Q. **(Reference Application Schedule B, pages 45, 46 and 47 of 98) For the Rebuild Distribution Lines (Pooled) project, please file for the record a copy of Report *4.4 Rebuild Distribution Lines Update.***

A. See Attachment A to this response for a copy of Report *4.4 Rebuild Distribution Lines Update*.

Distribution Rebuild Update

Distribution Rebuild Update

June 2012

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NEWFOUNDLAND POWER
A FORTIS COMPANY

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1.0 Introduction

Newfoundland Power (the "Company") has over 9,000 kilometres of distribution lines in service and has an obligation to maintain this plant in good condition to safeguard employees and the public and to maintain reliable electrical service. The replacement of deteriorated distribution structures and equipment is an important part of fulfilling this obligation.

The *Rebuild Distribution Lines* project involves rebuilding sections of lines or the selective replacement of various line components based on preventive maintenance inspections or engineering reviews. This typically includes the replacement of poles, crossarms, conductor, cutouts, lightning arrestors, insulators and transformers.

This report provides an update to information provided in the 2004 Capital Budget Application in support of the *Rebuild Distribution Lines* project.

2.0 Preventative Maintenance Inspections

As part of the Company's preventative maintenance program, all overhead primary distribution lines are required to have a minimum of one detailed ground inspection every seven years.[1] The Company has a total of 303 distribution feeders throughout its operating area, and inspects approximately 43 feeders annually.

The Company's Distribution Inspection Standard outlines the requirements to complete distribution line inspections. It is a guide for inspectors and job planners to ensure consistency in the preventative maintenance program.[2] The inspection standard is regularly reviewed and updated to adapt to changes in operating procedures, outage statistics and trending, or industry practices.

Capital work identified through distribution line inspections is completed under the *Rebuild Distribution Lines* project in the following year. High priority capital work that cannot wait to the next budget year is completed under the *Reconstruction* project.[3]

Planning and scheduling of work under the *Rebuild Distribution Lines* project is done by prioritizing deficiencies. For example, items of concern related to reliability are typically addressed on the main trunks of distribution feeders before feeder taps or laterals.[4] The amount of work completed is based on the amount of work identified through the distribution line inspections, which will vary depending on the age, length and condition of the feeders being inspected. At times, unanticipated work requirements such as new customer connections, third party work requests and storm-related work requires the Company to adjust the amount of work

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1 The Company also completes distribution vegetation inspections every three and a half years for brush clearing and tree trimming. Distribution pad mounted transformers are inspected annually. These inspections are typically completed at the same time as the distribution line inspections for feeders undergoing inspections during the same year.

2 This includes type and frequency of inspections, qualifications of inspectors, details for job planning, and specific guidelines for identifying and prioritizing deficiencies.

3 Deteriorated or damaged distribution structures and electrical equipment deemed to present a risk to safety or reliability are addressed through the *Reconstruction* project in the year in which they are identified.

4 This is done because failures on the main trunks of distribution feeders will affect more customers.

to be completed under the *Rebuild Distribution Lines* project.[5] This is done by focusing on the selective replacement of high priority items.[6] In keeping with the Company's normal preventative maintenance program, the lower priority work that is not completed in the budget year will be identified during the next distribution line inspection to be completed in a future *Rebuild Distribution Lines* project.[7]

3.0 Distribution Line Deficiencies

The Company's preventative maintenance program addresses deficiencies associated with distribution structures and electrical equipment that have been identified through inspections. This typically includes the repair or replacement of poles, crossarms, conductor, insulators, switches and transformers.

Deficiencies included in the *Rebuild Distribution Lines* project are those deemed to present a risk of failure before the next scheduled inspection in seven years. Examples of such deficiencies include:

- Heavily rusted transformers showing no signs of leaking or weeping
- Rotten or damaged poles or pole cribs requiring repairs
- Rotten or broken crossarms
- Insulators, bushings or switches with cracked porcelain insulation or skirts missing
- Deteriorated conductor with broken strands

Examples of deficiencies that would be identified during distribution line inspections are shown in the figures below.

