GE
Grid Solutions

Protection Schemes Testing Solutions

For Fixed Series Capacitors

Fixed series capacitors (FSC) directly reduce system impedance and effectively enhance power transfer on transmission systems. Since the capacitors are connected in series with transmission lines, they are exposed to high fault currents, which require sophisticated protection schemes.

In order to fulfill the requirements of NERC Reliability Standard PRC-005-6, transmission utilities need to implement maintenance and testing programs to evaluate the protection schemes affecting the reliability of the grid. Due to their specificities, FSC cannot be tested with conventional protection testing systems.

GE Solution

GE provides a safe and cost-effective solution to test GE's FSC protection schemes. The solution comprises three steps:

- **Test plan** developed by GE experts in compliance with NERC PRC-005-6
- **On-site test** performed with the Fixed Series Capacitor Bank Platform Simulator developed by engineers from GE FACTS Services Center of Excellence
- **Test report and recommendations** provided to maintain, repair or replace the protection schemes, providing document evidence of the maintenance activity, as per NERC PRC-005-6 requirements.

Smart Method

GE FACTS Services engineers have developed a Fixed Series Capacitor Platform Simulator (FSCPS) that simulates various system's faults and injects optical signals into the protection scheme of the FSC to test its performance.

Applications

FSC protection schemes testing solutions can be applied to any GE FSC equipment at the customer site.

Compliant

- Tests are performed in compliance with NERC. Reliability Standard PRC-005-6

Safe

- Testing platform uses optical signals
- The testing platform is installed next to the ground control protection cabinet, eliminating the need of heavy cabling

Cost Effective

- Only one technician needed to perform the test
- No outage required with redundant controller systems

Protection Relays Testing Protocol

Electronic/microprocessor-based protection relays measure voltages and currents directly from the low voltage side of the instrument transformers.

Once the voltage and current values are digitalized, the relay performs calculations and compares the results to settings previously determined by the operators. Depending on the result of the comparison, the relay will then command the circuit breaker's trip.

To test the relays, low electrical voltage and currents are injected on the inputs of the protection relay, simulating grid faults while monitoring relay trip output contacts. This kind of test allows to assess protection timing and accuracy.

Given the unique architecture of Fixed Series Capacitors (FSC) protection schemes, this conventional approach cannot be applied.

On one hand, FSC protection hardware in the substation control room is not sensing any electrical signal from the instrument transformers. This prevents conventional relay test set from being used in the control room as they only can provide electrical signals.

On the other hand, optical signals are being transmitted from hardware in the platform where the FSC is located. Performing injections from the capacitor bank platform is therefore challenging and makes it almost impossible to monitor the protection scheme trip contact response.

FSC Protection Testing Protocol

The Fixed Series Capacitor Platform Simulator (FSCPS) developed by GE solves the problem by simulating and injecting faults into the FSC protection scheme on an optical signal format. The tests are then performed safely and with high accuracy.

GE Fixed Series Capacitor Platform Simulator

The testing protocol consists of three stages. The first step is to develop a testing plan that suits the customer's FSC and meets NERC PRC-005-06 standard. Then, GE engineers perform the planned tests at site using the FSCPS – with the redundant FSC controllers, there is no need of a system outage. Finally, a report is produced, with test results and maintenance recommendations, providing the documented evidence required by NERC.

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