based on a single EPNode, but will almost always be based on an APNode. The weighting factors for most Hubs are fixed and determined in advance and are not based on energy injection and/or withdrawal levels at the associated EPNodes.

ARR Zones administered as Hub CPNodes are an exception to this practice. The weighting factors of EPNodes comprising an APNode representing an ARR Zone are calculated in the same manner as those of EPNodes comprising a Load Zone. For ARR Zone CPNodes that are

[1] Throughout this BPM, all rules and requirements for DRR - Type II Resources are applicable to SER - Type II resources on an equivalent basis, to the extent that SER – Type IIs are modeled as DRR – Type IIs for operational purposes (although they differ in how they are settled).

APNodes, the weighting factors are generally based on actual Load measurements. For the Day-Ahead and Real-Time Markets, a common set of weighting factors is used for all 24 hours of the Operating Day and are based on the average of the 24 hourly State Estimator Loads associated with the day seven days prior to the Operating Day.

An Interface CPNode can be based on a single EPNode or an APNode. MISO will determine the weighting factors for an Interface CPNode at the time the Network Model is updated. An Interface CPNode is established for each external Balancing Authority. The EPNodes and associated weighting factors are established to simulate as accurately as possible the sourcing or sinking of an Interchange Schedule within the associated external Balancing Authority based on the physical Resources within such Balancing Authority. In many cases, external Interface Buses represent an aggregation of the Resources within the external Balancing Authority that are most likely to move up or down to accommodate an Interchange Schedule to or from the MISO Balancing Authority.

EPNodes may be allocated by percent of ownership to more than one CPNode, provided that the total allocation equals 100 percent. CPNodes that represent Resources and Loads are referred to as assets and all of these types of Assets must be completely assigned (i.e., 100%) to an AO.

2.2.6 Asset Owners

The AO is the next higher hierarchical level in the Commercial Model and typically, but not necessarily, represents a company. A company may choose to be registered as more than one AO. Within the Commercial Model, AOs can own any combination of generation, Load, and/or FTR assets across any number of Local Balancing Authority Areas (“LBAAs”). All AOs must each be represented by an MP.

MISO calculates charges and produces market Settlements statements for each AO. Each Settlement statement provides the billing determinants for each transaction, along with the AO’s total financial obligation resulting from its transactions.

2.2.7 Market Participants

The MP is the highest hierarchical level in the Commercial Model and is the entity in the Commercial Model that is financially obligated to MISO for market Settlements. A single MP represents one or more AOs. A single MP may authorize other entities such as a Scheduling

Agent (SA) to act in the MISO Energy and Operating Reserve Markets on its behalf. The MP remains financially responsible for market Settlements. MPs receive Settlement summaries and invoices from MISO for Energy and Operating Reserve Markets activities executed by the MPs' or entities authorized by the MP. See the BPM for *Market Settlements* for detailed information.

2.3 Roles and Responsibilities

Roles and responsibilities are described for the following entities:

- MISO
- MPs
- Transmission Owners/Operators
- Generation Owners/Operators
- Load-Serving Entities ("LSEs")
- Market Support Services Providers
- Local Balancing Authorities ("LBAs")
- Independent Market Monitor ("IMM")

2.3.1 MISO

MISO provides all market services for Energy, Operating Reserve, other reserves and Transmission Service in accordance with the terms of the Tariff, the BPMs, and related agreements. This includes operation and Settlement of the Day-Ahead Energy and Operating Reserve Market and the Real-Time Energy and Operating Reserve Market.

MISO administers the Energy and Operating Reserve Markets through performance of the following processes:

1) **Reserve Zone Configuration and Reserve Requirements (see Section 3.):**
    - Identify and/or modify Reserve Zones on a quarterly basis consistent with updates of the Network Model
    - Calculate Market-Wide Operating Reserve Requirements on daily basis and post such Requirements 2 days prior to the applicable Operating Day.
    - Post Market-Wide Short-Term Reserve Requirements 2 days prior to the applicable Operating Day
2) **Multi-Day Reliability Assessment and Commitment ("MDRAC") (see Section 6.):**

- Accumulate information to assess system reliability for the next three to seven days, including gathering data for analyses, identifying potential problems, and determining if sufficient capacity is available to meet Energy, Operating Reserve, and other reserve requirements.
- Commit, if necessary, Generation Resources, Demand Response Resources – Type II and Demand Response Resources - Type I with Start-Up Notification Time + Start-Up Time greater than 24 hours for a future Operating Day.

3) Day-Ahead Energy and Operating Reserve Market (see Section 7.):

- Acquire Day-Ahead data, including transmission outages, generation outages, and Day-Ahead Bids and Offers **(see Section** Error! Reference source not found. **)**.
- Confirm Day-Ahead Interchange Schedules.
- Clear the Day-Ahead Energy and Operating Reserve Market by committing and dispatching Day-Ahead supply, including consideration of Start-Up, No-Load, Energy Offer, Regulating Reserve Offer, Spinning Reserve Offer (or On-Line Supplemental Reserve Offer if not Spin Qualified), Off-Line Supplemental Reserve Offer (if a Quick-Start Resource), Off-Line Short-Term Reserve Offer, On-Line Short-Term Reserve capability, and Ramp Capability for Generation Resources and DRRs-Type II; consideration of Energy Offer, Regulating Reserve Offer, Spinning Reserve Offer (or On-Line Supplemental Reserve Offer if not Spin Qualified), On-Line Short-Term Reserve capability, and Ramp Capability for External Asynchronous Resources (“EARS”); consideration of Shut-Down Offers, Hourly Curtailment Offers, Energy Offers, Spinning Reserve Offers, Supplemental Reserve Offers, and Off-Line Short-Term Reserve Offers for DRRs-Type I; and consideration of Regulating Reserve Offer for Stored Energy Resources (“SERs”), against Day-Ahead demand and Operating Reserve requirements.
- Calculate Day Ahead Ex Ante LMPs, Ex Post LMPs, Ex Ante MCPs and Ex Post MCPs **(see Section 5.)**
- Review Day-Ahead Energy and Operating Reserve Market results.
- Publish data for Day-Ahead Energy and Operating Reserve Market results (e.g., schedule, commitment, Load, Ex Ante LMP, Ex Post LMP, Ex Ante MCP and Ex Post MCP).
- Perform Day-Ahead Energy and Operating Reserve Market Settlement.

