Dynamic Reserves

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Agenda

- Background
- Supplemental Reserves
- Transmission Demand Curves
- NYCA 30-Minute Operating Reserve Demand Curve
- Cost Allocation for Dynamic Reserves
- Next Steps

Background

Previous Presentations

Title/Topic	Link
2021 RECA Study (Updated 2/2022)	https://www.nyiso.com/documents/20142/26734185/RECA(Dynamic%20Reserves)%20Study%20Report.pdf/27990919-e81b-76a4-12e1-57b9458b553d
March 3, 2022 MIWG Project Kickoff	https://www.nyiso.com/documents/20142/28897222/Dynamic%20Reserves%20Kickoff%20MIWG%2003032022_Final.pdf/b2b5cd26-4740-ab35-015c-5e93bf3ca23e
May 11, 2022 MIWG	https://www.nyiso.com/documents/20142/30555355/Dynamic%20Reserves%20MIWG%2020220511.pdf/35e8b44a-6a54-c8e0-ee30-b9e0709738af
June 16, 2022 MIWG	https://www.nyiso.com/documents/20142/31532822/6%20Dynamic%20Reserves.pdf/ca9ad944-c911-1874-2710-9ba04521d789

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Supplemental Reserves

Supplemental Reserves

- **The 2021 Reserve Enhancements for Constrained Areas (RECA) Study included the following consideration:**
  - Consideration: Assessing interplay between dynamic reserves scheduling and additional reserve requirements (e.g., supplemental reserves)
- **NYISO proposed a method for procuring additional reserve requirements beyond minimum reliability requirements ("supplemental reserves") as part of the 2020 Ancillary Services Shortage Pricing project**
  - The supplemental reserves proposal would have allowed NYISO to establish reserve procurement levels in excess of minimum reliability requirements to account for system uncertainty introduced by weather-dependent resources (distributed and grid-connected)
  - This proposal was rejected, without prejudice, by FERC and, therefore, has not yet been implemented

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Supplemental Reserves & Dynamic Reserves

- At the May 11, 2022 MIWG/ICAPWG meeting, the NYISO proposed a constraint to account for the potential risk of simultaneous loss (or reduction of energy output) of intermittent resources within a similar geographic area; NYISO will continue to discuss this concept at upcoming MIWG/ICAPWG meetings this year
- With the inclusion of the Intermittent Resource Contingency constraint, Dynamic Reserves would fulfill the intent of the Supplemental Reserves proposal
  - While this is a different method than what was proposed under the prior supplemental reserves proposal, the construct of Dynamic Reserves would account for the potential under-forecasting of intermittent resources by determining the MW at risk between different confidence levels of forecasts
  - As the method proposed for Dynamic Reserves does not depend on historic data, this method can more readily account for new resources that interconnect into NYCA and is based on location-specific data
- Supplemental Reserves also could have been triggered by under-forecasting net load and/or an increase in the number of adverse operating state declarations that occur on a monthly basis
  - The potential for under-forecasting net load, and modeling enhancements available to address it, will be discussed in the Balancing Intermittency project proposed for 2023
  - Given that market design enhancements may avoid increases in the number of adverse operating state declarations, this metric is best evaluated upon completion of the stakeholder process for these enhancements

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Transmission Demand Curves

Transmission Demand Curves

- **The 2021 RECA Study included the following consideration:**
  - Consideration: Interaction of the dynamic reserve requirements with the operating reserve demand curves (ORDCs) and transmission demand curves
- **Transmission constraint shadow costs represent the marginal change in total production cost when that constraint is relieved by one MW**
  - Operating reserve demand curves represent the cost to procure an additional MW of reserves
  - The transmission constraint pricing logic and operating reserves demand curves interact with each other to ensure pricing outcomes that reflect the relative reliability value of various system needs for each location on the bulk transmission system
    - During tight supply conditions, trade-offs can occur where the market commitment and dispatch software must decide whether to schedule supply to provide operating reserves or to manage flow across a transmission facility

