Frequency Response

Draft Final Proposal

February 4, 2016

Table of Contents

1. Introduction

On January 16, 2014, the Federal Energy Regulatory Commission (FERC) approved[1] Reliability Standard BAL-003-1[2] (Frequency Response and Frequency Bias Setting), submitted by the North American Reliability Corporation (NERC). With approving this standard, NERC created a new obligation for balancing authorities (BAs), including the ISO, must demonstrate they have sufficient frequency response to disturbances resulting in the decline of system frequency. The purpose of this initiative is to ensure the ISO provides sufficient primary frequency response (PFR) to support system reliability and complies with the new NERC requirement.

Compliance with BAL-003-1 will begin December 1, 2016.[3] NERC has established a methodology for calculating frequency response obligations. NERC determines a BA's obligation by first determining the interconnection frequency response obligation (IFRO) as a whole and then assigning a share to each BA based on its share of the total generation and load of the interconnection.

To assess each BA's performance, annually NERC will select at least 20 events within the year and measure the BA's response to each disturbance in units of MW per 0.1 Hz deviation in frequency. The median of these responses will be the balancing authority's frequency response measure (FRM) for the year. This measure will be compared with the BA's frequency response obligation (FRO) to determine whether the BA has complied with the requirement.

A BA's compliance with its FRO is based on actual frequency response performance, rather than merely having frequency response capability available. The standard requires the ISO to demonstrate the BA provided sufficient frequency response during frequency disturbance events. To respond to unpredictable frequency events, the ISO must design market mechanisms that ensure sufficient frequency response is available to meet the ISO's share of WECC's obligation whenever such an event occurs.

This paper describes the ISO's draft final proposal to ensure sufficient primary frequency response capability will be available to enable the ISO to comply with the BAL-003-1 standard. The ISO proposes several tariff changes related to requirements for participating generators' to enable governors (Section 7.2.2), data collection procedures (Section 7.2.2), authority for the ISO to treat day-ahead procured operating reserve as contingency only in the real-time market regardless of the resource's election (Section 7.2.3), and authority for the ISO to procure transferred frequency response from external BAs (Section 7.2.1). A second phase of this initiative will evaluate more comprehensive market solutions to procure frequency response such as a market product.

[1] See FERC Order No. 794 Docket No. RM13-11-000
[2] See Reliability Standard BAL-003-1
[3] The standard goes into effect on April 1, 2016, but NERC will not begin measuring compliance until December 1, 2016.

2. Changes to proposal

The ISO made the four following revisions to its straw proposal in this draft final proposal.

In Section 7.2.1, the ISO is not proposing to increase its ancillary service procurement under its near-term solutions. Instead, the ISO proposes to procure transferred frequency response (TFR) from external BAs.

In Section 7.2.4, the ISO is not proposing introducing performance requirements on generators under Phase 1. Under Phase 2, the ISO will evaluate performance requirements in coordination with a market mechanism.

In Section 7.2.5, the ISO is not proposing tariff revisions to address the allocation of any BAL-003-1 penalties since section 14.7 of the tariff currently includes a process for allocating reliability penalties.

The ISO adds Section 7.2.6 to propose the ISO monitor and report its BA PFR performance.

Further, the ISO added the following elements to the paper:

- In Section 4.2, ISO include additional tariff language from tariff section 8.4.4.
- In Section 5.1, ISO updated its performance analysis from 2012 – 2016 and to follow the manner it will report and be evaluated on its single event frequency response data (SEFRD) performance for compliance with BAL-003-1.
- In Section 5.3, ISO adds section to inform stakeholders of its findings after completing its resource outreach efforts assessing resource-level PFR performance.
- In Section 7.3, ISO requests input on frequency response product definition options.
- Appendix B contains figures from ISO's transmission planning studies.
- Both technical appendix and comment summary matrix added to the Draft Final Proposal as appendices.

3. Stakeholder Process and Timetable

The ISO will present its proposal developed through this initiative at the March 2016 ISO Board of Governors meeting. The current schedule for the policy stakeholder process leading up to this Board of Governors meeting is below.

Milestone	Date
Issue Paper Posted	Friday, August 7, 2015
Stakeholder Call	Thursday, August 13, 2015
Stakeholder Written Comments Due	Thursday, August 27, 2015
Straw Proposal Posted	Monday, October 12, 2015
Stakeholder Call	Monday, October 19, 2015
Stakeholder Written Comments Due	Tuesday, November 3, 2015
Working Group Call	Monday, December 14, 2015
Stakeholder Written Comments Due	Monday, January 4, 2016
Draft Final Proposal Posted	Thursday, February 4, 2016
Stakeholder Call	Tuesday, February 9, 2016
Stakeholder Written Comments Due	Tuesday, February 23, 2016
Board of Governors Meeting	Thursday, March 24, 2016 - Friday, March 25, 2016

4. The New Frequency Response Obligation

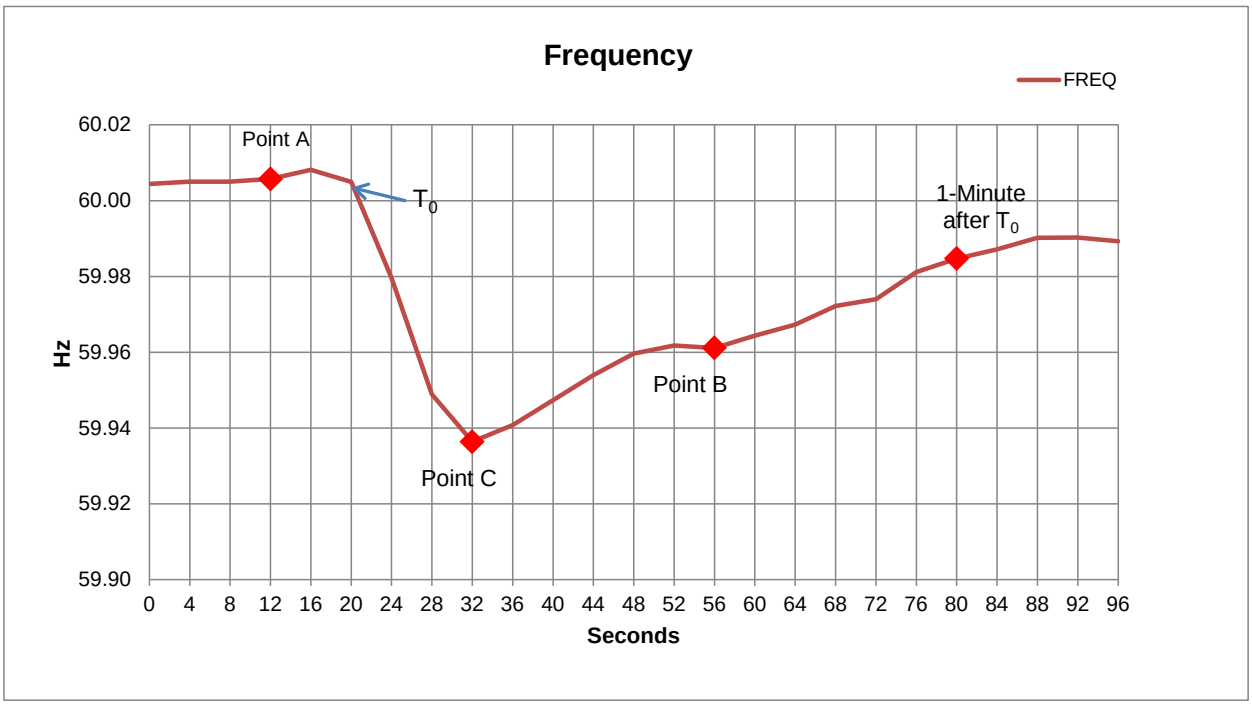
4.1. Frequency Response Standard

The new frequency response standard will require each BA to achieve a Frequency Response Measure (FRM) that meets its FRO starting in the 2017 compliance period (i.e. December 2016 through November 2017). Each BA's FRO will be a share of the IFRO, which reflects the minimum frequency response for WECC to maintain reliability and avoid tripping load through the under frequency load shedding (UFLS) threshold of 59.5 Hz.

Figure 1 below illustrates a generic system frequency event caused by a contingency event such as losing a large generating facility. Pre-event period (Point A) represents the system frequency prior to the event, arrested point (Point C) the lowest level to which system frequency drops because of the event, and event recovery period (Point B) the level to which system frequency recovers in less than a minute because of the PFR action. PFR is the automatic,

autonomous response of generating facilities equipped with governors or equivalent control systems to a change in frequency. With a drop in system frequency, shown in Figure 1, such generators directed by their governors will increase their output within seconds to restore system frequency. The BAL-003-1 standard, and this ISO initiative, focuses on how the interconnection and its member Balancing Authority Areas (BAAs) respond to restore frequency within the first minute after a frequency event i.e. the response between Point A and Point B.

Figure 1: Illustration of Primary Frequency Response



NERC determined WECC's IFRO[4] based on the largest potential generation loss, the loss of two Palo Verde generating units (2,626 MW).[5] NERC allocates this IFRO to each BA in the interconnection based on each BA's portion of the interconnection's annual generation and annual load. For this initiative, the ISO is using 30% as a conservative estimate of the ISO's share of WECC's IFRO. NERC will use data collected by the Federal Energy Regulatory Commission on Form 714, Annual Electric BAA and Planning Area Report, as the basis for determining the individual obligation for each BA.[6] FERC requires BAA's to report annually their electric generation and load on this form. Once NERC receives each BA's FERC Form 714,[7] NERC will calculate the total WECC generation and load and allocate to each BA its individual obligation (its FRO) based on its share of WECC's annual generation and load. The BA will

[4] WECC's FRO takes into consideration Arizona Public Service's remedial action scheme, which drops 120 MW of load for this outage.
[5] 2015 Frequency Response Annual Analysis.
[6] NERC will use Part II – Schedule 3, Balancing Authority Area Net Energy for Load and Peak Demand Sources by Month data for annual BAA generation and annual energy for load.
[7] BAs not required to submit FERC Form 714 will submit calculations for these values to NERC consistent with FERC Form 714.

receive its FRO in October 2016 for the 2017 compliance period from December 1, 2016 through November 30, 2017.[8]

In Table 1, the ISO estimates its ISO FRO expressed in MW/0.1Hz. To estimate the amount expressed in MW/0.1Hz, the ISO uses a conservative value of 30% for the portion of WECC annual generation and load so that its estimated FRO is 30% of WECC's IFRO at 858 MW/0.1Hz obligation. The estimated FRO is 258 MW/0.1Hz. Depending on the actual size of a frequency deviation, the ISO's actual frequency response expressed in MW will change to reflect this fluctuation.[9] While the actual frequency response (MW) varies, the ISO will be evaluated for compliance with this standard based on the conversion of the actual frequency response to its MW/0.1Hz unit compared to a constant FRO expressed in MW/0.1Hz.

Table 1: ISO FRO Estimate[10]

California ISO's Estimated Requirement	2016 FRO	Units
Western IFRO	858	MW/0.1Hz
Estimated ISO FRO	258	MW/0.1Hz

For a detailed explanation see the technical appendix.

NERC created its standard to ensure BAs have sufficient frequency response capability on hand. The ISO must plan on having an adequate amount of frequency response capability available to respond to actual frequency events.

Each year NERC requires BAs to report performance measurements for each of at least 20 frequency events chosen by NERC across the compliance period to evaluate whether the ISO and other BAs have complied with their obligation to respond to frequency disturbance events. NERC could select 2 or 3 events in each month to make up a sample size of between 24 and 36 events. The ISO's performance measurement reported for each event will be the difference between the net actual interchange measurements for the ISO BAA per 0.1 Hz drop in frequency during the recovery period and the net actual interchange measurements during the pre-event period. This value is the Single Event Frequency Response Data (SEFRD). [11] This value will reflect any changes in tie line flow resulting from resource output changes that occur to balance system frequency.

The standardized metric used to evaluate each BA's performance is the ratio of its Frequency Response Measure (FRM) and its FRO in MW/0.1Hz. For BAL-003-1 Requirement 1, FERC

[8] For the 2016 compliance period received October 2015, ISO's share for requirements 2 – 4 is 23%.
[9] For example, if the frequency deviation is 0.292 Hz between Point A and Point B the ISO's measured frequency response needed to meet the FRO would be 752 MW.
[10] 2015 Frequency Response Annual Analysis.
[11] Single Event Frequency Response Data (SEFRD) is the individual sample of the event selections and actual performance measurements data from a Balancing Authority which represents the change in Net Actual Interchange (NIA), divided by the change in frequency, expressed in MW/0.1Hz.

approved a violation risk factor (VRF) of high and four violation severity levels (VSL). The combination of VRF and VSL will inform the financial penalty NERC may assess a BA for failing the annual compliance assessment. A high violation risk factor means that FERC considers BAL-003-1 a high-risk because without sufficient PFR a frequency decline may not be arrested in time to prevent instability, uncontrolled separation or cascading failures.[12]

4.2. Other Standards or Requirements

Existing requirements are in place today to require a standard of frequency response capability for generator owners with governor function. WECC's Governor Droop Regional Criterion[13] requires generating units that have governor function to set their droop settings between 3 and 5 percent. The ISO tariff contains provisions requiring participating generators to follow NERC and WECC standards or criterion such as the WECC Governor Droop Regional Criterion. The tariff sections are:

- ISO tariff section 4.6.5.1 states: "Participating Generators shall, in relation to each of their Generating Units, meet all Applicable Reliability Criteria, including any standards regarding governor response capabilities, use of power system stabilizers, voltage control capabilities and hourly Energy delivery. Unless otherwise agreed by the ISO, a Generating Unit must be capable of operating at capacity registered in the ISO Controlled Grid interconnection data, and shall follow the voltage schedules issued by the ISO from time to time."
- Appendix A to the ISO tariff defines Applicable Reliability Criteria to mean: "The Reliability Standards and reliability criteria established by NERC and WECC and Local Reliability Criteria, as amended from time to time, including any requirements of the NRC."

There are other tariff provisions requiring resources providing spinning reserves to respond to frequency deviations. These tariff provisions include:

- ISO tariff section 8.4.4 states: "The providers of Spinning Reserve and Non-Spinning Reserve under this CAISO Tariff must comply with the following availability standards. Each Ancillary Service Provider shall ensure: (i) that its resources scheduled to provide Spinning Reserve and Non-Spinning Reserve are available for Dispatch throughout the Settlement Period for which they have been scheduled; and (ii) that its resources scheduled to provide Spinning Reserve are responsive to frequency deviations throughout the Settlement Period for which they have been scheduled."
- Appendix K, Part B 1.2 to the ISO tariff requires resources having governor controls certified to provide spinning reserve to respond immediately and automatically in proportion to frequency deviations through the action of a governor with the following minimum governor performance requirements:
    - 5 percent droop;
    - +/- 0.036 Hz deadband; and

[12] 18 CFR Part 40 Final Rule at 59.
[13] WECC Governor Droop Setting Regional Criterion

  - Power output changes in one second for any frequency deviation outside of the deadband.
- Appendix K, Part B 1.2 to the ISO tariff requires resources without governor controls certified to provide spinning reserve to provide primary frequency response through the action of other controls with the following minimum frequency responsive device performance requirements:
  - If frequency is less than or equal to 59.92 Hz, the resource must reach ten (10) percent of its awarded spinning capacity within eight (8) seconds.
  - The resources must change the power it delivers or consumes in one (1) second if system frequency is less than or equal to 59.92 Hz.

5. Current ISO Frequency Response Capability

5.1. Current Frequency Response

The ISO analyzed its historical PFR as the change in net actual interchange between Point B and Point A given the change in frequency between Point B and Point A, in other words the ISO's performance in MW/0.1Hz. The ISO updated its analysis to follow the manner it will report and be evaluated on its single event frequency response data (SEFRD) performance for compliance with BAL-003-1. The SEFRD data was analyzed relative to an estimated BA FRO of 258 MW/0.1Hz.[14]

For 111 frequency events from January 4, 2012 through January 3, 2016, the ISO's average performance was 224 MW/0.1Hz with a median of 218 MW/0.1Hz. With a 25th percentile of 153 MW/0.1Hz, the ISO could reasonably expect its performance to exceed 153 MW/0.1Hz.