Figure 1: Damaged Wooden Pole

Figure 2: Rotten Crossarm

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5 For example, in 2010 unplanned work related to the March ice storm and Hurricane Igor resulted in a significant decrease in the amount of planned distribution maintenance completed during that year.

6 Examples of higher priority work include the replacement of automatic sleeves and porcelain cutouts on the main trunk of distribution feeders.

7 Examples of lower priority work include the replacement of 2-piece insulators and porcelain cutouts not showing signs of failure, or the installation of lightning arrestors and current-limiting fuses.

Figure 3: Pole Crib Requiring Repairs

Figure 4: Rusted Transformer

4.0 Replacement Programs

The *Rebuild Distribution Lines* project includes selective replacement of specific line components to address known causes of safety and reliability issues. These programs are established based on engineering reviews of specific line components. Several replacement programs were identified in the Company's 2004 Capital Budget Application, including lightning arrestors, CP8080 and 2-piece insulators, current limiting fuses, automatic sleeves and porcelain cutouts.[8] The following is a discussion on each of the replacement programs that are currently part of the *Rebuild Distribution Lines* project.

4.1 Lightning Arrestors

Prior to the mid 1990s, Newfoundland Power did not install lightning arrestors on pole mounted distribution transformers. One of the reasons for this was that Newfoundland was not considered to be a high isokeraunic area.[9] There were also reliability and safety concerns with the porcelain housing of arrestors at the time.[10]

Over time, lightning arrestors became more reliable and less expensive. Also, arrestors became available in polymer housing, eliminating the safety concern from exploding porcelain glass. In the mid to late 1990s, the Company began installing arrestors in areas that were prone to lightning strikes. Since October 2002, Newfoundland Power has considered an arrestor to be an integral part of the transformer and all new transformer installations since that time have an arrestor included.[11]

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8 See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2 for further details.

9 The Isokeraunic Level (IKL) is a universally accepted measure to help utilities make some determination of the incidence of lightning in their service areas. It is defined as the number of days in a year (or month) that thunder is heard in a particular location.

10 Porcelain housing was a safety concern for employees because catastrophic failure of arrestors resulted in the shattering of porcelain, potentially causing serious injury.

11 See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2, Attachment B for further details on lightning arrestor requirements.

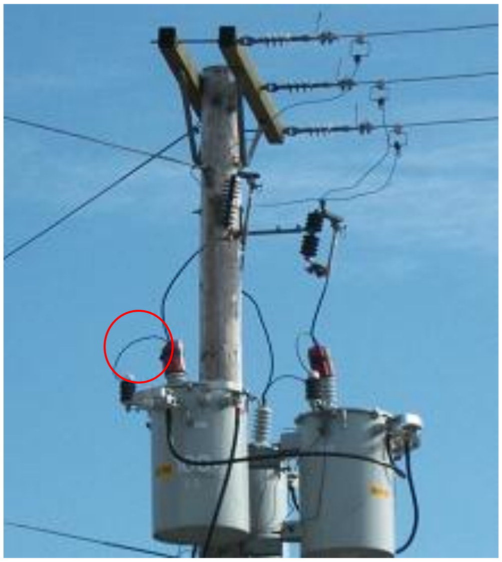

Figure 5: Lightning Arrestors In Service

4.2 CP8080 and 2-Piece Insulators

Premature failure of porcelain insulators due to "cement growth" is a known problem through the utility industry.[12] Newfoundland Power began to experience abnormal failures of porcelain insulation in the early 1980s.[13] Since that time, the Company has replaced a significant number of defective CP8080 suspension insulators and 2-Piece pin-type insulators.[14]

