California Independent
System Operator Corporation

Draft Final Proposal

Parameter Tuning for Uneconomic Adjustments in the MRTU Market Optimizations

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Department of Market and Product Development

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1. Executive Summary

This California ISO ("CAISO") Draft Final Proposal is provided as a follow-up to the CAISO's Issue Paper on this topic, which was posted on May 6 in the present stakeholder process.[1] As discussed in the Issue Paper, the Parameter Tuning effort builds upon work that was done in the Analysis Track Testing effort, and consists of two phases. For the first Parameter Tuning phase the CAISO is developing modifications to the existing MRTU tariff provisions regarding Uneconomic Adjustment, and will present these modifications to its Governing Board in July and, upon Board approval, file these modifications with FERC in the latter part of July. Along with the proposed tariff modifications, the July FERC filing will also include the CAISO's tariff changes and supporting explanations in compliance with previous FERC orders on the "LAP demand clearing" problem, a particular Uneconomic Adjustment case that can occur in the day-ahead Integrated Forward Market ("IFM"). In conjunction with this first phase of the Parameter Tuning effort, the CAISO is conducting analyses utilizing the MRTU market simulation software systems for the purpose of "tuning" – i.e., determining the optimal settings for – a set of special software parameters needed in conjunction with Uneconomic Adjustment, and on an ongoing basis will be documenting and posting the analysis results for discussion with stakeholders.

The second phase will be essentially a continuation of the analysis aspect of the first phase, but in the second phase the focus will be on establishing the complete set of parameter values what will be used in the MRTU software systems upon the start-up of the MRTU markets. In addition to presenting the results of this analysis for discussion with stakeholders at various points in the Parameter Tuning effort, the CAISO intends to publish the set of start-up pricing run parameter values in a Business Practices Manual ("BPM") at least 30 days prior to start-up, and at the same time will incorporate these values into the software for testing purposes during the final 30 days of pre-production leading to MRTU market launch. The scheduling run pricing parameters implemented at that time will be provided to market participants in an operating procedure.

For the FERC filing phase of this process the CAISO proposes to modify the provisions of the MRTU Tariff that require the CAISO market optimizations to utilize all submitted Economic Bids prior to making any Uneconomic Adjustment to submitted Self-Schedules. As explained in the previous Issue Paper and illustrated with examples during the May 13 stakeholder meeting, such a requirement will in certain situations result in scheduling and pricing outcomes that are neither operationally nor economically reasonable. The CAISO reiterates that such situations should be rare, but notes also that their frequency could be exacerbated when large quantities of Self-Schedules relative to Economic Bids are submitted by market participants, thus causing the market optimizations to run out of Economic Bids and resort to Uneconomic Adjustment more often.

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1 The May 6th Issue Paper is available at http://www.caiso.com/1fbf/1fbfe3a2498e0.pdf.

In modifying the existing tariff provisions, the CAISO does not propose to alter the priority given to Self-Schedules in general, nor the hierarchy of relative priorities among different categories of Self-Schedules as specified in the MRTU Tariff. Rather, the essence of the proposed changes to the tariff provisions in question will be to modify the currently inflexible requirement to utilize *all* Economic Bids before adjusting Self-Schedules so that extremely ineffective Economic Bids may be bypassed and some more effective Self-Schedule adjustments may be utilized to arrive at a feasible market solution while avoiding schedule and price outcomes that are operationally and economically unreasonable.

In addition to the matter just described, the CAISO also intends to file new tariff language to address how Ancillary Service Marginal Prices ("ASMPs") are determined under conditions of deficiency of AS supply. Such conditions have been an important subject of the Parameter Tuning analysis, for which some illustrative examples and discussion are provided later in this paper.

With regard to the procedure to be followed to address the "LAP demand clearing" problem, which is stated in Section 31.3.1.3 of the MRTU Tariff and is the subject of a FERC compliance requirement to be addressed in the July filing, the CAISO notes that in the MRTU software the procedure differs somewhat from how it is stated in the tariff in that it does not rely on the Pre-IFM processes. The implemented procedure, which is fully discussed later in this paper, follows the same conceptual approach as specified in Tariff Section 31.3.1.3 but is fully integral to the Integrated Forward Market (IFM) optimization, which the CAISO believes is superior to the set of discrete tests and re-runs of Pre-IFM processes as per the original approach. The implemented version of the procedure will be incorporated accurately into the MRTU Tariff and fully explained in the CAISO's July filing.

In conclusion, consistent with the two-phase Parameter Tuning effort described at the beginning of this Executive Summary, Section 4 of this paper contains the substance of the proposals the CAISO intends to submit to its Board in July for approval and, if the Board approves, submit to FERC later that month. Section 6, in contrast, should be viewed as an update and status report on the analytical aspect of the Parameter Tuning effort. As such it presents what the CAISO believes to be the most appropriate parameter values based on its testing to date, and describes in detail some specific cases the CAISO has analyzed since the previous report to stakeholders on these activities. The CAISO intends to continue the Parameter Tuning analysis and will report to stakeholders during the coming summer on the results of the further analysis and any recommended changes to the parameter values.

2. Proposed Process and Timetable

The following table summarizes the key steps and dates in the stakeholder process leading to the July Board decision and FERC filing. In a subsequent paper on Parameter Tuning the CAISO will provide additional process milestones and dates leading up to the posting 30 days prior to MRTU market launch of the parameter values to be used during the final 30 days of pre-production testing and in the MRTU markets when they begin production operation.

Date	Activity
Tu. May 6	CAISO posts Issue Paper
Tu. May 13	Stakeholder meeting

F. May 23	Written stakeholder comments due
M. June 9	CAISO posts Draft Final Proposal
F. June 13	Stakeholder conference call
W. June 18	CAISO posts draft tariff language
F. June 20	Written stakeholder comments due on Draft Final Proposal
M. June 23	MSC posts Draft Opinion
M. June 30	Written stakeholder comments due on draft tariff language
M. June 30	MSC adopts Final Opinion
Tu. July 1	CAISO posts Board documents, including Final Proposal
Week of July 7 (date tbd)	Stakeholder conference call on draft tariff language
W.-Th. July 9-10	Board meeting
F. July 18 (approx.)	FERC filing

3. Some Clarifications in Response to Stakeholder Comments

The comments submitted by stakeholders on May 23 raised a number of questions, some of which the CAISO can respond to with clarifying comments at this time. Others will require further analysis by the CAISO and will be discussed with stakeholders later in the Parameter Tuning effort.

1. The parameters in question – the so called “penalty prices – are an intrinsic element of the constrained optimization algorithms that comprise the basic software engines of the MRTU market processes.