The ISO reviewed its performance trend year over year and observed increasingly poor performance. As Shown in Table 2, the ISO observed a deterioration of its performance year over year where its median performance has steadily decreased from 263 MW/0.1Hz in 2012 to 184 MW/0.1Hz for the 2015 compliance period. Table 2 shows the PFR shortfall on average for an event increased to roughly 100 MW/0.1Hz on average for 2015 relative to a surplus in 2012.[15]

Table 2: ISO's Annual Performance Trend

		FRO (MW/0.1Hz)		Actual Frequency Response (MW/0.1Hz)		Shortfall ΔMW (FRO-FR)
Compliance Period	N	2016	Annual	Minimum	Median	Average
2012	27	258	252	56	262.77	-13
2013	26	258	252	95	209.52	24
2014	33	258	285	60	218.80	60

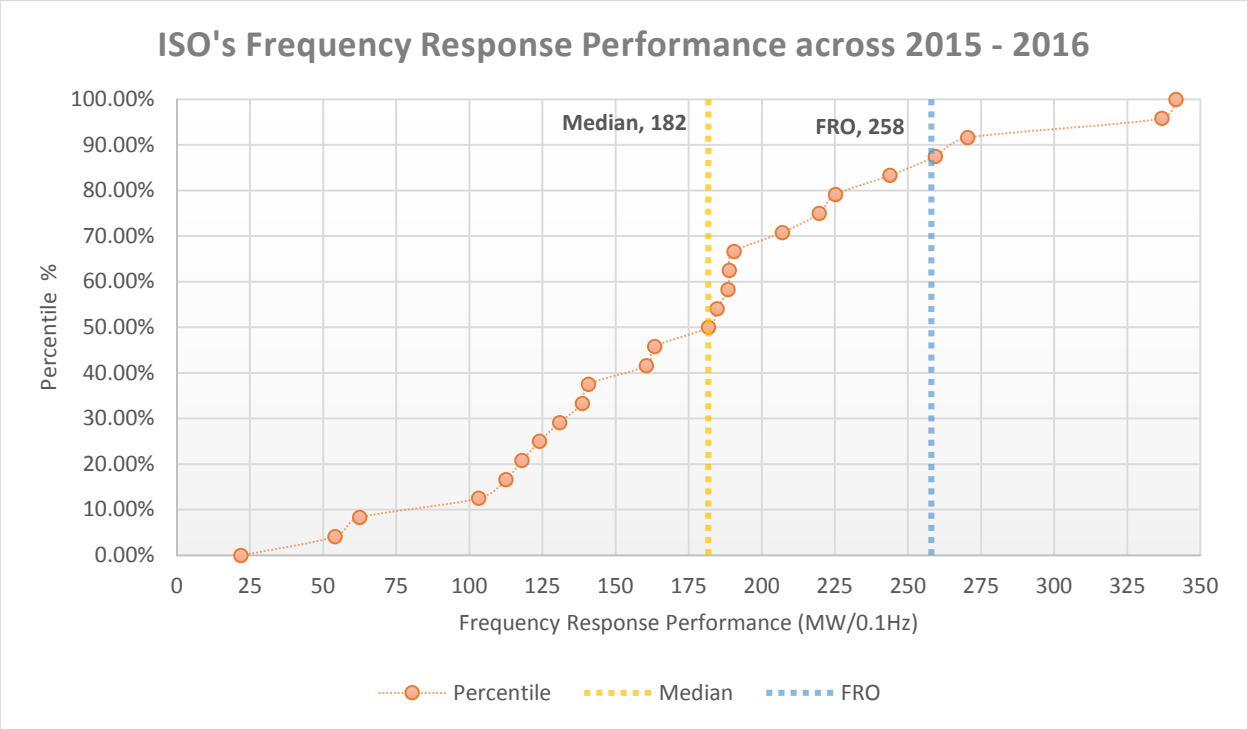
[14] Assumes conservative 30% share of WECC's IFRO.
[15] PFR shortfall or surplus is respectively the MW/0.1Hz amount the PFR performance rate either does not meet or exceeds the FRO.

2015	24	258	272	22	184.71	96
2016	1	258	258	141	140.78	117

Operations identified the main driver of this trend is largely the result of the increased proportion of renewable generation. Renewable generation amounts will continue to increase as California reaches its renewable goals. Given this trend, the ISO finds its projected performance insufficient to meet BAL-003-1 or support system reliability. Phase 2 of the initiative will evaluate a market mechanism to ensure sufficient primary frequency response performance in long-term.

The ISO isolated the 25 events during 2015 and January 2016 to assess its PFR performance over this period. Only 4 out of 25 events performance met the FRO of 258 MW/0.1Hz. During this timeframe, the ISO's average performance dropped to 174 MW/0.1Hz with a median of 182 MW/0.1Hz. Figure 2 shows the ranked single event performance data (MW/0.1Hz) relative to the ISO's estimated FRO (MW/0.1Hz). This data suggests the ISO's performance is unlikely to have met requirement 1 under BAL-003-1.

Figure 2: ISO's Frequency Response Performance 2015 - 2016



Given these results, the ISO estimates its median PFR performance rate may fall short of its FRO by as much as 100 MW/0.1Hz.[16]

[16] Estimate subject to revision

5.2. Performance Drivers

While PFR is an autonomous response driven by controls at the power plant level, it is an essential function which if not supported at that level has impacts on the entire BA's ability to provide sufficient PFR. As the balancing authority, the ISO must ensure sufficient PFR capability is available to meet the requirements of BAL-003-1.

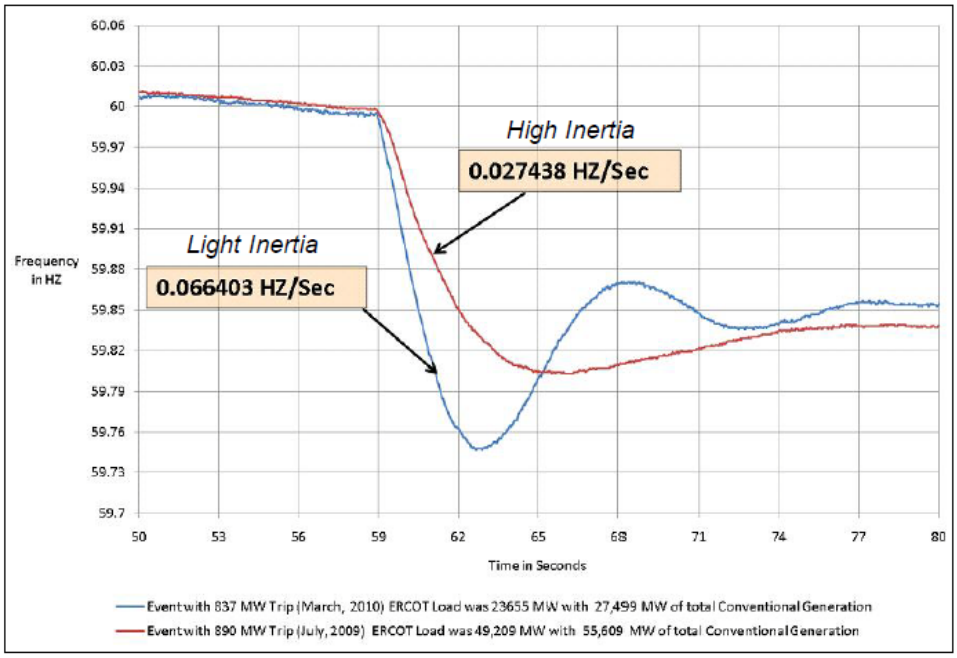
The main drivers of PFR performance are (1) magnitude of frequency deviation[17], (2) amount of synchronous on-line capacity providing sustained PFR, and (3) headroom available from that connected on-line capacity.

5.2.1. Magnitude of frequency deviation

System inertia can dampen the potential magnitude of a frequency event. There is the potential for enhancing ISO performance by managing inertia levels, including mechanical loads on the system, and providing incentives for settings of length of time delay or size of deadbands for governors.

Figure 3 below is a simple illustration of the inertia effect[18] on the frequency excursion event. It can be seen that when there is lower inertia on the system the frequency excursion slope is steeper resulting in a deeper frequency dip and requiring more generation output to respond to the event.[19]

Figure 3: Inertial Response Sensitivity[20]



[17] For a detailed description see the technical appendix.
[18] See the Frequency Response Issue Paper at 5.
[19] Frequency Response Initiative Report – October 2012 at 40.
[20] Frequency Response Initiative Report – October 2012 at 40.

The magnitude of the frequency deviation, the change in frequency between Point A and Point C, is a function of the magnitude of the imbalance caused by the contingency event and system conditions such as system inertia, load damping, and generator governor response time delay settings. These inherent factors in combination with faster deploy of PFR can reduce the risk of the frequency dip reaching the under-frequency load shedding threshold so governor response can reverse the dip.

Besides inertia, the effects of load damping impact this slope.[21] System load will vary since synchronized mechanical loads and the power they consume are functions of system frequency. As frequency levels drop, so will the power needed by the mechanical load to drive the motor at this lower speed.[22] This results in motor-driven load's ability to provide frequency response.

The time delay or the deadband settings employed on governors will affect when the arrested point occurs during a frequency disturbance because the frequency dip will continue until the governors trigger the automatic response in the synchronized generation resources with governors. A deadband provides a range around the scheduled frequency where a governor response will not be triggered for minor disturbances.

The size of the frequency change affects which events are acceptable candidate events by NERC for evaluating the performance. Since the goal of sampling single events is to select the cleanest events of a sudden loss of generation (Point A-to-Point C) and there is an expectation that inertia levels will be lowest during light load periods, special consideration to frequency response performance during light load periods is crucial.

5.2.2. Types of control modes affecting plant-level response

Understanding the control modes used by participating generators may allow the ISO to increase PFR from these generators. The different plant-level controls influence the ability of synchronous resources to provide PFR include but are not limited to[23]:

(1) Non-responsive mode where the turbine control valves are wide open or are under the command of a controller that does not respond to grid frequency such as the exhaust temperature limiter of a gas turbine (i.e. temperature loop control) or the pressure controller of a steam turbine.
(2) Preselected load mode without frequency bias (i.e. outer loop MW control) where plant controller applies secondary commands to the governor speed-load reference to hold the plant at a prescheduled output without reference to grid frequency usually set at the dispatch operating target.
(3) Preselected load mode with frequency bias where controller applies secondary control commands to the governor speed-load reference to hold the plant at a prescheduled output with the prescheduled output being biased by deviation of grid frequency. In this

[21] See Technical Appendix.
[22] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-21.
[23] Power and Frequency Control as it Relates to Wind-Powered Generation, Ernest Orlando Lawrence Berkeley National Laboratory at 3-4.

mode, the turbine provides PFR on a sustained basis when frequency deviates until frequency settles and then it reverts to the prescheduled output.

(4) Load frequency control mode where the speed-load reference of the turbine is manipulated by signals from the load frequency control system of the BAA.

(5) Simple droop mode where the turbine autonomously provides PFR to the grid when the governor is triggered by a frequency disturbance but no automatic or dependable secondary response is provided.

While asynchronous resources do not operate with governors, these resources have inverter-based control systems. There is a lack of standardization for these control systems as opposed to the standards guiding synchronous generators. The bulk power system is in the early stages of establishing nation-wide or Interconnection-wide requirements or operational expectations for asynchronous resources

The ISO requires any interconnection customers of inverter-based resources to install inverters programmed with frequency ride-through settings and is exploring adopting generator power management controls. The ISO proposes continued evaluation of whether asynchronous resources may also provide frequency response capabilities, especially during periods of light load with a large amount of asynchronous resources operating.

For example, in the ISO's Final Report for Assessment of Visibility and Control Options for Distributed Energy Resources[24] (DER), the ISO stated it expects these resources to have minimal frequency response capabilities since most will be inverter-based systems. But this expectation could change based on inverter technologies, regulatory rules or market design. If either market product or interconnection requirements were added to the ISO market design, developers said distribution connected storage, EV charging, and feeder connected PV installations could be developed to provide degree of PFR.[25]

5.2.3. Dispatching the connected on-line capacity so that headroom is available

Resources that are fully loaded, are transitioning between configurations of multi stage generators, or have recently received a dispatch operating target in the opposite direction may provide no frequency response during a disturbance and at worst continue to remove output from the system depending on the time it requires the unit to turn its movement from downward ramping to upward ramping.

[24] For purposes of this initiative, the ISO uses the term "distributed energy resource" or "DER" to mean any distribution connected resource, regardless of size or whether it is connected behind or in front of the end-use customer meter. "Distribution connected" means connected to distribution facilities controlled by a distribution utility, regardless of voltage level, and served by the ISO grid. Examples of distributed energy resources include generation such as rooftop solar, energy storage, plug-in electric vehicles, and demand response.

[25] Final Report for Assessment of Visibility and Control Options for Distributed Energy Resources at 101-102.

The Western Interconnection is seeing increased amounts of inverter-based non-synchronous variable energy resources (VERs) in wind, photovoltaic (PV), and distributed energy resources.[26] The penetration of non-conventional, asynchronous resources and the subsequent displacement of conventional, synchronous resources with active governor control results in reducing the system inertia levels and frequency responsive headroom respectively due to less kinetic energy provided from non-rotating mass and non-frequency responsive generation online increasing.

The Western Wind and Solar Integration Study Phase 3 – Frequency Response and Transient Stability: Executive Summary study released by National Renewable Energy Lab in December 2014 describes the expected impacts of this penetration, "The loss of system inertia associated with increased wind and solar generation is of little consequence for up to at least 50% levels of instantaneous penetration for the Western Interconnection as long as adequately fast primary frequency responsive resources are maintained".[27]

According to both NREL and Ernest Orlando Lawrence Berkeley National Laboratory, the potential for the penetration of non-conventional resources to impact the headroom available from on-line capacity is a concern.[28] Solar facilities particularly influence this lack of headroom due to the relatively rapid decline in solar PV generation during sunrise and sunset respectively. During these time periods, headroom on resources on governor control is expected to further reduce, which could cause a steady and monotonic decrease of PFR[29]. While solar facilities can cause the depletion of headroom, wind facilities are an untapped source of headroom. Wind manufacturers have shown that wind turbine generators can provide headroom up to 5% margin between its power output and capacity of the turbine given wind conditions.[30]

5.3. Unit Performance Survey

In Section 5.1, the ISO described its deteriorating PFR performance over the years and initiated outreach to resources. The ISO is estimating an expected PFR of each resource and was consistently seeing the actual PFR fall short of this expectation. The ISO's outreach assessed the causes of this difference and what measures must be addressed in short-term.

Based on its BA-wide survey of frequency response issues, the ISO finds:

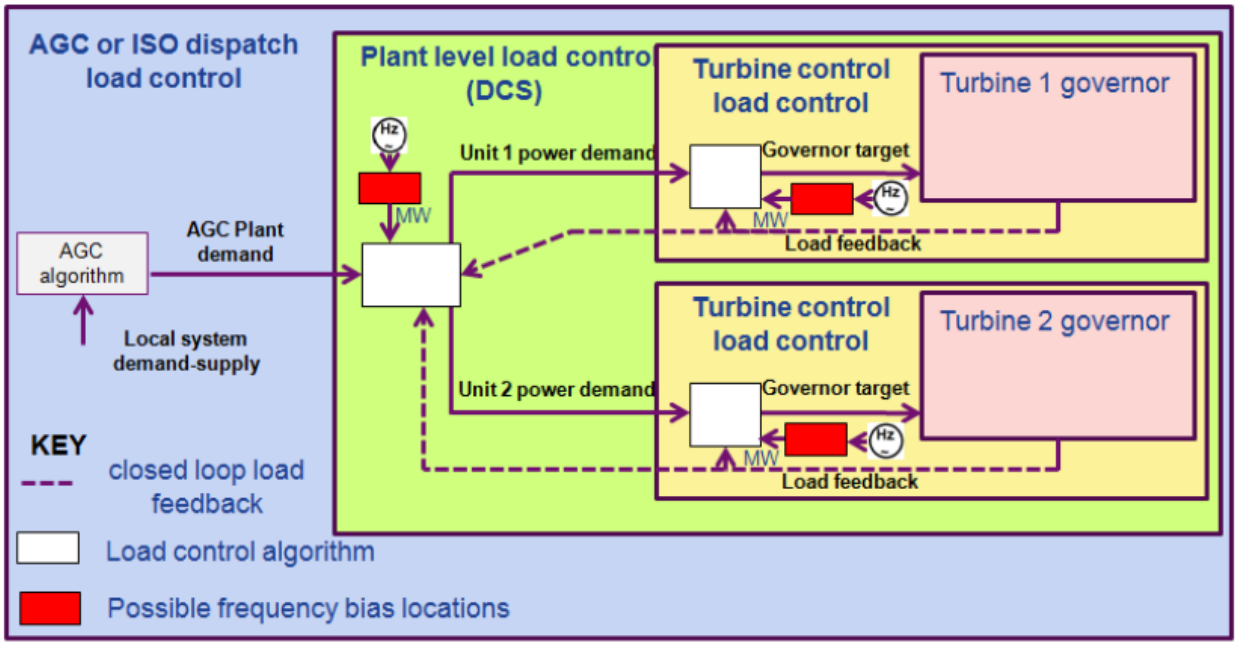
- Lack of frequency bias coordination across various levels of plant controls results in overriding frequency response so plant-level distributed control systems (DCS), turbine-level load control systems and governor controls need to be coordinated.

[26] Western Wind and Solar Integration Study Phase 3 – Frequency Response and Transient Stability: Executive Summary, NREL at 9.
[27] Western Wind and Solar Integration Study Phase 3 – Frequency Response and Transient Stability: Executive Summary, NREL at 16.
[28] Power and Frequency Control as it Relates to Wind-Powered Generation, Ernest Orlando Lawrence Berkeley National Laboratory at 11-12.
[29] Western Wind and Solar Integration Study Phase 3 – Frequency Response and Transient Stability: Executive Summary, NREL at 17.
[30] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-20.

- Temperature controls will override response to protect against mechanical damage.
- A Resource may have a different frequency responsive maximum output level than its maximum output level registered in Masterfile.
- When in downward ramp, resources response should be evaluated compared to its expected output level without governor controls not the prior output level.

First, the ISO found several resources did not respond as expected to frequency events because the DCS will almost completely override governor response. There is little to no performance if the DCS, plant level control systems, are not coordinated with the governor controls. Figure 4 below shows a high-level picture of a typical plant system, Plant A. In Figure 4, Plant A has two turbines each with governor control, shown by the red boxes. Plant A's system also incorporates unit load control systems either at the turbine level or the plant level (shown by white boxes). When at the plant level, these load controls are referred to as Distributed Control Systems (DCS).