4) **Day-Ahead Reliability Assessment and Commitment (DARAC) (see Section 6.):**
   - Following the posting of Day-Ahead Energy and Operating Reserve Market results, accumulate information to assess system reliability for the next Operating Day, including gathering data for analyses, identifying potential problems, and determining if sufficient capacity is available to meet Energy and Operating Reserve requirements.
   - Commit additional Resources not previously committed during the Day-Ahead Energy and Operating Reserve Market process, if necessary, to meet forecast Load, Operating Reserve requirements, and other reserve requirements for the next Operating Day based on Start-Up Offers, No-Load Offers, Energy Offers, Regulating Reserve Offers, Spinning Reserve Offers (or On-Line Supplemental Reserve Offers if not Spin Qualified), Off-Line Supplemental Reserve Offers (if a Quick-Start Resource), Off-Line Short-Term Reserve Offers, On-Line Short-Term Reserve capability and Ramp Capability for Generation Resources and DRRs-Type II; consideration of Energy Offer, Regulating Reserve Offers, Spinning Reserve Offers (or On-Line Supplemental Reserve Offers if not Spin Qualified), On-Line Short-Term Reserve capability and Ramp Capability for External Asynchronous Resources; consideration of Shut-Down Offers, Hourly Curtailment Offers, Spinning Reserve Offers, Supplemental Reserve Offers, and Off-Line Short-Term Reserve Offers for DRRs-Type I; and Regulating Reserve Offers for Stored Energy Resources. Both EAR and SER Resources are considered to be committed, if available, during this process.
   - Recommend, if necessary, Resource candidates to supply Regulating Reserve.
   - Recommend, if necessary, the release of the emergency high range or emergency low range on specific Resources should it be necessary to ensure power balance and satisfy Operating Reserve requirements.
   - Identify Quick-Start Resources selected to supply Supplemental Reserve.
   - Identify resources selected to supply Short-Term Reserve.
5) **Intra-Day Reliability Assessment and Commitment (IRAC) (see Section 6.):**
   - Continue to accumulate information to assess system reliability during the Operating Day, including gathering data for analyses, identifying potential

problems, and determining if sufficient capacity is available to meet Energy, Operating Reserve, and other reserve product requirements.

- Commit additional Resources not previously committed during the Day-Ahead Energy and Operating Reserve Market process, Day-Ahead RAC process or previous Intra-Day RAC process if necessary, to meet forecast Load, Operating Reserve requirements, and other reserve requirements for the remainder of the Operating Day based on Start-Up Offers, No-Load Offers, Energy Offers, Regulating Reserve Offers, Spinning Reserve Offers (or On-Line Supplemental Reserve Offers if not Spin Qualified), Off-Line Supplemental Reserve Offers (if a Quick Start Resource), Off-Line Short-Term Reserve Offers, On-Line Short-Term Reserve capability and Ramp Capability for Generation Resources and DRRs-Type II and Shut-Down Offers, Hourly Curtailment Offers, Spinning Reserve Offers, Supplemental Reserve Offers, and Off-Line Short-Term Reserve Offers for DRRs-Type I. External Asynchronous Resources, if available and not previously selected during the Day-Ahead Energy and Operating Reserve Market process or prior RAC processes, are also considered in this step based on their Energy Offers, Regulating Reserve Offers, Spinning Reserve Offers, Supplemental Reserve Offers, On-Line Short-Term Reserve capability and Ramp Capability.[2] SERs, if available and not previously selected during the Day-Ahead Energy and Operating Reserve Market process or prior RAC processes, are also considered in this step based on their Regulating Reserve Offers.
- Recommend, if necessary, Resource candidates to supply Regulating Reserve for the commitment period.
- Recommend, if necessary, the release of the emergency high range or the emergency low range on specific Resources should it be necessary to ensure power balance and satisfy Operating Reserve requirements and Market-Wide Short-Term Reserve requirement.
- Identify Quick-Start Resources selected to supply Supplemental Reserve and/or DRRs-Type I selected to supply Contingency Reserve.
- Identify resources selected to supply Short-Term Reserve.

[2] Only if not Spin Qualified

6) **Real-Time Energy and Operating Reserve Market (see Section 8.):**
   - Acquire Real-Time Energy and Operating Reserve Market Offers **(see Section 4.)**.
   - Acquire most recent RAC data (e.g. operating plan).
   - Confirm Real-Time Interchange Schedules and Real-Time Resource Offer data.
   - Acquire current system conditions, including: Binding Transmission Constraints (limits, actual flows and sensitivity factors) and actual generation.
   - Calculate 5-minute Load Forecast.
   - Operate and clear the Real-Time Energy and Operating Reserve Market and determine Ex Ante LMPs, Ex Ante MCPs, cleared Energy, cleared Operating Reserve, cleared ramp capability, cleared Short-Term Reserve Dispatch Targets.
   - Send Dispatch Targets to Market Participants with Generation Resources, DRRs-Type II, DRRs-Type I, Stored Energy Resources and External Asynchronous Resources every five minutes.
   - Send Setpoint Instructions to Market Participants with Generation Resources, Demand Response Resources - Type II, Stored Energy Resources and External Asynchronous Resources every four seconds.
   - Calculate and publish preliminary Ex Post LMPs and MCPs.
   - Review Real-Time Energy and Operating Reserve Market results.
   - Schedule and payback Inadvertent Interchange.
   - Initiate Emergency procedures, as needed.
   - Calculate and publish final Hourly Ex Post LMPs and MCPs.
   - Perform Real-Time Energy and Operating Reserve Market Settlement.

2.3.2 Market Participants

MPs are entities that are qualified, pursuant to criteria and procedures established by MISO, to perform the following actions:

7) **Day-Ahead Energy and Operating Reserve Market:**
   - Submit Interchange Schedules to MISO.
   - Submit Demand Bids to purchase Energy and/or submit Offers, including Self-Schedules, to sell Energy and Operating Reserve and other reserves.

- Submit Day-Ahead Financial Schedules to MISO by 1200 hours Eastern Standard Time ("EST") up to six days following the Operating Day (OD+6).
- Submit Virtual Supply Offers and Virtual Demand Bids.

8) Real-Time Energy and Operating Reserve Market:

- Submit Offers for any of the RAC processes (beginning at OD-7).
- Submit Interchange Schedules to MISO.
- Submit new or modified Offers, including Self-Schedules, to supply Energy and Operating Reserve and other reserves no later than 30 minutes prior to the Operating Hour.
- Submit Real-Time Financial Schedules by 1200 EST up to six days following the Operating Day (OD+6).

2.3.3 Transmission Operators

A Transmission Owner is a member of MISO that has (in whole or in part) transferred functional responsibilities of its transmission facilities classified as transmission and covered under the Tariff and TOA. Those facilities make up MISO's Transmission System. Transmission Operators perform the following actions on behalf of Transmission Owners:

1) Prior to the Operating Day:

- Receive and/or develop transmission maintenance requirements and plans for Transmission Owners.
- Define operating limits, develop contingency plans, and monitor operations of the transmission facilities under the Transmission Operator's control and as directed by MISO.
- Provide operating information to MISO.
- Determine amounts required and arrange for Other Ancillary Services from Generation Owners to ensure reactive supply and voltage control (e.g., from Generation Resources) in coordination with the LBAs and MISO.
- Update transmission facility ratings.

