ATTACHMENT D

TRANSMISSION LOSS CALCULATION

7.4 Transmission Losses.

7.4.1 Obligation to Provide for Transmission Losses.

Each Scheduling Coordinator shall ensure that it schedules sufficient Generation to meet both its Demand and Transmission Losses responsibilities as determined in accordance with this Section 7.4.

7.4.2 Determination of Transmission Losses.

The total Demand that may be served by a Generating Unit, in a given hour, taking account of Transmission Losses, is equal to the product of the total Metered Quantity of that Generating Unit in that hour and the Ex Post Generation Meter Multiplier calculated by the ISO in the hour for that Generator location except in accordance with Section 7.4.3. The Ex Post Generation Meter Multiplier shall be greater than one (1) where the Generating Unit's contribution to the ISO Controlled Grid reduces Transmission Losses and shall be less than one (1) where the Generating Unit's contribution to the system increases Transmission Losses. All Generating Units supplying Energy to the ISO Controlled Grid at the same electrical bus shall be assigned the same Ex Post Generation Meter Multiplier.

7.4.2.1 Procedures for Calculating Generation Meter Multiplier.

7.4.2.1.1 By 6:00 p.m. two days preceding a Trading Day, the ISO will calculate, and post on WEnet, an estimated Generation Meter Multiplier for each electrical bus at which one or more Generating Units may supply Energy to the ISO Controlled Grid. The Generation Meter Multipliers shall be determined utilizing the Power Flow Model based upon the ISO's forecasts of total Demand for the ISO Controlled Grid and Demand and Generation patterns throughout the ISO Controlled Grid. The ISO shall continuously update the data to be used in calculating the Generation Meter Multipliers to reflect changes in system conditions on the ISO Controlled Grid, and the ISO shall provide all Scheduling Coordinators with access to such data. The ISO shall not be required to determine new Generation Meter Multipliers for each hour; the ISO will determine the appropriate period for which each set of Generation Meter Multipliers will apply, which period may vary based upon the expected frequency and magnitude of changes in system conditions on the ISO Controlled Grid.

7.4.2.1.2 The ISO will calculate the Ex Post Generation Meter Multiplier for each electrical bus at which one or more Generating Units may supply Energy to the ISO Controlled Grid. The Ex Post Generation Meter Multipliers shall be determined utilizing the Power Flow Model based upon the ISO's total Demand for the ISO Controlled Grid and Demand and Generation patterns throughout the ISO Controlled Grid. The ISO's total Demand shall be determined using real time power flow data based on a state-estimation result.

7.4.2.2 Methodology for Calculating Generation Meter Multiplier. The ISO shall calculate the Generation Meter Multiplier for each Generating Unit location in a given hour by subtracting the Scaled Marginal Loss Rate from 1.0.

7.4.2.2.1 The Scaled Marginal Loss Rate for a given Generating Unit location in a given hour shall equal the product of (i) the Full Marginal Loss Rate for each Generating Unit location and hour, and (ii) the Loss Scale Factor for such hour.

7.4.2.2.2 The ISO shall calculate the Full Marginal Loss Rate for each Generating Unit location for an hour by utilizing the Power Flow Model to calculate the effect on total Transmission Losses for the ISO Controlled Grid of injecting an increment of Generation at each such Generating Unit location to serve an equivalent incremental MW of Demand distributed on a pro-rata basis throughout the ISO Controlled Grid.

7.4.2.2.3 The ISO shall determine the Loss Scale Factor for an hour by determining the ratio of forecast Transmission Losses to the total Transmission Losses which would be collected if Full Marginal Loss Rates were applied to each Generating Unit in that hour.

7.4.3 **[~~Not Used~~]** In the event that the Power Flow Model fails to determine Ex Post GMMs, for example if GMMs are outside the range of reasonability (typically 0.8 to 1.1), the ISO will use Default GMMs in their place.

23. Temporary Changes to the Real-Time Market for Imbalance Energy

23.2.1 Amendments to the Body of the ISO Tariff

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11.2.4.1 Net Settlements for ***Uninstructed*** Imbalance Energy.