Figure 4: NERC Reliability Guideline - Typical High Level System[31]



The DCS or turbine-level load controls must take into account primary frequency control to achieve sustained primary response during Point B recovery period. If frequency bias is not introduced into the load controls, the controls will react to the primary frequency response by the governor as an error and these controls will reverse any response from the turbine. Recent NERC Guidelines recommend the frequency bias should be applied at the highest level load

[31] Reliability Guideline: Primary Frequency Control v1.0 Final at http://www.nerc.com/comm/OC/Reliability%20Guideline%20DL/Primary_Frequency_Control_final.pdf.

controls.[32] Without a frequency bias algorithm programmed into the load controls, the ISO's and the system's response will remain unpredictable.

Second, the ISO found that temperature outer loop controls occur at a higher level control than the DCS. This means that even if a frequency bias algorithm was programmed into the DCS or turbine-level load controls to support the turbine governor response, if the temperature outer loop controls are triggered it will override and reverse the response. When a resource has temperature controls and is near to or fully loaded, the temperature controls will restrict the resource. In its survey, the ISO learned that for resources under temperature control when an event occurs, there is no expected frequency response outside of any inertial response during the initial arresting and rebound period. However, the ISO acknowledges the importance of these temperature controls since they allow the generator owner to avoid mechanical damage.

Third, resources' maximum capacity under governor control may not be the same as the maximum capacity registered in Masterfile. For example, a combined cycle gas turbine (CCGT) resource only have active governor controls on its gas turbine representing 2/3 of the resource's registered maximum output level while the steam turbine remains unresponsive to frequency events. Further, additional capacity may be included in the registered maximum output level from duct burners which would further reduce the portion of the resources' registered maximum output level responsive to events.

Finally, in some instances the ISO did not observe additional output when resource was decreasing their output in response to a downward dispatch instruction. Initially, the ISO's understanding was that governor controls would respond when an event occurs enabling the resource to reverse direction and provide additional MW output onto the system. After its survey, the ISO learned while some resources may be able to do so, others will respond to an event while in downward ramp by generating at a higher output level compared to its output without governor response. This information will inform the ISO's modeling designs under Phase 2 of this initiative.

As a result of its findings, the ISO proposes to refine its proposals for tariff requirements discussed in Section 7.2.2 to resolve two needs discovered during this survey: (1) require coordination of system controls necessary to support reliability and (2) require new data submissions necessary to design frequency response models.

6. Stakeholder Comments on Issue Paper

See Appendix C for a summary of stakeholder comments and the ISO responses.

[32] Reliability Guideline: Primary Frequency Control v1.0 Final at http://www.nerc.com/comm/OC/Reliability%20Guideline%20DL/Primary_Frequency_Control_final.pdf.

7. Draft Final Proposal

7.1. Summary

The ISO is considering a two-phase approach to ensure that sufficient primary frequency response capability will be available to enable the ISO to comply with BAL-003-1.

Phase 1 entails near-term approaches that the ISO can implement for the 2017 compliance period, which starts on December 1, 2016. It includes tariff revisions that include requirements for participating generators to enable governors, data collection procedures, and provisions to procure transferred frequency response from external BAs. Together these approaches should enable the ISO to comply effectively with the BAL-003-1 standard by December 1, 2016.

The next phase of this initiative, Phase 2, long-term approaches, will consider the potential efficiency improvements from implementing more comprehensive market solutions by implementing a reserve procurement constraint or new market product defined in a technology-neutral way that would allow all certified resources, including non-conventional resources, to have PFR capability. Such mechanisms could not be designed, approved and implemented by December 1, 2016, and therefore the ISO must consider them in a second phase of this initiative. As the supply mix evolves to include higher concentrations of VERs and DERs, in Phase 2 the ISO will also consider extending frequency response capabilities to all participating resources, to enable the diverse mix of resources to be deployed effectively to meet reliability standards and requirements such as for frequency response.

7.2. Phase 1, Near-term approaches for 2017 compliance period

The ISO and other BAs will be evaluated for compliance with NERC's BAL-003-1 standard starting December 1, 2016. The ISO proposes to enact the following six steps to ensure it can meet the requirement.

First, the ISO proposes to develop a competitive solicitation process for Transferred Frequency Response (TFR) from external BAs in Western Interconnection. TFR is a compliance instrument to enable the ISO to meet its FRO for the 2017 compliance period.

Second, the ISO proposes to revise the tariff to include requirements for all participating synchronous generators with governors, not just those providing spinning reserves, to set governors to specified droop settings and deadbands consistent with applicable reliability criteria, and to not override governor response through outer-loop controls or other mechanisms. The ISO also proposes additional data submission requirements for generator and plant level controls.

Third, the ISO proposes to revise the tariff to clarify the authority of the ISO to designate any reserve not previously identified as Contingency Only by a Scheduling Coordinator (SC) as Contingency Only reserves.

Fourth, the ISO proposes including frequency response performance requirements under Phase 2 in coordination with introducing a market design that procures frequency response performance.

Fifth, the ISO is not proposing tariff revisions to address the allocation of any BAL-003-1 penalties since section 14.7 of the tariff currently includes a process for allocating reliability penalties.

Finally, the ISO will monitor and report its PFR performance to the market on a periodic basis.

7.2.1. Addressing anticipated real-time PFR deficiencies

Under the straw proposal for phase 1, near-term approaches for the 2017 compliance period, the ISO proposed to develop a look-ahead tool to estimate a deficiency amount and primarily rely on spinning reserves to reserve additional frequency responsive unloaded capacity to cover the deficiency. In procuring reserves, it could either change the percentage allocation of spin versus non-spin capacity while procuring overall all reserves equal to the contingency reserve requirement, or it could procure excess reserves as spinning reserves. The ISO proposed to establish this amount based on the results of its look-ahead tool's forecast of frequency responsive headroom. If there is not sufficient spinning reserve capacity available, the ISO would also exceptionally dispatch resources either decrementally if fully loaded or to start-up if an insufficient number of resources are on-line. A resource providing spinning reserves would be compensated for opportunity costs of not generating power to create headroom for frequency response capacity.

After extensive internal and external evaluation, the ISO has ruled out its previous proposal to address PFR shortfall on a day-ahead or real-time basis as a short term solution. As described below, it would likely be very inefficient to use ancillary service (AS) to procure frequency response. Likewise, using exceptional dispatch is not a preferred option for procuring frequency response capability because frequency response can likely be procured much more economically from an external BA.

The ISO evaluates its AS offers through a cascaded AS procurement in co-optimization process between AS and energy offers. A cascaded AS procurement allows substituting a higher quality AS for a lower quality AS if resource can provide the lesser quality AS and is most economical according to co-optimization. Because of this, regulation awards could be contributing to fulfilling the 50% of ISO's operating reserve requirement from spinning reserves. For example, sufficient regulation awards are procured to meet 50% of the operating reserve requirement, these awards have been substituted for spinning reserves and the market will not procure spinning reserve awards.

The ISO believes increasing its ancillary service procurement is not a viable near-term solution. First, spinning reserves and primary frequency response products are significantly different products with different costs associated with their provision, shown below in Table 3. The additional costs of providing PFR would need to be considered by both regulation and spinning reserve resources potentially distorting market signals for both AS types.

Table 3: Ancillary Service Products

Product Definition	Spinning Reserves	Regulation	Primary Frequency Response
Synchronized to grid	Yes	Yes	Yes
Dispatch method	ISO signal	ISO signal	Frequency event triggers automatic, autonomous governor response
Service availability	10 minutes	4 seconds	20 seconds
Minimum service length	2 hours	10 minutes	32 seconds

Second, there is no guarantee that increased levels of spinning reserve procurement would improve ISO's performance. Under the cascading AS procurement process, the ISO could increase its spinning reserve requirement but only result in increased levels of regulation awards which have typically been awarded to a limited number of resources. Given the finite amount of PFR by a resource, if the ISO only increases its awards to limited number of resources it would have increased the headroom on the system but not increased the frequency response headroom. Without a market constraint to ensure the increased procurement was allocated to resources based on its PFR capabilities, the ISO cannot determine in advance if this intervention would improve its performance.

Alternatively, the ISO proposes to procure transferred frequency response from external BAs through a competitive solicitation process. Under the solicitation process, the ISO currently estimates it would procure 100 MW/0.1Hz of its PFR from external BAs. The PFR shortfall amount is subject to adjustment prior to issuing request for proposals (RFP).

The ISO finds developing its own competitive solicitation process the most viable solution because it:

- Enables the ISO to meet the requirements of the BAL-003 reliability standard at lowest cost from multiple sellers while maintaining system reliability
- Avoids inefficient market costs associated with employing sub-optimal market interventions such as using ancillary services or exceptional dispatches

Given WECC's surplus frequency response, BAs may be willing to enter into bilateral agreements to re-allocate obligation based on an expected frequency response performance deficiency or surplus while continuing to support grid reliability even in the event of loss of two Palo Verde units. The ISO's 2014-2015 planning study showed WECC's frequency response performance exceeding the performance rate needed to replace generation loss from the loss of

two Palo Verde units. Shown in Appendix B, the planning study performed for April 7, 2024 shows a WECC response over two and a half times larger than its IFRO of 858 MW/0.1Hz.[33]

The ISO proposes to file with FERC a proposed product definition to resolve regulatory uncertainties associated with managing risk through a competitive solicitation process. To ensure WECC, NERC, and FERC evaluate the use of transferred frequency response consistently, the ISO finds it necessary to seek prior approval of the product definition, solicitation process, and cost allocation before issuing request for proposals (RFP) for transferred frequency response (TFR). The ISO proposes to develop a competitive solicitation process to procure TFR using the following process:

1. File tariff revisions including product description of TFR and a solicitation process,
2. Post draft request for proposals (RFP) and a draft agreement,
3. Issue RFP and agreement pending FERC approval of product description and process,
4. Receive and review RFP responses
5. Announce contract winner(s),
6. Tender and execute a final agreement,
7. File non-conforming agreement at FERC

This draft final proposal addresses the first of the ISO's proposed competitive solicitation process. Currently, ISO tariff section 42 addresses the adequacy of facilities to meet operating and planning reserve criteria through various market mechanisms including but not limited to competitive solicitations. The ISO proposes to revise its tariff to explicitly provide it has similar authorities to ensure criteria compliance for meeting the BAL-003-1 standard. Specifically, the ISO has authority to enter into bilateral agreements for transferred frequency response to ensure compliance with applicable reliability criteria.

In addition to filing the above proposed process and clarifying the ISO's authority, the ISO proposes tariff revisions defining the TFR product as a compliance instrument covering the receiver's regulatory risk of non-compliance with BAL-003-1 where a BA would sell or purchase right to receive or deliver transferred frequency response adjustment on NERC reporting forms. The compliance instrument will allow BAs to include this adjustment to its frequency response performance reported in NERC Forms 1 and 2 where the TFR is a contracted amount of frequency response performance in MW/0.1Hz. Additionally, since the ISO would likely need to award RFPs to more than one BA it will clarify that a receiving or delivering BA can report an aggregate of transferred frequency response received or delivered respectively.

NERC's description of TFR and appropriate usage of adjustments according to instructions on Form 1 are shown below in Table 4.

Table 4: NERC Form 1 Instructions for utilizing Adjustments - Items 1 & 6[34]

[33] 2014-2015 Transmission Plan, available at http://www.caiso.com/Documents/Board-Approved2014-2015TransmissionPlan.pdf.

[34] NERC Form 1, Adjustments sheet. Available at: http://www.nerc.com/comm/OC/RS%20Landing%20Page%20DL/Frequency%20Response%20Standard%20Resources/MyBA_2015_FRS_FORM_1%209a_Western_Interconnection%20Final.xlsm.

Instructions
Balancing Authorities making adjustments must retain evidence to verify: - Adjustment values are determined from scan-cycle data using Value A and Value B averaging periods. Scan-cycle data must be available if adjustments are made. - Adjustments are necessary to improve accuracy of calculations compared to using Net Actual Interchange solely. Said differently, unless an adjustment compensates for significant known error, it should not be made. However, as noted in the next item, once a decision to include an adjustment for one or more of the five types is made for one event, the entity must calculate adjustments for that (those) type(s) for all events except for the Contingent BA Adjustment which is only utilized for the events that you are contingent during that event. - Adjustments are included consistently for all events (e.g. if adjustments for nonconforming load are made for one event, the load must be included for all events, etc.).
Transferred Frequency Response: - This value is the amount agreed upon between the entities expressed in MW/0.1 Hz. Form 2 will adjust this amount for the frequency deviation experienced. (e.g. if an entity agrees to provide 20 MW/0.1 Hz to another entity and a frequency event with a deviation of 50 mHz occurs, the delivering entity should enter +20 in the data column of Form 2 and the receiving entity should enter - 20. The spreadsheet will adjust the SEFRD for each entity by the 10 for this event.) - Values for the entity receiving the response must be entered as a negative number. - Values for the entity delivering the response must be entered as a positive number. - Values between entities must sum to zero.

The ISO proposes to refine this description under its tariff to state that since TFR is a compliance instrument there is no exchange of physical services between BAs. In times of a frequency event, the seller will provide its frequency response service directly to grid not to a specific BA. The proposed contract for TFR will be a forward annual contract since the compliance instrument is managing a regulatory risk on an annual basis and it allows adjustments to be reported consistently for all events selected by NERC. Under the contract, the ISO will ask sellers to:

- Request offered amount of TFR in MW/0.1Hz and TFR price in dollars
- Provide a showing it is capable of providing frequency response service in a manner consistent with BAL-003-1 that can sufficiently support reliability

Once a sufficient showing has been provided, the ISO will select the RFP winner through a least cost evaluation consistent with the ISO's tariff language in Section 42 which outlines if contracts are required, i.e. to meet Applicable Reliability Criteria, e.g. BAL-003-1 requirement 1, the ISO shall select bids enable ISO to meet applicable reliability criteria at the lowest cost.[35] The ISO

[35] ISO Tariff Section 42.1.4.

would evaluate the offers based on its expectation of costs through committing additional generation on-line through exceptional dispatches. Consistent with other competitive solicitation processes, the ISO can choose to not award a winner if all the offers are excessive. In the event no contract could be awarded due to excessive cost, ISO will rely on commitments through exceptional dispatches.

The new NERC standard was developed to ensure the reliability of the interconnection to benefit load. Therefore, the ISO proposes allocating the costs of the procured TFR amount to measured demand in a similar manner to allocation of NERC fees.

7.2.2. Tariff and interconnection revisions

The ISO's analysis based on historical data shows that without additional measures frequency response performance is expected to fall short of the FRO during certain operating conditions. This expectation will likely be exacerbated during periods with light load and fewer synchronous units online. While more progressive measures must be taken to ensure sufficient frequency response capability is available at the time of any event, the ISO proposes several tariff amendments to ensure adequate PFR capabilities. The proposed amendments would clarify generator and participating transmission owner requirements regarding supporting ISO grid reliability, formalize process for ancillary service treatment.

Through clarifying the standards and enforcing compliance, the ISO can clarify the obligation of participating generators and participating transmission owners to ensure proper tuning of governors, measurement of actual interchange flows, and establishment of interconnection requirements in light of the changing resource mix.

The ISO proposes to revise Section 4 of the tariff outlining responsibilities for participating generators having active governors to require minimum governor performance consistent with reliability criteria, similar to Appendix K, Part B, 1.2. The ISO proposes tariff changes to specify droop settings by technology type and dead band, and to limit the use of outer-loop controls that would otherwise override governor response when PFR is needed.

The ISO anticipates the tariff revision would clarify under Section 4.6.5 that resources with governor controls are responsive to frequency deviations in accordance with Good Utility Practice. Further, the ISO tariff proposes to clarify this requires resources to have the capability to respond immediately and automatically in proportion to frequency deviations through the action of a governor with the following minimum governor performance requirements:

- 4 percent droop for combustion turbines;
- 5 percent droop for other technology types;
- +/- 0.036 Hz deadband;
- Power output changes in one second for any frequency deviation outside of the deadband; and
- Plant-level distributed control systems (DCS), turbine-level load control systems and governor controls are coordinated with frequency bias applied at highest level load controls.

In addition to section 4.6.5, the ISO also proposes to revise Appendix K Part B's minimum governor performance requirements consistent with that of section 4.6.5. The ISO finds these adjustments to minimum governor performance must be made to align ISO's requirements with the NERC reliability guidelines on primary frequency control.

As part of this approach the ISO would require generators to provide governor control system and plant control system data to include in its Masterfile, which would register resource-specific data such as droop settings, deadbands, frequency responsive maximum output level, and level temperature loop controls are in effect. This information is necessary as inputs to modelling efforts the ISO needs to develop under Phase 2 as well as long-term planning and development of operation tools.

7.2.3. ISO practice of preserving operating reserve headroom

The ISO proposes to revise Section 34.10 of the tariff to clarify the authority for the ISO to treat day-ahead procured operating reserve as contingency only in the real-time market regardless of the resource's election. This will be necessary to preserve the frequency responsive headroom, as well as the contingency reserve capability, by not dispatching it for energy.

7.2.4. Performance Requirements

The ISO proposes to address a minimum performance requirement under Phase 2 of the initiative. The ISO finds a market for frequency response performance must be in place to require a specific amount of minimum performance. As discussed in Section 7.2.2, the ISO proposes to revise and clarify in tariff that the ISO requires under Good Utility Practice participating generators having governor controls to meet NERC and WECC guidelines for primary frequency controls.

