Pay for Performance Regulation

Draft Final Proposal

February 13, 2012

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1 Introduction

On October 20, 2011, the Federal Energy Regulatory Commission adopted a final rule to remedy what FERC indentifies as undue discrimination in the procurement of frequency regulation in the organized wholesale electric markets and ensure that providers of frequency regulation receive just and reasonable and not unduly discriminatory or preferential rates. The final rule requires a two part payment for frequency regulation: (1) a payment for regulation capacity and (2) a payment for performance of the resource in response to a regulation signal. This draft final proposal outlines the market design to comply with FERC's direction, including the development of a mileage payment based upon the automatic generation control (AGC) set points given to a resource and an accuracy adjustment based on the resource's actual response to these AGC set points. FERC's order adopting the final rule requires a compliance filing with proposed tariff language by April 30, 2012, and implementation in October 2012.

2 Plan for Stakeholder Engagement

Item	Date
Post Draft Final Proposal	February 13, 2012
Stakeholder Conference Call	February 15, 2012
Stakeholder Comments Due	February 27, 2012
Board Meeting	March 22, 2012

3 Changes from Revised Straw Proposal

- After determining the ISO can implement two separate constraints for mileage and capacity, incorporated these separate constraints into the methodology to establish the marginal clearing price for mileage and capacity. These prices will be the respective shadow prices of each constraint.
- Added a resource specific expected mileage calculation for use in the market optimization.
- Established a scarcity price for mileage of $55.00.
- Clarified that the round trip duration to send and acknowledge receipt of an AGC signal and obtain actual telemetry is 8 seconds.
- Clarified that mileage bids will be subject only to the GMC bid segment fee.

4 Overview of FERC Order 755

On October 20, 2011, FERC adopted a final rule to remedy what FERC identified as undue discrimination in the procurement of frequency regulation in the organized wholesale electric markets and ensure that providers of frequency regulation receive just and reasonable and not unduly discriminatory or preferential rates.[1] The order finds that current compensation methods for regulation service in organized markets fail to acknowledge the inherently greater amount of

[1] *Frequency Regulation Compensation in the Organized Wholesale Power Markets* 137 FERC ¶ 61,064 (October 2010). http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=12795915

frequency regulation service being provided by faster-ramping resources and that some Regional Transmission Operator (RTO) and Independent System Operator (ISO) practices result in economically inefficient dispatch of frequency regulation resources.

The rule requires RTOs and ISOs to compensate frequency regulation resources based on the actual service provided, including a capacity payment that includes the marginal unit's opportunity costs and a payment for performance that reflects the quantity of frequency regulation service provided by a resource when the resource is accurately following a dispatch signal. Specifically, the rule adds a definition at 18 C.F.R. § 35.2(g) for frequency regulation to read as follows:

> *The term frequency regulation as used in this part will mean the capability to inject or withdraw real power by resources capable of responding appropriately to a system operator's automatic generator control signal in order to correct for actual or expected Area Control Error needs.*

The rule also adds a new paragraph at 18 C.F.R. § 35.28(g)(3) to read as follows:

> *Each Commission–approved independent system operator or regional transmission organization that has a tariff that provides for the compensation of frequency regulation service must provide such compensation based on the actual service provided, including payment that includes the marginal unit's opportunity costs and a capacity payment for performance that reflects the quantity of frequency regulation service provided by a resource when the resource is accurately following the dispatch signal.*

The rule requires that the compensation method include specific components. For purposes of capacity payments, ISO and RTOs must allow a resource to submit verifiable inter-temporal opportunity costs as part of its offer to sell regulation. The rule also requires a payment for performance based on resource bids that reflect the cost of providing the service as opposed to an administrative price. The rule requires ISOs and RTOs to use two part bidding (capacity and performance) but does not specify how system operators should use bids in the market-clearing algorithm. While the rule does not require changes to settling the net energy injected (or withdrawn) as a result of providing regulation in ISO and RTO markets, the rule does require ISOs and RTOs to account for the accuracy of a resource's response to a dispatch signal when compensating the resource. The rule does not mandate a specific methodology for this requirement.

5 ISO's Current Regulation Design

The ISO uses regulation for system balancing to manage the differences between generating units' responses to dispatch instructions and actual load within a 5-minute period. The ISO procures regulation up and regulation down as separate products. In the day-ahead market, the ISO procures 100 percent of forecasted regulation needs in hourly intervals.[2] If additional regulation requirements arise in real-time, the ISO procures incremental regulation up and regulation down during real-time unit commitment in 15 minute intervals.[3]

The regulation signal sent to resources is intended to maximize the available ramp within awarded regulation capacity such that the ISO can respond to future variability and uncertainty. The ISO currently sends simultaneous regulation up and regulation down signals to resources in

[2] ISO tariff section 8.3.1.

[3] *Id. See also* ISO tariff section 8.2.3.1.

order to maximize future available ramping capability. The objective of the ISO's Automatic Generation Control (AGC) is to send regulation signals to resources to maintain ACE within the Balancing Area ACE Limit (BAAL), which is influenced by the system's actual frequency and error in net interchange. It is not to maintain Area Control Error (ACE) constantly at zero or any other given point. AGC will maintain units at their dispatch operating target whenever ACE is within the acceptable MW range. The ISO considers a resource's ramp rate in determining the regulation dispatch to send to individual resources. As a result, AGC set points are feasible based upon resource ramp limitations.

