Market Rule Amendment Proposal Form

Part 1 - Market Rule Information

Identification No.:	MR-00490-R00
Subject:	Adjustments to Real-Time Make-Whole Payments
Title:	Adjustments to Real-Time Make-Whole Payments
Nature of Proposal:	☒ Alteration ☐ Deletion ☒ Addition
Chapter:	Ch. 7 App.7.8, Ch. 9
Appendix:	Appendix 7.8
Sections:	App.7.8 s.4.4, Ch.9 s.3.5
Sub-sections proposed for amending:	Various
Current Market Rules Baseline:	54.1

Part 2 - Proposal History

Version	Reason for Issuing	Version Date
1.0	Draft for Stakeholder Review	December 4, 2025
2.0	Draft for Technical Panel Review	January 6, 2026

Approved Amendment Publication Date:

Approved Amendment Effective Date:

Part 3 - Explanation for Proposed Amendment

Provide a brief description that includes some or all of the following points:

- The reason for the proposed amendment and the impact on the *IESO-administered markets* if the amendment is not made.
- Alternative solutions considered.
- The proposed amendment, how the amendment addresses the above reason and impact of the proposed amendment on the *IESO-administered markets*.

Summary

The IESO proposes to amend the market rules to address unwarranted make-whole payments (MWPs) related to the following circumstances:

1- Lost Opportunity Cost (LOC) and forbidden regions of hydro-electric resources;
2- Operating Reserve (OR) ramping in LOC Economic Operating Point (EOP) calculations; and
3- Real-Time Make-Whole Payments (RT-MWPs) that are not offsetting amongst energy and OR products.

Further information can be found on the Adjustments to Real-Time Make-Whole Payments stakeholder engagement webpage.

Background

The ongoing monitoring and review of the renewed market has identified specific RT-MWP circumstances under which unwarranted MWPs are calculated. These are very specific and limited circumstances and only became apparent after the renewed market "go-live" and relate to the interaction between payments for Energy and OR.

The IESO is proposing targeted corrections to the formulas in the market rules and Charge Types and Equations, to ensure continued accuracy and consistency.

Discussion

Item 1: Lost Opportunity Cost (LOC) and Forbidden Regions

Some hydro-electric resources have forbidden regions in which they cannot maintain steady operation without equipment damage and can only ramp through. These forbidden regions are correctly considered in dispatch schedules but not when determining the EOPs upon which MWPs are based. The result is that the EOPs can be physically unattainable for the purpose of calculating the MWP. To ensure that MWP are based on physically achievable operations, there is a settlement process that subtracts out the portion of the MWP resulting from an energy schedule in a forbidden region or at the upper boundary. However, this settlement process does not exist for the Operating Reserve Lost Opportunity Cost MWP (OR LOC MWP) calculations when the energy schedule is in a forbidden region or at the upper boundary, resulting in unwarranted MWPs.

Corrections required: In the market rules, update the calculation for real-time LOC for OR to exclude the forbidden region for OR. A similar change is needed in Charge Types and Equations (CT 1905, 1906 and 1907), along with rounding conventions for the new equations:

- MR Ch.9 s.3.5.6d: Update the real-time LOC for OR (RT_OLOCk,h m,t) to exclude the forbidden region for OR (RT_OR_FROP_$LOCr$,k,h m,t);
- MR Ch.9 s.3.5.6.3: New formula that calculates (RT_OR_FROP_$LOCr$,k,h m,t), which represents the portion of the OR LOC MWP resulting from an energy schedule in a forbidden region or at the upper boundary.

Item 2: Operating Reserve ramping in LOC Economic Operating Point (EOP) Calculations

There is an inconsistency between the OR ramp constraints in the dispatch scheduling and optimization (DSO) and the EOP Calculation Engine. This inconsistency results in overstating LOC OR EOPs beyond what resources can be scheduled to. The result is inappropriate LOC MWPs.

Corrections required: Include the ramping constraints that are in the real-time calculation engine (Chapter 7 App 7.6 s.8.6.3) into the constraints section of the EOP calculations (Chapter 7 App 7.8 s.4.4):

- MR Ch.7 App.7.8 s.4.4.25: New section that introduces a constraint to recognize interval-to-interval changes in the energy schedule that may modify the amount of OR that a dispatchable generation resource or a dispatchable load can provide;
- MR Ch.7 App.7.8 s.4.4.26 to 4.4.29: Renumbering of subsequent sections.

Item 3: Make-Whole Payments (MWPs) that are not offsetting amongst energy and OR products

MWPs are intended to keep a market participant whole for following dispatch instructions that are co-optimized across energy, 10S, 10N, and 30R products. The RT-MWP calculation must be congruent to how energy and OR schedules are co-optimized. LOC MWP settlement is ignoring the profit realized for the same capacity in the market. At present, RT-MWP are not correctly netting across products, resulting in market participants being paid for the same MW twice.

