



Subject: Locational Reserve Availability Clearing Prices

The NYISO now calculates Day-Ahead and Hour-Ahead locational reserve clearing prices for payments to suppliers. Locational reserve clearing prices are determined for each of three reserve products in each of three reserve locations within the NYCA.

Details:

Suppliers scheduled to provide reserve availability products in the Day-Ahead and Hour-Ahead Markets are paid an hourly amount equal to the highest availability bid scheduled of any reserve provider that meets the reserve requirements for the reserve product scheduled, times the amount of MWs that the supplier is scheduled to provide in an hour in each reserve location for each reserve product. Loads purchasing reserve services pay their load-weighted share of the total NYCA cost of reserves. To the extent that reserve constraints between reserve locations are not binding<sup>1</sup>, then the clearing price for each reserve product is the same in each location. To the extent that reserve product constraints within the constraint areas are not binding, then the price of reserve products within each location is the same. In the case where the locational reserve constraints and reserve product constraints are binding, separate reserve availability prices are determined for each reserve product for each reserve location.

NYCA Constraint Areas and Reserve Locations

The NYCA is viewed as consisting of three reserve constraint areas for purposes of determining reserve requirements. These reserve constraint areas are:

- Total NYCA,
East of the Central-East constraint, and
Long Island.

Reserve requirements are determined for each of these constraint areas. Table 1 specifically defines the NYCA zones associated with the respective constraint areas.

Table 1 – NYCA Constraint Areas

Table with 2 columns: Constraint Areas, Zone(s). Rows: Total NYCA (A - K), East of Central -East (F - K), Long Island (K).

For purposes of determining locational clearing prices for reserve products the NYCA is partitioned into three reserve locations. These reserve locations are:

- West of the Central-East constraint (West),

1 The term "binding", with respect to locational constraints and product constraints refers to the condition where no additional capacity (transmission capacity in the case of locational constraints and product availability in the case of reserve product constraints) is available. "Not binding" refers to the condition where additional transmission and/or reserve product capacity does exist, i.e. the constraint is slack.



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- East of the Central-East constraint excluding Long Island (East) and,
- Long Island.

Reserve clearing prices are determined for each of these three reserve locations. Table 2 specifically defines the NYCA Zones associated with each of the three reserve locations.

Table 2 – NYCA Reserve Locations

Reserve Location	Zone(s)
West of Central-East	A, B, C, D, and E
East of Central -East (excluding Long Island)	F, G, H, I, and J
Long Island	K

It should be noted that reserve clearing prices for Long Island are limited, through provisions of this program, to the reserve clearing prices determined for the East of the Central-East Reserve Location when the Long Island reserve constraint is binding. Therefore the clearing price for reserve products on Long Island will never exceed East of Central-East locational reserve clearing prices.

### Reserve Products

There are three NYISO Reserve Availability Products for which locational reserve product pricing applies. These products are:

- 10-Minute Spinning Reserve,
- 10-Minute Total Reserve (may include 10-Minute Spinning Reserve) and,
- 30-Minute Reserve (includes 30-Minute Spinning Reserve and 30-Minute Non-Synchronous Reserve and may include 10-Minute Spinning Reserve and 10-Minute Non-Synchronous Reserve products).

Offers for the supply of these products are evaluated and, if selected, scheduled by the NYISO to meet the reserve requirements defined for 10-Minute Spinning Reserves, 10-Minute Total Reserves and 30-Minute Reserves. Higher quality reserve products may count towards meeting lower quality reserve requirements; for example, 10-Minute Spinning Reserve may count as 10-Minute Total Reserve and/or 30-Minute Reserve. However, lower quality reserve products may not be substituted for higher quality reserve products.

### Determination of reserve product clearing prices

Attachment A provides examples of the methodology employed to determine locational reserve clearing prices.



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## Attachment A

This set of examples illustrates the impact that various combinations of locational and reserve product binding constraints have on the determination of locational reserve clearing prices.