Because load and load forecast uncertainty largely drive the incremental need for regulation, the same regulation requirement is not actually needed in each hour of the day. To further improve the efficiency of regulation procurement, the ISO procures regulation on a variable basis by hour. An hourly variable regulation forecasting tool calculates the coincidental 10-minute peak requirement for regulation separately in the up and down direction for each hour based on changes in the demand forecast, generation self-schedule changes, and hourly intertie fluctuation.[4]

In connection with its efforts to examine system needs arising from the integration of a large volume of variable energy resources, the ISO has forecast a substantial increase in hourly regulation requirements in particular hours.[5]

5.1 Regulation Capacity Payment Includes Opportunity Costs

The ISO currently co-optimizes energy and ancillary services when determining regulation capacity awards and market clearing prices.[6] The market clearing price for regulation capacity includes opportunity costs that can result from the marginal resource not receiving an energy award in the day-ahead market in the same hour or in another hour as a result of inter-temporal constraints within the day. In real-time unit commitment, the ISO procures incremental regulation capacity (this procurement can also reflect energy opportunity costs). While the energy schedules resulting from real-time unit commitment are not financially binding, the ISO does consider known energy requirements when setting the market clearing price for regulation capacity. The ISO does not intend to modify its current approach for calculating opportunity costs for regulation capacity as part of this initiative to comply with Order 755.

5.2 Payment of Net Energy when Providing Regulation

The ISO currently pays resources responding to a regulation up dispatch at the real-time Resource-Specific Settlement Interval (10 minute) locational marginal price for the energy the resource provides. In addition, when a resource responds to a regulation down dispatch the resource is charged the real-time Resource-Specific Settlement Interval (10 minute) locational marginal price. For determining imbalance energy and deviations, regulation energy is deemed delivered. The ISO does not intend to modify its current approach for netting energy

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4 See ISO technical bulletin 2009-12-02 dated December 30, 2009 http://www.caiso.com/Documents/TechnicalBulletin-ASProcurement-Regulation.pdf

5 See generally, Integration of Renewable Resources: Operational Requirement and generation Fleet Requirement at 20 Percent RPS, August 2010. http://www.caiso.com/Documents//Integration-RenewableResources-OperationalRequirementsandGenerationFleetCapabilityAt20PercRPS.pdf

6 ISO tariff section 27.1.2.1

settlements from dispatches of regulation up and regulation down capacity as part of this initiative to comply with Order 755.

In its comments, Powerex highlights that the ISO's current approach for netting energy does not recognize the energy bid of the resource. Powerex believes the settlement for net energy dispatched should be the higher of the real-time LMP or its bid and the settlement for net energy consumed should be the lower of the real-time LMP or its bid. Powerex believes that resources should never be penalized for providing a service to the ISO and responding to ISO dispatches. While there may be instances in which a resource with a regulation award receives a locational marginal price for regulation energy at a price below its energy bid this issue is beyond the scope of this initiative. The ISO believes market participants can mitigate this risk through other means, including through the pricing of their regulation capacity bids. It would also be inappropriate to settle energy provided through regulation based on energy bids because energy bids are not used for determining its regulation dispatch. Furthermore, energy bids do not have to be submitted for resources to cover awarded regulation.

5.3 Inter-temporal Opportunity Costs

FERC Order 755 requires RTOs and ISOs to allow resources to include inter-temporal opportunity costs in a resource's offer to sell frequency regulation service, with the requirement that the costs be verifiable. The order does not require the ISO to calculate inter-temporal opportunity costs for resources. The ISO proposes to create a separate bid component to reflect inter-temporal opportunity costs. Scheduling coordinators will have the burden to justify inter-temporal opportunity costs contained within a resource's bid.

PG&E requested that the ISO defer the inclusion of inter-temporal opportunity costs because they may introduce significant complexity with limited benefits and potential gaming opportunities. The ISO is not proposing to implement the calculation of inter-temporal[7] opportunity costs or implement additional market constraints within the market optimization. These are not required by FERC Order 755. Instead to comply with FERC's rule, the ISO will allow scheduling coordinators to include any inter-temporal opportunity costs in their regulation bids. If a scheduling coordinator elects to include inter-temporal opportunity costs its regulation capacity bid, it must be able to demonstrate its inter-temporal opportunity costs. The capacity bid must still be below the bid cap of $250.00.

5.4 Mileage Payment

The ISO's current market design does not include a mileage payment for dispatches of regulation up and regulation down capacity. The ISO has described its proposal for a mileage payment based on the marginal unit's mileage bid in Section 6 of this draft final proposal.

5.5 Accuracy Adjustment

The ISO's current market design does not include an accuracy adjustment for dispatches of regulation up and regulation down capacity. The ISO has described its proposal for an accuracy adjustment contemplated by Order 755 in Section 7 of this draft final proposal. The ISO's

[7] The opportunity cost bid component is intended to address inter-temporal opportunity costs that are beyond what can be addressed within the market optimization horizon. For example in the day-ahead market, inter-temporal opportunity within the 24 hour horizon is already considered without a bid adder. However, inter-temporal opportunity cost from one season to another season cannot be explicitly considered within the market optimization horizon and can be incorporated into the resources opportunity cost bid component.

proposed accuracy adjustment will assess a resource's accuracy in responding to AGC set points. The accuracy adjustment will impact mileage payments for a resource that receives a dispatch of regulation up or regulation down.

