### 4.13.3 Identification of RDRRs and PDRs

Each Demand Response Provider shall provide data, as described in the Business Practice Manual, identifying each of its Reliability Demand Response Resources or Proxy Demand Resources and such information regarding the capacity and the operating characteristics of the Reliability Demand Response Resource or Proxy Demand Resource as may be reasonably requested from time to time by the CAISO. All information provided to the CAISO regarding the operational and technical constraints in the Master File shall be accurate and actually based on physical characteristics of the resources. Demand

Response Providers for Proxy Demand Resources may elect to specify in the Master File how the Proxy

Demand Resource will bid and be dispatched in the Real-Time Market: in (i) Hourly Blocks, (ii) fifteen (15)

minute intervals, or (iii) five (5) minute intervals. If Demand Response Providers do not submit an election

in the Master File, the CAISO will set Hourly Blocks as the default.

## \* \* \* \* \*

## 11.25 Settlement of Flexible Ramping Product

### 11.25.1 Settlement of Forecasted Movement

**11.25.1.1 Generally**

The CAISO will settle Forecasted Movement as described in this this Section 11.25.1 by Balancing Authority Area, which will be based on the Forecasted Movement determined for resources in the applicable Balancing Authority Areas in the EIM Area. The CAISO will also settle Forecasted Movement as described in this Section 11.25.1 by EIM Area, which will be based on the Forecasted Movement determined for resources in the Balancing Authority areas in the EIM Area that passed the flexible ramping insufficiency determination as specified in Section 29.34 (m).

**11.25.1.2 FMM.**

The CAISO will settle FMM Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

(a) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the applicable FMM Flexible Ramp Up Price; plus

(b) the product of the Forecasted Movement calculated for each resource pursuant to Section 44.3 in MWhs and the product of the applicable FMM Flexible Ramp Down Price and negative one.

**11.25.1.3 RTD.**

The CAISO will settle RTD Forecasted Movement with Scheduling Coordinators as follows, where upward movement is a positive amount and downward movement is a negative amount:

(a) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the applicable RTD Flexible Ramp Up Price, less any rescission amounts pursuant to section 11.25.3; plus

(b) the product of the difference between the RTD Forecasted Movement and the FMM Forecasted Movement for the relevant Settlement Interval, both calculated for each resource pursuant to Section 44.3 in MWhs, and the product of the applicable RTD Flexible Ramp Down Price and negative one, less any rescission amounts pursuant to section 11.25.3.

**11.25.1.4 Allocation of Residual Forecasted Movement Settlements.**

The CAISO will settle amounts remaining after settlement of Forecasted Movement pursuant to Section 11.25.1 to each Scheduling Coordinator’s metered EIM Demand or metered CAISO Demand in proportion to its share of the total metered EIM Demand and metered CAISO Demand.

### 11.25.2 Settlement of Uncertainty Requirement

**11.25.2.1 Payment to Resources.**

On a daily basis, the CAISO will settle Uncertainty Awards to resources for providing the Uncertainty Requirement at the applicable Flexible Ramp Up Price or Flexible Ramp Down Price less any payment rescission for each interval pursuant to Section 11.25.3.

**11.25.2.2 Allocation of Costs of Uncertainty Movement Procured.**

**11.25.2.2.1 Settlement Process.**

(a) **Generally.** The CAISO will settle Uncertainty Awards as described in Section 11.25.2.2 by Balancing Authority Area in the EIM Area based on the Uncertainty Requirements procured for applicable Balancing Authority Area. The CAISO also settle Uncertainty Awards by EIM Area, which will be based on the Uncertainty Requirements procured for the Balancing Authority Areas within the EIM Area that passed the flexible ramping insufficiency determination as specified in Section 29.34 (m).

(b) **Daily.** The CAISO will initially –

(1) allocate the cost of the Uncertainty Award within each Balancing Authority Area in the EIM Area and within the EIM Area on a daily basis according to the categories as set forth in this Section 11.25.2.2.2 and 11.25.2.2.3; and

(2) allocate the daily amounts to Scheduling Coordinators as set forth in this Section 11.25.2.2.4.

