



Manual 34

Reference Level Manual

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Revision History

Version	Date	Revisions
1.0	06/26/2012	Initial Release
1.1	07/05/2013	Section 10 Ancillary Services <ul style="list-style-type: none"> New section. Created in response to FERC Order 755
2.0	02/18/2016	Section 6.1 <ul style="list-style-type: none"> Clarifications to the general descriptions of the Fuel & Emission Cost Data section Section 6.2 <ul style="list-style-type: none"> Re-titled from “RLS Data Requirements” to “Fuel Cost Adders and Multipliers” Section 6.3.1 <ul style="list-style-type: none"> New section. Documentation needed to assert higher fuel commodity costs Section 6.3.2 <ul style="list-style-type: none"> New section. Bidding, fuel procurement and reference updates in the presence of gas balancing costs or Operational Flow Orders Section 6.3.3 <ul style="list-style-type: none"> New section. MMA Evaluation of Gas-fired Generators’ Fuel Cost Updates Section 6.3.4 <ul style="list-style-type: none"> New section. Gas Procurement Costs for Generators Committed to Meet Reliability Needs Section 9.1 <ul style="list-style-type: none"> Added examples in the Risk & Opportunity Cost Data section
3.0	01/02/2019	Global <ul style="list-style-type: none"> Changes to comply with FERC Order 831
4.0	5/1/2023	Section 9.2 <ul style="list-style-type: none"> New section. Dynamic Opportunity Cost for ESR Section 9.3 <ul style="list-style-type: none"> New section. Opportunity Cost Adjustments Section 11. <ul style="list-style-type: none"> New section. Reference level Development for Aggregations Global <ul style="list-style-type: none"> Minor corrections, link updates.

1. Introduction

1.1. Purpose for Manual

This Manual provides an overview of the NYISO's Reference Level Processes and details the various timelines that apply to the submission, review, approval, and update of cost-based data and to mitigation consultations. It defines the categories of costs that can be included within cost-based references and also describes the processes used by the NYISO and its MMU to evaluate submitted cost data and the considerations bearing on the NYISO's decision to approve or reject that data.

1.2. Audience for Manual

This Manual is primarily intended to be used by those submitting cost data or seeking consultation on a generator's reference level. It is intended to provide transparency to the consultation processes and guidance to Suppliers preparing to submit revisions to a generator's data or a consultation request in response to the occurrence of mitigation.

2. Reference Level Consultations

2.1. Description

Suppliers may submit for approval through the Reference Level Software (RLS) updates to cost data for generating facilities that are currently available in the RLS. Suppliers should refer to the Reference Level User's Guide (https://www.nyiso.com/documents/20142/3625950/RLS_UG.pdf) for instructions on how to make RLS submissions.

2.2. Process and Timelines

Upon being noticed of a RLS submittal, NYISO will initiate its review in consultation with its external Market Monitoring Unit ("MMU"). NYISO staff and the MMU are alerted simultaneously when a new submittal is received. The review will occur as follows:

1. The NYISO will establish the urgency and level of effort associated with the submission to determine the appropriate response standard.
 - a. Extremely time-sensitive (Urgent)
 - Fuel price or availability-related
 - b. Incremental updates to static data (Normal-Low)
 - Low level of effort required for approvers
 - Updates to individual cost families (e.g., change in RS1 rate for Suppliers)
 - Fully documented
 - c. Major changes to static data (Normal-High)
 - High level of effort required for approvers
 - Complex updates to multiple cost-families
2. For "Urgent" submittals, the NYISO will promptly contact the MMU to review the request and, following the discussion with the MMU, promptly contact the Supplier (conducting a conference call, if necessary). The discussions will identify the nature of the submittal and the basis for an immediate update. The NYISO will also communicate any concerns with the submittal and identify additional documentation required for approval. Any additional details discussed verbally will be documented in an e-mail from the NYISO and confirmed by the Supplier. If necessary, the Supplier will have the opportunity to provide additional information/detail by adding an attachment to its

original RLS submittal. Based on the data documented in the RLS and/or e-mail exchange, the NYISO and its MMU will approve or deny the urgent request within 16 hours of the submittal. The NYISO will provide the basis for any denial in its comments in the RLS (viewable by the Supplier).

3. For “Normal-Low” submittals, the NYISO will contact the MMU within one business day to review the request and, following that discussion, contact the Supplier within one additional business day. The intent of this communication would be to discuss the nature of the RLS submittal and to identify any initial concerns. Any specific comments or questions would be documented in the RLS and routed automatically to the Supplier for review and response. There may be a need for subsequent conversations to resolve open issues with the submittal. To the extent not documented in RLS, substantive discussions would be documented by the NYISO in an e-mail to the Supplier with a reply confirmation from the Supplier. Based on the data documented in the RLS or subsequent e-mails, the NYISO and its MMU will approve or deny the update within 5 business days of the submittal. The NYISO will provide the basis for any denial in its comments in the RLS (viewable by the Supplier).
4. For “Normal-High” submittals, the NYISO will contact the MMU within two business days to review the request, and following that discussion schedule a conference call with the Supplier and the MMU, to occur no later than five business days following receipt of the submittal. As part of the initial discussion, the NYISO and the Supplier will discuss and agree upon a communication plan, specifying the nature and timing of regularly scheduled touch-points. Within ten business days following receipt of the request, the NYISO will insert comments into the RLS indicating either that a determination has been made that all necessary supporting documentation has been provided or that additional data is required, including a detailed description of the additional data. The NYISO anticipates that such requests for additional data would be the focus of the regular touch points or ad hoc discussions. To the extent not documented in RLS, substantive discussions would be documented by the NYISO in an e-mail to the Supplier with a reply confirmation from the Supplier. The NYISO will regularly communicate with the MMU on pending reference consultations to review open issues and to identify additional concerns. The NYISO and the MMU will log the status of internal discussions using the Comments functionality within the RLS. Based on the data documented in the RLS and/or in e-mail correspondence, the NYISO and its MMU will approve or deny the update within 3 months of the submittal. The NYISO will provide the basis for any denial in its comments in the RLS (viewable by the Supplier). Comments associated with a denial of a submission will identify any elements of the submittal that would be approved, if submitted independently. Should the Supplier submit these identified “approvable” elements within ten

business days of the denial being issued, the NYISO and its MMU will conduct an abbreviated review of the revised submittal and issue a determination within three business days. The intent of the abbreviated review would be to verify that the revised submittal includes only those items from the initial submittal identified as "approvable". The NYISO will work with the Supplier to identify "approvable" elements of the submittal throughout the course of the consultation (even prior to a formal denial) and provide the Supplier the opportunity to have these elements approved while the consultation process continues on the remaining items.

5. The Supplier will be notified immediately upon approval of the submission. Changes in reference levels will be implemented prospectively. To the extent that a reference level change will be implemented on a temporary basis (e.g., for a season), the NYISO will communicate to the Supplier the expiration date.
6. The NYISO, in consultation with the MMU and the Supplier, will determine the appropriate period for which the approved updates should remain in effect.
7. A Supplier may request that its units be exempted from LBMP- or bid-based references because such references do not accurately reflect a generator's marginal costs. These requests need to be submitted through NYISO Customer Relations Department with a specific justification. These requests will be processed in accordance with the procedures and timelines outlined for "Normal-Low" reference-level consultations. The NYISO in consultation with its MMU and the Supplier will determine an appropriate period for which the approved exemptions will remain effect.
8. Each Supplier remains responsible for maintaining accurate cost information in the RLS, including timely reflecting cost decreases. Suppliers are expected to submit updated cost data in the event of material changes.
9. A Supplier should consider the above time-lines when determining when to submit consultation requests in order to ensure that time-sensitive cost-function changes (e.g., costs that are seasonal) can be processed and approved consistent with the changes to a generator's costs. For example, updates such as the inclusion of a seasonal NO_x adder would be treated as a "Normal-Low" submission whereas other, more complex, changes may require a "Normal-High" treatment. Given the range of circumstances, a Supplier should contact the NYISO through Customer Relations to discuss the specifics of the desired reference level changes.

2.3. Review Guidelines

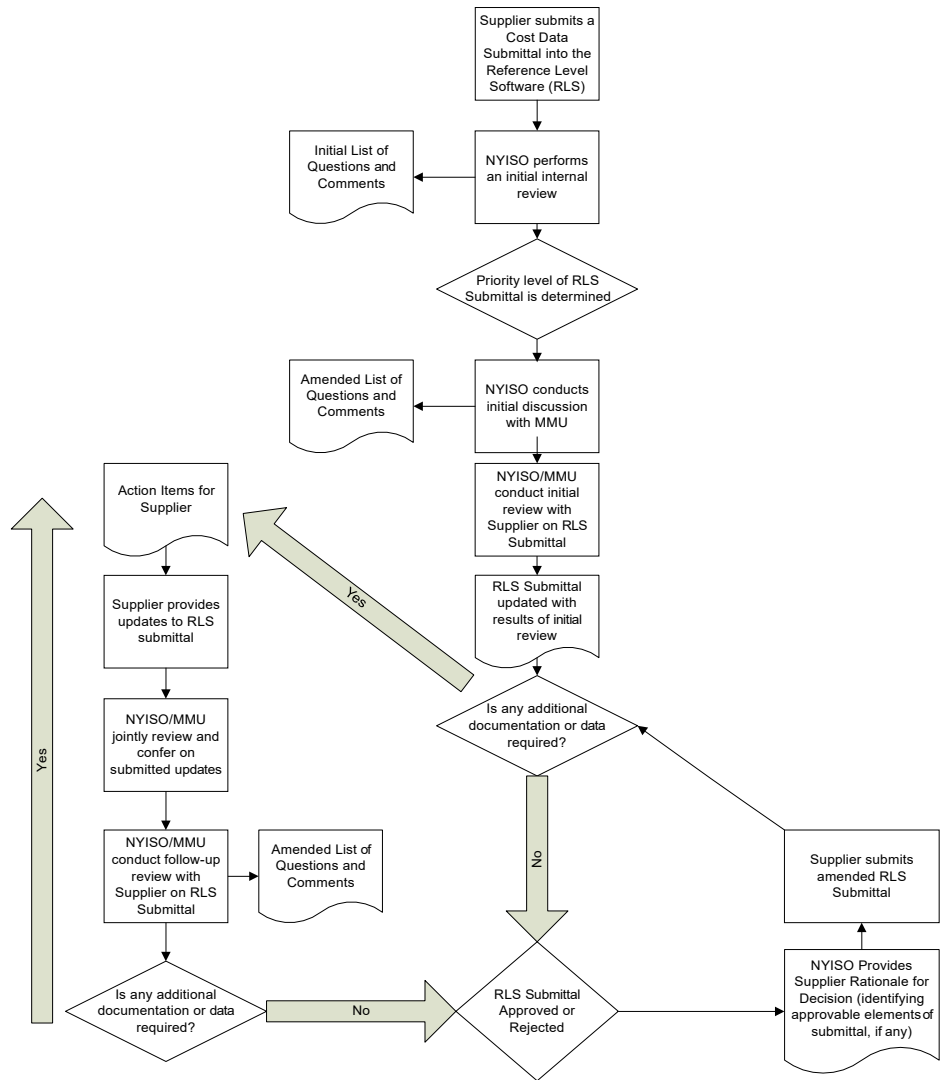
In reference level consultations the NYISO and its MMU will focus on changes from current cost- based data in RLS, will require documentation for all requested updates and may request additional documentation to support maintaining values currently in RLS.

