ConOp

Internal NYISO HVDC Controllable Line Scheduling

Concept of Operation

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Revision History

Date	**Additions, deletions, modifications**
	First Draft
1-30-04	Second Draft
2-6-04	Third Draft
5-4-04	Fourth Draft, changes include: • Limited the ConOp to just HVDC lines • Defined a controllable line • Clarified that MMU will consider standards and thresholds as needed for a new facility • Added revenue formulas • Clarified that performance criteria will be applied

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1. Introduction

COO 619 previously described the concept of operations for the NYISO business systems required for commercial operation of controllable lines interconnecting the NYISO with adjacent control areas. This concept of operations identifies the generalized business system requirements for scheduling and settlement of DC controllable lines that are internal to the NYCA transmission grid.

Under this approach a merchant transmission operator (MTO) would turn over the scheduling of the DC controllable line to the NYISO. That is, the NYISO would optimize the use of the DC controllable line as part of the overall NYISO transmission system. The NYISO would also set schedules for injections and withdrawals on the line which would be communicated to the MTO. Settlements with the MTO would be based on the overall economic value of the line (the rents it generates based on the LMP differential).

2. Definitions and Abbreviations

Item	**Description**
ATC	Available Transmission Capacity
BME	Balancing Market Evaluation
CRG	Customer Relations Group
HVDC	High Voltage Direct Current
MIS	Market Information System
MP	Market Participant
MTF	Merchant Transmission Facility
MTO	Merchant Transmission Operator
NERC	North American Electric Reliability Council
NYCA	NY Control Area
OASIS	Open Access Same Time Information System
PI	Plant Information, an application that collects real-time time-series data
PTF	Power Transmission Facility
SCUC	Security Constrained Unit Commitment

3. Discussion

3.1. Background

For the purposes of this concept document an internal DC controllable line is defined as a high voltage direct current (HVDC) facility that has both its source and sink terminals located within the New York Control Area (NYCA) and is controllable such that the power flows on the line can be set to a desired schedule.

3.2. Objective

Development of NYISO systems required for commercial operation of DC controllable lines having both sources and sinks located within the NYCA.

3.3. Scope and Deliverables

The following is a high-level overview of the projected scope and deliverables of this project:

- A source and sink proxy bus will be modeled for each internal DC controllable line.
- Definition of security issues (i.e., ramping limits).
- Installation of required metering and sign verification.
- Definition of possible changes calculations.
- Modifications to dispatchers' displays.
- System model modifications.
- Revision to *NYISO Facilities Requiring Coordination and Notification in NYISO Operating Manuals*
- SCUC and RTC will be able to economically evaluate use of the line based on line losses and operating costs.
- Line loss and operating costs specified by the DC controllable line operator will be subject to mitigation in RTS.
- RTD – Corrective action mode should be able to evaluate and make changes in schedules on the DC controllable line.

3.4. System Impact

3.4.1. Functional Business Units

The following NYISO functional business units will be impacted by this project:

- Market Services
  - The following manuals may require updating: *Emergency Operations, Outage Scheduling, and Transmission and Dispatching Operations*.
  - Customer registration procedures will require modification.
- Operations and Reliability
  - Display changes will be required.
  - Operating Instructions and Procedures will require updating.
  - Scheduling procedures will require development.
  - Operating procedures will need to be incorporated into NYISO dispatcher training.
- Billing and Accounting
- MMU real-time mitigation standards and approaches will need to be developed.

3.4.2. NYISO Systems

The following NYISO systems will be impacted by this project:

- BAS:
  - Addition of PTIDs to the sub-zone load tables.
  - Inclusion of PTIDs in relevant templates for download of MWh and settlement data.
- EMS/BMS:
  - Addition of buses in the unit commitment models (SCUC and BME).
  - Addition of PTIDs to PTS.
  - Addition of the DC controllable line to the State Estimator.
  - Addition of DC controllable line data to PI.
  - Addition of scheduling logic in SCUC and RTS, including mitigation in RTS and SCUC. SCUC and RTS would account for losses on the DC controllable line and would be able to attach a variable cost to scheduling power to flow on the DC controllable line.
- TCC auction and settlements
  - Addition of DC controllable line data and TCCs to base auction data.
  - Evaluate and award expansion TCCs.