6 Market Based Mileage Price

This section outlines how the ISO will determine a uniform clearing price for mileage. For purposes of this proposal, the ISO considers mileage as the absolute change in AGC set points between 4 second intervals. FERC Order 755 requires the ISO to have a uniform market clearing price for mileage based on the mileage bids submitted. Under this proposal, the ISO's market software will co-optimize energy, ancillary services and mileage to determine awards and market clearing prices based on the marginal unit's bid. Mileage will be settled based upon instructed mileage reduced by the accuracy adjustment at the mileage clearing price. While the optimization is making "awards" of mileage, there is no settlement for awarded mileage or scheduled mileage. The settlement only arises for actual response to the AGC signal.

6.1 Mileage Multiplier and Requirement

For purposes of this proposal, the mileage multiplier is the amount of expected mileage from 1 MW of regulation capacity. Several stakeholders requested the ISO calculate a more dynamic mileage multiplier in comments on the straw proposal. In response to these concerns, the ISO proposes to calculate an hourly mileage multiplier from the actual mileage of the prior week for each hour. The ISO will calculate the hourly mileage multiplier by summing the total mileage from all resources over the week for a given hour and dividing by the regulation capacity procured for the week in that hour. In Table 1 below, the mileage multiplier that will be used for HE 08 from Sunday through Saturday of the upcoming week would be 3.61. The ISO also intends to analyze, as part of the review outlined in Section 9, if other historical methods of calculating the mileage multiplier have a higher correlation to actual mileage use.

Table 1 – Example of calculation of mileage multiplier for HE 08

HE 08	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Total
Capacity	350	400	375	350	375	375	350	2575
Resource A Mileage	800	600	400	100	250	500	600	3250
Resource B Mileage	500	500	500	250	300	400	300	2750
Resource C Mileage	700	600	700	100	500	200	500	3300
Total Mileage	2000	1700	1600	450	1050	1100	1400	9300
Mileage Multiplier	5.71	4.25	4.27	1.29	2.80	2.93	4.00	3.61

The ISO will use the mileage multiplier to calculate the expected mileage from its regulation capacity procurement target. For example, if the regulation capacity procurement target for HE08 is 350MW, the mileage procurement target would be 1263 (350 x 3.61). The expected mileage will be a variable that determines the mileage requirement. In addition to the expected mileage, the average actual mileage from the prior week will be a variable which determines the mileage procurement target. For HE08 above, the average hourly mileage is 1328 (9300 divided by 7) with no operator adjustment. The ISO may adjust the average requirement based on operational needs. The ISO will also calculate an hourly resource specific mileage multiplier. A third variable to determine the mileage requirement will be the product resource specific mileage multiplier and the resource bid-in regulation capacity. The mileage

procurement target will be set at the minimum of these three values as shown in the optimization formulation in Section 6.2. With the third variable a mileage scarcity situation can be avoided. With the proposal, mileage requirement will not drive regulation capacity procurement.

If incremental regulation is procured during real-time unit commitment, the ISO will use the same system wide mileage multiplier as it used to award regulation in the day-ahead market to calculate the expected mileage. In addition, the ISO will use the same average mileage value as adjusted for operational needs.

6.2 Optimization Regulation Capacity and Mileage with Two Constraints

In the straw proposal, the ISO proposed to set separate constraints for mileage and regulation capacity in the market optimization. At the time of the straw proposal, the ISO believed that the two constraint approach could not be implemented. This was because the previous approach the ISO considered applied both the capacity and mileage constraint to each resource, resulting in the market optimization not being able to simultaneously determine a price for regulation capacity and mileage.

The proposal follows two guiding principles: (1) minimize the impact to the current regulation capacity market design, including cascading to lower quality operating reserves and (2) determine a uniform clearing price for mileage that takes in to consideration expected mileage even though only actual mileage will be compensated. In the revised straw proposal, combining both mileage and capacity bids in to a single price would result in expected mileage being included in the regulation capacity price at which regulation capacity only would cascade to spinning or non-spinning reserves.

In the approach outlined in this draft final proposal, the ISO has further refined the proposed optimization formulation to eliminate the application of the two constraints to each resource. This allows a resource to be awarded regulation capacity, while potentially not being awarded mileage that is in proportion (by a ratio of m_i as shown below) to the awarded regulation capacity. In the case a resource receives a mileage award below its mileage bid, the ISO is proposing to maintain the bid cost recovery rules from the revised straw proposal that apply to both regulation capacity and actual mileage.

Figure 1 shows the formulation of the optimization using a regulation capacity constraint and an expected mileage constraint.