Table A-1 represents 9 product/location pairings, in matrix form, with the highest accepted availability bid (\$/MW) in each respective category represented by the letters A through H. The examples that follow utilize this table.

Table A-1

<b>Reserve Product</b>	<b>West</b>	<b>East (Excluding LI)</b>	<b>Long Island</b>
10-Minute Spin	A	B	C
10-Minute Non-Sync	D	E	F
30 Minute Reserve	G	H	I

### Example 1 – The Base Case

This example assumes that none of the locational constraints are binding but that all of the pool wide product constraints are binding (i.e. we clear  $\leq 600$  MW of 10-Minute Spin,  $\leq 1200$  MW of 10-Minute Total and  $\leq 1800$  MW of 30-Minute Reserve). Table A-2 shows the reserve clearing prices that would result under these conditions.

Table A-2

<b>Reserve Product</b>	<b>West</b>	<b>East (Excluding LI)</b>	<b>Long Island</b>
10-Minute Spin	Max (A - I)	Max (A - I)	Max (A - I)
10-Minute Non-Sync	Max (D - I)	Max (D - I)	Max (D - I)
30 Minute Reserve	Max (G - I)	Max (G - I)	Max (G - I)

In this case, each reserve product has a unique price but the price for each reserve product is the same throughout the NYCA.

### Example 2 - Cascading Between Products

This example assumes there are still no binding locational constraints, that the pool wide 10-Minute Spin constraint is not-binding (we clear  $\geq 600$  MW spin), and the pool wide 10-Minute Total constraint is binding (we clear  $\leq 1200$  MW of 10-Minute Total reserves). In this case the prices would be determined as illustrated in Table A-3.

Table A-3

<b>Reserve Product</b>	<b>West</b>	<b>East (Excluding LI)</b>	<b>Long Island</b>
10-Minute Spin	Max (A - I)	Max (A - I)	Max (A - I)
10-Minute Non-Sync	Max (A - I)	Max (A - I)	Max (A - I)
30 Minute Reserve	Max (G - I)	Max (G - I)	Max (G - I)

The incremental value of an additional MW of either 10-Minute Spin or 10-Minute Non-Sync is equal to the shadow price<sup>2</sup> of the 10-Minute Total constraint. At the margin, 10-Minute reserves are being scheduled on both on and off-line units to meet the 10-Minute Total reserve requirement. Thus all 10-Minute reserves should be paid the same clearing price regardless of whether the reserves are carried on a spinning or non-sync unit because there is no scarcity value for reserves on on-line units beyond the value of 10-Minute reserves and reserves on spinning units are being scheduled to meet the 10-Minute reserve requirement. If we had less 10-Minute reserves on spinning units the NYISO would have to schedule more 10-Minute reserves at the 10-Minute price.

Example 3 - Cascading Between Regions

In this case we assume that all the pool wide product constraints are binding and all locational reserve constraints are not-binding except the East of Central-East spin constraint, which is binding. Prices would be determined as illustrated in Table A-4.

Table A-4

<b>Reserve Product</b>	<b>West</b>	<b>East (Excluding LI)</b>	<b>Long Island</b>
10-Minute Spin	Max (A, D - I)	Max (A - I)	Max (A - I)
10-Minute non-sync	Max (D - I)	Max (D - I)	Max (D - I)
30 Minute Reserve	Max (G - I)	Max (G - I)	Max (G - I)

Note that spinning reserve suppliers in the Long Island and East locations are paid the same amount regardless of where the last MW was cleared. The incremental value of 10-Minute Spin from either location is equal to the shadow price of the East 10-Minute Spin constraint. This is entirely analogous to the cascading of prices between products. If 1 MW less of spin were available in Long Island, the NYISO would need to schedule another MW at the East price.

