California ISO Frequency Response Initiative
Comments of Jack Ellis on ISO's Straw Proposal

These comments reflect my personal views and my professional opinions based on more than 40 years of power industry experience. I have prepared these comments on my own initiative, on my own time and at my own expense. I have no financial or commercial interest in the outcome. My purpose is to highlight certain issues regarding the ISO's straw proposal that may be of interest to the ISO and stakeholders. A copy of the ISO's comment template with selected responses appears at the end of this document.

1) It is helpful to understand how much frequency response-capable generating capacity is likely to be required to meet the ISO's frequency response obligation. For the purpose of this discussion, I focus on the amount of primary frequency responsive capacity (PFR), in MW, that would be required to meet the ISO's primary frequency response (PFR) obligation under worst-case conditions[1], which is approximately 780 MW. I also assume half of this amount is met by synchronous motor loads and for the foreseeable future, the rest is provided by hydroelectric and fossil-fired generators. Using the ISO's estimate that from 3.3-5% of a generator's nameplate capacity can provide PFR[2], hydroelectric and fossil-fired generators having an aggregate nameplate capacity of between 7,800 and 12,900 MW[3] would be have to be synchronized to the grid in order to meet the supply-side half of the ISO's requirement for frequency-responsive supply. I am not aware of any definitive method for estimating the amount of synchronous motor load but assuming it can meet half the ISO's PFR obligation under worst case conditions seems to be reasonable at this juncture in the absence of other information. To the extent synchronous motors are determined to provide more or less than half the ISO's frequency response requirement, the amount of aggregate nameplate hydroelectric and fossil-fired capacity that is required to meet the remainder of the requirement can be estimated at between 20 and 33 times the amount not supplied by synchronous motors[4].

2) The ISO's ability to meet its PFR obligation is currently a matter of chance. The ISO will likely be able to meet its PFR obligation during periods where there is a fortuitous combination of low to moderate hydroelectric production coupled with low to moderate imports and low to moderate renewable production. Any combination of high renewable production, high hydroelectric production and high imports forces fossil-fired generation to shut down, thereby leaving the ISO with inadequate headroom on fossil-fired generators. The aggregate amount of hydroelectric capacity in the ISO's Balancing

[1] Figures taken from Table 1 of the ISO's Draft Technical Appendix for Frequency Response. 30% of the 2016 IFRO multiplied by $DF_{CBR.}$

[2] Another way to think about this is in terms of the generator's maximum ramp rate for the first minute of a drop in frequency outside the .035 HZ deadband.

[3] Corresponding to the nameplate capacity of between 13 and 23 typical combined cycle plants of approximately 600 MW each.

[4] If the ISO assumed that the contribution of synchronous motor loads was zero, then the aggregate amount of fossil-fired and hydroelectric nameplate capacity required to meet the worst case BAL-003-1 requirement would vary between 15,600 and 25,800 MW.

Authority Area may be capable of meeting a large share of the ISO's PFR requirement under normal conditions, but during the spring runoff period there may be zero headroom on hydroelectric plants as well.

3) From the preceding discussion, it is reasonable to infer that the ISO will effectively be unable to meet its PFR obligation during those daytime hours in the spring when demand could exceed supply due to combinations of high hydro and solar PV production, and during those night time periods when a combination of imports, wind production and low demand forces most fossil-fired generators to shut down. These periods will likely amount to at least one thousand hours per year and perhaps more.