Corrections required:

- In the eligibility sections of MR Ch.9 ss.3.5.4.5 to 3.5.4.8, a change is made so that a resource is only ineligible for positive make-whole payment components (ELC, ELOC, OLC, OLOC) to ensure that off-setting occurs when they are negative values;
- Introduce a max function in energy and OR Lost Opportunity Cost calculations to ensure the operating profit based on EOP is always a positive value.

Part 4 - Proposed Amendment

Chapter 7 Appendix 7.8- Economic Operating Point

Constraints for Operating Reserve Ramping

4.4.22 For a *dispatchable resource*, the upper bound of the RT LOC EOP for all classes of *operating reserve* shall be less than or equal to the ~~it~~ *operating reserve* ramp rates as follows:

4.4.22.1 For a *dispatchable generation resource,* for interval $i \in I$ and bus $b \in B^{DG}$:

$$\sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} + \sum_{k \in K_{i,b}^{30R}} ES30RDG_{i,b,k} \leq 30 \cdot ORRDG_b$$

$$\sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} \leq 10 \cdot ORRDG_b$$

4.4.22.2 For a *dispatchable load,* for interval $i \in I$ and bus $b \in B^{DL}$:

$$\sum_{j \in J_{i,b}^{10S}} ES10SDL_{i,b,j} + \sum_{j \in J_{i,b}^{10N}} ES10NDL_{i,b,j} + \sum_{j \in J_{i,b}^{30R}} ES30RDL_{i,b,j} \leq 30 \cdot ORRDL_b$$

$$\sum_{j \in J_{i,b}^{10S}} ES10SDL_{i,b,j} + \sum_{j \in J_{i,b}^{10N}} ES10NDL_{i,b,j} \leq 10 \cdot ORRDL_b$$

4.4.23 For a *dispatchable generation resource* with $RLP10S_{i,b} > 0$, the amount of *ten-minute operating reserve* that a *dispatchable generation resource* is scheduled to provide shall be less than or equal to its *reserve loading point* for *ten-minute operating reserve*:

$$\sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} \leq \left(\sum_{k \in K_{i,b}^{E}} ESDG_{i,b,k} \right) \cdot \left(\frac{1}{RLP10S_{i,b}} \right) \cdot \left(min \left\{ 10 \cdot ORRDG_b, \sum_{k \in K_{i,b}^{10S}} Q10SDG_{i,b,k} \right\} \right)$$

4.4.24 For all *dispatchable generation resources* with $RLP30R_{i,b} > 0$, the amount of *thirty-minute operating reserve* that a *dispatchable generation resource* is scheduled to provide shall be less than or equal to its *reserve loading point* for *thirty-minute operating reserve*:

$$\sum_{k \in K_{i,b}^{30R}} ES30RDG_{i,b,k} \leq \left(\sum_{k \in K_{i,b}^{E}} ESDG_{i,b,k} \right) \cdot \left(\frac{1}{RLP30R_{i,b}} \right) \cdot \left(min \left\{ 30 \cdot ORRDG_b, \sum_{k \in K_{i,b}^{30R}} Q30RDG_{i,b,k} \right\} \right)$$

4.4.25 Constraints shall be applied to recognize that interval to interval changes to a *dispatchable resource's* schedule for *energy* may modify the amount of *operating reserve* that the *resource* can provide.

4.4.25.1 For a *dispatchable generation resource,* for all intervals $i \in I$ and all buses $b \in B^{DG}$:

$$\sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} + \sum_{k \in K_{i,b}^{30R}} ES30RDG_{i,b,k} \leq \sum_{k \in K_{i-1,b}^{E}} ESDG_{i-1,b,k} - \sum_{k \in K_{i,b}^{E}} ESDG_{i,b,k} + 30 \cdot ORRDG_b$$

and

$$\sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} \leq \sum_{k \in K_{i-1,b}^{E}} ESDG_{i-1,b,k} - \sum_{k \in K_{i,b}^{E}} ESDG_{i,b,k} + 10 \cdot ORRDG_b$$

4.4.25.2 For a *dispatchable load,* for all intervals $i \in I$ and all buses $b \in B^{DL}$:

$$\sum_{j\in J_{i,b}^{10S}} ES10SDL_{i,b,j} + \sum_{j\in J_{i,b}^{10N}} ES10NDL_{i,b,j} + \sum_{j\in J_{i,b}^{30R}} ES30RDL_{i,b,j} \leq -\sum_{j\in J_{i-1,b}^{E}} ESDL_{i-1,b,j} + \sum_{j\in J_{i,b}^{E}} ESDL_{i,b,j} + 30\cdot ORRDL_b$$

and

$$\sum_{j\in J_{i,b}^{10S}} ES10SDL_{i,b,j} + \sum_{j\in J_{i,b}^{10N}} ES10NDL_{i,b,j} \leq -\sum_{j\in J_{i-1,b}^{E}} ESDL_{i-1,b,j} + \sum_{j\in J_{i,b}^{E}} ESDL_{i,b,j} + 10\cdot ORRDL_b$$

Constraints for Energy Ramping

4.4.2~~6~~5 With the exception of the first *interval* of each *dispatch day*, the RT LOC EOP shall use its RT LOC EOP for the prior interval as its initial starting point as follows:

4.4.2~~6~~5.1 For a *dispatchable generation resource,* its RT LOC EOP for *energy* cannot vary by more than five minutes of the *resource's energy* ramping capability for interval $i \in I$ and bus $b \in B^{DG}$:

$$ESDGInitSch_{i,b} - 5\cdot DRRDG_{i,b,w} \leq \sum_{k\in K_{i,b}^{E}} ESDG_{i,b,k} \leq ESDGInitSch_{i,b} + 5\cdot URRDG_{i,b,w}$$

4.4.2~~6~~5.2 For a *dispatchable load,* its RT LOC EOP for *energy* cannot vary by more than five minutes of the *resource's* energy ramping capability for interval $i \in I$ and bus $b \in B^{DL}$:

$$ESDLInitSch_{i,b} - 5\cdot DRRDL_{i,b,w} \leq \sum_{j\in J_{i,b}^{E}} ESDL_{i,b,j} \leq ESDLInitSch_{i,b} + 5\cdot URRDL_{i,b,w}$$

Constraints for Pseudo-Units

4.4.2~~7~~6 For a *pseudo-unit,* its RT LOC EOP for *energy* for the *dispatchable* region and duct firing region shall be less than or equal to the respective maximum capabilities for those regions for interval $i \in$ I and bus $b \in B^{PSU}$:

$$\sum_{k \in K_{i,b}^{DR}} ESDG_{i,b,k} \leq MaxDR_{i,b}$$

$$\sum_{k \in K_{i,b}^{DF}} ESDG_{i,b,k} \leq MaxDF_{i,b}$$

4.4.28~~7~~ For a *pseudo-unit,* the sum of its RT LOC EOP for *energy* and the RT LOC EOP s for all classes of *operating reserve* shall be less than or equal to the sum of the maximum capabilities for its *dispatchable* region and duct firing region for interval $i \in \mathrm{I}$ and bus $b \in B^{PSU}$

$$\sum_{k \in K_{i,b}^{DR}} ESDG_{i,b,k} + \sum_{k \in K_{i,b}^{DF}} ESDG_{i,b,k} + \sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} + \sum_{k \in K_{i,b}^{30R}} ES30RDG_{i,b,k} \leq MaxDR_{i,b} + MaxDF_{i,b}$$

4.4.29~~8~~ For a *pseudo-unit* that cannot provide *ten-minute operating reserve* in from its duct firing region, the following constraint shall apply:

$$\sum_{k \in K_{i,b}^{E}} ESDG_{i,b,k} + \sum_{k \in K_{i,b}^{10S}} ES10SDG_{i,b,k} + \sum_{k \in K_{i,b}^{10N}} ES10NDG_{i,b,k} \leq MINQDG_b + QDR_{i,k}$$

Chapter 9

3.5.4 Notwithstanding this section 3.5, the following *resources* shall be ineligible for the following components of the real-time make-whole payment *settlement amount*:

3.5.4.1 The following *resources* shall be ineligible for ELC and ELOC:

a. *dispatchable loads* and *dispatchable electricity storage resources* that are registered to withdraw for any quantity of *energy* that they *bid* at the *maximum market clearing price* and which was scheduled in the *real-time market*;

b. combustion turbine *resources* or steam turbine *resources* that are registered as a *pseudo-unit* but not operating as a *pseudo-unit* for *metering intervals* in which they have a minimum constraint applied for combined cycle operation consistent with combustion turbine commitment;

c. hydroelectric *generation resources:*

i. for any *settlement hour* for which the hydroelectric *generation resource* receives an *hourly must run* binding constraint;

ii. that are registered to the same *forebay* as one or more other hydroelectric *generation resources,* for a *trading day,* except for any *metering intervals* for which it receives a *reliability* constraint*,* if the sum of the quantity of *energy* scheduled in the *real-time market* for all *settlement hours* of the *trading day* for all *resources* that are registered to the same *forebay* is less than or equal to the *minimum daily energy limit* of such *forebay;* or

iii. that are not registered to the same *forebay* as one or more other hydroelectric *generation resources,* for a *trading day,* except for any *metering intervals* for which it receives a *reliability* constraint*,* if the sum of the quantity of *energy* scheduled in the *real-time market* for all *settlement hours* of the *trading day* for such *resources* is less than or equal to its *minimum daily energy limit;*

3.5.4.2 *energy traders* participating with *boundary entity resources* shall be ineligible for ELC, ELOC, and OLOC for import transactions;

3.5.4.3 *energy traders* participating with *boundary entity resources* shall be ineligible for ELOC and OLOC for export transactions;

3.5.4.4 *dispatchable load resources* and *dispatchable electricity storage resources* that are registered to withdraw shall be ineligible for ELOC where the *price-quantity pairs* contained in its *energy bid* for a *settlement hour* are not the same as the *price-quantity pairs* contained in its *energy bid* for the immediately preceding and next *settlement hour* and such change results in the ramping of the *resource* described in the applicable *market manual;*

