



18 July 2024

Chris Stuart-Walker
Manager, Compliance – Energy Division
Essential Services Commission Victoria
Level 8, 570 Bourke Street
MELBOURNE VIC 3000

By email: compliance.reporting@esc.vic.gov.au

Dear Mr Stuart-Walker,

Notification of voltage harmonics non-compliance

We are writing to notify the Essential Services Commission (ESC) of a recently identified non-compliant power quality issue in the Northern Murray region of the Powercor network. Our comprehensive investigation has identified that the source of the power quality issues is harmonic disturbances which are primarily attributable to irrigation pumps in the area.

Information on our remediation plans is detailed below and, in a presentation, attached. The presentation outlines our project plan, including a timeline and the expected improvements in harmonic levels at each step of the plan.

What is harmonic distortion?

Harmonic distortion can be described in a simplistic way as "dirty power" or perhaps "fuzzy power" which must be limited within acceptable limits (compatibility limit – 8 per cent at the customer terminals) to ensure customer appliances receive a clean enough supply to operate as intended (compatibility limit).

How we identified voltage harmonic distortion non-compliance

Under the Electricity Distribution Code of Practice (EDCoP), we are required to maintain the total harmonic distortion in voltage (THDv) below the planning limit of 8 per cent in the medium voltage (MV) network. In the Northern Murray region, voltage harmonic distortion is observed to be non-compliant during the irrigation season. In some instances, harmonic distortion levels have exceeded allowable limits by up to 2.5 times. This has resulted in the malfunctioning of customers' appliances in the area. This is primarily attributed to the extensive irrigation pumping infrastructure, which sustains the region's agricultural production.

Our ongoing compliance monitoring at the zone substation level did not initially detect this issue, as the harmonic distortions are localised to specific feeders. It was only through more granular monitoring at the feeder level, that we were able to pinpoint the source of non-compliance.

Causes of harmonic distortion

The Northern Murray irrigation region is bounded by the New South Wales border and covers the north-west part of Victoria along the Murray River from Nyah to the South Australian border. This is a primarily agricultural area and produces 53 per cent of Victoria's gross value of agricultural production as per the Victorian Mallee Irrigation Region Land and Water Management Plan 2020–29. This plan stated that, almonds and grapes are the major crops produced in the region and account for approximately 51 per cent of total production in Victoria.

In this region, farmers use many variable speed drives (VSDs) for pumping water from the Murray River. VSDs are causing the voltage harmonic distortion in the network. The voltage distortion impacts the operation of customer equipment and is non-compliant with the EDCoP. Additionally, there are many customers (20+ sites) exceeding the allowable harmonic limits outlined in the EDCoP, further contributing to the non-compliance.

Customer impact

Approximately 650 customers supplied from Boundary Bend (BBD), Merbein (MBN), and Wemen (WMN) zone substations are experiencing harmonics greater than the acceptable limit. (Please find the customer split in the table on slide 4 of the attached slide pack)

- most customers on these feeders are agricultural
- residential customers constitute about 4 per cent on average on each impacted feeder
- harmonic distortion levels are high during the irrigation pumping season (October to April), averaging 10 hours each day. Please find graphs on slide 5 of the attached slide pack showing harmonics of a typical day at two different sites.

Mitigation measures and compliance plan

We have three stage approach to returning the network to compliance:

Customer emission management

We have initiated a multi-year customer compliance monitoring program aimed at identifying where harmonic currents exceed the limits of the EDCoP. Upon identification of non-compliance, we will promptly notify customers in writing, alerting them to the issue, and collaborate with them to rectify emissions. This process will involve data logging and targeted interventions to address site-specific harmonic challenges.

While the early stages of this program has shown promising results on certain feeders, the sheer magnitude of emissions means that even achieving full compliance with participating customers is unlikely to bring harmonic levels within the prescribed limits for the majority of feeders.

Network optimisation

In addition to addressing customer site resolutions, we are conducted harmonic modelling of three zone substations where voltage harmonic distortion levels are notably elevated. The initial modelling results suggest that optimising the pole top high voltage capacitors could yield further improvements in harmonic distortion within certain feeders.

We have achieved significant success in this initiative, with the MBN 31 and WMN 21 feeders, where harmonic emissions were reduced by approximately 5 per cent. Whilst this option has proven effective for these feeders, it falls short of fully restoring compliance across remaining feeders. This option was preferred because it reduces the overall need for augmentation of harmonic filters and provided a more cost-effective pathway to compliance.

In-feeder harmonic filters

Our regulatory obligations require us to report non-compliance and mitigate any potential risks associated with it. We acknowledge the possible consequences of this issue, and are taking proactive steps to address it through further investment.

We have initiated low-cost operating and maintenance works aimed at minimising the harmonic issues. However, early indications are these measures alone will not be sufficient to resolve the problems. Consequently, we have included a business case in our regulatory proposal to secure the more substantial

capital funding that will be necessary to resolve the issue fully. Our regulatory proposal will be lodged with the Australian Energy Regulator in January 2025.

We have included initial results from the operating and maintenance works in the Appendix of the attached presentation, demonstrating the partial mitigation achieved thus far.

Next steps

We will actively pursue operational improvements in harmonic levels until these enhancements are fully implemented. This entails measures like optimising the network's harmonic impedance and identifying customers exceeding prescribed harmonic limits, engaging with them to mitigate emissions.

In cases of customer-related issues, we will conduct investigations and implement localised solutions in collaboration with the affected customer. Previously, we have supported the affected customers by providing backup generators and uninterruptible power supply (UPS) when they experience issues with high harmonics, ensuring they can operate their pumps without interruption.

Additionally, we are committed to working closely with the ESC to ensure full compliance and to minimise any adverse impacts on our customers and the network.

Should you require any further information or wish to discuss this matter in more detail, please contact Zahra Crocker, Manager Regulatory Projects on 0428 182 389 or at zcrocker@powercor.com.au to schedule a meeting.

Yours sincerely



Brent Cleeve
Head of Regulatory Policy and Compliance
CitiPower, Powercor and United Energy