Note: West Murray Zone

28 June 2023

Torsional mode excitation in synchronous condensers in West Murray Zone

AEMO publishes this information for the general awareness of developers and operators of synchronous generators or condensers installed in areas of the National Electricity Market (NEM) power system where sub-synchronous oscillations may be present or likely.

AEMO has been closely monitoring the presence of sub-synchronous oscillations in the West Murray Zone (WMZ) since 2019 and most recently has published the following documents on the AEMO website:

- A comprehensive report on WMZ power system oscillations.
- A high level summary of observations from August 2020 through December 2021.
- A review of oscillations that occurred on 16 November 2021.

In 2019, AEMO observed sub-synchronous oscillations in the frequency range of 7-10 Hz in the WMZ. AEMO, network service providers (NSPs), generators and the original equipment manufacturer (OEM) worked together to implement solar farm tuning solutions to address observed oscillations.

During August 2020, AEMO observed lower magnitude sub-synchronous oscillations in the WMZ, and has since been closely monitoring this area. The oscillation magnitude has generally been less than 1% peak-peak (measured at 220 kilovolt transmission node in WMZ) and mostly in the frequency range of 15-20 Hz based on root-mean-square (RMS) data. The processing of high-resolution waveform data for a few incidents identified a presence of dominant 33 Hz and 67 Hz components in voltage and current in addition to the 50 Hz fundamental component.

In May 2023, AEMO was made aware of a hypothesis that the mechanical torsional modes of a synchronous condenser could be susceptible to the presence of these sub-synchronous power system oscillations, which may have contributed to mechanical shaft damage.

The potential effects of sub-synchronous oscillations on conventional synchronous generators have been documented[1]. During this phenomenon, the electrical oscillations in the power system induced by the presence of series capacitors or high voltage direct current (HVDC) control modes could interact with the sub-synchronous complement of the turbine-shaft natural mechanical modes and result in damage to the turbine-shaft. However, electro-mechanical interaction due to low-level oscillations resulting in torsional vibrations of the mechanical shaft in synchronous condensers has not been widely reported. As more synchronous condensers (with and without flywheels) are being installed in the NEM, further investigation of this possibility is warranted.

[1] P. M. Anderson, et al., Subsynchronous Resonance in Power Systems, Wiley-IEEE Press, 1990 , at https://ieeexplore.ieee.org/book/5264388.

AEMO is liaising closely with the relevant synchronous condenser operator, NSP and OEM to establish whether there is any possible link between the power system oscillations in the WMZ and issues identified with the synchronous condenser plant. AEMO notes that a number of other factors could also result in or contribute to excitation of the torsional natural frequencies of motor drive trains, such as during start up or pull out due to pulsating torque[2]. However, until any contribution from power system oscillations can be either confirmed or ruled out, owners and operators of synchronous generators or condensers in any network area prone to sub-synchronous oscillations should be aware of this hypothesis and potential risk factor, and may wish to consider additional monitoring to detect torsional vibrations in the mechanical shaft.

As mentioned in AEMO's reporting, NSPs in the WMZ have installed additional monitoring in the area to improve the monitoring of sub-synchronous oscillations. AEMO and relevant NSPs, generators and OEMs have worked together to identify a feasible solution to reduce the magnitude of the oscillations. This solution has been developed by an OEM and implementation work on the affected plant is underway.

AEMO will provide updates as and when any new information becomes available.

For any further enquiries please contact: StakeholderRelations@aemo.com.au.

[2] M.A. Corbo, et al., Torsional vibration analysis and testing of synchronous motor-driven turbomachinery, Proceedings of the thirty-first turbomachinery symposium, Turbomachinery Laboratory, Texas A&M University, College Station, Texas, pp. 153-174.