(c) **Monthly.** The CAISO will resettle the costs of the Uncertainty Awards by –

(1) reversing the daily allocation;

(2) assigning the monthly costs of the Uncertainty Awards to Peak Flexible Ramp Hours and Off-Peak Flexible Ramp Hours;

(3) separately allocating the monthly Peak Flexible Ramp Hours amounts and Off-Peak Flexible Ramp Hours amounts to the categories within each Balancing Authority Area in the EIM Area and within the EIM Area as set forth in this Section 11.25.2.2.2 and 11.25.2.2.3; and

(4) allocating the monthly amounts in each category to Scheduling Coordinators as set forth in this Section 11.25.2.2.4.

**11.25.2.2.2 Allocation of Charges to Categories.**

(a) **Determination of Uncertainty Movement for Resources.** For each interval, the CAISO will calculate the net Uncertainty Movement of each resource according to the following categories:

(1) for Supply resources other than non-Dynamic System Resources as the difference between the Dispatch Instruction of the binding interval in the next RTD run and the first advisory RTD interval in the current run.

(2) for non-Dynamic System Resources and export schedules as the difference between the schedule used in the RTD (accounting for ramp) for the binding interval in the next RTD run and the scheduled use for the first advisory interval in the current RTD run.

(b) **RTD Uncertainty Movement by Balancing Authority Area and by EIM Area.** The CAISO will determine the total net RTD Uncertainty Movement for each category separately for each Balancing Authority Area in the EIM Area and by EIM Area –

(1) for the category of Supply resources, which shall not include non-Dynamic System Resources, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2.2 of all the Supply resources in the category.

(2) for the category of Intertie resources, which shall comprise non-Dynamic System Resources and exports, as the net sum of the five-minute Uncertainty Movement determined pursuant to Section 11.25.2.2 of all the non-Dynamic System resources and export schedules.

(3) for the non-Participating Load category, as the difference between –

(A) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, of the binding interval in the next RTD run; and

(B) the CAISO Forecast of CAISO Demand, the CAISO forecast of Balancing Authority Area EIM Demand, or the CAISO forecast of EIM Area EIM Demand, as applicable, for the first advisory interval in the current RTD run.

**11.25.2.2.3 Assignment of Uncertainty Costs to Categories.**

The CAISO will allocate the total Uncertainty Award cost calculated pursuant to this section 11.25.2.2 to each category described in Section 11.25.2.2.2(b) based on –

(a) for upward Uncertainty Award cost, the ratio of such category’s positive Uncertainty Movement to the sum of the positive Uncertainty Movements of all categories with positive Uncertainty Movement for each Balancing Authority Area in the EIM Area and the EIM Area; and

(b) for downward Uncertainty Award costs, the ratio of such category’s negative Uncertainty Movement to the sum of the negative Uncertainty Movements of all categories with negative Uncertainty Movement for each Balancing Authority Area in the EIM Area and the EIM Area.

**11.25.2.2.4 Allocation to Scheduling Coordinators.**

(a) **Non-Participating Load Category.**  The CAISO will allocate the Uncertainty Awards costs of the non-Participating Load category to Scheduling Coordinators –

(1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator’s negative non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such negative non-Participating Load UIE, without netting that UIE across Settlement Intervals, in the Balancing Authority Area or EIM Area as applicable, and

(2) for downward Uncertainty Award cost calculated pursuant to Section 11.25, in proportion to the Scheduling Coordinator’s daily positive non-Participating Load UIE, excluding the non-Participating Load of an MSS that has elected to load-follow according to an MSS Agreement, without netting that UIE across Settlement Intervals, to the total of such positive non-Participating Load UIE, without netting that UIE across Settlement Intervals, in the BAA or EIM Area as applicable.

(b) **Supply Category.** The CAISO will allocate the Uncertainty Awards costs of the Supply category to Scheduling Coordinators for each resource in the Supply category based on the sum of the resource’s Uncertainty Movement and UIE –

(1) for upward Uncertainty Award cost in proportion to the Scheduling Coordinator’s positive sum of the resource’s Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total positive sum of all resources’ Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, in the BAA or EIM Area as applicable; and

(2) for downward Uncertainty Award cost in proportion to the Scheduling Coordinator’s negative sum of the resource’s Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, to the total negative sum of all resources’ Uncertainty Movement and UIE, without netting that sum across Settlement Intervals, in the Balancing Authority Area or EIM Area as applicable; except that

(3) for the MSS that have elected to load follow pursuant to an MSS Agreement, the CAISO will calculate the positive and negative sums specified above for each Settlement Interval as the sum of MSS non-Participating Load UIE, Supply resources within the MSS UIE, MSS Load Following Energy, MSS Load Following Operational Adjustments, and Uncertainty Movement of resources within the MSS Aggregation.