Cascading Between Regions and Products

There are many combinations of locational and pool wide product constraints that solve to different outcomes. There are too many to enumerate but we can examine one particular outcome and see how the prices would be determined. In this example the constraint configuration is as follows:

- 10-Minute Spin
  - The pool wide constraint is not-binding,
  - The East of Central-East constraint is binding, and
  - The Long Island constraint is not-binding.

<sup>2</sup> The “shadow price” concept is explained in NYISO Technical Bulletin #62.

- 10-Minute Total
  - The pool wide constraint is not-binding,
  - The East constraint is binding, and
  - The Long Island constraint is not-binding.
  
- 30-Minute Total
  - The pool wide constraint is binding,
  - The East of Central-East constraint is binding, and
  - The Long Island constraint is not-binding.

Table A-5 illustrates the reserve clearing price for each reserve product in each location under this set of conditions.

Table A-5

Reserve Product	West	East (Excluding LI)	Long Island
10-Minute Spin	Max (A, D, G)	Max (A - I)	Max (A - I)
10-Minute Non-Sync	Max (A, D, G)	Max (A, D - I)	Max (A, D - I)
30 Minute Reserve	Max (A, D, G)	Max (A, D, G - I)	Max (A, D, G - I)

Because the Long Island 10-Minute Spin constraint is not binding, the East 10-Minute Spin constraint has the highest shadow price, and therefore the East and Long Island 10-Minute Spin prices will be the highest of any of the products in any of the locations. Hence the prices are the Maximum of A-I. The reserves used to meet this requirement meet all of the other reserve requirements that are binding in this case. Therefore a MW of additional reserves meeting the East 10-Minute Spin requirement sets a ceiling on the shadow price of the other reserves. A MW of 10-Minute Spin in the East location could be scheduled to meet the East 10-Minute Total constraint, the East 30-Minute Total constraint and the pool wide 30-Minute Total constraint.

The next highest shadow price is the East 10-Minute Total constraint. The prices for the East 10-Minute Non-Sync product must be the highest of all 10-Minute Non-Sync or 30-Minute Reserve bids plus it must be higher than the West 10-Minute Spin bid as some of the West 10-Minute Spin is being used to meet the 30-Minute pool wide requirement, which has a lower shadow price. This is because the 10-Minute Non-Sync reserves East of Central-East meet the requirements of all the other binding constraints except the East 10-Minute Spin constraint. Thus, this shadow price sets a ceiling on the shadow prices of the other binding 10-Minute Total and 30-Minute Reserve constraints. If the prices for East 10-Minute Non-Sync were not higher than A, then we would have used additional 10-Minute Total reserves East of Central-East to meet the 30-Minute Reserve requirement in place of A. This price does not include B or C because that capacity is necessary to meet a binding constraint with a higher shadow price.

The next highest shadow price is the East of Central-East 30-Minute Total constraint. The price of East 30-Minute Reserves must be the highest of all 30-Minute bids plus it must be higher than the



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bids for 10-Minute Spin or 10-Minute Non-Sync in the West location as they are being used to meet the 30-Minute pool requirement. This is because 30-Minute Reserves East of Central East also meet the requirements of the 30-Minute pool constraint and thus set a ceiling on the shadow price of this constraint. Because additional 10-Minute Spin in the West is scheduled to meet the 30-Minute pool constraint, the East of Central-East 30-Minute price is greater than or equal to the West 10-Minute Spin price. If the prices for East 30-Minute Reserves were not higher than A then we would have used additional 30-Minute reserves in the East to meet the 30-Minute requirement in place of A or D. This price does not include B, C, E or F because that capacity is necessary to meet binding constraints with higher shadow prices.

The lowest shadow price will always be the 30-Minute total pool wide constraint as all reserves scheduled meet this requirement. This means the lowest cost MW in any location for any type of reserve can always be used to meet this requirement. All reserves in the West are being used to meet this requirement so the price for all West reserves is equal to the West 30-Minute Reserves price. Hence each of the West prices is the Maximum of A, D, or G. None of the East bids are included as they are all used to meet binding constraints with higher shadow prices.