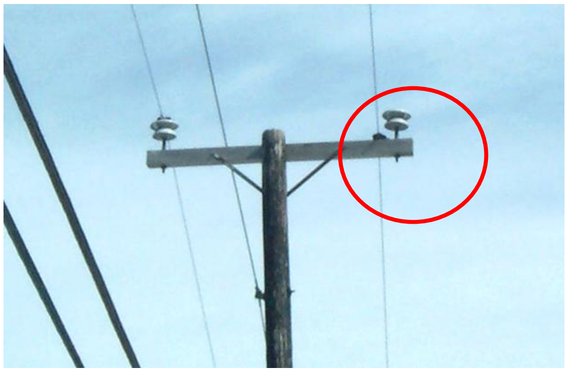

Figure 6: Broken Insulator In Service

Figure 7: Broken Insulator Removed From Service

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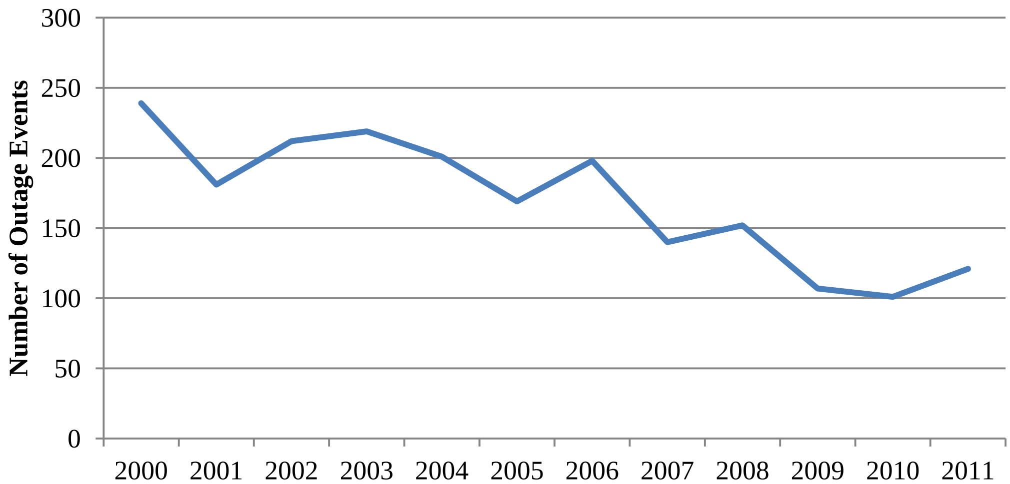
12 Since the early 1960s the term "cement growth" has been used to categorize a problem for premature failure of porcelain insulators. The volume expansion of the cement occurs in the presence of moisture and is attributed to a chemical change in the cement that occurs with age. The expansion typically occurs over 10 or more years. As the cement expands it produces stress on the porcelain that fails in tension by cracking.

13 See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2, Attachment C for further details on problem insulators.

14 CP8080 suspension insulators fail by radial cracks, which are sometimes contained inside the metal cap and are not visible. The crack causes a current path between the metal cap and pin and shorts out the insulator. Pin type and pin cap type (2-Piece) insulators fail by circumferential cracks. Failure is usually mechanical; the top shears off the insulator causing the conductor to float clear of the structure.

As shown in Graph 1 below, since 2000 the number of outages resulting from insulator failures has reduced to nearly half as a result of removing CP8080 and 2-Piece insulators from service as part of the *Rebuild Distribution Lines* project.[15] This has resulted in a positive impact on reliability.

Graph 1
Outages Caused by Insulator Failure



4.3 Current Limiting Fuses

Pole top distribution transformers are generally a very reliable component of the distribution system. However, they do eventually fail.[16] On rare occasions, transformer failures can lead to a buildup of pressure inside the tank, resulting in tank ruptures, oil spillage, or other *eventful* conditions. The probability of an eventful failure increases in locations with higher available fault current.

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[15] In 2000 there were 239 outages resulting from insulator failures while in 2011 the number of outages related to insulator failure had reduced to 121, or 50.6% (121/239 = 0.506)

[16] The large majority of transformer failures are uneventful, resulting in voltage abnormalities, electrical noise, power quality issues, open circuit conditions, or an electrical fault which blows the transformer protection fuse. Other types of failure may include leaking tanks, broken or cracked bushings, or other mechanical component failures.