Transmission Demand Curves (continued)

- **No impact or design considerations have been identified, and it is expected that the transmission demand curves will continue to interact with ORDCs as they have with static reserve regions**
  - Transmission headroom is calculated based on limits calculated in offline studies, and therefore any transmission relief due to transmission shortage pricing would not impact/modify the reserve requirement
- **NYISO will identify test cases to confirm expectations and identify any unexpected interactions**
  - Test cases will include enhancements to the current transmission constraint pricing logic that were proposed as part of the Constraint Specific Transmission Shortage Pricing project in 2021 and 2022

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NYCA 30-Minute Operating Reserve Demand Curve

Operating Reserve Demand Curves

- **The 2021 RECA Study included the following consideration:**
  - Consideration: Interaction of the dynamic reserve requirements with the operating reserve demand curves (ORDCs) and transmission demand curves
- **Each operating reserve product and location pair produces a shadow price for procurement of the reserve product**
  - The shadow prices represent the cost to procure one additional MW of the reserve product in question
  - The maximum shadow price value is capped based on the pricing values of the operating reserve demand curves
  - The NYCA 30-Minute Operating Reserve Demand Curve is a multi-stepped demand curve that represents the value of operating reserves in specific quantities

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Current Demand Curve Values and Rationale

Reserve Region	Reserve Product	Reserve Reqt.	Demand Curve	Rationale
NYCA	30-minute	2,620 MW	200 MW at $40/MWh	Allow a portion of the 30 minute total reserves to be forgone against price volatility
			125 MW at $100/MWh	Facilitate reduction of unnecessary price volatility by further graduation of the NYCA 30-minute reserve demand curve
			55 MW at $175/MWh	Consistent with cost of operator actions to maintain 30-minute reserves (GT OOMs)
			55 MW at $225/MWh	Consistent with cost of operator actions to maintain 30-minute reserves (SREs)
			55 MW at $300/MWh	Facilitate reduction of unnecessary price volatility by further graduation of the NYCA 30-minute reserve demand curve
			55 MW at $375/MWh	Represents a value aligned with the average cost of 99% of the resource costs observed for historic SRE and OOM commitments
			55 MW at $500/MWh	Consistent with cost of activating SCR/EDRP resources to maintain reserves
			55 MW at $625/MWh	Facilitate reduction of unnecessary price volatility by further graduation of the NYCA 30-minute reserve demand curve
			1,965 MW at $750/MWh	Consistent with cost of operator actions to replenish reserves by converting 30 min GTs to energy
NYCA	10 minute total	1,310 MW	$750/MWh	Consistent with cost of operator actions to replenish reserves by converting 30 min GTs to energy
NYCA	10 minute spin	655 MW	$775/MWh	Provide scheduling priority to NYCA 10-minute total and NYCA 30-minute reserves
EAST	30-minute	1,200 MW	$40/MWh	Facilitates distribution of reserves throughout NYCA
EAST	10 minute total	1,200 MW	$775/MWh	Recognizes equal importance with NYCA 10-min spinning reserves
EAST	10 minute spin	330 MW	$40/MWh	Facilitates distribution of reserves throughout NYCA

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Current Demand Curve Values and Rationale

Reserve Region	Reserve Product	Reserve Reqt.	Demand curve ($/MWh)	Rationale
SENY	30-minute	1,550 MW or 1,800 MW	250 MW or 500 MW at $40/MWh	Additional 30-minute reserves to facilitate returning transmission assets to Normal Transfer Criteria following a contingency (see Reserves for Resource Flexibility project)
			1,300 MW at $500/MWh	Consistent with cost of activating SCR/EDRP resources to maintain reserves
NYC	30-minute	1,000 MW	$25/MWh	Facilitates distribution of reserves throughout NYCA
NYC	10-minute total	500 MW	$25/MWh	Facilitates distribution of reserves throughout NYCA
LI	30-minute	270-540 MW	$25/MWh	Facilitates distribution of reserves throughout NYCA
LI	10-minute total	120 MW	$25/MWh	Facilitates distribution of reserves throughout NYCA