2.4. Operational Metrics

The response standards indicate the timewithin which the NYISO will approve or reject a submission within the RLS (resulting in an automated e-mail to the Supplier). The targets for the three categories of submittals are as follows:

1. Urgent : 16 hours
2. Normal-Low: 2-5 business days
3. Normal High: 1-3 months

Figure 1: Reference Level Consultation Process



3. NYISO-Initiated Reference Level Consultation

3.1. Description

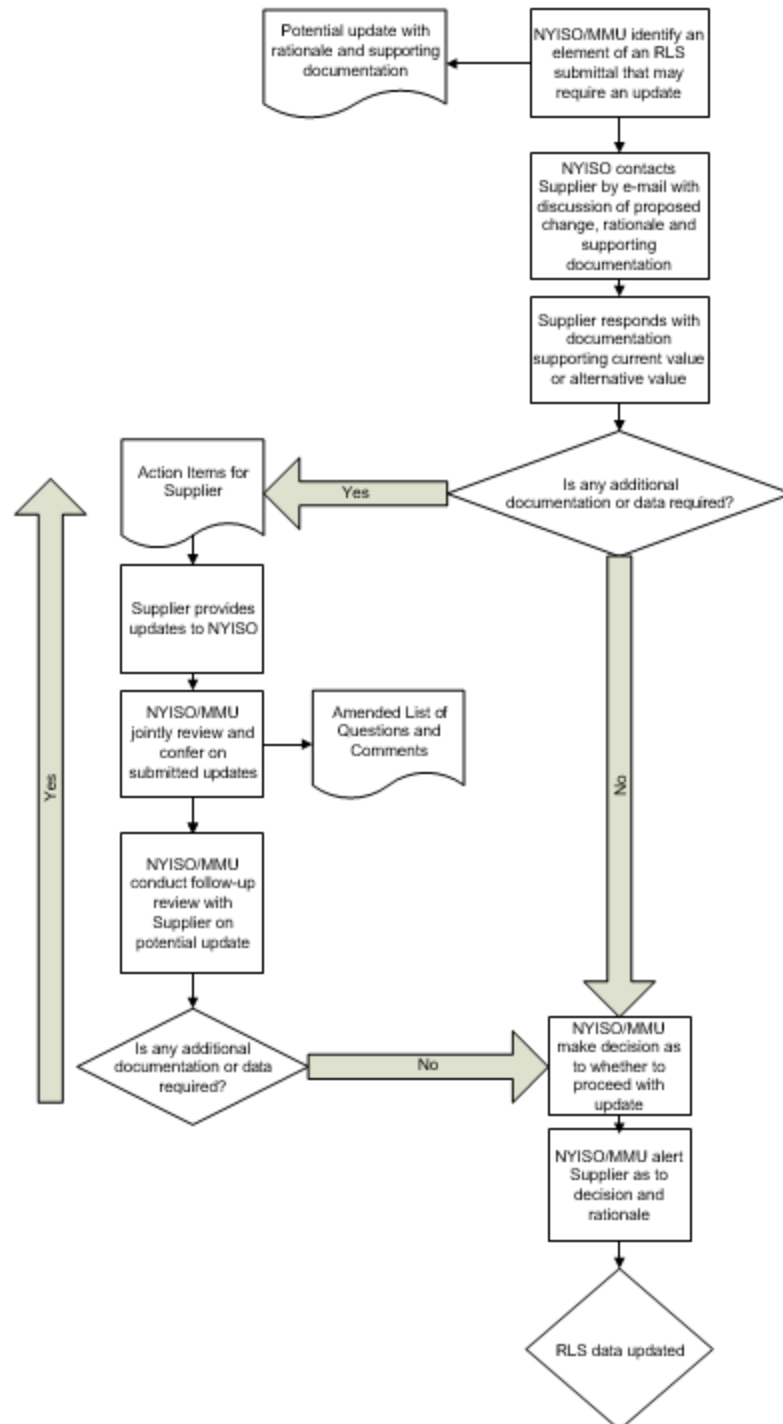
The NYISO, in consultation with its MMU, performs periodic reviews of RLS cost data in order to ensure its completeness and accuracy. This may result in the need to re-verify or revise previously- approved RLS data.

3.2. Process and Timelines

Reviews of existing reference level information will be implemented as follows:

1. Upon determining that an update may be required, the NYISO will provide the Supplier with notice of:
 - a. the revision that the NYISO is considering;
 - b. the amounts and or categories that the NYISO proposes to revise;
 - c. the specific reason(s) for revision, including any documentation, justification or other detailed information that supports the need for a revision;
 - d. the date on which the NYISO proposes to implement the revision; and
 - e. the last date on which a Supplier may submit explanatory information.
2. A Supplier will have no less than ten business days after the day on which it receives notice to provide the NYISO with any documents, justifications, and other information that supports inclusion of the cost in question. Dependent upon the complexity of the information requested, the NYISO may provide additional time for the Supplier to respond. Additionally, to the extent that the NYISO materially alters the nature of its inquiry or makes additional data requests beyond the scope of the original request, the NYISO would provide a Supplier additional time to reply.
3. After the last day a Supplier can submit explanatory information, the NYISO will ordinarily require 5 business days to determine whether to proceed with the revision.
4. The NYISO will inform the Supplier whether or not it will be implementing the revised cost data at least three business days prior to implementing the change, unless the NYISO, in consultation with the MMU, determines that the inaccurate reference level is having a significant impact on market clearing prices or guarantee payments and needs to be modified sooner.

Figure 2: NYISO-Initiated Consultation Process



4. Mitigation Consultations

4.1. Description

Suppliers whose bids are mitigated may seek to consult on their generators' reference levels after the mitigation has occurred. These requests need to be submitted and documented by opening a ticket with Stakeholder Services. The Supplier is required to provide the following information:

1. Organization
2. Generator(s) Mitigated
3. Dates, Hours, and Market for each instance of Mitigation
4. Type of Mitigation (*e.g.*, the NYISO process that imposed mitigation [real-time AMP, rest-of-state reliability] plus the characteristic(s) mitigated [Energy, Mingen, Start-up, BPCG, DAMAP])
5. Specific nature of consultation request (*e.g.*, how the calculated reference level was inaccurate, why the bids submitted were competitive, or why the mitigation was otherwise unwarranted)
6. Relevant supporting documentation (*e.g.*, fuel invoices, operational data)

4.2. Process and Timelines

Upon being noticed of the consultation request, NYISO will initiate its review jointly with its MMU. The review will occur as follows:

1. The NYISO will contact the Supplier within five business days to review consultations opened within the preceding five business days. This initial review will be to:
 - a. confirm receipt of request;
 - b. review Consultation Request Form and data submittal;
 - c. ask any clarifying questions;
 - d. identify any documentation concerns; and/or
 - e. discuss root causes of mitigation and resolutions.
2. At the time of the initial review, the NYISO and the Supplier will also determine whether and when subsequent touchpoints may be required to address consultations. Such touchpoints would be to:

- a. discuss status of open consultation tickets and tickets ready for closure;
 - b. alert Supplier as to expected resolution and resettlement date (if any); and/or
 - c. resolve open questions (if any).
3. The NYISO will review each mitigation consultation to identify a root cause and collaborate with the Supplier and the MMU to design and implement a plan to reduce future occurrences.
 4. The resolution of a mitigation consultation is strictly limited to the dates, hours and units that are the subject of the consultation and to the specific mitigation measure and bid component in question. A Supplier may opt to request a revision to a unit's reference levels based on the results of a mitigation consultation by making an RLS submission that would be processed in accordance with Section 2 of this manual.

4.3. Review Guidelines

The NYISO and its MMU will review, as appropriate, fuel invoices and other documentation of acceptable costs not reflected in the reference level upon which the NYISO's application of mitigation was based, to the extent that such costs are documented appropriately and provided to the NYISO in a timely manner.