Uninstructed Imbalance Energy attributable to each Scheduling Coordinator in each Settlement Period in the relevant Zone shall be deemed to be sold or purchased, as the case may be, by the ISO and ***charges or*** payments for ***Uninstructed*** Imbalance Energy shall be settled by debiting or crediting, as the case may be, the Scheduling Coordinator with an amount for each Settlement Period equal to ***the sum of***:

(a) The quantity of undelivered Instructed Imbalance Energy, multiplied by the Effective Price, and

(b) The quantity of deviation from the final Hour-Ahead Schedule multiplied by the Hourly Ex Post Price.

Imbalance Energy charge will be calculated as follows:

IECharge = DevC + ASSEDevC

where:

$$DevC = \sum_i GenDevC_i - \sum_i LoadDevC_i + \sum_q \mathrm{ImpDevC}_q - \sum_q ExpDevC_q + UFEC$$

$$ASSEDevC = \sum_i ASSEGenDevC_i + \sum_i ASSELoadDevC_i + \sum_q ASSEImpDevC_q$$

and

The deviation between scheduled and actual Energy Generation for Generator i represented by the Scheduling Coordinator for the Settlement Period is calculated as follows:

$$\underline{GenDev_i = G_s * GMM_f - \left[\left(G_a - G_{adj}\right) * GMM_a - G_{a/s} - G_{s/e}\right] - UnavailAncServMW_{ixt}}$$

$UnavailAncServMW_{ixt}$ =Max[-($G_{i,\ oblig}$-$G_{a/s}$), Min(0,Pmax- Ga-($G_{i,\ oblig}$-$G_{a/s}$))]

$GenDevC_i$= $GenDev_i$ * P in case of (b) above, and

If $G_{a/s} + G_{s/e} > 0$ and $P < P_{eff}$ then:

$ASSEGenDevC_i$=Max[0,[$G_{a/s}$+ $G_{s/e}$-Max[0,(G_a -G_{adj}-G_s)]]]* (P_{eff-I} -P) in case of (a) above, or

If $G_{a/s}$ + $G_{s/e}$ < 0 and P > P_{eff} then:

ASSEGenDevC$_i$=Min[0,[$G_{a/s}$+$G_{s/e}$ -Min[0,(G_a -G_{adj}-G_s)]]]* (P_{eff-I} -P) in case of (a) above

The deviation between scheduled and actual Load consumption for Load i represented by the Scheduling Coordinator for the Settlement Period is calculated as follows:

$$LoadDev_i = L_s - \left[\left(L_a - L_{adj}\right) + L_{a/s} + L_{s/e}\right] - UnavailDispLoadMW_{ixt}$$

Where:

UnavailDispLoadMW$_{ixt}$= Max[0, ($L_{i,\ oblig}$-$L_{a/s}$)-L_a]

LoadDevC$_i$=LoadDev$_i$ * P in case of (b) above, and

If $L_{a/s}$ + $L_{s/e}$ > 0 and P < P_{eff} then:

ASSELoadDevC$_i$=Max[0,[$L_{a/s}$ +$L_{s/e}$-Max[0,-(L_a -L_{adj}-L_s)]]]* (P_{eff-I} -P) in case of (a) above, or

If $L_{a/s}$ + $L_{s/e}$ < 0 and P > P_{eff} then:

ASSELoadDevC$_i$=Min[0,[$L_{a/s}$ +$L_{s/e}$-Min[0,-(L_a -L_{adj}-L_s)]]]* (P_{eff-I} -P) in case of (a) above

The deviation between forward, scheduled and Real Time adjustments to Energy imports, adjusted for losses, for Scheduling Point q represented by the Scheduling Coordinator for the Settlement Period is calculated as follows:

$$ImpDev_q = I_s * GMM_{fq} - \left[\left(I_a - I_{adj}\right) * GMM_{aq}\right] + I_{a/s}$$

ImpDevC$_q$= ImpDev$_q$ * P in case of (b) above, and

If $I_{a/s}$ > 0 and P < P_{eff} then

ASSEImpDevC$_q$=Max[0,[$L_{a/s}$ -Max[0,(L_a -L_{adj}-L_s)]]]* (P_{eff-q} -P) in case of (a) above, or