2) During the Operating Day:

- Operate or direct the operations of the Transmission System within equipment and facility ratings established by the Transmission Owners and Generation Owners, and system ratings established by MISO.

- Deploy reactive Resources from Transmission Owners and Generation Owners Other Ancillary Services to maintain acceptable voltage profiles and direct Distribution Providers to maintain voltages within limits.
- Provide Real-Time operations information to MISO.
- Notify Generation Owners and other affected entities of Transmission System problems (e.g., voltage limitations or equipment overloads that may affect Generator operations).
- Request MISO actions to mitigate equipment overloads for facilities not monitored by MISO.
- Coordinate Load Shedding with, or as directed by, MISO and direct Distribution Providers to shed Load.

2.3.4 Generation Owners/Operators

A Generation Owner is an entity that owns, or leases with rights equivalent to ownership, facilities for generation of Energy and provision of Operating Reserve and other reserves that are located within or are used to supply Energy and Operating Reserve and other reserves in the MISO market footprint ("Market Footprint"). Generation Resources within the Market Footprint must be represented by an MP. Generator Operators perform the following actions:

1) **Prior to the Operating Day:**
   - Submit maintenance schedules.
   - Submit operational parameters and facility limitations (e.g., long lead time units).
2) **During the Operating Day:**
   - Respond to dispatch and control directives or signals.
   - Respond to reactive supply and voltage control directives.
   - Respond to Start-Up and Shut-Down directives.

2.3.5 Load-Serving Entities

LSEs are any parties taking Transmission Service on behalf of wholesale or retail power customers, that have undertaken an obligation to provide or obtain Energy and/or reserves for end-use customers by statute, franchise, regulatory requirement, or contract for Load located within or attached to the Transmission System.

An LSE must either qualify as an MP, or arrange with an MP to be served through the Energy and Operating Reserve Markets. LSEs perform the following actions:

1) **Prior to the Operating Day:**
   - Coordinate with their LBA in the development of Load Forecasts (hourly for 7 days out) that the LBA submits to MISO.
2) **During the Operating Day:**
   - Respond to MISO interruptible Load and Load Shedding directives either directly or through their LBA.

2.3.6 Aggregators of Retail Customers ("ARCs")

ARCs are any parties that have contracted to provide load interruption services or behind the meter generation to the Energy and Operating Reserve Markets with one or more retail or wholesale customers whose load they have not undertaken an obligation to provide or obtain Energy and/or reserves for end-use customers by statute, franchise, regulatory requirement or contract for Load located within or attached to the Transmission System.

An ARC must either qualify as an MP, or arrange with an MP to be served through the Energy and Operating Reserve Markets. ARCs perform the following actions:

3) **Prior to the Operating Day:**
   - Submit Maintenance Schedules
   - Submit operational parameters and facility limitations (e.g., long lead time Resources)
4) **During the Operating Day:**
   - Respond to dispatch and control directives or signals
   - Respond to Start-Up and Shut-Down directives

2.3.7 Market Support Services Providers

There are three types of market support services providers:

- ***Scheduling Agent ("SA")*** – an agent designated by an MP to physically exchange market information, such as submitting Bilateral Transactions, Bids, and Offers or receiving market data and notifications from MISO on the MP's behalf.
- ***Meter Data and Management Agent ("MDMA")*** – an entity that is designated by an MP to manage and conduct the metering function.

- ***Billing Agent*** – an entity that may be designated by an MP to receive bills and/or make payments on behalf of the MP.

Market support services providers do not need to be qualified as MPs as long as the MPs they represent remain financially liable to MISO for all the activities that the market support services providers perform. The market support services providers are required to act in accordance with the provisions of the Tariff. However, the MP's responsibilities and liabilities to MISO cannot be transferred to market support service providers.

2.3.8 Local Balancing Authorities

Local Balancing Authority responsibilities are specified in the Amended Balancing Authority Agreement.

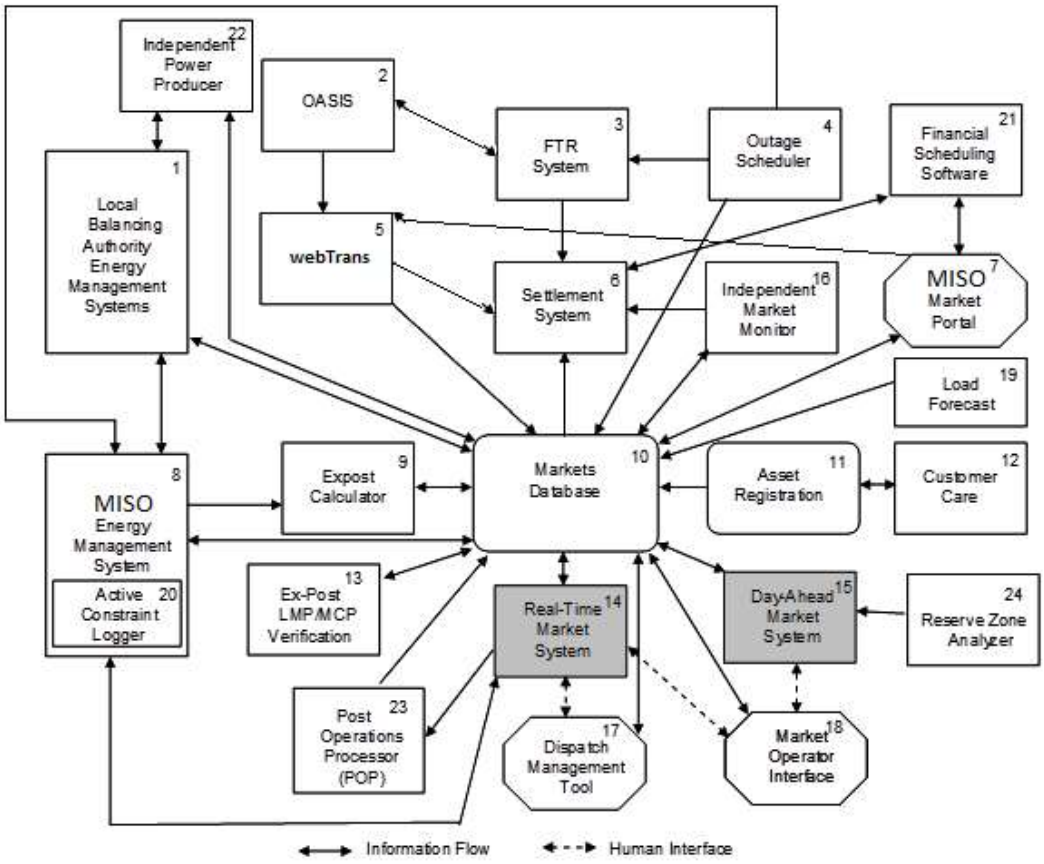
2.3.9 Independent Market Monitor

MISO uses the services of its IMM to provide for the independent, impartial, and effective monitoring and reporting on the MISO Energy and Operating Reserve Markets as a whole. In addition, the IMM provides the means for MISO to mitigate the market effects of any conduct that would distort competitive outcomes in the Energy and Operating Reserve Markets. For further information on the IMM, please see the BPM for *Market Monitoring and Mitigation*.