3.5.4.5 *resources* shall be ineligible for positive ELC when its ~~it is injecting or withdrawing~~ *real-time schedule* for *energy* is less than~~below~~ it~~'~~s RT_LC_EOP;

3.5.4.6 *resources* shall be ineligible for positive ELOC when its *real-time schedule* for~~it is injecting or withdrawing~~ *energy* is greater than ~~above~~its RT_LOC_EOP;

3.5.4.7 *resources* shall be ineligible for positive OLC when its *real-time schedule* for *operating reserve* is less than its RT_OR_LC_EOP;

3.5.4.8 *resources* shall be ineligible for positive OLOC when its *real-time schedule* for *operating reserve* is greater than its RT_OR_LOC_EOP;

3.5.4.9 *non-quick start resources* shall be ineligible for ELOC and OLOC when its *real-time schedule* is less than its *minimum loading point*; and

3.5.4.10 Subject to section 3.5.4.10.1, *dispatchable loads* and *dispatchable electricity storage resources* that are registered to withdraw shall be ineligible for ELOC when (i) its RT_LOC_EOP is greater than its *real-time schedule;* (ii) its RT_LOC_EOP is greater than its actual quantity of *energy* withdrawn; and (iii) any of the following conditions exists:

Real-Time Make-Whole Payment for Dispatchable Generation Resources That Are Not Pseudo-Units and Dispatchable Electricity Storage Resources That Are Registered to Inject

3.5.6 For a *delivery point* 'm' associated with a *dispatchable electricity storage resource* that is registered to inject or a *dispatchable generation resource* that is not a *pseudo-unit*, the real-time make-whole payment *settlement amount* is calculated as follows:

$$RT\_MWP_{k,h}^{m} = \sum^{T} Max\left(0, RT\_ELC_{k,h}^{m,t} + RT\_OLC_{k,h}^{m,t}\right) + Max\left(0, RT\_ELOC_{k,h}^{m,t} + RT\_OLOC_{k,h}^{m,t}\right)$$

Where:

a. $RT\_ELC_{k,h}^{m,t}$ is calculated in accordance with section 3.5.6.1;

b. $RT\_OLC_{k,h}^{m,t} = \sum_{R}\{-1 \times \left[OP\left(RT\_PROR_{r,h}^{m,t}, Max(DAM\_QSOR_{r,k,h}^{m}, RT\_QSOR_{r,k,h}^{m,t}), BOR_{r,k,h}^{m,t}\right) - OP\left(RT\_PROR_{r,h}^{m,t}, Max(RT\_OR\_LC\_EOP_{r,k,h}^{m,t}, DAM\_QSOR_{r,k,h}^{m}), BOR_{r,k,h}^{m,t}\right)\right]/12\}$

c. $RT\_ELOC_{k,h}^{m,t}$ is calculated in accordance with section 3.5.6.2;

d. $RT\_OLOC_{k,h}^{m,t} = \sum_{R}\left[\{Max[0, OP\left(RT\_PROR_{r,h}^{m,t}, RT\_OR\_LOC\_EOP_{r,k,h}^{m,t}, BOR_{r,k,h}^{m,t}\right)] - Max\left[0, OP\left(RT\_PROR_{r,h}^{m,t}, RT\_QSOR_{r,k,h}^{m,t}, BOR_{r,k,h}^{m,t}\right)\right] - RT\_OR\_FROP\_LOC_{r,k,h}^{m,t}\}/12\right]$

Where:

i. if the *offer* price of $BOR_{r,k,h}^{m,t}$ is greater than $RT\_PROR_{r,h}^{m,t}$, the *IESO* shall revise the *offer* price of $BOR_{r,k,h}^{m,t}$ to be equal to $RT\_PROR_{r,h}^{m,t}$.; and

ii. $RT\_OR\_FROP\_LOC_{r,k,h}^{m,t}$ is calculated in accordance with section 3.5.6.3.

3.5.6.1 The *IESO* shall calculate $RT\_ELC_{k,h}^{m,t}$ as follows:

$$RT\_ELC_{k,h}^{m,t} = -1\,x\,\left[\!\left[\left[OP\left(RT\_LMP_{h}^{m,t}, Max(DAM\_QSI_{k,h}^{m}, Min(RT\_QSI_{k,h}^{m,t}, AQEI_{k,h}^{m,t})), BE_{k,h}^{m,t}\right) - OP\left(RT\_LMP_{h}^{m,t}, Max(RT\_LC\_EOP_{k,h}^{m,t}, DAM\_QSI_{k,h}^{m}), BE_{k,h}^{m,t}\right)\right] - RT\_FROP\_LC_{k,h}^{m,t}\right]\!\right] /12$$

