A536: Real-Time Scheduling

Automated Mitigation Process (RT-AMP)

CONCEPT OF OPERATION (COO)

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Document Locator:
A536_coo_rtamp.doc

Revision History:	
Date:	**Additions, deletions, modifications:**
4/22/2002	Draft #1
5/31/2002	Draft #2
6/7/2002	Draft #3
7/2/2002	Straw man #1
7/12/2002	Straw man #1, refinements
7/13/2002	Straw man #1, Savitt, Patton edits
9/12/2002	Straw man #2 (following internal meetings)
10/15/2002	Semi-final: Patton, Savitt comments
10/25/2002	Final: Patton, Savitt comments & decisions, Example
12/31/2002	Guarantee payment impact definition
02/25/2003	Strawman #3
03/04/2003	Strawman #3, incorporation of comments and resolution of open design issues
03/21/2003	Final: Ops Comments

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1 INTRODUCTION

1.1 Goal Statement

Software and procedures are to be developed by ISO staff to automate the real-time detection and mitigation of the exercise of market power. Two detection process are being proposed: (i) conduct and impact tests applied to pre-defined super-zones in the NYCA; and (ii) conduct and impact tests applied to load pockets that may develop within designed constrained areas of the NYCA. Currently only NYC (zone J) has been designated as a constrained area. The following offer parameters are candidates for the mitigation:

- Incremental energy cost
- Start-up cost
- Minimum generation cost

1.2 Definitions, Acronyms, and Abbreviations

Term	Description
Base-Set	Initial set of offers being evaluated by RTC. The Base-Set may include previously mitigated offers as well as unmitigated offers.
Local congestion	Congestion associated solely with facilities inside a constrained area.
Mit-Set	Set of offers after mitigation is finalized. Mit-Set may contain more mitigated offers than Base-Set and fewer mitigated offers than Ref-Set.
MMP	Market Monitoring and Performance
Plan	Market monitoring plan
RTC	Real-time commitment
RT-AMP	Commitment and testing portions of the real-time automated mitigation process
RTD	Real-time dispatch
RTS	Real-time scheduling (composed of RTC, RTD, and RT-AMP)
Ref-Set	Intermediate set of offers after mitigation is applied to all offers tripping the conduct test (subject to the arming process).

1.3 Background

The real-time scheduling process consists of a real-time commitment (RTC) process that runs at 15-minute intervals and a real-time dispatch (RTD) process that runs at 5-minute intervals. Offers of incremental energy cost, minimum generation level, and minimum generation cost may be updated hourly. This document presents the methods to be used by an automated mitigation procedure in real-time. The method uses a second run of RTC, called RT-AMP, to calculate conditions that can be used in an impact test.

Information used for the automated mitigation process must include:

- Offers for energy, startup and minimum generation
- References for energy, startup and minimum generation
- RTC energy prices of intervals during which offers are locked
- Energy prices of the previous RTC during those same intervals
- Base points of the previous RTC during those same intervals
- RT-AMP energy prices of intervals during which offers are locked

- Constrained facilities determined by the previous RTC
- Generator shift factors (maybe)
- Association of energy resources with owner/operator portfolios

1.3.1 RTC Process

The RTC process is illustrated in Figure 1. RTC runs every 15 minutes and calculates conditions for ten 15-minute intervals. Each RTC is named for the time when its results are posted. Thus RTC_{15} runs during the interval :00 to :15; calculates conditions for :30, :45, :00(+1), :15(+1) ,…, :45(+2); and posts by :15. Offers are locked during the initial RTC intervals and those intervals are candidates for an automated mitigation process. Offers beyond the initial intervals are subject to change and mitigation, if applied, is only advisory during those intervals.

	Intervals with Offers Locked	Intervals with Offers Subject to Change
RTC_{15}	:30, :45, :00(+1), :15(+1), :30(+1), :45(+1)	:00(+2), :15(+2), :30(+2), :45(+2)
RTC_{30}	:45, :00(+1), :15(+1), :30(+1), :45(+1)	:00(+2), :15(+2), :30(+2), :45(+2), :00(+3)
RTC_{45}	:00(+1), :15(+1), :30(+1), :45(+1)	:00(+2), :15(+2), :30(+2), :45(+2), :00(+3), :15(+3)
RTC_{00}	:15, :30, :45	:00(+1), :15(+1), :30(+1), :45(+1), :00(+2)), :15(+2), :30(+2)

For each interval, RTC determines an energy price ($/MWH) at the terminal bus of each energy resource. RTC also determines which facilities are constrained. RT-AMP will calculate the same quantities using some mitigated offers in place of those used by the corresponding RTC.