2.4 Energy and Operating Reserve Markets System Components

The Day-Ahead and Real-Time Energy and Operating Reserve Markets ("DART") system consists of software, servers, and related applications used to support the operation of the Day-Ahead and Real-

Time Energy and Operating Reserve Markets. Exhibit 2-3 depicts the major components of this system.
Exhibit 2-3: DART Components Overview



The following components are shown in Exhibit 2-3:

1) ***LBA/MP Energy Management Systems*** – The LBA and MP EMSs that are within the Market Footprint provide SCADA via ICCP, and the MISO EMS and MP EMSs that are within the Market Footprint provide Dispatch Targets, to Resources that are dispatched by MISO. MISO also sends Resource Dispatch Targets to LBAs.
2) ***Open Access Same-Time Information System ("OASIS")*** – Used to manage Transmission Service reservations that may be used to schedule Interchange

Transactions. Reservations for Firm Transmission Service may also be accompanied by an FTR request via the OASIS.

3) ***FTR System*** – Maintains records of FTR Holders, allocates new FTRs, and conducts auctions.
4) ***Outage Scheduler*** – The system that tracks the status of transmission and generation outages and their expected return to service.
5) **webTrans** – The system for entering and disseminating Interchange Schedule information. Interchange Schedules are submitted to webTrans via NERC E-Tag.
6) ***Settlement System*** – Calculates the MP charges and credits for the Day-Ahead Energy and Operating Reserve Market, the Real-Time Energy and Operating Reserve Market, and the FTR Market.
7) ***MISO Market User Interface ("MUI"), also known as the Market Portal*** – The internet portal by which MP information is entered via input/output displays and data templates[3].
8) ***MISO Energy Management System*** ("EMS") – consists of the power system network analysis functions (including the State Estimator and Contingency Analysis) that are used by MISO Operators to maintain reliable power system operations and the AGC system.
9) ***Real Time Ex-Post Calculator*** – Calculates five-minute Ex-Post LMPs and MCPs based on the same input data and SCED-Pricing algorithm used to clear the Real-Time Energy and Operating Reserve Market.
10) ***Markets Database*** – The Markets Database is the central repository of all market-related data and coordinates market component communications.
11) ***Asset Registration*** – The system for the storing of authorized MP information relevant to participation in the MISO markets.
12) ***Customer Care*** – Customer services and the MISO response to market inquiries.
13) ***Ex- Post LMP/MCP Verification*** – Verification and correction of Ex-Post Calculator results.
14) ***Real-Time Market System*** – Provides Dispatch Targets for a near-term forecast of operating conditions for the Real-Time Energy and Operating Reserve Market, using a simultaneously co-optimized SCED algorithm. For the Real-Time Energy and

[3] For more information regarding querying and submitting Market data to the MUI, please see the *latest Market User Interface API Specification*

Operating Reserve Market, the SCED algorithm is executed on a five-minute periodic basis to produce a security constrained co-optimized economic dispatch and reserve clearing and determines Ex-Ante LMPs and Ex-Ante MCPs based on the current system conditions, the actively managed transmission constraints, the Sub-Regional Power Balance Constraint and the forecast system conditions. The SCED algorithm is not used in RAC.

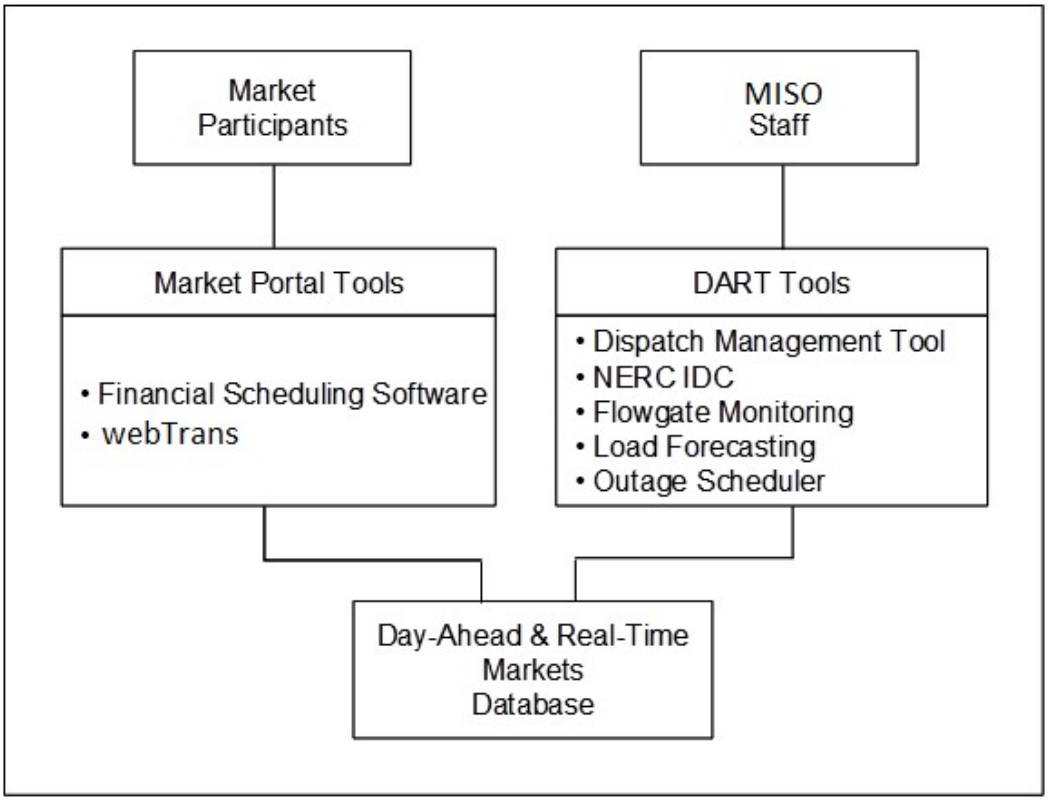
15) ***Day-Ahead Market System*** – Provides SCUC commitments, SCED schedules and SCED-Pricing prices, based on MP submitted Offers and Bids and forecast Operating Reserve and other reserve requirements. The following applications are executed for each hour:
    - ***Resource Scheduling and Commitment ("RSC")*** – A SCUC which performs generation commitment for the 24-hour period.
    - ***Scheduling, Pricing and Dispatch ("SPD")*** – A SCED that uses the Network Model to perform dispatch for 24 hours and determines Ex Ante LMPs and Ex Ante MCPs.
    - ***Simultaneous Feasibility Test ("SFT")*** – Performs contingency analysis for each hour to evaluate network security of a set of injections and withdrawals under a range of contingent scenarios.
    - ***Day Ahead Locational Marginal Price ("DALMP")*** – A SCED, specifically SCED-Pricing, that uses the Network Model to perform dispatch for 24 hours and determines Ex Post LMPs and Ex Post MCPs.
16) ***Independent Market Monitor ("IMM")*** – Provides the independent observation of market activities to detect market rule violations and the influence of market power.
17) ***Energy Market Displays ("EMD")*** – Allows the Operator to make changes to the planned operation of specific Resources,
18) ***Market Operator Interface ("MOI")*** – Allows the Operator to view the inputs and outputs of the market system, and to make input parameter adjustments.
19) ***Load Forecast*** – Provides short-term Load forecast over the next hour for the Real-Time Energy and Operating Reserve Market dispatch and provides 24 hour Load forecast values for rolling seven days for use in the RAC for the Real-Time Energy and Operating Reserve Market.
20) ***Active Constraint Logger*** – Records and logs transmission constraints that are "actively" being controlled and impacting the dispatch solution produced by UDS in the Real-Time Energy and Operating Reserve Market.

