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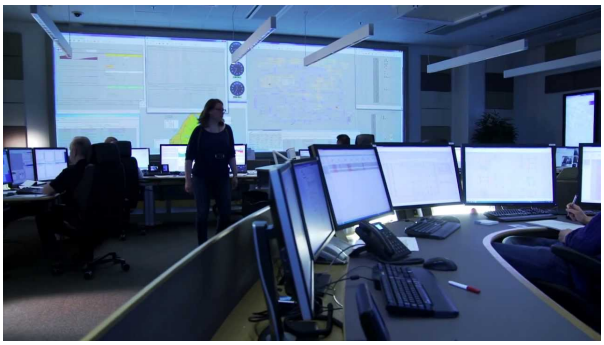
Situational Awareness During Extreme Loss of Control Center Capabilities



Project Highlights:

- Increased resiliency through tools and processes to restore observability and functional level of situational awareness during emergency operations
- Determine deployment of field personnel (number and location) to provide local measurements
- Develop process to estimate states of entire control area using the sparse field measurements
- Identify frequency control needs and process when Area Generation Control (AGC) is unavailable

Background and Project Objectives

Power Control Center (PCC) functionalities (SCADA, EMS, and AGC) are critical for reliable operation of the grid, and power system analysis and communication sub-systems within a PCC are well-protected and designed for high availability and reliability. Primary and back-up, or dual primary installations, are typical. All credible failure modes of individual components and systems are diligently analyzed and addressed in design and maintenance practices; however, low probability events can occur which could impact EMS and/or control center functionality. To maintain operations during these events, EPRI has developed a generic methodology[1] to restore observability.

This project will apply this methodology to participating utility systems to provide the basis for the utility's degraded control center capability operating procedure, including the following aspects:

- Determine locations (substations) where field personnel should be deployed to provide local measurements to the control center using emergency communication channels when all normal communications are lost.
- Develop procedures and toolset (data parser, automation scripts for developing load flow data, etc.) for restoring the functional level of situational awareness required to sustain operations.
- Analyze frequency control needs and resources to manage frequency when AGC is not available.
- Assist the utility to prepare for and conduct a table-top exercise to demonstrate and fine tune extreme emergency operations planning.

New Learning

EPRI expects that this project will provide the foundation for transmission operators to increase system resiliency by developing the processes and tools required to restore system observability during high-impact, low frequency (HILF) events that degrade control center capabilities. The project will extend and improve upon the algorithms developed in prior research including the following:

1. Determine the number and location of substations to monitor with field personnel so that minimal system observability can be established across various times of day and seasons of the year;
2. Investigate methods and procedures for utilizing sparse data obtained from human remote terminal units (RTUs) in real-time contingency analysis; and
3. Provide essential information for development of operations plans to address extreme emergency situations resulting from the loss of all normal communications.

[1] Bulk Power System Operations: Following Extreme Control Center Contingencies. EPRI, Palo Alto, CA: 2019. 3002015502

Project Approach and Summary

Using the load clustering method that was developed in a previous EPRI project, the minimum number of substations to deploy field personnel (human remote terminal units - HRTUs) needed to estimate all system loads across various load conditions for participating members' specific control area will be determined. This information will then be used to set up a power flow case to establish minimal functional system observability to sustain system operation.

The process of determining HRTU locations and estimating all other substations not monitored by field personnel will be shared with the participating utility. The analytical process and associated automation scripts that implement this method will be made available to the participating utility.

Next, this project plans to develop and apply a process to populate the most recent, pre-contingent operational power flow cases using observation from the HRTUs with respect to load, generation, and tie line data, and validate accuracy of the developed power flow case with a known operating condition. During the degraded control center event, these manually updated power flow cases (based on the HRTU reported observations) will serve as a situational awareness tool and be used for real time contingency analysis (RTCA) to manage system voltages and to evaluate various switching options.

This project also will include development of methods for analyzing frequency issues when AGC is not available. In doing so, recommendations for managing frequency during the HILF event will be developed.

Finally, the EPRI project team will assist the participating utility in developing an extreme emergency operation plan that outlines procedures and steps to be taken to implement these new methods during an event. This will include performing tabletop exercises with the individual utilities to implement the new processes and working with utilities to identify gaps to adjust the new methods and tools as needed.

It will be essential for the utility to assign a subject matter expert to interpret the data provided by the utility and assess availability of system models and current emergency operation measures.

Deliverables

1. Technical report summarizing results of the analysis
2. Analytical process to identify HRTU locations on utility systems
3. Process (and automation scripts) to intake and utilize HRTU data in power flow case
4. Recommendations for extreme emergency operation procedures
5. On-site support for tabletop exercise to evaluate new processes and tools

The non-proprietary results of this work will be incorporated into EPRI's Transmission Operations and Planning R&D program and made available to the public for purchase or otherwise.

Price of Project

The cost of participation will be $95,000. The project is eligible for Tailored Collaboration (TC) and Self-Directed Funds (SDF).

Project Status and Schedule

The project duration will be 12 months from the start date.

Contact Information

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