MRP Implementation: Summary of Batch 3 Market Rules for Calculation Engines

In order to facilitate the implementation of the Market Renewal Program (MRP), changes are required to the *market rules*. Due to the volume and complexity of changes anticipated in MRP, the *IESO* is releasing changes by 'batches'. This document describes the changes in the Calculation Engines batch.

Calculation Engines Changes

Changes to Market Rules

Appendix 7.5A – The DACP Calculation Engine Process of Chapter 7 of the *market rules* is being superseded by Appendix 7.1A – The Day-Ahead Market Calculation Engine.

Appendix 7.5 – The Market Clearing and Pricing Process of Chapter 7 of the *market rules* is being superseded by Appendix 7.2A – The Pre-Dispatch Market Calculation Engine and Appendix 7.3A – The Real-Time Calculation Engine.

A series of new definitions were added to chapter 11 of the *market rules* to facilitate the new procedures related to the three *calculation engines*. Some existing definitions were modified to align with market design under MRP. Some existing definitions were deleted as they were associated with procedures that are being superseded by the new *calculation engine* procedures.

When navigating the defined terms contained in the three sets of *calculation engine market rule* amendments, please refer to the following documents:

- MR-00461-R00: Market Renewal Program - Batch 1 Definitions;
- MR-00461-R01 - Market Power Mitigation: Batch 2 Definitions;
- MR-00461-R02: Market Renewal Program: Calculation Engines: Batch 3 Definitions;
- Existing Chapter 11 Definitions.

Summary of New Market Rules for Appendix 7.1A (The Day Ahead Market Calculation Engine Process): February 2022

Appendix 7.1A (Day-Ahead Market)		
Section	**Topic**	**Description**
1	Appendix 7.1A – The Day-Ahead Market Calculation Engine Process	Identifies the purpose of the appendix.
2	Day-Ahead Market (DAM) Calculation Engine	Subsections identify the three pass structure of the *day-ahead market calculation engine*.
3	Information Used by the Day-Ahead Market Calculation Engine	Subsections identify the information provided to the *day-ahead market calculation engine* by upstream processes in accordance with section 3A.1 (new) of Chapter 7 which will be part of the Market and System Operations batch of draft *market rule* amendments.
4	Sets, Indices and Parameters Used in the Day-Ahead Market Calculation	Subsections define the mathematical notations, used by the DAM scheduling and pricing algorithms, that correspond to resource-specific data, *IESO* input data, and data derived by the *day-ahead market calculation engine*.
5	Initialization	Subsections define the set-up procedures that must be performed prior to the execution of the *day-ahead market calculation engine*.
6	Security Assessment Function	Subsections describe the role of the *security* assessment function, how it interacts with the scheduling and pricing algorithms and the analysis it performs. Includes references to section 3A.1 (new) of Chapter 7, which will be part of the Market and System Operations batch of draft *market rule* amendments.

Appendix 7.1A (Day-Ahead Market)		
Section	**Topic**	**Description**
7	Pass 1: Market Commitment and Market Power Mitigation Pass	Provides an overview of the scheduling and pricing algorithms, and ex-ante market power mitigation executed by Pass 1 as described in sections 8 through 16.
8	As-Offered Scheduling	Subsections describe the optimization to determine initial *resource* schedules.
9	As-Offered Pricing	Subsections describe the optimization to determine initial prices. The optimization differs from As-Offered Scheduling in that some *resource* schedules and commitments from As-Offered Scheduling are used as inputs and additional constraints are used for price-setting eligibility purposes.
10	Constrained Area Conditions Test	Subsections describe the first test for the ex-ante mitigation process, identifying when and where competition is restricted and determining which *resource*s will undergo the Conduct Test described in section 11.
11	Conduct Test	Subsections describe the second test for the ex-ante mitigation process, determining which *resources* indentified by the Constrained Area Conditions Test shall have their financial dispatch data parameters replaced with corresponding reference level values in Reference Level Scheduling and Reference Level Pricing.
12	Reference Level Scheduling	Subsections describe the optimization to determine schedules used in Reference Level Pricing. The optimization is similar to the As Offered Scheduling algorithm in section 8, using *reference level values* for *resources* that failed the Conduct Test in section 11.