Figure 1 - Optimization Formulation

$$\min\left(\sum_i (BCP_i \times Reg_i + BMP_i \times Mile_i) + \text{cost of energy and other AS}\right)$$

$$s.t. \quad \sum_i Reg_i \geq Req_{Reg} \qquad (1)$$

$$\sum_i Reg_i + \sum_j Spin_j \geq Req_{Reg} + Req_{Spin} \qquad (2)$$

$$\sum_i Mile_i \geq \min(Req_{Mile,t-1}, m \times Req_{Reg}, \sum_i m_i \times BCC_i) \qquad (3)$$

$$m_i \times Reg_i - Mile_i \geq 0 \qquad (4)$$

$$-Reg_i + Mile_i \geq 0 \qquad (5)$$

$$0 \leq Reg_i \leq BCC_i \qquad (6)$$

and other constraints

where

BCP_i, BCC_i – bid price and bid in MW for regulation capacity

BMP_i – bid price for regulation mileage

Reg_i, $Mile_i$ – regulation capacity and mileage awards

Req_{Reg}, Req_{Spin} – regulation and spin requirements

$Req_{Mile,t-1}$ – regulation mileage requirement average from prior week

m, m_i – systemand rescource – specific mileage multiplier

The regulation capacity price will be determined by the shadow price from constraint 1 and the mileage clearing price will be determined by the shadow price from constraint 2.

The third constraint seeks to avoid mileage scarcity and minimize instances where mileage requirements can drive increased regulation capacity procurement above the regulation capacity requirement. The constraint is necessary to meet the first guiding principle.

The use of an inequality for constraints 5 and 6, provide a linkage between an individual resource's mileage awards and capacity awards, but allows price formation for mileage and capacity consistent with the second guiding principle. As illustrated by the constraints above, a resource will receive a mileage award that is at least as much as its capacity award (5), but no more than the product of its resource-specific mileage multiplier and capacity award (4). The awards are not financially binding since resources will be paid based upon actual mileage resulting from the AGC signal, but the awards are used to determine a uniform mileage price.

In Table 2, the ISO illustrates the solution of the optimization formulas outlined above.

Table 2 – An Example of Energy, Regulation, and Mileage Co-Optimization Model with Solution

Energy, Regulation, and Mileage Co-Optimization Model													Mileage Multiplier -	m	m1	m2	m3
														3	2.8	3.1	3.2
Variables	Reg1	Reg2	Reg3	Spn1	Mile1	Mile2	Mile3	SlackReg	E1	E2	E3		Mileage Requirement	t-1	m*Cap	m_i*BidCap$_i$	
Variable Values	30	50	20	100	61	155	64	0	649	150	200			280	300	367	
Coef	7	8	9	4	3.8	2	3	250	52	48	49		Objective				
Coef*Value	210	400	180	400	232	310	192	0	33748	7200	9800		52671.8				
															Shadow		
Constraint Coefficients*Variable												LHS	>=	RHS	Price		
Reg Requirement	30	50	20					0				100	>=	100	5.44	α	
Spinning Requirement	30	50	20	100				0				200	>=	200	4	β	
Mileage Requirement					61	155	64					280	>=	280	3.8	χ	
Energy Balance									649	150	200	999	>=	999	52	δ	
Reg1 vs Mile1 -max	84				-61							23	>=	0	0	ε	
Reg2 vs Mile2 - max		155				-155						0	>=	0	1.8	ϕ	
Reg3 vs Mile3 - max			64				-64					0	>=	0	0.8	γ	
Reg1 vs Mile1 -min	-30				61							31	>=	0	0	η	
Reg2 vs Mile2 - min		-50				155						105	>=	0	0	φ	
Reg3 vs Mile3 - min			-20				64					44	>=	0	0	κ	
Total Capacity 1	30			100					649			779	<=	790	0	λ	
Total Capacity 2		50								150		200	<=	200	-4	μ	
Total Capacity 3			20								200	220	<=	220	-3	ν	
Max Reg1	30											30	<=	30	-2.44	ο	
Max Reg2		50										50	<=	50	-3.02		
Max Reg3			20									20	<=	40	0		
Max Spn1				100								100	<=	120	0		

Variables (MW)	Reg1	Reg2	Reg3	Spn1	Mile1	Mile2	Mile3	SlackReg	E1	E2	E3
	30.00	50.00	20.00	100.00	61.00	155.00	64.00	0	649.00	150.00	200.00
Shadow Price ($/MWh)	α	β	χ	δ	ε	ϕ	γ	λ	μ	ν	ο
	5.44	4.00	3.80	52.00	0.00	1.80	0.80	0.00	-4.00	-3.00	-2.44
Clearing Price ($/MWh)	Reg	Spinning	Mileage	Energy							
	9.44	4.00	3.80	52.00							

Solve!

The ISO will use an individual resource's historical accuracy and certified ramp rate to determine the resource-specific expected mileage. A resource will not submit a mileage MW, but only a mileage bid. The resource-specific expected mileage quantity that is dependent on the resource's operational characteristics is defined as follows:

$$\hat{m}_i = \eta_i \, T_r \, r_i \, \frac{\hat{c}_i}{C_i} \qquad (1)$$

Where:

- I is the resource index;
- $\hat{m}_i$ is the expected mileage bid quantity (MW) from resource *i*;
- η_i is the monthly average regulation accuracy (%) of resource *i*;
- T_r is the regulation time domain (10 min);
- r_i is the regulating ramp rate bid (MW/min) of resource *i*;
- $\hat{c}_i$ is the capacity bid quantity (MW) from resource *i*; and
- C_i is the certified regulating capacity (MW) for resource *i*.