The need for the CAISO’s Parameter Tuning effort is not peculiar to the MRTU design, nor does it reflect any problems in the MRTU software. Rather, it is a natural part of all software systems of this type, including the ones used by the Eastern ISOs. The Security Constrained Unit Commitment (“SCUC”) and Security Constrained Economic Dispatch (“SCED”) algorithms are structured to commit and schedule the most efficient supply resources to meet demand in each interval, subject to a number of constraints including transmission flow limits, AS procurement requirements, generator ramp rates, system power balance, etc. Whereas Economic Bids for supply and demand and offers of AS capacity all have price-quantity bid curves, these other constraints do not have any associated prices, either submitted by market participants or inherent in their nature. Yet the optimization software must have the ability to determine, when it cannot reach a feasible solution using only Economic Bids, which of the constraints can be relaxed, and in what priority order, to find a solution. The settings of the “penalty prices” associated with each of the constraints play a role analogous to that of the bid prices associated with Economic Bids and thus are the means by which the software is instructed how and in what order to relax constraints when needed.

2. The incorporation of Self Schedules in the MRTU design with a hierarchical priority order among different types of Self Schedules essentially creates another set of constraints that the software must observe, and these require their own parameter settings.

For example, the requirement to accept a specified level of output from a particular generator (i.e., a supply Self-Schedule) is a constraint on the market optimization that is for all practical purposes the same as a flow limit on a transmission line that cannot be exceeded. Thus the system of scheduling priorities associated with different classes of Self Schedules must be implemented in the market optimizations as a set of constraints with associated parameters. The determination of appropriate settings for these parameters then becomes a necessary exercise for the system of priorities to work as intended.

3. The constraint parameters generally need to be large numbers – outside the range of Economic Bids in the market, both in the negative direction and the positive direction – to ensure that the most crucial constraints are always observed.

As the May 6 Issue Paper and the CAISO's May 13 presentations have demonstrated, even though the prices on Economic Bids for Energy must be between -$30 and $500, there are cases where economic market solutions can result in LMPs outside the bid cap range. This may result, for example, when a relatively ineffective Economic Bid for supply is utilized to relieve a transmission constraint. In order for the optimization software to treat some constraints as "hard" constraints and other constraints as relatively softer constraints, some of the scheduling run penalty price values need to be orders of magnitude higher than the bid caps.

4. When there is a system of priorities among different classes of constraints (including Self Schedule types), the parameters associated with each class need to be far enough apart numerically to ensure that the hierarchical adjustment sequence will be observed most of the time.

This point is an elaboration of the previous point. The greater the number of different categories or classes of constraints that need to have distinct priorities in the hierarchy of Uneconomic Adjustments, the larger or more extreme (positive and negative) the scheduling run penalty price values needed to implement the desired hierarchy.

5. Because the needed parameters tend to be numerically extreme in order to maintain the desired priority levels, and many of them will be orders of magnitude outside the range of Economic Bids, such parameters would lead to extreme market prices if they were used to set prices. For this reason, the MRTU markets are structured with a "scheduling run" followed by a "pricing run."

The scheduling run utilizes the extreme parameter values to ensure that the desired priorities will be observed as fully as possible, consistent with prudent operational practice and reasonable economic tradeoffs, in determining schedules. The pricing run then applies generally less extreme parameter values to calculate "reasonable" market prices associated with the schedules that resulted from the scheduling run.

6. As the logic of the above points should suggest, there are no "correct" parameter values in any absolute sense. Rather, the parameters must be chosen through an analytical process to try to achieve an optimal balance among a few competing objectives. Parameter Tuning is the process by which these optimal values are determined.

As stated in the May 6 Issue Paper, the overall objective of the parameter tuning analysis is to determine, for the various MRTU market optimization processes, appropriate penalty prices for scheduling runs and pricing parameters for pricing runs to:

   a. Observe the desired priorities for self-scheduling and constraint relaxation in the scheduling runs of each market process, consistent with the fundamental MRTU design principles;

b. Provide efficient economic signals in the form of large magnitude (positive or negative) prices when warranted, in particular to link settlement charges to cost causation and avoid creating incentives for participants to schedule and operate in a manner that undermines the operational and efficiency objectives of the MRTU design;

c. Prevent “unreasonable” price outcomes in the pricing runs, which may occur if curtailment priorities are enforced inflexibly even under the most extreme circumstances; and

d. Achieve scheduling and pricing outcomes that are consistent with good operational practice and support reliable operation of the CAISO transmission system.

It is important to recognize that these objectives are somewhat competing and therefore require tradeoffs. For example, the more rigidly we try to enforce the priority hierarchy, the more likely the optimization will make extreme schedule adjustments or calculate extreme prices. Also, the more the pricing run parameters are set to tightly limit prices to a narrow range, the weaker will be the disincentive for market participants to schedule so as to cause uneconomic adjustment.

7. Utilizing penalty prices associated with the schedules of specially-situated parties such as holders of ETC rights does not diminish these parties’ rights.

Throughout the MRTU development process the CAISO has been committed to honoring these pre-existing rights, and the present Parameter Tuning effort does not in any way compromise that commitment. Just as these rights today are to various degrees subject to the availability of transmission, the MRTU market rules have been designed not to alter the underlying factors that affect transmission availability nor the relationships of ETC and other transmission rights to transmission availability. The assignment of high penalty prices to ETC schedules provides their holders the appropriate priorities for scheduling transmission associated with the exercise of their rights, but also allows the software systems to make adjustments when grid conditions limit the amount of transmission that is available.

8. The need for the market systems to utilize Uneconomic Adjustment, and hence to apply the scheduling run penalty prices and pricing run parameters, increases as the proportion of Self Schedules relative to Economic Bids increases.

Although the ability of participants to Self Schedule demand and supply in the CAISO markets as needed is a mainstay of the MRTU design, there are many reasons why participants would want to use Self Schedules judiciously, i.e., when they really need to rely on the higher priority associated with Self Schedules, and to submit Economic Bids as often as possible. The main reason is that it makes economic sense for the market participant. That is, it is economically rational to operate one’s own supply resource – whether to serve one’s own load or to fulfill a contract to supply a buyer – when the market price is high enough to make that resource profitable, and to buy from the market instead when the price is lower. A second reason is that if the participant has any concerns about potential price impacts of Uneconomic Adjustment due to the penalty parameters, submitting Economic Bids allows the participant to limit exposure to such impacts.

4. Elements of the Proposed July FERC Filing

4.1. Adjusting Supply Self-Schedules to Relieve Transmission Constraints

A fundamental market design principle behind the CAISO's MRTU project is to rely as far as possible on submitted Economic Bids to clear each market with respect to Energy, congestion management and Ancillary Service (AS) procurement. In the course of developing the MRTU design, it was always recognized that in some instances using Economic Bids alone would not yield a complete and feasible solution, in which case the MRTU market software would resort to "Uneconomic Adjustments" to arrive at a solution. Such Uneconomic Adjustments could consist, depending on the specific market conditions, of adjustments to submitted Self Schedules in accordance with the scheduling priority hierarchy specified in the MRTU Tariff, or the relaxation of other constraints on the optimization such as transmission line limits or AS procurement requirements.[2]

As the above principle was incorporated in the MRTU Tariff as filed in February 2006, however, it was stated as an absolute rule which could lead in certain circumstances to schedule and price outcomes that are not consistent with either prudent operational practice or underlying economics. Specifically, Section 31.4 states: "If all Economic Bids in the IFM are exhausted, resource Self-Schedules … will be subject to uneconomic adjustments …" Section 34.10 states the equivalent for the Real Time Market. The requirement to utilize "all" Economic Bids before adjusting Self-Schedules fails to recognize that there are situations – which should be rare but are not impossible – where the only available Economic Bid may be so ineffective in relieving a constraint that it requires an extremely large MW adjustment at an extremely high cost to reach a feasible solution, even though the same constraint relief could be achieved by a relatively small MW adjustment to a more effective Self-Schedule.

