

1 **Q. Describe Newfoundland Power’s protective relaying criteria (standard design**
2 **philosophies) for its transmission lines, substations, and distribution feeders and**
3 **provide copies of any documents that describe the criteria. Explain the degree to**
4 **which Newfoundland Power has not met its relaying criteria.**

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6 A. *Transmission Lines and Transmission Line Breakers*

7 Newfoundland Power uses a single relay protection scheme with backup protection
8 provided by remote, back-line protection in case of relay failure. Three types of
9 protection schemes are used for transmission lines, (1) line current differential protection
10 schemes with fibre optic communication, (2) distance or impedance protection and (3)
11 overcurrent protection with phase and ground fault elements.

12
13 Line current differential protection is considered for short transmission lines less than 10
14 km in length. 138 kV looped transmission lines use distance protection. Other
15 transmission lines use either distance or overcurrent protection.

16
17 Newfoundland Power is in the process of modernizing the technology used in its
18 protection schemes. As a protection scheme is modernized, a review occurs to determine
19 if the existing protection scheme should be modified. In general this has resulted in
20 increased use of distance protection and a decreased use of overcurrent protection as the
21 primary protection scheme. Also new protection schemes are implementing the
22 expanded functionality of programmable relays to provide multiple protection schemes
23 and as appropriate using overcurrent protection as a back-up to differential and distance
24 relaying schemes. Further, the modernization is adding breaker fail schemes for backup
25 in case a breaker fails to operate.

26
27 *Substation Protection*

28 Newfoundland Power’s substation protection has 3 protection zones, (1) high voltage (66
29 kV and 138 kV) bus protection, (2) power transformer protection and (3) low voltage bus
30 protection. The protection scheme used varies depending on the number of transmission
31 line terminations and transformers.

32
33 Differential protection schemes are provided for high voltage buses that have 2 or more
34 breaker controlled transmission lines.¹ Other high voltage buses are protected by remote,
35 back-line transmission line protection. High voltage buses with 3 or more transformers
36 have high voltage bus tie breakers to improve fault clearing selectivity and to improve
37 service reliability.

¹ The principle of bus differential protection is based on the engineering rule that the total amount of electricity entering an electrical node must exactly equal the amount of electricity leaving the node. For substation buses, if this rule fails because the electricity flow on transmission lines into the substation bus does not match the electricity flow through to the distribution feeders then it is assumed that there is a fault on the bus. This will cause the bus differential protection to operate and isolate the substation bus.

1 The power transformers with capacities greater than a 7.5 MVA base rating have a
2 differential current protection scheme along with phase and ground overcurrent
3 protection. In substations where there is no high voltage breaker the transformer
4 protection scheme operates a high-speed ground switch which trips back-line
5 transmission line protection.² Power transformers rated 7.5 MVA and lower are
6 protected by power fuses.

7
8 The substation low voltage bus is protected by the transformer overcurrent protection
9 coordinated with the feeder protection.

10 *Distribution Feeder Protection*

11 Distribution feeder protection is comprised of phase and ground overcurrent protection.
12 Urban feeders have two trips to lockout (one reclose). Rural feeders have three trips to
13 lockout (two recloses). Instantaneous protection is blocked after the first trip to allow
14 time for downline fuses to operate before the feeder trips the second time.

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17 Older relays are continually being replaced with new micro-processor relays under the
18 Substation Refurbishment and Modernization program. Protection schemes meet the
19 protective relaying criteria at time of installation. When relaying schemes are
20 modernized, they are reviewed to ensure the most appropriate scheme is installed.

21
22 There is no formal documentation describing these standard design philosophies.

² Where practical, such as at the end of a radial transmission circuit, Newfoundland Power installs a high speed ground switch that when operated places a line to ground fault on 1 phase of the incoming transmission line. This fault is detected by the over current protection scheme at the upstream substation, which in turn trips the transmission line breaker, de-energizing the transmission line and the faulted transformer at the downstream substation.