

Lesson Learned

SOL and IROL Monitoring Tool Leads to Unnecessary Manual Load Shedding

Primary Interest Groups

Reliability Coordinators (RCs)
Balancing Authorities (BAs)
Transmission Operators (TOPs)

Problem Statement

A breaker fault on a shunt reactor of a high-voltage transmission line caused the line to trip. This event led to the exceedance of two interconnection reliability operating limits (IROLs). Immediate actions were taken to clear those IROL exceedances within the required 30 minutes.

However, the involved interfaces have both a system operating limit (SOL) and an IROL. This caused the transmission system operator to misinterpret the information by not noticing that the flows were still above the SOLs while the IROL exceedances were being addressed. Since the transmission system operator confused the SOLs for the IROLs, the operator proceeded to manually shed load in an attempt to return the flows back to within what was believed to be IROL values but were really SOLs. This occurred 28 minutes after the start of the event

Details

During the morning peak, the transmission system operator ordered the de-energization of a shunt reactor connected to a high-voltage transmission line for voltage control. During the operation, a fault occurred in the shunt reactor breaker that caused the high-voltage transmission line to trip, resulting in two IROL exceedances.

The transmission system operator was informed of the IROL exceedances through both visual and audible alarm messages within the energy management system (EMS) and by the control room timer display for SOL/IROL exceedances.

At that point in time, the transmission, balancing, and interchange system operators took emergency operating control actions to restore the interface flows below the IROLs by:

- The starting of gas turbines
- Curtailment of interchange transactions
- Emergency energy imports
- Regional voltage reduction

It is important to note that each of the interfaces have two limits, an SOL and an IROL, and both of these limits are represented at the same time on the EMS monitoring displays adjacent to the interface flows. The system is normally operated within the SOL limits but, when the “emergency condition” is enabled in the EMS by the system operators initiating an emergency operations control action, the values of the SOLs on the EMS monitoring displays disappear and all the monitoring and assessment tools focus on the IROL limits. This control action is used when the transmission system operator considers the system in an emergency state and ensures the release of any bottled capacity on the interfaces that might be limited by their SOL. That supplemental capacity can then be used to mitigate an emergency condition such as an IROL exceedance.

When the exceedances of the IROL occurred following the loss of the high-voltage transmission line, the transmission system operator did not enable the “emergency condition” in the EMS as stated in emergency operations procedures/instructions. The system operator mistook the value of the SOL as the value of the IROL, which led to a false assessment of actions to clear the IROL exceedances. That assessment, based on the lower SOL value instead of the IROL value, led to the use of more emergency operation control actions than necessary.

After 23 minutes, even though the interface flows were back under the IROLs but still above the SOLs, the transmission system operator became confused with the SOL/IROL distinction. Unfortunately, he was still thinking he was exceeding the IROL even though the alarm messages for IROL exceedances had disappeared. Also, the blinking of the SOL/IROL timer indicated that counting was underway toward the potential SOL exceedances. When an exceedance of both the SOL and IROL occurs, independent timers start for both limits and are superimposed on the control room timer display, which contributed further to the operator’s confusion in this case.

Twenty eight minutes after the event started, the transmission system operator manually shed a significant amount of load even though it was not required.

Corrective Actions

The entity conducted system operator training that featured additional stressful circumstances to more accurately reflect real-life conditions that can occur on the grid during an event. The entity reviewed the system operator’s understanding of several topics as well, including:

- The differences between the types of limits (SOLs versus IROLs) on a particular interface and how to monitor them
- The emergency operations control actions list
- The system operators training guide regarding the monitoring of SOL and IROL limits to determine if additional clarification is required

The entity also conducted a re-evaluation of its monitoring tools.

- The entity verified that the EMS monitoring display’s contents are adequate to clearly differentiate between the SOL and IROL limits.

- The entity created a new tool for displaying the SOL and IROL limit timers on the control room timer display for SOL/IROL exceedances.
- The entity developed a new display for the transmission and balancing system that would help to quickly select the required control actions according to the type of SOL/IROL exceedance.

The entity also re-evaluated its operating procedures.

- It clarified the definition of the SOL and IROL limits in its operating procedures and instructions.
- It clarified the application of the “emergency condition” in its operating procedures and instructions.

Lessons Learned

- Clearly differentiate the SOL and IROL limits in the EMS displays and the control room timer display for SOL/IROL exceedances to ensure they will not lead to system operator confusion.
- Review system operator understanding of the SOL and IROL limits and the emergency operations control actions permitted in each situation on a regular basis.
- More simulation training for system operators is needed with added stressful circumstances in order to enhance system operator situational awareness and response during emergency operations.

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