Appendix 7.1A (Day-Ahead Market)		
Section	**Topic**	**Description**
13	Reference Level Pricing	Subsections describe the optimization to determine prices used for the Price Impact Test in section 14. The optimization is similar to the As-Offered Pricing algorithm in section 9, using reference level values for *resources* that failed the Conduct Test in section 11.
14	Price Impact Test	Subsections describe the third and final test for the ex-ante mitigation process, comparing prices from As-Offered Pricing and Reference Level Pricing to determine which *resources* will have their *financial dispatch data parameters* replaced with corresponding *reference level values* in Mitigated Scheduling and Mitigated Pricing.
15	Mitigated Scheduling	Subsections describe the final optimization for the ex-ante market power mitigation process to determine schedules used for Pass 2. The optimization is similar to the As Offered Scheduling algorithm in section 8, using *reference level values* for *resources* that failed the Price Impact Test in section 14.
16	Mitigated Pricing	Subsections describe the final optimization for the ex-ante market power mitigation process to determine prices used for Pass 2. The optimization is similar to the As Offered Pricing algorithm in section 9, using *reference level values* for *resources* that failed the Price Impact Test in section 14.
17	Pass 2: Reliability Scheduling and Commitment	Identifies that Pass 2 only includes the execution of the Reliablity Scheduling alogirthm described in section 18.
18	Reliability Scheduling	Subsections describes the optimization to determine whether additional *resource*

Appendix 7.1A (Day-Ahead Market)		
Section	**Topic**	**Description**
		commitments are required to meet peak demand. Additional constraints are used to respect the schedules and commitments from Pass 1.
19	Pass 3: DAM Scheduling and Pricing	Provides an overview of the final scheduling and pricing algorithms executed by Pass 3 as described in sections 20 and 21.
20	DAM Scheduling	Subsections describe the optimization to determine final DAM schedules. The optimization is similar to the As Offered Scheduling algorithm in section 8, using *reference level values* for *resources* that failed the Price Impact Test in section 14 and any additional *resource* commitments from Pass 2.
21	DAM Pricing	Subsections describe the optimization to determine final DAM prices. The optimization is similar to the As Offered Pricing algorithm in section 9, using *reference level values* for *resources* that failed the Price Impact Test in section 14, any additional *resource* commitments from Pass 2, and some *resource* schedules from DAM Scheduling.
22	Pseudo-Unit Modelling	Subsections describe the conversion of physical *resource* constraints to *pseudo-unit* equivalents for the *day-ahead market calculation engine* to evaluate *pseudo-units* in all passes, and to convert *pseudo-unit* schedules to their physical *resource* equivalents.
23	Pricing Formulas	Subsections describe the pricing formulas used to calculate DAM *locational marginal prices* and their components, *virtual transaction zone* prices and the *Ontario zonal price*, subject to *settlement* bounds.

Summary of New Market Rules for Appendix 7.2A (The Pre-Dispatch Calculation Engine Process): February 2022

Appendix 7.2A (Pre-Dispatch)		
Section	**Topic**	**Description**
1	Appendix 7.2A – The Calculation Engine Process	Identifies the purpose of the appendix.
2	Pre-Dispatch (PD) Calculation Engine	Subsections identify the single pass structure of the *pre-dispatch calculation engine* and define the changing time horizon of the PD look ahead period.
3	Information Used in the Pre-Dispatch Calculation Engine	Subsections identify the information provided to the *pre-dispatch calculation engine* by upstream processes in accordance with section 3A.1 (new) of Chapter 7, which will be part of the Market and System Operations batch of draft *market rule* amendments.
4	Sets, Indices and Parameters Used in the Pre-dispatch Calculation Engine	Subsections define the mathematical notations, used by the PD scheduling and pricing algorithms, that correspond to *resource* specific data, *IESO* input data and data derived by the *pre-dispatch calculation engine*.
5	Initialization	Subsections define the set-up procedures that must be performed prior to the execution of the *pre-dispatch calculation engine*. Those unique to the *pre-dispatch calculation engine* include initialization of data when the PD look ahead period spans two *dispatch days*.
6	Security Assessment Function in the Pre-dispatch Calculation Engine	Subsections describe the role of the security assessment function, how it interacts with the scheduling and pricing algorithms and the analysis it performs. Includes references to section 3A.1 (new) of Chapter 7, which will be part of the Market and System Operations batch of draft *market rule* amendments.