The CAISO therefore proposes to modify the tariff language in the sections noted above to state that the priorities for the different classes of Self-Schedules, as specified in the existing tariff language, will be enforced through the settings of penalty price parameters used in the market optimizations, and that the values of these parameters will be specified in the Business Practice Manuals. The parameter settings – in particular the penalty prices for relaxation of transmission constraints – will thus govern the threshold at which ineffective Economic Bids will be bypassed in favor of a more effective Self-Schedule adjustment.

The choice of penalty prices for relaxation of transmission constraints will, however, continue to reflect the relative priorities placed on different types of resource Self-Schedules by establishing the threshold price at which the optimization will relax a transmission constraint rather than adjust a high-priority Self-Schedule.

4.2. Ancillary Service Pricing Under Deficiency Conditions

When the supply of a particular ancillary service within a particular AS region is not sufficient to meet the specified procurement requirement, the procurement requirement must be relaxed in the scheduling run in order for the optimization to reach a feasible solution. In such cases the pricing run parameter associated with the relaxed AS requirement will be the AS bid cap, which is set to $250 per MW for MRTU start-up. In most cases this penalty price will effectively set a

[2] The MRTU Tariff provisions regarding Uneconomic Adjustment are found in Sections 31.3.1.1 and 31.4 (with regard to the Integrated Forward Market) and 34.10 (with regard to the Real Time Market.

price cap on the Ancillary Service Marginal Price (ASMP).[3] The present section discusses the CAISO's proposed pricing principles for situations of AS deficiency.

The MRTU Tariff defines the substitution relationship between AS reserves as the ability to use a surplus of available higher quality reserve to meet a requirement for a lower quality reserve. For example, the CAISO can procure more Spinning reserve than needed to meet the minimum Spin requirement, and use the surplus to meet the minimum procurement requirement for Non-Spin. Similarly, surplus procurement of a reserve in an AS Sub-Region can be used to meet the minimum requirement in any outer regions that contain the AS Sub-Region. These substitution principles generally mean that the ASMP of a higher quality reserve should be no lower than that of a lower quality reserve in the same AS Region or Sub-Region. Similarly, the ASMP of a reserve in an AS Sub-Region should be no lower than that of the same reserve in a outer Region or Sub-Region.

There are a few main types of scenarios where AS procurement deficiency may occur; that is, where the available supply is not sufficient to meet the minimum requirement of the reserve. For each scenario the CAISO is proposing pricing rules to reflect the specific situation of deficiency, consistent with the substitution provisions mentioned above. The scenarios and proposed pricing rules are the following.

1. Deficiency of an AS reserve in an AS Region or Sub-Region

Under this scenario, the ASMP of a deficient reserve in a Region or Sub-Region will be set directly by its penalty price, which is set to the AS bid cap at $250/MW. The ASMPs of non-deficient higher-quality reserves available to serve the deficient region will be $250/MW plus the opportunity cost, if any, for the capacity not being used for the lower quality deficient reserve.

The ASMPs of reserves in a more granular non-deficient Sub-Region included in the deficient Region or Sub-Region will be $250/MWh plus the opportunity cost, if any, for providing reserve in between the nested Region and/or Sub-Regions.

The ASMPs of reserves in non-deficient outer Regions or Sub-Regions that include the deficient Region or Sub-Region will be determined by economic bids since there is no deficiency.

2. Deficiency of an AS reserve in multiple nested AS Regions and Sub-Regions

The ASMP of a reserve in the Region or Sub-Region where the reserve is deficient is set directly by its penalty price at $250/MW.

The ASMP of the reserve in a more granular non-deficient Sub-Region included in the deficient Regions and Sub-Regions will be $250/MW plus the opportunity cost, if any, for providing reserve in between the nested Regions and Sub-Regions.

The ASMP of the reserve in the outer Regions or Sub-Regions that include the deficient Region and Sub-Regions will be determined by economic bids since there is no deficiency.

4.3. The LAP Demand Clearing Problem

The Load Aggregation Point ("LAP") demand clearing problem discussed here is specific to the IFM; it does not arise in either the RUC or the RTM because market participants do not bid or self-schedule demand using LAPs in these market processes.[4]

[3] In some cases it is possible for the ASMP to rise above the bid cap due to the effect of opportunity cost or due nested regions in the calculation of a resource and service specific ASMP. Section 6.3 provides examples to illustrate the effect of opportunity cost on ASMPs.

In the MRTU design, one important principle embodied in the mechanism for clearing Demand Bids (including Self Schedules) submitted at the LAP level is that the load distribution factors (LDFs) used to distribute the submitted LAP Demand Bids to PNodes should be preserved in the clearing of Demand against Supply for the LAP. This is a necessary feature for obtaining internally consistent prices in the IFM, because it ensures that nodal LMPs and cleared nodal Demand quantities will aggregate to a LAP price and quantity that is on the LAP Demand curve.[5] This same feature has a potential to lead to undesirable consequences, however, under certain conditions, which are expected to be rare. The typical case occurs when there is internal congestion within the LAP that creates a load pocket[6] and there is a shortage of supply within the load pocket. Constraining the LDFs to remain fixed so that LAP Demand clears at a point on the LAP Demand curve can result in (a) a large volume of LAP Demand Bids being curtailed in the IFM, which shifts that Demand out of the IFM and into Real-Time and leads to a higher level of RUC procurement, or (b) extremely high Day-Ahead LMPs within the load pocket, or (c) both.

In general this problem is avoidable with an effective Resource Adequacy (RA) program that requires well-specified local capacity requirements, combined with clear, effective obligations on RA capacity under the CAISO market rules to make itself available in the IFM. Such obligations ensure that local supply scarcity – a key condition for the above scenario to occur – will be uncommon, limited to situations where facility outages or derates severely constrain the supply into a load pocket. In addition, the problem is more likely to occur when there are large-area LAPs that contain load pockets, instead of establishing a separate LAP for each known load pocket.

It is important to note that even if the CAISO were not to use LAP Demand Bids in the IFM, high LMPs in a load pocket can occur when supply into that area is severely constrained, for which the MRTU design includes effective local market power mitigation to minimize the impacts of such conditions on Demand. Another point to keep in mind is that even though LMPs in the load pocket may be high, the LAP Demand is settled at a LAP price which corresponds to a point on the LAP Demand curve and thus will still be a price that the LAP Demand is willing to pay based on its submitted LAP Demand Bids, even though a few of the individual LMPs that comprise the LAP price may be high.