4. Description

4.1. Creation of Additional Proxy Buses

Additional source and sink proxy buses would be created for each internal DC controllable line. The prices at these proxy buses would be used for settlements with the MTO.

4.2. NYISO Scheduling Procedures

4.2.1. Scheduling Prior to the Schedule Hour

Schedule Day Minus 1:

- The MTO will inform the NYISO of the available capacity on the line, the loss factor (i.e. the ratio of injections to withdrawals) to be used in scheduling the line, and the variable operating cost per MWh to be used in scheduling the line.
- No special provision will be made for accepting virtual supply and demand bids at the MTO proxy buses nodes.
- The NYISO will run the Day-Ahead Market and as part of the DAM posting, the MTO will receive an hourly schedule of flows on the DC controllable line.

Schedule Day:

- Prior to each hourly market closing, the MTO will inform the NYISO of the available capacity on the line, the loss factor (i.e., the ratio of injections to withdrawals) to be used in operating the line, and the variable operating cost per MWh to be used in scheduling the line.

- As part of the normal in-day scheduling process, the NYISO will initiate an RTC execution every 15 minutes for the quarter hour.[1]
- 15 minutes prior to each quarter hour the NYISO will post the scheduled flows on the DC controllable line for the upcoming quarter hour.[2]
- The DC controllable line is ramped to the new schedule from 5 minutes of to 5 minutes after the quarter hour.[3]

4.2.2. In-hour Operations

In general, DC controllable line schedules will be determined by RTC and the NYISO will redispatch the system to maintain these schedules on internal DC controllable lines. The cost of this redispatch will be reflected in the price of energy at the injection and withdrawal proxy buses for the DC controllable line.

In the event an intra-quarter hour schedule change is required for reliability purposes (as determined by RTD-CAM), the NYISO will coordinate with the MTO to make the change.

Formal notification procedures for intra-quarter hour schedule changes will need to be developed, which will include the following:

- Coordination of the NYISO, MTO and affected TOs for various scenarios.
- Specification of the number of MWs required, direction of change, ramp rate and time of change initiation.
- Communication among the parties for various scenarios.
- Conditions when parties other than the above need to be notified.
- Conditions when defined procedures may be deviated from, such as an extreme emergency (risk to life or equipment). Post-event communication procedures will be defined for these cases.
- Post-event notification and coordination procedures, which will include schedule verifications.

4.3. Market Power Mitigation

Market power mitigation will potentially be applied to the scheduling of the line in SCUC and RTS. This mitigation would potentially apply to the loss factor and variable cost parameter. The Market Monitoring & Performance Unit will consider what standards should be applied and will develop thresholds as needed for a new facility.

The NYISO will optimize use of the DC controllable line based on costs in both SCUC and RTS and arbitrage of day-ahead and real-time prices will be based on normal virtual supply offers and demand bids (which are currently zonal).

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[1] This procedure will apply to internal DC controllable lines able to accommodate quarter hour schedule changes. Lines not able to accommodate quarter hour schedule changes will receive hourly schedules.

[2] This procedure will apply to internal controllable lines able to accommodate quarter hour schedule changes. Lines not able to accommodate quarter hour schedule changes will receive hourly schedules.

[3] This procedure will apply to internal controllable lines able to accommodate quarter hour schedule changes. Lines not able to accommodate quarter hour schedule changes will receive hourly schedules.

4.4. Metering and Sign Verification

Metering required to properly monitor and operate the DC controllable line will need to be identified. Quantities to be metered and required granularity will be determined. Upon installation, readings will need to be verified for accuracy and that they conform to NYISO sign convention.

4.5. Settlements

4.5.1. Pricing

The pricing of energy delivered over the DC controllable line would be governed by the fundamental LBMP pricing equation:

$$P_i = (1 + L_i)\, P_{ref} + \Sigma_j\, \Sigma_k\, SP_{jk}\, SF_{jki}; \qquad [1]$$

Where:

P_i = Locational price at Bus i;

L_i = Marginal loss factor at Bus i;

P_{ref} = Locational price at the reference bus;

SP_{jk} = Shadow price of constraint j in contingency k; and

Sf_{jki} = Shift factor for real load at Bus i on constraint j, in contingency k.

