CASE STUDY
IMPROVING RELIABILITY

S&C ELECTRIC COMPANY
Excellence Through Innovation

Protection and Control Engineering for Canada's Largest Wind Farm

S&C Featured Solution: Engineering services

Location: Sault Sainte Marie, Ontario

Customer Challenge

To ensure safe, reliable operation of a wind farm, protective relaying must detect faults and trip the appropriate protective devices as quickly as possible. Rapid isolation of the affected portion of the electrical system is essential to minimize equipment damage and hazards to personnel and to maintain system stability.

A sophisticated protection and control system was required for the Prince Wind Farm—the largest wind generation facility in Canada. Located on the north-east shore of Lake Superior in Sault Sainte Marie, Ontario, the facility can provide 189 megawatts of power from 126 wind turbine generators…enough energy for nearly 40,000 homes. It is an important contributor to the provincial government's goal to generate 5% of Ontario's energy requirement from renewable sources.

S&C Solution

S&C Electric Company was the primary contractor for the two collector substations that consolidate power from the 1500-kW, 34.5-kV wind turbine generators; a 6.6-mile (10.6-km) long, 230-kV transmission line; and the interconnect substation that is the interface to the power transmission company. Along with other design and installation services, S&C engineered the protection and control systems that protect wind farm equipment from the damaging effects of electrical faults.

The Prince 1 substation receives power from four feeders through the underground collector system connected to 66 of the generators. The Prince 2 substation receives power from three feeders through the predominantly overhead collector system connected to the remaining 60 generators. Collector system bus is protected by a high-impedance differential relay. Feeders are protected by directional instantaneous and non-directional time-overcurrent schemes programmed into micro-processor-based multifunction electronic relays.

Each collector substation includes a 60/80/100-MVA, 34.5-kV delta/240-kV grounded-wye transformer with automatic tap changer, which steps up the 34.5-kV collector system voltage to the 230-kV transmission system voltage level. The transformer is protected by differential relays with overcurrent backup.

Recognizing reliability of the 230-kV transmission line is of paramount importance, a fully redundant relaying system was furnished for the line, ranging from battery

Line differential relay.

Distance relay.

chargers, protective relays, and auxiliary devices, all the way to dual trip coils on the circuit breakers. Redundant differential relaying is used, featuring relays from different manufacturers. Each differential relay reverts to a back-up distance relay scheme if communication is interrupted.

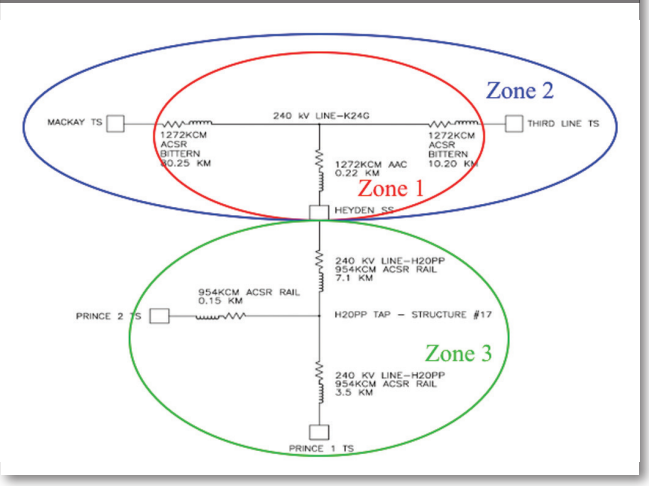
Distance relays look out into the transmission line. Zone 1 is instantaneous trip and reaches to 80% of the distance to the nearest substations. Zone 2 is a directional comparison blocking scheme and reaches past the end of the line at the furthest remote substations; it will trip after a coordinating time delay if a blocking signal is not received from either remote end. Zone 3 is a reverse element that provides a blocking signal for the directional comparison blocking scheme at the remote substations. Communication for the protection and control system is accomplished over fiber-optic cable with redundant multiplexers

Results

The protection and control systems were tested and commissioned as the interconnect substation, the Prince 1 substation, and the Prince 2 substation were brought online. End-to-end testing was subsequently performed to verify proper functionality.

The multifunction relays regularly perform self-checks and report the results though the wind farm's SCADA system, providing assurance the protection system is ready to perform when required. The relays further provide power system metering information on an ongoing basis.

Zone protection at Heyden substation.



Multiplexer.