Figure 8: Current Limiting Fuses In Service

To reduce the probability of eventful transformer failures, the Company uses Current Limiting Fuses ("CLFs") to limit the available current when a fault occurs.[17] The Company installs CLFs in the following locations:

- All fused cutouts located where fault current may exceed their maximum interrupting rating of 10,000 and 12,000 amps asymmetrical at 12.5kV and 25kV respectively.
- Transformers located in areas where fault levels exceed 5,000 amps symmetrical.
- Transformers located within 7 meters of sensitive locations where fault levels exceed 3,000 amps symmetrical.
- Other specified locations such as capacitor banks and primary metering installations.

4.4 Automatic Sleeves

Newfoundland Power adopted automatic sleeves for use as an alternative to joining conductors by means of compression sleeves.[18] This was done on a limited basis in 1993, and in 1999 the Company approved automatic sleeves for use on the entire distribution system. However after

[17] See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2, Attachment D for further detail on current limiting fuse requirements.

[18] Compression sleeves require the use of a specialized compression tool and are relatively labour intensive to install. Automatic or "quick" sleeves were quick and easy to install and did not require the use of a specialized tool. While the automatic sleeve was more expensive to purchase, the additional cost was justified by the increase in productivity.

nine years in service these automatic sleeves began showing signs of premature deterioration, in large part due to our severe environmental conditions.[19]

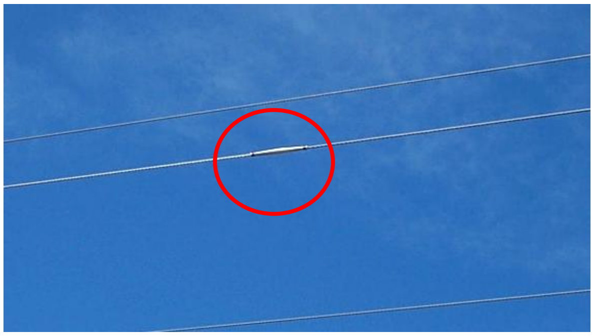

Figure 9: Automatic Sleeve In Service

Figure 10: Disassembled Automatic Sleeve Showing Corrosion

First indications of a problem surfaced in early 2002 when an automatic sleeve failed. An investigation followed which showed a high percentage of sleeves were experiencing signs of water ingress and internal corrosion.[20] The potential risks to public and employee safety, as well as system reliability prompted the Company to discontinue the use of automatic sleeves by the fall of 2002.[21]

4.5 Porcelain Cutouts

Porcelain insulated cutouts have been in use in the electrical industry for many decades.[22] Throughout that time, design and manufacturing processes have changed somewhat, but porcelain remained as the basic insulating material. In 2000 and 2001, the Company began to experience incidents of failed porcelain cutouts. Through 2002 and into 2003, hundreds of cutout failures were reported, and line personnel became increasingly concerned with the safety hazards associated with cutout failures.[23]

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19 See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2, Attachment E for further detail on automatic sleeves.

20 In the Fall of 2002, a total of 35 sleeves were removed from various areas throughout the Company and inspected. The results indicated widespread internal deterioration of automatic sleeves. 71% of the sleeves removed showed at least some corrosion with 37% being severely corroded.

21 Mechanical failure of a corroded automatic sleeve would result in line separation and the potential of an energized line dropping to the ground, presenting a public safety hazard. This hazard would also exist for line personnel performing energized work. In addition to mechanical failure, there is the risk of electrical failure of the sleeve creating an open circuit. This is particularly hazardous if a sleeve is on a neutral conductor. Voltage differences could be present across an electrically open sleeve on a neutral conductor that would be hazardous to line personnel. Mechanical or electrical failure of automatic sleeves can each result in customer outages.

22 The cutout is a pole-mounted device used to disconnect or reconnect equipment to a source of electricity.

23 Throughout the Company cutouts are opened and closed as part of regular system operations. This is typically done by line personnel positioned in the pole or the bucket of a line truck using a 10' long *hotstick*. Operating a cutout that is close to failure while it is energized may result in the cutout breaking, placing line personnel in an unsafe situation.