Where:

a. the *dispatchable generation resource* is registered as a hydroelectric *generation resource*, $RT\_QSI_{k,h}^{m,t}$ is greater than $FR\_LL_{k}^{m,f}$, and $RT\_QSI_{k,h}^{m,t}$ is less than or equal to $FR\_UL_{k}^{m,f}$, then:

$$RT\_FROP\_LC_{k,h}^{m,t} = Max\ [0, OP\big(RT\_LMP_{h}^{m,t}, Max(DAM\_QSI_{k,h}^{m}, Min(RT\_QSI_{k,h}^{m,t}, AQEI_{k,h}^{m,t})), BE_{k,h}^{m,t}\big)] - OP\big(RT\_LMP_{h}^{m,t}, Max(FR\_LL_{k,h}^{m,t,f}, DAM\_QSI_{k,h}^{m}, RT\_LC\_EOP_{k,h}^{m,t}), BE_{k,h}^{m,t}\big)$$

Where:

i. '$FR\_UL_{k}^{m,f}$' is the *forbidden region* upper limit from *forbidden region* set 'f' where $RT\_QSI_{k,h}^{m,t} <= FR\_UL_{k}^{m,f}$, as submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

ii. '$FR\_LL_{k}^{m,f}$' is the *forbidden region* lower limit from *forbidden region* set 'f' where $RT\_QSI_{k,h}^{m,t} > FR\_LL_{k}^{m,f}$, as submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

iii. 'f' = (1…N) of the *forbidden region* set $\{FR\_UL_{k}^{m,f}, FR\_LL_{k}^{m,f}\}$ and 'N' is the maximum number of *forbidden regions* submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

b. Otherwise $RT\_FROP\_LC_{k,h}^{m,t}$ shall equal zero.

3.5.6.2 The *IESO* shall calculate $RT\_ELOC_{k,h}^{m,t}$ as follows:

$$RT\_ELOC_{k,h}^{m,t} = \{Max[0, OP\big(RT\_LMP_{h}^{m,t}, RT\_LOC\_EOP_{k,h}^{m,t}, BE_{k,h}^{m,t}\big)] - Max\big[0, OP\big(RT\_LMP_{h}^{m,t}, Max(RT\_QSI_{k,h}^{m,t}, AQEI_{k,h}^{m,t}), BE_{k,h}^{m,t}\big)\big] - RT\_FROP\_LOC_{k,h}^{m,t}\} /12$$

Where:

a. if the *offer* price of $BE_{k,h}^{m,t}$ is greater than $RT\_LMP_{h}^{m,t}$, the *IESO* shall revise the *offer* price of $BE_{k,h}^{m,t}$ to be equal to $RT\_LMP_{h}^{m,t}$

b. if the *dispatchable generation resource* is registered as a hydroelectric *generation resource*, $RT\_QSI_{k,h}^{m,t}$ is greater than or equal to $FR\_LL_{k}^{m,f}$ and $RT\_QSI_{k,h}^{m,t}$ is less than $FR\_UL_{k}^{m,f}$, then:

$$RT\_FROP\_LOC_{k,h}^{m,t} = Max\ [0, OP\big(RT\_LMP_{h}^{m,t}, Min(FR\_UL_{k,h}^{m,f}, RT\_LOC\_EOP_{k,h}^{m,t}), BE_{k,h}^{m,t}\big)] - Max\big[0, OP\big(RT\_LMP_{h}^{m,t}, Max(RT\_QSI_{k,h}^{m,t,f}, AQEI_{k,h}^{m,t}), BE_{k,h}^{m,t}\big)\big]$$

Where:

i. '$FR\_UL_{k}^{m,f}$' is the *forbidden region* upper limit from *forbidden region* set 'f' where $RT\_QSI_{k,h}^{m,t} < FR\_UL_{k}^{m,f}$, as submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

ii. '$FR\_LL_{k}^{m,f}$' is the *forbidden region* lower limit from *forbidden region* set 'f' where $RT\_QSI_{k,h}^{m,t} >= FR\_LL_{k}^{m,f}$, as submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

iii. 'f' = (1…N) of the *forbidden region* set {$FR\_UL_{k}^{m,f}$, $FR\_LL_{k}^{m,f}$} and 'N' is the maximum number of *forbidden regions* submitted by *market participant* 'k' for *delivery point* 'm' as daily *dispatch data*.

c. Otherwise $RT\_FROP\_LOC_{k,h}^{m,t}$ shall equal zero.

3.5.6.3 The *IESO* shall calculate $RT\_OR\_FROP\_LOC_{r,k,h}^{m,t}$ as follows:

$$RT\_OR\_FROP\_LOC_{r,k,h}^{m,t} = Max[0, OP(RT\_PROR_{r,h}^{m,t}, (RT\_OR\_LOC\_EOP_{r,k,h}^{m,t} - QTY\_ADJ_{r,k,h}^{m,t}), BOR_{r,k,h}^{m,t})] - Max\left(0, OP\left(RT\_PROR_{r,h}^{m,t}, RT\_QSOR_{r,k,h}^{m,t}, BOR_{r,k,h}^{m,t}\right)\right)$$