This resource specific expected mileage formula has several terms:

1) $T_r \times r_i$ is the maximum resource capacity that could be loaded or unloaded during the time domain of the regulation service if there were no capacity constraints (unlimited capacity); it is a measure of regulation speed, expressed in MW so that it can be in the same terms as the capacity bid.
2) $\hat{c}_i / C_i$ is a capacity factor that prorates the expected mileage based on the capacity the resource makes available in the market compared to its full certified amount. This term provides incentives, particularly for fast-ramping resources, to maximize their capacity bid quantity, guarding against a scenario where fast-ramping resources can withhold

capacity while reaping the benefits of their relatively higher expected mileage versus slower resources.

3) η_i is the monthly average of the resource regulation accuracy. This term provides incentives for resources to attain and maintain high accuracy in providing regulation, thereby improving the quality of the service.

The ISO will calculate the historical accuracy monthly, based on a thirty day simple average of 15 minute accuracy measurements. The ISO will use the monthly accuracy value for each individual resource during the calendar month for all market intervals in which the resource submits a regulation capacity bid. In the event that no mileage occurs in a fifteen minute interval, the ISO will not include the 15 minute interval in calculating the resource's historical accuracy. In the event that a resource has not provided regulation over the past thirty days, the ISO will use the ISO's system wide accuracy as the initial adjustment factor. The ISO will calculate separate historical accuracy for both regulation up and regulation down. The same historical accuracy will be used for the measurement of the minimum performance threshold outlined in Section 8.4.

6.3 Bidding Rules for Mileage

Resources must submit separate mileage bids for regulation up and regulation down. Scheduling coordinators may not submit a mileage quantity. Instead, the calculated mileage multiplier will be used for all resources and applied to the regulation capacity offered. If a resource does not submit a mileage bid when submitting a regulation capacity bid, the ISO will generate a default mileage bid of $0.00 for the resource.

The minimum bid for mileage is $0.00 which is consistent with the minimum bid for regulation capacity (negative bids are not allowed). The ISO is proposing a maximum mileage bid price of $50.00. The ISO's current maximum ancillary service bid price is $250.00.[8] For purposes of establishing the maximum mileage bid price, the ISO assumed a mileage multiplier of 5 and divided the current $250.00 regulation capacity maximum bid price accordingly. In addition, since mileage and capacity will be priced at the shadow price of the individual constraints, the ISO proposes a scarcity price for mileage of $55.00. The ISO will reassess the level of the maximum mileage bid price and scarcity price as part of the review it intends to conduct as discussed in Section 9.