(c) **Intertie Category.** The CAISO will allocate the Uncertainty Awards costs of the Intertie category to Scheduling Coordinators for each non-Dynamic System Resource and export based on the sum of the resource’s Uncertainty Movement and Operational Adjustment –

(1) for upward Uncertainty Award cost in proportion to the magnitude of the Scheduling Coordinator’s negative Operational Adjustment for non-Dynamic System Resources, or positive Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments in the Balancing Authority Area or EIM Area, without netting that sum across Settlement Intervals; and

(2) for downward Uncertainty Award cost in proportion to the magnitude of the Scheduling Coordinator’s positive Operational Adjustment for non-Dynamic System Resources, or negative Operational Adjustment for export resources, to the sum of the magnitudes of such Operational Adjustments in the Balancing Authority Area or EIM Area, without netting that sum across Settlement Intervals; and

(3) for the purposes of the allocations specified above, the MSS Load Following Operational Adjustment is excluded.

(d) **Uncertainty Award Cost Offset.**  If the sum of the settlement of Uncertainty Awards and the charges to Scheduling Coordinators for Uncertainty Award costs is nonzero, the CAISO will allocate such amounts to Scheduling Coordinators based on the ratio of their metered CAISO Demand and metered EIM Demand to the total EIM area metered demand.

### 11.25.3 Rescission

**11.25.3.1 Amount of Rescission.**

For each Settlement Interval in which a resource has either a UIE deviation or Operational Adjustment and a Flexible Ramping Product settlement, separately for upward and downward, the CAISO will rescind Settlement Amount for the overlap of the UIE or Operational Adjustment and the sum of RTD Forecasted Movement and Uncertainty Award, at the RTD Flexible Ramp Up Price or Flexible Ramp Down Price.

**11.25.3.2 Order of Rescission.**

For each Settlement Interval in which a resource has either a UIE deviation or Operational Adjustment and a Flexible Ramping Product settlement, separately for upward and downward, the CAISO will rescind Settlement Amount for the overlap of the UIE or Operational Adjustment and the sum of RTD Forecasted Movement and Uncertainty Award, at the RTD Flexible Ramp Up Price or Flexible Ramp Down Price.

### 11.25.4 [Not Used]

### 11.25.5 [Not Used]

\* \* \* \* \*

**27.5.6 Management & Enforcement of Constraints in the CAISO Markets**

The CAISO operates the CAISO Markets through the use of a market software system that utilizes various information including the Base Market Model, the State Estimator, submitted Bids including Self-Schedules, Generated Bids, Transmission Constraints, and transmission and generation Outages, including due to Remedial Action Schemes. The market model used in each of the CAISO Markets is derived from the most current Base Market Model available at that time. To create a more relevant time-specific network model for use in each of the CAISO Markets, the CAISO will adjust the Base Market Model to reflect Outages and derates that are known and applicable when the respective CAISO Market will operate, and to compensate for observed discrepancies between actual real-time power flows and flows calculated by the market software. Through this process the CAISO creates the market model to be used in each Day-Ahead Market and each process of the Real-Time Market. The CAISO will manage the enforcement of Transmission Constraints, consistent with good utility practice, to ensure, to the extent possible, that the market model used in each market accurately reflects all the factors that contribute to actual Real-Time flows on the CAISO Controlled Grid and that the CAISO Market results are better aligned with actual physical conditions on the CAISO Controlled Grid. In operating the CAISO Markets, the CAISO may take the following actions so that, to the extent possible, the CAISO Market solutions are feasible, accurate, and consistent with good utility practice:

(a) The CAISO may enforce, not enforce, or adjust flow-based Transmission Constraints if the CAISO observes that the CAISO Markets produce or may produce results that are inconsistent with observed or reasonably anticipated conditions or infeasible market solutions either because (a) the CAISO reasonably anticipates that the CAISO Market run will identify Congestion that is unlikely to materialize in Real-Time even if the Transmission Constraint were to be ignored in all the markets leading to Real-Time, or (b) the CAISO reasonably anticipates that the CAISO Market will fail to identify Congestion that is likely to appear in the Real-Time. The CAISO does not make such adjustments to intertie scheduling limits.

(b) The CAISO may enforce or not enforce Transmission Constraints if the CAISO has determined that non-enforcement or enforcement, respectively, of such Transmission Constraints may result in the unnecessary pre-commitment and scheduling of use-limited resources.