The other potential consequence of a local supply scarcity condition – severe curtailment of LAP Demand in the IFM – is a direct consequence of holding the LDFs fixed in all circumstances. From the perspective of economic consistency this is the correct thing to do because, as noted above, it ensures that the cleared nodal Demand and LMPs aggregate up to a point on the LAP Demand curve. But in practical terms the LDFs are statistically derived and as such will deviate randomly from the true distribution of Demand in any given hour. With a sound methodology for estimating the LDFs, the LDFs will be reliable and the random deviations should be small, but even so it should be recognized as a strong presumption to insist that the LDFs be fixed under all circumstances. Moreover, although high LMPs in load pockets are appropriate when those

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4 Note, however, that even though the optimizations use the CAISO demand forecast in RUC and RTM, the demand can only move in aggregate and not at a nodal level. Therefore in these market processes the penalty price on not meeting forecast demand in the scheduling run is an extremely high value, specifically, the value associated with the power balance constraint. See section 6.7 of this paper for further details.

5 Indeed, this feature was incorporated to address the number one issue that LECG identified in their February 2005 report assessing the overall MRTU market design, which is available at: http://www.caiso.com/docs/2005/02/23/2005022316342657 01.pdf.

6 The load pocket is not the only type of situation where this occurs. Fixed distribution factor LAPs have been observed in some conditions to result in extremely low negative prices for supply Self-Schedules located behind a constraint.

areas are constrained and supply is scarce, it is less desirable to curtail IFM Demand across an entire LAP when a local constraint is binding. Such curtailment is purely an artifact of the fixed LDFs which are maintained as LAP demand is reduced. Of course, a large reduction of Self Scheduled demand in the IFM does not mean that the demand will not be served in real time, it only means that the demand is not being scheduled in the IFM, which will in turn increase the amount of capacity procured in RUC for that hour.

Based on the scenarios described above, the CAISO included in the filed MRTU tariff certain provisions to address the local scarcity circumstances described here, to mitigate what would otherwise be highly artificial scheduling or pricing outcomes. The most current version of these tariff provisions is contained in section 31.3.1.3.[7]

FERC's September 21, 2006 Order on the February 2006 MRTU Tariff filing discussed the CAISO's proposal for addressing the LAP Demand Clearing scenario and concluded with the following compliance requirement.

> 618. We agree with PG&E that the parameters that govern the CAISO's use of MRTU Tariff section 31.3.1.2 could significantly impact rates and find that the CAISO should provide further details on those parameters in MRTU Tariff section 31.3.1.2. This section currently states that "the CAISO will evaluate the validity of the binding constraints and if it is determined that the constraint can be relaxed based on the operating practices, will relax the constraint consistent with operating practices" and "the CAISO may 'soften' the Load Distribution Factor constraints on a node or sub-LAP basis, i.e., adjust load at individual nodes or, in aggregate, a group of nodes to relieve the constraint in such a way that minimizes the quantity of load curtailed." While the CAISO anticipates using these provisions only under rare conditions, the provisions must be fully developed and transparent. Thus, the CAISO must revise this section to include the parameters that would govern its use of MRTU Tariff section 31.3.1.2. Accordingly, we direct the CAISO to file a compliance filing within 60 days of the date of this order reflecting this change.

The CAISO revised section 31.3.1.2 in compliance with the above order, and in response FERC issued further compliance requirements in its June 25, 2007 order on the CAISO's compliance filing.

> 162. We agree with parties' contention that the proposed tariff language is unclear and requires further clarification. For example, several parties raised concerns on the use of penalties for constraint violations. We share those concerns. While the CAISO attempts to explain the penalty as a mathematical device for relaxing constraints, we believe the CAISO should give further details about the impact of the proposed penalty levels in the IFM.
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> 163. In addition, we note that the CAISO has failed to respond to certain issues raised by commenting parties. For example, the CAISO's answer does not address Six Cities or SoCal Edison's concerns relating to how the rules will function, who are the affected parties, how they are affected, or the impact it will have on market prices. We believe the parties raise legitimate concerns that the CAISO must address in a subsequent compliance filing directed in this order. Accordingly, we direct the CAISO to resubmit

[7] The material now in Section 31.3.1.3 was originally in Section 31.3.1.2. In response to requests by participants to add additional detail from BPMs into the Tariff and by the CAISO's own initiatives in the BPM MRTU proceeding, the CAISO has proposed to add language to Section 31.3.1.2 to more clearly state how Ancillary Services will be treated in the IFM. The material on LAP Demand Clearing was therefore placed into Section 31.3.1.3.

> revised tariff language that clearly indicates that the penalty is not a financial penalty in the traditional sense and clarify what constitutes an effective economic bid. In addition, we direct the CAISO to clearly articulate in the compliance filing transmittal letter: (1) what the revised provision does; (2) how the provision works in practice; (3) the practical and financial effect of the provision on the market participants; and (4) detailed answers to the questions raised by commenters.
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> 164. We hereby direct the CAISO to resubmit revised tariff sheets in conjunction with the compliance filings it will make on or before August 3, 2007. We also accept the CAISO's commitment to conduct the market simulation which will better inform us on the performance of the proposed penalty and direct the CAISO to propose modifications if necessary.

The CAISO subsequently filed a series of motions for extension of time to allow for thorough testing and analysis of the proposed procedures using the market simulation software. The CAISO filed the last of these motions on January 31, 2008, wherein it described the further testing it intends to complete and committed to file in compliance with the above order as soon as such testing and analysis were completed but no later than sixty-two days prior to the start-up of the MRTU markets. FERC approved this motion, and on that basis the CAISO is including the analysis associated with the LAP Demand Clearing scenario in this Parameter Tuning effort and will incorporate its compliance on this matter into the planned July filing.

Part of the compliance requirement, as seen in the FERC order excerpts above, is to explain more clearly how the LAP demand clearing mechanism will work and its impacts. As noted earlier, the software implementation of the LAP demand clearing mechanism utilizes the same conceptual approach as stated in Tariff Section 31.3.1.3, but improves upon that approach by internalizing the procedure in the IFM rather than performing a sequence of discrete tests and optimization re-runs in the Pre-IFM processes. The rest of this section describes the LAP clearing mechanism as implemented in the MRTU software, and discusses some of the related parameter tuning issues.[8] The CAISO's July filing will provide revised tariff language to reflect the revised mechanism, and will address the questions FERC directed the CAISO to answer in its orders.

