Case Study 1: Fault Detection and Auto-Sectionalizing

Customer: Investor Owned Utility

Location: Mid-Atlantic Region of East Coast

Problem Definition: This customer was experiencing frequent faults on 69 kV circuits feeding distribution substations, resulting in loss of service to large numbers of residential customers. Faults were difficult to locate and isolation was slow; pole top, cross-arm mounted center-break switches were used to manually sectionalize the faulted section of line.

Business Objective: Improve reliability and reduce customer outage time by adding new automation capabilities to quickly locate and isolate faults on 69 kV feeder circuits.

The primary functional requirements of the new system were to include: (1) a means to sectionalize the 69 kV system, (2) rapid recognition and location of faults, (3) monitor and control of system by supervisory control personnel, and (4) optionally, isolate the fault automatically without human intervention.

Other requirements included: (5) a single vendor solution to reduce coordination issues and to insure proper integration of all elements of the system; (6) a unitized, factory pre-assembled equipment package that was easy for field personnel to install, i.e. less than 1 crew day per location; (7) light weight, suitable for mounting on a single class 1 wood pole.

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

(20) SEECO 69 kV, 1200 amp center-break switches with polymer insulators
(60) SEECO 69 kV, 1200 amp combination current and voltage sensors
(20) SEECO motor operators with integral power supply (batteries and charger)
(20) GE Harris 9650 RTU's w/ auto-sectionalizing feature
(20) SEECO aluminum trusses
(120) Ohio Brass 69 kV, 350 BIL drop out style lightning arrestors

Note: To complete the system required a communication device. The customer elected to purchase this device (radio) themselves and exclude it from the SEECO-supplied material package.

The primary requirement for the new system was the immediate recognition of a fault and the determination of its direction (location). Utilizing the SEECO combination current and voltage sensor provided the critical capability to recognize the occurrence of a fault, and to determine whether it was located upstream or downstream of the sensor. The companion requirement to provide a means to monitor phase voltage and current is also achieved through the sensor, which functions as a data collection device providing
continuous indication of actual current and voltage in conjunction with the RTU and radio. By providing indication of both faults and actual voltage/current, system operators can exercise control of the switch through the motor operator to sectionalize the 69 kV circuit at their discretion.

In addition to manual intervention, the auto-sectionalizing feature of the RTU permits the independent and automatic operation of the motor operator to open or close the switch under multiple criteria including gain or loss of potential, current threshold, phase reversal (fault direction) or other additional criteria. The RTU provides a programming function (ladder logic), which allows customer personnel to specify the desired criteria or operating conditions that will initiate the automatic operation. The design for the new system anticipates that auto-sectionalizing will be the eventual default mode of control.

The complete equipment package was fully factory assembled and adjusted prior to shipment. To unitize the SEECO 69 kV center-break switch, individual switch poles were assembled, adjusted and then mounted on the assembled truss. All three poles were then connected to the inter-phase pipe and the crank arm was adjusted for toggle. This enabled the unitized switch to be shipped, installation-ready, with no field assembly or adjustment required other than to mount the truss to the pole structure and hang the vertical control pipe. The pre-assembly principle extended also to the motor operator where the enclosure (cabinet) was enlarged and sized to accommodate the RTU, which was installed by SEECO assembly personnel and wired to the terminal blocks prior to shipment. The degree of factory pre-assembly insured that the original objective to install in less than 1 day per location was achieved.

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The total equipment package, when installed, weighed approximately 1,300 lbs making it extremely light in weight when compared to other proposed designs. Several design choices by SEECO's application engineers contributed to the overall desired result. The use of polymer insulators for the 69 kV switch reduced weight significantly. An aluminum truss structure provided a more favorable strength to weight ratio than a steel structure. Finally, the combination current and voltage sensor weighed less than 10% of a comparable oil filled CT/PT device. The light weight of the switch/truss combination also made it easier to handle and work with, contributing to the ease of installation.

A single vendor solution was offered with SEECO acting as the integrator of all material regardless of source. Most of the major components of the new system were of SEECO manufacture, including the 69 kV switch, current and voltage sensors, motor operator with power supply, and aluminum truss. Other major components such as the GE Harris RTU, Ohio Brass lightning arrestors, and Mclean polymer insulators were purchased by SEECO and engineered into the larger equipment package to provide an integrated solution. The customer recognized the desired benefit of writing a single purchase order to one supplier (SEECO) who provided one point of coordination and one vendor to guarantee the performance of all elements of the new system.

Implementation: Twenty locations were selected for the first phase of this project with each 69 kV feeder circuit equipped with two or more switches. During this initial trial period supervisory control personnel are exercising direct control over the system; system operators are making the critical decision of when to remotely open or close each switch based on the local intelligence provided by the sensor at each physical location. As personnel gain confidence and become more familiar with the new system the customer
anticipates enabling the default mode of the RTU allowing for the independent, automatic operation of the motor operated switches.

A number of feeders were candidates for the new fault isolation and autosectionalizing capabilities. Prioritization for feeders was based on the historical reliability of the feeder circuit and the degree of potential impact for improved service. The feeders with the highest incidence of outages and number of customers affected were given a higher priority. As might be expected, longer feeder circuits frequently correlated with a higher incidence of fault events and a larger number of affected customers, and these frequently received a higher priority.

SEECO field engineers participated in the installation of the initial units to assist the customer and the customer's contractor. After the first installed unit, successive installations met the original criteria for 1 crew day per location. This allowed the customer to accomplish a major project objective: installation of all 20 switches before the end of the budget year.

Conclusion: The customer's internal evaluation of the initial project has been highly favorable and continuation of the program has been authorized.

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