4) Once committed, a fossil-fired generator has to operate at roughly 30% of its nameplate capacity in order to be capable of providing PFR, and at that point it is capable of providing PFR equal to between 3.3 and 5% of its nameplate capacity. If the ISO has to commit additional fossil-fired generation in order to procure additional frequency responsive spinning reserve as its straw proposal suggests, every MW of additional spinning reserve will displace at a minimum between 6 and 10 MW of imports or require curtailment of between 6 and 9 MW of renewable production[5]. If the running cost of fossil-fired generation so deployed is $25/MWh and the cost of curtailing renewable production or reducing imports is $35/MWH, then each additional MW of spinning reserve procured by committing additional fossil-fired generation will increase the costs borne by consumers by between $260 and $540/MW/hour in order to compensate generators for running at minimum load and renewable producers for curtailing output. If the ISO has to procure on average 200 MW of additional frequency responsive spinning reserve by committing additional fossil-fired generation, the hourly cost will amount to between $52,000 and $108,000/hour. If the ISO has to procure these spinning reserves for 1,000 hours per year, the additional annual cost that will be borne by consumers will amount to between $52 and $108 million. Stated another way, procuring spinning reserves to ensure the ISO can always meet its PFR obligation will simultaneously cause increases in consumer costs and curtailments of renewable energy production. This problem is unlikely to be mitigated by procuring more spinning reserve, which must be provided by capacity that is committed and synchronized to the grid, and a correspondingly smaller amount of non-spinning reserve that can remain off-line.

5) Unless the monetary penalty that can be imposed by the FERC for the ISO's failure to meet its PFR obligation is significantly more than $1 million, it would be economically irrational for the ISO to move forward with its straw proposal, since the cost of meeting BAL-003-1 under the ISO's Phase 1 proposal will probably exceed the penalty by 50-100 times or more.

6) The ISO's proposal to impose performance requirements on generators with governors who fail to perform in accordance with the *ISO's* expectations[6] presumes the ISO can reliably and accurately

[5] The ISO will obtain between 3 and 5 MW of frequency responsive spinning reserve for every 100 MW of nameplate capacity that must operate at a minimum of 30 MW. If the ISO needs 390 MW of frequency responsive spinning reserve, it must commit between 7,800 and 12,900 MW of nameplate capacity that will have to produce a minimum of between 2340 and 3870 MW of energy. Under high hydro conditions, fossil-fired headroom would be obtained by curtailing either renewables or imports.

[6] Straw Proposal, section 6.2.4

forecast PFR performance for an individual generator under any and all plant operating configurations and setpoints. However the ISO has not explained how it will accomplish this task, particularly in light of statements by generators that they themselves don't know the PFR performance of their equipment, other than to propose collecting additional data from generators that, while significant in its scope and volume, may still not be sufficient to produce reasonably accurate forecasts.

7) The ISO proposes to allocate part or all of any penalties imposed by FERC for failing to meet its PFR obligation to generators that do not perform as they should. No matter how the performance obligation of a resources that is expected to provide primary frequency response is determined[7], the combination of a "no harm/no foul" rule[8] and allocating some portion of what are currently relatively modest penalties to those who fail to perform is inconsistent with the incentive mechanisms in the ISO's other product "markets" and it arguably provides only weak compliance incentives. If the risk associated with the Western Interconnection's failure to meet its aggregate frequency response obligation is high, then penalties imposed on resources that make specific, defined commitments to help meet that obligation should be onerous enough to compel performance without any additional sanctions[9].

8) The ISO proposes to "...forecast, on an ongoing basis and based on current system conditions, the magnitude of a frequency deviation that would occur due to the loss of 2 Palo Verde units."[10] However the ISO has not explained how it would accomplish this in either its Straw Proposal or the Technical Appendix, nor has it discussed how robust the results of such a forecast might be, the factors that would affect its forecast of frequency deviations, how it proposes to ensure the underlying data is current and accurate, or whether in fact such a forecast would lead to materially lower costs for procuring additional spinning reserve. The ISO could help stakeholders better understand the value of forecasting situation-dependent frequency deviations by provide some general guidance on the likely magnitude of frequency deviations during periods with high hydroelectric production, high renewable production, and a combination of the two, which are the time periods when the ISO's supply of PFR is most likely to be significantly limited.

