May 3, 2019

The Honorable Kimberly D. Bose
Secretary
Federal Regulatory Energy Commission
888 First Street, NE
Washington, DC 20426

Re: California Independent System Operator Corporation
Response to Deficiency Letter
Docket No. ER19-1153-_____

Dear Secretary Bose:

The California Independent System Operator ("CAISO") provides the following responses to the Deficiency Letter issued in this docket on April 18, 2019.[1]

The CAISO respectfully requests that the Commission approve the tariff revisions submitted in the CAISO's original filing effective, as requested, on April 30, 2019. Granting the CAISO's original requested effective date is consistent with the Commission's earlier decision this year on other interconnection process enhancements.[2] The tariff revisions proposed by the CAISO comprise generator interconnection agreement ("GIA") provisions. GIAs take considerable time to draft, tender, negotiate, and execute, and moving the CAISO's proposed effective date would disrupt these processes.[3] The CAISO has not proposed any amendment herein that would require a new 60-day notice period. As such, no party will be prejudiced by maintaining the CAISO's original requested effective date of April 30, 2019.

1. In its transmittal CAISO states that "[t]he inverter must produce full rating reactive current when the AC voltage at the inverter terminals drops to a level of 0.50 per unit, and must continue to operate and attempt to maintain voltage for transient voltage conditions between 1.10 and 1.20 per unit." CAISO further notes in its transmittal that it "anticipates that inverter-based resources will read voltage at their generator terminals, but will often be under the control of a central plant controller that will maintain voltage at the high side of the generator substation."[4] CAISO's proposed tariff language in section A.i.3 of Appendix H requires that for transient low

1 Pursuant to the Deficiency Letter, the CAISO has attached a tariff record to this filing.

2 *California Independent System Operator Corp*., 166 FERC ¶ 61,113 (2019).

3 *See* Section 13 of Appendix DD to the CAISO tariff.

4 CAISO Transmittal at 18, n.72.

voltage conditions, the inverters will inject reactive current based on the voltage at the inverter AC terminals.

NERC Reliability standard PRC-024-2 ensures that generator owners set their generator protective relays such that generating units remain connected during voltage excursions at the point of interconnection (for excursions that remain within the no-trip zone), and states that "for the purposes of this standard, point of interconnection means the transmission (high voltage) side of the generator step-up or collector transformer."

If inverters will react based on the voltage that is measured at the inverter AC terminals, which can differ from voltage at the high side of the generator step-up transformer (e.g., an inverter AC terminal reads 1.25 per unit and the generator high-side terminal reads 1.15 per unit which is inside the no trip zone), please explain how the proposed voltage ride-through requirements will ensure that inverters perform in accordance with NERC Reliability Standard PRC-024-2.

NERC Reliability Standard PRC-024-2 is designed to ensure that generator owners set their generator protective relays such that generating units remain connected during defined frequency and voltage excursions. The standard identifies regions where it is not permissible to trip, and for the purposes of the standard, the voltage is referenced to the point of interconnection, which is further defined as the high voltage side of the generator step-up or collector transformer.

The current version of the standard is silent on whether or not it is permissible for an inverter-based resource to enter momentary cessation as an acceptable response to voltage (or frequency) deviations. However, the CAISO has observed inverter-based resources entering into momentary cessation within the *no trip* zone as defined by the current version of PRC-024. As described in the CAISO's transmittal letter, during momentary cessation, the inverter-based resource remains connected but ceases to contribute any support (real or reactive) to the system during transient voltage excursions.

This is one of the primary reasons why the CAISO proposed that inverters produce reactive current during transient voltage excursions. If an inverter has tripped or entered into momentary cessation, it cannot produce or absorb reactive current. However, as long as the inverter is supplying reactive support to the system within its *no trip* zone during transient voltage conditions, it has not ceased to operate within the requirements of PRC-024.

It is important to note that the use of reactive current injection is considered a temporary operating condition. For severe voltage dips that remain on the system long enough for a resource to enter the *may-trip* zone, the inverter-based resource may disconnect from the system. However, an inverter's system protection algorithms are

separate from the controls that direct the inverter to enter into the momentary cessation or reactive current injection operating modes. Further, the "settings" used in these algorithms may be selected or programmed by the generator owner. Prior to equipment commissioning, the generator owner will normally commission an engineer to review all the control and protection equipment and develop settings (including relay settings). The scope of this work includes the protection algorithms within the inverter itself. At that time, the engineer can select the settings such that the inverter will comply with the requirements of PRC-024.

