

All our energy.
All the time.



January 21, 2019



Ms. Cheryl Mosher
Regulatory Services
Island Regulatory and Appeals Commission
PO Box 577
Charlottetown PE C1A 7L1

Dear Ms. Mosher:

***Review and Report on the November 29, 2018
Storm and Restoration***

Please find enclosed 6 copies of Maritime Electric's Review and Report on the November 29, 2018 Storm and Restoration.

If you have any questions, please do not hesitate to contact the undersigned at 902-629-3696.

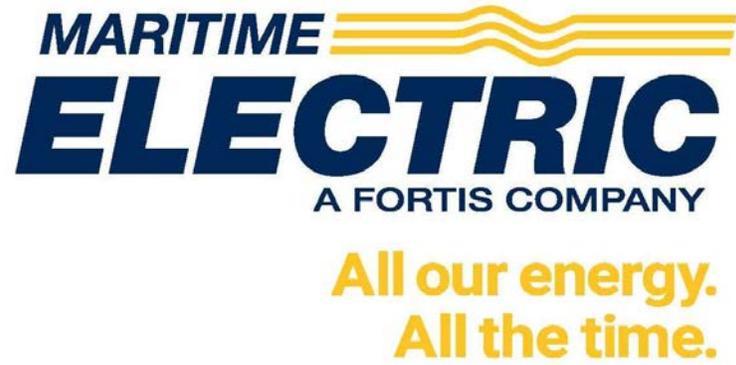
Yours truly,

MARITIME ELECTRIC

A handwritten signature in blue ink, appearing to read "J. Roberts".

Jason C. Roberts
Vice President, Finance and
Chief Financial Officer

JCR10
Enclosure



November 29, 2018 Storm Post-Mortem

January 21, 2019

EXECUTIVE OVERVIEW

On the night of November 28, 2018, a winter storm began that affected Maritime Electric Company, Limited (the 'Company') customer supply until December 3. The storm lasted approximately 24 hours and consisted of snow mixed with rain and high winds with peak gusts over 100km/h. Early on November 29, both 138kV transmission lines connecting Western PEI to Central and Eastern PEI tripped off, resulting in the loss of all energy supply to both Central and Eastern PEI. This was shortly followed by the loss of all energy supply from New Brunswick to PEI.

The Company initially encountered issues when attempting to start Combustion Turbine #3 (CT3). When started however, it supplied roughly 30 MW of Charlottetown area load for most of the day. Combustion Turbine #2 (CT2) was also started later on November 29 and supplied a portion of the Borden area load for several hours.

The NB transmission system was ready for energization mid-day, but a number of protection and control issues delayed the energization until later on November 29. Cables #3 and #4 were energized first, but due to ongoing protection and control issues at Murray Corner, Cables #1 and #2 could not be restored until early November 30.

The outages with the most significant impact to customers were generally addressed on November 29, but there remained significant damage to the distribution system. In addition to MECL crews, restoration resources, including 23 contractor crews and 12 mutual aid crews, were dispatched to help with efforts. As western PEI sustained the most damage, the additional resources were sent there first. Central and Eastern Maritime Electric crews completed their restoration efforts before joining the Western district for additional support.

This storm caused an island-wide outage for all 80,000 customers as well as longer outage times for customers in areas with more damage. It also produced the most social media interaction of any event experienced by the Company. SAIDI figures show that the average outage for customers as a result of this storm was 15.85 hours. The estimated cost of restoration was approximately \$1,144,500.

The following is a brief summary of the events that led to the outages experienced due to this storm. For a more detailed sequence of events, please refer to the Summarized Sequential Event Log attached as Appendix 'A'.

The first outages occurred during the early morning on November 29. Transmission system issues started appearing by 0630 hours, and the Island's electrical system lost its supply from New Brunswick just before 0900 hours. Two main transmission lines (Y-109 and Y-111) connecting Central and Eastern PEI to Western PEI tripped at 0626 hours and 0728 hours because of tree contacts. This caused a loss of all energy supply to Central and Eastern PEI. At 0821 hours the first of four transmission lines supplying NB Power's Memramcook substation, the source of supply for all four Submarine Cables between NB and PEI, tripped due to a phase-to-phase fault. The second of four transmission lines into Memramcook substation tripped on a phase-to-ground fault that resulted from snow and ice built-up on conductors and overhead ground wire at 0846 hours. This left one remaining dedicated transmission line feeding the Memramcook substation and a secondary transmission line.

NB Power automatically initiated a remedial action scheme ('RAS') to protect the remaining transmission lines. As part of the RAS, NB Power requested that Nova Scotia and PEI dispatch generation in order to alleviate loading on the remaining transmission lines. Before PEI was able to dispatch generation, the final transmission lines feeding Memramcook substation tripped off on thermal protection, cutting all energy supply from New Brunswick to PEI.

SYSTEM AND INTERCONNECTION RESTORATION

At 0755 hours, the Company's Energy Control Centre ('ECC') initiated the black start procedures for Combustion Turbine #3 ('CT3') to start generation and reconnect Central and Eastern PEI customers shortly after the loss of the transmission tie between Central/Eastern PEI and Western PEI (Y-109 and Y-111). Initially, the start-up proceeded normally, but an issue with the associated switchgear and the subsequent loss of energy supply from NB Power delayed its operation until mid-morning. At 1000 hours, CT3 started, and ECC began to pick up load in the Charlottetown area beginning with priority areas including the Queen Elizabeth Hospital. The voltage on CT3 was low and could not be increased. This limited the amount of output from the generator, thus

limiting the load that could be picked up. At 1615 hours, CT3 tripped off due to low voltage and a mechanical issue forced it into a four-hour cool down lockout before being restarted. In mid-December, the voltage protection for CT3 was modified to enable full output of the unit when in 'Islanded mode' as experienced during the storm.