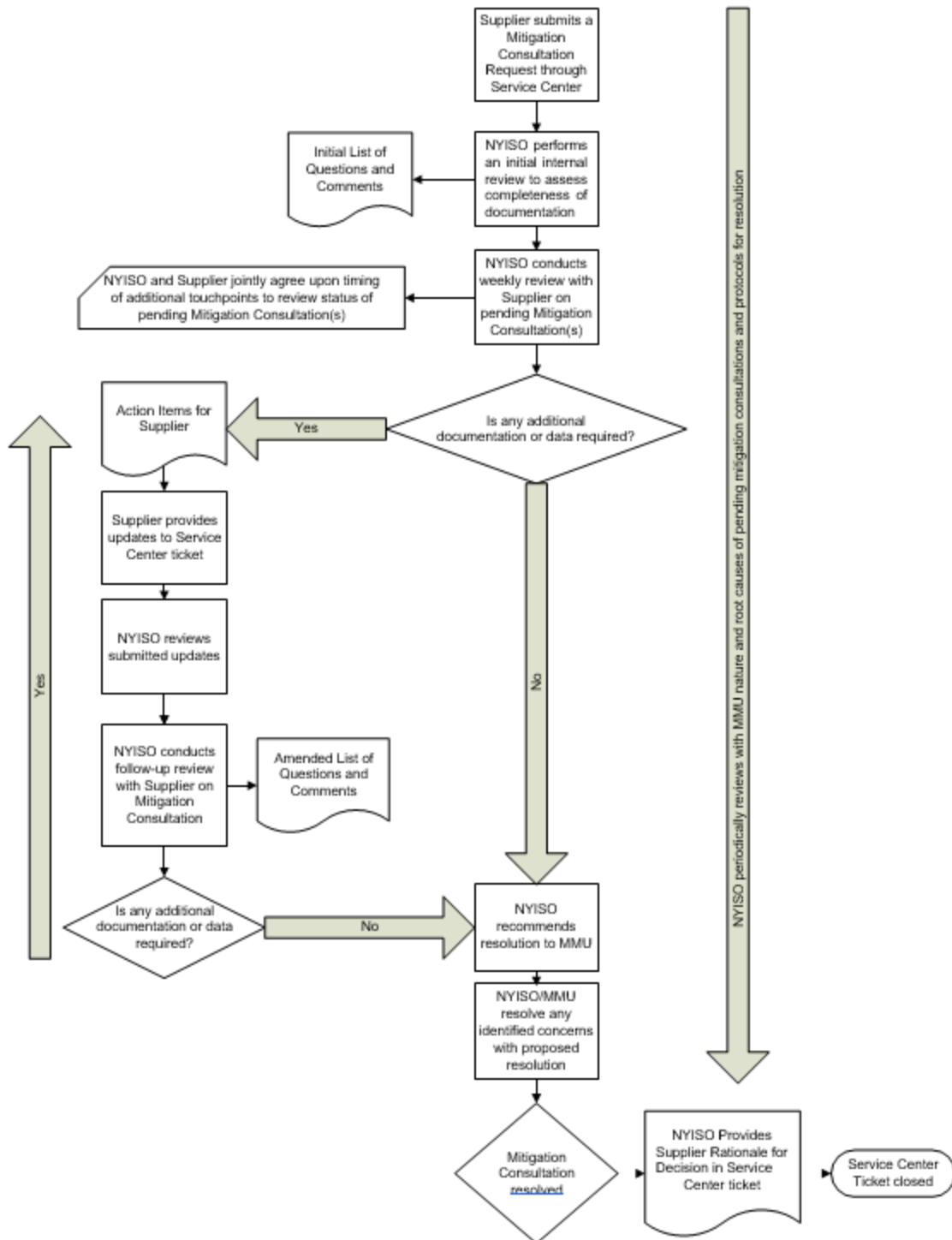
4.4. Operational Metrics

The NYISO will monitor the timeliness of mitigation consultations against the following targets and will report back to MIWG periodically. Targets will be reviewed annually as part of the goal setting process.

1. 75% of fully-documented, consultation requests resolved within 20 business days
2. 100% within 50 business days

For the purpose of this section, consultation requests will be considered “fully-documented” when the Supplier has submitted a fully-completed Consultation Request form and provided all the data that the NYISO and the MMU have requested to evaluate the Consultation request.

Figure 3: Mitigation Consultation Process



5. Heat Rate Data

5.1. General Description

Heat rate curve data is utilized within the Reference Level Software (RLS) to determine a generator's fuel consumption at its Minimum Generation level and the incremental fuel requirements at each point on its output curve.

Suppliers are required to submit two types of generator-specific heat rate data: Heat Input at Minimum Generation (mmBTU/hour) and an Incremental Heat Rate Curve. The first, Heat Input at Minimum Generation, provides the total amount of thermal energy (i.e., mmBTUs) used by the generator to produce its minimum generation level for a single hour, including auxiliary equipment fuel or electrical power requirements but excluding normal plant heating. The second, the Incremental Heat Rate curve, provides the amount of thermal energy used by a generator to achieve an incremental change in electrical energy output (i.e., the amount of thermal energy used to produce an additional unit of output) at each designated point on the generator's output curve.

5.2. Reference Level Software (RLS) Data Requirements

Suppliers must provide as part of its heat rate submission the generator's minimum generation level, the Heat Input at Minimum Generation, the generator's maximum capacity, and an Incremental Heat Rate Curve for the generator that encompasses the complete range of the unit's output for which the incremental fuel requirement is a monotonically, increasing function of the generator's output.

5.3. Required Documentation

5.3.1. Incremental Heat Rate Curves and Heat Input Data

All submittals of Incremental Heat Rate Curves and Heat Input at Minimum Generation must be submitted in terms of net output. Suppliers may submit heat rate curves and heat input data using the results of tests actually performed on the generator or submit the manufacturer suggested heat rate curves and heat input values.

In addition, if available, historical usage data should be submitted which includes fuel consumption rates for the last 25 periods a generator operated at its minimum generation level. If a unit does not have the requisite 25 periods of historical fuel consumption rate data, the Supplier must submit the fuel consumption data that it does possess and may also include a fuel consumption rate at the generator's minimum generation level (mmBTU/hour) based on manufacturer suggested values.

5.3.2. Input-Output Curves

Suppliers must develop and submit generator-specific heat-input versus power-output curves (“I/O Curves”). These curves are utilized to validate the accuracy of the submitted heat rate curves. The generator's total heat (or fuel) I/O Curves must be based on the generator's design or data from comparable generators, modified by available actual generator test data. The actual data for the total heat (or fuel) I/O Curve must include minimum and maximum output levels and at least two intermediate output levels.

6. Fuel & Emission Cost Data

6.1. General Description

The NYISO's tariffs allow the inclusion in cost-based references of fully-burdened fuel costs. These could include, in addition to the raw fuel cost, applicable taxes, transportation costs, incremental payments to fuel procurement agents, and emission allowance costs.

At the end of each commodities trading day, the NYISO obtains from its data provider fuel and emissions costs derived from that day's trading (calendar day t). The NYISO currently employs the services of Argus Media, Ltd as its data provider and retrieves data from Argus's website at approximately 9:30 p.m. The cost data obtained is then incorporated into the reference levels utilized in the next day's real-time Market (RTM) (day t + 1) and the following day's Day-Ahead Market (DAM)(day t + 2). This data represents the "opportunity cost" of fuel or emissions for a Supplier and is presently viewed to be the best data reasonably available to the NYISO at the time it develops reference levels.¹ In the rare event that the NYISO, or its Reference Level Software (RLS), is unable to obtain updated fuel cost information, the RLS instead uses the most recent data available to the RLS in its development of cost-based reference levels.

Note that on a daily basis, the NYISO only updates indexes for certain fuel types (i.e., natural gas and fuel oils). Fuel types whose indexes are not updated daily (e.g., coal), will have the fuel price entered into the RLS as a static value. Suppliers should periodically review this data and update as necessary with a cost data submission.

The Reference Level Software provides to a limited extent the capability for generators to have multiple fuel pricing points (i.e., commonly quoted major pipeline delivery points) and fuel blends (e.g., oil/gas). Generators are initially associated with a default fuel type/source but requests to be moved to the alternate fuel type can be made through an RLS submittal. Such requests may reflect a change in fuel availability for a specific period of time, e.g., due to a pipeline operational flow order (OFO).

In addition, to the extent that a precise fuel blend is unavailable, Suppliers may request the temporary incorporation into the RLS of a larger fuel "adder" to reflect the additional costs associated with burning a higher percentage of the more expensive fuel. For example, a generator whose default fuel is natural gas but due to pipeline maintenance is required to burn 50% natural gas / 50% fuel oil can request a temporary increase in its fuel adder to reflect the need to burn a gas/oil blend if a 50/50 gas/oil blend is not available to the generator in RLS. Whenever possible, requested changes in fuel adders should reflect

¹ When the end of the month intersects with the normal weekend strip gas delivery package the NYISO will use the Argus day-ahead gas price that corresponds with the actual flow date to develop reference levels.

the historical fuel usage patterns during periods when similar circumstances existed. In the example, the adder would need to reflect the fuel-related marginal costs (\$/MWh) of each fuel-type weighted by the projected burn percentage of each fuel. This type of temporary fuel adder should reflect historical fuel prices over the preceding two-week period and should be updated bi-weekly at minimum, until the end of the temporary supply limitation.

Suppliers may submit “Fuel Cost Updates” (a fuel price update or a fuel type update, or both) on their RTM bids. These fuel costs should not reflect speculative changes in fuel prices, but must be supported by documented quotations and may later be compared to the actual cost of fuel consumed.

6.2. Fuel Cost Adders and Multipliers

Suppliers may submit into RLS for inclusion in their cost-based references (a) applicable percentage tax rate multipliers, and (b) adders (\$/mmBtu). Multipliers and adders may be used to capture additional costs incurred in the delivery of the fuel to the generator, beyond those captured in the raw fuel cost. Different \$/mmBtu adders can be submitted for DAM and RTM.

Suppliers may also submit for inclusion in their cost-based reference levels the costs associated with securing emission allowances to offset SO_x, CO₂, and NO_x emissions (annual and seasonal). Suppliers are required to submit for each emission type (e.g. CO₂), an emissions rate (lb/mmBTU) and any requested emissions adder (\$/MWh).

6.3. Fuel Cost Adjustments

If a Supplier's fuel cost for a Generator will temporarily exceed its burdened fuel reference cost, then the Supplier may submit a “Fuel Cost Adjustment” (FCA). FCAs are temporary updates to reference fuel price or fuel type that the Supplier can submit with its energy Bids (which may include Start-up, Minimum Generation and Incremental Energy) that are entered into the NYISO's Market Information System.² These higher fuel costs should not reflect speculation about changes in fuel prices, but must be supported by documented quotations³ and may later be compared to the actual cost of fuel consumed in determining whether the FCA submittal was an attempt to exercise market power.

6.3.1. NYISO's Automated Screening Limits on the Magnitude of Fuel Cost Adjustments that Can be Implemented without prior NYISO Review

FCAs are direct inputs to the reference levels that the NYISO uses to test Generator Bids for the possible exercise of market power. Significant increases to Generator fuel costs, and the associated increased energy

² FCAs may be included with either DAM bids or with RTM bids.

³ Documentation requirements are explained in Section 6.5 below.

Bids, can increase LBMPs and/or the clearing price of other co-optimized products. If FCAs and associated energy Bids are overstated, market prices and/or guarantee payments can be distorted. In addition, substantial sudden increases in fuel costs often affect more than one Generator. When this occurs NYISO needs to know about the cost increases so that it can make adjustments to broader reference parameters so that all Generators can Bid in ways that accurately reflect their costs. For these reasons, the Market Mitigation Measures permit the NYISO to use both automated and manual processes to screen FCA submissions before they take effect. Automated screening limits that are referred to as “Fuel Entry Thresholds” are set periodically by the NYISO, and posted on the NYISO website.⁴

If a Supplier schedules a reference level consultation and provides evidence to NYISO that the burdened fuel prices it actually pays for a Generator are unusually volatile relative to a Generator’s burdened fuel reference cost index, then the NYISO can augment the default Fuel Entry Threshold with a Generator-specific, “secondary” Fuel Entry Threshold. These secondary Fuel Entry Thresholds incorporate information about size and estimated volatility of Generator-specific costs. The NYISO keeps Generator-specific secondary Fuel Entry Thresholds confidential. As with changes to Generator reference levels, secondary Fuel Entry Thresholds are implemented on a going-forward basis.

6.3.1.1. Implications for Generators of NYISO’s automated Fuel Entry Thresholds and the process of FCA validation

When a Supplier submits a Bid that includes an FCA, it should keep in mind the size of the relevant Fuel Entry Threshold that is posted on the Market Monitoring page of the NYISO’s web site.⁵ If a bidder plans to submit an FCA that exceeds the Generator’s burdened fuel reference level by more than the corresponding Fuel Entry Threshold, it should notify the NYISO promptly, explaining why the NYISO should temporarily implement an increased Generator-specific Fuel Entry Threshold. Initial notification can take the form of an e-mail to stakeholder_services@nyiso.com, a phone call to NYISO’s Stakeholder Services (24/7) at 518-356-6060, or a reference level submittal via RLS, tagged “urgent” rather than “normal”. If the NYISO is not informed sufficiently in advance of the need for an increase to a Generator’s Fuel Entry Threshold, it may not have time to review and process the request prior to market close.

