2.17 Applying Transmission Constraint Penalty Factors in the Market Clearing Engine

Transmission constraint penalty factors are parameters used by the Market Clearing Engine (MCE) to specify the maximum cost willing to be incurred to control a transmission constraint. The ultimate effect of the transmission constraint penalty factor is that it limits the controlling actions the MCE can take to resolve a constraint by limiting the cost that is willing to be incurred to control it.

The objective of the constraint control logic is to dispatch the least cost set of resources to meet the target facility limit that dispatch is trying to control the constraint to at a marginal cost at or below the transmission constraint penalty factor. The transmission constraint penalty factor does not directly impact the marginal value of a constraint as long as the constraint can be solved by resources whose effective costs are lower than the value of the penalty factor. The cost of using a resource to control a constraint, or its effective cost, can be approximated by using the following equation.

$$Effective\ \ Cost\left(\frac{\$}{MWh}\right) =$$

$$/\frac{(Energy\ Price + Loss\ Price + Congestion\ Price\ (all\ binding\ constraints\ ) + Incremental\ Cost)}{Dfax}/$$

If the flow on the constraint cannot be controlled below the level to which dispatch is attempting to control the facility it results in a constraint violation in the MCE optimization. The transmission constraint penalty factor is then used to set the marginal value of the violated transmission constraint.

PJM internal constraints including Market-to-Market coordinated constraints, regardless of voltage level, are defaulted to a $30,000/MWh transmission constraint penalty factor in the Day-ahead MCE when determining the Day-ahead security constrained economic dispatch, known as the dispatch run, and $2,000/MWh in the determination of Day-ahead Prices in the pricing run. All PJM internal constraints, regardless of voltage level, are defaulted to a

$2,000/MWh transmission penalty factor in the Real-time Energy Market. PJM may adjust the default penalty factor in Real-time for Market-to-Market coordinated constraints to reflect the operating practices which are mutually agreed upon with the neighboring RTO/ISO for managing such constraints. In Real-time, the transmission constraint penalty factor value for an individual constraint is utilized in both the dispatch and pricing runs.

PJM can also adjust, for an individual constraint, the default penalty factor or temporarily change the default penalty factor for an individual constraint, in order to reflect system operational needs and the cost of the resources available to effectively relieve congestion on the constraint. PJM may also adjust the default Transmission Constraint Penalty Factor in either Day-Ahead or Real-Time Energy Market if the constraint is caused by a transmission outage associated with a Regional Transmission Expansion Plan (RTEP) or planned transmission upgrade necessitated by interconnection request (s) in the impacted area designed to improve system reliability.

~~When PJM identifies that the effective cost of controlling actions available to relieve congestion on the constraint is not consistent with the default penalty factor, the penalty factor is increased or decreased as documented in the Transmission Constraint Penalty Factor Adjustment Guidelines.~~

~~In Real-time the transmission constraint penalty factor value for an individual constraint is utilized in both the dispatch and pricing runs.~~

When PJM identifies that the cost of controlling actions are not being properly reflected in pricing, the transmission constraint penalty factor will be increased or decreased as explained in examples detailed below. Once it has been identified that an adjustment is required, PJM dispatchers and real-time markets support engineers make real-time evaluations of the appropriate transmission constraint penalty factor adjustments based on an effective resource's cost to control a constraint (expressed in $/MW as defined below):

$$\frac{\$}{MW} = \frac{(Resource\ Offer\ Price - System\ Energy\ Price)}{dfax}$$

When not enough relief can be provided by resources at a cost below the default transmission constraint penalty factor, PJM retains the ability to increase the transmission constraint penalty factor (or willingness to pay for control) for a constraint when congestion flow is over or approaching the controlled limit and additional available resources have a $/MW cost above the default transmission constraint penalty factor. Conditions requiring increasing the transmission constraint penalty factor for a constraint include, but are not limited to:

1. An effective resource with a raise-help dfax is required, but the system energy price has decreased such that the resource's $/MW cost exceeds the default transmission constraint penalty factor.
2. An effective resource with a lower-help dfax is required, but the system energy price has increased such that the resource's $/MW cost exceeds the default transmission constraint penalty factor.
3. Additional relief for a constraint is required from a resource with a $/MW cost above the default transmission constraint penalty factor based on the resource's Offer Price and/or dfax.

When the congestion flow is within the controlled limit, PJM also retains the ability to lower the transmission constraint penalty factor for a constraint in order to prevent a high cost resource that cannot provide material relief on the constraint from inappropriately setting price. Conditions requiring lowering the shadow price limit for a constraint include, but are not limited to:

1. A thermal surrogate is used to set price for a resource called for voltage control and the resource's $/MW is lower than the default transmission constraint penalty factor.
2. A constraint with many low dfax, high cost resources where the available control is sufficient and over controlling the constraint by allowing ineffective resources to artificially raise the price would result in ACE deviations and/or other system controlling issues.
3. A constraint caused by a transmission outage associated with a Regional Transmission Expansion Plan (RTEP) or planned transmission upgrade by interconnection request in the impacted area designated to improve system reliability

PJM incorporates a buffer typically of 25% above the effective resource's $/MW

cost when setting the adjusted marginal value limit. This buffer accounts for any fluctuation in the system energy price that would increase a resource's $/MW cost.