Technical Bulletin

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Information on Modeling of Transmission Constraints

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This bulletin provides information on modeling of transmission constraints in the ISO market with recent examples after a significant generation outage in Southern California.

1. Background

Transmission constraints are modeled in the ISO market to safeguard system reliability. Market applications automatically adjust system resources to relieve or mitigate any transmission congestion to avoid physical overload and/or other limit violations in the power systems as mandated by applicable industry reliability standards.

2. Transmission Constraints

Different types of transmission constraints may be appropriate depending on the operational circumstances. The commonly used transmission constraints are listed below:

- Normal flowgate ratings.
- Emergency flowgate ratings (observed by running pre-defined contingencies in the market software automatically).
- Nomogram limits and branch group limits.
- Minimum online capacity (MOC, presently in day-ahead).
- Intertie scheduling limits (MSL or ITC).

Some of the major constraints and nomograms are defined at a high level in the BPM for Management of the Full Network Model and the BPM for Market Operations. Below are some additional details on the actions the ISO can take in modeling a particular constraint through: 1) defining a contingency in the day-ahead/real-time markets, 2) adding a nomogram in the day-ahead/real-time markets and/or; 3) adding an MOC in the day-ahead market.

3. Application considerations

The three modeling approaches discussed above are all methods to protect against or prepare the system for the next contingencies or N-1 contingencies.

3.1 Defining a contingency

A contingency can be incorporated into the ISO market network model by opening certain breakers and/or disconnects that remove a transmission element. Once a contingency is incorporated in the market applications, the market software can automatically run a power flow solution to verify that opening the breakers/disconnects will result in power flow on all monitored

flowgates exceeding their respective emergency ratings. The market software would then economically dispatch resources to reduce/mitigate any overload.

A contingency can be used when the potential reliability concern is limited to thermal overload issues only. Presently, the power flow algorithm in the market software only checks for over load conditions. It does not simulate voltage collapse or transient stability. Therefore, if there are reliability concerns other than thermal overloads such as voltage instability and transient instability, use of contingencies in the market would not be appropriate. A contingency that removes supply or demand cannot be modeled because doing so disrupts the power balance. Other limitations of using a contingency include lack of WECC full network model and RAS/SPS logic and pre-programmed actions.

Modeling of contingencies can occur in both day-ahead and real-time markets.

3.2 Nomogram limits and branch group limits

A nomogram is a linear expression of two or more variables. The most common use of a nomogram in the ISO market is to model a combined loading limit on two or more circuits such that upon loss of one of the circuits, the remaining circuit would be above their respective emergency ratings. The limit is referred to as the right hand side (RHS) limit.

C1 * (power flow on flowgate 1) + C2 * (power flow on flowgate 2) + …< RHS

Coefficients C1 and C2 … are pre-determined using offline power flow by operations engineers. For thermal overload constraint, C1 and C2 are also referred to as outage distribution factors or shift factors.

Nomograms are versatile and commonly used in the ISO market to model various types of transmission constraint. They can be used for N-1 thermal overload reliability concerns as well as voltage collapse and transient instability concerns. When used for voltage collapse and transient stability limits, coefficients C1 and C2 … are usually of value 1.

Use of a nomogram is not limited to model a simple contingency. It can also be used when a contingency triggers RAS/SPS actions or results in loss of supply or demand.

Nomograms are used in both day-ahead and real-time markets.

3.3 Minimum Online Commitment (MOC)

Unlike a contingencies or a nomogram, an MOC is a constraint used in the day-ahead or real-time market to secure a minimum amount of capacity to be online at or above Pmin in real-time. MOC is usually used to meet minimum reactive power margins required to protect against voltage collapse should the next contingency occurs in real-time. MOC can also be used to provide minimum amount of inertia required to protect against transient instability in real-time.

4. Examples

Example 1: SDGE/CFE import branch group

Name: SDGE_CFEIMP_BG

Limit: RHS (less than or equal to) 1700 MW ~ 2100 MW

Purpose: This nomogram ensures that market applications automatically adjust system resources to mitigate from voltage instability in the ISO controlled grid following loss of a contingency event.

Potential Market Impact: Congestion may occur on this constraint when the load is high and the generation is low in the local area enclosed by the branch group components. Local generation will be dispatched up to mitigate the congestion, resulting in positive congestion cost inside the branch group.

Example 2: SDGE import nomogram related to an outage: SLIC 1883001

Name: SLIC 1883001_SDGE_OC_NG

Limit: RHS (less than or equal to) 2408 MW

Purpose: This nomogram ensures that market applications automatically adjust system resources to be prepared to mitigate from voltage violation in the ISO controlled grid should the most severe contingency in the area is forced out of service.

Potential Market Impact: Congestion may occur on this constraint when the load is high and the generation is low in the local area enclosed by the branch group components. Local generation will be dispatched up to mitigate the congestion, resulting in positive congestion cost inside the branch group.

Example 3: Miguel Banks nomograms related to an outage: SLIC 1883001

Names: SLIC 1883001 Miguel_BKS_NG, and

SLIC 1883001 Miguel_BKS_NG_2

Limits: RHS (less than or equal to) 1400/1600 MW

Purpose: Working together, the above two nomograms ensure that market applications automatically limits the amount of pre-contingency flow on major transmission lines based on: 1) an adjustable limit depending on the amount of generation produced on active special protection scheme (SPS) and 2) up to a maximum flow level limit once generation on special protection scheme (SPS) reaches maximum level. The two nomogram limits are used to ensure post-contingency flow on the Miguel Banks remain below required levels in case of transmission contingency. Keeping the transmission grid intact is critical for reliability in southern California given the present system conditions with a significant amount of generation capacity unavailable in the region.

Potential Market Impact: When congestion occurs on these constraints, market applications will dispatch system resources to mitigate the congestion, resulting in positive and/or negative congestion costs on either side of the constraints.

Example 4: Path 26 north-to-south nomogram

Name: PATH26_N-S

Limit: RHS (less than or equal to) variable (80 MW ~ 4000 MW), depending on operational conditions and outages.

Purpose: This nomogram ensures that market applications automatically adjust system resources to adhere to the WECC Path 26 limitation. The Path 26 limitation can be due to thermal or voltage violation.

Potential Market Impact: Congestion may occur on this constraint when the load is high and the generation is low south of Path 26. Generation in SP 26 will be dispatched up to mitigate the congestion, resulting in positive congestion cost in SP 26 and negative congestion cost in NP 26.

Related information: PATH26_BG, PATH26_N-S and PATH26_S-N are all used to model transmission capacity on Path 26 for reliable operations.

Branch group PATH26_BG has hourly limits and is in effect in all trade hours of the day. The PATH26_BG is associated with WECC rated path and any associated transmission rights. It has a “from” rating and a “to” rating to denote the direction of the branch group limits. Because the limit is defined hourly, it is mainly for the DA market applications.

Nomograms PATH26_N-S and PATH26_S-N are used in real-time. Each has a limit in one direction. N-S means from north to south direction; S-N means south to north direction. They are defined in 15 minute intervals which offer greater flexibility for real-time operations than PATH26_BG which is defined in hourly increments. When system condition changes in real-time, the nomograms can be updated and changed more quickly than PATH26_BG as dynamic conditions affecting the flow limits changes.

5. Transmission Constraint Information Access

Detailed information on transmission constraints is available on the ISO information system CMRI. CMRI is a secured information system that is accessible to market participants and parties who have a legitimate business need. Application to access CMRI can be obtained by contacting the ISO Business Solutions.

More information is being made available through the Data Release Phase III initiative which will add additional details on transmission constraints such as nomogram limits in the fall of 2012.