If a bidder submits an FCA that exceeds the Generator’s burdened fuel index by more than the applicable Fuel Entry Threshold (including any applicable Generator-specific secondary threshold), the FCA will be rejected when the NYISO performs its validation at market close. The NYISO’s software will use the unmodified index price of the fuel to develop overall reference levels for the Generator, and will send

⁴ See MST Section 23.3.1.4.6.7 and the Fuel Entry Thresholds that are posted on the Market Monitoring page of the NYISO’s website.

⁵ <http://www.nyiso.com/market-monitoring>

an error message about the FCA validation failure to the bidder, with an error code indicating that the FCA exceeded the applicable Fuel Entry Threshold. The submitted energy Bid will still be economically evaluated, and may be mitigated. In some limited cases the Services Tariff provides the opportunity for an *ex post* mitigation consultation and an opportunity to recover out-of-pocket costs after the fact.⁶

6.3.2. How validated FCAs are used

RLS uses a Generator's validated FCA to develop revised reference levels. The NYISO's Market Software uses the revised reference levels when performing conduct and impact tests to determine whether Bids need to be mitigated.

6.4. Submission Process when a NYCA Generator's Energy Bid exceeds \$1000/MWh

The NYISO has developed rules to permit NYCA Generators to submit, and for the NYISO to validate, cost-based Incremental Energy and Minimum Generation Bids that exceed \$1000/MWh, provided that the Generator is able to justify and document its costs.

Section 23.7 of the NYISO's Market Services Tariff sets forth the basic rules a Market Party must follow when submitting Incremental Energy and/or Minimum Generation Bids that exceed \$1000/MWh for a NYCA Generator, and how the NYISO must process those Bids. The following subsection of the Reference Level Manual explains how Market Parties should document and justify Incremental Energy and/or Minimum Generation Bids that exceed \$1000/MWh to minimize the time NYISO requires to perform its validation.

6.4.1.A FCA submittal must accompany Incremental Energy and Minimum Generation Bids that exceed \$1,000/MWh

Whenever a Market Party submits a Minimum Generation or Incremental Energy Bid that exceeds \$1000/MWh (even if only one step of the Incremental Energy Bid curve exceed \$1,000/MWh), that Bid *must* be accompanied by a FCA. When a Market Party submits a valid FCA with an Incremental Energy Bid and/or Minimum Generation Bid that exceeds \$1000/MWh, it is indicating that the Generator's actual or reasonably expected incremental costs (including, but not limited to, its fuel costs) are so high that it expects its cost of Minimum Generation, or at least one step of its Incremental Energy Bid curve, will exceed \$1000/MWh. If an Incremental Energy Bid or a Minimum Generation Bid that, in whole or in part, exceeds \$1000/MWh is *not* accompanied by a FCA, then all components of the energy Bid (including Start-Up, Minimum Generation and Incremental Energy) will receive a Validation Failed bid status with a message explaining that the corresponding bid requires the submission of FCA information. If the Bid receives a Validation Failed status, then the invalidated Bid will not be economically evaluated for commitment

⁶ See MST Sections 23.3.1.4.6.6, 23.3.1.4.6.8, 23.7.2.5 and 23.7.3.3

and/or dispatch and the bidder will have until market close to submit a Bid that includes an FCA.

When an Incremental Energy or Minimum Generation Bid that exceeds \$1000/MWh is accompanied by an FCA, the FCA itself must pass a fuel threshold validation test. Section 6.3.1.1 above describes the FCA validation test. If the FCA fails validation, then:

1. a bid message will be returned when the FCA is invalidated and reference levels will not be updated,⁷
2. any elements of the associated Bid that exceed \$1000/MWh will be capped at \$1000/MWh, and a bid message will be returned to the bidder, and
3. all elements of the Bid will be tested for possible mitigation based upon the fuel costs included in the Generator's original RLS reference levels, without adjustment.⁸

6.4.1.1. Process for Generators that do not burn oil or natural gas to submit FCAs in support of Incremental Energy Bids and Minimum Energy Bids that exceed \$1000/MWh

When the NYISO evaluates Incremental Energy or Minimum Generation Bids that exceed \$1000/MWh that are submitted on behalf of Generators that do not burn oil or natural gas, it uses the submittal of a FCA (a) to search for and identify Incremental Energy Bids and Minimum Generation Bids that exceed \$1,000/MWh for further review, and (b) to ensure that a cost-based reference level (as opposed to a Bid-based or an LBMP-based reference level) is used to validate such Bids. For these reasons, *all* Incremental Energy and Minimum Generation Bids that exceed \$1000/MWh must have an accompanying FCA submittal, even when the Generator for which the Bid is offered does not consume oil or natural gas (so an FCA would not otherwise be submitted).

Non-oil/gas units that intend to submit an Incremental Energy and/or Minimum Generation Bid in excess of \$1000/MWh can provide an "FCA submittal" by entering their default fuel type in the Fuel Type blank on the MIS bid form without entering an adjustment to Fuel Cost. Generators that need to utilize such fuel type adjustments if they wish to place energy Bids greater than \$1000/MWh include, but are not limited to, nuclear, wind, coal and hydro units.⁹

⁷ DAM and RTM fuel threshold validation tests of FCAs occur at market close.

⁸ While rejection of FCAs can result in energy Bids being capped at \$1000/MWh, as well as reversion to original unadjusted energy references and possible automatic mitigation, in some limited cases the Market Services Tariff provides an opportunity for an ex post mitigation consultation and an opportunity to recover out-of-pocket costs after the fact. See MST Sections 23.7.2.5 and 23.7.3.3.

⁹ If a dual-fuel unit typically burns coal or wood chips, but has the capability to burn oil/gas instead (not simply for start-up), these units may find it appropriate to simply enter their standard non-oil/gas Fuel Type (with no adjustment to Fuel Cost), if that is the fuel that the Generator plans to burn if the unit is scheduled. However, if the Generator will switch the unit temporarily to oil/gas if scheduled, they should enter a change to Fuel Type and Fuel Cost to inform

To permit a timely-submitted Incremental Energy and/or Minimum Generation Bid that exceeds \$1000/MWh to be economically evaluated for commitment and/or dispatch by the NYISO after market close, the following steps must be taken in advance of market close:

1. Include an FCA that complies with the guidelines set forth above with the energy Bid for the non-oil/gas unit—an FCA that complies with the guidelines above.¹⁰
2. Make an RLS reference level submittal tagged “urgent” rather than “normal”, for the non-oil/gas unit, well in advance of market close. The submittal must explain the increase in costs that leads the bidder to anticipate placing an Incremental Energy and/or Minimum Generation Bid that exceeds \$1000/MWh. Submittals of large increases in *non-fuel* costs may take NYISO longer to evaluate than submittals involving increased *fuel* costs. Submitting the claimed costs and supporting explanation to the NYISO well in advance of market close reduces the risk that NYISO will not have sufficient time to evaluate and approve the proposed reference level increase before market close.
3. If the NYISO approves the urgent RLS reference cost submittal before market close, and is able to timely update the reference levels, then the verified Incremental Energy Bid and/or Minimum Generation Bid that exceeds \$1000/MWh will be economically evaluated for commitment and/or dispatch.

6.4.2. How NYISO applies the cost-based energy reference curve derived from a validated FCA, when Minimum Generation and/or Incremental Energy Bids exceed \$1000/MWh

If a Generator’s Minimum Generation Bid or any component of its Incremental Energy Bid exceeds the corresponding validated reference level, then the Minimum Generation Bid or Incremental Energy Bid component that exceeds \$1000/MWh will be capped at the greater of (a) \$1000/MWh, or (b) the validated cost-based reference level for that Bid or Bid component. Mitigation may be applied to any Minimum Generation Bid and/or component of an Incremental Energy Bid that has been capped at \$1000/MWh using the same cost-based reference curve that was used in the bid-capping process.¹¹

6.4.3. Process for eligible *Demand-Side Resources* to place energy supply Bids in excess of \$1000/MWh

Demand-Side Resources are not normally required to develop cost-based Incremental Energy or

NYISO of the expected change in the unit’s fuel type and cost. For these unusual dual-fuel Generators, the best option may be to contact the NYISO prior to submitting an offer that exceeds \$1000/MWh.

¹⁰ RLS software will check whether the Incremental Energy or Minimum Generation Bid actually contains a component that exceeds \$1000/MWh. If no Bid component exceeds \$1,000/MWh, then the energy Bid will not be capped and the Generator’s reference levels will not be changed. The Bids will still be subject to the appropriate tests for possible mitigation.

¹¹ See MST Section 23.7.2.1

Minimum Generation reference levels. However, eligible Demand-Side Resources that participate in the Day-Ahead Demand Response Program (DADRP) and Demand-Side Ancillary Service Program (DSASP) may want the capability to place Incremental Energy Bids or Minimum Generation Bids that exceed \$1,000/MWh at times when their costs justify such Bids.¹² NYISO's Market Services Tariff (Section 23.7.4) describes how these two types of Demand Side Resources can become eligible to utilize this capability.¹³

At least 30 days prior to the start of the Capability Period for which the Market Party wants to have cost based reference levels in place for an existing Demand Side Resource, or prior to the completion of the ISO's registration process for Demand Side Resources that are entering the NYISO markets for the first time, the Market Party must develop and provide to the ISO a detailed estimate of the Demand Side Resource's incremental costs and methodology of providing load reduction, and participate in a reference level development consultation with the ISO. Updated cost information must be submitted whenever a Demand-Side Resource's costs change substantially. Cost information must be updated on an annual or more frequent basis.

Section 10 of this Reference Level Manual sets forth guidelines for Demand Side Resources that wish to work with the NYISO in developing (or updating) cost-based reference levels for their Incremental Energy and Minimum Generation Bids.

If a Market Party has an up-to-date cost-based reference level in place for its DADRP or DSASP Demand Side Resource, the provider might determine that its Resource's incremental cost of providing load reduction is expected to exceed \$1,000/MWh for an upcoming DAM or RTM day.

In that case, before the Demand Side provider can place an Incremental Energy Bid or a Minimum Generation Bid that exceeds \$1000/MWh, it must develop an updated, detailed estimate of the Demand Side Resource's incremental costs of providing load reduction, submit that information to the NYISO by way of an urgent RLS Submission and contact the ISO to schedule a reference level consultation no later than 9 a.m. on the day before the close of the relevant DAM¹⁴ or RTM hour.

