Reference: 3.1 2024 Transmission Line Rebuild

Q. Page 1. Newfoundland Power introduced its Transmission Line Rebuild Strategy as part of its 2006 Capital Budget Application. Please file a copy of this strategy for the record in this proceeding.

A. Newfoundland Power's *Transmission Line Rebuild Strategy* filed with its *2006 Capital Budget Application* is included as Attachment A.

ATTACHMENT A:

Transmission Line Rebuild Strategy

Transmission Line Rebuild Strategy

June 2005

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PROVINCE OF NEWFOUNDLAND

NEWFOUNDLAND POWER
A FORTIS COMPANY

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3.1 Transmission Line Rebuild Strategy

1.0 Executive Summary

This report outlines a 10 year plan to rebuild Newfoundland Power's aging transmission lines to ensure a safe and reliable supply of electricity to customers.

The important role transmission lines play in providing reliable service to large numbers of customers requires they be rebuilt before they deteriorate to the point that they fail in service. While the Company's approach to distribution reliability improvement includes rebuilding and upgrading those feeders that have the worst reliability performance on a targeted basis, that approach is not recommended for establishing priority for transmission line upgrading and rebuilding. Transmission lines serve more customers and therefore have a higher degree of overall electrical system criticality than distribution lines.

Assessment of current reliability performance statistics alone will not necessarily identify transmission lines that are at risk of failure. Field assessment of actual asset conditions are essential to establishing a sound capital maintenance strategy for transmission systems.

Newfoundland Power intends to redesign and rebuild its oldest and most deteriorated lines on a priority basis over the next 10 years at a total estimated cost of $43.5 million. Priority will be determined by the physical condition of the lines, the risk of line failure and the impact failure would have on customers.

Those transmission lines built in the late 1960s, the 1970s and beyond were designed and built to a higher standard than many of the older lines and are close to, or meet, present design and construction standards. These lines are expected to require only regular capital maintenance and component replacement to maintain their integrity through the 10 year transmission planning horizon.

2.0 Description of Newfoundland Power's Transmission Lines

Newfoundland Power has 104 transmission lines in service with a total length of 2,056 km. These lines range in length from 2 km to 94 km with an average length of 19 km.

2.1 Line Classification

Three different voltage classes exist within Newfoundland Power's electrical system, 33 kV, 66 kV, and 138 kV. The total length of lines in each of these voltages is set out in Table 1.

Table 1
Transmission Lines by Voltage

Voltage	Length (km)	%
33 kV	26	1
66 kV	1,410	69
138 kV	620	30

The total number of transmission poles in service is approximately 27,000, with the vast majority being pressure treated wood. A small number are specialty constructions of either steel or laminated wood. Lines are one of two structural configurations: H-frame or Single Pole, with 138 kV lines being of H-frame design and 66 kV lines being of either H-frame or Single Pole design. Table 2 summarizes the Company's transmission lines by structure configuration.

Table 2
Transmission Lines by Structure

Structure	Length (km)	%
H-Frame	1,186	58
Single Pole	870	42

2.2 Radial and Looped Lines

Many of Newfoundland Power's transmission lines are radial (i.e. there is only one transmission line path from the main supply point to the customer). These lines are predominately found in rural areas. When radial lines fail, customers are without power until the line is repaired.

Some of Newfoundland Power's radial lines have backup capability in the form of diesel generators, gas turbines or hydro generating plants. In the event of the failure of one of these radial lines the backup generation may be able to provide sufficient power to serve some or all of the customers depending on the time of year and how much generating capacity is available at the time of line failure.

When there is more than one transmission path from the customer to the main grid, these lines are categorized as looped lines. These are more common in urban areas. Failure of a looped line normally does not result in an outage to customers. Customers served by looped transmission lines receive a higher reliability of service than those served from radial transmission systems. As well, looped lines are more conveniently maintained as repair work can be completed on a de-energized line without the need for coordinating planned service interruptions with customers.

Table 3 summarizes the Company's transmission lines as radial or looped, identifying the proportion of radial lines with generation backup.

Table 3 Transmission Lines Radial or Looped		
Type	**Length (km)**	**%**
Radial	496	24
Radial (partial backup)	440	22
Looped	1,120	54

2.3 Age of Lines

Currently, the oldest original transmission line still in service was built in 1942 while the newest line was built in 1997. Several lines and parts of lines have been upgraded or completely rebuilt over the years. Table 4 shows the vintage of transmission lines in service and takes into account the sections of lines that have been rebuilt.