Appendix 7.2A (Pre-Dispatch)		
Section	**Topic**	**Description**
7	Pass 1: Pre-Dispatch Scheduling Process	Provides an overview of the scheduling and pricing algorithms, and ex-ante market power mitigation executed by Pass 1 as described in sections 8 through 14.
8	Pre-Dispatch Scheduling	Subsections describe the optimization to determine initial schedules. Subject to ex-ante market power mitigation, these schedules will be the final *pre-dispatch schedules*.
9	Pre-Dispatch Pricing	Subsections describe the optimization to determine initial prices. Subject to ex-ante market power mitigation, these prices will be the final pre-dispatch prices. The optimization differs from Pre-Dispatch Scheduling in that some *resource* schedules and commitments from Pre-Dispatch Scheduling are used as inputs and additional constraints are used for price-setting eligibility purposes.
10	Constrained Area Conditions Test	Subsections describe the first test for the ex-ante mitigation process, identifying when and where competition is restricted and determining which *resources* will undergo the Conduct Test described in section 11.
11	Conduct Test	Subsections describe the second test for the ex-ante mitigation process, determining which *resources* identified by the Constrained Area Conditions Test shall have their *financial dispatch data parameters* replaced with corresponding *reference level values* in Reference Level Scheduling and Reference Level Pricing.
12	Reference Level Scheduling	Subsections describe the optimization to determine schedules used for in Reference Level Pricing. The optimization is similar to the Pre-Dispatch Scheduling algorithm in section 8, using *reference level values* for *resources* that failed the Conduct Test in section 11 and failed the Price Impact Test from previous *pre-dispatch calculation engine* runs.

Appendix 7.2A (Pre-Dispatch)		
Section	**Topic**	**Description**
13	Reference Level Pricing	Subsections describe the optimization to determine prices used for the Impact Test in section 14. The optimization is similar to the Pre-Dispatch Pricing algorithm in section 9, using *reference level values* for *resources* that failed the Conduct Test in section 11 and failed the Price Impact Test from previous *pre-dispatch calculation engine* runs.
14	Price Impact Test	Subsections describe the third and final test for the ex-ante mitigation process, comparing prices from Pre-Dispatch Pricing and Reference Level Pricing to determine which *resources* will have their *financial dispatch data parameters* replaced with corresponding *reference level values* in subsequent runs of the *pre-dispatch calculation engine*.
15	Pseudo-Unit Modelling	Subsections describe the conversion of physical *resource* constraints to *pseudo-unit* equivalents for the *pre-dispatch calculation engine* to evaluate *pseudo-units*, managing steam turbine *forced outages*, and converting *pseudo-unit* schedules to their physical *resource* equivalents. *Pseudo-unit* modelling features unique to the *pre-dispatch calculation engine* include application of *single cycle mode* when the PD look ahead period spans two *dispatch days*.
16	Pricing Formulas	Subsections describe the pricing formulas used to calculate PD *locational marginal prices* and their components, *virtual transaction zone* prices, prices for islanded nodes, and the *Ontario zonal price*, subject to *settlement* bounds.

Summary of New Market Rules for Appendix 7.3A (The Real-Time Calculation Engine Process): February 2022

Appendix 7.3A (Real-Time)		
Section	**Topic**	**Description**
1	Appendix 7.3A – The Real-Time Calculation Engine Process	Identifies the purpose of the appendix.
2	Real-Time (RT) Calculation Engine	Subsections identify the single pass structure of the *real-time calculation engine* and define time horizon of the RT look ahead period.
3	Information Used by the Real-Time Calculation Engine	Subsections identify the information provided to the *real-time calculation engine* by upstream processes in accordance with section 3A.1 (new) of Chapter 7, which will be part of the Market and System Operations batch of draft *market rule* amendments.
4	Sets, Indices and Parameters Used by the Real-Time Calculation Engine	Subsections define the mathematical notations, used by the RT scheduling and pricing algorithms, that correspond to *resource*-specific data, *IESO* input data and data derived by the *real-time calculation engine*.
5	Initialization	Subsections define the set-up procedures that must be performed prior to the execution of the *real-time calculation engine*. Those unique to the *real-time calculation engine* include initialization of data based on values from the *IESO*'s *energy* management system.
6	Security Assessment Function in the Real-Time Calculation Engine	Subsections describe the role of the *security* assessment function, how it interacts with the scheduling and pricing algorithms and the analysis it performs. Includes references to section 3A.1 (new) of Chapter 7, which will be part of the Market and System Operations batch of draft *market rule* amendments.
7	Pass 1: Real-Time Scheduling and Pricing	Provides an overview of the scheduling and pricing algorithm executed by Pass 1 as described in sections 8 and 9.