If the Market Party does not timely schedule a reference level consultation and submit the information required in MST Section 23.7.4.3, or the Market Party timely schedules a reference consultation and

¹² DSASP providers of reserves are required to enter a "bid" of \$0 for Minimum Generation cost (See Ancillary Services Manual, Section 6.3.1).

¹³ No other categories of Demand Side Resources are eligible to submit Incremental Energy Bids or Minimum Generation Bids.

¹⁴ The DAM closes at 5:00 a.m. on the day before the RTM day, so a consultation addressing an eligible Demand Side Resource's Day-Ahead Incremental Energy or Minimum Generation reference level would need to be requested by 9:00 a.m. two days before the RTM day.

submits updated cost data, but the NYISO is unable to approve the requested reference cost update prior to the market close, then the NYISO shall restrict to \$1000/MWh any Incremental Energy Bid or Minimum Generation Bid submitted for the DADRP or DSASP Demand- Side Resource that exceeds \$1,000/MWh.¹⁵

6.5. Required Documentation

Suppliers must provide all documentation necessary to substantiate any fuel-related or emissions-related costs submitted for approval, including invoices identifying local tax and transportation rates and annual generator-specific emission rates reported to EPA.

6.5.1. Documentation Needed to Assert Higher Fuel Commodity Cost

Absent Market Party submitted evidence of temporarily increased real-time fuel costs, or of the inability to obtain sufficient fuel, MMA's estimate of a generator's fuel price ordinarily uses the least-cost fuel type available to a generator and incorporates the RLS fuel price index that is associated with that fuel type.

When a Supplier submits to MMA a temporary change in fuel type or fuel price because the commodity fuel cost exceeds the fuel cost used to develop a generator's Reference Level, MMA may request evidence of the increased fuel cost. If the change in fuel cost is submitted by:

1. Using an Emergency Reference Level Submittal, the supporting documentation must be *timely* provided by the Generator. (That is to say, enough in advance of the close of bidding to allow MMA to review and process the submittal, as explained in Services Tariff § 23.3.1.4.6.7.)
2. Using the Generator Bid Screen, submit a Fuel Cost Update. Supporting documentation must be available for MMA's review *after the fact*.

In response to MMA's request for documentation, a supplier that uses natural gas might provide one or more of the following, to document increased real-time natural gas costs:

- Invoices for gas purchased in real-time that demonstrate an incremental gas cost above the burdened gas cost that was used to develop a Generator's reference levels.
- Quotes from gas suppliers for real-time gas that demonstrate an incremental gas cost above the burdened gas cost that was used to develop a Generator's reference levels.
- Evidence of other deals transacted in real-time at a price above the burdened gas cost that was used to develop reference levels.

¹⁵ See MST Sections 23.7.4.4 and 23.7.4.6

- When a generator is authorized to use gas balancing service, the expected incremental cost of that service. (Per MST Section 23.3.1.4.6.2.1, the ISO shall not permit charges for unauthorized natural gas use to be included as a component in the development of a Generator’s reference levels, and Market Parties shall not be eligible to recover costs associated with unauthorized gas usage.) See Sections 6.5.2.1 to 6.5.2. 3 of this Reference Level Manual.
- An offer to buy gas in real-time on a trading platform at or above the burdened gas cost that was used to develop reference levels, where the offer was posted for a reasonable period of time but was not accepted. The documentation required would include the name of the trading platform, the price offered to buy the gas, the time the offer was placed and the time the offer was removed or rescinded.

Other evidence of real-time gas costs temporarily above the gas reference index will also be considered. Generators may propose other methods of demonstrating temporarily increased gas costs to MMA. However, unsupported assertions of RT gas costs above the gas reference index will not be accepted.

6.5.2. Bidding, fuel procurement and reference updates in the presence of gas balancing costs or Operational Flow Orders

6.5.2.1. Considerations affecting NYISO’s evaluation of requests to include gas balancing costs in reference levels ¹⁶

- The NYISO expects that suppliers will normally procure fuel day-ahead to meet their generators’ DAM commitments.
- The NYISO expects that suppliers will normally timely procure sufficient gas to meet their generators’ reliability commitments.
- In order to protect gas system reliability, suppliers should procure gas to operate their generators in real-time, rather than relying on imbalance service, when it is possible to do so.
- Absent e-mail notification to MMA by the Market Party submitting a Fuel Cost Adjustment or an Emergency Reference Level Submittal, the NYISO will ordinarily assume that when a Supplier proposes the inclusion of gas balancing costs in its Generator’s reference levels, the costs do not include the use of unauthorized or penalty gas. ¹⁷

¹⁶ See Attachment H Sections 23.4.3.2(v), 23.4.3.3.3, 23.3.1.4.6.8, 23.3.1.4.6.8.5 and 23.3.1.4.1.3.

¹⁷ Attachment H Section 23.3.1.4.6.1.1.1 describes what constitutes unauthorized gas.

6.5.2.2. Fuel-related incremental costs that may be eligible for recovery in reference levels

- Suppliers may request that incremental costs they incur to comply with federal and state laws, rules, regulations and orders, or to comply with valid rules and orders that are issued by the NYISO to ensure the reliable operation of the electric system, or by gas Local Distribution Companies (LDC) or gas pipelines to ensure the reliable delivery of natural gas, be included in Generator reference levels.
- For SRE and Out-of-Merit commitments in the Real-Time Market, Generators may request that the reference levels used to perform ex-post mitigation tests include the permitted gas balancing charges that were actually incurred.
- NYISO will not permit inclusion in reference levels of gas balancing charges to meet generator fuel needs that are predictable and can reasonably be anticipated.

6.5.2.3. MMA review of Fuel Cost Updates that incorporate gas balancing costs

If intermittent reductions in RTM schedules relative to DAM schedules create a significant likelihood of underburn/cashout losses, that risk may be reflected in a DAM risk premium (see the paragraph titled Cashout Risk in Section 9.1).

If overburns expose a Generator to gas balancing costs, and the Generator uses the RTM Bid screen to submit increased real-time gas cost via a Fuel Cost Update, the Generator's RTM Bids and gas cost submittals will be reviewed *ex post* by MMA. Tariff-mandated tests¹⁸ will be carried out to verify accuracy of Fuel Cost Updates and competitiveness of the associated RTM Bids. For purposes of these tests, MMA will often ask for documentation from the Generator.

The documentation that MMA requests will typically depend upon the liquidity of the intraday gas markets at the time that gas must be procured to support the generation offered in the RTM Bid.¹⁹ The Generator must be able to produce upon request the following types of documentation, depending on the hour of day:

- If a Generator asserts incremental gas balancing costs for the hours in the RTM for which natural gas can usually be procured intraday, then MMA may request that the Generator provide evidence that lack of gas market liquidity made it unlikely that enough gas could be procured to avoid an overburn for the gas day as a whole. Such evidence might include:

¹⁸ See Attachment H Sections 23.4.3.2(v), 23.4.3.3.3, 23.3.1.4.6.8 and 23.3.1.4.6.8.5.

¹⁹ Changes to the NAESB gas nomination cycle are expected to take effect in 2015. The addition of a third intraday nomination period should enable gas markets to remain liquid longer. When MMA determines the impact of the gas market calendar change, MMA will adjust its practices accordingly.

- Increased real-time gas/fuel costs due to lack of gas market liquidity, or
- Some other demonstration that additional gas was not available for purchase in real-time.²⁰
- If a Generator asserts incremental gas balancing costs for the hours in the RTM for which gas is usually difficult to procure intraday, then upon request from MMA, the Generator will be expected to provide the final volume of gas nominations for the relevant gas-day, and the cumulative gas burn at the time the RTM bid was submitted for the relevant market hour. If a Generator participates in a gas balancing pool, then the final volume of gas nominations and the cumulative gas burn at the time the RTM bid was submitted would be required for the relevant gas balancing pool as a whole, not simply for the unit(s) for which Fuel Cost Adjustments were made.

Ideally, information on cumulative gas burn (from the start of the gas flow day through the time the RTM energy bid is submitted) will be obtained by the Generator from the gas Local Distribution Company (“LDC”) or pipeline that distributes gas to the Generator. If the gas LDC/pipeline cannot provide such information in real-time, the Generator that asserts exposure to gas balancing charges would be expected to estimate cumulative gas-burn using real-time unit generation and applicable heat rates unless the generator can show that the additional costs associated with estimating the cumulative gas-burn in real-time during illiquid hours would exceed the revenue a Market Party would reasonably expect to gain by making its generators available during those hours.

If a Generator submits a Fuel Cost Update based on its expectation of incurring authorized incremental gas balancing charges, the Generator’s competitive incremental fuel cost should be calculated based on an incremental cost curve that reflects expected incremental balancing charges for each unit in the same gas balancing pool as the Generator for which the Fuel Cost Update was submitted. The order of the units’ priority in the gas cost curve would ordinarily be based on heat rates, but if a Generator presents other relevant economic or reliability criteria MMA will consider them. If the Generator proposes an alternative basis for ordering its units’ priority on its overall gas cost curve, MMA will determine whether to accept the proposed alternative priority ordering as consistent with operational constraints, and consistent with competitive behavior and/or marginal cost bidding.

²⁰ For example, an offer to buy gas in real-time on a trading platform that was posted for a reasonable period of time, but that did not draw any responses. See Section 6.3.1, above.

6.5.2.4. Bidding requirements and Reference Levels during gas system OFOs

- Unlimited use of balancing gas by generators could, in some circumstances, endanger gas system reliability. On days when gas system reliability could be at risk, the LDC, interstate or intrastate gas pipeline may invoke an Operational Flow Order (OFO) or issue other instructions restricting use of gas imbalance service. When the Generator's LDC or pipeline has issued an OFO, or instructions restricting imbalance usage, the Generator may be subject to charges for incurring gas imbalances that exceed certain limited tolerances specified in the OFO or instruction. NYISO will not ordinarily permit inclusion in generator reference levels of charges for violating Operational Flow Orders or for violating LDC/pipeline instructions restricting gas usage. However, if and to the extent that a Market Party has obtained specific authorization from the relevant natural gas LDC or pipeline to use gas that would otherwise be unauthorized, the ISO shall not consider such usage to be unauthorized use. Market Parties shall make every effort to clearly document authorization they obtain from an LDC or pipeline. Documentation obtained after the fact will be considered.
- A dual-fuel Generator that has been assigned a default reference fuel type of gas, but is unable to obtain gas due to an OFO, might nonetheless be able to run on oil for the day. By including a fuel type adjustment (from gas to oil) in its Market Information System (MIS) bid form, the Generator may avoid unnecessary mitigation.
- A gas-only Generator is not expected to offer additional, incremental energy or ancillary services in real-time during an OFO if it cannot procure additional gas or would have to use unauthorized gas services in order to operate to effectuate its energy or ancillary service offer.²¹ The failure of a gas-only Generator to offer additional incremental (in excess of its scheduled MWs) energy or ancillary services in the RTM during an OFO due to the inability to obtain gas, would be deemed conduct consistent with competitive behavior for purposes of Physical Withholding evaluations conducted pursuant to the NYISO's Market Power Mitigation Measures (Services Tariff § 23).
- During an OFO, an oil-fired unit that has not already been scheduled to provide non-synchronous reserves, or to start, and that must start on natural gas might need to

²¹ Attachment H Section 23.3.1.4.6.1.1.1 describes what constitutes unauthorized gas.

find intraday startup gas. If the LDC refuses to grant such a Generator a partial waiver from the OFO, allowing the use of startup gas, and startup fuel cannot be obtained, then an oil-fired unit that must start on natural gas is not expected to bid in the Real-Time Market while the OFO is in effect.