9) The processes of procuring and deploying frequency responsive resources and verifying performance should be as simple as possible in order to avoid introducing points of failure that adversely affect the ability of the ISO and gnerators to comply with BAL-003-1. Moreover, resources that provide PFR must do so with the expectation that they will deliver when called upon rather than on a best-efforts basis, and that they will face steep penalties for failing to perform. This may mean, for example, that although suitably equipped wind and solar are capable of providing PFR when they are operating, they may decline to do so because the financial risk of failing to perform outweighs any compensation they can earn. Similarly, loads such as water pumps that sign up to provide PFR via specifically calibrated

[7] Whether via an ISO forecast or in the case of a market product by the supplier's offered volume
[8] Resources that fail to perform pay nothing if the ISO is not penalized
[9] This should only be the case if the resource's commitment to provide frequency response is *not* an outcome of an ISO "forecast" of PFR capability.
[10] Section 6.2.1

underfrequency load shedding relays may have to commit to operate when they would otherwise prefer to shut down for economic reasons.

10) The combination of a spinning reserve capacity payment and an opportunity cost payment might make sense for resources that have already been committed and are "in the money" in the ISO's energy market. The same rationale does not hold for hydroelectric or fossil-fired resources that have to be committed and held on at minimum load in order to provide PFR, or for resources like interruptible loads or storage that are standing by to provide PFR using a distributed, autonomous control system[11] but are not otherwise under the ISO's operational control. Moreover, paying different resources for the same service in the same time interval using different algorithms that can produce different prices is not reasonable. Consequently the ISO should consider allowing resources that provide PFR to submit an offer price for capacity that includes the asset owner's estimate of any opportunity costs rather than computing and adding an opportunity cost to payments for PFR after-the-fact.

11) There are several reasons for the ISO to develop a market product and drop the idea of adding some kind of market constraint. First, the market constraint approach requires all possible providers of PFR resources to participate in the ISO's energy or ancillary services markets, thereby excluding resources like curtailable loads, storage devices with energy storage capacity that are large enough to provide PFR but not necessarily large enough to provide ancillary services, and renewable resources that may wish to provide PFR instead of being curtailed. Second, the market constraint approach would seem to discriminate against or at least increase the complexity around making purchases of PFR from a PFR-sharing group. Third, it further complicates the ISO's existing market operations. Finally, it may not yield a rational operating plan during periods with high levels of renewable production, high levels of imports, and/or high hydroelectric production. On the other hand, a separate market product is likely to attract a more diverse group of potential PFR-capable resources, thereby lowering the cost of complying with BAL-003-1.

12) One potential source of PFR that receives little attention in both the ISO's straw proposal and the technical appendix is the damping effect of synchronous motor loads that decline as system frequency declines. Since any PFR provided by operating motor loads does not have to be provided by other resources, it is important for the ISO to develop estimates of the amount of PFR available from motor loads and to understand how subsequent energy efficiency retrofits of synchronous motors with variable frequency drives will influence this estimate over time. CEC end-use data and forecasting tools should be able to provide at least order of magnitude estimates.

13) In my opinion pursuing Phase I of the ISO's straw proposal will demonstrate to FERC, NERC, the CPUC and other stakeholders that the ISO is taking steps to comply with BAL-003-1 but it will not assure that the ISO is in compliance for the 2017 compliance year. I recommend that the ISO abandon Phase I and instead a), inform FERC, NERC and the CPUC that it will be unable to comply by January 2017 without creating undue burdens on consumers, other Balancing Authority Areas and renewable energy

[11] Interruptible loads, for example, should be deployed by the activation of underfrequency load shedding relays rather than a control signal from the ISO.

producers, b) negotiate a new compliance date, c) immediately commence work on designing a new frequency response market product.

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Stakeholder Comments Template

Submitted by	Company	Date Submitted
Jack Ellis jack@casaraquel.com (530) 581-2134	N/A	28 October 2015

Please use this template to provide your comments on the presentation and discussion from the stakeholder web conference held on October 19, 2015.

Submit comments to InitiativeComments@caiso.com

Comments are due November 2, 2015 by 5:00pm

The presentation discussed during the October 19, 2015 stakeholder web conference may be found on the Frequency Response Initiative webpage.

Please provide your comments on the ISO's straw proposal for each of the eight issues listed below along with the ISO's straw proposal. The ISO welcomes comments in addition to these issues as well.