The LAP demand clearing mechanism that is implemented in the MRTU software integrates the solution into the IFM optimization rather than performing a sequence of tests and iterative re-runs of the All Constraints Run (ACR) of the Pre-IFM process, as described in section 31.3.1.3 of the current MRTU Tariff. To be more specific, the scheduling run penalty prices in the IFM are set so as to replicate through adjustment priorities the same sequence of steps one and two described in the current tariff section, but within the context of the IFM market optimization. To illustrate how this works, consider the situation where there is insufficient supply within a load pocket that is part of a larger LAP to serve all the Self-Scheduled demand in that LAP. In other words, a transmission line going into the load pocket is loaded to its limit, but the combination of this energy imported into the load pocket plus the energy available from supply inside the load pocket (including any demand response that is participating in the market) is not sufficient to meet the portion of the Self-Scheduled LAP demand that is inside the load pocket according to the applicable LDFs. In this situation, in order for the optimization to reach a feasible solution either the Self-Scheduled LAP demand must be reduced across the entire LAP, or additional Energy supply within the load pocket must be found (for example, by making available the Energy from self-provided AS), or the transmission constraint must be relaxed, or the

[8] An illustrative example of the LAP demand clearing mechanism as implemented in the MRTU software is discussed in the presentation given by Jim Price at the May 13 stakeholder meeting. The presentation is available at http://www.caiso.com/1fc5/1fc5e2b72f540.pdf.

relationship among the LDFs must be varied so that Self-Scheduled demand within the load pocket can be reduced without reducing such demand across the entire LAP. The sequence of alternatives just described is the same as the steps indicated in MRTU Tariff section 31.3.1.3.

To compare the current tariff approach to the actual implementation, in the latter case the IFM scheduling run penalty price on Self-Scheduled LAP demand is set to $1600 in order to place a high priority on protecting such demand from being reduced. The IFM penalty prices that govern the release of conditionally qualified self-provided AS are set, as indicated in the May 6 Issue Paper, to $275 for Non-spin, $280 for Spin, and $285 for Regulation. Conditionally qualified self-provided AS is considered "conditionally" qualified precisely because of the fact that it may, by virtue of its obligation to provide Energy if needed (under an RMR or RA contract) be utilized by the IFM to provide energy to relieve a congestion constraint if the constraint would otherwise cause a reduction in Self-Scheduled LAP demand. The way this works in the software is that the conditionally qualified AS self-provision is assigned a negative bid price (-$275, -$280 or -$285 for Non-spin, Spin or Regulation, respectively), which is a stronger signal to the optimization software than an AS bid at the bid cap of $250 that the AS self-provision should be honored. In fact, the optimization software faces an even higher incentive to honor the AS self-provision, because the total cost of converting the self-provision to energy requires both payment of the penalty price plus the energy bid price, which can reach a total of several hundred dollars.

Thus the procedure implemented in the MRTU software corresponds to the first step of the LAP demand clearing mechanism described in the current MRTU Tariff section 31.3.1.3. Note that in releasing self-provided AS the settings of the penalty prices will release first Non-spin, then Spin, then Regulation. In the pricing run, the same values are used for the pricing parameters to ensure that Economic Bids to provide AS (subject to the $250 bid cap) are utilized for AS so that the self-provided AS capacity released in the scheduling run will be optimized to provide energy.

Next, the penalty price on internal transmission constraints that would affect LAP demand is set to $5000, which means that the optimization would accept an Economic Supply bid priced at the $500 bid cap that is at least 10 percent effective in relieving the binding constraint. Thus if the first step of releasing self-provided AS within the load pocket does not yield sufficient additional energy to relieve the constraint – considering all Energy bids for which the product of bid price times effectiveness is no greater than $5000 – then the IFM scheduling run will relax the constraint, consistent with the second step indicated in current tariff section 31.3.1.3. In the pricing run, the pricing parameter of $1500 is used for the amount of constraint relaxation from the line's normal limit up to the relaxation level determined in the scheduling run, but the pricing parameter of $5000 is retained for any potential relaxation above the scheduling run level. The choice of $1500 is consistent with tariff section 31.3.1.3 which says that a price of three times the bid cap will be used when a transmission constraint is relaxed to prevent a reduction in Self-Scheduled LAP demand. The use of $5000 for relaxation above the scheduling run level will prevent the pricing run from relaxing the constraint even further.

The $1500 pricing parameter will result in a differential of $1500 in the congestion components of the LMPs on either side of the binding constraint. This means that, if there were only a single constraint that had to be relaxed in the scheduling then, then one or more LMPs in the load pocket could be in the range of $1500 to $2000, depending on system conditions. Although this may seem like an extreme undesirable price, it is important to recognize that demand can limit its exposure to such prices by submitting Economic Bids rather than Self-Schedules. In addition, for Self-Scheduled LAP demand, the LAP price will be the weighted average of all the LMPs that comprise the LAP, so the LAP price that the demand pays will not be as extreme as these LMPs within the load pocket.

The LAP demand clearing mechanism implemented in the MRTU software does not have any provisions comparable to step three of section 31.3.1.3, which involves modifying some of the LDFs for the LAP so that demand within the load pocket can be reduced without reducing demand across the entire LAP. In considering how to implement step three the CAISO found that it would be very difficult in comparison to the unlikelihood that steps one and two would both be insufficient; thus the anticipated benefit of step three was determined not to be worth the cost of implementing it.

5. Process for Posting and Updating of Parameter Values

At noted earlier in this paper, the CAISO's Parameter Tuning effort will continue over the next several months with the goal of establishing a set of parameters that will be implemented in the market simulation software at least 30 days prior to MRTU market launch and will be used in the production software when the markets go live. When these values are specified at the 30-day before launch date, the pricing run parameters will be incorporated into a Business Practices Manual. Thus, once the MRTU markets go into production, the BPM Change Management Process will govern any subsequent changes to the pricing run parameter values. The scheduling run penalty prices will be made available to market participants in an operating procedure.

6. Parameter Tuning Analysis – Further Results

The CAISO's May 6 Issue Paper contained the parameter values for the IFM market runs that had been developed as of that date, based on tariff requirements as summarized below in section 6.1 and testing of the MRTU market software. During the stakeholder meeting on May 13, the presentation given by Jim Price explained the process that the CAISO used to develop these values, and illustrated their results.[9] Additional testing since that time has not identified any need for changes to the recommended values in the May 6 Issue Paper, which are stated in section 6.2 below.

Additional testing has allowed the CAISO to come to an understanding of certain results in the pricing of ancillary services, which are discussed in section 6.3; and perform initial testing of parameter values for the Residual Unit Commitment (RUC) process, described in section 6.4.

6.1. Day Ahead Market Discussion

The initial parameter values recommended for the IFM based on the parameter tuning effort to date implement a priority order that is consistent with the MRTU tariff, particularly sections 31.3.1.3 (Reduction of LAP Demand) and 31.4 (Uneconomic Adjustments in the IFM). Section 31.4 lists the scheduling priorities in IFM as follows:

1. Reliability Must Run (RMR) Generation pre-dispatch reduction;
2. Day-Ahead TOR Self-Schedules (balanced demand and supply reduction);
3. Day-Ahead ETC Self-Schedules (balanced demand and supply reduction); different ETC priority levels will be observed based upon global ETC priorities provided to the CAISO by the Responsible PTOs;

[9] The May 13th presentation is available at http://www.caiso.com/1fc5/1fc5e2b72f540.pdf.