21) ***Financial Scheduling Software ("finSched")*** – Used by MPs to enter Financial Schedules.
22) ***Independent Power Producer ("IPP")*** – A Generation Resource that operates within an LBA and that submits MW/Price Offers into the Energy and Operating Reserve Markets, independently of any other Generation Resource(s) within the LBA.
23) ***Post Operation Processor ("POP")*** – Calculates hourly MCPs and cleared Operating Reserve and other reserve MW for use in the hourly Settlements in the Real-Time Energy and Operating Reserve Market.

2.5 Market Operations Tools

Many software tools are required for the operation of the Day-Ahead and Real-Time Energy and Operating Reserve Markets. These tools, listed as part of the system components described under Section 2.4, can be categorized as illustrated by Exhibit 2-4, which distinguishes between those tools designed for MP interaction and those tools designed primarily for MISO staff interaction.

Exhibit 2-4: Market Operations Tools



The following software tools are available to assist MISO with the management of the Energy and Operating Reserve Markets and interactions with MPs, and are described in this subsection:

- Financial Scheduling Software ("finSched")
- Physical Scheduling Software ("webTrans")
- MISO Market Portal

2.5.1 Financial Scheduling Software

The finSched MUI application provides MPs with the ability to create Financial Schedules that transfer the financial responsibility for Energy, but not the physical flow of Energy. A Financial Schedule identifies the parties, Source Point, Delivery Point, Sink Point, and Energy schedules.

The Source/Delivery/Sink Points can be any CPNode. The following MP capabilities and functionalities are incorporated in finSched:

- Define contracts between two parties who are each MPs in the Energy and Operating Reserve Markets. The contracts permit parties to create schedules, which transfer financial responsibility between parties.
- Define MW schedules for periods of time consistent with the contracts that are defined between the parties.
- Define financial transfers within and across MISO's Market Footprint.
- Acknowledge/accept the contracts and schedules entered by the counterparty.
- Provide the MPs with web and Market User Interface API methods to schedule Financial Schedules. Those MPs with a programmatic interface receive notification from finSched of schedules that are pending their approval.
- Provide financial schedule reports to MPs via web browser and Market User Interface API programmatic interface.
- Enter and confirm Financial Schedules (by both parties to the agreement) by 1200 EST on the sixth day after the Operating Day (OD+6).

See Section 4.1.3 of this BPM for a description of Financial Schedules.

2.5.2 Physical Scheduling Software (webTrans)

OATI's webTrans processes and tracks the Interchange Schedules that enter, exit, pass through or exist within MISO's market footprint. In general, webTrans is used to process Interchange Schedules with external entities and validate transactions against rules explained in BPM-007.

2.5.3 MISO Market Portal

MPs may submit Bilateral Transactions, Resource Offers, Demand Bids, and Virtual Transactions into the Energy and Operating Reserve Markets through MISO's Market Portal. The Market Portal also serves as the focal point for posting unrestricted (public) information and private information to authorized MPs.

3. Energy and Operating Reserve Market Requirements and Product Description

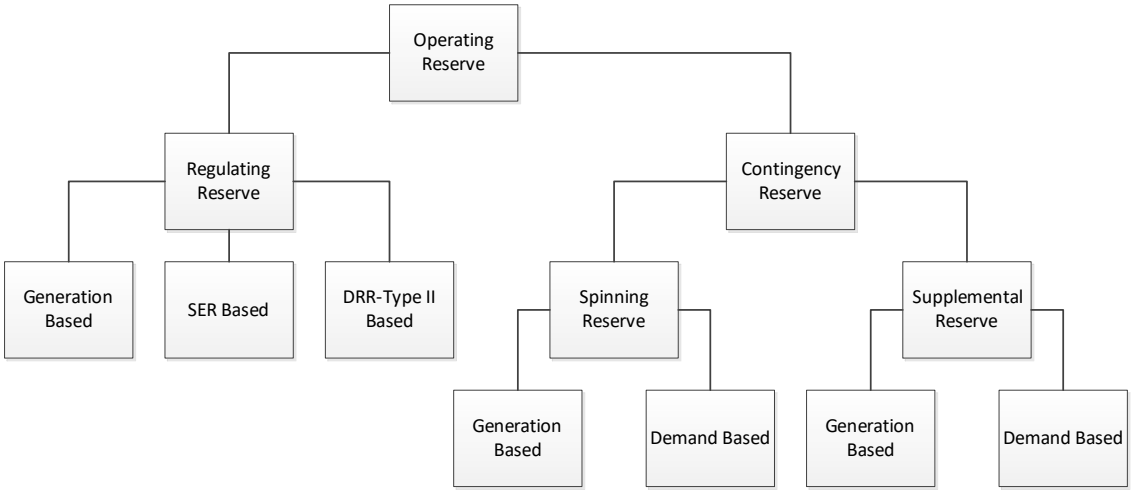
The following six products are traded in both the Day-Ahead and Real-Time Energy and Operating Reserve Markets to meet the MISO Energy and Operating Reserve Market requirements:

- Locational Energy;
- Regulating Reserve;
- Spinning Reserve;
- Supplemental Reserve;
- Ramp Capability;
- Short-Term Reserve.