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Operating Reserve Demand Curves: Formulaic Calculation

Shortage Price ($/MWh)	Reserve Level (MW)	Demand Curve (MW)	Percent of Largest Contingency	Reserve Shortage Relative to Requirement
750	0 to 1,965	1,965	150%	655 to 2620
625	1,965 to 2,020	55	4%	600 to 655
500	2,020 to 2,075	55	4%	545 to 600
375	2,075 to 2,130	55	4%	490 to 545
300	2,130 to 2,185	55	4%	435 to 490
225	2,185 to 2,240	55	4%	380 to 435
175	2,240 to 2,295	55	4%	325 to 380
100	2,295 to 2,420	125	10%	200 to 325
40	2,420 to 2,620	200	15%	0 to 200

- The existing NYCA 30-Minute ORDC has 9 steps, as shown in the table above
- To develop a dynamic ORDC, NYISO calculated the percent of the largest contingency that the total MW of each step represents. For example, the $625/MWh shortage price would occur if the reserve level was between 1,965 and 2,020 MW. Those 55 MW represent 4% of the largest contingency.
  - This ensures that the same proportion of reserves are being priced at the existing shortage prices
- The NYCA 30-Minute Operating Reserve Demand Curve would be formulaically updated such that the percent of the largest contingency that is procured at each step of the demand curve is maintained.

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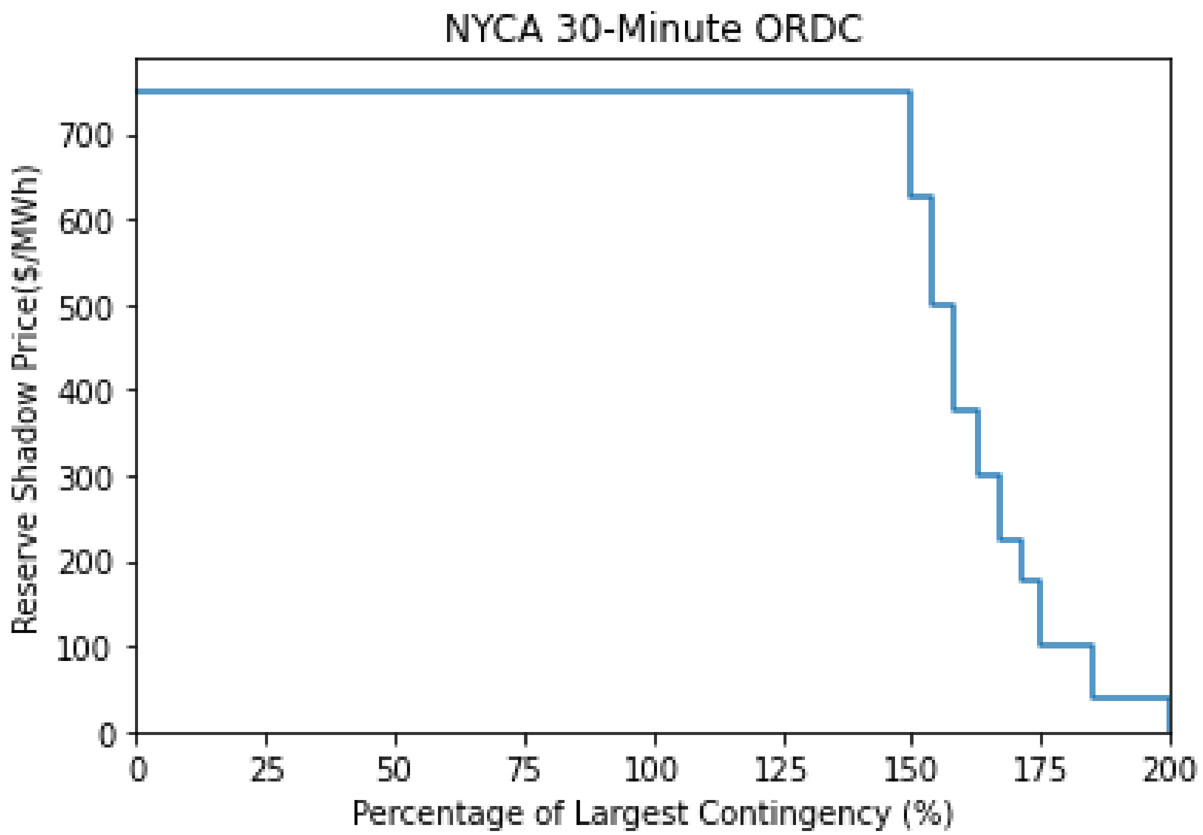
Operating Reserve Demand Curves: Formulaic Calculation (continued)