(c) The CAISO may not enforce Transmission Constraints if it has determined it lacks sufficient visibility to conditions on transmission facilities necessary to reliably ascertain constraint flows required for a feasible, accurate and reliable market solution.

(d) For the duration of a planned or unplanned Outage, the CAISO may create and apply alternative Transmission Constraints that may add to or replace certain originally defined constraints.

(e) The CAISO may adjust Transmission Constraints for the purpose of setting prudent operating margins consistent with good utility practice to ensure reliable operation under anticipated conditions of unpredictable and uncontrollable flow volatility consistent with the requirements of Section 7.

(f) The CAISO may adjust Transmission Constraints for the purpose of reserving internal transfer capability in the Day-Ahead or Real-Time Markets, based on anticipated conditions on the natural gas delivery system, to reliably serve load in specific geographic regions of the CAISO Balancing Authority Area, or to assure deliverability of Ancillary Services. The CAISO may or may not release such reserved internal transfer capability based on natural gas and electric system conditions, or observed market inefficiencies. Upon determining that an adjustment is necessary, the CAISO will issue a notification specifying the amount of the adjustment.

To the extent that particular Transmission Constraints are not enforced in the operations of the CAISO Markets, the CAISO will operate the CAISO Controlled Grid and manage any Congestion based on available information including the State Estimator solutions and available telemetry to Dispatch resources through Exceptional Dispatch to ensure the CAISO is operating the CAISO Controlled Grid consistent with the requirements of Section 7.

## \* \* \* \*

## 44. Flexible Ramping Product

## 44.1 In General.

The CAISO may enforce flexible ramping constraints in the Real-time Market to meet Forecasted Movement and Uncertainty Requirements, using tools as further described in the Business Practice Manual that estimate the Demand Forecast and Supply forecast error, as set forth in this Section 44.

## 44.2 Uncertainty Awards

### 44.2.1 Optimization.

**44.2.1.1 Generally.**

The CAISO will optimize the procurement of Uncertainty Awards in the Real-Time Market simultaneously with the procurement of Energy and Ancillary Services, as applicable. Uncertainty Awards do not overlap with Ancillary Services Awards or Available Balancing Capacity.

**44.2.1.2 Nodal Procurement**

### The CAISO will optimize procurement of Uncertainty Awards such that Energy that can be potentially be dispatched from resource capacity corresponding to the Uncertainty Awards will not result in flows exceeding Transmission Constraints and scheduling limits, including EIM transfer limits. 44.2.2 Variable Energy Resources.

The CAISO will use the CAISO’s own forecast (Independent Third Party Forecast) to determine the Uncertainty Awards and Forecast Movement for Variable Energy Resources.

### 44.2.3 Eligibility for Uncertainty Award.

**44.2.3.1 Generally.**

All resources that have Economic Bids in the RTM that can be dispatched on a five-minute basis by RTD are eligible for receiving Uncertainty Awards.

**44.2.3.2 Suspension.**

If the CAISO deems the resource to be non-compliant, the CAISO will suspend the resource’s eligibility as specified in Section 34.13.2.

**44.2.3.3 Ineligible Operating States.**

A resource is not eligible for an Uncertainty Award if it is in a Forbidden Operating Region or during an MSG Transition.

### 44.2.4 Determination of Uncertainty Requirement.

**44.2.4.1 Requirement.**

The CAISO will determine the Uncertainty Requirement for each Real-Time Market run, by each BAA and for the EIM Area overall.

**44.2.4.2 Procurement Curve.**

(a) **Generally.** Based on statistical analysis of the Uncertainty Requirement, the CAISO will calculate constraint relaxation parameters to ensure the total cost of the Uncertainty Awards will not exceed the cost of expected power balance violations in absence of the Uncertainty Award, by each Balancing Authority Area and for the EIM Area overall, as set forth in the Business Practice Manual.

(b) **Procurement Curve Cap.** The CAISO will establish in the Business Practice Manual a limit on the procurement curve –

(1) at an amount less than the contingency relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of an upward demand curve; and

(2) at an amount more than the regulation down relaxation penalty pricing parameter specified in the Business Practice Manual for market operations, in the case of a downward demand curve.