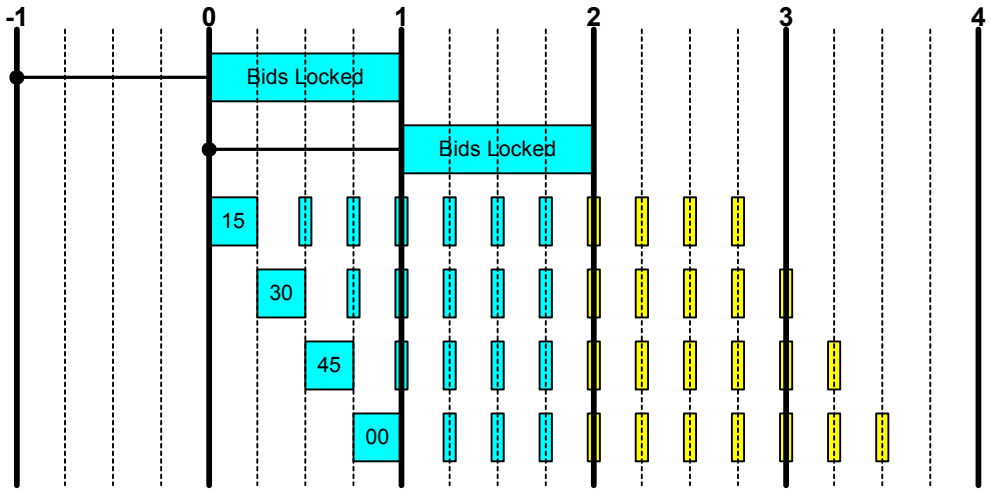

Figure 1. RTC Process

1.4 Business Need

The Market Monitoring and Performance unit has the responsibility to quickly and accurately detect and mitigate the exercise of market power. Automation of tests and screens, consistent with the plan, is the most viable means of accomplishing this responsibility.

1.5 System Impact

The following systems would be impacted:

- Real-time commitment process
- Market information system

2 DESCRIPTION

The automated real-time mitigation process must incorporate both conduct tests and an impact tests. The conduct test compares the price of each energy offer, including start-up and minimum generation costs, to references. When reference prices have been exceeded by a significant amount the conduct test is said to have "tripped."

The first impact test examines the change in prices that would prevail if offer prices were mitigated. This test "trips" if mitigation of offers would significantly change prices. A variation of the first impact test applied to designated constrained areas examines a localized change in congestion and "trips" if the change in local congestion is significant. This first impact test will be implemented with a full recommitment and dispatch.

A second impact test examines the change in guarantee payments to an energy supplier with mitigation of offer prices. The second test "trips" if the change in guarantee payments is significant.

There are many rules, parameters, limits, and thresholds that have to be clearly defined before any automated mitigation process is put in place. Those considerations include:

- Determination of super-zones in the NYCA and load pockets in constrained areas
- Determination of a threshold values for each load pocket of a constrained area
- Determination of the nesting pattern of load pockets
- Arming of an automated mitigation process
- Portfolio exclusion that may be applied to super-zones and load pockets.

2.1 Mitigation Plan

Automation of real-time mitigation will be consistent with the Mitigation Plan. Provisions of the Mitigation Plan, such as the exemption from automated mitigation for incremental energy offers of less than a threshold amount (currently $25.00/MWH) and ancillary service offers less than a threshold amount (currently $5.00), will be observed. Additionally, the Mitigation Plan may require modification if the automation of real-time mitigation discovers situations that are not adequately documented in the Mitigation Plan.

2.2 RT-AMP Process

Automated mitigation relies on a second unit commitment evaluation to assess the impact of mitigation. Thus, two unit commitment executions are required at each time step. The first determines the prices and schedules that would occur with the original set (Base-Set) of offers. The second determines the prices and schedules that would occur with a mitigated set (Ref-Set) of offers. The combined execution times of the unit commitments needed to evaluate both Base-Set and Ref-Set is likely longer than the RTC interval (15 minutes). However, each commitment can be executed as a separate process so they can be run in parallel as shown in Figure 2. The advantage is that a full RTC cycle (15 minutes) can be used to evaluate impact; hence, timing concerns are minimized. When done in parallel, the possibility of mitigation would be tested for the next RTC cycle (15 minutes) in the future. RTC_{15} and $RT\text{-}AMP_{15}$ would perform unit commitment evaluations simultaneously. Results of RTC_{15} and $RT\text{-}AMP_{15}$ would then evaluate for impact and, if mitigation were necessary, mitigated offers would be sent to RTC_{30}. Mitigation of offers for RTC_{15} would have been decided previously by $RT\text{-}AMP_{00}$.