- The breakpoints of the ORDC can also be calculated as a percentage of the largest contingency
- This graph illustrates each break point as a percent of the largest contingency

Operating Reserve Demand Curves: Formulaic Calculation Example

Shortage Price ($/MWh)	Percent of Largest Contingency	ORDC Break Points (MW) Largest Contingency = 1310 MW	Dynamic Break Points (MW) Largest Contingency = 1500 MW
750	150%	1965	2250
625	154%	2020	2313
500	158%	2075	2376
375	163%	2130	2439
300	167%	2185	2502
225	171%	2240	2565
175	175%	2295	2628
100	185%	2420	2771
40	200%	2620	3000

- **To demonstrate the formulaic calculation of ORDC, the NYISO estimated how the ORDC Breakpoints would change based on a largest contingency of 1,500 MW**
  - This would result in a reserve requirement of 3,000 MW
  - The first step of the demand curve would correspond to 1.5x the largest contingency – 2,250 MW
  - This tables illustrates the MW value that would be applicable to each shortage price

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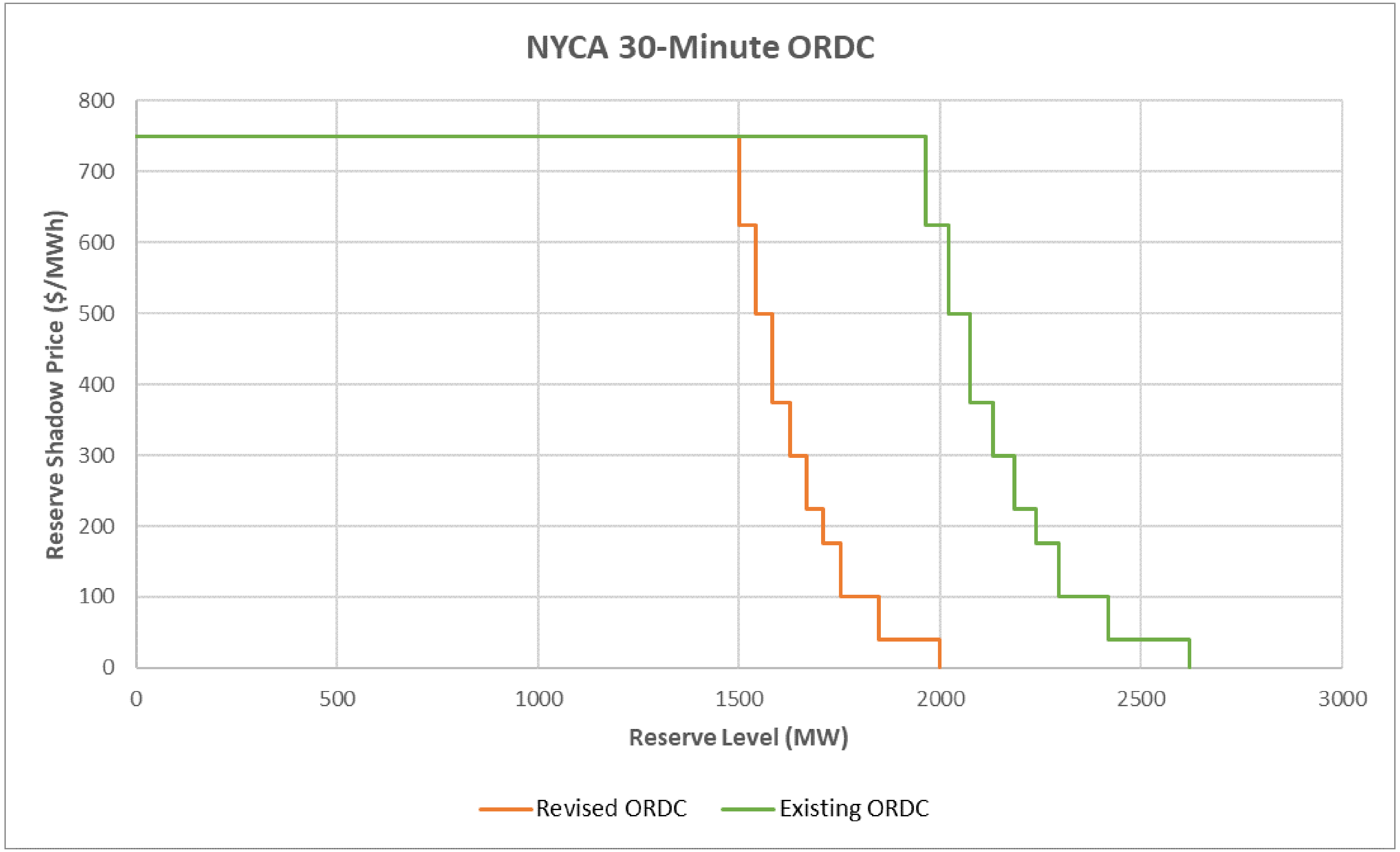
Operating Reserve Demand Curves: Formulaic Calculation Example (continued)



This graph illustrates how the shape of the demand curve is maintained using a formulaic calculation

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Operating Reserve Demand Curves: Proposal

- Dynamic Reserves would allow for the scheduling of economic energy above 1,310 MW from individual suppliers when it is economic to do so, while procuring enough reserves to cover the largest source contingency that may result from the energy schedules
- The existing ORDC is based on a procurement of 2,620 MW, and would not be sufficient for the procurement of reserves above that amount
- NYISO is proposing to introduce a dynamic demand curve that would be proportional to the steps of the existing demand curve
  - NYISO is not proposing any changes to the shortage prices as part of Dynamic Reserves
  - In 2020, stakeholders approved enhancements to the NYCA 30-Minute Demand Curve as part of the Ancillary Services Shortage Pricing project, which included adjustments to shortage pricing values and additional demand curve steps (https://www.nyiso.com/documents/20142/16885911/06%20Ancillary%20Services%20Shortage%20Pricing.pdf/54a66576-327d-54df-bef0-ac3d08139b99)

Cost Allocation for Dynamic Reserves

Reserve Cost Allocation

- **Currently, operating reserve costs are allocated statewide on a load-ratio share basis**
- **NYISO does not propose any changes to the cost allocation due to Dynamic Reserves**
  - Dynamic Reserves is expected to be a more economically efficient market construct, as was seen in market reruns completed for the 2021 study. This efficiency led to lower LBMPs and lower total production costs
  - NYISO believes that consumers will benefit from likely lower production costs and more efficient price signals for reserves and therefore the current allocation of reserve costs remains appropriate when reserve requirements are established dynamically