4. Other Self-Schedules of CAISO Demand reduction subject to Section 31.3.1.3, exports explicitly identified in a Resource Adequacy Plan to be served by Resource Adequacy Capacity explicitly identified and linked in a Supply Plan to the exports, and Self-Schedules of exports at Scheduling Points explicitly sourced by non-Resource Adequacy Capacity;
5. Self-Schedules of exports at Scheduling Points not explicitly sourced by non-Resource Adequacy Capacity, except those exports explicitly identified in a Resource Adequacy Plan to be served by Resource Adequacy Capacity explicitly identified and linked in a Supply Plan to the exports as set forth in Section 31.4(d);
6. Day-Ahead Regulatory Must-Run Generation and Regulatory Must-Take Generation reduction;
7. Other Self-Schedules of Supply reduction; and
8. Economic Bids of Demand and Supply.

Section 31.3.1.3 further specifies the priority process for resolving situations where the IFM cannot resolve a non-competitive transmission constraint utilizing effective Economic Bids, such that load at the LAP level would otherwise be adjusted to relieve the Constraint, of which the first two steps are summarized as follows:[10]

Step 1: Schedule the Energy from Self-Provided Ancillary Service Bids from capacity that is obligated to offer an Energy Bid under a must-offer obligation such as from an RMR Unit or a Resource Adequacy Resource.

Step 2: Relax transmission constraints, subject to provisions including applying a penalty price for pricing transmission constraints at three times the Energy Bid cap, and this penalty price being less than the penalty price for curtailing firm, price-taker load.

The recommended scheduling run and pricing run penalty price values for the Day Ahead Market based on the CAISO's parameter tuning analysis to date are summarized in the following tables, with brief comments explaining the rationale for these values.

6.2. Integrated Forward Market (IFM) Parameter Values

As recommended in the May 6 Issue Paper and subsequently confirmed through ongoing testing, the CAISO's recommended values for the Integrated Forward Market are presented in the following table.

Penalty Price Description	Scheduling Run Value[11]	Pricing Run Value	Comment
Market energy balance	45,000	1500, 5000	In the scheduling run, it is essential to produce supply matching demand plus losses. In the pricing run, the penalty price is the same as for transmission

[10] In the tariff there is a Step 3 identified in which load distribution factors would be adjusted. At this point it appears unnecessary and impractical to execute this step. Therefore the parameter tuning is not relying on Step 3 for analysis.

[11] Penalty values are negatively valued for supply reduction and positively valued for demand reduction.

			constraints to ensure that LMPs remain within a reasonable range. This is relevant to the MPM and RUC passes in which the objective is to meet CAISO Forecast Demand.
Transmission constraints: Intertie scheduling	30,000	30,000	Intertie scheduling constraints are explicitly excluded from the LAP clearing mechanism described in section 31.3.1.3.
Reliability Must-Run (RMR) pre-dispatch curtailment (supply)	-6000	-30	The CAISO considers transmission constraints when determining RMR scheduling requirements. However, for this and other parameters listed below, bid prices are limited to between -$30 and $500 in the pricing run, as described earlier in this paper.
Pseudo-tie layoff energy	-6000	-30	Pseudo-tie layoff energy is scheduled under contractual arrangements with the Balancing Authority in whose area a pseudo-tie is located.
Transmission constraints: branch, corridor, nomogram (base case and contingency analysis)	5000	1500, 5000	In the scheduling run, the guideline applied to transmission constraints is that an Economic Bid should be accepted if it is priced at the bid cap and is at least 10% effective in relieving a transmission constraint. In the pricing run, two penalty price segments are available: one is priced at three times the Energy Bid cap pursuant to section 31.3.1.3, extending from the original limit to any constraint relaxation resulting from the scheduling run, minus a small amount called “epsilon”, then the second of “epsilon” around the relaxed limit must equal the penalty price of the scheduling run in order to ensure reasonable LMPs.
TOR self schedule	4500, -4500	500, -30	A TOR Self-Schedule would only be adjusted if it has very high effectiveness in relieving a constraint that cannot otherwise be enforced.
ETC self schedule	3200, -3200	500, -30	An ETC Self-Schedule would only be adjusted if it has high effectiveness in relieving a constraint that cannot otherwise be enforced. The typical value is set at 200% of the generic self-scheduled demand, but different values from $3400 to $4500 are possible if differential priorities are established among ETC rights.
CVR self schedule	3200, -3200	500, -30	A CVR Self-Schedule is assigned the same priority as the typical value for ETC Self-Schedules.

Ancillary Service Region Minimum Requirements	2000	250	In the event of bid insufficiency, AS minimum requirements would be honored in priority to serving generic Self-Scheduled demand, but not at the cost of overloading transmission into AS regions.
Ancillary Service Region Maximum Limit on Upward Services	1500	50	In the event of multiple AS regional requirements having bid insufficiency, it is undesirable to have the multiple constraints produce AS prices significantly exceeding the AS bid cap. An alternative for enforcing sub-regional AS requirements is to enforce a maximum AS requirement on other AS regions, thereby reducing the AS prices in the other regions without excessive AS prices in the sub-region with bid insufficiency.
Perfect hedge without scheduling priority (lowest ETC priority level)	1600, -1600	500, -30	Some merchant transmission may receive "perfect hedge" settlement treatment but not high scheduling priority, and a resource associated with such would thus be priced the same as generic self-schedules for demand.
Self-scheduled CAISO demand and self-scheduled exports using identified non-RA supply resource	1600	500	Pursuant to section 31.3.1.3, the uneconomic bid price for self-scheduled demand exceeds the penalty price for relaxed transmission constraints in the pricing run.
Self-scheduled exports not using identified non-RA supply resource	800	500	Self-scheduled exports using RA capacity would be priced at 50% of generic self-schedules for demand.
Regulatory Must-Run and Must Take supply curtailment	-750	-30	Regulatory must-run and must-take supply received priority over generic self-schedules for supply resources.
Price-taker supply bids	-550	-30	Generic self-schedules for supply receive higher priority than Economic Bids at the bid cap, and would be priced 10% higher in the scheduling run.
Conditionally qualified Reg Up or Down self-provision	285	285	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of regulation, over spinning and non-spinning reserve.
Conditionally qualified Spin self-provision	280	280	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of spinning reserve, over non-spinning reserve.
Conditionally qualified Non-Spin self-provision	275	275	The CAISO has determined this penalty price for conversion of self-provided non-spinning reserves through empirical

			testing, as a value that balances the maintenance of AS self-schedules with ensuring that the conversion to energy occurs before transmission constraints are relaxed.
Conditionally unqualified Reg Up or Down self-provision	75	75	In instances where AS self-provision is not qualified pursuant to the MRTU tariff, the capacity can still be considered as an AS bid, along with regular AS bids. The price used for considering unqualified AS self-provision is lower than the AS bid cap, to allow it to be considered as an Economic Bid.
Conditionally unqualified Spin self-provision	50	50	Same as above.
Conditionally unqualified Non-Spin self-provision	35	35	Same as above.