Locational Energy is a commodity that is both purchased and sold by MPs to meet Energy requirements. Day-Ahead Energy requirements are based upon Demand Bids, Virtual Demand Bids and Export Schedules. Real-Time Energy requirements are based upon actual real-time metered deviations from Day-Ahead Energy requirements. Regulating Reserve, Spinning Reserve and Supplemental Reserve represent Ancillary Services procured to meet MISO Operating Reserve requirements to ensure reliable operation of the MISO Balancing Authority. The three Operating Reserve products are related through the Operating Reserve Hierarchy (See

Exhibit 3-1). The Ramp Capability Ancillary Service is used to reduce the occurrence of energy and reserve scarcity by reserving ramping capacity for future load variations and uncertainty. Ramp Capability does not fit within the hierarchy of Operating Reserves for the purpose of product substitution. The Short-Term Reserve Ancillary Service is a 30-minute product used to meet market-wide, sub-regional and local flexibility needs. Short-Term Reserve also does not fit within the hierarchy of Operating Reserves for the purpose of product substitution.

Exhibit 3-1: Operating Reserve Product Hierarchy



Based on the Operating Reserve Hierarchy, Operating Reserve is comprised of Regulating Reserve and Contingency Reserve; Regulating Reserve is comprised of Generation-based, DRR-Type II based and SER-based Regulating Reserve; Contingency Reserve is comprised of Generation-based and Demand-based Spinning Reserve and Generation-based and Demand-based Supplemental Reserve. This Section describes the Operating Reserve products and the methods used by MISO to calculate the Market-Wide and Co-Optimized Zonal Regulating Reserve Requirements. The Market-Wide Operating Reserve Requirement is always equal to the sum of the Market-Wide Regulating Reserve Requirement and the Market-Wide Contingency Reserve Requirement.

3.1 Regulating Reserve Product and Requirements

The Regulating Reserve product and the methods used by MISO to set the Market-Wide and Co-Optimized Zonal Regulating Reserve Requirements are described in the following subsections.

3.1.1 Regulating Reserve Product Description

Regulating Reserve products cleared in either the Day-Ahead or Real-Time Energy and Operating Reserve Market to meet either the Co-Optimized Zonal or Market-Wide Regulating Reserve Requirements must meet the following criteria:

- All cleared Regulating Reserve products must be fully deployable in both the regulation-up and regulation-down directions within the Regulation Response Time. MISO will determine automatically the maximum amount of Regulating Reserve that is fully deployable from a specific Resource within the Regulation Response Time based on active ramp rates and/or the clearing of other products on the Resource.
- The Regulation Response Time may be reviewed and adjusted if it is determined by MISO that the current setting is not providing acceptable reliability compliance at a reasonable cost.
- All Regulating Reserve products must be supplied by Regulation Qualified Resources, where Regulation Qualified Resources are Resources that are registered as such, meet the requirements outlined in Section 4.2 of this BPM for Regulation Qualified Resources and have their hourly Regulation Qualified Flag set to "True" for the Operating Hour in question.
- The amount of Regulating Reserve product that can be economically cleared on Stored Energy Resources is limited to be less than or equal to the Market-Wide Regulating Reserve Requirement. This could result in price separation between the SER-based Regulating Reserve product and the non-SER-based Regulating Reserve product. If an amount of Regulating Reserve greater than the Market-Wide Regulating Reserve Requirement is Self-Scheduled or offered with price zero by SERs, then the amount of Regulating Reserve cleared on SERs will be greater than the Market-Wide Regulating Reserve Requirement; however, this Regulating Reserve will not be eligible to substitute for other Operating Reserve products.

3.1.2 Market-Wide Regulating Reserve Requirements

MISO sets the Market-Wide Regulating Reserve Requirements based upon the follow criteria:

- Hourly requirements will apply to both the Day-Ahead and Real-Time Energy and Operating Reserve Markets. The MISO Market-Wide Regulating Reserve Requirement may be adjusted for the Real-Time Energy and Operating Reserve Market if necessary due to an Emergency operating condition.
- The hourly Market-Wide Regulating Reserve Requirements will be reviewed daily to ensure acceptable compliance levels with Electric Reliability Organization standards and applicable Regional Entity standards related to control performance. Acceptable compliance levels are performance levels that meet reliability standards at a reasonable cost. Market-Wide Regulating Reserve Requirements will be set to comply

with Electric Reliability Organization Standards related to control performance. Should these standards be modified, replaced or terminated, or should additional standards related to control performance be adopted, the method used to set the hourly Market-Wide Regulating Reserve Requirements will be updated accordingly.

3.2 Contingency Reserve Product and Requirements

The Contingency Reserve product and the methods used by MISO to set the Market-Wide and Co-Optimized Zonal Contingency Reserve Requirements are described in the following subsections.

3.2.1 Contingency Reserve Product Requirements

Contingency Reserve products cleared in either the Day-Ahead or Real-Time Energy and Operating Reserve Market to meet either the Co-Optimized Zonal or Market-Wide Contingency Reserve Requirements must meet the following criteria:

- All cleared Contingency Reserve must be fully deployable within the Contingency Reserve Deployment Period. MISO will automatically determine the maximum amount of Contingency Reserve that is fully deployable from a specific Resource within the Contingency Reserve Deployment Period based on active ramp rates and/or the clearing of other products on the Resource.
- The Contingency Reserve Deployment Period will be governed by Reliability standards, but in no case will be set greater than 10.0 minutes. Based on Electric Reliability Organization ("ERO") Standard BAL 002-0, a Balancing Authority has 15.0 minutes (the Disturbance Recovery Period) to return its Area Control Error to the lesser of zero or the pre-disturbance Area Control Error level. MISO currently allows five minutes to notify Resources to deploy Contingency Reserve after the occurrence of a disturbance which requires a Contingency Reserve Deployment Instruction. Therefore, MISO will set the Contingency Reserve Deployment Period at 10.0 minutes, which is the difference between the Disturbance Recovery Period (15.0 minutes) and the notification time (5.0 minutes).
- Contingency Reserve will be comprised of Spinning Reserve and Supplemental Reserve. Spinning Reserve is Contingency Reserve supplied from Spin Qualified Resources whereas Supplemental Reserve is Contingency Reserve supplied from Supplemental Qualified Resources that are not Spin Qualified Resources. However, it

is important to note that Spin Qualified Resources may supply Supplemental Reserve through product substitution.