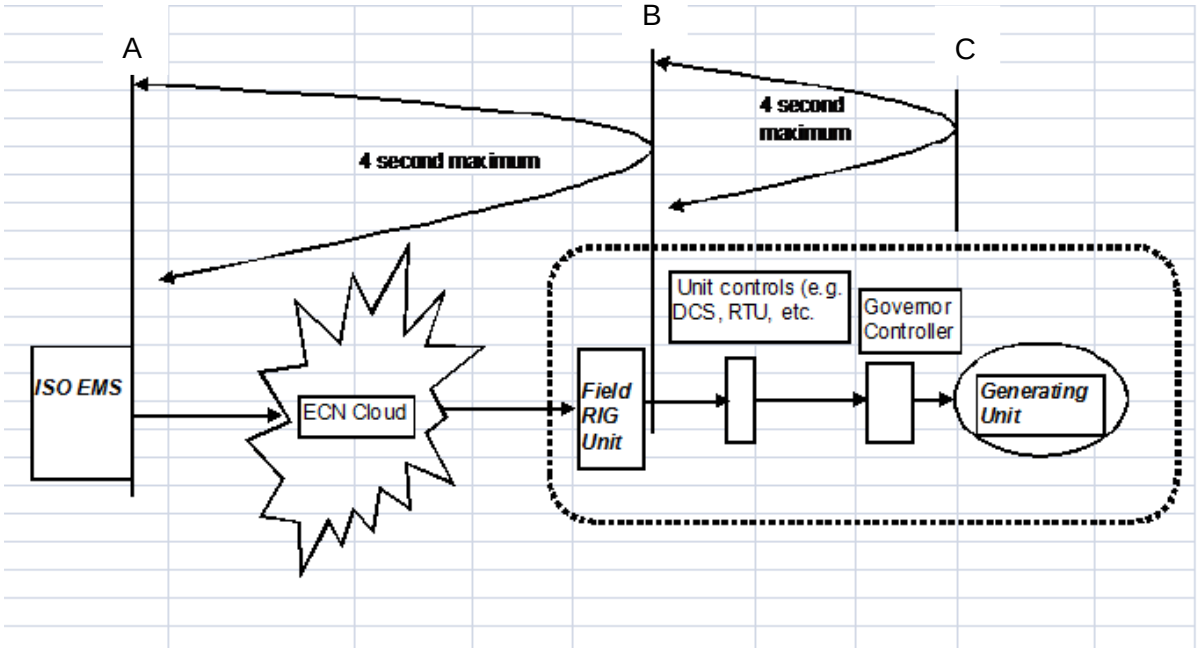
7 Mileage Performance Adjustments

Under this proposal, the ISO defines mileage as the absolute change in AGC set points between 4 second intervals. Accuracy is the absolute value of actual telemetry compared to the AGC set point in a given regulation interval. Thus, the ISO will consider positive and negative deviations equally in assessing the accuracy of the resource's response to AGC. The accuracy adjustment will be determined for each 15 minute interval. For each 15 minute interval, the ISO will reduce the resource's mileage in the 15 minute interval by the sum of under response adjustments to determine the quantity of actual mileage. The ISO will calculate the accuracy adjustment as the sum of AGC set points less the 15 minute sum of deviations from the AGC set point, and then divide that sum by the sum of the AGC set points. This percentage value is the accuracy of the resource's performance as compared to AGC set points. The ISO will apply this percentage to reduce any mileage payment for the 15 minute interval.

[8] ISO tariff section 39.6.1.3

Several stakeholders have requested clarification regarding data latency and the timeframe for receiving AGC signals, acknowledging receipt, and actual telemetry. As Figure 1 illustrates, the roundtrip duration is eight seconds from when the ISO sends the AGC signal and when the ISO receives actual telemetry data from the resource.[9] For purposes of calculating accuracy adjustments, the ISO will compare the AGC signal sent at point A to the telemetry data received from point C.

Figure 2 - Timing of Telemetry Data for Resources



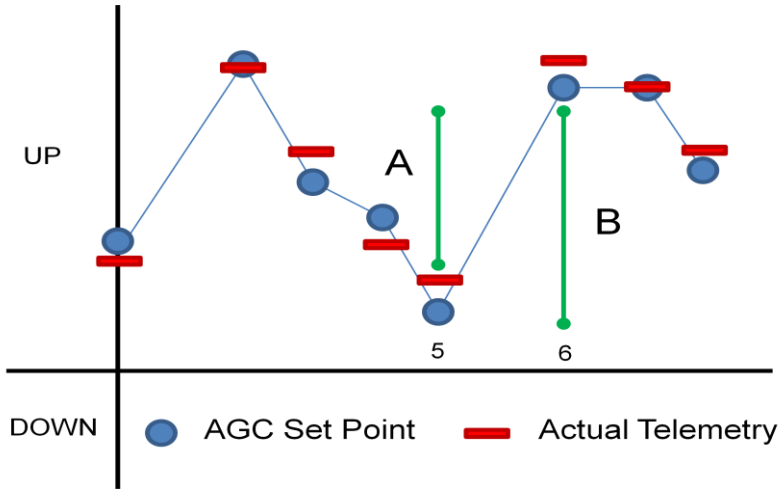
The ISO posted a spreadsheet on the website with the straw proposal for this initiative that provided actual hourly data and the calculation of the under response adjustment and accuracy adjustment. In order to align day-ahead and real-time regulation settlement, the ISO is proposes to calculate mileage and accuracy for each 15 minute interval.

7.1 Under Response Adjustment

Since a resource's mileage is based on changes in AGC set points, the ISO is proposing to adjust the mileage when the resource under-responds in the prior interval when the direction of the AGC signal changes. In Figure 2 below, the resource under responds to the AGC set point in interval 5. Because the direction of the regulation signal changed, the appropriate mileage is represented by bar A, since the resource's movement towards the AGC set point in interval 6 was achieved as a result of under responding to the AGC set point in interval 5. If mileage was calculated simply as the delta between AGC set points as illustrated by bar B, the resource would receive an overpayment for mileage. Under this proposal, the resource will not receive mileage compensation that results from deviating from the prior interval's AGC set point.

[9] Additional information is available in the Direct Telemetry Business Practice Manual at https://bpm.caiso.com/bpm/bpm/version/000000000000158

Figure 3 – Example of Under Response and need to adjust mileage calculation



7.2 Response Accuracy to AGC Set Point Adjustment

The ISO proposes to measure the accuracy of a resource's response to AGC as the absolute value of the difference between the AGC set point and actual telemetry for each 4 second regulation interval. On a 15 minute basis, the ISO will sum a resource's AGC set points for each 4 second regulation interval. The ISO will then sum the total deviations from the AGC set point for each 4 second regulation interval. The sum of AGC set points less the sum of total deviations bounded by zero will then be divided by the sum of AGC set points. The resulting performance percentage will reflect the accuracy of the resource in responding to AGC set points for the fifteen minute interval. The accuracy percentage value can range from 0 to 100 percent. The accuracy percentage is then applied to the mileage payments based upon the actual mileage times the mileage marginal clearing price. The mileage payments will be reduced based on the resource's accuracy in responding to AGC.

The ISO is not proposing a dead band by which a resource would be considered to have met the AGC set point. For example a 5% bandwidth, would assume that if a resource was within 95% or 105% of the AGC set point, the resource would be assumed to be 100% accurate. The ISO believes calculating the actual deviations without a dead band will provide better market transparency, which resources can more efficiently incorporate within their mileage bids over time.