**44.2.4.3 Nodal Procurement**

The CAISO will distribute the upward and downward Uncertainty Requirement to the Demand and Variable Energy Resources Locations within each Balancing Authority Area in the EIM Area based on allocation factors derived from historical or forecasted information that reflect the relative contributions of Demand and Variable Energy Resources to overall Uncertainty Requirement.

## 44.3 Forecasted Movement

### 44.3.1 Generally.

The CAISO will determine the Forecasted Movement for each Generating Unit, System Resource, Pumped Storage, Pseudo-Tie, Non-generating Resource, PDR, Participating Load, and any other resource that has a schedule or dispatch change in the Real-Time Market as described below.

### 44.3.2 RTD Forecasted Movement.

For the RTD, the Forecasted Movement for the resource will be the MW difference between the resource’s non-binding dispatch instruction in the first five-minute advisory RTD interval and its Dispatch Instruction in the financially binding RTD interval, in the same RTD run.

### 44.3.3 FMM Forecasted Movement.

For FMM the Forecasted Movement will be the difference between the resource’s advisory FMM schedule in the first advisory FMM interval and its FMM Schedule in the financially binding FMM interval for the same applicable FMM run.

**Appendix A Definitions**

**- Flexible Ramp Down Price**

The Shadow Price of the downward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the downward Uncertainty Requirement constraint ($/MWh), by Location.

**- Flexible Ramp Up Price**

The Shadow Price of the upward Uncertainty Requirement constraint, which is the cost sensitivity of relaxing the upward Uncertainty Requirement constraint ($/MWh), by Location.

* **Base Market Model**

A computer based model of the CAISO Controlled Grid, and for purposes of the Energy Imbalance Market, including the prospective EIM Entity and EIM Entity Balancing Authority Area(s), that is derived from the Full Network Model as described in Section 27.5.1 and that, as described further in Section 27.5.6, is used as the basis for formulating the market models used in the operation of each of the CAISO Markets.

# Appendix CLocational Marginal Price

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## B. LMP Composition in the Real-Time Market

In each 15-minute interval and each 5-minute interval of the Fifteen Minute Market and Real-Time Dispatch, respectively, the CAISO calculates the LMP for each PNode, based on the Bids of sellers and buyers selected in those markets as specified in the FMM Schedule and 5-minute Real-Time Dispatch Instructions. The CAISO designates a Reference Bus, *r*, for calculation of the System Marginal Energy Cost (*SMECr*), which is the shadow price of the system power balance constraint. The CAISO uses the distributed load in the EIM Area as the Reference Bus to calculate loss sensitivities and shift factors used to linearize the power balance and Transmission Constraints. Resources that have constraints that prevent them from being marginal are not eligible to set the Locational Marginal Price. For each bus other than the Reference Bus, the CAISO determines separate components of the LMP for the marginal cost of Energy, Marginal Cost of Congestion, Marginal Cost of Losses, and Marginal Greenhouse Gas Cost relative to the Reference Bus, consistent with the following equation:

LMP*i*  SMEC*r*  MCC*i*  MCL*i*  MCG*i*

LMP*r*  SMEC*r*

where:

* *MCGi* is the LMP component representing Marginal Greenhouse Gas Cost.

For each PNode within an EIM Entity Balancing Authority Area, the LMP shall include a fourth component, the EIM Bid Adder component.

## C. The System Marginal Energy Cost Component of LMP (Day-Ahead and Real-Time Market)

The SMEC shall be the same for each location throughout the system. SMEC is the sensitivity of the power balance constraint at the optimal solution. The power balance constraint ensures that the physical law of conservation of Energy (the sum of Generation and imports equals the sum of Demand, including exports and Transmission Losses) is accounted for in the network solution. This system level power balance constraints is enforced over the CAISO Balancing Authority Area for the Day-Ahead Market and over the EIM Area in the Real-Time Market. For the designated reference location the CAISO will utilize a distributed Load Reference Bus for which constituent PNodes are weighted using the Reference Bus distribution factors. The Load distributed Reference Bus distribution factors are based on the Load Distribution Factors at each PNode that represents cleared Load in the Integrated Forward Market or forecast Load for MPM, RUC and RTM. In the Integrated Forward Market, in the event that the market is not able to clear based on the use of a distributed load Reference Bus, the CAISO will use a distributed generation Reference Bus for which the constituent nodes and the weights are determined economically within the running of the Integrated Forward Market based on available economic bids. In the event that the CAISO employs a distributed generation Reference Bus, it will notify Market Participants of which Integrated Forward Market runs required the use of this backstop mechanism. A distributed Load Reference Bus will be used for RUC and RTM regardless of whether a distributed Generation Reference Bus were used in the corresponding Integrated Forward Market run. If the market-clearing problem is limited by the system-level power balance constraint, the market clearing process would create a Shadow Price for the power balance constraint only when the relaxation of the constraint would result in a reduction in the total cost to operate the system.

