

## Protection of EHV Transmission Lines With Series Compensation: BC Hydro's Lessons Learned

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### Abstract

The BC Hydro transmission network includes 33 wholly owned, 500 kV circuits and 3, 500 kV interconnections with other utilities. Eleven of these lines include series compensation and many have been upgraded to provide single-pole tripping capability to improve power transfer capability and stability margins. To reduce construction costs, the majority of these lines are not shielded, which increases the probability of low-grade, single-line-to-ground faults due to high tower grounding resistance. Over the years, BC Hydro has developed strict performance specifications for both sensitivity and speed of the protection systems based upon fault location and fault type and has a well-developed process for model power system testing of protection systems to verify their conformance to these performance specifications.

This paper discusses lessons learned in applying protection systems and optimizing protection sensitivity and speed for these challenging applications. The paper discusses a number of problems and challenges discovered in real-world experiences and during simulation. Many of the problems are associated with discerning the difference between normal system unbalances and/or unbalances caused by operation of series capacitor protection and resistive ground faults up to 300 ohms. The paper also includes discussion of the impact of reclosing control and automatic reinsertion control of series capacitors on the protection systems. The presentation includes a number of digital fault recorder records for actual power system faults on series-compensated lines.

### Discussion Points

1. BC Hydro has an extensive network of EHV transmission lines so there is a great deal of experience to share on the operation and protection challenges associated with that network.
2. The protection systems have been optimized to provide both high-speed protection for high-grade faults and high-sensitivity for low-grade faults. The lessons learned show how to overcome some of the challenges to achieve this high degree of optimization.
3. One of the challenges of applying protection systems on series-compensated systems is to coordinate sensitive ground fault elements with series capacitor bypass protection. Some of the lessons learned provide information on this important application consideration.

### Short Paragraph

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