3.2.2 Market-Wide Contingency Reserve Requirements

MISO sets the Market-Wide Contingency Reserve Requirements based upon the following criteria:

- Hourly requirements will apply to both the Day-Ahead and Real-Time Energy and Operating Reserve Markets.[4] The MISO Market-Wide Contingency Reserve Requirement may be adjusted anytime following the posting of the requirements 48 hours prior to the Operating Day if necessary due to changing reliability requirements, such as loss of most severe system contingency and MISO, in such cases, will post the revised requirements as quickly as possible.
- The hourly MISO Market-Wide Contingency Reserve Requirement will be set equal to the most restrictive requirement mandated by Electric Reliability Organization standards, applicable Regional Entity standards or applicable Contingency Reserve Sharing Agreement requirement allocations. In no case will the hourly MISO Market-Wide Contingency Reserve Requirement be set less than the largest single supply contingency (Resource or transmission). Currently, Electric Reliability Organization Standard BAL-002-3 indicates that, *"Each Responsible Entity shall develop, review and maintain annually, and implement an Operating Process as part of its Operating Plan to determine its Most Severe Single Contingency and make preparations to have Contingency Reserve equal to, or greater than the Responsible Entity's Most Severe Single Contingency available for maintaining system reliability".* The MISO Market-Wide Contingency Reserve requirement may be adjusted after the close of the Day-Ahead Energy and Operating Reserve Market for the Real-Time Energy and Operating Reserve Market if one or more events result in a different requirement level.
- The hourly Market-Wide Spinning Reserve requirement will be equal to the greater of i) the most restrictive frequency responsive Contingency Reserve requirement, expressed in MW or as a percent of Contingency Reserve, specified by Electric Reliability Organization standards, applicable Regional Reliability Organization standards and/or applicable Contingency Reserve Sharing Agreements or ii) the most restrictive spinning reserve requirement, expressed in MW or as a percent of Contingency Reserve, specified by Electric Reliability Organization standards,

applicable Regional Reliability Organization standards and/or applicable Contingency Reserve Sharing Group agreements.

- Electric Reliability Organization Standard BAL-002-3 indicates that, following a supply contingency, a Balancing Authority or Reserve Sharing Group must restore their Contingency Reserve within the Contingency Reserve Restoration Period, which is (defined in NERC's Glossary of Terms as) the 90 minute period following the end of the Contingency Event Recovery Period. After the Contingency Reserve Restoration Period expires, the Real-Time Energy and Operating Reserve Market will restore the Market-Wide Contingency Reserve Requirement back to its pre-disturbance level. However, should there be capacity available to clear additional Market-Wide Contingency Reserve, the Real-Time Energy and Operating Reserve Market will clear additional Market-Wide Contingency Reserve up to the pre-disturbance Market-Wide Contingency Reserve requirement prior to the end of the Contingency Reserve Restoration Period.

3.3 Reserve Zone Establishment and Zonal Operating Reserve Requirements

MISO establishes and reconfigures Reserve Zone boundaries and sets the minimum Operating Reserve requirements for each Reserve Zone based upon the follow methodology:

3.3.1 Method to Establish Reserve Zones

One or more Reserve Zones will be established to ensure Regulating Reserve, Contingency Reserve and Short-Term Reserve are dispersed in a manner that prevents adverse operating conditions that affect the reliability of the Transmission System. Reserve Zone Configuration Studies will be performed, as described below, on a quarterly basis, in conjunction with the update of the Network Model, except as provided for under Section 3.3.1, Method to Establish Reserve Zones. Reserve Zone Configuration Studies establish the number of Reserve Zones and the assignment of Resource, Load and/or Interface Elemental Pricing Nodes to specific Reserve Zones concurrent with the update of the Network Model until the next scheduled update of the Network Model and results will be available to Market Participants electronically through downloadable files no less than seven (7) days prior to the date on which the new or reconfigured Resource Zones take effect, except as provided for under Section 3.3.1. It is important to note that due to the physical characteristics of Stored Energy Resources, the Regulating Reserve

cleared on Stored Energy Resources is ineligible to satisfy Zonal Regulating Reserve Requirements.

In performing Reserve Zone Configuration Studies, MISO applies the following process to establish the Reserve Zones and assign Resource, Load and/or Interface Elemental Pricing Nodes to specific Reserve Zones:

- Utilizing a Network Model representation within the Reserve Zone study software for the target study period, identify all transmission constraints that could occur through Resource re-dispatch. Transmission constraint identification will include consideration of projected system demands and planned generation and transmission outages for the period;
- This list of transmission constraints is then screened to limit the applicable transmission constraints to only those that will have a significant impact on the Reserve Zone determination based on projected system demands and planned generation and transmission outages for the period;
- Once a final set of transmission constraints is identified, Resource, Load, and/or Interface Elemental Pricing Nodes are grouped based on similar impact on all of the remaining transmission constraints. The groups of Resource, Load and Interface Elemental Pricing Nodes represent the Reserve Zones. Multiple Resources and/or Loads normally connected at the same Elemental Pricing Nodes will all be included within a single Reserve Zone.
- Lastly, all remaining Resource, Load and Interface Elemental Pricing Nodes not assigned specifically through the Reserve Zone Configuration Study are assigned to a separate Reserve Zone that represents the remaining part of the system Reserve Zone Reconfiguration

MISO may adjust the number of Reserve Zones and/or the assignment of Resource, Load and/or Interface Elemental Pricing Nodes to specific Reserve Zones as required if:

- A condition or event occurs, including, but not limited to, an unplanned transmission facility outage, a Generator Forced Outage, or an event of Force Majeure, as defined in Section 10.1 of the Tariff;
- Such condition or event results in an adverse reliability condition that cannot be resolved through operating procedures;
- Such condition or event has a projected duration of two or more Operating Days and;

- MISO determines such adjustment is necessary to ensure the reliability of the Transmission System.

The duration of any Reserve Zone adjustment will coincide with the duration of the condition or event, or until the next quarterly Reserve Zone Configuration Study update, whichever is less. MISO will publish a notice on OASIS identifying the reasons for any such Reserve Zone adjustment, and the expected duration. MISO will not implement an adjustment to a Reserve Zone without a minimum of a forty-eight (48) hour notice prior to the Operating Day for which the Reserve Zone adjustment will apply.