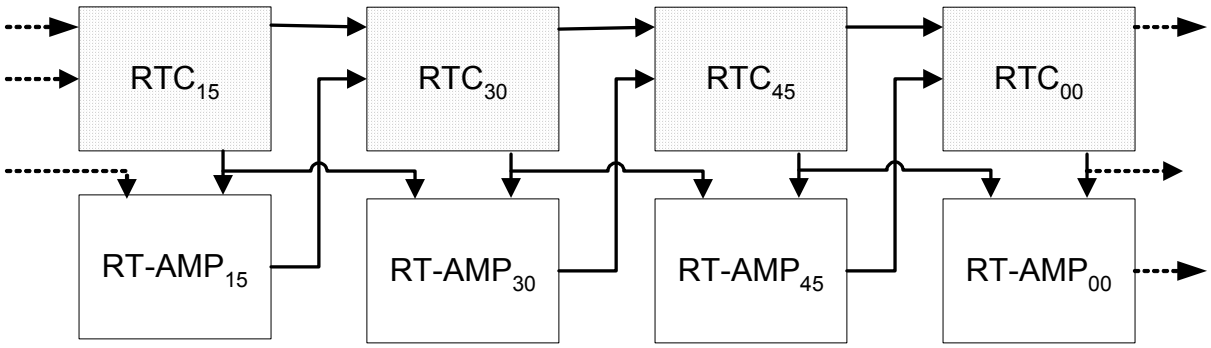

Figure 2. Parallel Impact Test

A third unit commitment is required to assure that prices and schedules are consistent with the final set of offers, some of which may be mitigated. When the test is conducted in parallel, only one, instead of two, additional unit commitments are required in each RTC cycle. As shown in Figure 3, for the time period 15 to 30, Base-Set and Mit-Set are identical. RTC_{15} provides the base case unit commitment. Simultaneously $RT\text{-}AMP_{15}$ calculates the reference unit commitment, conducts the impact test, and determines the actual set of resources whose offers are to be mitigated (Mit-Set). Finally, RTC_{30} ensures that the commitment is consistent with the set of mitigated offers. Subsequently Mit-Set is used as the Base-Set and RTC_{30} would provide the base case for $RT\text{-}AMP_{30}$ and so on.