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Next Steps

Next Steps: Intermittent Resource Contingency Constraint

- **At the 5/11 MIWG/ICAPWG meeting, NYISO introduced a constraint that would account for the potential risk of simultaneous loss (or reduction of energy output) of intermittent resources within a similar geographic area**
- **NYISO is developing responses to the following stakeholder comments:**
  - Discussion on the use of scheduled wind output vs. forecasted wind output in the proposed constraint
  - Information on how Probability of Exceedance (POE) forecasts are calculated by NYISO's vendor
- **NYISO is targeting a late August MIWG/ICAPWG to continue the discussion on the Intermittent Resource Contingency constraint**

Components Previously Discussed: Q2

- **To date, NYISO has completed initial stakeholder discussions on the following topics:**
  - Correlated contingencies that might impact reserve requirements
  - Use of forecast load in mathematical formulation
  - Interaction of dynamic modeling with intermittent resource contingencies
  - Securing of reserves in export constrained areas (e.g., Long Island)
  - Interplay between Thunderstorm Alerts (TSAs) and dynamic reserves
  - Process for posting of dynamic reserve requirements

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Next Steps: Q3

- **The NYISO will continue discussions on the following topics at ICAP/MIWG in the coming months**
  - Q3 (August, September): Items in blue discussed at August 9th ICAPWG/MIWG
    - Interaction of dynamic reserves with operating reserve demand curves
    - Interaction of dynamic reserves with transmission demand curves
    - Interplay between dynamic reserves scheduling and additional reserve requirements
    - Impacts on scarcity pricing logic
    - Interplay with current/future efforts: More Granular Operating Reserves, Long Island Constraint Pricing, Reserves for Congestion Management
    - LBMP formation (including cost allocation, pricing of virtual supply in DAM)
    - Follow-up on previously discussed topics: Use of Forecast vs. Bid Load, Intermittent Resource Contingency Constraint
  - Discussion of prototyping, which could include:
    - Impacts on day-ahead and real-time market solutions
    - Interaction with new resource models
  - Project deliverable is Market Design Concept Proposed in Q4

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Questions?

Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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Appendix: Mathematical Formulation

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Equations: Securing a Reserve Area for the Loss of Generation

Calculating Actual Energy Flows in a Reserve Area

$$RA_{a_{Flow_i}} = (RA_{a_{Load_i}} + RA_{a_{Losses_i}} - RA_{a_{Gen_i}})$$

- RA_a is the applicable reserve area
- $RA_{a_{Flow_i}}$ is the actual energy flow into or out of reserve area *a* for time step *i*
  - $RA_{a_{Flow_i}}$ is positive into reserve area *a*
  - $RA_{a_{Flow_i}}$ is negative out of reserve area *a*
  - Note: For the NYCA reserve area (Load Zones A-K), $RA_{a_{Flow_i}}$ value is equal to 0 MW because external proxies are evaluated as generators
- $RA_{a_{Load_i}}$ is the forecasted load in reserve area *a* for time step *i* (Day-Ahead or Real-Time, as applicable)
- $RA_{a_{Losses_i}}$ is the calculated losses in reserve area a for time step *i* (Day-Ahead or Real-Time, as applicable)
- $RA_{a_{Gen_i}}$ is the sum of all energy schedules on resources inside reserve area *a* for time step *i*

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Calculating the Available Transmission Headroom in a Reserve Area

$$\mathrm{RA}_{aResCapability_i}^{10Minute} = RA_{a_{EmerLimit_i}} - RA_{a_{Flow_i}}$$
$$\mathrm{RA}_{aResCapability_i}^{30Minute} = RA_{aNorm_{Limit_i}} - RA_{a_{Flow_i}}$$

- $\mathrm{RA}_{\mathrm{aRes}_{\mathrm{Capability}_\mathrm{i}}}$ is the capability to secure reserves external to reserve area *a* for time step *i*
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{EmerLimit}_\mathrm{i}}}$ is the pre-contingency emergency limit for the reserve area *a* for time step *i*
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{NormLimit}_\mathrm{i}}}$ is the pre-contingency normal limit for the reserve area *a* for time step *i*
  - Note: For the NYCA reserve area (Load Zones A-K), the $RA_{EmerLimit}$ and $RA_{NormLimit}$ value is equal to 0 MW because external proxies are evaluated as generators