Where:

a. $QTY\_ADJ_{r,k,h}^{m,t} = \text{Max}\left(0, QTY\_DIFF_{r,k,h}^{m,t} - FR\_QTY\_AVAIL_{r,k,h}^{m,t}\right)$

b. $QTY\_DIFF_{r,k,h}^{m,t} = RT\_OR\_LOC\_EOP_{r,k,h}^{m,t} - RT\_QSOR_{r,k,h}^{m,t}$

c. For synchronized *ten-minute operating reserve*:

$$FR\_QTY\_AVAIL_{r1,k,h}^{m,t} = Max\left[0, Max\left(DAM\_QSI_{k,h}^{m}, Min\left(RT\_QSI_{k,h}^{m,t}, AQEI_{k,h}^{m,t}\right)\right) - Max\left(FR\_LL_{k,h}^{m,t}, DAM\_QSI_{k,h}^{m}, RT\_LC\_EOP_{k,h}^{m,t}\right)\right]$$

d. For non-synchronized *ten-minute operating reserve*:

$$FR\_QTY\_AVAIL_{r2,k,h}^{m,t} = FR\_QTY\_AVAIL_{r1,k,h}^{m,t} - \left(RT\_OR\_LOC\_EOP_{r1,k,h}^{m,t} - QTY\_ADJ_{r1,k,h}^{m,t} - RT\_QSOR_{r1,k,h}^{m,t}\right)$$

e. For thirty-minute *operating reserve*:

$$FR\_QTY\_AVAIL_{r3,k,h}^{m,t} = FR\_QTY\_AVAIL_{r2,k,h}^{m,t} - \left(RT\_OR\_LOC\_EOP_{r2,k,h}^{m,t} - QTY\_ADJ_{r2,k,h}^{m,t} - RT\_QSOR_{r2,k,h}^{m,t}\right)$$

Real-Time Make-Whole Payment for Dispatchable Loads and Dispatchable Electricity Storage Resources That Are Registered to Withdraw

3.5.7 For a *delivery point* 'm' associated with a *dispatchable load* or *dispatchable electricity storage resource* that is registered to withdraw, the real-time make-whole payment *settlement amount* is calculated as follows:

$$RT\_MWP_{k,h}^{m} = \sum^{T} Max\left(0, RT\_ELC_{k,h}^{m,t} + RT\_OLC_{k,h}^{m,t}\right) + Max\left(0, RT\_ELOC_{k,h}^{m,t} + RT\_OLOC_{k,h}^{m,t}\right)$$

Where:

a. $RT\_ELC_{k,h}^{m,t} = \left[OP\left(RT\_LMP_{h}^{m,t}, Max(DAM\_QSW_{k,h}^{m}, Min(RT\_QSW_{k,h}^{m,t}, AQEW_{k,h}^{m,t})), BL_{k,h}^{m,t}\right) - OP\left(RT\_LMP_{h}^{m,t}, Max(RT\_LC\_EOP_{k,h}^{m,t}, DAM\_QSW_{k,h}^{m}), BL_{k,h}^{m,t}\right)\right]/12$

b. $RT\_OLC_{k,h}^{m,t} = \sum_{R}\{-1 \times \left[OP\left(RT\_PROR_{r,h}^{m,t}, Max(DAM\_QSOR_{r,k,h}^{m}, RT\_QSOR_{r,k,h}^{m,t}), BOR_{r,k,h}^{m,t}\right) - OP\left(RT\_PROR_{r,h}^{m,t}, Max(RT\_OR\_LC\_EOP_{r,k,h}^{m,t}, DAM\_QSOR_{r,k,h}^{m}), BOR_{r,k,h}^{m,t}\right)\right]/12\}$

c. $RT\_ELOC_{k,h}^{m,t} = -1 \times \{Max\ [0, OP\left(RT\_LMP_{h}^{m,t}, RT\_LOC\_EOP_{k,h}^{m,t}, BL_{k,h}^{m,t}\right)] - OP\left(RT\_LMP_{h}^{m,t}, Max(RT\_QSW_{k,h}^{m,t}, AQEW_{k,h}^{m,t}), BL_{k,h}^{m,t}\right)\}/12$

And where:

i. if the *bid* price of $BL^{m,t}_{k,h}$ is less than $RT\_LMP_{h}^{m,t}$, the *IESO* shall revise the *bid* price of $BL^{m,t}_{k,h}$ to be equal to $RT\_LMP_{h}^{m,t}$

d. $RT\_OLOC_{k,h}^{m,t} = \sum_{R}\left[Max[0, \{OP\left(RT\_PROR_{r,h}^{m,t}, RT\_OR\_LOC\_EOP_{r,k,h}^{m,t}, BOR_{r,k,h}^{m,t}\right)] - Max\left[0, OP\left(RT\_PROR_{r,h}^{m,t}, RT\_QSOR_{r,k,h}^{m,t}, BOR_{r,k,h}^{m,t}\right)\right]\}/12\right]$

And where:

i. if the *offer* price of $BOR^{m,t}_{r,k,h}$ is greater than $RT\_PROR^{m,t}_{r,h}$, the *IESO* shall revise the *offer* price of $BOR^{m,t}_{r,k,h}$ to be equal to $RT\_PROR^{m,t}_{r,h}$