7.2.5. Allocation of BAL-003-1 non-compliance penalties

Section 14.7 of the ISO tariff includes a process to allocate reliability-based penalty costs. This process allows the ISO, with FERC approval, to directly allocate cost of relability-based penalties to entities that contributed to the violations giving rise to the penalty. This tariff section describes the precedent for any such direct allocation, including (1) notice of and opportunity to partcipate in any enforcement proceeding; (2) a finding by FERC, NERC or WECC that the entity contributed to the violations that gave rise to a penalty; and (3) any such findings made by NERC or WECC are filed with FERC.

The process in ISO tariff section 14.7 applies to any reliability-based penalty. The ISO requested comment on how it could apply these tariff provisions to BAL-003-1 compliance in its straw proposal. Several parties commenting on FERC's notice of proposed rulemaing to approve BAL-003-1 raised the concern that BAL-003-1 places the obligation on the BA, which does not control the actual resources that provide frequency response, but places no obligation on the generating facilities that the BA must rely on to provide primary frequency response. In response to these concerns, FERC said in its January 2014 order adopting a final rule to approve BAL-003-1 that BAs could develop and file such provisions. FERC also stated that "NERC and its stakeholders had, and still have, the option to propose a Reliability Standard

imposing obligations directly on resources, if they find it appropriate."[36] The ISO requested comment from stakeholders regarding whether it should explore additional tariff provisions beyond those set forth in section 14.7 to impose responsibility for penalties on any resource that fails to provide primary frequency response for which it has an obligation to provide.

Since the ISO is not proposing a minimum performance requirement at this time, the ISO is not proposing additional tariff provisions beyond section 14.7.

7.2.6. ISO monitoring and reporting BA performance

To improve market understanding of the ISO's primary frequency response performance, the ISO proposes to monitor and report on a monthly basis its PFR performance. At this time, the ISO anticipates using its Monthly Market Performance Reports to share information on observed trends in the performance drivers such as inertia, load damping, size of generation loss, and headroom available as well as the PFR performance rate expressed in MW/0.1Hz.

The ISO will continue to perform the more detailed analysis of individual unit response and initiate outreach to resources to better understand and improve understanding of the reasons BA response performance is inconsistent with ISO's expected performance.

7.3. Phase 2, Long-term approaches

Under Phase 2, the ISO will evaluate a market mechanism that encourages frequency response capabilities of all participating resources, enables the diverse mix of resources to provide services, and ensures ISO meets applicable reliability criteria. Both conventional and non-conventional resources have the capabilities to provide PFR. The challenge to PFR provision by non-conventional resources has been the inverters installed at the facilities and the lack of compensation for headroom reserved for PFR.

Two options for allowing more diverse resources to provide PFR based on their individual capabilities instead of as a byproduct of being certified to provide ancillary services would be to either:

(1) Incorporate a market constraint to include logic that solves for the least cost commitment and dispatch constrained by the need for sufficient headroom on-line to provide the upward capability to meet the FRO.
(2) Create a new product that would allow economic bidding to provide a PFR product in the form of headroom from PFR-capable units.

Two options for the product definition of a frequency response product would be to either procure:

(1) Frequency response performance regardless of size of event (e.g. MW amount) where the minimum performance requirement regardless of event is that MW amount

[36] 18 CFR Part 40 Final Rule at 61.

(2) Frequency response performance tuned to size of event (e.g. MW/0.1Hz) where minimum performance requirement is that rate for each 0.1Hz of the event

A fundamental principle the ISO tries to follow in its market initiatives is to specify its operational needs in technology-neutral terms, to allow any resource types or technologies that can provide the needed performance to offer the needed service. By moving away from the procurement of headroom from spinning reserves, the ISO can consider both conventional and non-conventional PFR-capable resources. The ISO understands that newer inverter technologies can provide PFR capability and are becoming standard features on asynchronous generators. It is therefore likely if there were a market providing an incentive for a paradigm shift in control operations that wind, solar, and distributed energy resources (DER) would can provide PFR and would compete in such a marketplace.

The ISO knows that encouraging the interconnection of storage facilities onto the system may provide increased efficiencies and desirable market outcomes to these frequency response needs. The economics of storage result in limited levels of penetration but as the economics change the ISO believes increased levels of storage capability will improve overall system efficiency and reduce the concern of ISO compliance with this standard.

8. Next Steps

The ISO will discuss this draft final proposal with stakeholders during a call on February 9, 2016. Stakeholders are asked to submit written comments by February 23, 2016 to InitiativeComments@caiso.com.

Appendix A: Technical Appendix

1. Factors influencing the slope of a frequency excursion

As depicted visually in the ISO's proposal, the speed at which a frequency response drops after the disturbance event occurs is a function of the on-line inertia constant. The speed is also a function of load damping and the change in power output[37].

$$Slope = \frac{\Delta P}{D + 2H}$$

$$\textbf{Where}: \Delta \mathrm{P} = P_{t+1} - P_t$$
$$\text{and } t = T_0$$

$Slope$	Frequency Excursion Slope.
ΔP	Magnitude of the imbalance.
D	Load damping factor ranging from 0 to 2 where 2 represents all-motor load.
H	Inertia Constant of system ranging from 2.5 to 6.5.
T_0	First SCADA scan showing change in frequency

2. Impacts of technology type on primary frequency response

Various technology types have diverse PFR capabilities. The various technology can provide different levels of PFR across the timeframe associated with primary frequency control. The ISO believes that while resources should be treated equivalently regardless of technology type from a requirement stance, the ISO will evaluate if the frequency response characteristics vary by technology type.

Resources dispatched to full load cannot provide primary frequency response. Resources that have multiple configurations may have a different maximum capacity for each configuration.

Fossil-fuel steam resources can provide PFR with various characteristics depending on the control mode in which it is operating. The characteristics for each control mode are as follows:[38]

(1) Boiler-follow mode: prompt and sustained increase in power followed by long delay from 10 seconds to minutes until full increase in power is achieved.
(2) Turbine-follow mode: slower response relative to boiler-follow mode.
(3) Coordinate control: compromise between fast response of boiler-follow mode and sluggish response of turbine-follow mode while maintaining better control of boiler.

[37] Frequency Response Initiative Report – October 2012 at 39.
[38] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-5.

(4) Sliding-pressure control: sluggish response to PFR since it's relying on controlling boiler and fuel which respond more slowly than turbine control valves left open in this mode.

Combined cycle gas turbine (CCGT) resources similarly to hydro facilities are only expected to provide at most a small percentage (e.g. 5% to 10 %) of 2/3 of their maximum capacity within the first minute of an event. However, this estimate is based on the unit not being fully loaded or at a level of their capacity where temperature control loop is in effect. If either of these conditions exist, the CCGT will provide little to no PFR. The main reasons a CCGT typically only provides at most a percentage of 2/3 of its capacity is that only the gas turbine has an active governor and the sliding-pressure control mode frequently used has a sluggish response. Frequency response could be increased if the steam turbines had active governors and allowed for some valve control. While this would improve frequency response it would affect overall plant efficiency. Additionally to extend the life of the gas turbines, CCGT use a deadband so the governor response is activated only when the change in frequency is outside the deadband.[39]

Hydro facilities respond fairly predictably to a frequency excursion event since multiple unit hydro facilities are not fully loaded but are instead used as peaking or spinning reserve resources[40]. Their response is relatively slow with the beginning of their response expected by T_{30} and roughly 2/3 of their capacity by T_{60}[41]. Since the most reliability value is gained from response early in the period following an event, this technology would have less reliability value than faster responding types. The slowed power response rate is driven in part by the feedback signal used by the resources. Many older hydro resources use a mechanical signal that uses the wicket gate position as a proxy for the power signal. The response could be improved if electrical power signals were instead used as feedback.

A nuclear plant is typically operated at full load. Therefore it would not respond to an under-frequency event with a governor-like response, but acts to limit the severity of a frequency event by providing inertia. While the Lepreau Generating Station in New Brunswick provides primary frequency response,[42] this is not a widespread practice especially in the WECC.

3. NERC Process for Determining IFRO

The ISO's new frequency response obligation is the ISO's portion of a new obligation for the entire Western Interconnect, the Interconnection Frequency Response Obligation (IFRO). Federal Energy Regulatory Commission approved the Petition of the North American Electric Reliability Corporation (NERC) for approval of BAL-003-1, Frequency Response and Frequency

[39] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-17.
[40] This holds true unless units are needed for water flow control and then they will not be able to provide PFR.
[41] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-6.
[42] Interconnected Power System Response to Generation Governing: Present Practice and Outstanding Concerns, IEEE, May 2007 at 1-15.

Bias Setting on March 29, 2013 where this new standard requires the ISO to meet a BAA level Frequency Response Obligation (FRO) effective April 1, 2016.

The primary objective of Requirement 1 (R1) from BAL-003-1 is to determine whether a BA has sufficient frequency response for reliable operations[43]. The standard requires each interconnection to maintain a minimum amount of frequency response. The IFRO is the minimum MW/0.1 Hz frequency response to protect against a loss of generation event that would cause the system frequency encroaching on the trip setting of the Under Frequency Load Shedding (UFLS) relays. An important goal of this standard is to avoid tripping the first block of the UFLS relays for a frequency event resulting in the actual system frequency dipping to 59.5 Hz[44].

FERC approved NERC's recommended target resource loss protection criteria (RLPC) reflecting the simultaneous loss of resources without system adjustments for the largest reasonably expected contingency. The Western Interconnection must protect against the largest N-2 event, which is the loss of 2 Palo Verde units (2,626 MW). The Interconnection will be credited for 120 MW of load that trips by a Remedial Action Scheme (RAS) following this N-2 event. The Adjusted Resource Loss Protection Criteria (ARLPC) is 2,506 MW.

The maximum delta frequency (MDF) following an event should ensure the interconnection frequency does not trip the first block of UFLS relays. For the Western Interconnection, the MDF, calculated by NERC to promote system reliability is 0.292 Hz[45].

NERC must analyze annually frequency response performance and update the statistical analyses and calculations. The updated Frequency Response Annual Analysis serves as the vehicle for communicating the recommended IFROs for a compliance period. The statistical analysis will be performed over a three year period prior to the upcoming compliance period. The statistical analysis for the 2014 frequency response period (December 2013 – November 2014) uses data points across 2010-2012.

The following are the formulae comprising the calculation of the IFRO and a table illustrating the results for the Western Interconnection for the 2013 – 2016 periods[46].

$$DF_{BASE} = F_{START} - UFLS$$

$$DF_{CC} = DF_{BASE} - CC_{ADJ}$$

$$DF_{CBR} = \frac{DF_{CC}}{CB_R}$$

$$MDF = DF_{CBR} - BC'_{ADJ}$$

[43] NERC Petition at 15.
[44] Frequency Response Initiative Report – October 2012 at 51 – 52.
[45] 2015 Frequency Response Annual Analysis.at 13.
[46] Frequency Response Initiative Report – October 2012 at 56 - 61.

$$ARLPC = RLPC - CLR$$

$$IFRO = \frac{ARLPC}{MDF}$$

Table 5: NERC recommended IFRO for the 2013 – 2016 evaluation periods

Explanation of Calculations		2013[47]	2014[48]	2015[49]	2016[50]	Units
F_{START}	Starting Frequency is the 5% of the lower tail samples over three-year window representing 95% change frequency will be at or above value at start of an event.	59.976	59.971	59.968	59.967	Hz
$UFLS$	Prevailing UFLS First Step	59.500	59.500	59.500	59.500	Hz
DF_{BASE}	Base Delta Frequency from F_{START} to UFLS First Step	0.476	0.471	0.468	0.467	Hz
CC_{ADJ}	95% confidence interval adjustment for differences between Point C when comparing 1-second and sub-second measurements of Point C.	0.004	0.008	0.011	0.000	Hz
DF_{CC}	Delta frequency adjusted for differences between 1-second and sub-second Point C observations	0.472	0.463	0.457	0.467	Hz
CB_R	Statistically determined ratio of arrested frequency response (Point C) to settled frequency response (Value B) where CB_R is defined as expected Value A – Point C / Value A – Value B plus a 95% confidence adjustment.	1.625	1.774	1.672	1.598	Hz
DF_{CBR}	Delta frequency adjusted for the ratio of Point C to Value B	0.291	0.261	0.273	0.292	Hz
BC'_{ADJ}	Statistically determined adjustment in the event nadir occurs below settled frequency response only applying to the Eastern Interconnect.	N/A	N/A	N/A	N/A	Hz
MDF	Maximum allowable delta frequency	0.291	0.261	0.273	0.292	Hz
$RLPC$	Resource Loss Protection Criteria (Largest N-2 Event)	2,740	2,626	2,626	2,626	MW
CLR	Credit for load resources	300	150	150	120	MW
$ARLPC$	Adjusted Resource Loss Protection Criteria	2,440	2,476	2,440	2,506	MW
$IFRO$	Interconnection Frequency Response Obligation	-840	-949	-906	-858	MW/ 0.1Hz

[47] Frequency Response Initiative Report – October 2012 at 56 - 61.
[48] 2013 Frequency Response Annual Analysis.
[49] 2014 Frequency Response Annual Analysis.
[50] 2015 Frequency Response Annual Analysis.

The IFRO value will change from year to year primarily as the result of the changes to:

1. Statistical frequency variability over a three-year window of 1-second frequency measurements affecting Fs_{TART}.
2. Statistical "C-to-C" adjustment over a three-year window comparing 1-second and sub-second measurements of Point C.
3. Statistical "C-to-B" ratio adjustment over a three-year window comparing the Value A – Point C and Value A – Value B ratio.

NERC will collect data to calculate the 2017 IFRO and allocate 2017 IFRO to individual BAs starting on January 1, 2015 through December 31, 2015. The ISO will provide the 2015 data from FERC Form 714 to NERC by fall 2016. NERC will approve the 2017 IFRO by September 2016 and allocate the IFRO to the BA level. The ISO expects to receive this FRO by October 2016 for implementation December 1, 2016 – November 30, 2017[51].

4. NERC Process for Allocating IFRO to BAA

The IFRO will be allocated to the BA level based on the BA's annual load[52] and annual generation[53] from the most recently reported FERC Form 714 values or other representative data.

FERC Form 714 is the Annual Electric Balancing Authority Area and Planning Area Report in which the ISO reports its BAA net energy for load and peak demand sources by month (Part II - Schedule C). These values are reported for each month and an annual total. The IFRO allocation will be determined using the annual total reported on these forms or a similar calculation for BAAs not reporting with FERC Form 714[54].

$$FRO_{BA} = IFRO \times \frac{Annual\ Gen_{BA} + Annual\ Load_{BA}}{Annual\ Gen_{INT} + Annual\ Load_{INT}}$$

FRO_{BA}	BAA frequency response obligation.
$IFRO$	Interconnection frequency response.
$Annual\ Gen_{BA}$	BAA net generation (MWH) annual total reported FERC Form 714, Part II – Schedule 3, Column C, line 13.
$Annual\ Load_{BA}$	BAA net energy for load (MWH) annual total reported FERC Form 714, Part II – Schedule 3, Column E, line 13 which is the sum of BAA net generation (MWH) and net h interchange (MWH).

[51] BAL-003-1 Detailed Implementation Timeline, North American Electric Reliability Corporation, August 20, 2014.
[52] Annual Gen_{BA} is total annual BAA Net Generation (MWh) as reported on FERC Form 714, column c of Part 11 – Schedule 3.
[53] Annual $Load_{BA}$ is total annual BAA Net Energy for Load (MWh) as reported on FERC Form 714, column c of Part 11 – Schedule 3 which is the sum of the BAA Net Generation and Net Actual Interchange.
[54] BAL-003-1 Standard, Attachment A.

$Annual\ Gen_{INT}$	The sum of all net generation (MWH) across all BAA in the Interconnection.
$Annual\ Load_{INT}$	The sum of all net energy for load (MWH) across all BAA in the Interconnection.

5. Measuring the ISO's actual performance for standard

Prior to the standard, NERC's guidance to a BA was to calculate frequency response by identifying interchange values "immediately before" and "immediately after" a frequency excursion event and use the difference to calculate MWs deployed for event[55]. While generally this is calculated by showing change in net actual interchange measurements, with BAL-003-1 in place there is a more standardized approach to defining how this change is measured.

One of the challenges in measuring performance is no reasonable calculation can be made on the arresting frequency, Point C, using Energy Management System (EMS) scan rate data on 4 second intervals or tie-line flows. NERC determines Point C by using phasor measurement units (PMU) sub-second frequency data and makes an adjustment to compensate for slower EMS scans of Point C to calculate an IFRO. The standard attempts to standardize measurement given the Point C measurement using EMS scan data.

NERC analysis showed a single-event-based compliance measure is unsuitable for compliance evaluation when the data has a large degree of variability[56]. The analysis further demonstrated that a sampling of at least 20 events is sufficient to stabilize the results and alleviate the problem associated with outliers in the measurement of BAA frequency response performance[57]. Therefore, NERC selected the median value from all events sampled to designate as the Frequency Response Measure (FRM), calculated in units of MW/0.1Hz[58]. NERC selected the median because this measurement met the two most important factors: reduce influence of outliers and noise

The actual frequency response performance for each candidate event will be calculated using the SEFRD data[59]. The performance is determined by calculating the change of a BA's net actual interchange on its tie lines with its adjacent balancing authorities adjusted for the loss of generation if the contingency occurred within the ISO BAA divided by the change in interconnection frequency[60]. The performance will be measured by comparing the average of discrete scans of net actual interchange (Ni_A) across the defined sampling periods. The sampling periods provide the Value A and Value B averages for 16 seconds prior to an event and 20 to 52 seconds after an event. The 20 – 52 second period following an event was

[55] Frequency Response Standard Background Document – November 2012 at 11.
[56] Frequency Response Initiative Report – October 2012 at 70.
[57] Frequency Response Initiative Report – October 2012 at 72.
[58] NERC Petition at 13.
[59] Single Event Frequency Response Data (SEFRD) is the individual sample of the event selections and actual performance measurements data from a Balancing Authority which represents the change in Net Actual Interchange (NIA), divided by the change in frequency, expressed in MW/0.1Hz.
[60] BAL-003-1 Standard, Attachment A.

selected because it measures response after transient period completely settles and show squelched response during the recovery period[61].