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Multipliers Determine Product Quality Ratios

$$Res_{RA_{a_i}}^{10Spin} \geq Mult_{\mathrm{RA}_a}^{10Spin} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10SPin}\}\} - RA_{aResCapability_i}^{10Minute}$$

$$Res_{RA_{a_i}}^{10Total} \geq Mult_{\mathrm{RA}_a}^{10Total} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10Total}\}\} - \mathrm{RA}_{aResCapability_i}^{10Minute}$$

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{30Total}\}\} - \mathrm{RA}_{aResCapability_i}^{30\mathrm{Minute}}$$

- $\mathrm{Res}_{\mathrm{RA}_{a_i}}^{10\mathrm{Spin}}$ is the 10 $-$ minute spinning reserve requirement in reserve area a for time step i
- $\mathrm{Res}_{\mathrm{RA}_{a_i}}^{10\mathrm{Total}}$ is the 10 $-$ minute total reserve requirement in reserve area a for time step i
- $\mathrm{Res}_{\mathrm{RA}_{a_i}}^{30\mathrm{Total}}$ is the 30 $-$ minute total reserve requirement in reserve area a for time step i

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Correlated Loss of Multiple Generators: Proposal

- **This constraint would capture the potential risk of losing multiple resources whose combined output may be the largest single source of generation in a reserve area**
  - The definition of correlated loss of multiple generators includes a single tower or line contingency leaving a generation complex that would result in the loss of multiple generating resources simultaneously
- **NYISO's proposal would allow generators to be linked such that their combined output would be evaluated in the standard form below:**
  - $Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \{\{gen_{\mathrm{A_i}} + 30T_{\mathrm{A_i}} + gen_{\mathrm{B_i}} + 30\mathrm{T}_{\mathrm{B_i}}\}\} - RA_{aRes_{Capability_i}}$

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Intermittent Resource Contingency: Proposal

- This constraint would capture the potential risk of losing multiple intermittent resources whose combined output may be the largest single source of energy in a reserve area
- NYISO proposes to use the difference between the schedules (based on a POE50) and the forecasted values based on a higher POE, in the standard format:

$$Res^{30Total}_{\mathrm{RA}_{ai}} \geq Mult^{30Total}_{\mathrm{RA}_a} * \left(\sum_{RA_{a_i}} IPP_{Schedule_i} - \sum_{RA_{a_i}} POEXX_{Forecast_i} \right) - RA_{aRes_{Capability_i}}$$

- Scheduling of wind resources is based on a Probability of Exceedance (POE) 50 forecast
  - A POE(50) forecast represents a value that will be exceeded 50% of the time; in turn, observations will be below this value 50% of the time
- NYISO's proposal would use a POE forecast greater than 50 to calculate the quantity of generation that may be at risk
  - The use of a higher POE (higher confidence) forecast would provide greater certainty of expected output. At this time, NYISO has not determined what POE forecast that will be used for this constraint
    - For example, a POE(95) represents a value with a 95% chance of being exceeded. This value is less than a POE(50) value as there is higher confidence that the forecast will be above it

Securing a Reserve Area for the Loss of Transmission

Contingency Headroom on Interface

$$10minute_{PostCon_{Import_{RA_{a_i}}}} = Limit_{Emer_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

$$30minute_{PostCon_{Import_{RA_{a_i}}}} = Limit_{Norm_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

$$30minute_{PostDualCon_{Import_{RA_{a_i}}}} = Limit_{Emer\_Dual_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

- $10\mathrm{minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 10 minutes
- $30\mathrm{minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 30 minutes
- $\mathrm{Limit}_{\mathrm{Emer}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the emergency transfer limit of reserve area *a* for time step *i*, depending on the applicable reliability rules to determine the need for 10 minute or 30-minutes reserves
- $\mathrm{Limit}_{\mathrm{Norm}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the normal transfer limit of reserve area *a* for time step *i*, depending on the applicable reliability rules to determine the need for 30-minutes reserves