3.3.2 Method to Establish Minimum Co-Optimized Zonal Operating Reserve Requirements

MISO identifies the minimum Co-Optimized Zonal Operating Reserve Requirements as the minimum amount of Contingency Reserve needed within a Reserve Zone as determined by co-optimization with Post Reserve Deployment Constraints. The Post Reserve Deployment Constraints are the post zonal Operating Reserve deployment flows on the transmission constraints, used to determine the Co-optimized Zonal Regulating Reserve Requirement, Co-optimized Zonal Contingency Reserve Requirement, and Co-optimized Zonal Spinning Reserve Requirement, for each Reserve Zone. Post Reserve Deployment Constraints are valued at the Post Reserve Deployment Constraints Demand Curves as defined in MISO Tariff Schedule 28C.

3.4 Ramp Capability Product

The Ramp Capability product is described in the following subsections.

3.4.1 Ramp Capability Product Description

The Ramp Capability Product is cleared in the Day-Ahead or Real-Time Energy and Operating Reserve Markets to reserve ramp capability to respond to net load variations and includes the following features:

- The Up Ramp Capability and Down Ramp Capability requirements are designed to model both the expected net energy demand change and additional uncertain variation across all market processes and across different system operational conditions at a system level (zonal values will be calculated).
- The contribution of a resource to the ramp capability constraint is limited by its operating limits and its ramp rate over the modeled deployment time. No MP offer price

is needed. MPs will be able to indicate their offered dispatch status as either "Economic" or "Not Participating".

- Ramp capability is not explicitly "deployed." Rather Ramp Capability prepositions resources so that adequate ramp is available in subsequent dispatch intervals. Ramp Capability Requirement Demand Curve will enforce this constraint as a soft constraint. Cleared amounts will be reduced if the cost of violation is lower than the cost of economically dispatching energy to meet the Ramp Capability Requirement. The ramp capability product demand curves allow for relaxation for the ramp requirements at a relatively low cost when the resource ramping capability needs to be used in the current interval dispatch.
- Zonal ramp capability requirements are not required since post-deployment constraints ensure that the cleared ramp capability is deliverable to the load without violating transmission constraints after deployments. Although zonal requirements are not decided by the market clearing process and not a direct input, there may be pricing differences as determined by the post-deployment transmission constraints.
- Demand curves for the Up Ramp Capability and Down Ramp Capability products are defined which represent the value for the ramp capability service and provide a mechanism for limiting the clearing of ramp capability and the associated impact on prices when ramp capability is in short supply, e.g., when maintaining the ramp capability is infeasible or unduly expensive. Refer to the MISO Tariff Schedule 28 for more information about the ramp capability demand curve.
- The ramp capability constraints are added to the simultaneous co-optimization of the existing energy and Ancillary Services. The modeled costs include the re-dispatch opportunity cost associated with providing the ramp capability and the existing products and the demand curves for Up and Down Ramp Capabilities. When the ramp capability is "deployed" as energy dispatch during a subsequent Real-Time Dispatch, the simultaneous co-optimization of all products will select the most economical resources to respond with changes in energy output and to fulfill operating reserve and ramp capability requirements.

3.4.2 Ramp Capability Requirements

MISO sets the System-Wide Up and Down Ramp Capability Requirements based upon the following components:

- Net Load Uncertainty is a calculated value based on load forecast error, wind generation forecast errors and dispatchable resources not following set points. This calculated value is fixed for the up and down directions and applies to all case types for all intervals in the Day Ahead and Real Time Markets.
- Net Load Change is a calculated value based on load forecast change, wind generation change and NSI change. The Real-Time Market uses a deploy time window of 10 minutes. The Day-Ahead Market and other forward processes scale the 10 minute window used in real-time to a deploy time window of one hour.

3.5 Short-Term Reserve Product

The Short-Term Reserve product is described in the following subsections.

3.5.1 Short-Term Reserve Product Description

The Short-Term Reserve Product is cleared in the Day-Ahead or Real-Time Energy and Operating Reserve Markets to reserve 30-minute flexible capacity and includes the following features:

- It can be provided by online or offline resources that can provide energy within the STR deployment period of 30 minutes.
- The product separately addresses market-wide, sub-regional and local short-term reserve needs through a market-wide requirement and Post Reserve Deployment Constraints.
- Online Short-Term Reserve is cleared on an opportunity cost basis and is deployed as energy dispatch. Offline Short-Term Reserve is cleared based on an offer price and requires operator commitment instructions.
- Demand curves for Short-Term Reserve are defined to represent the value of the product. When the cleared Short-Term Reserve level is less than the market-wide requirement, the Market-Wide Short-Term Reserve Demand Curve sets the Market-Wide Short-Term Reserve constraint shadow price as defined in MISO Tariff Schedule 28. Sub-regional and local Short-Term Reserve requirements are established using Post Reserve Deployment Constraints and are valued at the Post Reserve Deployment Constraints Demand Curves as defined in MISO Tariff Schedule 28C.

3.5.2 Short-Term Reserve Requirements

MISO sets the Market-Wide Short-Term Reserve Requirement based on offline analysis. Sub-regional and local Short-Term Reserve requirements are established using Post Reserve

Deployment Constraints. These constraints dynamically determine requirements based on the loss of generation elements and associated change in flow, and the flow limits.

3.6 Load Forecasting

This subsection describes how MISO develops Load Forecasts for use in the Real-Time Energy and Operating Reserve Market.

3.6.1 High Level Description of Load

MISO needs a forecast of Load for the following purposes:

- The RAC process performed each day for the next several days and also for any RAC process performed current day for future hours of that day
- The LAC process performed for the rolling future hours
- The Real-Time 5-minute dispatch

The values that the Load Forecast represents for each of these purposes are the same and conceptually can be defined as follows:

- ***MISO Forecast Load:*** The Load (including losses) within the telemetered boundary of the MISO LBA members. This includes any Load served "Behind-the-Meter" where the Load and Generation Resources are explicitly modeled in the Network Model for reliability purposes. Load served by generation that MISO has not explicitly modeled in the Network Model is excluded[4].

MISO needs this Load to be at LBA granularity. The definition for the LBA forecast Load is as follows:

- ***Local Balancing Authority Forecast Load:*** The Load (including losses) within the telemetered boundary of a MISO LBA member. This includes any Load served Behind-the-Meter where the Load and generation are explicitly modeled in the Network Model

[4] Note that MISO uses ICCP Load data from its members to assist in producing the 5-minute Load Forecast. To be consistent with this definition, the ICCP Load value received from the LBAs should include Load served by generation behind the meter where the generation is included in the MISO Network Model. The forecast Load received from LBAs should also include this Load served by generation behind the meter where the generation is included in the Network Model. Load associated with a DRR-Type I should be submitted on a net basis (i.e., a host DRR-Type I Load of 50 MW that has a DRR-Type I Targeted Demand Reduction Level of 20 MW, should submit a 30 MW Load Forecast for hours in which the DRR-Type I is committed, assuming the load reduction actually occurs).