The ISO will submit to NERC its performance measurements for each event using Frequency Response Survey (FRS) Form1 and Form 2[62] which provide a consistent, objective process for evaluating the Frequency Response Measure (FRM).

6. Determining Frequency Response Measure

NERC performed a field trial of SEFRD data to come to a recommendation for a sampling approach to the compliance of this standard instead of a single-event based compliance measure. The analysis showed a single-event based compliance measure is unsuitable for compliance evaluation when data has large degree of variability[63]. The analysis further demonstrated that a sampling of at least 20 events stabilizes the results and alleviate the problem associated with outliers in the measurement of a BA's frequency response performance[64]. Out of this sampling, the median value of SEFRD data for actual frequency response performance described above expressed in MW/0.1Hz is selected as the FRM[65].

The FRM will be determined from a sampling of the largest (A-to-B) 20-35 events provided by NERC on FRS Form 1[66] where 2 or 3 events are from each calendar month[67]. If 20 events cannot be identified during the period, similar acceptable events from the next year will be used and the compliance period will be extended from 12 months to 24 months.

NERC detects a frequency event has occurred in the Western Interconnection if during a 15-second rolling time window the frequency deviation between Value A and Point C exceeds 40 mHz[68]. NERC will then select 2 or 3 events per month for the sample based in part on the following criteria[69]:

- Value A should be relatively steady around the scheduled frequency of 60.000Hz.
- The change in frequency as defined by the difference between Pre-event period, Value A, and arrested frequency Point C is greater than 0.04 Hz and Point C for a frequency dip is less than 59.95 Hz.
- Typically, the time from the start of the rapid change in frequency until the point the frequency stabilizes within a narrow range should be less than 18 seconds.
- If any data point in Value B period recovers to the Value A level, the event will not be considered as a candidate.

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[61] Frequency Response Standard Background Document – November 2012 at 13.
[62] MyBA FRS Forms 2.10 MultiBAInterconnection.
[63] Frequency Response Initiative Report – October 2012 at 70.
[64] Frequency Response Initiative Report – October 2012 at 72.
[65] BAL-003-1 Standard, Attachment A.
[66] MyBA 2016 FRS Form 1.10 Western Interconnection.
[67] Procedure for ERO Support of Frequency Response and Frequency Bias Setting at 1-2.
[68] Frequency Event Detection Methodology, NERC, May 2012.
[69] Procedure for ERO Support of Frequency Response and Frequency Bias Setting Standard at 1 – 2.

- Events that include 2 or more events not stabilizing within 18 seconds, during large ramping or load changes, within 5 minutes of the top of the hour will be excluded from consideration if other acceptable events are available.

The ISO will submit its 2017 Frequency Response Measure (FRM) by March 7, 2018. NERC will evaluate whether the ISO met the 2017 FRO by comparing the percentage difference between the FRM and the FRO.

Appendix B: ISO Planning Study Figures

Figure 4 and Figure 5 shown below, support the ISO's conclusion that for 2017 compliance period there is not an Interconnection reliability concern for 2017 compliance period.[70] [71]

Figure 5: 2024 Planning Study

Table 3.4-3: Frequency Response and Headroom, April 7, 2024 11 a.m.

Area	Response	Response	Response		Headroom	Load	Generation	
	MW	MW/0.1 HZ	% of Pmax, all	% of Pmax, responsive governors	MW	MW	All, MW	Responsive MW
WECC	2,705	2,292	1.6%	4.0%	30,152	100,410	103,580	65,597
PG&E	217	184	1.0%	3.9%	3,585	12,470	10,770	5,575
SCE	83	70	0.6%	3.3%	732	9,500	11,280	2,240
SDG&E	18	15	1.7%	5.1%	103	2,150	600	344
Total ISO	318	269	0.9%	3.8%	4,420	24,120	22,650	8,159
ISO/WECC	11.7%	11.7%	53.0%	93.1%	14.7%	24.0%	21.9%	12.4%

Figure 6: 2025 Planning Study

Table 3.2-2. Frequency Response study results for the 2025 Spring Off-Peak Conditions

Case	Name	Settling Frequency	Response WECC (FRO 858 MW/0.1HZ)		Response ISO (w/out SMUD) (FRO 258 MW/0.1 HZ)		Headroom, MW		Responsive Units (with increased output)	
		HZ	MW	MW/0.1 HZ	MW	MW/0.1 HZ	WECC	ISO (w/out SMUD)	WECC	ISO (w/out SMUD)
1	2025 Spring-off- peak base	59,843	2,393	1,527	445	284	15,514	2,416	722	148
2	High renewable, replacing base loaded	59,844	2,369	1,512	446	284	15,514	2,416	722	148
3	Reduced Headroom in ISO	59,839	2,314	1,433	317	196	14,056	1,001	688	114
4	Reduced Headroom ISO and WECC	59,768	2,290	989	385	166	9,206	1,001	610	114
5	Reduced Headroom WECC only	59,791	2,306	1,104	576	276	10,619	2,416	640	146
6	Extreme Low Headroom WECC only	59,748	2,227	883	662	263	8,175	2,416	610	146

[70] 2014-2015 Transmission Plan, available at http://www.caiso.com/Documents/Board-Approved2014-2015TransmissionPlan.pdf

[71] 2015-2016 Transmission Plan, available at http://www.caiso.com/Documents/Draft2015-2016TransmissionPlan.pdf.

Appendix C: Stakeholder Comments Summary

Topic	Market Participant	Comment	ISO Response
Working Group Comments	PG&E	PG&E supports the ISO's examination of buying frequency response from a balancing authority within the Western Interconnection. While PG&E supports the ISO's proposal to buy frequency response from a neighboring balancing authority, PG&E requests that the ISO confirm the following points in advance of moving forward with any transaction: 1. The ISO will define and use a clear process for any procurement transaction… 2. The procurement transaction will be acceptable to NERC… 3. The ISO will confirm that there is sufficient transmission capacity to support the transaction… While neighboring balancing authorities can provide valuable frequency response capability, the ISO ultimately needs to take steps to ensure that it has efficient and reliable levels of frequency response provided by internal resources. On that front, PG&E still supports many of the ideas proposed by the ISO in its October 2015 straw proposal, and PG&E strongly encourages the ISO to continue driving towards clarified and enforced internal requirements. In addition, PG&E recommends that the ISO adjust its market optimization to reserve frequency responsive headroom at the least cost. Ultimately, such requirements and headroom should lead to better frequency response performance within the ISO and should thus reduce the need for inter-BA transaction, unless such options are more cost effective.	The ISO is engaging in a defined PFR procurement transaction process acceptable to NERC. See section 7.2.1 of the ISO's draft final proposal. Exploration of market optimization enhancements to ensure PFR at the least cost will be explored in the second phase of this initiative.
	California Large Energy Consumers Association (CLECA)	CLECA is encouraged by the discussion on the frequency response working group call on December 14, 2015 regarding frequency response obligation transfers. The option of either a frequency response sharing group that is a collaboration of balancing authorities or an obligation transfer would allow the ISO to take advantage of the fact that there is sufficient PFR capability in the WECC although	The ISO is proposing a request for proposal to ensure adequate procurement of PFR in phase one of this initiative. See section 7.2.1 of the

		apparently possibly insufficient frequency response in the ISO's balancing authority based on analysis performed by the ISO to date. The apparent consensus on the call was that the sale of frequency response would be a compliance instrument like a REC and would include reports to NERC without the need for transmission or delivery to the grid. CLECA continues to support the development of a market product in phase 2 of this stakeholder process. CLECA does have a concern about the cost of procuring such reserves from outside the balancing authority, given the apparent limit on possible suppliers. The department of market monitoring should review the apparent lack of possible competitive suppliers to see if such a pricing proposal is appropriate and should review the price at which the ISO receives offers for such a service from other balancing authorities.	draft final proposal for more details.
	NRG Energy	To prevent undue discrimination, the ISO must either pay all of the resources that are providing the ISO with FR – or pay none of them. A paradigm in which the ISO would take FR service from generators within its Balancing Authority Area without compensation but would provide compensation to the operators of another Balancing Authority for FR service is patently discriminatory. As NRG understands the proposed schedule in this stakeholder initiative, the ISO plans to defer discussion of a market-based FR product until Phase 2. Since it seems clear that the ISO will have no way to provide compensation to generators within its Balancing Authority Area providing FR until Phase 2 is complete, it would be discriminatory to provide compensation for FR to other Balancing Authorities until such compensation is provided to resource providing FR service within the ISO Balancing Authority Area. For this reason, NRG respectfully urges the ISO to defer any discussion of acquiring compensated FR service from another Balancing Authority until Phase 2 of this initiative. With regards to the ISO joining or forming an FRSG – that action would be reasonable, as long as all generators within the FRSG that includes the ISO are treated the same with regards to how they provide and are compensated for providing FR. As NRG noted in its initial comments – given that Order 794 was issued in January 2014, it is unfortunate the CAISO did not initiate discussions	The ISO proposes to seek authority to enter into contractual arrangements for transferred frequency response with one or more external balancing authorities in the Western Interconnection as a means to ensure compliance with the BAL-003-1 standard in the near term. The ISO expects to obtain primary frequency response capability from resources within its balancing authority and plans to implement a market product for this capability in 2017. Entering into an out of market contract for primary frequency response

		about market products through which to acquire FR prior to the end of 2015. Nevertheless, NRG will oppose the ISO's efforts to acquire and compensate FR service from sources other than internal generators unless and until the ISO determines how to compensate internal generators for providing that same service. Finally, with regards to transferring some of the ISO's FRO to another BA - NRG offers caution on concentrating too much of the interconnection's frequency response in one geographic area (e.g., the Pacific Northwest). Doing so could require the operator of that BA to maintain sufficient headroom on outbound transmission to avoid overloading transmission lines and complicating or delaying the recovery.	with resources within the ISO's balancing authority would require system changes for the ISO's market process to recognize and preserve this capability and may also disrupt the efficient operation of the ISO's markets.
	Office of Ratepayer Advocates (ORA)	ORA encourages the ISO to further evaluate its capability to meet the NERC frequency response standard BAL-003-1. If the study shows that generators have sufficient headroom to provide the required frequency response, it will not be necessary to explicitly set the Spinning Reserve as Contingency Only. ORA is concerned that setting the Spinning Reserve as Contingency Only could lead to operating reserve over procurement or restrict the ISO from dispatching resources in the 5-minute Real Time Dispatch. ORA is also concerned about the over procurement of Spinning Reserve approach to meet the frequency response needs. Doing so may not resolve the frequency response under performance issue. In addition, this approach could also drive up the Spinning Reserve prices. Under this approach, these generators and other resources would not get any explicit compensation for the services they provide. To address this concern, the ISO could prioritize these frequency response resources when conducting the residual unit commitment processes. As a result, these frequency response resources will have more opportunities to sell their energy to the existing market. If the ISO, with the above approach, still cannot address the frequency response under performance issue, ORA agrees with other stakeholders' comments that the ISO should explore the concept of Frequency Response Sharing Group. This will make it more economical for using the existing frequency response capabilities than developing new ones.	The ISO proposes to clarify its authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves. The opportunity cost is reflected in the market prices for such reserves. The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See

			section 7.2.1 of the draft final proposal.
	Powerex	As explained at the December 14 Working Group meeting, Powerex believes that a competitive solicitation process whereby external balancing authorities ("BA") can submit offers to transfer frequency response to assist the ISO in meeting its BAL-003-1 requirement for the 2017 compliance period (i.e., December 1, 2016 through December 2017) represents the most promising avenue available to meet the ISO's primary frequency response needs on an interim basis. First, the ISO, in collaboration with interested BAs, should work with NERC and any other relevant regulatory bodies to confirm the specific process for transferring frequency response from one BA to another for a particular period. Second, the ISO should analyze the costs of meeting the frequency response standard during the initial 2017 compliance period using only internal resources for purposes of establishing the price cap to be applied in the competitive solicitation process. Third, the ISO should issue a revised draft proposal in this stakeholder process specifying the terms and conditions for the proposed competitive solicitation process, with a goal of seeking the ISO Board approval and making a filing with FERC no later than March 2016 seeking authorization to conduct the competitive solicitation process. The ISO should consider establishing a mechanism to procure primary frequency response service from internal resources and external BAs on a year-ahead and month-ahead basis.	As discussed in the working group call, the ISO is exploring regional solutions in this initiative. See section 7.2.1 for more details on the terms and conditions for the request for proposal. Procurement of PFR through cost-effective measures is one of the policy objectives under phase 2 of this initiative.
	SDG&E	Thus, SDG&E believes Powerex's phase 2 proposal is premature. Powerex proposes 'capacity like' payments either via a centralized forward procurement market or by amendments to LSE's Flexible RA program. SDG&E does not support designing capacity like payments until we know this mechanism is necessary to drive investment in resources ability to provide frequency response. Another RA type payment risks adding a potentially unnecessary cost in the form of a frequency response capacity payment in addition to a market product which would provide a revenue stream for the service	The ISO agrees designing capacity payments prior to determining the necessity to drive investment is premature. The ISO will continue to evaluate the costs of meeting compliance for BAL-003-01 to determine

		provided. The market and stakeholders do not have enough information at the present time to know an additional RA or capacity payment is warranted in the long run. SDG&E continues to request attention to cost and detail of meeting compliance for BAL-003-01. Options to meet the early stage compliance, phase 1, should be analyzed on a cost basis to see if modeling the frequency response deficiency and procuring reserve is more cost effective than contracting with other BAs to meet obligations.	if transactional arrangements have merit.
	Six Cities	After reviewing the presentations from Powerex and BPA, the Six Cities continue to believe that the use of spinning reserves is the best Phase 1 solution for meeting the ISO's frequency response obligation. As noted in the previous two rounds of comments, the Six Cities do not believe that developing a product to procure frequency response is the best path to achieve frequency response levels that comply with BAL-003-1. Using spinning reserves to meet the frequency response obligation likely would result in only a modest incremental increase in costs overall. According to the ISO's "2014 Annual Report on Market Issues and Performance" ("2014 Annual Report"), at page 108, ancillary services amount to only 0.6% of wholesale energy costs. Approximately two-thirds of those costs are attributable to spinning reserves. See 2014 Annual Report at 114, Figure 5.7. Therefore, the cost of procuring additional spinning reserves to meet the frequency response obligation, if needed, is likely to be some fraction of 0.4% of total wholesale energy costs. Certainly this cost must be less than the cost of developing an entirely new product or process. However, it would be useful for the ISO to provide an estimate of how much additional spinning reserves would be necessary to ensure compliance in order to better estimate the additional incremental cost. Powerex proposes a forward competitive solicitation process from external BAs as a potential Phase 1 approach to meeting the ISO's frequency response obligation. As discussed above, creating this new process seems unnecessary when there are already existing products	The ISO is no longer exploring modifications to ancillary services in phase one of this initiative. Given the capabilities of the western interconnection, the ISO finds exploration of regional solutions to be a cost-effective approach for the interim requirements. Phase 2 of this initiative will support long-term procurement of PFR capability.
	SCE	The ISO proposes to have FR requirements on all synchronous generators, not just SR resources. Since the ISO tariff requires SR resources to provide FR, the ISO proposes to rely primarily on these resources.	Section 7.2.2 of the draft final proposal clarifies existing WECC and NERC

		However, SCE does not believe that the obligation may always be met by SR resources. The ISO should analyze a sample number of SR units and summarize the observations on the actual vs. expected FR performance of SR resources. The ISO should pay particular attention to whether Automatic Generation Controls (AGC) do indeed prevent any FR. If existing SR resources are not providing FR as expected by the ISO, the cause and potential remedies should be explored prior to establishing any new requirements for other resources. Until the ISO determines whether the existing equipment in its SR fleet provides adequate FR, any projected studies are based on assumptions that may be inaccurate. For example, assuming that insufficient FR headroom is a primary cause; in fact, additional headroom does not guarantee additional FR. Further, as section 30.5.2.6.2 of the tariff states, headroom is at the discretion of the supplier – the ISO may not have the ability to affect that even if it were determined to be the cause. As the ISO and several stakeholders stressed during the call, a cost-benefit analysis is a prerequisite to any further progress on the reserve-sharing component of the ISO proposal. SCE believes the procurement and pricing alternatives may result in a few proposed frameworks of the reserve-sharing offering. Each of these proposed frameworks should be independently assessed for costs and benefits. In turn, further details on procurement and pricing will be needed before any framework can be developed. SCE reserves its position until such details as well as cost-benefit analysis are provided.	reliability requirements. Minimum PFR performance requirements are no longer being proposed in phase one of the initiative. The ISO will continue to evaluate the costs associated with the regional approach detailed in section 7.2.1.
Frequency Response Standard	NRG Energy	NRG believes the ISO has adequately set forth what its frequency response obligation is and how the ISO's performance will be measured. However, NRG sees much work ahead to define how individual resources' performance will be measured and how those resources' consequences for inferior performance will be determined and allocated.	PFR performance requirements, and appropriate market incentives for PFR will be explored in the second phase of this initiative. See section 7.2.5 for clarifications on the ISO's existing process for allocating the costs of reliability-based penalties.