## D. Marginal Congestion Component Calculations (Day-Ahead and Real-Time)

The CAISO calculates the Marginal Costs of Congestion at each bus as a component of the bus-level LMP. The Marginal Cost of Congestion (MCCi) component of the LMP at bus i is calculated in the Day-Ahead Market using the equation:

$$MCC\_{i}=-\sum\_{m=1}^{M}\sum\_{j=1}^{J\_{m}}c\_{j,m} PTDF\_{i,j} μ\_{m}-\sum\_{k=1}^{K}\sum\_{m=1}^{M}PTDF\_{i,m}^{k} μ\_{m}^{k}-\sum\_{g=1}^{K\_{g}}\sum\_{m=1}^{M}\left(PTDF\_{i,m}^{g}+δ\_{O\_{g},i}\sum\_{n=1}^{N}PTDF\_{n,m}^{g} GLDF\_{O\_{g},n}\right) μ\_{m}^{g}$$

where:

 *i* is a node index.

 *n* is a node index.

 *m* is the constraint or monitored element index.

 *k* is the preventive contingency case.

 *g* is the generation contingency case.

 *Og* is the node index associated with the generator contingency case *g*.

 *j* is the transmission component index of Transmission Constraint *m*. When Transmission Constraint *m* is a Nomogram, there can be more than one transmission component. When Transmission Constraint *m* is any other Transmission Constraint, there shall be only one transmission component.

 ** is the number of preventive contingencies.

 *K* is the number of preventive transmission contingencies, both in the base case for meeting Demand and in modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.

 *Kg* is the number of preventive generation contingencies.

 ** is the number of monitored elements, both in the base case for meeting Demand and in modeling the dispatch of Energy for the capacity corresponding to the Uncertainty Awards.

 *Jm* is the number of transmission components for constraint *m*.

 *PTDFi,j* the Power Transfer Distribution Factor for the bus *i* on transmission component *j* of the Transmission Constraint *k* which represents the flow across that transmission component *j* when an increment of power is injected at bus *i* and an equivalent amount of power is withdrawn at the Reference Bus. The CAISO does not consider the effect of losses in the determination of PTDFs.

 *Cj,m* is the constraint coefficient for the transmission component *j* in constraint *m*. When constraint *m* is a Nomogram, this represents the relevant coefficient for that component. When constraint *m* is any other Transmission Constraint, this coefficient will always be one.

 *µm* is the constraint Shadow Price on constraint *m* and is equivalent to the reduction in system cost expressed in $/MWh that results from a marginal increase of the capacity on constraint *m*. If the market-clearing problem is limited by any Transmission Constraint including Interties, branch groups, flowgates, nomograms, and Energy Imbalance Market-related transmission constraints (EIM Transfer constraints and power balance constraint for a Balancing Authority Area), the market clearing process would create a Shadow Price for the Transmission Constraint, only when the relaxation of the constraint would result in a reduction in the total cost to operate the system.

 $μ\_{m}^{k}$is the constraint Shadow Price on constraint *m* in the preventive transmission contingency case *k* and is equivalent to the reduction in system cost expressed in $/MWh that results from a marginal increase of the capacity on constraint *m* in the preventive transmission contingency case *k.* If the market-clearing problem is limited by any Transmission Constraint including Interties, branch groups, flowgates, nomograms, and Energy Imbalance Market-related transmission constraints (EIM Transfer constraints and power balance constraint for a Balancing Authority Area), the market clearing process would create a Shadow Price for the Transmission Constraint, only when the relaxation of the constraint would result in a reduction in total cost to operate the system.

 $μ\_{m}^{g}$is the constraint Shadow Price on constraint *m* in the preventive generator contingency case *g* and is equivalent to the reduction in system cost expressed in $/MWh that results from a marginal increase of the capacity on constraint *m* in the preventive generator contingency case *g.* If the market-clearing problem is limited by any Transmission Constraint including Interties, branch groups, flowgates, nomograms, and Energy Imbalance Market-related transmission constraints (EIM Transfer constraints and power balance constraint for a Balancing Authority Area), the market clearing process would create a Shadow Price for the Transmission Constraint, only when the relaxation of the constraint would result in a reduction in the total cost to operate the system.