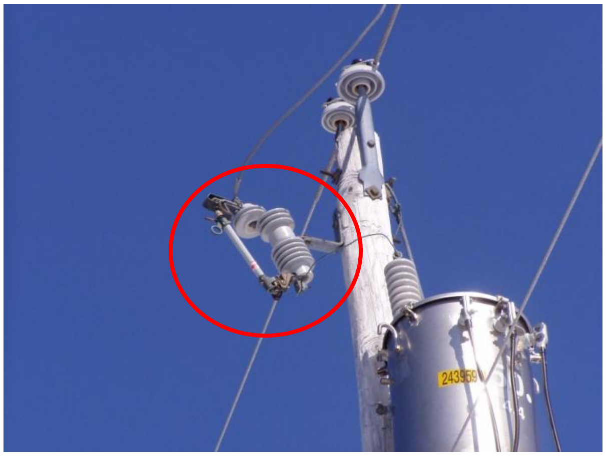


Figure 11: Broken Porcelain Cutout In Service

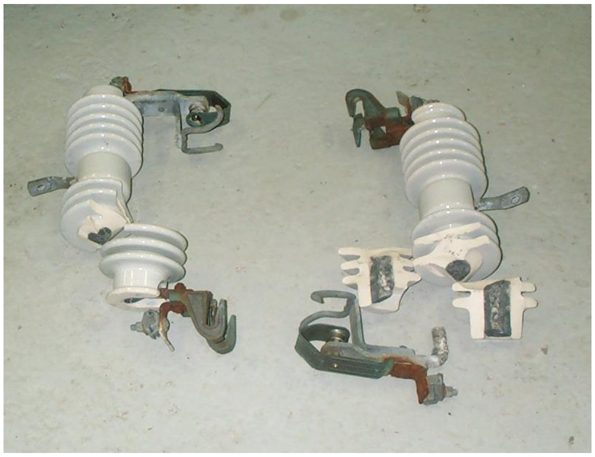
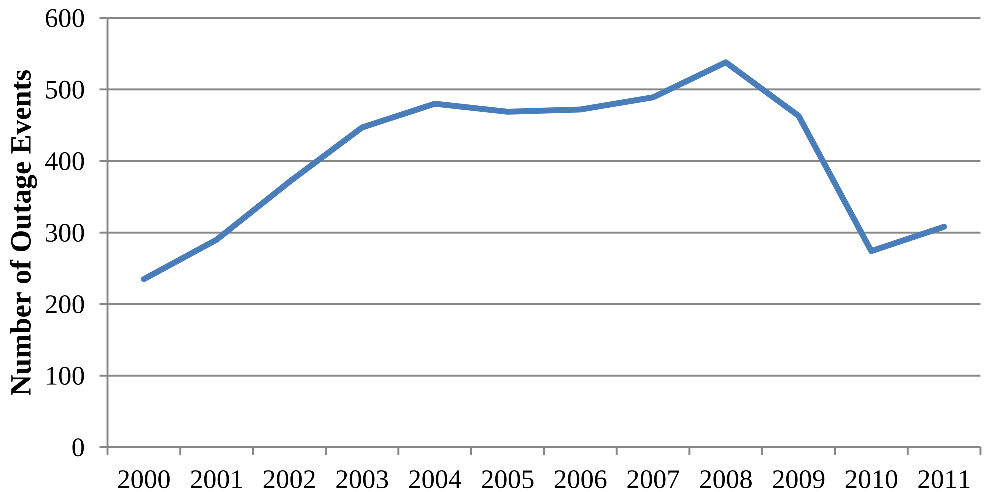


Figure 12: Two Broken Porcelain Cutouts Removed From Service

In 2003, as a result of the increasing rate of failures, the Company decided to discontinue the use of porcelain insulated cutouts and adopt the polymer insulated cutout as its new standard.[24]

Porcelain cutout failures continued to increase after 2003, and since that time, the Company has expanded the replacement program to all porcelain cutouts on the main trunk of distribution feeders, as well as lateral taps and large customers.