If $I_{a/s}$ < 0 and P > P_{eff} then:

ASSEImpDevC$_q$=Min[0,[$L_{a/s}$ -Min[0,(L_a -L_{adj}-L_s)]]]* (P_{eff-q} -P) in case of (a) above

The deviation between forward, scheduled and Real Time adjustments to Energy exports for Scheduling Point q represented by the Scheduling Coordinator for the Settlement Period is calculated as follows:

$$ExpDev_q = E_s - (E_a - E_{adj})$$

ExpDevC$_q$= ExpDev$_q$ * P

and where:

G_s = sum of effective schedules for Day-Ahead and Hour-Ahead

GMM_f = estimated GMM for Day-Ahead

G_a = actual metered Generation

G_{adj} = deviations in real time ordered by the ISO for purposes such as Congestion Management

~~GMM_{ah} = hour-ahead GMM (proxy for ex-post GMM)~~

GMM_a = *Ex Post GMM*

$G_{a/s}$ = Energy generated from Ancillary Service resource ~~or Supplemental Energy resource~~ due to ISO dispatch instruction

$G_{s/e}$ = ***Energy generated from Supplemental Energy resource due to ISO dispatch instruction***

L_s = sum of Demand scheduled for Day-Ahead and Hour-Ahead

L_a = actual metered Demand
L_{adj} = Demand deviation in real time ordered by ISO for purposes such as Congestion Management

$L_{a/s}$ = Demand reduction from Ancillary Service resource due to ISO dispatch instruction

$L_{s/e}$ = ***Demand reduction from Supplemental Energy resource due to ISO dispatch instruction.***

GMM_{fq} = estimated GMM for an Energy import at Scheduling Point q for Day-Ahead

~~GMM_{ahq} = estimated GMM for an Energy import at Scheduling Point q for Hour-Ahead (proxy for ex-post GMM)~~

GMM_{aq} = *Ex Post GMM for an Energy import at Scheduling Point q*

I_S = sum of Scheduled Energy import scheduled through Scheduling Point q for Day-Ahead and Hour-Ahead

I_a = sum of actual Energy import scheduled through Scheduling Point q.

I_{adj} = deviation in real time import ordered by ISO for purposes such as Congestion Management, and import curtailment.

$I_{a/s}$ = Energy generated from Ancillary Service System Resources or Supplemental Energy from interties due to dispatch instruction

E_S = sum of scheduled Energy export scheduled through Scheduled Point q for Day-Ahead and Hour-Ahead

E_a = sum of actual Energy export scheduled through Scheduling Point q for Day-Ahead and Hour-Ahead

E_{adj} = deviation in real time export ordered by ISO for purposes such as Congestion Management, and export curtailment

P = Hourly Ex Post Price for ***Uninstructed*** Imbalance Energy for the relevant hour***, as defined in Section 2.5.23.2.2***

P_{eff} = Effective Price for Instructed Imbalance Energy for the relevant Settlement Period

$G_{i, oblig}$ = the amount of Spinning Reserve, the amount of Non-Spinning Reserve, and the amount of Replacement Reserve that Generating Unit or System Resource i has been selected to supply to the ISO, as reflected in final Ancillary Services schedules.

$PMax_i$ = the maximum capability (in MW) at which Energy and Ancillary Services may be scheduled from the Generating Unit or System Resource i.

$L_{i, oblig}$ = the amount of Non-Spinning Reserve and Replacement Reserve that dispatchable Load i has been selected to supply to the ISO, as reflected in final Ancillary Services schedules for Settlement Period t.

