**This new paragraph will be added to section 6.6.5 of the Market Operations BPM due to FERC 831 phase 2 initiative.**

**Power Balance relaxation**

The power balance constraint ensures that the sum of generation and imports equals the sum of demand, including exports and transmission losses. The shadow price of the power balance constraint establishes the system marginal energy cost, which the market uses to determine locational marginal prices. This constraint is set to the maximum energy bid price (the “soft” bid cap of $1,000/MWh under most circumstances) in the pricing run. This allows for bids to clear up to the soft bid cap. The power balance constraint needs to be at least as high as the highest submitted energy bid price. Otherwise, the optimization will relax the constraint rather than clear bids priced above its value. The CAISO market utilizes both a scheduling and pricing run to produce awards (dispatches) and prices. In the scheduling run, the market optimizes all submitted bids and clears awards based on the most effective economic solution. In the event a solution cannot be achieved, the market will adjust non-priced parameters (i.e., uneconomic adjustments) or relax constraints to attain a solution. The awards and resulting prices of this solution are passed to the pricing run. The pricing run information of the potential uneconomic adjustments and/or constraint relaxation is retained because after solving the scheduling run, the amounts of the adjustments and relaxations are known. These instances are modeled in the pricing run with slack variables with a small range beyond the solution of the scheduling run in order to have room in the optimization of the pricing run to find a solution and produce binding prices. In the event uneconomic adjustments are made or constraints are relaxed, the relevant penalty prices are applied.

The power balance penalty price in the market’s pricing run remains at $1,000/MWh under routine conditions and all other market constraint penalty prices will remain scaled to $1,000/MWh. The power balance penalty price increases to a $2,000/MWh pricing run price (the “hard” bid cap), and the rest of the market constraint penalty prices are scaled relative to $2,000/MWh, under specific conditions described below. Consequently, this assumes that under normal market conditions the shortage price signal sent by the power balance constraint relaxation price should be based on the $1,000/MWh soft energy bid cap. The market utilizes two sets of pricing parameters:

1. Pricing parameters will be scaled to a $1,000/MWh power balance penalty price when both of the following conditions exist in any interval of the market horizon:
	1. Resource-specific resources have not submitted a cost-verified energy bid greater than $1,000/MWh.
	2. The CAISO-calculated maximum allowable import bid price is not greater than $1,000/MWh.
2. Pricing parameters will be scaled to a $2,000/MWh power balance penalty price when either of the following conditions exists in any interval of the market horizon:
	1. A Resource-specific resource has submitted a cost-verified energy bid greater than $1,000/MWh.
	2. The CAISO-calculated maximum allowable import bid price is greater than $1,000/MWh.

If the conditions are satisfied to set the pricing parameter for the power balance constraint to $2,000/MWh and the market must relax the power balance constraint, the market would set energy prices in the pricing run based on the amount of infeasibility from the scheduling run. The amount of infeasibility in the scheduling run will be compared to a small threshold value. If the infeasibility is less than the threshold value, the market would set prices based on the price of the highest priced cleared bid. If the infeasibility is more than the threshold value, prices will be set based on the $2,000/MWh power balance penalty price. The threshold value is intended to account for small supply shortfalls for which it is not appropriate to send the strong shortage pricing signal that setting prices based on $2,000/MWh would. These small apparent shortfalls may not actually represent actual shortfalls because of forecast and modeling inaccuracies. In addition, in balancing authority areas other than the CAISO in the EIM, they may not represent actual shortfalls because of other resources these balancing authority areas have that are not in the market.

The threshold value for each balancing authority area in the EIM is based on the NERC BAL-001-2 Requirement R2. The requirement aims to maintain reliability by controlling interconnection frequency within defined limits. This is accomplished by ensuring Balancing Authority Area Control Error (ACE) is kept between predefined limits (BAAL). These BAAL limits (BAALLow and BAALHigh) are defined individually for each balancing authority area. The CAISO will utilize the BAALLow limit to define the threshold value for each balancing authority area in the EIM. This value can be used to represent the amount of supply that can be less than load while still maintaining system frequency within acceptable reliability criteria. Frequency is related to the balance of supply and load. System frequency is maintained by matching supply to demand. However, small mismatches and resulting differences in frequency from the desired 60 Hz are acceptable.