Frequency Response Standard

The ISO believes the straw proposal and its accompanying technical appendix covers the standard's requirements for compliance purposes. The ISO is endeavoring to provide sufficient information to stakeholders for effective evaluation of the ISO's proposal. The ISO seeks comments on whether any unresolved questions on the standard and the ISO's obligation still exist.

Comments:

I have no questions regarding information provided by the ISO. If the ISO elects not to abandon its Phase 1 approach, I suggest the ISO provide additional technical detail regarding its proposed look-ahead tool and the method by which it proposes to assess the PFR capability of generators. I also recommend the ISO conduct and publish two analyses - one that estimates

the amount of synchronous motor load and the amount of PFR it can provide, and a second that estimates the slope and magnitude of any frequency decline that would result from the loss of both Palo Verde units during periods with combinations of high renewable production, high hydro production, and low gross demand, which are the same time periods when PFR from within the ISO footprint is likely to be inadequate under current ISO operating practices.

Frequency Response Drivers

Several factors contribute to the primary frequency response performance of participating generators having governors. The ISO discusses some of the main drivers of PFR performance in Section 4.2 of its straw proposal. These factors include (1) magnitude of frequency deviation, (2) amount of synchronous on-line capacity providing sustained PFR, and (3) headroom available from that connected on-line capacity.

The ISO is evaluating what additional data points would need to be included in its Masterfile or through other mechanisms to facilitate a market tool or product to be designed. The ISO seeks comments on what factors influence a generators ability to provide PFR in the event of a frequency disturbance and the pieces of information necessary to estimate expected PFR.

Comments:

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.

Phase 1, addressing real-time deficiencies

Section 6.2 of the straw proposal discusses Phase 1 of the initiative which will enact the five steps to ensure it is capable of meeting the requirement at that time. 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:

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 redirecting resources to developing a market product for PFR.

Phase 1, tariff and interconnection revisions

Section 6.2 of the straw proposal discusses Phase 1 of the initiative which will enact five steps to ensure it is capable of meeting the requirement at that time. The first step discussed in section 6.2.2 is 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, and to not override governor response through outer-loop controls or other mechanisms.

The ISO seeks comments on the tariff revisions it is proposing to help the ISO ensure sufficient frequency responsive headroom and whether other revisions should be considered.

Comments:

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.

Phase 1, ISO's practice of preserving operating reserve headroom

Section 6.2 of the straw proposal discusses Phase 1 of the initiative which will enact five steps to ensure it is capable of meeting the requirement at that time. The first step discussed in section 6.2.3 is 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.

Comments:

No comment.

Phase 1, performance requirements

Section 6.2 of the straw proposal discusses Phase 1 of the initiative which will enact five steps to ensure it is capable of meeting the requirement at that time. The first step discussed in section 6.2.4 is to include frequency response performance requirements for resources with governor control and frequency responsive capacity available.

The ISO will continue to develop the details of a proposed performance requirement and seeks comments from stakeholders on an appropriate performance requirement.

Comments:

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.

Phase 1, allocation of BAL-003-1 non-compliance penalties

Section 6.2 of the straw proposal discusses Phase 1 of the initiative which will enact five steps to ensure it is capable of meeting the requirement at that time. The first step discussed in section 6.2.5 is considering provisions for allocating any non-compliance penalties associated with BAL-003-1, should they be imposed on the ISO, to resources that should have provided more PFR than they actually delivered during frequency events.

The process discussed in ISO tariff section 14.7 applies to an allocation of any reliability-based penalty. The ISO seeks comment on how it could apply these tariff provisions to BAL-003-1 compliance and 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.

Comments:

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 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.

Phase 2, long-term approaches

Phase 2 of the initiative will evaluate if a market constraint or product is better suited to competition for frequency response capability (Section 6.3 of straw proposal). Such market-based mechanisms could not be designed, approved and implemented by December 1, 2016, and therefore the ISO will need to consider them in a second phase of this initiative.

Comments:

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.