Table 4 Transmission Lines by Vintage	
Vintage	**km**
1940s	11
1950s	321
1960s	470
1970s	748
1980s	269
1990s	120
2000s	117
Total	**2,056**

3.0 Transmission Line Design

Newfoundland Power designs lines to meet Canadian Standard Association (“CSA”) standards and guidelines. In keeping with CSA standards Newfoundland Power generally designs transmission lines to withstand 12.5 mm of radial ice on conductors with 90 km/hr wind or 25 mm of radial ice on conductor with no wind. On the Avalon and Bonavista Peninsulas, where ice loading is more severe, Newfoundland Power designs its lines to withstand 18.0 mm of radial ice on conductors with 90 km/hr wind.

Prior to the amalgamation of the three largest utilities in the province in 1966 (United Towns Electric, Newfoundland Light & Power, and Union Electric) there was limited transmission design expertise in any utility. There was little consistency in the design of transmission lines and, as a result, many lines built before 1960 were not designed to any standard (and do not meet present day standards).

During the 1960s a number of lines were designed by out of province engineering consultants. For example, Montreal Engineering Company designed many lines during the 1960s and early 1970s when the transmission system was expanding quickly with the drive to electrify the island following the formation of the Power Commission and development of the large Bay d'Espoir hydro generation station. In addition, by the 1970s, the amalgamated Newfoundland Light & Power had developed its own transmission line design and construction expertise. These developments largely explain why the majority of lines built in the 1970s and beyond were designed and constructed to meet present day standards.

4.0 Transmission Line Construction

A transmission line is only as strong as its weakest component or structure. Transmission lines are often built "across country", away from roads in long straight sections which results in the least cost construction to connect system supply points and substations. Along straight transmission line sections, the structures are more exposed to cascading failure (when one structure fails the additional loading placed on adjacent structures causes a chain reaction of multiple structure failures). Reducing the risk of cascading structure failures requires careful line inspection and replacement of components and structures before a single component failure occurs.

Two relatively recent examples of cascading failures occurred in 1992 and 1998. In 1992, a 4.3 km section of H-frame 138 kV line failed on 123L on the Bonavista Peninsula. In 1998, a 6.6 km section of H-frame 66 kV line failed on 305L on the Burin Peninsula.

Lines that are built away from the roadside or in remote locations are more difficult to patrol and locate problems and take a longer time to repair and restore to service. Often when sections of transmission lines fail (such as major ice storm damage) the requirement to restore power as soon as possible eliminates the opportunity to redesign and upgrade the line to a stronger standard.

Such was the case in the example of 123L noted above. In that case, because it was a radial line, the section that failed was temporarily rebuilt under emergency conditions to the same design standard prior to failure. The following year this newly constructed section of line was re-designed to a higher ice loading standard and rebuilt again.

5.0 Transmission Line Aging

Transmission lines can supply a single substation but generally supply several substations and multiple distribution feeders. They are a critical link in the electrical system in the transport of generated power to the distribution system. While feeders typically supply several hundred up to two thousand customers, transmission lines often supply a few thousand up to tens of thousands of customers. Therefore it is important that transmission lines be designed, constructed and maintained to provide a high degree of reliability. As transmission lines age and deteriorate they become subjected to increased risk of component failure. To ensure reliable performance:
(i) older lines must be inspected regularly, (ii) the risk of component and structural failure must be assessed carefully, and (iii) any suspect components and structures must be replaced before failure occurs.

Newfoundland's weather and environment subjects transmission lines to high winds, salt contamination, lightning, ice and snow loading, and frequent freeze/thaw and wet/dry cycles. Wooden components of transmission lines are susceptible to fungi growth (rot), insect damage and weathering causing deep splits and cracks which further advances rotting. Wind causes stresses and vibration on structures with resulting wear and tear on hardware components and conductors. Exposure to lightning, salt contamination and mechanical stresses can cause insulators to age and breakdown. After 40 to 50 years of exposure to the elements many line components are deteriorated to the point they are weakened and at risk of failure.

Transmission lines of sub-standard design and lines that are not engineered to withstand the local environmental conditions in which the line operates will be more susceptible to failure.