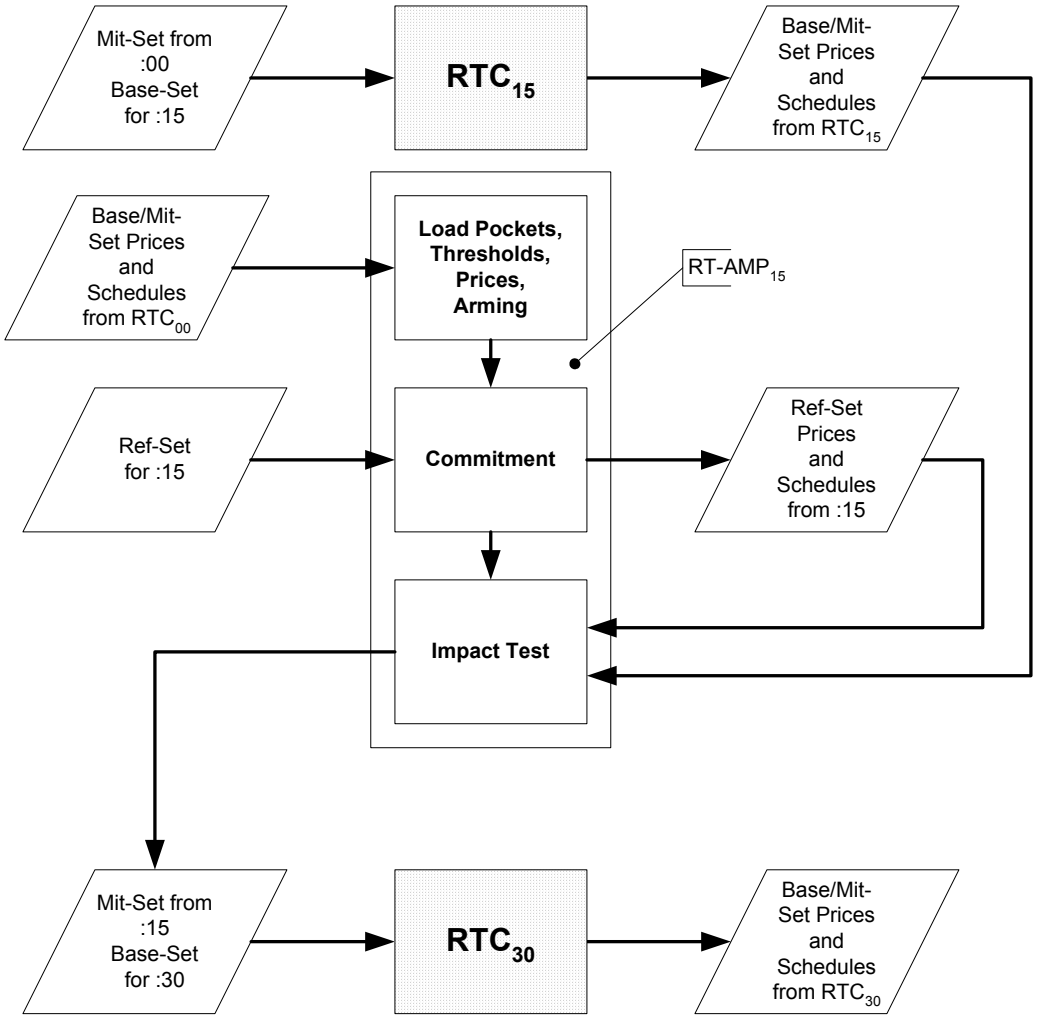

Figure 3. Parallel Impact Test 15 to 30 Minutes

2.3 Mitigation Locations

The four super-zones that have previously been defined for the day-ahead AMP will also be applied in real-time. In addition, load pockets will be associated with constrained facilities or interfaces in pre-defined constrained area(s).

2.3.1 NYCA Super-Zones

The NYCA has previously been divided into four nesting locations, called super-zones, for the DA automated mitigation. These super-zones, shown in Figure 4, will be extended to real-time automated mitigation.

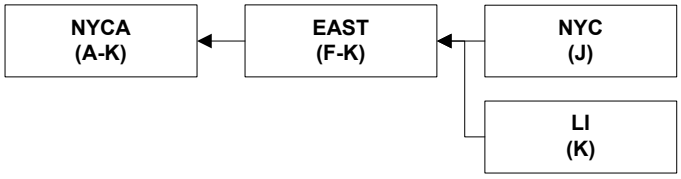

Figure 4. NYCA Super-Zones

It is possible that the number of NYCA super-zones will be increased in the future to accommodate changes in the prevailing congestion patterns. One possible change is shown in Figure 5. It is desirable the RT-AMP accommodate changes to the number and nesting pattern of NYCA super-zones.

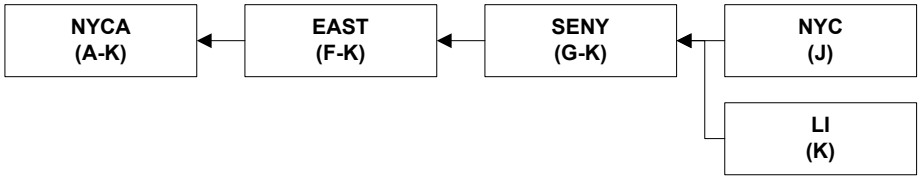

Figure 5. Possible Future NYCA Super-Zones

2.3.2 NYC Constrained Area

RT-AMP provides the possibility of extending the concept of "load pocket" to individual facilities (line, cable, transformer, etc.) in addition to selected interfaces that are composed of several facilities. The set of resources that are able to relieve the facility can be either pre-defined or identified in real-time. The original idea of "load pocket" would be generalized to a set of monitored facilities and interfaces that may become constrained. The set of energy resources "within a load pocket" would be generalized to be the set of resources that could best relieve the constraint. This methodology can also be applied DA.

The current RT in-city mitigation has identified a number of load pockets that receive special, automated, scrutiny and mitigation. These are shown in Figure 6 and form a telescoping set. The emphasis in RT-AMP will shift from the predefined telescope of Figure 6 to a list of facilities or interfaces that may become constrained.