The special consideration in applying the LMP pricing equation to deliveries over DCcontrollable lines is that energy scheduled to flow over a DC controllable line would be priced as withdrawn and injected at a distinct proxy bus, i.e., energy scheduled to flow over a controllable line would be modeled distinctly from energy injected by generation at the point of delivery from the DC controllable line. Thus, distinct prices would be calculated for deliveries of energy over a DC controllable line to a bus and from a generator at that bus, and the prices could differ, depending on the binding constraints and contingencies.

Similarly, the proxy bus price for energy injected at a given point[4] and scheduled to flow over a DC controllable line would be distinct from and could exceed the proxy bus price for energy withdrawn to meet load at the same bus.

In most circumstances, energy scheduled and delivered over a DC controllable line will be priced as if delivered from a generator located at the delivery point of the DC controllable line and withdrawn from the NYISO by a load located at the receipt point. This would not be the case in the circumstance in which the outage of the DC controllable line is one of the binding contingencies[5] nor in the case in which the post-contingency level of flows on the DC controllable line impacts a binding transmission constraint.

In the circumstance in which the contingency outage of the DC controllable line is the only binding contingency, the congestion component of the price paid for energy scheduled and delivered over the DC controllable line would be the same as the congestion component of the price at the withdrawal point for the DC controllable line. Thus, it would not be economic to schedule the internal DC controllable line to operate at this level since the DC controllable line would not be meeting its variable operating cost requirements. Another circumstance in which the congestion component of the LBMP price at the DC controllable lines proxy buses may differ from the congestion component of the price paid by or to loads and generation at the source and sink of the DC controllable line is the situation in which the post-contingency flows on the DC controllable line exceed the pre-contingency flows and impact a binding

[4] This point could either be another control area or the source bus of the controllable line.

[5] It is anticipated that DC lines will generally be sized such that their outage would normally not be the binding contingency, but such a situation may nevertheless arise from time to time.

transmission constraint.[6] Since the loss components of the LMP price are calculated pre-contingency, they might still differ between the source and sink of the DC controllable line in either of these circumstances.

4.5.2. Settlement Approaches

The DC controllable line will be made available by the MTO for scheduling by the NYISO along with the rest of the transmission system by SCUC in the day-ahead market and by RTC in real-time. The scheduling of the internal DC controllable line by the NYISO would generate rents based on the LBMP differential and the value of these rents would be assigned to the MTO.

There are several potential mechanisms by which the rents generated by the DC controllable line might be identified and assigned to the MTO:[7] TCC Obligations and Options; Make Whole Approach; and NYISO Schedule Approach.

4.5.2.1 NYISO Schedule Approach

The preferred approach to settlements for DC lines would be for the NYISO to calculate the value of the day-ahead schedule on the DC controllable line and the value of the real-time deviations from the day-ahead schedule and assign this value to the MTO.

The rents paid to the MTO will be calculated based on the LBMP differential in the day-ahead and real-time markets. The rents in the day-ahead market would be the LBMP price at the point of delivery times the day-ahead delivery schedule minus the LBMP price at the source times the day-ahead withdrawal schedule at the DC controllable line source proxy bus. The rents in the real-time market would be the real-time LBMP price at the point of delivery times the difference between the real-time deliveries and the day-ahead delivery schedule minus the real-time LBMP price at the source times the difference between the real-time withdrawals and the day-ahead withdrawal schedule at the DC controllable line source proxy bus. As discussed in Section 4.5.1 the price at the DC controllable line source proxy bus may be higher than the price for generation or loads connected to the system at the same location because of different post contingency flows.

The formula for Day-Ahead Revenue is as follows:

$$\text{Day-Ahead Revenue} = \text{DA LBMP}_{POD} \times \text{Scheduled Flow}_{POD} - \text{DA LBMP}_{POR} \times \text{Scheduled Flow}_{POR}$$

The formula for Real-Time Revenue is as follows:

$$\text{Real-Time Revenue} = \text{RT LBMP}_{POD} \times (\text{Metered Flow}_{POD} - \text{Scheduled Flow}_{POD}) - \text{RT LBMP}_{POR} \times (\text{Metered Flow}_{POR} - \text{Scheduled Flow}_{POR})$$

Where:

POD is the Point of Delivery to the AC power system
POR is the Point of Receipt from the AC power system

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[6] This circumstance would generally not arise for DC lines, which would be able to control post-contingency flows.