6.0 Line Rebuild and Maintenance Strategy

The important role transmission lines play in providing reliable service to large numbers of customers requires that they be rebuilt before they deteriorate to the point that they are at significant risk of failure. While the Company's approach to distribution reliability improvement includes rebuilding and upgrading those feeders that have the worst reliability performance, that approach is not recommended for establishing priority for transmission line upgrading and rebuilding. Transmission lines serve more customers and have a higher degree of overall electrical system criticality than distribution lines. Therefore the strategy is to proactively rebuild transmission lines before they start experiencing failures due to deteriorated condition and aging.

Rebuilding lines after they have collapsed is expensive and the pressure to restore service quickly does not permit sufficient time to design and construct the new line to a higher standard (i.e. often the only practical approach following a major line failure is to put back the line as it was beforehand). This replacement strategy identifies lines at risk and establishes a plan for replacement in a proactive manner.

6.1 Sub-Standard Lines

Sub-standard lines will be rebuilt completely to meet present design and construction standards. Newfoundland Power will rebuild its oldest and most deteriorated lines on a priority basis. Priority will be determined by the physical condition of the lines, the risk of line failure and the impact failure would have on customers.

Some 37 transmission lines built in the 1940s, 50s and 60s have been identified as sub-standard lines to be rebuilt over the next 10 years.

6.2 Standard Lines

Those lines built in the 1970s and beyond, and some built in the 1960s, were designed and built to a higher standard than many of the older lines and are close to, or meet, present design and construction standards.

Standard lines are expected to require only regular maintenance and component replacement to maintain their integrity through the 10 year transmission planning horizon.

7.0 Proposed Transmission Line Rebuilds: 2006 to 2015

To redesign and rebuild Newfoundland Power's sub-standard transmission lines will require an expenditure of approximately $43.5 million. To fulfill the Company's obligation to provide reliable electric service at least cost, it is recommended that these capital costs be allocated over a ten year period beginning in 2006. The rebuilding of sub-standard transmission lines is prioritized based on several factors including age, condition, location and impact on customers should the line fail.

Table 5 shows the proposed transmission rebuilds for the period 2006 to 2015.

The timing of actual rebuilds may change, however, it is anticipated that proposed expenditures for transmission rebuilds for each year will form part of Newfoundland Power's annual capital budget applications through to 2015.

Table 5
Transmission Line Rebuilds: 2006 – 2015 ($000s)

Line	Year Built	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Totals
12L KBR-MUN	1950			240								**240**
13L SJM-SLA	1962										180	**180**
14L SLA-MUN	1950				70							**70**
15L SLA-MOL	1958				140							**140**
16L PEP-KBR	1950						250					**250**
18L GOU-GDL	1952				420							**420**
20L MOB-CAB	1951		675	567	567							**1,809**
21L 20L-HCP	1952					355						**355**
23L MOB-PBK	1942					357						**357**
25L GOU-SJM	1954			760								**760**
30L RRD-KBR	1959		340									**340**
32L OXP-RRD	1963					217						**217**
35L OXP-KEN	1959					238					160	**398**
41L CAR-HCT	1958					1,425						**1,425**
43L HCT-NCH	1956	1,081	441									**1,522**
49L HWD-CHA	1966				189							**189**
55L BLK-CLK (upgrading)	1971		250									**250**
57L BRB-HGR	1958				1,350							**1,350**
68L HGR-CAR	1958				390							**390**
69L KEN-SLA	1951		269									**269**
94L BLK-RVH (upgrading)	1969				250							**250**
95L RVH-TRP (upgrading)	1969		250									**250**
102L GAN-RBK	1958					690	1,193	1,500		1,193		**4,576**
110L CLV-LOK	1958	604	1,269		900		990				990	**4,753**
111L LOK-CAT	1956			2,325								**2,325**
124L CLV-GAM	1964		390				1,000	756	1,500	1,593	900	**6,139**
146L GAN-GAM	1964			1,105					1,190	1,190		**3,485**
302L SPO-LAU	1959		200			1,560						**1,760**
407L STV-STG	1956	658										**658**
24L MOB-BIG	1964							539				**539**
53L 38L-GEA	1961						420					**420**
301L SPO-GRH	1959								70			**70**
100L SUN-CLV	1964							1,500				**1,500**
101L GFS-RBK	1957						2,100					**2,100**
105L GFS-SBK	1963								980			**980**
400L BBK-WHE	1967										2,000	**2,000**
403L TAP-ROB	1960								280			**280**
Total		**$ 2,343**	**$ 4,084**	**$ 4,997**	**$ 4,276**	**$ 4,842**	**$ 5,953**	**$ 4,295**	**$ 4,020**	**$ 3,976**	**$ 4,230**	**$43,016**