 $δ\_{O\_{g},i}$ is the binary parameter that identifies the node with a generator outage under generator contingency case *g.* This parameter is one for all nodes in index *i* when *i* is the outage node *Og* associated with a generator contingency case *g*. This parameter is zero for all nodes in index *i* when *i* is not the outage node *Og* associated with the generator contingency case *g.*

 $PTDF\_{i,m}^{k}$is the Power Transfer Distribution Factor for the bus *i* on transmission component *m* under the preventive contingency case *k,* which represents the flow across that transmission component *m* when an increment of power is injected at bus *i* and an equivalent amount of power is withdrawn at the Reference Bus. The CAISO does not consider the effect of losses in the determination of PTDFs.

 $PTDF\_{i,m}^{g}$ is the Power Transfer Distribution Factor for the bus *i* on transmission component *m* under the generator contingency case *g*, which represents the flow across that transmission component *m* when an increment of power is injected at bus *i* and an equivalent amount of power is withdrawn at the Reference Bus. The CAISO does not consider the effect of losses in the determination of PTDFs.

 $PTDF\_{n,m}^{g} $is the Power Transfer Distribution Factor for the bus *n* on transmission component *m* under the generator contingency case *g*, which represents the flow across that transmission component *m* when an increment of power is injected at bus *n* and an equivalent amount of power is withdrawn at the Reference Bus. The CAISO does not consider the effect of losses in the determination of PTDFs.

 *GLDFOg,n* is the generation loss distribution factor in the preventive generator contingency case *g*. The value is negative one when *n* is *Og*. This value is zero when *n* is not *Og*, and when *n* is not associated with a frequency response capable generator. This value is the committed generator maximum capacity at *n* divided by the sum of the maximum capacity from all committed frequency response capable generators when *n* is not *Og* and *n* is associated with a frequency response capable generator.

The MCC at PNodes in an EIM Entity Balancing Authority Area *j* in the Real Time Market includes an additional contribution from the shadow price of the power balance constraint for that Balancing Authority Area, *j*, as follows:

$$MCC\_{i}=λ\_{j}-\sum\_{m=1}^{M}PTDF\_{ij}∙μ\_{m}-\sum\_{k=1}^{K}\sum\_{m=1}^{M}PTDF\_{i,m}^{k} μ\_{m}^{k}-\sum\_{g=1}^{K\_{g}}\sum\_{m=1}^{M}\left(PTDF\_{i,m}^{g}+δ\_{O\_{g},i}\sum\_{n=1}^{N}PTDF\_{n,m}^{g} GLDF\_{O\_{g},n}\right) μ\_{m}^{g}$$

A power balance constraint is not formulated for the CAISO Balancing Authority Area alone in the RTM. The shadow price of the power balance constraint for EIM Entity Balancing Authority Area *j* (*j*) has the following contributions:

a) the shadow price of the EIM Transfer distribution constraint (*j*), which distributes the EIM Transfer for Balancing Authority Area *j* to Energy transfers on interties with other Balancing Authority Areas in the EIM Area; and

b) the shadow price of the EIM Transfer scheduling limit for Balancing Authority Area *j*, upper (*j*) or lower (*j*):

*j*  *j* - *j*  *j*

Where *j* is zero for the CAISO Balancing Authority Area since the power balance constraint is not formulated for it.

The difference between the shadow prices of the EIM Transfer distribution constraints for two Balancing Authority Areas *j* and *k* in the EIM Area has the following contributions from any intertie *l* used for energy transfers between these two Balancing Authority Areas:

a) the EIM Transfer schedule cost that applies to that intertie *l* (c*l*);

b) the shadow price of the Energy transfer schedule limit from Balancing Authority Area *j* to Balancing Authority Area *k* that applies to that intertie *l*, upper limit (*l*) or lower limit (*l*); and

c) the shadow price of the scheduling limit that constrains both Energy transfers and additional schedules to Balancing Authority Area *j* on that intertie *l*, upper limit (*l*) or lower limit (*l*):

*j* - *k*  -c*l* - *l*  *l*  *l* - *l*

There may be multiple scheduling limits under (c) above that constrain schedules on a given EIM Intertie.