The BAALLow limit, as defined by NERC is the following:

$$BAAL\_{Low}=\left(-10B\_{i} ×\left(FTL\_{Low}- F\_{s}\right)\right)× \frac{(FTL\_{Low}- F\_{s})}{(F\_{A}- F\_{s})}$$

Where:

* $BAAL\_{Low}$ is the Low Balancing Authority ACE Limit (MW)
* 10 is a constant to convert the Frequency Bias Setting from MW/0.1 Hz to MW/Hz
* $B\_{i}$ is the Frequency Bias Setting for a Balancing Authority (expressed as MW/0.1 Hz)
* $F\_{A}$ is the measured frequency in Hz.
* $F\_{s}$ is the scheduled frequency in Hz.
* $FTL\_{Low}$ is the Low Frequency Trigger Limit (calculated as $F\_{s}$ - 3ε1I Hz)
* Where ε1I is the constant derived from a targeted frequency bound for each Interconnection.
	+ Western Interconnection ε1I = 0.0228 Hz

For establishing the threshold value, the Western Interconnection is balanced and the scheduled frequency is 60 Hz. Therefore, the CAISO will not apply the following term from the BAALLow limit equation in the calculation of the threshold values: $\frac{(FTL\_{Low}- F\_{s})}{(F\_{A}- F\_{s})}$. This part of the equation modifies the frequency limits based on actual frequency in real-time. Consequently, it is not possible to incorporate this part of the equation to calculate set threshold limits in advance. It would not be practical to use limits that change for pricing purposes.

Consequently, the CAISO will calculate the threshold value for each EIM balancing authority area and the CAISO using the first term of the BAALLow limit as follows:

$Threshold=\left(-10B\_{i} ×\left(FTL\_{Low}- F\_{s}\right)\right)$.

Table 1 lists the applicable frequency bias setting values and the corresponding calculated threshold values for each participating EIM balancing authority area and the CAISO based on 2020 information.

**Table 1 Frequency Bias Settings and Calculated Threshold Values**

|  |  |  |
| --- | --- | --- |
| **Balancing Authority Area** | **2020 Frequency Bias Setting (MW/0.1 Hz)[[1]](#footnote-1)**  | **CAISO Calculated Threshold Values (MW)** |
| AZPS | -99.1 | 67.8 |
| BANC – total | -28.4 | 19.4 |
| BCHA | -112.9 | 77.2 |
| CAISO | -341.7 | 233.7 |
| IPCO | -37.7 | 25.8 |
| NEVP | -63.0 | 43.1 |
| PACE | -89.9 | 61.5 |
| PACW | -46.1 | 31.5 |
| PGE  | -39.5 | 27.0 |
| PSEI  | -35.1 | 24.0 |
| SCL | -39.0 | 26.7 |
| SRP | -56.7 | 38.8 |

The CAISO real-time market includes individual power balance constraints for each EIM balancing authority area and an overall power balance constraint for the market. The overall power balance constraint for the market applies to the CAISO balancing authority area as well. The CAISO will set all of these power balance constraints at $2,000/MWh, and scale the other market constraints accordingly, when the conditions are met to set the power balance penalty price to $2,000/MWh.

Additionally, it is important to note that if the conditions are met to set the power balance penalty price to $2,000/MWh for any hour in the day-ahead market, the $2,000/MWh power balance penalty price will apply for all trading hours of the day-ahead market and real-time market for the same trading day. If the conditions are not met to set the power balance penalty price to $2,000/MWh in the day-ahead market, but the conditions apply to set the power balance penalty price to $2,000/MWh in the real-time market, the real-time market will use the $2,000/MWh power balance penalty price for all intervals of overlapping real-time market horizons. If the conditions to set the power balance penalty price to $2,000/MWh in all intervals of a real-time market horizon are not met, a $1,000/MWh power balance penalty price will be used in all intervals of that real-time market horizon. This is irrespective of the fact that a $2,000/MWh power balance penalty price may have been used for one or more of these intervals in a previous real-time market run. This approach is necessary so the market functions consistently across all intervals in its horizon.