	Calpine	ISO should state parameters it seeks from synchronous generation (acceptable droop settings, non-responsive bandwidth, and outer-loop/frequency bias parameters). ISO should re-evaluate overall performance once these are set and generators are given the opportunity to modify systems. ISO should consider operational conditions which limit unit's/parts of unit's response to frequency perturbations. Supports exploration of regional approach	After evaluating the ISO's overall performance and the operational characteristics of resources, section 7.2.2 of the draft final proposal proposes to clarify standards and enforce compliance. The ISO has proposed tariff amendments requiring minimum governor performance consistent with reliability criteria. As discussed in the working group call, the ISO is exploring regional solutions in this initiative.
	Large-scale Solar Association	Unresolved question concerns use of existing interruptible load programs for PFR. PFR trip settings of IOU Base Interruptible Programs could be modified. The ISO's calculation of its PFR includes a reduction in the WECC obligation to reflect 120 MW in load tripping in Arizona, indicating that this approach is being used in other BAAs. As a separate matter, LSA is concerned that the entities providing that interruptible load might consider that as part of its compliance, i.e., the ISO should calculates its share of the WECC obligation without subtracting that PFR source. This issue should be examined further.	Examination of load modifying products contributing PFR will be explored in the second phase of this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	California Wind Energy Association/ American Wind	CALWEA and AWEA Agrees with the ISO strategy intended to assure availability of sufficient PFR capability to address the reliability of its controlled grid by: 1) ISO strategy to incentivize synchronous resources to provide mandated governor response when availability at all times; and 2) developing	The ISO will develop market incentives and determine non-compliance penalties for PFR

	Energy Association (CALWEA/AWEA)	market incentives or financial compensation mechanisms for asynchronous resources (variable energy and storage resources, etc.) to add PFR capability to their suite of services. Recommends all resources, including synchronous generators that have an obligation to offer governor response, be compensated for the provision of PFR. Proposes payment method similar to that used for providing regulation service ("performance payment" or "mileage payment"). A performance payment coupled with the "non-compliance" penalty" will incentivize all generators and particularly synchronous generators to ensure availability and appropriate governor settings.	capability in phase 2 of this initiative.
	Jack Ellis	Suggests ISO abandons phase 1 approach. Alternative suggestion is to provide additional technical detail regarding proposed look-ahead tool and methodology for estimating PFR capability. Recommends ISO publish analyses of synchronous motor load PFR capability and N-2 frequency decay estimation for adverse PFR conditions (high renewable and hydro production, low gross demand).	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	California Department of Water Resources (CDWR)	The actual frequency response (FR) is calculated using data recorded in the Energy Management System. The post ante analysis is reliable to the extent of ISO measurement accuracy. The frequency response obligation is based on the ISO's estimation the WECC obligation, which is derived from the ISO's annual load and generation share within the interconnection. The ISO conservatively estimated a 30% share of the WECC interconnection frequency response obligation (NERC pre-determined value). The variation observed in figure 2 FRO numbers is relative to the size of the disturbance. In other words, the pre-defined rate of performance required by NERC (MW/.1Hz) and the disturbance size (e.g.	The FR values are based on ex post analysis of ISO measurements. The FRO is a fixed rate, yet the size of the disturbance (e.g., 0.1–0.3Hz) will determine the ISO's obligation. This is illustrated both in MW and as a percentage value of FR/FRO.

		0.1Hz-0.3Hz frequency decline) determines the ISO's frequency response obligation for a particular event.	
Frequency Response Drivers	Western Power Trading Forum (WPTF)	As noted in the above answer, it is difficult to comment on additional information or data points that should be included in the market tool or Masterfile given the lack of detail surrounding design and intent of the proposed tool. WPTF highly encourages the ISO to produce another draft prior to the draft final proposal. Above the proposed tool is described as a "market tool." WPTF is unsure whether this is the same tool described previously as an "out-of-market tool" that would be used by operators to determine the amount of reactive power need in the near-term (also described below as the "look ahead" tool?) WPTF has different recommendations depending on the purpose of the tool and what the ISO would do with the tool results. Without additional information, WPTF cannot provide feedback at this time except to note the following: (1) A simple version of a "look ahead" tool could be to use static data to determine a simple formula that fixes the total MW value of frequency response the grid must have in any hour. (2) A simple alternative to gathering large amounts of onerous information (including governor control system data) from scheduling coordinators in order to predict the amount of frequency response each resource could provide, is to simply allow the generator to bid in an amount each hour and hold the resource financially responsible for the provision of that amount. (3) Any look ahead tool should have its methodology and outputs fully transparent in real-time. This is of great importance to WPTF as often these tools are opaque and developed after the stakeholder initiative is completed. Any tool that affects the market outcome as this one does vis a vis the spinning requirement needs to be completely transparent to all market participants.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	NRG Energy	Currently, market participants who provide reserve products to the ISO may earn both reserve and energy payments if the ISO dispatches energy from such reserves. Requiring contingency only reserves eliminates the possibility of being dispatched to	The ISO proposes to clarify its authority to designate any reserve not previously identified

		provide energy, impacting revenue streams and in turn bidding of reserve products. The ISO should consider Regulation in setting the performance requirements for frequency response. Development of such requirements should be collaborative and transparent. Initial performance should be assessed in a "matchsticks" environment until adequate experience with the requirement is achieved.	as contingency only by a scheduling coordinator as contingency only reserves. The opportunity cost is reflected in spinning reserve market prices. Minimum performance requirements will be explored in phase 2 of this initiative.
	California Wind Energy Association/ American Wind Energy Association (CALWEA/AWEA)	Agrees with ISO on the main drivers supporting the availability of frequency response from synchronous generators. Given the relatively undefined nature of PFR capability from inverter-based resources, suggests a technical workshop with inverter-based resource manufacturers and other stakeholders to further understand asynchronous generation frequency response availability.	The ISO will further explore the PFR capability from inverter-based resources, and appropriate incentive mechanisms in the second phase of this initiative.
	SDG&E	Suggests ISO explores cooperation with other Bas in meeting frequency response requirements. ISO must have correct information on resources ability to provide PFR. Believes ISO must develop methodology that determines multi stage generation units operating level at any given time with respect to its PFR. Additional operating limitations of resources and exceptional dispatch conditions for competing objectives should be considered.	The ISO is exploring cooperation with other BAAs in meeting requirements. Determining a specific resource's exact PFR capability in any instant can present challenges.
	California Energy Storage Alliance (CESA)	There could be a constraint in the optimization that would act similarly to a Frequency Response product or constraint.	The ISO is will consider such modifications to the market optimization in the second phase of this initiative.
	Union of Concerned Scientists	Data should be collected from asynchronous resources and incorporated into the look-ahead tool. In developing the "look-ahead" tool, the ISO should include contributions to primary frequency response (PFR) from asynchronous resources such as electricity storage, solar photovoltaics, wind, and demand response. To include asynchronous resources in the look-ahead tool, the ISO will need adequate data from these resources. Collection of PFR data from	The ISO is no longer prioritizing development of the look-ahead tool as a part of policy design within this stakeholder initiative. The ISO will consider

		these resources can also help set the stage for Phase 2 of the frequency response initiative.	asynchronous resources PFR characteristics for developing appropriate PFR procurement capability in the second phase of this initiative.
	Calpine	Difficulties exist in accurately calculating PFR movement from individual units. Many generators may have outer loop control systems programmed to drive to ISO dispatch orders, potentially squelching PFR. ISO should consider imbalance energy costs and other indirect charges before requiring generation to deviate from ADS. Not all units can provide PFR, and ISO cannot accurately calculate PFR for every resource.	The ISO agrees difficulties exist in accurately calculating PFR movement from individual units. Section 7.2.2 of the draft final proposal clarifies existing WECC and NERC reliability requirements. Minimum PFR performance requirements are no longer being proposed in phase one of the initiative.
	SDG&E	A market product would not be implemented in time and may not be needed in the medium to long term.	The ISO will consider the implementation impacts of a market product in phase 2 of this initiative.
	California Large Energy Consumers Association (CLECA)	The idea of a frequency response product has merit. There should be proper compensation to insure that resources do not limit governor response. Also, resources should be compensated for investing in smart inverters or reducing load to help with frequency response.	The ISO will consider proper compensation and incentivized investment for PFR in phase 2 of this initiative.
	California Energy Storage Alliance (CESA)	The ISO should review regulation product designs. Eventually, there should be a Frequency Response product for both DA and RT markets.	The ISO will consider existing ancillary service market designs in developing the second phase of this initiative.

	Jack Ellis	The ISO should not waste its limited resources attempting to forecast how much primary frequency response (PFR) a participating generator can provide, in part because the forecasts will inevitably be wrong and in part because it is inappropriate for the ISO to forecast the performance of assets it does not own. Instead, the ISO should expedite development of a specific market product to procure PFR and then allow suppliers to tell the ISO how much they are willing to provide based on the performance requirements that should be part of any market product definition, and at what price. If the ISO needs to forecast anything, it is the amount of PFR that is available from synchronous motors so that it can determine how much PFR it must procure from other PFR-capable resources.	The ISO agrees forecasting generator's PFR capability presents challenges. The ISO will consider synchronous motors in developing forecasting capabilities of PFR. The exploration of a market product solution will begin with phase 2 of this initiative.
	NRG Energy	If there is not a market product, there should be uniform non-discriminatory compensation.	The ISO will consider a market product in phase 2 of this initiative.
	Large-scale Solar Association	A market would incent asynchronous resources to provide frequency response and pay for added costs.	The ISO agrees a market product is necessary to incent asynchronous resources to provide frequency response.
	PG&E	The ISO should work on developing a permanent solution and needs to provide analysis justifying any interim measures.	The ISO agrees that a permanent solution must be developed in regards to PFR. The ISO also agrees that providing analysis justifying interim PFR measures is necessary.
Phase 1, addressing real-time deficiencies	Western Power Trading Forum (WPTF)	The first step discussed in section 6.2.1 is to develop "look-ahead" tools to assess the PFR capability of the system at various time horizons in the future based on current system conditions. If the look ahead indicates an anticipated deficiency of PFR the ISO can take actions to address the deficiency. The ISO seeks comments on its proposal for addressing real-time PFR deficiencies for 2017 compliance period. Comments: If WPTF understands the ISO's proposal correctly, the first step from the ISO will be to increase the spinning reserve requirement or proportion spinning reserve that meets the spinning	The ISO is no longer prioritizing development of the look-ahead tool as a part of policy design within this stakeholder initiative. The ISO is no longer considering modifications to ancillary service

		requirement. (WPTF is assuming the ISO is not counting regulation capacity as available to meet the frequency reserve requirement.) No other constraints will be added, i.e. this will be done without adding a resource constraint to limit the amount of spinning reserve a resource can provide to the amount of frequency response they can provide. The idea is simply to "see if this works" and if the market does not procure additional needed frequency response then the ISO will use the exceptional dispatch tool to directly procure additional frequency response capability. WPTF seeks clarification in regards to timing of the use of the tool and the procurement of additional spinning reserves. If the ISO determines, for example, 4 hours ahead of time that additional frequency response is needed, when will the incremental need be added to the spinning requirement and when will the ISO validate that additional MWs of spinning reserve were sufficient? In real-time any incremental ancillary services are re-optimized with energy every 15-minutes. It seems like the ISO will not know for certain whether there is sufficient frequency response on the system until the binding FMM interval procures the additional spinning reserve. The only way the ISO could ensure the additional spinning capacity would yield sufficient frequency response is by adding a constraint in resources (especially MSG) that have restricted frequency response to spinning reserve ratios.	procurement in phase 1 of this initiative.
	NRG Energy	The "look-ahead" tool ("LAT") must be developed, implemented and managed in a transparent way. Specifically: · How it determines the ISO's frequency response requirement must be clear to market participants. The ISO should publish, either in a technical bulletin or operating procedure, the inputs to and calculations performed by the LAT. · The ISO should run this tool on a regularly scheduled basis and publish the results of this tool's analysis on OASIS. · The ISO should regularly (e.g., monthly, as part of the monthly market performance metrics documents) publish metrics that describe how this tool performed and how the CAISO met the frequency response requirements that the tool developed. · To the extent market participants are determined to have caused the ISO to fail to meet its frequency	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.

		response performance, the ISO should publish that information (with the identity of the market participant withheld) so as to help market participants improve their performance.	
	Six Cities	. The Six Cities believe the use of a look-ahead tool is an appropriate way to identify PFR deficiencies. The Six Cities also support the use of spinning reserves to meet the frequency response requirements of BAL-003-1. Until there is a demonstration that there is an incremental need for additional spinning reserves, the Six Cities believe that the existing level of operating reserves should be relied on to provide frequency response. If, after exhausting available operating reserves, the ISO finds that additional spinning reserves are needed for frequency response, then at that time the ISO could consider procuring additional reserves as spinning reserves.	Phase 1 of this initiative will monitor and report on ISO's performance. The ISO is no longer prioritizing development of the look-ahead tool as a part of policy design within this stakeholder initiative.
	PG&E	PG&E supports the ISO's proposal to develop a frequency response forecasting tool, which will provide the ISO with better visibility of both the system need and system capability to provide primary frequency response. PG&E also supports the ISO's proposal to procure additional frequency response capability in order to ensure NERC compliance. However, PG&E is hesitant to support any specific procurement solution that combines spinning reserves with frequency response, as PG&E is concerned that such a combination will have unintended consequences. PG&E looks forward to working with the ISO and other stakeholders on the details of other solutions. PG&E recommends that the ISO consider procuring frequency response reserves from other Western Interconnection balancing authorities, if this is the most effective solution. For example, Bonneville Power Administration (BPA) has stated that it has "more frequency response reserves than it needs to meet its own obligations under the new standard" and is proposing to sell reserves to other balancing authorities. Further analysis would be needed by the CAISO to understand all the implications of procuring frequency response outside of its balancing authority area	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	California Wind Energy Association/ American	As noted before, CALWEA and AWEA support the ISO's overall strategy in addressing primary frequency response in two phases. As we see it, for Phase 1 of this broad approach, the biggest factors for the ISO to consider is the magnitude of PFR requirement and	The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to

	Wind Energy Association (CALWEA/AWEA)	the ISO's obligation to meet its share of the total magnitude. And this magnitude needs to be measured on a daily basis, once before the DA market and again between the DA and the FMM markets. The capability to meet the ISO's share of the requirement should become a constraint for the DA unit commitment and 15-minute market unit commitment processes. Only in this fashion will it be possible to ensure the availability of sufficient PFR from the ISO footprint. However, when it comes to addressing the capability question, it is essential that the share of PFR for each Balancing Area (BA) is correctly apportioned. This apportionment should be based on the effectiveness of the PFR from each BA in resolving the interconnection-wide PFR need – similar to generation curtailment to resolve emergency transmission overloads; it should not be based on the magnitude of load and generation within the BAs.	be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal. The ISO will report and continue to monitor its performance. The magnitude of the PFR requirement for each interconnection is provided by NERC, as are the requirements basis for compliance.
	Powerex	Mandatory elections of "contingency only" operating reserves eliminates the resources opportunity to provide an economic energy bid despite declining "contingency only" status in its bid. Straw proposal lacks discussion on compensating resources "held back" from real-time energy sales would receive. Proposes at a minimum providing opportunity cost to such resources, similar to that provided under flexible ramping constraint. ISO should clarify if "contingency only" applications will be technology agnostic. ISO should consider compensation mechanisms for synchronous resources required to adhere to governor response mechanisms to ensure owners are not counterproductively disadvantaged as a result of being technically qualified to provide PFR. Additional spinning reserve procurement will incur an additional cost that is distinct from the cost of procuring operating reserves.	The ISO proposes to clarify its authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves. The opportunity cost is reflected in the payment for such reserves. Existing cost allocation for spin. The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	Union of Concerned Scientists	To the greatest extent possible, the look-ahead tool and results should be made publicly available.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative.