7.3 Examples

The following two tables illustrate the calculation of the under-response adjustment, accuracy adjustment, and actual mileage. Since the accuracy adjustment is 90%, if the mileage price was $0.50, the resource would be paid at $0.45 for its actual mileage (instructed mileage less under-response adjustment) of 88 MW mileage.

Table 3 - Regulation Up Range

	Regulation Interval (4 Seconds)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
AGC Set Point (MW)	10	15	12	18	10	15	12	21	10	15	12	18	10	7	15	200
Mileage Expected	10	5	3	6	8	5	3	9	11	5	3	6	8	3	8	93
Under-Response Adjustment	0	0	-1	0	0	0	-1	0	-2	0	-1	0	0	0	0	-5
Actual Mileage	10	5	2	6	8	5	2	9	9	5	2	6	8	3	8	88
Actual Telemetry	9	14	11	19	10	14	11	19	7	14	11	22	10	10	14	195
Deviation	1	1	1	1	0	1	1	2	3	1	1	4	0	3	1	21

Accuracy Adjustment 90%

Table 4 - Regulation Down Range

	Regulation Interval (4 Seconds)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
AGC Set Point (MW)	-10	-15	-12	-18	-10	-15	-12	-21	-10	-15	-12	-18	-10	-7	-15	-200
Mileage Expected	10	5	3	6	8	5	3	9	11	5	3	6	8	3	8	93
Under-Response Adjustment	0	0	-1	0	0	0	-1	0	-2	0	-1	0	0	0	0	-5
Actual Mileage	10	5	2	6	8	5	2	9	9	5	2	6	8	3	8	88
Actual Telemetry	-9	-14	-11	-19	-10	-14	-11	-19	-7	-14	-11	-22	-10	-10	-14	-195
Deviation	1	1	1	1	0	1	1	2	3	1	1	4	0	3	1	21

Accuracy Adjustment 90%

Since the ISO procures separate capacity for regulation up and regulation down, the mileage and accuracy calculations are distinct for each direction. There can be instances where a resource has been awarded both regulation up and regulation down and receives an AGC set point which moves the resource from the regulation up range to the regulation down range. For example, assume a resource's AGC set point was 25 MW in interval 1 and negative 10 MW in interval 2, the resource would receive mileage of 25 MW at the regulation up mileage price and 10 MW at the regulation down mileage price. If the resource's actual telemetry in interval 2 was 3 MW, the calculation of the accuracy adjustment for the regulation up deviation would be 3 MW and the regulation down deviation would be 10 MW. If the resource's actual telemetry in interval 2 was negative 4 MW, the regulation up deviation would be 0 MW and the regulation down deviation would be 6 MW.

7.4 Treatment of Real-Time Awards

The ISO procures incremental regulation in the real-time market during real-time unit commitment. Regulation procured in the real-time market is for 15 minute intervals. Since both the regulation capacity and mileage prices can differ between day-ahead and real-time, a method is needed to establish a single mileage price for the 15 minute interval. If a resource is awarded incremental regulation in the real-time market, the mileage price for that 15 minute interval will be the weighted average price of both the day-ahead and real-time mileage clearing price. For example, if a resource was awarded 80 MW of regulation in the day-ahead market with a mileage clearing price of $1.00 and awarded 20 MW of regulation in the real-time market with a mileage clearing price of $2.00, the mileage price for the resource in the 15 minute interval for which it was awarded regulation in the real-time market would be $1.20. If the resource was not awarded incremental regulation capacity the mileage price for the resource would remain at $1.00. If the resource did not have a day-ahead award, the mileage price for the resource is based solely on the real-time mileage clearing price, or $2.00.

8 Other Design Elements

8.1 Mileage Cost Allocation to Ancillary Service Obligations

Similar to regulation capacity, mileage payments made to resources will be allocated to regulation up and regulation down ancillary service obligations.[10] Mileage in the regulation up range will be allocated to regulation up ancillary service obligations. Mileage in the regulation down range will be allocated to regulation down ancillary service obligations. The reduction in mileage payments resulting from the accuracy adjustments will reduce allocated regulation costs.

SCE requested that the ISO address potential changes in the cost allocation of regulation through this initiative. The ISO, however, intends to examine guiding principles for cost allocation in a separate initiative. The ISO intends to apply any adopted guiding principles on cost allocation to the flexible ramping product in the first instance. The second phase of this the cost allocation initiative will examine the application of any adopted guiding principles across all ISO products, including regulation.

8.2 Missing Accuracy Data

In the event of lost accuracy data, the ISO will use the simple average of the resource's previous ten 15 minute accuracy percentages for the periods of missing data for settlement purposes. The ISO will not include the 15 minute intervals with missing accuracy data to calculate the resource's historical accuracy in order to determine its adjusted regulation cost or to assess the minimum performance threshold. It should be noted that a resource which stops responding to AGC set points will be subject to rescission of capacity payments for regulation and disqualification for purposes of any mileage payments.

8.3 Disqualification of Mileage Payments

If a resource is disqualified to provide regulation capacity, the ISO will also disqualify any mileage payments for the period the resource is disqualified to provide regulation capacity. In the event that a partial disqualification occurs, the mileage payment for the same period shall be disqualified accordingly for the product of the disqualified regulation capacity, the mileage multiplier and the mileage price.