Graph 2
Outages Caused by Cutout Failure



As shown in Graph 2 above, the number of outages resulting from cutout failures steadily increased up until 2008, but declined in recent years as a result of removing porcelain

24 See the 2004 Capital Budget Application, Volume III, Distribution, Appendix 2, Attachment F for further detail on porcelain cutouts.

cutouts from service as part of the *Rebuild Distribution Lines* project.[25] This has improved reliability.

4.6 Stainless Steel Pole Mounted Transformer Hanging Brackets

The Company began purchasing pole mounted transformers manufactured with 316L stainless steel in 2001. This was done as a result of numerous failures due to rusting transformer tanks, largely due to higher levels of salt contamination in Newfoundland. After several years of using the new stainless steel tank design, the issue of broken hanging brackets began to surface on 25 kVA and 50 kVA transformers.[26]

Following discussions with the manufacturer it was determined that the hanging brackets were not sufficient for the mechanical forces exerted by higher wind conditions in the Newfoundland environment. To address this issue, the Company changed its specification for stainless steel transformers in 2007, requiring a hanging bracket made of a thicker gauge stainless steel.

Figure 13: Stainless Steel Pole Mounted Transformer

Figure 14: Broken Stainless Steel Transformer Hanging Bracket

In total there have been 27 transformer bracket failures reported on stainless steel transformers manufactured from 2001 to 2006, inclusive.[27] As a result, the Company has worked with the manufacturer to develop a reinforcing bracket that can be installed on in-service transformers. Beginning in 2013, 25 kVA and 50 kVA transformers manufactured between 2001 and 2006 will be identified and retrofitted with a reinforcing bracket as part of the *Rebuild Distribution Lines* project.

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25 Over the period from 2004 to 2009 the annual average number of outages caused by cutout failure was 485, peaking at 538 in 2008. By 2011 the number of outages caused by cutout failure had declined to 308.

26 The first reported bracket failure occurred in 2003 when a lower bracket split after being in service for several months. A second reported bracket failure occurred in February 2006.

27 Of the reported failures, 19 were 50 kVA units, 7 were 25 kVA units and 2 others did not have the size reported.

5.0 Concluding

This *Rebuild Distribution Lines* project involves the replacement of deteriorated distribution structures and electrical equipment that have been previously identified through the ongoing preventative maintenance program or engineering reviews. It is justified on the basis of the need to replace defective or deteriorated electrical equipment in order to maintain a safe, reliable electrical system.

The Company will continue its ongoing preventative maintenance program to identify damaged, broken or defective equipment, and will continue with the specific programs targeting lightning arrestors, CP8080 and 2-piece insulators, current limiting fuses, automatic sleeves and porcelain cutouts. The Company will also identify stainless steel transformers manufactured between 2001 and 2006 as part of annual distribution line inspections and retrofit these transformers with reinforcing brackets as part of the *Rebuild Distribution Lines* project.

The annual distribution line inspection program will identify:

- *Locations where transformers not equipped with a lightning arrestor in areas prone to lightning strikes*. In the year following the inspection, lightning arrestors are installed on identified transformers as part of the *Rebuild Distribution Lines* project.

- *Locations where CP8080 and 2-Piece insulators remain in service*. In the year following the inspection, insulators identified for replacement are included as part of the *Rebuild Distribution Lines* project.

- *Locations where a CLF is required and not installed*. In the year following the inspection, CLFs are installed as part of the *Rebuild Distribution Lines* project.

- *Locations where automatic sleeves remain in service*. In the year following the inspection, automatic sleeves identified for replacement are removed as part of the *Rebuild Distribution Lines* project.

- *Locations where porcelain cutouts remain in service* on the main trunk of distribution feeders, as well as lateral taps and large customers. In the following year porcelain cutouts identified for replacement are removed as part of the *Rebuild Distribution Lines* project.

- *Locations of stainless steel transformers manufactured from 2001 to 2006*. In the year following the inspection, transformers identified to be retrofitted with a reinforcing bracket will be included as part of the *Rebuild Distribution Lines* project.