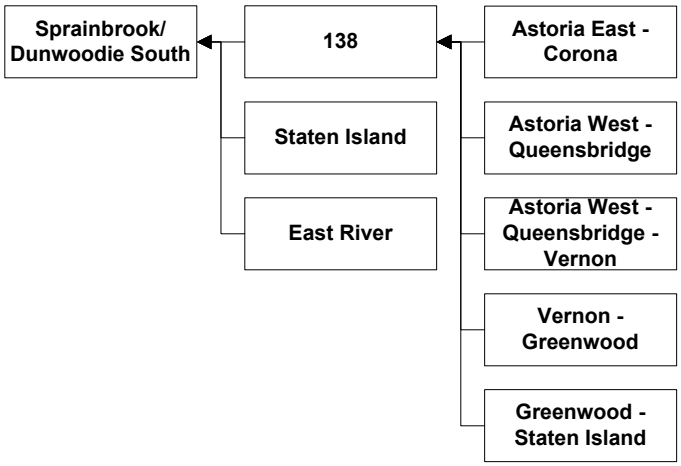

Figure 6. Current Load Pockets of the NYC Constrained Area

The definition of the set of facilities and interfaces that are of interest is a necessary preliminary step. Thresholds will be associated with each facility/interface. This set of facilities/interfaces, with associated thresholds, will be defined prior to implementation. Each facility/interface, when constrained, will spawn a load pocket. Here, the term "load pocket" actually refers to the set of energy resources that are best able to relieve the constrained facility. It is anticipated that the set of monitored facilities will be updated periodically, but infrequently. The initial set of monitored facilities/interfaces and thresholds, as well as the periodic updates, will be provided by MMP. The set may be something like:

Facility/Interface	Threshold
Sprainbrook -	

Dunwoodie South	
M51	$37.63
M52	$37.63
71	$37.63
72	$37.63
138	
29211	$4.81
29212	$4.81
32077	$4.81
32078	$4.81
32711	$4.81
36311	$4.81
36312	$4.81
Astoria West - Queensbridge	
15055	$3.12
31281	$3.12
31282	$3.12
East River	
44371	$25.70
44372	$25.70
Etc.	**…**

Automated mitigation will first detect whether each monitored facility/interface is constrained. Conduct and impact thresholds applied to the energy resources within a load pocket will be the facility/interface thresholds. The result of this process is a set of constrained facilities, each of which has a load pocket with arming and impact thresholds and a set of resources each of which has a conduct threshold. The association of generators with load pockets can be done in one of two ways: static or automatic.

2.3.2.1 Manual Facility/Generator Association

An off-line study of generator shift factors would lead to a static association of generators with load pockets. That is, the set of generators that could most effectively relieve a constrained facility would be pre-defined and subject to infrequent change. A static association of generators with load pockets (constrained facilities) might take the following form:

Facility	**Energy Resource**
M51	QuothTheRaven 3
M51	ChesterArthur 1
M51	ChesterArthur 2
M51	ClintEastwood 6
M51	ClintEastwood 7
44372	ClintEastwood 6
44372	ClintEastwood 7
Etc.	…

Any particular generating unit may be effective in relieving several facilities. Therefore, a single generating unit would appear in the list of facility/generator associations multiple times. In addition, it is known that the Astoria generating units may be connected to the network at one of two places: Astoria East or Astoria West. The set of facilities that may be relieved by these units changes markedly from one connection to the other. A manually maintained facility/generator association must provide for the actual connection of the Astoria generating units.

2.4 Arming, Conduct, and Impact Thresholds

Statewide thresholds are defined for arming, conduct, and impact tests performed on super-zones. In addition, special thresholds are used for load pockets pre-defined constrained area(s).

2.4.1 NYCA Thresholds

Thresholds for conduct and impact are defined in the plan. These thresholds shall be used for the NYCA super-zones as is currently done in the DA AMP.

2.4.2 Thresholds of the NYC Constrained Area

Each facility/interface, when constrained, will spawn a load pocket and each shall be assigned a threshold value. The threshold shall be used for:

- Conduct test applied to the incremental energy offer
- Local congestion impact test

Facility/interface thresholds will be determined by periodic off-line study and will reflect and the frequency that the facility/interface binds, including the frequency that "upstream" facilities bind. Arming and impact thresholds applied to the load pocket, as well as conduct thresholds applied to resources within the load pocket, will be determined from the facility/interface threshold. In the event that a resource is in multiple load pockets, the smallest of its multiple conduct thresholds shall be used.

Facility (load pocket) threshold values shall be updated manually by MMP and will be accessed by the RT-AMP program via a look-up table. MMP shall determine the threshold values according to the following formula:

$$LPT_i = \left[\frac{2.0\% \times 8760 \times AP}{CH_i} \right]$$

Symbol	Description
LPT_i	Threshold value for load pocket "i." Threshold shall be determined periodically.
AP	Rolling average price of energy in Zone J. Average shall be determined monthly and shall consider only non-constrained hours with no units OOM for reliability reasons for the previous 12 months.
CH_i	Congested hours of facility "i," or any "upstream" facility within the constrained area over the previous 12 months.

For the purpose of counting congested hours, the upstream/downstream structure of facilities within the NYC constrained area is shown in Figure 7. Each monitored facility within the NYC constrained area shall be assigned an attribute indicating which facilities are "upstream." The attribute may take one of two values:

- Downstream of Sprainbrook/Dunwoodie South, or
- Downstream of 138 KV. In turn, the 138 KV interface is downstream of Sprainbrook/Dunwoodie South. Therefore, all facilities designated as downstream of 138 KV are also downstream of Sprainbrook/Dunwoodie South.