The Commission asks, "please explain how the proposed voltage ride-through requirements will ensure that inverters perform in accordance with NERC Reliability Standard PRC-024-2." The Commission should note that the CAISO is not proposing voltage ride-through requirements. Rather the CAISO is proposing to eliminate the use of momentary cessation during certain transient voltage conditions. Instead, the CAISO is proposing to require interconnection customers to program their inverters to provide reactive support during these conditions. As noted earlier, these control algorithms are separate and distinct from the protection algorithms, and can be programmed by the generator owner (or inverter manufacturer) separately. In short, the inverter may initially enter reactive current injection, but if the voltage dip is deep enough and lasts long enough to enter into the *may trip* zone of PRC-024, the inverter may trip.

Finally, it should be noted that inverter-based resources subject to PRC-024-2 and already in service must comply with the standard, which does not conflict with the CAISO's proposal. These inverters will normally measure the voltage at the inverter terminals. The inverters can be brought into compliance with PRC-024 by choosing voltage "set points" compensated to the point of interconnection (i.e., the high voltage terminals of the substation transformer). NERC has issued guidance in the form of a paper entitled "Generator Voltage Protective Relay Settings Implementation Guidance PRC-024-2 Requirement R2."[5]

2. In its transmittal, CAISO explains that its proposal prohibits unnecessary "…momentary cessation - ceasing to inject current during a fault…"[6] and requires generators to remain online and provide reactive current only within the existing "no trip" zone. CAISO states that its proposal does not preclude active current injection during a fault. CAISO further states that "[a]fter first meeting the voltage control need, current can be used to produce active output at the same time."[7] However, CAISO's proposed

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5 *Available at* https://www.nerc.com/pa/comp/guidance/EROEndorsedImplementationGuidance/PRC-024-2%20R2%20Generator%20Frequency%20and%20Voltage%20Protective%20Relay%20Settings%20..pdf#search=Generator%20Voltage%20Protective%20Relay%20Settings%20implementation%20guidance%20PRC%2D024%20R2.

6 *Id.* at 17.

7 *Id.* at 22.

tariff language in section A.i.3 of Appendix H only specifies the following requirements for reactive current injection: "[F]or transient low voltage conditions, the Asynchronous Generating Facility's inverters will inject reactive current. The level of this reactive current must be directionally proportional to the decrease in per unit voltage at the inverter AC terminals."[8]

Please explain if CAISO has any expectations or requirements around active current injection during transient low voltage situations in the no trip zone and, if so, what they are and where they are stated (e.g., if any such requirements are not included in the tariff, whether these details would be included in the relevant business practice manual). Specifically, what are the active power expectations, if any, for inverters during the fault conditions for voltages from 0.9 per unit to 0.5 per unit, and from 0.5 per unit to 0.0 per unit?

Under the transient low voltage condition within the *no trip* zone, the CAISO's proposed tariff revisions would require inverter-based resources to produce reactive current. The proposal does not require active current injection during these low voltage conditions. The proposal requires the inverters automatically transition to normal active current injection upon the cessation of transient voltage conditions and the return of the grid to normal operation voltage between 0.90 per unit and 1.10 per unit. The inverters must ramp up to inject active current with a minimum ramping rate of 100% rated current per second. The transition to normal active current injection must be completed in one second or less.

Once the reactive current requirement is met during transient low voltage conditions, an inverter-based resource could but would not be required to produce active current up to the inverter-based resource's equipment limit. The available, active current depends on the inverter's capability and other equipment limitations. For example, if the inverter has a transient current capability of 1.0 per unit, then for voltage under 0.5 per unit, there is no active current; and for voltage between 0.5 and 0.9 per unit, the available active current could be between 0 and 1.0 per unit. If the inverter has a transient current capability of 1.3 per unit and with a reactive current limit of 1.0 per unit, then the available active current could be between 0.83 and 1.3 per unit. Again, the CAISO has not proposed specific requirements for active power injection during transient low voltage conditions. Reactive current control is a function of the voltage. Therefore, a quantitative control requirement with regards to the voltage can be specified. By contrast, the active current control depends on the pre-disturbance operating condition and the frequency excursion. The desired active current cannot be specified simply based on the voltage condition, but instead depends on a number of factors, including among others, the availability of fuel at the resource after the disturbance event.

[8] CAISO Tariff, Appendix H of Appendix EE, Proposed § A.i.3; Attachment 7 of Appendix FF, Proposed § A.i.3.

For these reasons and those set forth in the CAISO's transmission letter, the Commission should approve the CAISO's proposed tariff revisions as just and reasonable with an effective date of April 30, 2019, as originally requested.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that I have served the foregoing document upon all of the parties listed on the official service list for the above-referenced proceeding, pursuant to the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated at Folsom, California, this 3rd day of May, 2019.

/s/ Grace Clark
Grace Clark