Real-Time Make-Whole Payment for Dispatchable Generation Resources That Are Pseudo-Units

Combustion turbine

3.5.9 For a *delivery point* 'c' for a combustion turbine *resource* associated with a *pseudo-unit*, the real-time make-whole payment *settlement amount* is calculated as follows:

$$RT\_MWP^{c}_{k,h} = \sum^{T} Max\left(0, RT\_ELC^{c,t}_{k,h} + RT\_OLC^{c,t}_{k,h}\right) + Max\left(0, RT\_ELOC^{c,t}_{k,h} + RT\_OLOC^{c,t}_{k,h}\right)$$

Where:

a. $RT\_ELC^{c,t}_{k,h} = (-1) \times \left[OP\left(RT\_LMP^{c,t}_{h}, Max(DAM\_QSI^{c}_{k,h}, Min\left(RT\_QSI^{c,t}_{k,h}, AQEI^{c,t}_{k,h}\right)), RT\_DIPC^{c,t}_{k,h}\right) - OP\left(RT\_LMP^{c,t}_{h}, Max\left(RT\_LC\_EOP^{c,t}_{k,h}, DAM\_QSI^{c}_{k,h}\right), RT\_DIPC^{c,t}_{k,h}\right)\right]/12$

b. $RT\_OLC^{c,t}_{k,h} = \sum_{R}\left[(-1) \times \left\{OP\left(RT\_PROR^{c,t}_{r,h}, Max(DAM\_QSOR^{c}_{r,k,h}, RT\_QSOR^{c,t}_{r,k,h}), RT\_OR\_DIPC^{c,t}_{r,k,h}\right) - OP\left(RT\_PROR^{c,t}_{r,h}, MAX(RT\_OR\_LC\_EOP^{c,t}_{r,k,h}, DAM\_QSOR^{c}_{r,k,h}), RT\_OR\_DIPC^{c,t}_{r,k,h}\right)\right\}/12\right]$

And where:

i. If the *offer* price in the $RT\_OR\_DIPC^{c,t}_{r,k,h}$ *offer* curve is greater than $RT\_PROR^{c,t}_{r,h}$ for the same *class r reserve*, the *IESO* shall revise the *offer* price of $RT\_OR\_DIPC^{c,t}_{r,k,h}$ to be equal to $RT\_PROR^{c,t}_{r,h}$.

c. $RT\_ELOC^{c,t}_{k,h} = \left\{Max\left[0, OP\left(RT\_LMP^{c,t}_{h}, RT\_LOC\_EOP^{c,t}_{k,h}, RT\_DIPC^{c,t}_{k,h}\right)\right] - Max\left[0, OP\left(RT\_LMP^{c,t}_{h}, Max\left(RT\_QSI^{c,t}_{k,h}, AQEI^{c,t}_{k,h}\right), RT\_DIPC^{c,t}_{k,h}\right)\right]\right\}/12$

And where:

i. If the *offer* price in the $RT\_DIPC^{c,t}_{k,h}$ *offer* curve is greater than $RT\_LMP^{c,t}_{h}$, the *IESO* shall revise the *offer* price of $RT\_DIPC^{c,t}_{k,h}$ to be equal to $RT\_LMP^{c,t}_{h}$

d. $RT\_OLOC^{c,t}_{k,h} = \sum_{R}\left[Max\left[0, OP\left(RT\_PROR^{c,t}_{r,h}, RT\_OR\_LOC\_EOP^{c,t}_{r,k,h}, RT\_OR\_DIPC^{c,t}_{r,k,h}\right)\right] - Max\left[0, OP\left(RT\_PROR^{c,t}_{r,h}, RT\_QSOR^{c,t}_{r,k,h}, RT\_OR\_DIPC^{c,t}_{r,k,h}\right)\right]\right]/12$

And where:

i. If the *offer* price in the $RT\_OR\_DIPC_{r,k,h}^{c,t}$ *offer* curve is greater than $RT\_PROR_{r,h}^{c,t}$ for the same *class r reserve*, the *IESO* shall revise the *offer* price of $RT\_OR\_DIPC_{r,k,h}^{c,t}$ to be equal to $RT\_PROR_{r,h}^{c,t}$.

Steam turbine

3.5.10 For a *delivery point* 's' for a steam turbine *resource* associated with a *pseudo-unit* where at least one of the combustion turbine *resources* associated with the *pseudo-unit* has a *real-time schedule* greater than or equal to its *minimum loading point* during the applicable *settlement hour*, the real-time make-whole payment *settlement amount* is calculated as follows:

$$RT\_MWP_{k,h}^{s} = \sum^{T} Max\left(0, RT\_ELC_{k,h}^{s,t} + RT\_OLC_{k,h}^{s,t}\right) + Max\left(0, RT\_ELOC_{k,h}^{s,t} + RT\_OLOC_{k,h}^{s,t}\right)$$