UFEC = the Unaccounted for Energy Charge for the Scheduling Coordinator calculated as follows:

Unaccounted for Energy Charge

The hourly Unaccounted for Energy Charge on Scheduling Coordinator j for Settlement Period t for each relevant Zone is calculated in the following manner:

The UFE for each utility service territory *k* is calculated as follows,

$$E_{UFE\_UDC\_k} = \left(I_k - E_k + G_k - \left(RTM_k + LPM_k\right) - TL_k\right)$$

The Transmission Loss calculation per Settlement Period t per relevant Zone for each utility service territory k is calculated as follows,

$$TL_k = \sum\left[G_a * \left(1 - GMM_a\right)\right] + \sum\left[I_a\left(1 - GMM_{aq}\right)\right]$$

Each metered demand point, either ISO grid connected or connected through a UDC, is allocated a portion of the UFE as follows:

$$E_{UFE\_z} = \frac{D_z}{\sum_Z D_z} E_{UFE\_UDC\_k}$$

The UFE charge for Scheduling Coordinator j per Settlement Period per relevant Zone is then,

$$UFEC_j = \left(\sum_z E_{UFE\_z} \right) * P_{xt}$$

Where the terms used in the equations have the following meaning:

$E_{UFE\_UDC\_k}$ -- MWh

The Unaccounted for Energy (UFE) for utility service territory k.

E_{UFE_z} -- MWh

The portion of Unaccounted for Energy (UFE) allocated to metering point z.

I_k -- MWh

The total metered imports into utility service territory k in Settlement Period t.

E_k -- MWh

The total metered exports from utility service territory k in Settlement

Period t.

G_k -- MWh

The total metered Generation in Settlement Period t in utility service territory k.

RTM_k -- MWh

The Settlement Period t total of the real-time metering in utility service territory k in Settlement Period t.

LPM_k -- MWh

The calculated total of the Load Profile metering in utility service territory k per Settlement Period t.

TL_k -- MWh

The Transmission Losses per Settlement Period t in utility service territory k.

D_z -- MWh

The Demand including Exports in Settlement Period t at metered point z

The ISO shall develop protocols and procedures for the monitoring of persistent intentional excessive imbalances by Scheduling Coordinators and for the imposition of appropriate sanctions and/or penalties to deter such behavior. The net balance of the charges attributable to all Scheduling Coordinators represents the Transmission Losses imbalance total for each hourly Settlement Period.

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23.5 Amendments to the Settlement and Billing Protocol

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~~D 2.1~~***D 2.1.1 Uninstructed*** Imbalance Energy Charges on Scheduling Coordinators

Uninstructed Imbalance Energy attributable to each Scheduling Coordinator in each Settlement Period in the relevant Zone shall be deemed to be sold or purchased, as the case may be, by the ISO and charges or payments for Uninstructed Imbalance Energy shall be settled by debiting or crediting, as the case may be, the Scheduling Coordinator with an amount for each Settlement Period equal to the sum of:

(a) The quantity of undelivered Instructed Imbalance Energy, multiplied by the Effective Price, and

(b) The quantity of deviation from the final Hour-Ahead Schedule multiplied by the Hourly Ex Post Price.

Imbalance Energy charge will be calculated as follows:

$IECharge = DevC + ASSEDevC$

Where:

$$DevC = \sum_i GenDevC_i - \sum_i LoadDevC_i + \sum_q ImpDevC_q - \sum_q ExpDevC_q + UFEC$$

$$ASSEDevC = \sum_i ASSEGenDevC_i + \sum_i ASSELoadDevC_i + \sum_q ASSEImpDevC_q$$

and

The deviation between scheduled and actual Energy Generation for Generator i represented by Scheduling Coordinator j in Zone x during ~~***Trading Interval t***~~ ***Settlement Period t*** is calculated as follows:

$$GenDevC_i = G_s * GMM_f - [(G_a - G_{adj}) * GMM_{a\cancel{h}} - G_{a/s} - G_{s/e}] - UnavailAncServMW_{ixt}$$

Where:

$UnavailAncServMW_{ixt} = Max[-(G_{i,oblig} - G_{a/s}), Min(0, PMax - Ga - (G_{i,oblig} - G_{a/s}))]$

$GenDevC_i = GenDev_i * P$ in case of (b) above, and

If $G_{a/s} + G_{s/e} > 0$ and $P < P_{eff}$ then:

$ASSEGenDevC_i=Max[0,[G_{a/s}+ G_{s/e}-Max[0,(G_a-G_{adj}-G_s)]]]*(P_{eff-I}-P)$ in case of (a) above, or