6.3. Additional Discussion of Ancillary Service Pricing Results

The examples discussed in this section were modified from an actual test case for the purpose of illustrating certain principles of AS pricing, specifically the ways in which opportunity costs can affect AS Marginal Prices (ASMPs). As such the examples reflect extreme conditions which the CAISO does not expect to occur in actual market operations. In particular, in the examples the CAISO's entire requirement for an ancillary service (Regulation Up, in these examples) must be provided within the SP26 sub-region, and the available bid quantities for most generators in this region are reduced by 90 to 99 percent. Although the two examples discussed in his section do not involve constraint violations, they illustrate how ASMPs can exceed the penalty price that applies to the AS capacity requirement in the event of supply deficiency. The rules regarding the setting of ASMPs in the event of supply deficiency are discussed in section 4.2 of this paper; the results discussed in this section show that supply deficiency is not the only condition that can produce ASMPs at or above the AS bid cap, since these cases have adequate AS bids to meet their regions' AS requirements.

In the first example, a generator has a Regulation Up bid of 150 MW at a price of $210/MW, a Spinning Reserve bid at $1.50/MW for its full capacity above its self-scheduled Energy, an Energy self-schedule, and an Energy bid curve in which the first bid segment is priced at $0. Its ramp rate is the same for all of these bids, and it has a fast ramping rate at which both its Regulation Up and Spinning Reserve bids can be provided in less than 10 minutes. Its AS region has limited Regulation bids available, so this generator is the marginal resource for satisfying the AS region's Regulation Up requirement. The ASMP for Spinning Reserve is $101.50, which is set by a different resource, and the LMP for Energy at this location is $60.

A fundamental market design principle in MRTU is the co-optimization of the procurement of Energy and AS. When a resource is certified to provide more than one product, the effective cost in the optimization for its output of each product reflects not only its bid price for that product, but also the value that in the resource foregoes by not providing the alternative product(s), which is called "opportunity cost." The most familiar form of Energy and AS co-optimization is a trade-off between scheduling a resource's capacity for Energy versus an AS product. In such cases, the capacity requirement for Regulation Up has a penalty price of

$2000 in the scheduling run, so this generator is scheduled to provide Regulation up to the point where the AS region's requirement is satisfied, and is awarded Spinning Reserve for the remaining capacity up to its maximum regulating capacity. If the trade-off in co-optimization were only Regulation Up versus Energy, and the foregone Energy dispatch would have been in the first bid segment, the opportunity cost of Energy would be the LMP of $60 (i.e., the Energy LMP at this location) minus the Energy bid price of $0 (i.e., the cost of buying Energy from this resource), which equals $60. Thus the effective cost of buying Regulation Up from this generator is its bid price of $210 plus the opportunity cost of $60, which sum to $270. This is the marginal resource for satisfying the applicable AS region's Regulation Up requirement, so this calculation would set the ASMP to $270, if the pertinent opportunity cost were related only to provision of Energy.

This resource would have a higher opportunity cost for providing Spinning Reserve in the co-optimization with Regulation Up. Because all other bids for Regulation Up have been awarded before this generator's bid, meeting the AS region's remaining Regulation Up requirement has limited its award of Spinning Reserve to less than its bid quantity. Buying more Spinning Reserve from this generator would have a value of $101.50, so the opportunity cost relative to its bid price of $1.50 is $100. If the AS region's Regulation Up requirement were reduced by 1 MW, if another resource increased its bid quantity of Regulation Up by 1 MW at a lower price, or if this generator's capacity increased by 1 MW, the system could reduce the cost of Spinning Reserve by buying another MW of Spin from this generator at its bid price of $1.50 and reducing the marginal resource's award by 1 MW at its Spin bid price of $101.50. Because this generator is the marginal resource in its AS region for Regulation Up, the ASMP for Regulation is its bid price of $210 plus its opportunity cost of $100 based on Spinning Reserve, which produces an ASMP for Regulation Up of $310.

In this example, the applicable constraint has been the total capacity of the generator. Other constraints such as ramping rates can have similar effects. In a second example, consider a different generator with a ramp rate for Spinning Reserve of 7 MW/minute but a ramp rate while providing Regulation of only 2 MW/minute. Thus, during the 10 minute period that is allowed for providing either Spin or Regulation, it could only provide 20 MW of Regulation Up, but it could provide 70 MW of Spin, which is 3.5 times the amount of Regulation Up that could be provided. Its Spinning Reserve bid price is $1.50 as in the first example, the ASMP for Spinning Reserve is still $101.50, but this generator's bid price for Regulation Up is $20/MW in this example. Its bid price for Energy exceeds its LMP, so its Energy dispatch is kept at its minimum load. Market conditions have changed from the first example, and this second generator is now the marginal resource for Regulation Up, but its output is needed to meet the AS regional requirement for Regulation Up. If its Regulation Up award could be reduced by 1 MW, its award for Spin could be increased by 3.5 MW, at the opportunity cost for Spin of $100/MW. Thus the opportunity cost for Regulation is 3.5 times $100, which is $350. Adding in its bid price for Regulation Up, it sets the ASMP for Regulation Up at $370.

As noted above, these results have produced ASMPs in excess of the AS bid cap not due to bid insufficiencies, but rather due to the effect of opportunity costs. Because there are no constraint violations in these cases, there are no optimization parameter values that could hold these ASMPs to lower values.

6.4. Residual Unit Commitment (RUC) Parameter Values

In addition to the parameters that generally affect the Day Ahead Market, as listed above, the RUC process is affected by constraint penalty prices for minimum on-line capacity, quick-start resource capacity, and minimum load energy. In the CAISO's test cases, these penalty price values are set generally at $1000. In addition, the RUC process uses uneconomic bid prices for estimated Hour-Ahead self schedules for energy (which the CAISO has set to $550, to match the uneconomic bid price in the IFM for self-scheduled supply), and the Day-Ahead energy schedule resulting from the IFM run (which the CAISO has set to $600, to exceed the uneconomic bid price in the IFM for self-scheduled supply). The CAISO is continuing to test the sensitivity of RUC results to these parameter values, and thus far has not detected any anomalous results using these current values.

6.5. Real Time Market Discussion

In most cases the Day Ahead and Real Time market processes (RTUC and RTD) will utilize the same penalty price values for the corresponding Self Schedule types and constraints. There are some design differences between Day Ahead and Real Time, however, that are implemented through different values for the parameter settings.