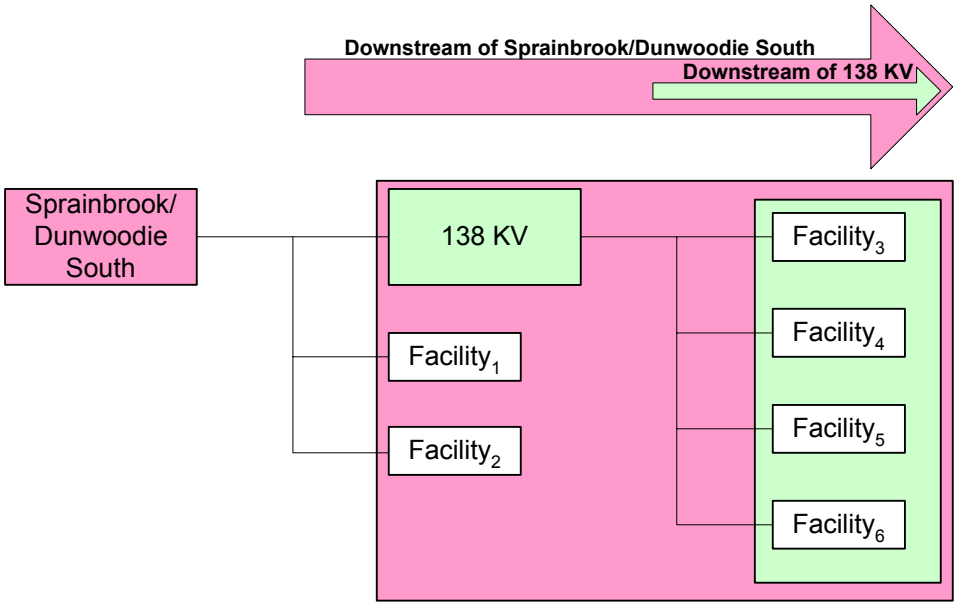

Figure 7. Nesting to Determine Constrained Hours

As shown in the table below, the "Downstream Of" attribute value for the facilities in the NYC constrained area would have one of two possible values: "Sprainbrook/Dunwoodie South" or "138 KV." These values would be assigned and maintained by ISO staff.

Facility/Interface	Downstream Of
Sprainbrook - Dunwoodie South	
M51	Sprainbrook/Dunwoodie South
M52	Sprainbrook/Dunwoodie South
71	Sprainbrook/Dunwoodie South
72	Sprainbrook/Dunwoodie South
138	
29211	Sprainbrook/Dunwoodie South
29212	Sprainbrook/Dunwoodie South
32077	Sprainbrook/Dunwoodie South
32078	Sprainbrook/Dunwoodie South
32711	Sprainbrook/Dunwoodie South
36311	Sprainbrook/Dunwoodie South
36312	Sprainbrook/Dunwoodie South
Astoria West - Queensbridge	
15055	138 KV
31281	138 KV
31282	138 KV
East River	
44371	Sprainbrook/Dunwoodie South
44372	Sprainbrook/Dunwoodie South
Etc.	-

The annual constrained hours of a facility that has been designated as "downstream of Sprainbrook/Dunwoodie South" shall include all hours of the previous 12 months when any one (or more) of the following are binding:

- The facility itself, and/or
- Any component of the Sprainbrook/Dunwoodie South interface (most likely the M51, M52, 71, and/or 72 lines)

Examples of facilities that might be given the attribute "downstream of Sprainbrook/Dunwoodie South" are the 32078 line (part of the 138 KV interface) and the 44372 line (part of the East River interface).

The annual constrained hours of a facility that has been designated as "downstream of 138 KV" shall include all hours of the previous 12 months when any one (or more) of the following are binding:

- The facility itself, and/or
- Any component of the Sprainbrook/Dunwoodie South interface (most likely the M51, M52, 71, and/or 72 lines), and/or
- Any component of the 138KV interface (most likely the 29211, 29212, 32077, 32078, 32711, 36311, and/or 36312 lines)

Examples of facilities that might be given the attribute "downstream of 138 KV" are the 34125 and 15055 lines (each part of the Astoria West/Queensbridge interface) or the 28241, 28242, 28243, and 28244 lines (each completely contained within the Astoria West/Queensbridge load pocket).

2.5 Arming

The arming test makes an initial determination of whether mitigation is likely to result in a material price impact. Subsequently the impact test verifies a material price impact, whether on LBMP or on a portion of the congestion component of LBMP.

2.5.1 Arming of NYCA Super-Zones

The real-time arming threshold ($RTCB_1$) for the super-zones of the NYCA shall be the same as the arming threshold of the DA AMP, which currently has a value of $150.00.

