Case Study 5: Fault Detection and Auto-Sectionalizing

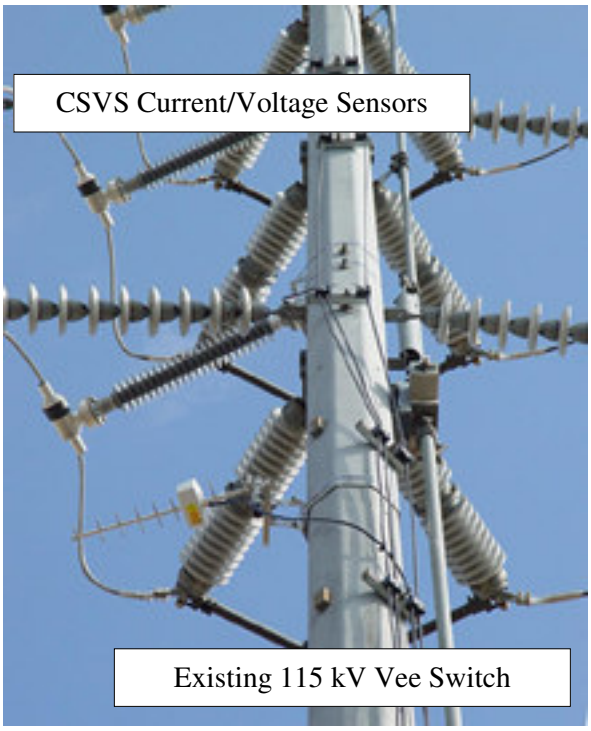

Figure 1

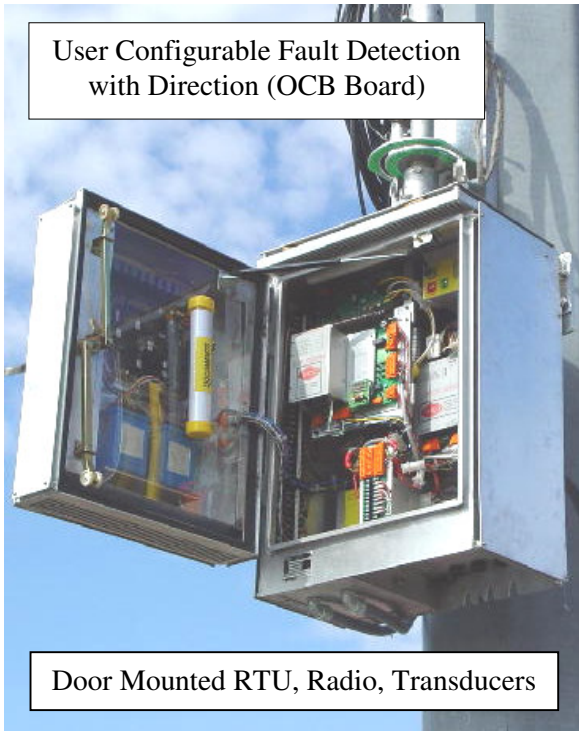

Figure 2

Customer: Investor Owned Utility

Location: Southwest U.S.

Problem Definition: This customer was experiencing frequent faults on 115 kV radial feeder circuits resulting in loss of service to many residential customers. When a fault occured detection and isolation was time consuming resulting in significant delays in service restoration. The utility historically has used center Vee switches in a phase-over-phase configuration to manually sectionalize the line for maintenance and fault isolation purposes.

Business Objective(s): Improve reliability and reduce customer outage time by adding new automation capabilities to quickly locate and isolate faults on 115 kV feeder circuits.

The primary functional requirements of this project were to include: (1) utilize existing center Vee switches, (2) provide rapid recognition and location of faults by phase including fault direction, (3) provide means for remote operation and control of the center Vee switches, and (4) provide means for remote monitoring of switch and motor operator status points as well as analog voltage and current values.

Other requirements included: (5) provide a system that allows rapid field installation and reduces associated outage time for access to each circuit, and (6) a single vendor solution to reduce coordination issues and to insure proper integration of all elements of the system.

Solution: To meet the customer's objectives SEECO provided an integrated solution, which included these major system components:

(9) SEECO 115 kV combination current and voltage sensors with 3000 amp coils; one per phase
(9) RIS voltage transducers; one per sensor
(9) RIS current transducers; one per sensor
(3) SEECO motor operators; one per switch
(3) ACS RTU's; one per motor operator
(3) Spread spectrum radios; one per motor operator
(3) SEECO OCB boards for fault detection; fault threshold user configurable from 600 to 3000 amps; one per motor operator

Implementation: Three locations were selected for the initial pilot project and the SEECO supplied material package was used to automate the existing 115 kV center Vee switches at each site. The existing switches were a mix of brands (manufacturers), ages and mounting structures. Though different by location, a single automation solution was provided that was sufficiently flexible to accomodate these differences with only minor modification for mounting requirements.

Three sensors were utilized at each location to provide voltage and current monitoring on each phase of the circuit. The sensors are extremely light weight (65 lbs) and compact, which allowed the units to be mounted directly to the pole structures (figure 1) using stainless steel banding. Installation of the sensors was relatively simple as the original pigtails were relocated through the center of the current sensing mechanism without splices or other modification. The current sensing mechanism is powered directly off the line current.

SEECO motor operators (figure 2) were also installed at each location for remote switch operation. This provided system operators with a means to immediately open or close these switches remotely at their discretion for maintenance, fault isolation or other sectionalizing requirements.

The motor operators are an integral part of the overall automation strategy as they act as the data collection hub for the various components of the system. The operator enclosure is used to house the RTU, radio, transducers, OCB (fault detection) board and the sensor output unit. All components were factory installed within the motor operator enclosure and tested for proper integration, which greatly simplified field installation time and effort.

Voltage and current monitoring utilizes the transducers to convert the output signals of the sensor output unit into milliamp values acceptable to the RTU. Actual voltage and current values by location and phase can now be monitored continuously by system operators and planners. The use of tranducers is not typically required however the RTU specified by the customer on this project had a limited range of acceptable analog inputs.

Fault detection is accomplished utilizing the current outputs of the sensor output unit in conjunction with SEECO's OCB board. The OCB board is a propietary daughter board installed on the sensor output unit which provides user definable threshold values for the fault event; customers can specify both the current amount (amps) and the number of cycles that define the fault. Using a 3000 amp current coil in the sensor unit and the OCB board allowed for a user definable range of 600 - 3000 amps and 0-99 cycles for this application. When both threshold values are met a contact closure is provided through the RTU.

Conclusion: The pilot project has been operational for several months and successfully tested by multiple fault events. Project personnel have approved the SEECO automation package for further deployment throughout their transmission system where similar combinations of radial feeds and high incidents of faults occur.