If $G_{a/s} + G_{s/e} < 0$ and $P > P_{eff}$ then:

$ASSEGenDevC_i=Min[0,[G_{a/s}+ G_{s/e}-Min[0,(G_a-G_{adj}-G_s)]]]*(P_{eff-I}-P)$ in case of (a) above

The deviation between scheduled and actual Load consumption for Load i represented by Scheduling Coordinator j in Zone x during Trading Interval t is calculated as follows:

The deviation between scheduled and actual Load consumption for Load i represented by Scheduling Coordinator j in Zone x during Trading Interval t is calculated as follows:

$$LoadDev_i = L_s - \left[\left(L_a - L_{adj}\right) + L_{a/s} + L_{s/e}\right] - UnavailDispLoadMW_{ixt}$$

Where:

$UnavailDispLoadMW_{ixt} = \quad Max[0, (L_{i,\ oblig} - L_{a/s}) - L_a]$

$LoadDevC_i = LoadDev_i * P$ in case of (b) above, and

If $L_{a/s} + L_{s/e} > 0$ and $P < P_{eff}$ then:

$ASSELoadDevC_i=Max[0,[L_{a/s}+ L_{s/e}-Max[0,-(L_a-L_{adj}-L_s)]]]*(P_{eff-I}-P)$ in case of (a) above, or

If $L_{a/s} + L_{s/e} < 0$ and $P > P_{eff}$ then:

$ASSELoadDevC_i=Min[0,[L_{a/s}+L_{s/e}-Min[0,-(L_a-L_{adj}-L_s)]]]*(P_{eff-I}-P)$ in case of (a) above

The deviation between forward scheduled and Real Time adjustments to Energy imports[1], adjusted for losses, for Scheduling Point q represented

by Scheduling Coordinator j into zone x during ~~***Trading Interval t***~~ <u>***Settlement Period t***</u> is calculated as follows:

$ImpDev_q = I_s * GMM_{fq} - [(I_a - I_{adj}) *GMM_{ahq}]+I_{a/s}$

$ImpDevC_q = ImpDev_q * P$ in case of (b) above, and

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1 Note that this deviation is a difference between a forward Market value and a Real Time value. It is not inadvertent energy.

2 Note that this deviation is a difference between a forward Market value and a Real Time value. It is not inadvertent energy.

If $I_{a/s} > 0$ and $P < P_{eff}$ then:

$ASSEImpDevC_q=Max[0,[I_{a/s}-Max[0,(I_a-I_{adj}-I_s)]]]*(P_{eff-q}-P)$ in case of (a) above, or

If $I_{a/s} < 0$ and $P > P_{eff}$ then:

$ASSEImpDevC_q=Min[0,[I_{a/s}-Min[0,(I_a-I_{adj}-I_s)]]]*(P_{eff-q}-P)$ in case of (a) above

The deviation between forward scheduled and Real Time adjustments to Energy exports[2] for Scheduling Point q represented by Scheduling Coordinator j from Zone x during ~~***Trading Interval t***~~ ***Settlement Period t*** is calculated as follows:

$$ExpDev_q = E_s - Ea - E_{adj}$$

$$ExpDevC_q = ExpDev_q * P$$

The Hourly Ex Post Price applicable to uninstructed deviations in Settlement Period t in each zone will equal the Energy weighted average of the BEEP Interval charges in each zone, calculated as follows:

$$P_{xt} = \frac{(\sum_{ji} \left| MWh_{jix} \right| * BIP_{ix})}{\sum_{ji} \left| IMWh_{jix} \right|}$$

Where:

BIP_{jx}= BEEP Interval Ex Post Price

P_{xt} = the Hourly Ex Post Price in Zone x

$IIEC_{jix}$ = the Instructed Imbalance Energy Charges for Scheduling Coordinator j for BEEP Interval i in Zone x

$IMWH_{jix}$ = the Instructed Imbalance Energy for Scheduling Coordinator j for the BEEP Interval i in Zone x