The threshold value is not applied in the day-ahead market due to the differences in the way the market clears in DA VS real time. Additionally, since the NERC BAL-001-2 Requirement R2 is a real-time operating standard, it does not make sense to apply the threshold value based on this standard to the day-ahead market.

**Example A**:

The following example illustrates how penalty prices will remain set to the $1,000/MWh power balance penalty price when the highest-priced submitted bid from a resource-specific resource is less than $1,000/MWh and the CAISO-calculated maximum allowable import bid price is less than $1,000/MWh.

Assume the following market inputs in the real-time market:

* Highest-priced bid from a resource-specific resource = $900/MWh
* CAISO-calculated maximum allowable import bid price = $200/MWh
* CAISO threshold value = 233.7 MW

Given the conditions listed above, in the power balance penalty price would be set to $1,000/MWh to determine the dispatch and prices.

Assume the market must relax the power balance constraint. Energy prices would be set based on the $1,000/MWh power balance penalty price.

**Example B**:

The following example illustrates how penalty prices will be set to the $2,000/MWh power balance penalty price when the highest-priced submitted bid from a resource-specific resource is greater than $1,000/MWh. This example also outlines how energy prices are determined in the pricing run based on the amount of infeasibility.

Assume the following market inputs in the real-time market:

* Highest-priced, cost-verified bid from a resource-specific resource = $1,200/MWh
* CAISO-calculated maximum allowable import bid price = $700/MWh
* CAISO threshold value = 233.7 MW

The power balance penalty price would be set to $2,000/MWh to determine the dispatch because there is a submitted and cost-verified energy bid from a resource-specific resource greater than $1,000/MWh.

Assume the market must relax the power balance constraint and the highest-priced cleared economic bid is $1,200/MWh. Energy prices in the pricing run would be set based on the following:

* If the scheduling run infeasibility ≤ 233.7 MW, energy prices in the pricing run will be based on the $1,200/MWh highest-priced cleared economic bid.
* If the scheduling run infeasibility > 233.7 MW, energy prices in the pricing run will be based on the $2,000/MWh power balance penalty price.

**Example C**:

The following example illustrates how penalty prices will be set to the $2,000/MWh power balance penalty price when the CAISO-calculated maximum allowable import bid price is greater than $1,000/MWh. This example also outlines how energy prices are determined in the pricing run based on the amount of infeasibility when there is no resource-specific bid greater than $1,000/MWh.

Assume the following market inputs in the real-time market:

* Highest-priced bid from a resource-specific resource = $900/MWh
* CAISO-calculated maximum allowable import bid price = $1,100/MWh
* CAISO threshold value = 233.7 MW

The power balance penalty price would be set to $2,000/MWh to determine the dispatch because the CAISO-calculated maximum allowable import bid price is $1,100/MWh, which is greater than $1,000/MWh.

Assume the market must relax the power balance constraint and the highest-priced submitted bid from a resource-specific resource is $900/MWh. Energy prices in the pricing run would be set based on the following:

* If the scheduling run infeasibility ≤ 233.7 MW, energy prices in the pricing run will be based on the $1,000/MWh because there is no resource-specific bid greater than $1,000/MWh.
* If the scheduling run infeasibility > 233.7 MW, energy prices in the pricing run will be based on the $2,000/MWh power balance penalty price.

**Example D**:

The following example illustrates how penalty prices will be set to the $2,000/MWh power balance penalty price when the CAISO-calculated maximum allowable import bid price is greater than $1,000/MWh. This example also outlines how a submitted resource-adequacy import bid will be reduced to the CAISO-calculated maximum allowable import bid price. Further, this example highlights how energy prices are determined in the pricing run based on the amount of infeasibility.