Appendix 7.3A (Real-Time)		
Section	**Topic**	**Description**
8	Real-Time Scheduling	Subsections describe the optimization to determine real-time schedules, subject to ex-ante market power mitigation decisions from the *pre-dispatch calculation engine*.
9	Real-Time Pricing	Subsections describe the optimization to determine real-time prices, subject to ex-ante market power mitigation decisions from the *pre-dispatch calculation engine*. The optimization differs from Real-Time Scheduling in that some *resource* schedules from Real-Time Scheduling are used as inputs and additional constraints are used for price-setting eligibility purposes.
10	Pseudo-Unit Modelling	Subsections describe the conversion of physical *resource* constraints to *pseudo-unit* equivalents for the *real-time calculation engine* to evaluate *pseudo-units*, managing steam turbine *forced outages*, and converting *pseudo-unit* schedules to their physical *resource* equivalents. *Pseudo-unit* modelling features unique to the *real-time calculation engine* include determining effective *pseudo-unit* values from the *IESO*'s *energy* management system values for the corresponding physical *resources*.
11	Pricing Formulas	Subsections describe the pricing formulas used to calculate RT *locational marginal prices* and their components, *virtual transaction zone* prices, prices for islanded nodes, and the *Ontario zonal price*, subject to *settlement* bounds.

Appendix 7.1A (The Day Ahead Market Calculation Engine Process)
Summary of Market Rule Updates: July 2022

Appendix 7.1A (Day-Ahead Market)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
Appendix 7.1A – to be renumbered to Appendix 7.5		Appendix Reference Number	Editorial	The reference number for Appendix 7.1A – The Day-Ahead Calculation Engine has been changed to Appendix 7.5. The re-use of Appendix 7.5 will reduce the instances of "Intentionally left blank – section deleted" instances throughout the *market rules*. Existing Appendix 7.5 – The Market Clearing and Pricing Process will be deleted in its entirety. This change was made in response to internal feedback.
	4.2.2.10, 4.2.2.11, 4.2.2.12, 4.2.2.13, 4.2.2.14, 4.2.9.10, 4.2.9.11, 4.2.9.12, 4.2.9.13	Market Participant Data Parameters	Modification	Clarified the definition of URRDGb, DRRDGb, URRDLb and DRRDLb to reflect multiple ramp rate values. This content was updated in response to stakeholder feedback from OPG (comment ID1).
	4.3.8.22	IESO Data Parameters	Editorial	Corrected a typographical error and replaced the broad constrained area threshold from "200%" to "300%," as per the detailed design.

Appendix 7.1A (Day-Ahead Market)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
				This change was made in response to internal feedback.
	4.3.8.32, 4.3.8.38, 4.3.8.39	Ex-Ante Market Power Mitigation	Editorial	Corrected typographical errors and replaced "thershold" with "threshold."
	8.3.1.12, 9.2.1.1, 13.2.1.1, 16.2.1.1, 18.2.1.1.2, 21.2.1.1	Variables and Objective Function/ Information, Sets, Indices and Parameters	Modification	Added MinQDGCb to the definition of the SDG variable to clarify that the SDG quantity referes to *energy* scheduled above a *resource's minimum loading point*. This content was updated in response to stakeholder feedback from OPG (comment ID 11B).
	8.6.1.1, 8.6.1.2	Dispatch Data Inter-Hour/Multi-Hour Constraints	Modification	Modified section 8.6.1.1 and inserted section 8.6.1.2 to reflect that multiple ramp rates are evaluated in the *day-ahead market calculation engine* . This content was updated in response to stakeholder feedback from OPG (comment ID 14A).
	10.5.2	Constrained Area Conditions Test for Global	Modification	Moved the contents of section 10.5.2.2.2 within section 10.5.2.1. This content was updated in response to stakeholder

Appendix 7.1A (Day-Ahead Market)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
		Market Power (Energy)		feedback from OPG (comment ID 6).
	10.7.1	Constrained Area Conditions Test for Global Market Power (Operating Reserve)	Editorial	Updated to replace "if" with "where." This change was made in response to internal feedback.
	10.7.2	Constrained Area Conditions Test for Global Market Power (Operating Reserve)	Editorial	Updated to correct typographical error – replaced "pre-dispatch" with "*day-ahead market*." This content was updated in response to stakeholder feedback from OPG (comment ID 7).