8.4 Minimum Performance Threshold for Regulation Certification

Since the ISO is now collecting accuracy information for resources providing regulation, the ISO proposes to establish a minimum performance threshold. If a resource violates the minimum performance threshold, the resource will have ninety days to re-certify to provide regulation. If the resource does not re-certify within the ninety days, the ISO will change the Master File to reflect that the resource is no longer certified to provide regulation.

The minimum performance threshold will initially be set at 50% accuracy for both regulation up and regulation down. If a resource has a simple average of 15 minute interval measured accuracy of less than 50% in any calendar month, the resource must re-certify within ninety days. The ISO will provide written notice to the scheduling coordinator if a resource falls below the minimum performance threshold. In the event a resource falls below the minimum

[10] A Scheduling Coordinator's hourly obligation for Regulation Down and Regulation Up is calculated pursuant to Section 11.10.2.1.3 and 11.10.2.2.2, respectively.

performance threshold for one regulation service (e.g. regulation down), the resource will only be required to re-certify to provide that regulation service (in this example, regulation down). The minimum performance threshold may change as the ISO gains more experience once the ISO implements pay for performance regulation. The ISO will review potential changes after one year of operational data and will propose any changes if needed as part of the study outlined in Section 9.

8.5 Ramp Certification for Regulation

Currently the ISO tariff Appendix K Part A1.1.2 determines the maximum regulation capacity that a resource may offer as the amount reached within a period that may range from a minimum of 10 minutes to a maximum of 30 minutes, as such period may be specified by the ISO. The ISO proposes to standardize the duration of the ramping interval to 10 minutes. Regulation up will continue to cascade to spinning reserves and non-spinning reserves when the expected cost of regulation up is economic to do so. Using the 10 minute ramp, the certification process will use the same ramp measurement interval for regulation, spinning reserves and non-spinning reserves.

8.6 Bid Cost Recovery

Mileage revenue for instructed AGC signals will be included in bid cost recovery (BCR) in the same manner as regulation capacity is included in BCR calculations. The mileage accuracy adjustments will not be included in BCR. Otherwise, a poor performing resource could be eligible for bid cost recovery because its mileage revenue was reduced because of its poor performance. The following are the formulas for BCR revenue and BCR cost:

BCR Revenue = Capacity Price x Award + Mileage Price x Instructed Mileage

BCR Cost = Capacity Bid x Award + Mileage Bid x Instructed Mileage

In addition, if a resource was awarded regulation in the day-ahead market and awarded additional regulation in real-time unit commitment, the mileage revenue will be segmented between day-ahead BCR and real-time BCR based upon the relative weights of the regulation capacity awards. For example a resource has instructed mileage of 500 and received an 80 MW day-ahead award and an incremental 20 MW in real-time unit commitment, then the resource's day-ahead BCR instructed mileage would be 400 and real-time BCR instructed mileage would be 100. As discussed in Section 7.4, the mileage price will be the weighted average price for the fifteen minute interval.

8.7 Data Release

The ISO will publish on OASIS the mileage price, mileage multiplier and actual mileage.

8.8 Grid Management Charge

Pursuant to ISO tariff section 11.2.5, mileage bids will be subject to the $0.005 bid segment fee.[11] The ISO previously proposed that the market services charge be applied to awarded mileage. Since the awarded mileage is not settled, but the actual mileage is settled, the ISO does believe it is appropriate to apply the market service charge to mileage. All resources will

[11] Regulation capacity is only allowed one bid segment. *See*, ISO tariff section 30.5.2.6. Mileage bids will also only include one bid segment.

still be subject to the market services charge for regulation capacity which is currently $0.0851per MW.

8.9 Market Power Mitigation

FERC Order 755 requires RTOs and ISOs either to submit tariff provisions for market power mitigation methods appropriate to their redesigned frequency regulation markets or explain how their current mitigation methods are sufficient to address market power concerns. Since the mileage award is co-optimized with regulation capacity and energy, the ISO believes current market power mitigation method is sufficient to address market power concerns.

9 Conduct Review after 1 Year Operation Experience

The ISO proposes to conduct an operational review based on one year of data after pay for performance regulation reaches production. Since many design elements of this proposal are based upon historical data, the ISO believes it is prudent to evaluate the design and determine if any modifications are necessary. One year of operational data will be used to evaluate the ISO's design, including, but not limited to, the appropriateness of the minimum performance threshold level, the historical data used to calculate the mileage multiplier, whether the regulation capacity procurement target should reflect historical accuracy of resources, the level of the mileage maximum bid price and mileage scarcity price, and the change in resource participation in regulation under the new compensation mechanism.

10 Next Steps

The ISO plans to discuss the draft final proposal with stakeholders during a conference call on February 15. The ISO requests comments from stakeholders on the proposed market design described in this draft final proposal. The ISO specifically requests stakeholder comments on any concerns with delaying implementation of this market enhancement until the spring of 2013. Based on current market enhancements scheduled to go into production in the fall of 2012 and the market system changes necessary to design, test and implement a performance payment for regulation pursuant to Order 755, the ISO currently intends to request authority to implement a performance payment for regulation in the spring of 2013. Stakeholders should submit written comments by February 27 to PFPRegulation@caiso.com