Assume the following market inputs in the real-time market:

* Highest-priced bid from a resource-specific resource = $900/MWh
* Highest-priced resource adequacy import bid = $1,200/MWh
* CAISO-calculated maximum allowable import bid price = $1,100/MWh
* CAISO threshold value = 233.7 MW

The power balance penalty price would be set to $2,000/MWh to determine the dispatch because the CAISO-calculated maximum allowable import bid price is $1,100/MWh, which is greater than $1,000/MWh. The market reduces the submitted $1,200/MWh resource adequacy import bid to the $1,100/MWh maximum allowable import bid price.

Assume the market must relax the power balance constraint and the highest-priced cleared economic bid is the $1,100/MWh import bid. Energy prices in the pricing run would be set based on the following:

* If the scheduling run infeasibility ≤ 233.7 MW, energy prices in the pricing run will be based on the $1,100/MWh highest-priced cleared economic bid.
* If the scheduling run infeasibility > 233.7 MW, energy prices in the pricing run will be based on the $2,000/MWh power balance penalty price.

**Example E:**

The following example illustrates how penalty prices will be set to the $2,000/MWh power balance penalty price when the highest-priced, cost-verified submitted bid from a resource-specific resource is greater than $1,000/MWh. This example also outlines how energy prices are determined in based on the amount of infeasibility for an EIM balancing authority area when it is import constrained and the market must relax the power balance constraint for that specific EIM balancing authority area.

Assume the following market inputs in the real-time market:

* Highest-priced, cost-verified bid from a resource-specific resource within an EIM balancing authority area = $1,200/MWh
	+ This EIM balancing authority area is import constrained.
* CAISO-calculated maximum allowable import bid price = $900/MWh
* EIM balancing authority area’s threshold value = 25 MW
* EIM balancing authority area’s available balancing capacity supply = 20 MW @ $100/MWh

Given the conditions listed above, the power balance penalty price would be set to $2,000/MWh to determine the dispatch because there is a submitted and cost-verified energy bid from a resource-specific resource greater than $1,000/MWh. This applies to all individual balancing authority area power balance constraints in the EIM area and the market power balance constraint for the EIM area as a whole.

Assume the market must relax the power balance constraint in the import constrained EIM balancing authority area. The highest-priced cleared economic bid within the balancing authority is the $1,200/MWh bid. Energy prices in the pricing run would be set based on the following:

* If the scheduling run infeasibility ≤ 45 MW, energy prices in the pricing run will be based on the $1,200/MWh highest-priced cleared economic bid.
* If the scheduling run infeasibility > 45 MW, energy prices in the pricing run will be based on the $2,000/MWh power balance penalty price.

The scheduling run infeasibility is compared to the sum of the EIM balancing authority area’s threshold value and their available balancing capacity supply amount.

Since the market outside of this import constrained EIM balancing authority area can reach a feasible solution, the overall system’s power balance constraint does not need to be relaxed in this example, and prices outside the constrained balancing authority area are produced using its normal process.

The “available balancing capacity” feature currently implemented in the EIM allows the market to recognize additional resources outside the market EIM participants use to meet their balancing authority area responsibilities.[[2]](#footnote-2) It includes bids for these resources in the market’s bid stack, when the market must relax the power balance constraint for an EIM balancing authority area. This allows the marginal economic bid to set the energy price within the balancing authority area and not the power balance penalty price.

In the event the market would otherwise relax the power balance constraint for a balancing authority area in the EIM other than the CAISO, the available balancing capacity feature uses the capacity from the out-of-market available balancing capacity at penalty prices from $1,050/MWh to $1,200/MWh. This ensures that all available bids submitted up to the bid cap of $1,000/MWh are scheduled prior to releasing available balancing capacity into the bid stack. The pricing run then produces prices incorporating bids from the available balancing capacity resources.

Under this approach, the available balancing capacity will be released between $2,100/MWh and $2,400/MWh in the scheduling run when the $2,000/MWh set of pricing parameters is used in the market. This will ensure the priority level of available balancing capacity is maintained in the bid stack in the scheduling run.

1. [↑](#footnote-ref-1)
2. [↑](#footnote-ref-2)