Appendix 7.2A (The Pre-Dispatch Calculation Engine Process)
Summary of Market Rule Updates: July 2022

Appendix 7.2A (Pre-Dispatch)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
Appendix 7.2A– to be renumbered to Appendix 7.5A		Appendix Reference Number	Editorial	The reference number for Appendix 7.2A – The Pre-Dispatch Calculation Engine has been changed to Appendix 7.5A. The re-use of Appendix 7.5A will reduce the instances of "Intentionally left blank – section deleted" instances throughout the market rules. Existing Appendix 7.5A – The DACP Calculation Engine Process will be deleted in its entirety. This change was made in response to internal feedback.
	2.1.1.1	Pre-Dispatch Look-Ahead Period	Editorial	Corrected a typographical error and replaced the *pre-dispatch calculation engine* start time from "1:00" to "00:00" EST. This content was updated in response to stakeholder feedback from OPG (comment ID9).
	4.2.2.10, 4.2.2.11, 4.2.2.12, 4.2.2.13, 4.2.2.14, 4.2.9.10, 4.2.9.11,	Market Participant Data Parameters	Modification	Clarified the definition of URRDGb, DRRDGb, URRDLb and DRRDLb to reflect multiple ramp rate values. This content was updated in response to stakeholder

Appendix 7.2A (Pre-Dispatch)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
	4.2.9.12, 4.2.9.13,			feedback from OPG (comment ID1).
	4.3.9.22	IESO Data Parameters	Editorial	Corrected a typographical error and replaced the broad constrained area threshold from "200%" to "300%," as per the detailed design. This change was made in response to internal feedback.
	8.3.1.10, 9.2.1.1, 13.2.1.1	Variables and Objective Function/ Information, Sets, Indices and Parameters	Modification	Added MinQDGCb to the definition of the SDG variable to clarify that the SDG quantity referes to *energy* scheduled above a *resource's minimum loading point*. This content was updated in response to stakeholder feedback from OPG (comment ID 11B).
	8.6.1.1, 8.6.1.2	Dispatch Data Inter-Hour/ Multi-Hour Constraints	Modification	Modified section 8.6.1.1 and inserted section 8.6.1.2 to reflect that multiple ramp rates are evaluated in the *pre-dispatch calculation engine* . This content was updated in response to stakeholder feedback from OPG (comment ID 14A).

Appendix 7.2A (Pre-Dispatch)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
	10.5.2	Constrained Area Conditions Test for Global Market Power (Energy)	Modification	Moved the contents of section 10.5.2.2.2 within section 10.5.2.1. This content was updated in response to stakeholder feedback from OPG (comment ID 6).

Appendix 7.3A (The Real-Time Calculation Engine Process)
Summary of Market Rule Updates: July 2022

Appendix 7.3A (Real-Time)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
Appendix 7.3A – to be renumbered to Appendix 7.6		Appendix Reference Number	Editorial	The reference number for Appendix 7.3A – The Real-Time Calculation Engine has been changed to Appendix 7.6. The re-use of Appendix 7.6 will reduce the instances of "Intentionally left blank – section deleted" instances throughout the market rules. Existing Appendix 7.6 – Local Market Power will be deleted in its entirety. This change was made in response to internal feedback.
	4.2.2.1, 4.2.2.15, 4.2.7, 4.2.7.14	Market Participant Data Parameters	Modification	Removed the 'maximum' descriptor to clarify the definitions of DRRDG, URRDG, DRRDL and URRDL to reflect multiple ramp rate values. This content was updated in response to stakeholder feedback from OPG (comment ID1).
	5.6.2.1.4	Initial Scheduling Assumptions – Start-up and Shutdown for Non-Quick Start Resources	Modification	Clarified the definition of EvalSD to indicate that the *resource* can be evaluated for *energy* schedules below its *minimum loading point* but can still be scheduled at or above its *minimum loading point.* This content was updated in response to stakeholder

Appendix 7.3A (Real-Time)				
Chapter	**Section**	**Topic**	**Type of Change**	**Description**
				feedback from OPG (comment ID12).
	8.6.1.1, 8.6.1.2	Dispatch Data Inter-Hour/ Multi-Hour Constraints	Modification	Modified section 8.6.1.1 and inserted section 8.6.1.2 to reflect that multiple ramp rates are evaluated in the *real-time calculation engine* . This content was updated in response to stakeholder feedback from OPG (comment ID 14A).
	10.1.4.2	Pseudo-Unit Model Parameters	Editorial	Corrected section numbers under section 10.1.4.2. This change was made in response to internal feedback.
	10.6.4.8	Conversion of Pseudo-Unit Schedules to Physical Resource Schedules	Editorial	Corrected a typographical error and replaced the term (STP30N_i,k) after the summation operation to (STP30R_i,k). This change was made in response to internal feedback.
	11.3.2.1.12	Energy Locational Marginal Prices for Intertie Metering Points	Editorial	Deleted the definition for $PRef_i^1$ which is already defined in section 11.3.1.1.2. This change was made in response to internal feedback.