- Energy resources in zones A-K shall be evaluated for conduct and energy price impact if the price at any generator in zones A-E is $RTCB_1$ or higher in any interval;
- Energy resources in zones F-K shall be evaluated for conduct and energy price impact if the price at any generator in zones F-I is $RTCB_1$ or higher in any interval;
- Energy resources in zone J shall be evaluated for conduct and energy price impact if the price at any generator in zone J is $RTCB_1$ or higher in any interval;
- Energy resources in zone K shall be evaluated for conduct and energy price impact if the price at any generator in zone K is $RTCB_1$ or higher in any interval;

The conduct tests and guarantee payment impact test shall be performed regardless of the arming criteria for the energy price impact test.

2.5.2 Arming Within the NYC Constrained Area

The "arming" process activates the automated mitigation logic. A load pocket will be armed, that is, will be evaluated for possible mitigation, if the criteria below are satisfied for any interval during an hour. Arming shall apply to whole hours consistent with the offer period.

1. The facility/interface is constrained in any, and

2. The local congestion at any energy resource within the load pocket exceeds the threshold associated with the facility that spawned the load pocket.

Local congestion may be defined in one of two ways: relative to a pre-selected reference or calculated from the shadow prices of monitored facilities.

2.5.2.1 Local Congestion Method 1

The first method of determining "local congestion" requires the identification of a reference location outside, but close to, the NYC constrained area. The "local congestion" at the site of an energy resource within the NYC constrained area is then the difference in the congestion components at the energy resource and reference locations. That is:

$$LC_g = \left[C_g - C_r\right]$$

Where:

Term	Description
LC_g	Local congestion at the site of energy resource "g"
C_g	Congestion component of LBMP at the site of energy resource "g"
C_r	Congestion component of LBMP at the reference site

2.6 Portfolio Exclusion

The portfolio exclusion limit provides a mechanism of exempting a small amount of generation from mitigation. The portion of each portfolio (set of generators) within a load pocket shall be exempt from mitigation if the cumulative capacity (portions of the incremental energy offer curves) that trips the conduct test is less than the portfolio exclusion limit. The portfolio exclusion methodology will remain as a function contained within the MIS.

2.6.1 NYCA Portfolio Exclusion

The same portfolio exclusion that is used in the DA AMP shall be used in the NYCA super-zones. Currently that exclusion is 50 MW.

2.6.2 Portfolio Exclusion of NYC Constrained Area

A portfolio exclusion of zero shall be applied to the NYC constrained area and the load pockets that form with that constrained area.

2.7 Conduct Test

The conduct tests compare offers of suppliers for start-up, minimum generation, and incremental energy with references for those quantities. Differences are compared to thresholds to determine whether conduct suggests the economic withholding of resources or the attempt to exercise market power. A subsequent impact test, see below, tests the market power hypothesis. Conduct tests are established in the Market Monitoring Plan and are not expected to change, other than to define how special thresholds may be applied to load pockets with a designated constrained area. An energy resource may be associated with several load pockets, each of which has a threshold value. In such a case the conduct test shall use the smallest threshold value from the group of actively constrained load pockets. This functionality was previously done in the MIS that will now be incorporated into the RT-AMP software.

2.8 Price Impact

The impact test compares prices (or local congestion) determined with two sets of offers: (i) an original set called the Base-Set and (ii) a set resulting from the mitigation of offers tripping the conduct test (subject to the arming criteria), called the Ref-Set. The price impact test is evaluated at each time interval. The test will trip for an interval if the difference in energy price (or local congestion) is significant. Ultimately a one-hour granularity, aligned with the one-hour offer periods, shall be used and the price impact shall trip for an entire hour if it trips for any interval during the hour.

2.8.1 NYCA Energy Price Impact

The same energy impact threshold that is applied to NYCA super-zones DA shall also be applied to the NYCA super-zones in RT. The energy impact threshold is currently $100. Currently the DA-AMP measures impacts on price of each zone in a super-zone. Zonal price is a weighted average of prices and the generators within a zone. The energy price impact test in RT-AMP will measure impacts on price at each generator in a super-zone. When armed, the impact by super-zone is:

- West (zones A-E): If the change in LBMP at the location of any energy supplier in zones A-E exceeds the threshold for a 15-minute RTC interval then all energy resources in zones A-K are subject to mitigation for the hour containing the interval.

- East (zones F-I): If the change in LBMP at the location of any energy supplier in zones F-I exceeds the threshold for a 15-minute RTC interval then all energy resources in zones F-K are subject to mitigation for the hour containing the interval.