Where:

a. $RT\_ELC_{k,h}^{s,t} = (-1) \times \left[OP\left(RT\_LMP_{h}^{s,t}, Max(DAM\_DIGQ_{k,h}^{s}, Min\left(RT\_QSI\_DIGQ_{k,h}^{s,t}, AQEI_{k,h}^{s,t}\right)), RT\_DIPC_{k,h}^{s,t}\right) - OP\left(RT\_LMP_{h}^{s,t}, Max\left(RT\_LC\_EOP\_DIGQ_{k,h}^{s,t}, DAM\_DIGQ_{k,h}^{s}\right), RT\_DIPC_{k,h}^{s,t}\right)\right]/12$

b. $RT\_OLC_{k,h}^{s,t} = \sum_{R}\left[(-1) \times \left\{ OP\left(RT\_PROR_{r,h}^{s,t}, Max(DAM\_QSOR_{r,k,h}^{s}, RT\_QSOR_{r,k,h}^{s,t}), RT\_OR\_DIPC_{r,k,h}^{s,t}\right) - OP\left(RT\_PROR_{r,h}^{s,t}, Max\left(RT\_OR\_LC\_EOP_{r,k,h}^{s,t}, DAM\_QSOR_{r,k,h}^{s}\right), RT\_OR\_DIPC_{r,k,h}^{s,t}\right)\right\}/12\right]$

And where:

i. If the *offer* price in the $RT\_OR\_DIPC_{r,k,h}^{s,t}$ *offer* curve is greater than $RT\_PROR_{r,h}^{s,t}$ for the same *class r reserve*, the *IESO* shall revise the *offer* price of $RT\_OR\_DIPC_{r,k,h}^{s,t}$ to be equal to $RT\_PROR_{r,h}^{s,t}$.

c. $RT\_ELOC_{k,h}^{s,t} = \left\{Max\left[0, OP\left(RT\_LMP_{h}^{s,t0}, RT\_LOC\_EOP\_DIGQ_{k,h}^{s,t0}, RT\_DIPC_{k,h}^{s,t0}\right)\right] - Max\left[0, OP\left(RT\_LMP_{h}^{s,t0}, Max\left(RT\_QSI\_DIGQ_{k,h}^{s,t0}, AQEI_{k,h}^{s,t0}\right), RT\_DIPC_{k,h}^{s,t0}\right)\right]\right\}/12 + \left\{OP\left(RT\_LMP_{h}^{s,t1}, RT\_LOC\_EOP\_DIGQ_{k,h}^{s,t1}, RT\_DIPC_{k,h}^{s,t1}\right) - Max\left[0, OP\left(RT\_LMP_{h}^{s,t1}, RT\_QSI\_DIGQ_{k,h}^{s,t1}, RT\_DIPC_{k,h}^{s,t1}\right)\right]\right\}/12$

And where:

i. 't_0' is *metering interval* 't' in *settlement hour* 'h' when none of the combustion turbine *resources* associated with the steam turbine *resource* have a *real-time schedule* that is less than its respective *minimum loading* *point*. For greater certainty, 't_1' and 't_0' *metering intervals* are mutually exclusive, and the calculation will be conducted using either the 't_1' or 't_0' variables, depending on whether the relevant *metering interval* meets the criteria of 't_1' or 't_0', respectively;

ii. 't_1' is *metering interval* 't' in *settlement hour* 'h' when (1) at least one combustion turbine *resource* associated with the steam turbine *resource* has a *real-time schedule* greater than or equal to its *minimum loading point*; and (2) at least one of the combustion turbine *resources* associated with the steam turbine *resource* has a *real-time schedule* that is less than its respective *minimum loading point.* For greater certainty, 't_1' and 't_0' *metering intervals* are mutually exclusive, and the calculation will be conducted using either the 't_1' or 't_0' variables, depending on whether the relevant *metering interval* meets the criteria of 't_1' or 't_0', respectively; and

iii. If the *offer* price in the $RT\_DIPC_{k,h}^{s,t}$ *offer* curve is greater than $RT\_LMP_{h}^{s,t}$, the *IESO* shall revise the *offer* price of $RT\_DIPC_{k,h}^{s,t}$ to be equal to $RT\_LMP_{h}^{s,t}$.

d. $RT\_OLOC_{k,h}^{s,t} = \sum_R \left[\left\{ Max\left[0, OP\left(RT\_PROR_{r,h}^{s,t}, RT\_OR\_LOC\_EOP_{r,k,h}^{s,t}, RT\_OR\_DIPC_{r,k,h}^{s,t}\right)\right] - Max\left[0, OP\left(RT\_PROR_{r,h}^{s,t}, RT\_QSOR_{r,k,h}^{s,t}, RT\_OR\_DIPC_{r,k,h}^{s,t}\right)\right]\right\} / 12 \right]$

And where:

i. If the *offer* price in the $RT\_OR\_DIPC_{r,k,h}^{s,t}$ *offer* curve is greater than $RT\_PROR_{r,h}^{s,t}$ for the same *class r reserve*, the *IESO* shall revise the *offer* price of $RT\_OR\_DIPC_{r,k,h}^{s,t}$ to be equal to $RT\_PROR_{r,h}^{s,t}$.