	SDG&E	SDG&E believes a 'look ahead' tool could be helpful in determining where PFR deficiencies may occur and mitigate issues before they arise. However, any method of implementing a tool of this nature comes with its own challenges. The ISO has outlined a straightforward tool: estimating PFR capabilities after the day-ahead market is run, comparing this to frequency response obligations and curing any deficiencies by procuring additional spinning reserves or, if necessary, issuing EDs. This method stands to be administratively simple to construct and support. However, how much accurate information does this method actually provide for decision making? How does the tool account for details such as the fact not all spinning reserve procured in the DA market will be available for PFR? The Straw Proposal even notes the 'initial calculation is likely to underestimate any deficiency' (pg 14). SDG&E would like more information on the tool and how it will account for these inaccuracies and interactions with real-time operations to address overgeneration and ramping needs.	The ISO is proposing to transfer a portion of the ISO's PFR obligation to an external BA through a request for proposal process. The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative.
	Calpine	In general, Calpine does not object to the development of a "look-ahead" tool to assess the availability of PFR (of course, knowing the precise amount of PFR available from any particular unit at any particular time may not be reliable.) Calpine understands this proposal is preliminary, but much more information on the calculation methodology would be required. In general, this calculation should form the basis of the demand for the new product on a forward basis. Calpine would not support the development of this forward-looking tool if it merely establishes a basis for the ISO Operator out-of-market actions. As discussed below, any unit commitments necessary for PFR must create a capacity and / or shadow price. To do otherwise would unduly suppress energy market and Ancillary Services clearing prices.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	Jack Ellis	It is a poor use of ISO staff resources for several reasons. First, it adds unnecessary complexity. Second, the ISO has not provided enough information for stakeholders to assess whether in fact the ISO is able to develop a credible "look-ahead" tool. The ISO and stakeholders would be better served by	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative.

		redirecting resources to developing a market product for PFR.	Development of a market product will be considered in phase 2 of this initiative.
	California Department of Water Resources (CDWR)	CDWR supports development of "look-ahead" tool to assess PFR capability and assist in anticipating deficiencies. Cautiously supports use of spinning reserves to ensure unloaded frequency response capacity. Through this methodology, ISO procures PFR as a byproduct of spin which will likely distort spinning reserve prices. CDWR would prefer to see two types of spinning reserve products separated if spinning reserve prices start to rise. Additional cost of procuring PFR headroom from spinning reserves will increase the ancillary services allocation to measured demand. CDWR believes costs for such purpose should be allocated to all market participants since everyone benefits, especially generators.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	California Energy Storage Alliance	In the long term, the ISO could work with CPUC and other LRAs to come up with longer-term/capacity contract solutions.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
Phase 1, tariff and interconnecti on revisions	Western Power Trading Forum (WPTF)	WPTF supports defined parameters for synchronous generators; including acceptable droop settings, non-responsive bandwidth and outer loop control system parameters. Once the ISO defines parameters, and generators are given the opportunity to modify	Proposed modifications to section 4 of the tariff will clarify requirements

		systems, the CAISO should reevaluate the overall performance and the need for any performance requirements and non-compliance penalties.	consistent with NERC and WECC criteria. The ISO is not proposing minimum performance requirements under phase 1 of this initiative.
	NRG Energy	The ISO's proposed provisions should help provide better PFR in the near-term, but should not become the long-term preferred solution. Doing so would put the entire PFR burden on a single class of market participants (synchronous generators).	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO finds exploring regional solutions to ensure BAL-003 compliance at the lowest cost to be a prudent near-term solution, as suggested by several stakeholders in this initiative. See section 7.2.1 of the draft final proposal.
	Calpine	Notwithstanding the concerns with the creation of imbalance energy above, we do not object to including objective Masterfile standards for droop, bandwidth and frequency bias. Even with these characteristics, however a steam turbine (as part of a CCGT, or as part of a geothermal project) may have no useful PFR.	The ISO is proposing to revise section 4 of the tariff to clarify resources with governor controls are required to maintain droop and deadband settings consistent with NERC and WECC criteria.
	California Wind Energy Association/ American Wind Energy Association	CALWEA and AWEA strongly support this part of CAISO proposal. At the same time, as we broadly presented in our response to the first question, CALWEA and AWEA believe that synchronous generators should receive a performance (mileage) payment after the provision of governor response (in addition to getting penalized for not providing their PFR obligation in sufficient magnitude) in order to	Phase 2 of this initiative will evaluate various market structures for PFR. The ISO will not propose minimum performance requirements or

	(CALWEA/AWEA)	better incent these resources to participate in the provision of governor response.	changes to its authority to allocate reliability based penalties in this initiative.
	Bay Area Municipal Transmission Group	The ISO should consider the effect on the amount of spinning reserve procured and the spinning reserve provided for a single unit.	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	California Department of Water Resources (CDWR)	CDWR in general supports section 4.0 of the tariff being revised to clarify minimum synchronous generator governor performance. However, the ISO must be sensitive to the limitations of governor technologies that are already installed. The ISO should not require synchronous generators to upgrade their governors without also requiring the same from installed asynchronous generators. CDWR recognizes that PFR for asynchronous generators is still at its infancy, technology is still being developed, and may be expensive to add to an asynchronous generator design. Similar to reactive power capabilities for asynchronous generators, CDWR believes that PFR will also become a standard option at an incrementally minimal price for asynchronous generators. The ISO's long term goal for complying with the new PFR standard is that all generators, both synchronous and asynchronous, should provide some minimal amount of PFR at no charge. If additional PFR headroom is required, then the ISO can procure additional PFR capability from PFR certified resources. CDWR also believes penalties should apply to generators that do not meet their minimum PFR performance.	The ISO is not requiring synchronous generators to upgrade their governors, modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria.
	California Energy Storage Alliance (CESA)	If Spinning Reserve is used, resources should be able to include Frequency Response in addition to Spinning Reserve costs.	The ISO is proposing to transfer a portion of the ISO's PFR obligation to an external BA through a request for proposal process. The ISO is no longer considering modifications to ancillary service procurement in

			phase 1 of this initiative.
	Union of Concerned Scientists	Increasing spinning reserve requirement could lead to new capacity costs.	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	California Large Energy Consumers Association (CLECA)	Concerned about using spinning reserve in lieu of a frequency response product. ISO may have to procure more spinning reserve at additional costs.	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	PG&E	PG&E supports all of the ISO's proposals related to tariff and interconnection revisions. More specifically, PG&E supports the ISO's proposal to clarify requirements around governor settings for participating synchronous generators with governors. PG&E would like to better understand, however, the rules and process for exempting certain units that physically cannot provide primary frequency response.	Proposed modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria. The ISO is not proposing minimum performance requirements under phase 1 of this initiative.
	SDG&E	How much supply and procurement of spinning reserve is the ISO currently seeing in the DA and RT markets? How liquid is the market or what does the Page 2 of 4 supply price (cost) curve look like? How large is the spinning reserve market now and how much would the estimated need increase if looking at procuring to meet frequency response needs in the future? How costly may this method be, particularly in periods of over generation?	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	Jack Ellis	The ISO's proposed tariff changes as outlined in Section 6.2.2 are appropriate as an interim measure only until a PFR market product can be developed.	Proposed modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria.

			Development of a market product will be explored in phase 2 of this initiative.
	NRG Energy	Procuring additional spinning reserves might work as an interim measure, but buying more spinning reserve on same synchronous machines may not increase response.	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	Large Scale Solar Association (LSA)	LSA's last comments encouraged the ISO to first rely on enforcement of current WECC rules concerning governors for asynchronous generators. LSA supports any tariff clarifications that would facilitate generator compliance with WECC rules, and the proposed revisions should be consistent with those rules.	Proposed modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria.
	California Energy Storage Alliance (CESA)	If there's no explicit frequency response requirement for spinning reserve, there could be potential reliability risks (noncompliance with NERC rules).	The ISO is proposing to transfer a portion of the ISO's PFR obligation to an external BA through a request for proposal process. The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
Phase 1, ISO's practice of preserving operating reserve headroom	Western Power Trading Forum (WPTF)	WPTF has no objection to this proposal, but requests clarification on why this is necessary. It is our understanding that non-contingent spin is only "released" and able to be dispatched as energy if the ISO has sufficient spinning reserves to meet the requirement. If the ISO's plan is to increase the requirement, why would the ISO need to designate incremental spinning reserves as contingent-only?	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative. Clarifying the ISO's authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as

			contingency only reserves ensures reliable operation of ISO market systems.
	NRG Energy	"Currently, market participants who provide reserve products to the ISO may earn both the reserve payment and an energy payment if the ISO dispatches energy from those reserves. Holding reserves as Contingency Only will reduce the possibility of being dispatched to provide energy and will affect those revenue streams. That, in turn, may impact bidding of reserve products."	The ISO proposes to clarify its authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves. The opportunity cost is reflected in the market prices for such reserves. The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative.
	SCE	SCE does not support the ISO's proposal to require spinning reserve-capable resources to tune their governors to ISO specified settings. NERC has learned that coordinating Automatic Generation Control (AGC) with each resource's Distributed Control System (DCS) is essential to providing desired FR2. In other words, the ISO's dispatch must consider each resource's own FR algorithm for appropriate response. NERC emphasizes the importance of AGC and DCS coordination, and while NERC provides an advisory maximum of ± 36 mHz governor deadband setting3, there is understanding that AGC and DCS coordination are essential to guarantee FR. Thus, the ISO should seek to ensure this coordination. The proposal to treat all DA operating reserves as contingency-only, regardless of the Scheduling Coordinator's election, can lead to uneconomic solutions and RTM price spikes, which would result in higher market costs. Under the ISO proposal, some or all of the otherwise economically dispatchable non-contingent operating reserves would no longer be included in the RTM energy bid stack, even if the total operating reserve remained above the requirement.	The ISO is no longer considering modifications to ancillary service procurement in phase 1 of this initiative. The ISO proposes to require resources submit governor and plant control systems data to enhance AGC and DCS coordination.

		The ISO should evaluate the trade-off between the impact to the RTM price volatility and the potential benefit to FR. To the extent that designating operating reserves as contingent-only can be demonstrated to provide FR benefit, the ISO should apply this only to hours with PFR deficiencies.	
	PG&E	PG&E supports the ISO's proposal to clarify its authority to treat day-ahead procured operating reserves as contingency only in the real-time market, regardless of the resource's election.	Clarifying the ISO's authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves ensures reliable operation of ISO market systems.
	California Wind Energy Association/ American Wind Energy Association (CALWEA/AWEA)	CALWEA and AWEA support this part of the ISO's proposal. At the same time, we believe that if the actual unit commitment process is formulated to ensure sufficient PFR is available in the system there should be no need for taking such measures. However, until such time that the need for PFR is not modeled in the DA and FMM unit commitment processes, we agree with the ISO that converting the contingency flag for all reserve capacity to Contingency Only flag will help ensure the available of the needed FPR within the CAISO footprint.	Clarifying the ISO's authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves ensures reliable operation of ISO market systems.
	Six Cities	The Six Cities support this aspect of the ISO's proposal because the ability to designate any reserve not previously identified as Contingency Only by a Scheduling Coordinator as Contingency Only reserves is necessary to support the use of spinning reserves for frequency response.	Clarifying the ISO's authority to designate any reserve not previously identified as contingency only by a scheduling coordinator as contingency only reserves ensures reliable operation of ISO market systems.
	Calpine	First, Calpine agrees with the Union of Concerned Scientists and the statements of WPTF that PFR and Spinning Reserves should be separate markets. Calpine does not object to more spinning capacity being designated as contingency-only, however, we are not convinced that increasing the quantity of the	The ISO agrees with stakeholders that spinning reserves and PFR should be separate markets. The ISO is no longer

		spinning reserves is an efficient or appropriate way to increase PFR. First, without additional constraints, additional procurement of spin does not translate equivalently into more PFR. Simply put, the ability to meet a dispatch and generate in 10 minutes does not translate directly into autonomous primary frequency response. In fact, the false presumption that spin and PFR are fungible will most likely result in deeper and more significant frequency perturbations. And more troubling, the absence of known autonomous response could allow the nadir (point C in the ISO graphs) to drop, possibly low enough to trigger under-frequency load shedding. Second, by designating more reserves as contingency-only, the ISO creates less available energy for dispatch (load following, e.g., 15-minute, or 5-minute dispatch). Finally, spinning reserves and PFR are distinct products. Counting spinning reserves as meeting a PFR obligation is inappropriate on its face.	considering modifications to ancillary service procurement in phase 1 of this initiative.
	California Department of Water Resources (CDWR)	CDWR understands that designating all spinning reserve as Contingency Only will help preserve the PFR capability of a generator by not dispatching unused spinning reserve as energy. CDWR cautiously supports this proposed tariff change because automatically designating all spinning reserves as Contingency Only may have unintended effects on spinning reserve and non-spinning reserve prices. As explained earlier, inflated reserve prices will have a negative financial consequence on measured demand. If the CAISO decides to make this tariff change CDWR recommends that the CAISO's DMM monitor spinning/non-spinning reserve prices and activities for anomalies or inefficiencies.	The ISO is proposing to monitor and report PFR performance through this initiative. The ISO's department for market monitoring presently monitors ancillary service prices and activities in its annual report.
Phase 1, performance requirements	NRG Energy	The development of clear performance requirements is critically important. Both the performance requirements and the way the ISO will assess performance must be clearly specified in the ISO Tariff. The ISO's and market participants' experience with the performance requirements for Regulation should be considered in setting the performance requirements for frequency response. As the ISO discovered with regulation, setting an arbitrary performance threshold for frequency response could be problematic. For all of these reasons, the ISO should: (1) collaboratively and transparently develop the proposed performance requirement and the means	The development of performance requirements for PFR will not be considered until phase 2 of this initiative. Experience gained since the ISO began exploring PFR capability in 2012 will be leveraged in such development.

		by which the performance requirement will be measured; (2) initially assess performance in a "matchsticks" environment for a period of time until there is adequate experience with the performance requirement."	
	Calpine	Calpine asserts that as with other reserves, an explicit tariff requirement coupled with Masterfile characteristics and periodic reviews of response is a sufficient performance requirement. Of course a diligent and comprehensive review process should be established, with both a substantial opportunity for unit-owners to explain alleged non-performance as well as increasingly severe consequences of non-performance.	The development of performance requirements for PFR will not be considered until phase 2 of this initiative. The ISO will develop market incentives and determine non-compliance penalties for PFR capability in phase 2 of this initiative.
	California Department of Water Resources (CDWR)	CDWR understands that all synchronous generators must comply with WECC's existing Governor Droop Regional Criterion. Is the ISO proposing in this section of the proposal to apply "minimum FR performance requirements" different than or exceeding WECC's?	The ISO's proposed modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria. Additional performance requirements will be considered in conjunction with a market product, during phase 2 of this initiative.
	Large-scale Solar Association (LSA)	As noted above, LSA believes that the the ISO should first rely on enforcement of current WECC rules concerning governors for synchronous generators, and LSA supports any tariff clarifications consistent with those rules.	The ISO is proposing to clarify requirements for resources with governor controls are required to maintain droop and deadband settings consistent with NERC and WECC criteria. See section 7.2.2 for details.

	SDG&E	SDG&E appreciates the imprecise science of allocating system penalties for underperformance for PFR. In this case, penalty allocation may not be as simple as a direct allocation to event underperformers. While there are only 25 instances the ISO will be measured on for frequency response performance, there are additional frequency response events during the year. It may not be fair to directly allocate penalties to resources which don't respond on a single measured event, especially if they are traditionally reliable resources providing frequency response to the system. In fact, allocation penalties to event underperformers could result in perverse incentives. New generators may choose not to add frequency response capability if there is the possibility for large underperformance penalties. SDG&E looks forward to the ISO's development of this topic.	The ISO is no longer proposing changes to its authority to allocate reliability based penalties. Incentivizing procurement of PFR from generators will be addressed in phase 2 of this initiative.
	Jack Ellis	Ideally any PFR-capable resource that offers into a PFR market to be defined should be prepared to a) initiate deployment within three seconds of the time system frequency falls below the lower deadband, b) deploy the full amount offered, if required, within 50 seconds, c) sustain full response for up to ten minutes, d) deploy in proportion to the amount of any frequency decline, e) back off on its response as frequency recovers and other grid services are deployed. Some method of controlling the deployment so that it is roughly proportional to the change in system frequency should limit the potential for oscillations since governors and other controls will lag any changes in system frequency.	Minimum requirements for PFR-capable resources and the development of a PFR market will be considered in phase 2 of this initiative.
	PG&E	PG&E questions the ISO's proposal to require spinning reserve-certified resources to provide frequency response. More specifically, PG&E is concerned that certain types of generators, while able to provide spinning reserves, will not be able to provide primary frequency response.	The ISO is no longer considering PFR minimum performance requirements for spinning reserves or other generating resources in this phase of the initiative.
Phase 1, allocation of BAL-003-1 non-compliance penalties	Western Power Trading Forum (WPTF)	WPTF requests additional details and has many concerns regarding this proposal. In general, there is significant risk in creating artificial performance thresholds. An example of how something that sounds reasonable in theory, but work out terribly in practice is the original regulation threshold created in	The ISO is no longer considering PFR minimum performance requirements in the

		pay-for-performance.1 It is important to recognize within the policy that there are units or parts of units that will not respond to frequency perturbations – either because of operational conditions or because some mechanical governors have a response time lag- and will not provide a response in the evaluated time horizon.	first phase of this initiative.
	NRG	The ISO needs to protect market participants against unreasonable outcomes – such as a small deficiency incurring a very large penalty. The ISO should adopt a "cap" and allocate penalties above the cap to the broader market.	ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.
	PG&E	PG&E conceptually supports the ISO's proposal to allocate non-compliance penalties to those resources that fail to provide frequency response in line with their obligation. However, PG&E requests additional details related to this proposal, so that the proposal can be adequately evaluated.	ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.
	Large-scale Solar Association (LSA)	Steps 1 and 2 of the ISO's proposed plan to remedy deficiencies rely on additional purchases of Spinning Reserve. The very significant problems with this approach discussed on the stakeholder conference calls indicate that this may not be an optimal remedy, e.g.: · Only a small portion of the additional purchases would be available for PFR, depending on the type of resource. The discussion on the last two conference calls indicates that this would be something like 3-8% of the incremental procurement. · The additional purchases made in merit order could be those that are least efficient (or incapable) in providing PFR. · Resources that are not bid or selected for SR could be those that could provide the most PFR benefit, e.g., Energy Storage resources. It may be more efficient and effective for the ISO to just use Steps 3 and 4, i.e., rely more on Exceptional Dispatch of resources that are most likely to fill in any PFR gaps. Again, the 29-30 MW average deficiency	The ISO agrees with stakeholders that spinning reserves and PFR should be separate markets. The ISO is no longer considering modifications to ancillary service procurement in this phase of the initiative.