Contingency Headroom on Interface

- **The difference between the applicable transfer limit and the flow is the available import capability**
  - When negative, this number represents a deficiency that needs to be held as reserves within the reserve area due to the lack of transmission headroom to import reserves.
- **All limits will be calculated via an offline study by NYISO Operations**

Securing the RA for Loss of Transmission

$$Res_{RA_{a_i}}^{10Spin} \geq -Mult_{\mathrm{RA}_a}^{10Spin} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

$$Res_{RA_{a_i}}^{10Total} \geq -Mult_{\mathrm{RA}_a}^{10Total} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

$$Res_{RA_{a_i}}^{30Total} \geq -Mult_{\mathrm{RA}_a}^{30Total} * \left(30minute_{PostCon_{Import_{RA_{a_i}}}}\right)$$

Tying the Loss of Generation and Loss of Transmission Together

Simultaneous Constraints 10-Minute Spinning Reserves

- **Simultaneous Constraints for 10-minute spinning reserves:**

$$Res_{RA_{a_i}}^{10Spin} \geq Mult_{\mathrm{RA}_a}^{10Spin} * \{\max_{\mathrm{k \in Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10SPin}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{10Spin} \geq -\mathrm{Mult}_{\mathrm{RA_a}}^{\mathrm{10Spin}} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

The more restrictive of the two equations will determine the applicable requirement for the reserve area.

Simultaneous Constraints 10-Minute Total Reserves

- **Simultaneous Constraints for 10-minute total reserves:**

$$Res_{RA_{a_i}}^{10Total} \geq Mult_{\mathrm{RA}_a}^{10Total} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10Total}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{10Total} \geq -Mult_{\mathrm{RA}_a}^{10Total} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

The more restrictive of the two equations will determine the applicable requirement for the reserve area.

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Simultaneous Constraints 30-Minute Total Reserves

- **Securing for loss of source contingency with a security multiplier:**

$$Res_{RA_{a_i}}^{30Total} \geq \mathrm{Mult}_{\mathrm{RA_a}}^{30\mathrm{Total}} * \{\max_{\mathrm{k \in Gen}_{RA_a}} \{\mathrm{gen}_{k_i} + res_{k_i}^{30Total}\}\} - RA_{aRes_{Capability_i}}$$

- **Securing for one source contingency and N-1 transmission contingency:**

$$Res_{RA_{a_i}}^{30Total} \geq \{\max_{\mathrm{k \in Gen}_{RA_a}} \{\mathrm{gen}_{k_i} + res_{k_i}^{30Total}\}\} - RA_{aRes_{Capability_i}} + \left(30minute_{PostCon_{Import_{RA_{a_i}}}} - 10minute_{PostCon_{Import_{RA_{a_i}}}}\right)$$

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Simultaneous Constraints 30-Minute Total Reserves (continued)

- **Secure transmission for N-1 to normal transfer capability:**

$$Res_{RA_{a_i}}^{30Total} \geq -Mult_{\mathrm{RA}_a}^{30Total} * \left(30minute_{PostCon_{Import_{RA_{ai}}}}\right)$$

- **Secure transmission for N-1-1-0 to normal transfer capability (applies to NYC and NYC load pockets):**

$$Res_{RA_{a_i}}^{30Total} \geq -\left(30minute_{PostdualCon_{Import_{RA_{ai}}}}\right)$$

- **Secure for loss of two elements within 30 minutes:**

$$Res_{RA_{a_i}}^{30Total} \geq -10minute_{PostCon_{Import_{RA_{ai}}}} - \left\{\max_{\mathrm{k}\in\mathrm{Gen}_{\mathrm{RA_a}}}\{gen_{\mathrm{k_i}}\}\right\}$$

The more restrictive of the equations will determine the applicable requirement for the reserve area.

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