[7] The MTO may contractually assign these rents to other entities, such as entities buying capacity on the line.

The line rents calculated in this manner will in many circumstances reflect the full economic value of the controllable transmission line. There are, however, circumstances in which this will not be the case. These circumstances are in general cases in which the post-contingency flows on the DC controllable line are different from the pre-contingency flows on the line. The MTO would be assigned TCCs that could capture the additional value of the DC controllable line in these circumstances. These TCCs would be of three general types.

First, if the contingency outage of the DC controllable line is likely to be a binding contingency, the MTO would be assigned TCCs from the load bus at the point of withdrawal to the DC controllable line withdrawal proxy bus reflecting the increase in transfer capability between the source and sink in this contingency.

Second, if there is a potential for the post-contingency flows on the DC controllable line to exceed the pre-contingency flows, then the MTO would be assigned TCCs reflecting the impact of the operation of the MTF on transfer capability. In this circumstance, the change in transfer capability could be either greater or less than the pre-contingency schedule on the DC controllable line. In the instance in which the level of post-contingency flows on the DC controllable line would adversely impact a binding constraint, the impact of the DC controllable line on transfer capability could be either positive or negative.

In the instance in which post-contingency flows on the DC controllable line either relieve or do not impact the binding constraints, the increase in transfer capability provided by the DC controllable line may exceed the pre-contingency schedules on the line and additional TCCs could be awarded to the MTO.

The third circumstance in which TCCs would be awarded to the MTO is the circumstance in which the operation of the DC controllable line impacts the transfer capability of the AC system, by impacting voltage or stability limits.[8]

All of these TCC awards would be subject to the application of the make-whole approach in the DAM.

4.5.2.3 Real-Time Performance

The DAM settlements, including TCC payments for DC controllable lines, would be subject to application of a settlement mechanism to deviations between day-ahead schedules and real-time schedules and between real-time schedules and real-time flows. Differences between day-ahead and real-time schedules would be settled at real-time prices.

In the event that actual flows over a DC controllable line are less than the quarter hourly schedules, the NYISO schedule approach will be applied to the actual flows over the DC controllable line. Thus, if actual deliveries are less than schedules, the MTO will be compensated only for actual deliveries.

Similarly, MTOs awarded TCCs would also be subject to the application of the make-whole approach to differences between day-ahead availability and schedules and real-time performance.

There will be no compensation for unscheduled excess delivery above the 3% tolerance window.

4.5.2.4 Bid Production Cost Guarantee

In addition to payments based on the LBMP differential and TCCs, an MTO would potentially receive bid production cost guarantee payments in the event real-time schedules are uneconomic at real-time prices. The potential for revenue shortfalls will exist with 15-minute schedules (because 5-minute prices may differ from those expected by RTC) and will be greater for lines scheduled on an hourly basis.

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[8] While these effects would generally be to improve transfer capability, the criterion would be applicable in the circumstance in which operation of the controllable line adversely impacted voltage or stability limits.

The bid production cost guarantee would also be applicable to day-ahead schedules, although the circumstances in which such a revenue shortfall would arise in the DAM are not readily apparent. The DC controllable line bid production cost guarantee would not be applicable to real-time revenue shortfalls arising from deratings or unavailability of the MTF. In the event that the MTO is awarded TCCs, the application of the BPCG to DAM revenues would include these TCC revenues.

4.6. ICAP/UCAP Treatment

4.6.1. UDR

Internal DC controllable lines will be eligible for assignment of Unforced Capacity Deliverability Rights (UDRs). Locational ICAP requirements will be determined as if the internal DC controllable line does not exist for the New York City Locality, Zone J and the Long Island Locality, Zone K, respectively.

UDRs will be granted based on Installed Capacity backed energy that is deliverable to the NYCA interface with the Locality. Availability both of the DC controllable line and associated ICAP generation will be tracked.