		cited by the CAISO indicates that such dispatches would likely be limited, and it certainly would be better to issue that level of Exceptional Dispatches than to procure many times that amount of SR. LSA also encourages the ISO to examine the Exceptional Dispatch compensation provisions, similar to its actions in the Reactive Power & Financial Compensation initiative, to ensure that resources dispatched down to provide headroom for PFR are compensated for their opportunity costs. (For asynchronous generators and others paid on a volumetric basis, that opportunity cost should be based on the forgone revenue under their Power Purchase Agreements (PPAs).	
	NRG Energy	ISO would need to discuss changes in governor droop settings with participants if spinning reserves were used.	The ISO is no longer proposing minimum PFR performance requirements in this phase of the initiative. See section 7.2.2 of the draft final proposal for details on resources with governor controls.
	California Wind Energy Association/ American Wind Energy Association (CALWEA/AWEA)	As we noted before, CalWEA and AWEA fully support this penalty provision of the proposal.	ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.
	Jack Ellis	It would be inappropriate for the ISO to use its assessment of the PFR performance for generators as the basis for penalties since the ISO is not in a position to make this assessment and the ISO should not be making this assessment - the asset owner should. Any penalties should be assessed based on whether a resource delivers what it committed to deliver rather than what the ISO believes it can deliver. Assuming the ISO proceeds directly to developing a market product, any failure by a resource to perform in accordance with its obligations should lead to financial penalties that are proportional to the magnitude of any performance	The ISO is no longer proposing minimum PFR performance requirements in this phase of the initiative. ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond

		deficit and large enough that the cost of failing to perform is greater than any compensation. In my opinion simply clawing back amounts previously paid to a supplier is not a sufficient incentive to compel performance in accordance with a contractual obligation. If a generator's failure to perform leads to unplanned load shedding, a million dollar penalty is wholly inadequate, assuming a single resource is solely responsible. Resources that provide PFR should have clear, strong incentives to perform irrespective of the magnitude of any frequency deviation or whether there is any subsequent harm. In the energy market, suppliers that fail to perform pay for replacement energy. Since there is no way to determine replacement cost and since the consequences of a failure to supply PFR can be much more severe, some sort of fixed penalty per MW of deficiency is required, as is a reasonable methodology to determine the magnitude of a performance deficiency by a single supplier.	this. See section 7.2.5 of the draft final proposal.
	Six Cities	The Six Cities support the ISO's proposal to allocate non-compliance penalties associated with BAL-003-1 to resources that should have provided more PFR than they actually delivered during frequency events. However, the Six Cities do not support additional tariff provisions beyond those set forth in section 14.7. The process set forth in the ISO Tariff, Section 14.7, is sufficient to impose responsibility for penalties on any resource that fails to provide primary frequency response that it has an obligation to provide. Under Section 14.7, the ISO already has the ability to directly assign penalties, which is what it would seek to achieve through any new tariff provision. There is no need for additional tariff provisions to address penalties related to non-compliance with BAL-003-1.	The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.
	Union of Concerned Scientists	Droop settings specify response as MW/Hz, but UCS is unaware of a response time in which the resource must provide this response. Is there a standard for this?	Phase 2 of this initiative will consider the appropriate mechanism for incentivizing resources to provide PFR. Phase 1 of this initiative is intended on ensuring compliance to BAL-003 reliably.

	Calpine	Calpine "strenuously objects" to this proposal. First, as stated above, the ISO does not possess the information necessary to calculate (without false precision) the counterfactual PFR response. Any assertion that a unit should have, or could have, or must have produced more responsive energy would open detailed and likely repeated factual disputes about the then-current conditions and the ability of individual machines to respond. Second, the penalty proposal is unfair because not all units (e.g., vintage variable resources) are capable of providing PFR. Absent any other compensation, units subjected to asymmetric penalties would have to raise their capacity prices to reflect the risk-adjusted exposure to the penalties. This ironically, would place units providing a valuable service to the grid at a competitive disadvantage compared to units that have no ability to provide PFR. Third, the proposal is cursed by a problem of big numbers. That is, if the ISO is assessed a single occurrence penalty for not providing its individual share of PFR, that penalty could be as high as $1MM. If only one generator did not meet the ISO's counterfactual response, it could be assessed the full $1MM for a couple MW for a few seconds.	The ISO is no longer proposing minimum PFR performance requirements in this phase of the initiative. ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.
	California Department of Water Resources (CDWR)	CDWR supports in general that penalties imposed on the ISO due to failure to comply with the new frequency response standard (BAL-003-1) should be subsequently imposed on the resources responsible. However, due to the lack of information on how the ISO will measure resource PFR performance, CDWR cannot provide detailed recommendation on how to allocate this fine to generators. Can the ISO please answer the following questions? 1. Can the ISO measure "sufficient" and "insufficient" PFR performance from specific generators? 2. Can the PFR performance of a generator, or lack of performance, be tied back to a specific frequency event? In other words, for a specific frequency event that was used in the BAL-003-1 evaluation, can the ISO determine which generator(s) under performed and by how much? 3. Can the ISO calculate a "weighted under-performance value" for each generator that is tied to a frequency event that caused the ISO to fail the BAL-003-1 evaluation? 4. Can BAL-003-1 fines be allocated to generators based on the above "weighted under-performance	The ISO is no longer proposing minimum PFR performance requirements in this phase of the initiative. ISO tariff section 14.7 addresses reliability-based penalties. The ISO is no longer proposing additional tariff penalty provisions beyond this. See section 7.2.5 of the draft final proposal.

		values"? 5. Has the ISO allocated similar penalties in the past? How was it done? 6. How have other ISOs handled similar fines imposed on them?	
Phase 2, long-term approaches	SCE	SCE does not support consideration of another ISO market product. Additional market products will not guarantee a solution to the issue. SCE recommends the ISO consider using a market constraint and determine whether the ISO's FR needs are met with that constraint. However, quantifying the ability of the existing generation mix to supply FR is a prerequisite for any longer-term actions.	The ISO will consider evaluating a market product solution and other PFR procurement solutions in the second phase of this initiative.
	Western Power Trading Forum (WPTF)	WPTF reiterates its skepticism that the current ISO proposal is implementable by December 1, 2016, but a simplified market product is impossible. Currently the ISO is proposing a complicated look-ahead tool, large data gathering efforts in Masterfile, and an after-the-fact check and penalties. A biddable ancillary service product would from an implementation perspective be a simple copy of the current ancillary service products software design and only require minor changes to Masterfile. If it requires additional time, WPTF suggests relying temporarily on exceptional dispatches while the product is finalized.	The ISO is no longer prioritizing the look-ahead tool's development as a policy design objective in this initiative. The ISO is no longer proposing additional tariff penalty provisions beyond this. The ISO proposes to seek authority to enter into contractual arrangements for transferred frequency response with one or more external balancing authorities in the Western Interconnection as a means to ensure compliance with the BAL-003-1 standard in the near term. The ISO expects to obtain primary frequency response capability from resources within its balancing authority and plans to implement a

			market product for this capability in 2017.
	PG&E	For the long-run, PG&E recommends that the ISO explore frequency response requirements for asynchronous generators. With modern inverter technology, asynchronous resources will be increasingly able to provide primary frequency response, and so PG&E recommends that the ISO ultimately work with NERC and WECC to explore such requirements. This is particularly important for the ISO, given that asynchronous resources in California are displacing synchronous resources for large portions of the day.	The ISO agrees asynchronous resources will be increasingly able to provide PFR, and will consider incentivizing such capability in the second phase of this initiative.
	Six Cities	As described in the Six Cities' comments on the ISO's Frequency Response Issue Paper, the Six Cities do not believe that developing a product to procure frequency response is the best path to achieving frequency response levels that comply with BAL-003-1. Developing a new product introduces an additional level of complexity that may be unnecessary if sufficient frequency response capability can be achieved through other solutions. Further, there is no need to carve out frequency response from other operating contingencies that spinning reserves are intended to address. Disturbances resulting in a decline in system frequency are among the types of contingencies that spinning reserves are intended to deal with, not an entirely independent system requirement. There is a natural overlap between the kinds of conditions that give rise to the need for frequency response and the kinds of contingencies spinning reserves are intended to address. It is unnecessary to create a separate product when an existing product is available to meet the need, particularly when the existing product already is intended to meet this type of need.	The ISO will evaluate the benefits of a market product solution compared to modifications of existing ancillary services to determine the reliability need for any changes.
	SDG&E	SDG&E urges the ISO to focus more on identifying short term options and making an informed decision as opposed to spending time and resources on hypothesizing a long-term approach. We really don't have enough information on how the ISO system will be changing over the next few years to begin to develop a solution for the long run compliance of BAL-003. Before SDG&E can make informed recommendations on a market constraint versus a market product, we think it prudent to do more analysis on what the system will look like in 2017 and	Given existing publications and data analyses suggest deteriorating PFR performance, the ISO is evaluating additional concerns outside of phase 1 solutions interim. See section 5.1 of

		beyond. Information from experience is best when looking to shape the long term solution.	the draft final proposal.
	Powerex	Powerex strongly supports the eventual development of a discrete PFR product procured and compensated through CAISO's day-ahead and real-time markets. Frequency Response is an example of an attribute—related to but distinct from the provision of electrical energy—of certain resources participating in ISO's markets. Resources will vary in their ability to provide PFR based on a number of factors, including operational flexibility, whether control systems (e.g.,governors) are in place, and the configuration of those control systems. And there is no reason to believe that resources that can provide energy at least cost are necessarily the resources that can provide PFR at least cost. Moreover, providing PFR requires preserving "headroom," which means foregoing alternative uses of that capacity. These complex interactions make it highly likely that the cost of meeting the ISO BAA's need for energy and associated capacity products, including PFR, can be minimized only through joint optimization. Development of a formal PFR product will ensure competitive and efficient prices reflecting the value of providing PFR. This is important for at least two reasons. · It provides appropriate compensation to resources that provide a necessary service. This is a core objective of efficient pricing in ISOs and RTOs, most recently articulated by FERC in the context of shortage pricing, "…prices in each dispatch interval should reflect the value provided by dispatched resources. In times of shortage, the value of services a resource provides increases because operating needs have increased." Market based compensation for PFR provides an important price signal for longer-term incremental investments and upgrades in physical resources capable of providing the needed service. As the ISO considers the development of a PFR product, Powerex recommends that it pursue appropriate ways in which that product can be supplied by physical resources located outside the ISO BAA. It is axiomatic that ISO's needs will be met at lowest cost when it is able to draw upon the broadest set of qualifying resources. It would be highly inefficient, for instance, for the ISO BAA to procure all of its PFR needs solely from in-state thermal generators if resources located outside the BAA were able and willing to provide comparable	The ISO agrees the consideration of a PFR product ensures competitive and efficient prices reflecting the value of providing PFR. Determining the necessity and appropriateness of incentivizing PFR procurement is the goal of phase 2. The ISO also finds exploring regional solutions to ensure BAL-003-1 compliance at the lowest cost to be prudent.

		service at lower cost.	
	California Wind Energy Association/ American Wind Energy Association (CALWEA/AWEA)	Again, CALWEA and AWEA fully support the implementation of a market constraint to ensure the availability of sufficient PFR in the ISO footprint. As we have also noted before, this market constraint should be combined with incentives to synchronous generators (performance payments) in Phase 1 and asynchronous generators (PFR capability payments and performance payments) in Phases 1 and 2 of the ISO strategy to ensure the sufficiency of PFR from the ISO BA.	The ISO is proposing to transfer a portion of the ISO's PFR obligation to an external BA through a request for proposal process in phase 1 of this initiative. Incentivizing PFR capability within ISO markets will be explored in phase 2 of this initiative.
	Calpine	Calpine supports the development of a PFR market product that is separate and distinct from other reserve products. A separate revenue stream (or a separate statement of demand) will provide just and reasonable compensation for the incremental reliability value. Under no circumstances should the ISO create an uncompensated constraint in the market model that could force on units uneconomically. Such a capacity constraint (very much like the highly controversial Minimum Online Capacity Constraint) will, when binding, not create any shadow prices and in fact, will have a price suppressive effect. However, Calpine sees no conflict with expanding the proposed Contingency Modeling Enhancements concept to a PFR constraint. That is, the ISO could create the new constraint and establish a nodal capacity payment akin to CME.	The ISO is no longer proposing a market model constraint in phase 1 of this initiative. The ISO will explore the development of a separate and distinct PFR market product in the second phase of this initiative.
	NRG Energy	Not having a market product could result in an inefficient procurement of frequency response. Market product will assess the viability of other products, like acquiring PFR from inverter-based resources." Would like to comment on what seems to be a recent ISO movement away from market-based products to requiring market participants to provide critical reliability services as good utility practice as part of being interconnected to the ISO Controlled Grid. As the ISO is well aware, requiring services to be provided as part of interconnection may not fully address cost recovery for those services (unless the ISO assumes the problem away by concluding that all such services are fully	The ISO will evaluate a market product as an efficient PFR solution. As noted, such mechanisms provide transparent investment signals.

		compensated through financial arrangements that happen outside of the ISO's markets). Moreover, this non-transparent approach sends no prices signals that allow the market to determine if the procurement of the needed service is efficient, or to spur the development of newer, cleaner technologies to provide these services."	
	Large-scale Solar Association (LSA)	LSA strongly supports investigation of a market-based approach to PFR procurement as the most efficient and viable solution for the provision of PFR from solar and other resources, and the ISO should consider that approach as soon as possible. A market-based solution is needed to incentivize solar facilities to install the necessary equipment and contract in a manner that enables the necessary headroom.	The ISO will evaluate a market-based approach to PFR procurement in phase 2 of this initiative.
	California Department of Water Resources (CDWR)	CDWR has no preferential treatment for a market constraint or PFR product at this time. The ISO's long term goal for complying with the new PFR standard is that all generators, both synchronous and asynchronous, should provide some minimal amount of PFR at no charge to the ISO. The ISO can procure additional PFR capability from specified resources (through market constraints or a PFR product) based on the anticipated deficiencies determined by the ISO's new PFR "look-ahead" tool. This long-term goal is parallel with the ISO's current plan to make sure there is enough reactive power and voltage control in the system In this initiative, both asynchronous and synchronous generators must meet minimum reactive power requirements (a baseline); anything required above the baseline will be procured by the ISO.	See section 7.2.1 of the draft final proposal for details on the ISO's near-term PFR solution. The ISO will explore procurement of additional PFR capability from specified resources based on anticipated deficiencies in phase 2 of this initiative.
	Jack Ellis	The ISO should stop all work on Phase I since it will not be effective, and immediately initiate a design for a separate and distinct frequency response product. If the ISO feels it does not have enough time to design and implement a market product by the end of 2016, then it should notify both the FERC and NERC that it will be unable to comply with the BAL-003-1 standard and negotiate an appropriate extension of time by which it must comply that allows sufficient time for a market product to be developed.	Exploring the appropriateness of designing a separate product to incentivize PFR procurement is the goal of phase 2. The ISO finds exploring regional solutions to ensure BAL-003-1compliance at the lowest cost to be a prudent near-term solution, as suggested by

			several stakeholders in this initiative.
	Union of Concerned Scientists	In comments on the issue paper, many stakeholders including UCS supported the creation of a market product for PFR, and the addition of constraints to the market optimization to ensure that enough PFR is committed. The ISO and stakeholders should suggest frequency response performance requirements for asynchronous resources in addition to those in Appendix K, Part B 1.2 to the ISO tariff. For example, do asynchronous resources need to follow a droop curve when responding to frequency excursions, or can their response be non-proportional to the size of the frequency deviation? If asynchronous resources must follow a droop curve, what droop setting or range of settings is required? Solar facilities can be particularly effective at providing PFR if they have headroom available. Some level of renewable curtailment will be a reality going forward, and frequency response may be a good way to use the headroom created by renewable curtailment to support grid reliability. The ISO's frequency response straw proposal does not adequately characterize the potential for solar power facilities to provide PFR.	Minimum performance requirements for resources to provide PFR, including asynchronous resources, will be explored in the second phase of this initiative. In addition, the appropriate mechanism for incentivizing PFR to meet anticipated needs will be evaluated.
	Office of Ratepayer Advocates (ORA)	Since the Frequency Response service is provided automatically and there is no need for operator intervention, the most economical way of getting this service is for generators to continue to provide it of free. Therefore, ORA recommends that the ISO modify its tariff—especially the generator interconnection agreement and/or participating generator agreement to require generators to automatically provide the service for free via the use of governors. For renewable generators, the ISO should require them to install smart invertors so they can also provide the frequency response service automatically for free. This approach will be more economic because the ISO does not need to design a new ancillary service product and incur corresponding administrative costs.	Proposed modifications to section 4 of the tariff will clarify requirements consistent with NERC and WECC criteria. See section 7.2.2 of the draft final proposal. Incentivizing PFR capability and developing minimum performance requirements will be explored in phase 2 of this initiative.
	SolarCity	SolarCity recommends that the ISO emphasize developing market products sooner rather than later. Out of market measures (such as the look-ahead tool proposed by the ISO in Phase 1) should only be looked at as an interim solution given the uncertainties of meeting BAL-003-1 in a cost effective	The ISO finds exploring regional solutions to ensure BAL-003-1 compliance at the lowest cost to be a

		manner. These measures may indeed lead to sub-optimal market solutions by procuring additional spinning reserve with no regards to PFR capability and costs. Alternatively, the ISO should procure PFR through a robust market mechanism that minimizes cost and promotes technologies which are more efficient and accurate in meeting BAL-003-1 by considering performance attributes. In order to ensure that capable DERs have mechanisms to offer cost-effective PFR, ESDER Phase II scope should include a dedicated discussion on this topic	prudent near-term solution, as suggested by several stakeholders in this initiative. Exploration of PFR procurement through an efficient and robust market mechanism that minimizes costs is a phase 2 objective.