D 2.1.2 Instructed Imbalance Energy Charges on Scheduling Coordinators

The Instructed Imbalance Energy charge for Settlement Period t for Scheduling Coordinator j for Zone x is calculated using the following formula:

$IIEC_j = IGDC_j + ILDC_j + IIDC_j$

The instructed Generation deviation payment/charge is calculated as follows:

$$IGDC_j = \sum_{gi} \frac{G_{gi} * P_i}{HBI}$$

The instructed Load deviation payment/charge is calculated as follows:

$$ILDC_j = \sum_{Li} \frac{L_{Li} * P_i}{HBI}$$

The instructed import deviation payment/charge is calculated as follows:

$$IIDC_j = \sum_{Ii} \frac{I_{Ii} * P_i}{HBI}$$

D 3.38 $IGDC_j$ - $

The total of instructed Generation deviation payments/charges for Scheduling Coordinator j in Settlement Period t.

D 3.39 $ILDC_j$ - $

The total of instructed Load deviation payments/charges for Scheduling Coordinator j in Settlement Period t.

D 3.40 $IIDC_j$ - $

The total of instructed import deviation payments/charges for Scheduling Coordinator j in Settlement Period t.

D 3.41 G_{gi} - MW

Instructed Energy for Generating Unit g during BEEP Interval i.

D 3.42 L_{Li} - MW

Instructed Energy for Load L during BEEP Interval i.

D 3.43 I_i – MW

Instructed Energy for import I during BEEP Interval i

D 3.44 P_i -- $/MWh

The BEEP Incremental Ex Post Price for BEEP Interval i if the net instructed Energy for resources is positive, or the BEEP decremental EX Post Price for BEEP Interval i if the net instructed Energy for resources is negative.

D 3.45 HBI – Number

The number (2-12) of BEEP Intervals in Settlement Period t.

D 3.46 ReplObligRatio$_{jxt}$ – fraction

$$ReplObligRatio_{jxt} = \frac{ReplOblig_{jxt}}{\sum_j ReplOblig_{jxt}}$$

where:

where:

ReplOblig$_{jxt}$ is the replacement reserve capacity obligation as defined in Appendix C section C3.67.

Appendix A

Master Definitions Supplement

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Default GMM	Pre calculated GMM based on historical Load and interchange levels.

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Ex Post GMM	GMM that is calculated utilizing the real time Power Flow Model in accordance with Section 7.4.2.1.2.
Ex Post Prices	The Hourly Ex Post Price or the BEEP Interval Ex Post Prices.
Ex Post Transmission Loss	Transmission Loss that is calculated based on Ex Post GMM.

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Scheduling Protocol

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SP 4.2.1 Derivation of GMMs

(a) The ISO will utilize the Power Flow Model to determine the GMMs which will be used to allocate, to each Generating Unit and external import, scheduled and ~~re-estimated~~ Ex Post Transmission Losses.

(b) For each Settlement Period, the GMMs will be first calculated before SCs submit Day-Ahead Preferred Schedules. Prior to the time when SCs are required to submit their Day-Ahead Preferred Schedules, the ISO will forecast the total Control Area Demand. This forecast, along with the ISO forecast of Generation and Demand patterns throughout the ISO Control Area, will be used to develop estimated GMMs for each Generating Unit and each external import. The ISO will calculate and publish (in accordance with SP 3.2.1) GMMs for each Settlement Period to reflect different expected Generation and Demand patterns and expected operations and maintenance requirements, such as line Outages, which could affect Transmission Loss determination and allocation.

(c) ~~After determination of the Final Schedules in the Hour-Ahead Market, t~~The ISO will utilize the real time Power Flow Model to calculate ~~revised~~ Ex Post GMMs to allocate ~~re-estimated~~Ex Post Transmission Losses to each Generating Unit and each external import. This run of the Power Flow Model will use metered Generation and Demand ~~from the Final Hour-Ahead Schedule~~. Any difference between scheduled and ~~re-estimated~~Ex Post Transmission Losses will be considered as an Imbalance Energy deviation and will be purchased or sold in the Real Time Market at the Hourly Ex Post Price.