- During an “hourly” or “1/24th” OFO, a gas LDC or pipeline may require its Generator customers to maintain similar levels of gas usage across an entire gas day. For gas-fired GTs that might only receive DAM schedules for an hour or two of the gas day, the DAM schedule might, in some cases, force a Generator to buy more gas than it actually needs, and then sell the extra gas it purchased at a loss. The NYISO will work with generators that face such a risk to include temporary adders in DAM start-up reference levels to allow Generators to reflect expected sell-back losses. Occasionally this may also be acceptable in real-time, depending on facts and circumstances and subject to coordination with the generator’s gas supplier.
- If an OFO prevents a DAM scheduled Generator from securing gas to meet its schedule, and there is no available alternative fuel, the NYISO would expect the Generator to take a forced outage.
- Sometimes an LDC or pipeline will post advance notice of a possible OFO, but not yet issue an actual OFO. Such warnings might affect gas-fired Generators’ expectations of fuel cost as they prepare to Bid in the DAM.
 1. If an OFO warning causes a Generator to expect to incur fuel costs in excess of the fuel cost expectations used to develop its reference level, and
 2. if the Generator therefore plans to Bid at levels in excess of its currently effective reference levels, then
 3. The Generator should provide timely notice to the NYISO of its high fuel cost expectations in compliance with Section 23.3.1.4.6.7 of Attachment H.
- Inclusion of fuel costs in reference levels by designated “Critical Generators”
 1. A Gas System Event, such as an OFO, could force a Power Plant Operator to derate its gas-fired Generator(s).²² Very rarely, the NYISO or a Transmission

²² The terms “Critical Generator,” “Gas System Event” and “Power Plant Operator” are defined in Attachment BB to the NYISO’s OATT.

Operator may then determine that the loss of the derated gas-fired generator(s) due to the Gas System Event will likely lead to a loss of firm electric load. In this case, the NYS Gas-Electric Coordination Protocol set forth in Attachment BB to the NYISO's Open Access Transmission Tariff will be implemented. The Generator will be designated a "Critical Generator". If the LDC or pipeline that issued the OFO permits an upward adjustment to the Critical Generator's gas schedule, the generator will be allowed to reflect in its RTM offers the additional incremental fuel cost it expects to incur. If time permits, MMA will adjust the Generator's RLS Fuel Entry Threshold, so that the NYISO's automated screens will not reject the Generator's Fuel Cost Update under these circumstances.

6.5.3. MMA Evaluation of Gas-fired Generators' Fuel Cost Updates

1. If the gas cost is documented by gas invoices, MMA will typically evaluate the asserted burdened cost by
 - a. taking a weighted average of the intraday gas invoice prices (after adjusting for any applicable non-invoiced burden components), and then
 - b. comparing the result with the burdened fuel cost submittal.
2. If a gas-burning Generator placed a RTM bid expecting that low liquidity would require it to pay a premium for commodity gas (relative to the day-ahead gas price index), but does not provide invoices that substantiate its claim, the Generator would be required to provide other evidence as outlined in subsection 6.3.1, above.

6.5.4. Gas Procurement Costs for Generators Committed to Meet Reliability Needs

NYISO expects Generators that receive a reliability commitment will procure fuel in a cost-effective manner and undertake reasonable efforts to minimize other incremental production costs in the manner a generator facing economic competition would. A reliability-committed Generator that seeks to recover the cost of gas with premium quality delivery service at a price that exceeds the timely interruptible market price will be required to show that it faced a sufficiently large risk of non-performance to justify paying for the higher-quality service. Generators' gas procurement procedures and gas costs for SRE commitments (or RTM out-of-merit commitments) might differ from procurement procedures and costs for DAM commitments. Fuel cost difference should reflect the different timing of notification that the unit will likely be dispatched.

7. Start-up Cost Data

7.1. General Description

Start-up costs for a generator represent all of the costs incurred in order to bring the generator online and to make it available to produce power. Only the costs incurred from start-up through minimum generation output and from breaker open to shutdown are permissible start-up costs. Such costs would include fuel costs and start-up adders (\$/start) which may include start-related operation and maintenance costs and additional non-fuel costs incurred during start-up (e.g., water, consumables, labor). Revenues paid to the generator during its start-up/shutdown cycle, if any, should offset any costs incurred. It is expected that the amount of fuel consumed to start a generator will be an increasing function of the hours the generator is off-line. Suppliers should submit separate start-up data, including fuel requirements, for each fuel type.

7.2. RLS Data Requirements

Suppliers need to provide separately for the DAM and the RTM a start-up curve (i.e., hours off-line with the associated fuel requirement (mmBTU)) with a minimum of three points, corresponding to a hot, warm and cold start, e.g., 8, 24 and 72 hours offline. Gas turbines should submit a single fuel requirement associated with a one hour down-time (i.e., time off-line). Suppliers may also provide a start-up adder corresponding to each of the time off-line levels.

7.3. Required Documentation

Suppliers should provide the methodology, supporting data and calculations utilized in developing the start-up curves and the start-up adders. If available, historical data must be used to determine the typical amount of fuel consumed per start for each point on the start-up curve.

Suppliers should submit, for each point on the start-up curve, fuel consumption rates for the lesser of the last 10 starts or every start within the past three (3) years. For each start type, Supplier should submit the historical fuel consumption data, an average amount of historical fuel consumption, and the requested fuel requirement.

Suppliers should include in its submittal data on fuel consumption, fuel consumption rates during the shutdown of the unit, if applicable, and revenues earned during start-up/shutdown to the extent that the generator participates in the NYISO's Start-up/Shutdown program.²³

²³ Approved Generators may designate Start-Up/Shut Down (SU/SD) waiver periods during which they will not be subject to performance penalties and will be paid LBMP for all.

If a Supplier does not have the historical fuel consumption rates for each start described above, the Supplier must submit the aforementioned data that it does possess and may also include per- start fuel consumption rates based on manufacturer suggested values.

If a Supplier submits as supporting documentation historical start-up fuel consumption data on a per hour basis (mmBtu/hour), it must also provide documentation of the average number of hours it requires to reach the generator's minimum generation level for each start-up type (i.e., cold, warm or hot).

8. Variable Cost Data

8.1. General Description

8.1.1. Operating Costs

Operating costs are the non-fuel costs incurred while a generator is operated, whether incurred during start-up or at different output levels. These costs may include, for example, labor costs, the cost of consumables and non-durable goods and water costs.

NYISO will only approve operating costs that are incremental costs; fixed operating costs will be rejected. Additionally, NYISO will only approve submitted operating costs to the extent that they reasonably represent the incremental operating costs at the stage of the power generation cycle for which they are submitted (start-up, operation at Minimum Generation output, or operation above Minimum Generation output). For example, NYISO might approve the wages paid to on-call, hourly employees that are needed to help start a generator. Conversely, NYISO would not approve labor costs that are incurred regardless of an incremental commitment (such as those associated with salaried, on-call employees). The reasonableness of an allocation is highly dependent on individual circumstances; thus, NYISO will make this determination on a case-by-case basis. In making this determination, NYISO will consider factors such as whether a generator's operating costs relate to starting the generator or running at different operating levels, follow industry standards, and coincide with manufacturer expectations.

8.1.2. Maintenance Costs

Maintenance costs are costs associated with the maintenance, repair, inspection, and upkeep of generation resources, as well as their parts and equipment. Maintenance costs will only be approved to the extent that they represent the maintenance costs resulting from an incremental period of usage. Maintenance costs are a proportionate share of future maintenance costs and may generally be allocated using hours-based, starts-based, or equivalent-operating-hours criteria. They should reflect projected costs to be incurred. The allocation of maintenance costs not yet borne to starts or run-hours must be based upon generator usage that is reasonably anticipated to occur during the interim; that is, prior to the maintenance cost being incurred. Suppliers should provide manufacturer recommendations as to maintenance periodicity and, as appropriate, factors associated with the calculation of equivalent-operating hours.

In considering whether or not to approve submitted maintenance costs, NYISO will consider factors such as whether the costs and frequency of maintenance anticipated by a Supplier coincides with manufacturer expectations; whether the starts and usage anticipated for the generator is practical, or is

likely given the type of generator and general market conditions, or coincides with historical data.

8.1.3. Regulatory Costs

Cost-based reference levels may include documented regulatory costs, which could include costs assessed by NYISO.

8.2. RLS Data Requirements

Suppliers may submit a Variable O & M cost at each output level as well as an Other Variable Cost (\$/MWh) at each output level. For each value submitted, Suppliers should include a description of the requested costs. Suppliers may also separately submit for inclusion in the cost-based references regulatory and related costs, e.g., the NYISO's Rate Schedule 1 charge for injections.

8.3. Required Documentation

Suppliers must provide the methodology, supporting data and calculations supporting the variable cost data submitted. The data must be generator-specific and must clearly describe how the costs submitted relate to the incremental operation of the generator, i.e., number of starts, run-hours or volume of MWhs generated. Variable O & M costs may be substantiated by costs incurred in historic periods for maintenance associated with the generator's operation (not upgrades) provided that the length of the historic data series is equal to or longer than the periodicity of the scheduled maintenance claimed as costs. For example, a Supplier that claims a cost is incurred every 3 years should submit a minimum of three years of supporting cost data. All maintenance costs submitted should fall within the established variable maintenance categories. (See Appendix A)

In developing cost submittals for operating and maintenance costs, Suppliers may opt to index the historic time-series of actual costs. In such cases Suppliers should provide the historic data series, raw and indexed; as well as a description of the index used and a rationale for its use.

Unplanned maintenance costs should reflect a projection of expected costs. This may be based on public information on the risks of equipment failure, historic information on unplanned maintenance costs of the unit, or similar units, adjusted for changes in circumstances going forward. Historic costs submitted should typically be for a seven year period, Suppliers should derive a per-start or per-MWh value for unplanned maintenance costs using historic operational data (i.e., aggregated starts, output).

