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Q. Why is it necessary to replace silicon carbide lightning arrestors on transformers with new metal oxide arrestors?

A. Silicon carbide lightning arrestors are obsolete. At the end of their life they are replaced with the current industry standard metal oxide arrestors.

The silicon carbide arrestors were installed on Newfoundland Power substation transformers until the mid-1980s. The silicon carbide arrestors still in service are beyond their normal life span and are prone to failure. The failure occurs when water leaks past the arrestor seal and into the arrestor causing an electrical fault to occur.

There is no reliable test to predict the impending failure or remaining life of arrestors. Lightning arrestor failures on substation power transformers result in power outages to large numbers of customers. To minimize the impact of unscheduled outages upon customers the Company has been using scheduled projects to remove the silicon carbide arrestors.

More background information can be found in the 2006 Capital Budget Application in the report *2006 Rebuild Substations.* Appendix A, to this report is included as Attachment A to this response.

2006 Capital Application Schedule B

2006 Rebuild Substations, Appendix A

Appendix A

Lightning Arrestors Replacement

Background

The most critical asset in a substation is the power transformer. It is expensive to purchase and requires a lead time of a minimum six to eight months. To avoid large expenditures or long outages, it is important that the transformer be adequately protected. One means of protecting the transformer is through the use of lightning arrestors connected to the transformer. Lightning arrestors protect transformers from lightning strikes and from switching surges associated with operating electrical system breakers and fuses.

Most of Newfoundland Power's transformers are protected by silicon carbide gap type lightning arrestors. This arrestor type is made up of a series of gaps inside a porcelain housing which flashes over when the voltage level reaches the rating of the arrestor, thereby protecting the power transformer. Newer technology in lightning arrestor design which became common during the 1980s replaced the gap type arrestor with an arrestor that utilized metal oxide disks in-series inside a porcelain housing. This design (metal oxide arrestors) provided a greater margin of protection for the equipment and has proved to be less prone to failure.

When gap type arrestors reach the end of their life, they are prone to high failure rates. The high failure rate of the gap type arrestor has been attributed to a failure in the seals on the ends of the arrestor. This seal failure then allows the ingress of moisture and subsequent failure. Failure of an arrestor can cause extensive power outages to customers. Several methods of testing have been tried over the years to identify those arrestors close to the end of their life. The two methods in use today are power factor testing and infrared scanning. Infrared has not proven to be effective and utilities are discontinuing using this method. Power factor testing, though proven to be an effective means of testing arrestors is not practical as it requires a transformer outage to test. The only practical time to perform this testing is when the transformer is out of service for major maintenance, usually on a ten year cycle. This testing cycle is not of adequate frequency to detect imminent failure of an arrestor and maintain a reliable electrical system.

The arrestors installed at Newfoundland Power, with a few exceptions, were installed when the transformers were originally installed. Newfoundland Power currently has 190 power transformers in service ranging in age of one year to sixty-four years. Approximately 160 of these transformers were installed prior to 1980. Based on these numbers and the few arrestor replacements that have occurred in recent years, it is estimated that approximately 60% of installations (115 transformers) still have the silicon carbide gap type arrestor in service.

Recent Failures

In 2004 there were 3,213,815 customer minutes of unscheduled outages due to failures in substations. Of this amount 594,218 customer minutes, or 18% of the total, was caused by the failure of gap type lightning arrestors.

To date in 2005, there have been 2,330,001 customer minutes of unscheduled outages due to failures in substations. Of this amount 967,414 customer minutes, or 42% of the total, was caused by gap type lightning arrestors.

North American Utility Experience

Feedback from other North American utilities involved with the Canadian Electrical Association Technologies Inc. (CEATI) group (comprised of approximately twenty-five Canadian and American utilities of which Newfoundland Power is a member), indicates that silicon carbide gap arrestors still in service are beyond their expected life span and prone to failures. Many utilities have completed replacement of all gap type arrestors on their system.

Plan

In order to confirm the numbers of silicon carbide gap type lightning arrestors at each installation, an inspection program will be completed in 2005. Following these inspections, cost estimates will be completed and a replacement schedule developed over a multi-year period. Replacing all of the remaining gap type arrestors in the system will involve an approximate expenditure between one million and two million dollars.

Recommendations

1. Allocate $350,000 in the 2006 Capital to do engineering and start replacement of the silicon carbide gap arrestors.

2. Develop a comprehensive multi-year plan for completion of all required substation lightning arrestor replacements.