

Lesson Learned

540 MW of Wind Turbine Generation Loss due to Unexpected and Insufficient Ride-through Performance

Primary Interest Groups

Generator Owners (GO)
Generator Operators (GOP)

Problem Statement

Insufficient ride-through performance for wind turbine generators continues to cause repeated events due to incorrect protection settings, insufficiently maintained uninterruptible power supply (UPS) systems, and the previous tripping causes remaining unidentified. This lesson learned discusses a recent wind farm event to serve as an example of the type of event occurring frequently across the bulk power system (BPS).

Details

For this event, there was a loss of 540 MW of wind generation that occurred coincident with a transmission line fault. After the entity's investigation of the failure to ride through the normally cleared system fault, it was determined that there were numerous instances of incorrect protection settings as well as a failure to maintain critical facility infrastructure. This investigation was completed through coordination between both the GO and the original equipment manufacturer's Engineering department. Additional details on this event are as follows:

- The largest percentage of wind turbine generator (WTG) tripping (201 turbines, 264 MW) was due to an incorrectly set logic parameter in the low voltage ride-through control scheme. This parameter is responsible for enabling or disabling a WTG's low voltage ride-through curve. With this parameter and function unintentionally disabled, WTGs cannot utilize their low voltage ride-through curves; instead, they use extremely sensitive low-voltage trip thresholds and time delays during grid disturbances. This unintentionally enabled low-voltage protection setting caused a facility to trip off-line for a point of interconnection (POI) voltage that, during the grid disturbance, was well within the "No Trip Zone" specified in NERC PRC-024.¹
- Numerous WTGs (39 turbines, 55 MW) also tripped off-line due to the failure of the WTG controller's UPS system. The UPS failed to keep the WTG controllers from restarting and tripping the WTGs off-line. Low battery levels within the UPS and unintentional operations of the UPS system caused the WTGs to fail to remain on-line during the grid disturbance. Both the low UPS battery and unintentional operation of the UPS systems are due to a failure by the GO to sufficiently maintain this critical facility infrastructure.
- 100 WTGs (221 MW) also tripped off-line due to a converter trip signal in the control system. The GO and the WTG manufacturer have not been able to determine the cause of this tripping. These same turbines tripped for a similar fault in 2020 and the cause was not determined at that time either. This lack of ability to determine the cause of the tripping is resulting in the continual failure of a significant number of wind turbines being able to ride through normally cleared faults on the transmission system.

Corrective Actions

As a result of the failure to ride through and the subsequent investigations, the GO has implemented a number of corrective actions to ensure that the facility's ride through performance addresses the "No Trip Zone" in the future.

¹ [Frequency and Voltage Protection Settings for Generating Resources \(nerc.com\)](https://www.nerc.com/~/media/NERC/PDF/2021/Frequency_and_Voltage_Protection_Settings_for_Generating_Resources_(nerc.com))

The facility dynamic models are also undergoing updates to be submitted to the facility's TOP. Additional details on these corrective actions are as follows:

- The GO and original equipment manufacturer coordinated to determine the parameter at fault and to specify the appropriate parameter value. The correct parameter value is currently in the process of being updated at all WTGs across the affected facilities to enable the expected low-voltage ride through capability.
- The GO is currently performing upgrades on all WTG UPS systems to ensure that battery levels are monitored and maintained sufficiently and that the UPS systems will operate as expected.

Lesson Learned

The events described above have many similarities to the issues discussed in prior NERC Lesson Learned, "[LL20170701 'Loss of Wind Turbines due to Transient Voltage Disturbances.'](#)"² It is essential to BPS reliability for generation facilities to perform as expected and to ride through point of interconnection disturbances within the "No trip zone" as specified in NERC PRC-024. The following are lessons learned for this report:

- Sufficient documentation and maintenance of essential controls and systems is necessary for reliable operation. Investigations of as-left settings should be performed, and any discrepancies between as-left settings and those documented should be investigated, studied, and corrected.
- UPS systems are critical to the ride-through performance of WTGs. Routine maintenance and adequate monitoring are necessary to ensure UPS systems are operational.
- It is critical that GOs analyze and determine the cause(s) of poor ride through performance when they occur even when the amount of MW loss is below reportable thresholds as the causes of small losses are often the same as larger losses. Failure to determine the cause of these events and take appropriate corrective action continues to subject the BPS to higher reliability risk.

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This document is designed to convey lessons learned from NERC's various activities. It is not intended to establish new requirements under NERC's Reliability Standards or to modify the requirements in any existing Reliability Standards. Compliance will continue to be determined based on language in the NERC Reliability Standards as they may be amended from time to time. Implementation of this lesson learned is not a substitute for compliance with requirements in NERC's Reliability Standards.

² LL20170701 "Loss of Wind Turbines due to Transient Voltage Disturbances," https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20170701_Loss_of_Wind_Turbines_due_to_Transient_Voltage_Disturbances.pdf