One key difference between the IFM and the Real Time Market processes is that Demand can be bid in with Economic Bids and Self Schedules in the IFM, whereas internal Demand is essentially fixed at the CAISO Forecast of CAISO Demand in the RTUC process, and is determined to maintain Real Time balance in the RTD. In particular, there is no Self Scheduling of internal Demand in the RTM, though there is Self Scheduling of export Demand in the HASP run of the RTUC. Thus penalty price associated with Self Scheduled internal Demand in the IFM corresponds to the CAISO Forecast of CAISO Demand in the RTUC.

Another key difference is that in the IFM a higher priority is assigned to meeting AS minimum requirements than to scheduling energy to supply load if there is shortage in generating capacity, whereas in the RTM the market will utilize AS capacity to provide energy if needed to serve load, even if this means falling below required AS quantities. Under this AS priority in the IFM both economic and Uneconomic Adjustments of demand would be utilized to obtain a solution prior to any violations of AS minimum requirements. In contrast, in the RTM market applications, system load has the highest priority, so that minimum AS requirements could be violated in order to dispatch energy from unloaded capacity to meet system load.

Finally, among the RTM market applications, the RTPD (RTUC) co-optimizes energy and AS, whereas the RTD optimizes energy only. Therefore, scheduling run penalty prices and pricing run pricing parameters associated with AS requirements are not relevant in the RTD.

At this point in the parameter tuning analysis, the CAISO has not completed sufficient test cases to provide a basis for definitive recommendations for the Real Time market processes. The values listed in the following tables are therefore mostly the same as their corresponding values in the IFM, with only certain differences based on the considerations noted above. The CAISO intends to complete additional test cases and provide additional rationale for the Real Time penalty price values in the next version of this paper on May 29.

6.6. Real Time Market Parameter Values

The Real Time Market (RTM) includes the quarter-hourly Real Time Pre-Dispatch (RTPD, also known as the Real Time Unit Commitment or RTUC, a special hourly running of which is the Hour Ahead Scheduling Process or HASP) and the five-minute Real Time Dispatch (RTD). The basis of the Real-Time priority structure is established in the MRTU Tariff in Sections 34.10.1 and 34.10.2. The table below presents and explains the parameter values to be used in the RTM processes. Except for the penalties protecting DA Awards and Self-Provision, the RTD parameter values are the same as those of RTUC.

Penalty Price Description	Scheduling Run Value	Pricing Run Value	Comment
Energy balance/Load curtailment and Self-Scheduled exports utilizing non-RA capacity	45,000	1500, 5000	In the scheduling run, it is essential to produce supply matching demand plus losses. In the pricing run, the penalty price is the same as for transmission constraints to ensure that LMPs remain within a reasonable range. This includes CAISO Forecast of CAISO Demand. Since Self-Scheduled Exports being supported by Non-RA capacity is to receive the same priority as CAISO Forecast of CAISO Demand this same priority is used for such Exports. (Tariff Section 34.10.1)
Reliability Must-Run (RMR) pre-dispatch curtailment (supply), and Exceptional Dispatch Supply	-6000	-30	The CAISO considers transmission constraints when determining RMR scheduling requirements. However, for this and other parameters listed below, bid prices are limited to between -$30 and $500 in the pricing run, as described earlier in this paper.
Pseudo-tie layoff energy	-6000	-30	Pseudo-tie layoff energy is scheduled under contractual arrangements with the Balancing Authority in whose area a pseudo-tie is located.
Transmission constraints: branch, corridor, nomogram (base case and contingency analysis)	5000	1500, 5000	In the scheduling run, the guideline applied to transmission constraints is that an Economic Bid should be accepted if it is priced at the bid cap and is at least 10% effective in relieving a transmission constraint. In the pricing run, two penalty price segments are available: one is priced at three times the Energy Bid cap pursuant to section 31.3.1.3, extending from the original limit to any constraint relaxation resulting from the scheduling run, minus a small amount called “epsilon”, then the second of “epsilon” around the relaxed limit must equal the penalty price of the scheduling run in order to ensure reasonable LMPs.
Real Time TOR Self Schedule	4500, -4500	500, -30	A TOR self-schedule would only be adjusted if it has very high effectiveness in relieving a constraint that cannot otherwise be enforced.
Real Time ETC Self Schedule	3200, -3200	500, -30	An ETC self-schedule would only be adjusted if it has high effectiveness in relieving a constraint that cannot otherwise be enforced. The typical value is set at 200% of the generic self-scheduled exports, but different values

			from $3400 to $4500 are possible if differential priorities are established among ETC rights.
Ancillary Service Region Minimum Requirements	2000	250	In the event of bid insufficiency, AS minimum requirements would be honored in priority to serving generic self-scheduled demand, but not at the cost of overloading transmission into AS regions.
Ancillary Service Region Maximum Limit on Upward Services	1500	50	In the event of multiple AS regional requirements having bid insufficiency, it is undesirable to have the multiple constraints produce AS prices significantly exceeding the AS bid cap. An alternative for enforcing sub-regional AS requirements is to enforce a maximum AS requirement on other AS regions, thereby reducing the AS prices in the other regions without excessive AS prices in the sub-region with bid insufficiency.
Perfect hedge without scheduling priority (lowest ETC priority level)	1600, -1600	500, -30	Some merchant transmission may receive “perfect hedge” settlement treatment but not high scheduling priority, and a resource associated with such would thus be priced the same as generic self-schedules.
Self-scheduled exports not using identified non-RA supply resource	800	500	Self-scheduled exports using RA capacity would be priced at 50% of generic self-schedules for demand.
Regulatory Must-Run and Must Take supply curtailment	-750	-30	Regulatory must-run and must-take supply received priority over generic self-schedules for supply resources.
Final IFM Supply Schedule	-650	-30	
Price-taker supply bids	-550	-30	Generic supply self-schedules receive higher priority than Economic Bids at the bid cap, and would be priced 10% higher in the scheduling run.
Conditionally qualified Reg Up or Down Real Time self-provision (RTPD only)	285	285	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of regulation, over spinning and non-spinning reserve.
Conditionally qualified Real Time Spin self-provision (RTPD only)	280	280	Conversion of AS self-schedules to Energy pursuant to section 31.3.1.3 will give higher priority to maintaining the availability of spinning reserve, over non-spinning reserve.
Conditionally qualified Real Time Non-Spin self-provision (RTPD only)	275	275	The CAISO has determined this penalty price for conversion of self-provided non-spinning reserves through empirical testing, as a value that balances the

			maintenance of AS self-schedules with ensuring that the conversion to energy occurs before transmission constraints are relaxed.
Conditionally unqualified Reg Up or Down Real Time self-provision (RTPD only)	75	75	In instances where AS self-provision is not qualified pursuant to the MRTU tariff, the capacity can still be considered as an AS bid, along with regular AS bids. The price used for considering unqualified AS self-provision is lower than the AS bid cap, to allow it to be considered as an Economic Bid.
Conditionally unqualified Spin Real Time self-provision (RTPD only)	50	50	Same as above.
Conditionally unqualified Non-Spin Real Time self-provision (RTPD only)	35	35	Same as above.