Suppliers may submit Long-Term Service Agreements (LTSAs) to support requested maintenance costs to the extent that the maintenance costs covered by the LTSA are consistent with the set of costs approved as variable; the dollar value of each component of the long-term maintenance is defined specifically in the LTSA; and the LTSA clearly defines the frequency of each maintenance activity (i.e., number of starts, run-

hours, volume of output). Suppliers may reflect cost escalators in their submissions to the extent that these escalators are included in the LTSA.

Supplier should furnish the NYISO with copies of any contracts necessary to document the requested costs and to demonstrate the variable nature of the costs. As with all data submitted in support of a cost-based reference level, contract-related costs are subject to review by the NYISO and its MMU to determine the reasonableness and appropriateness for inclusion in energy reference levels. NYISO has approved for inclusion in cost-based references such items as fuel management fees when presented on a per mmBTU basis.

9. Risk & Opportunity Cost Data

9.1. General Description

The NYISO's tariffs permit the inclusion of risk and opportunity costs within a generator's cost-based reference level.²⁴ These costs are broadly segmented into emergency output costs, opportunity costs, and risk premium costs.

Emergency output adders should reflect costs incurred for a generator to reach UOLe that are not captured in a change in the incremental heat rate or additional operating or maintenance costs; for example, costs associated with the removal of a piece of equipment.

Opportunity cost adders are limited to generators with regulatory, environmental, technical, or other restrictions that limit their availability, and reflect the net revenues that are expected to be foregone by running in lower-priced hours, e.g., hydroelectric generators with pondage. If such generators produce MWh at times when LBMPs are low, they may lose the opportunity to produce MWh at times when LBMPs are higher, and their output is more valuable to the system.

Two examples:

Example 1. Hydroelectric generators with pondage can sometimes boost generation beyond their norm by drawing down their reservoir(s). However, absent favorable rainfall or snowmelt runoff, such ponding hydro generators will later have to act to refill their reservoir; that is, they may have to forego generation later on. These hydro units' "opportunity cost" of producing additional MWs that use water reserves is then related to the LBMP expected for the future hour in which they anticipate foregoing generation and restoring the water level of their reservoir.²⁵ Usually, competitive generators in such a situation would choose to forego generation and refill reservoirs at a time when LBMPs are relatively low.

In this first example, the ponding hydro unit's estimate of prospective LBMP foregone must be documented, taking into account the likely amount of time that will be required to refill the reservoir. If average LBMPs have not shifted much recently, relative to the corresponding past experience, relevant documentation might include the generator's "price duration curve". Graphs of such a curve show on

²⁴ See Attachment H Sections 23.3.1.4.1.3, 23.3.1.4.2.1, 23.4.2.1.

²⁵ In exceptional cases, if reservoir water levels are already unusually low, then the ponding hydro unit's opportunity cost might have another (possibly seasonal) component. That is, incremental generation might lower water levels enough to reduce generating capacity/efficiency in subsequent hours of generation prior to refill of the water used for the incremental generation. The rule-of-thumb explanation: hydroelectric generation is proportional to rate of water flow through turbines times the "head", or height of water level above the turbine. In such cases, refill would be necessary more promptly than in the text example, and the opportunity-cost documentation would be more complex.

the horizontal axis the number of hours in the relevant historical time interval(s) for which generator LBMP was greater than the level shown on the vertical axis. The length of the historical time interval(s) should be chosen to match the likely amount of time available to refill the reservoir. Then, given the number of hours in which the unit is likely to be scheduled in the refill "window", one can read off from the graph the corresponding generator LBMP--which is related to the energy "opportunity cost" for the ponding hydro unit.

Example 2. Fossil units occasionally face constraints on generation resulting from annual emissions limits built into their operating permit from the Department of Environmental Conservation (DEC).

Suppose:

- a. A cumulative emissions limit exists in the DEC permit, and
- b. Historical or other evidence (and not simply speculation) suggests that the annual emissions limit is likely to bind later in the year.

If the generating unit in Example 2 generates more now, its permit may require the unit to forego generation later in the year. Presumably, in competitive markets such a generator should choose to forego output during the least profitable hours when it would have been scheduled.

- a. The unit's present incremental cost of energy generation may be related to current production cost, plus an "opportunity cost" adder. In this example, the opportunity cost adder is defined as the expected difference between LBMP and incremental physical production cost in the future hour when the generator is forced to reduce its output to ensure compliance with emissions limits.

Risk premium adders. The reference cost subcategory called "Risk Premium" is not a measure of the cost to generators of volatility in incremental costs. Rather, it reflects the NYISO's expectation of the average level of an incremental net cost (other than variable operating and maintenance costs) that occurs infrequently, at irregular intervals, and whose extent may vary, on the occasions when the cost does occur.

For many generators, no such reference risk premium is applicable. However, a risk premium might be appropriate to reflect infrequent situations like the following example:

"Trip-repurchase cost":

- A generator has a DAM schedule to provide energy and that schedule is not curtailed in real time; and

- The generator experiences a forced outage during these scheduled hours.

For the outage period that corresponds to the generator's DAM schedule, the generator must buy back its DAM schedule at the RTM LBMP. The RTM LBMP might be less than the DAMLBMP, in which case the generator experiences a gain in this respect, not a loss. Still, a risk premium might be justifiable if historical or other evidence (not speculation) shows that the generator's net "repurchase" losses are likely to systematically exceed its gains. If so, the premium would also need to reflect the likelihood that a forced outage will occur. In light of these two considerations, the premium would typically amount to expected net repurchase losses over a year divided by expected total DAM-scheduled MWhs over the same year.

Cashout risk. A Market Party with multiple gas-fired generating units in a balancing pool might request that the NYISO include in its generating units' DAM references an adder to reflect cashout risk.

- Cashout risk represents the expected incremental loss from selling back unused gas at a price below its purchase cost when DAMMWh commitments are reduced in real-time.
- Only a small fraction of DAM-scheduled MWhs result in an increase in daily cashout losses. The risk premium would need to incorporate the frequency and typical size of NYISO reductions in RTM schedules relative to DAM schedules.

9.2. Dynamic Opportunity Cost for ESR Generators

Energy Storage Resources (ESRs) have the option of including both static opportunity costs and dynamic opportunity costs in their Risk and Opportunity cost data family. On a daily basis, dynamic opportunity costs will be calculated for all hours of a market day for the Day-Ahead and Real-Time markets. Dynamic opportunity costs represent the NYISO's estimate of an optimal energy arbitrage schedule and the net revenues that may be foregone by deviating from this schedule. The dynamic opportunity cost estimate will be based on the prior 30-day history of available LBMPs for the Day-Ahead Market and the Day-Ahead LBMPs from the current market date for the Real-Time Market. If for any reason the dynamic opportunity cost is not calculated, the reference level would be calculated using only the opportunity costs include in the generator cost data.

9.3. Opportunity Cost Adjustments

If a Supplier's opportunity cost for a Generator will temporarily exceed the opportunity cost included in the reference level, then the Supplier may submit an "Opportunity Cost Adjustment" (OCA). OCAs are temporary updates to a reference that the Supplier can submit with its Energy Bids that are entered into the NYISO's Market Information System. These higher opportunity costs may be reviewed after-the-fact to

determine whether the OCA submittal resulted in an exercise of market power.

9.3.1. How validated OCAs are used

RLS uses a Generator's validated OCA to develop revised reference levels, The submitted OCA replaces all opportunity costs included in the Risk & Opportunity Cost Data family. A Generator that has no opportunity cost included in the Risk & Opportunity Cost Data family may still submit an OCA if that Generator has a temporary opportunity cost that it will be reflecting in its Bids.

9.4. RLS Data Requirements

For each of the three categories of risk and opportunity costs, Supplier needs to submit into the RLS the requested costs for each MW segment with a description of the requested costs.

9.5. Documentation Requirements

Suppliers need to provide through attachments to its RLS submittal all methodologies, data and calculations necessary for the NYISO to understand the Supplier's rationale for the costs and process for developing the costs.

10. Reference Level Development for Demand-Side Resources

10.1. Introduction

Demand-Side Resources are not typically required to develop cost-based Incremental Energy or Minimum Generation reference levels. However, if an eligible Demand-Side Resource wants the capability to place these types of bids at levels above \$1000/MWh, it must first work with the NYISO to develop corresponding cost-based reference levels, following the steps described above in Section 6.4.3 (and subject to Market Services Tariff Section 23.7.4). In essence, evidence of expected costs must be demonstrated to the NYISO before it can approve cost-based reference levels for a Demand-Side Resource.

10.2. Method for developing reference cost of Incremental Energy and Minimum Generation for a Demand-Side Resource

The incremental cost of load reduction (per MWh) is the expected reduction in the discounted future stream of net revenues to the load-reduction provider resulting from providing an extra MWh of load reduction in the upcoming NYISO market hour.²⁶ The extent of this expected incremental cost, as submitted in reference level consultations, may vary substantially among demand-reduction providers, depending on many different considerations.

For example, a Market Party might provide to the NYISO an estimate of incremental cost that includes items such as:

1. The immediate reduction in the Demand-Side Resource's production resulting from the incremental reduction in load usage;
2. The amount of gross revenue directly corresponding to the volume of production foregone in the short run as a result of the additional 1 MWh constraint on energy usage;
3. The reduction in quantity and value of incremental labor, energy and other inputs used per MWh of load reduction; and
4. The extent of a Demand-Side Resource's "flexibility in timing of production". That is, the expected extent of the medium-term reduction in present discounted value of net revenues, relative to the (perhaps larger) immediate losses associated with items 1, 2 and 3 above.

The above four incremental costs are provided as illustrative examples. A variety of other costs might

²⁶ For many DADRP providers, reference costs of Incremental Energy will be based upon "opportunity cost", defined as the incremental change in the discounted future stream of expected revenues minus costs of the supplier's business process, as a result of being scheduled in the immediately upcoming DAM.

conceivably be appropriate to include in a reference cost submittal by a load-reduction provider.

Once a reference level has been developed for a DADRP or DSASP Resource, the Market Party is responsible for informing the ISO of substantial changes to its Demand Side Resource's incremental costs of providing load reduction, and must submit updated cost information to the ISO at least annually.²⁷

²⁷ See MST Section 23.7.4.2

11. Reference Level Development for Aggregations and Hybrid Storage Resources

11.1. Introduction

Reference levels for groups of resources, known as Aggregations, that submit bids with a single energy curve may be determined by the NYISO using average marginal costs for the resource types within the group. This could include generators participating in the NYISO through the Distributed Energy Resource model, the Hybrid Storage Resource model, or similar market participation methods. Single resources participating as an Aggregation would also have reference levels determined using the method described in this section.