- NYC (zone J): If the change in LBMP at the location of any energy supplier in zone J exceeds the threshold for a 15-minute RTC interval then all energy resources in zone J are subject to mitigation for the hour containing the interval.

- LI (zone K): If the change in LBMP at the location of any energy supplier in zone K exceeds the threshold for a 15-minute RTC interval then all energy resources in zone K are subject to mitigation for the hour containing the interval.

2.8.2 Local Congestion Impact in the NYC Constrained Area

If the change in local congestion at the location of any energy supplier in a load pocket exceeds the threshold for a 15-minute RTC interval then all energy resources in the load pocket are subject to mitigation for the hour containing the interval.

2.9 Mitigation Duration

Mitigation will be applied for whole hours, or, if the need for mitigation is detected during the current hour, for the remainder of the current hour. Mitigation of individual intervals during an hour will lead to erratic schedules for energy resources so mitigation will not be applied to individual 15-minute intervals.

An energy resource may be associated with several load pockets, any of which may trip the impact test. To be mitigated for the remainder of the current hour, or all of the next hour, a resource must be in at least one load pocket that trips the impact test for the appropriate time period. If a resource is in two or more load pockets that trip the impact test, the mitigated offer shall be prepared using the smallest of the load pockets' thresholds.

Mitigation will be applied for the remainder of the current hour and/or all of the next hour when the need for mitigation is detected. Mitigated offers shall be used by both RTC and RTD. Both RT-AMP$_{15}$ and RT-AMP$_{30}$ are able to mitigate offers for all or part of 2 hours. RT-AMP$_{45}$ is able to mitigate offers for an hour. RT-AMP$_{00}$ is able to mitigate offers for part of an hour. Possible mitigation intervals are tabulated below and shown in Figure 8.

RTC	Possible Mitigation Time Intervals

RTC_{15}	:30 to :45, or :00(+1) to :45(+1), or :30 to :45(+1)
RTC_{30}	:45, or :00(+1) to :45(+1), or :45 to :45(+1)
RTC_{45}	:00(+1) to :45(+1)
RTC_{00}	:15 to :45

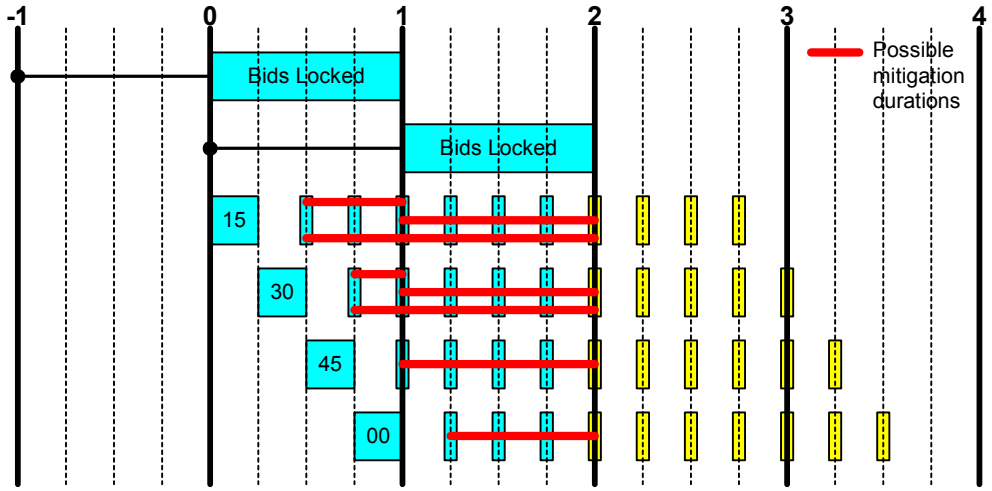

Figure 8. Mitigation Durations

The tables below show duration of mitigation when a price (local congestion) impact is detected and when a guarantee payment impact is detected. Thus (see first row of first table), if a price impact is detected in both the current hour and the next hour (and offers in the next hour are locked) then units tripping the conduct test for energy, start-up, and/or minimum generation (in valid load pockets) will be mitigated for both hours.

Price Impact			**Binding Mitigation**					
			Current Hour			**Next Hour (offers locked)**		
Current Hour	**Next Hour (offers locked)**		**E**	**SU**	**MG**	**E**	**SU**	**MG**
Y	**Y**		**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Y	**N**		**Y**	**Y**	**Y**	**N**	**N**	**N**
N	**Y**		**N**	**Y**	**Y**	**Y**	**Y**	**Y**
N	**N**		**N**	**N**	**N**	**N**	**N**	**N**

N: No, Y: Yes, E: Energy, SU: Start-up, MG: Minimum Generation (if conduct)