11.2. Method for developing reference levels

The NYISO will develop an estimate of the cost of each of the various resource types that might participate in the Energy market and record these estimates as cost data templates. Cost data templates contain all the same cost data as the submissions created by Suppliers. Templates are created by the NYISO and the same template can be assigned to multiple Aggregations with that resource type, as opposed to submissions by Suppliers which are confidential and unique to a specific resource or set of resources. When an Aggregation joins the NYISO markets, the NYISO will assign the Aggregation a cost data template for all the different resource types within the Aggregation. Market Participants will be able to see the final reference level calculated by each template but will not be able to view the cost data within the template. An Aggregation may then indicate which resource should be used to set its reference level for each market hour by submitting the fuel type associated with that resource with its Energy Bids that are entered into the NYISO's Market Information System. An Aggregation may select any one of the resource templates it has available for setting reference levels, as long as that resource will be available in the market hour for which Bids are being entered.²⁸ It is the Market Party's responsibility to timely inform the NYISO of its Aggregation's reasonably expected costs. If an Aggregation fails to select a resource via a fuel type selection with its Energy Bid, then the Aggregation's Energy reference levels will be set using the most economic resource type included in the Aggregation, even if that resource type could not operate during the relevant market hour.

If a Market Party believes that the generic cost data templates the NYISO develops do not provide a reasonable representation of its Aggregation's cost, the Market Party may consult with the NYISO on the

²⁸ So a solar resource should not be selected at night, and an Energy Storage Resource that has expended all of its Energy should only be selected if it is expected to charge.

development of unique reference levels for its Aggregation, as described in the previous sections of this manual. Similarly, if the NYISO believes that the cost data templates are not a reasonable representation of a particular Aggregation's cost, the NYISO may request additional data from the Market Party to support the development of Aggregation-specific reference levels.

12. Ancillary Services

12.1. Regulation Movement

12.1.1. Regulation Movement Cost Overview

The NYISO will develop cost-based reference levels for Regulation Movement for all units expected to offer Regulation Capacity and Regulation Movement. These reference levels will be calculated pursuant to the NYISO's proposed revisions to its Market Administration and Control Area Services Tariff ("Services Tariff"), which were filed with the Federal Energy Regulatory Commission on January 22, 2013 and remain pending. See ER12-1653. The proposed Services Tariff revisions require the NYISO to determine a Regulation Movement reference level using the best information available, taking into account such data as may be furnished by the Market Party.

12.1.2. Regulation Movement Cost Components

Consistent with the NYISO's proposed Services Tariff revisions, the NYISO will establish a reference level for Regulation Movement, for each regulation provider, that reflects the unit's marginal costs of responding to regulation-related changes in 6 second dispatch basepoints. The reference level for Regulation Movement will be calculated by the NYISO using the best information available, taking into account such data as may be furnished by the Market Party. The NYISO welcomes any Regulation Movement cost information or documentation that a Market Party may provide, whether qualitative or quantitative. However, numerical data and calculations will be the most helpful. If the Market Party does not provide Regulation Movement cost information or documentation to the NYISO, the NYISO will determine a reference level on the basis of the NYISO's estimate of the costs or physical parameters of the relevant Electric Facility, taking into account available operating costs data and the best information available to the NYISO.

Some units may incur costs of the following type as a result of providing Regulation Movement:

- Additional thermal losses (beyond the energy used to generate the same number of MWs at a constant rate), and
- Additional maintenance costs from Regulation Movement (beyond the wear and tear from generating the same number of MWs at a constant rate).

If a Market Participant believes that its unit's Regulation Movement results in incremental costs that are not related to the categories above, they may claim such costs (for example, a Market Participant might also claim costs associated with increased trip risk due to Regulation Movement, or financial risk of failing

to accurately follow regulation basepoints). However, as with any reference level submittal, the NYISO may follow up by asking a Market Participant to substantiate asserted Regulation Movement costs with data or supporting documentation.

12.1.3. Form of Movement Cost Component Submissions

The NYISO welcomes both quantitative and qualitative information from Market Participants about the costs of providing Regulation Movement. However, quantitative estimates will be most helpful if they are provided within the following framework:

For thermal losses associated with providing Regulation Movement, either:

- The number of additional mmBTUs consumed while providing regulation for one hour.
- The percentage increase in fuel consumption associated with providing regulation service for one hour. This is calculated using the ratio of the following numbers.
 - The numerator: additional mmBTUs consumed while on regulation at an assumed energy basepoint.
 - The denominator: total mmBTUs consumed while not on regulation, at the same assumed energy basepoint.
 - If providing thermal losses as a percentage, please assume a typical energy basepoint for providing Regulation Movement, and please specify the energy basepoint assumed.

For maintenance costs associated with providing Regulation Movement, either:

- The amount, in dollars, of additional maintenance costs incurred per hour of providing Regulation Movement; or
- The percentage increase in maintenance costs associated with providing Regulation Movement. This is the ratio of the additional maintenance cost incurred per hour of providing Regulation Movement divided by the maintenance cost per hour of operating at the same assumed basepoint while not on regulation.

12.1.4. Translation of Cost Components into Costs per MW-Hr

The NYISO will calculate Regulation Movement costs per MW-hr by incorporating the cost submissions from Market Participants described above with:

- Burdened fuel cost information from RLS (for thermal losses).

- Heat rate data from RLS (for thermal losses).
- Maintenance/VOM costs from RLS (for maintenance costs).
- Data on average MWs of movement incurred per hour of Regulation Movement.

Appendix A Variable Cost Categories²⁹

O&M for All Generating Plants

- Water consumption in plant operations
- Emission credits
- Incremental operating labor
- Auxiliary equipment repair
- Replacement of consumables and normal wear-and-tear items (e.g., seals, lockplates, nuts, bolts, gaskets, etc.)
- Mechanical parts replacement
- On-line running maintenance
- Performance testing (oxygen boiler test, on-line testing, pre-air heater test)
- Vibration analysis monitoring
- Waste water treatment
- Auxiliary equipment maintenance
- Filter changes
- Oil changes
- Oil and water level checks
- Condensate Pump inspection and overhaul
- Circulation Pump inspection and overhaul
- Steam Turbine Generator inspection/repair/overhaul
- Preventive/predictive maintenance tests
- Auxiliary power consumption
- Auxiliary fuels/lubricants
- Compressor and turbine rotors inspection
- Feedwater pump inspection and overhaul
- Cooling tower equipment inspection and overhaul
- Fuel metering equipment replacement
- Gas turbine auxiliaries
- Transformer maintenance and testing
- Relay cleaning
- Battery system service
- Oxygen boiler test
- Condenser inspections and cleaning
- Water demineralization and treatment
- Boiler tube repair
- Generator field rewinds
- Stop valve inspection
- Control valve inspection
- Boiler casing leak repair (where applicable)
- Relay & interlock testing
- Water box cleaning
- Chemical waste disposal fees
- Non-destructive testing
- Hotwell cleaning
- Turning and ratchet gear maintenance
- Instrumentation and controls replacement
- Emissions monitoring tests
- Emissions control equipment repairs
- High energy piping inspections

²⁹ Appendix A contains listings of potential cost categories which are non-exhaustive and may not be appropriate for all units. See section 8.1.1 of this manual for a description of approvable operating and maintenance costs.

O&M for Coal-Fired Plants

- ♦ Boiler safety valve testing
- ♦ Steam drum repairs
- ♦ Water wall repairs
- ♦ Seals replacement
- ♦ Coal bunker repair
- ♦ Coal crusher repair
- ♦ Coal freeze proofing
- ♦ Chemical cleaning of internal heating surfaces
- ♦ Burner repairs
- ♦ Feedwater heater repairs
- ♦ Deaerator repairs
- ♦ Air heater repairs
- ♦ Ash hopper repairs
- ♦ Precipitator/bag house repairs
- ♦ Ash handling equipment repairs
- ♦ Evaporator tubing repairs
- ♦ Superheater/reheater/economizer tubing and headers repairs
- ♦ Heat exchanger cleaning
- ♦ Coal drying
- ♦ Coal-handling and distribution equipment repair
- ♦ Stack, fans and draft repair
- ♦ Coal feeder pulverizing equipment repair
- ♦ Boiler condition assessment

O&M for CT/CC Plants

- Alignment check of the gas turbine to the generator, as well as of the gas turbine to the accessory gear
- Boroscope inspections of compressor casings and turbine shells
- Casings, shells, and frames/diffusers inspected for cracks and erosion
- Checks of alignment between gas turbine and generator; gas turbine and accessory gear.
- Radial and axial clearances check
- Seals for rubs and deterioration of clearance checks
- Device calibrations check
- Chemical Cleaning or Hydro-Blasting of Heat Transfer Surfaces
- Fluorescent penetrant inspection of bucket vane sections
- Combustion Turbine Generator Evaporative cooling system media replacement
- Combustion Turbine Generator Inspections
- Compressor inlet and flow-path inspection for fouling, erosion, corrosion, and leakage
- Compressor wash systems repair
- Distillate Fuel Pumps Inspection and Overhaul
- Electric generator inspection and overhaul
- Environmental: SCR /CO replacement
- Inlet Air Filter Replacement /maintenance
- Inspection of bearing liners and seals for clearance and wear
- Buckets inspection
- Fuel Gas Compressors Inspection and Overhaul
- Fuel System replacement
- Heat Transfer Surface Replacements
- Inspection of compressor blades for rubs
- Hydrogen embrittlement testing
- Inspection of flow sleeve welds for cracking
- Inspection of fuel nozzles for plugging and erosion of tip holes
- HRSG inspections/condition assessments
- Detectors, combustor flow sleeves, flow sleeve welds, combustion system and discharge casing
- Maintenance of fuel treatment system
- Mechanical inlet air cooling chiller and pump inspection and overhaul
- Sampling of turbine lube oil for viscosity, chemical composition, contamination, particulate, and water-contamination
- Impact damage, corrosion, and buildup of deposits
- Inspection of cross-fire tube, retainer, and combustion liner for cracking, oxidation, corrosion, and erosion
- Inspection of fluid, air, and gas passages in the nozzle assembly for plugging, erosion, corrosion, etc
- Inspection of fuel nozzles, liners, transition pieces, crossfire tubes and retainers, spark plug assemblies, flame
- Inspection of inlet systems for corrosion, cracked silencers, and loose parts
- Refurbishing bucket coatings
- Inspection of combustion chamber interior
- Inspection of later-stage diaphragm packing
- Inspection of bucket seals for clearances, rubs, and deterioration
- Inspection of turbine stationary shrouds
- Inspection of wheelspace instrumentation
- Inspection of variable inlet guide vanes (VIGVs)
- Repair and refurbishment of second and third-stage nozzles
- Recoating of turbine buckets
- Replacement or refurbishment of hot gas parts
- Gas turbine combustion and hot gas path inspections
- Compressor and turbine rotors inspection