At 1426 hours, Combustion Turbine #2 ('CT2') located at the Borden Generating Station was started via the black start procedure and was connected to the system. Shortly following this, the Albany station was energized. ECC then began closing the four circuits out of the Albany Substation and found one of the circuits could not be energized. ECC then attempted to synchronize CT2 and CT3 operations by reenergizing the 138 kV system. ECC soon decided to forgo further 138 kV energization as the system protection configuration would not allow synchronizing with Y-107 (Y-107 is a transmission line connecting the Borden Riser Station and the Bedeque Switching Station) out of service. Y-107 had to be de-energized to provide a safe work environment for the Y-109 redirection project, which was ongoing when this storm arrived.

Following NB Power informing the Company that the Memramcook substation was available to supply the Island, the Company's engineering personnel began working with NB Power Technicians to enable the interconnection to be safely reenergized. At 1612 hours, Cable #3 and the associated NB transmission line were energized and at 1620 hours, Cable #4 was energized. With two Cables back on line, the Company was able to focus on energizing transmission lines and substations that were prepared for energization. The work on removing fault conditions on the lines continued through the evening of November 29 and into November 30.

Loss of supply to the Memramcook substation had initiated protection/control issues with the Murray Corner substation that had to be corrected prior to energizing Cables #1 and #2. On November 30 at 0300 hours, Cable #1 was energized and Cable #2 was energized later that morning. Once all four cables were energized, the energy supply from New Brunswick to PEI was secured. CT3 was kept online until mid-afternoon to ensure that the transmission system was reliable, at which point it was taken offline.

CORE TRANSMISSION SYSTEM RESTORATION

Overall, the core transmission and protection system performed relatively well. Outages occurred, mainly due to tree contacts and broken poles on T-2, T-23, Y-101, Y-103, Y-104, Y-109 and Y-111; however, there was no major damage to the transmission system. The Company's transmission system was fully operational just after mid-day on November 30, once the four submarine cables and transmission lines Y-109 and Y-111 were re-energized.

Several substations also sustained restricted operations due to a lack of power. The length of outage to the substations caused their battery banks to drain, which affected remote breaker, and other system control device, operation when trying to reenergize the substations. The Company will be expanding its use of backup generators in substations as a possible solution to this issue.

DISTRIBUTION SYSTEM RESTORATION

The Company responded to distribution outages on November 29 with all of its resources. However, the number of outages was significant, and it was apparent restoration would take some time. At this point the Outage System Level was raised from low (restoration in less than 24 hours) to Medium (restoration in 24 to 72 hours). A more thorough investigation of the distribution system revealed significant system damage, especially in western PEI. The outage system level was elevated again on December 1 from Medium to High (restoration in greater than 3 days).

There were 149 poles damaged during the storm. Of this, five were transmission structures and the remaining 144 were distribution poles. 95 of the 144 distribution poles that were damaged were Eastern Cedar poles, while the remaining were Penta and CCA. There were also 8 transformers and 2.5 km of conductor replaced as a result of the storm.

WIND FARM RESTORATION

A total loss of supply to Central and Eastern PEI occurred when both transmission lines (Y-109 and Y-111) between these areas tripped on November 29. The wind farms in Eastern PEI both tripped at that time due to a lack of system voltage support. The wind farms located in Western PEI tripped when the supply from NB Power was lost.

Company crews completed required repairs during the day and evening of November 30 and all windfarms were back on line by late evening November 30th.

IMPACT ON RELIABILITY

The system average interruption duration index ('SAIDI') is commonly used as a reliability indicator by electric utilities. The SAIDI statistics are indicated in the table below.

Statistic	Hours	Comment
SAIDI (Excluding MED)	0.50	The average SAIDI (excluding Major Event Days) or "expected" average outage without major storm
SAIDI (All-in) – Nov 29 - Dec 3 - Storm	15.85	The average outage experienced by customers as a result of the storm
SAIDI (All-in) - January 2008 Ice Storm	15.56	The SAIDI figure for the last major outage event – An ice storm in January of 2008

OPERATIONS CREWS DISPATCH

Operations crews were dispatched based on the locations for highest-impact of system restoration. In general, Operations crews were initially dispatched to locate the transmission system faults, since the transmission system supplies the largest number of customers. Crews were also dispatched to Bedeque, Borden, and Cape Tormentine to assist in re-establishing the NB-PEI interconnections. While operations crews concentrated on transmission system issues on November 29, they also repaired several distribution system issues that day. After the transmission damages were repaired, there was a concerted focus on repairing the distribution system.

MUTUAL AID AND CONTRACTOR RESOURCES

The Company recognized the significant impact of this storm very early and contacted on-Island contractor crews immediately. On November 29, 16 contractor crews were assisting with the restoration efforts. This number increased to 23 by December 1 (14 H-Line, 4 Atlantic Reach and 5 GSD crews). The Company also reached out to mutual aid partners and Fortis companies on November 29 to investigate the possibility of assistance in the storm clean up. Based on the reports back from the spotters on November 30, the Company decided mid-day on November 30 to utilize mutual aid from outside. A total of 12 crews were brought onto the Island; 4 crews and a supervisor from NB Power, 4 crews and a supervisor from NS Power, and 4 crews and a supervisor from Fortis Ontario.

These crews arrived over the period of December 1-2 and were given a safety and system orientation immediately, then promptly put to work alongside Company personnel.

CUSTOMER RESTORATION

The following table highlights the number of customers out at the indicated time. All customers were restored by 2000 hours on December 3.

Date	Time	# Customers Out
November 29	0900h	80,000
	2000h	34,000
November 30	0600h	35,000 ¹
	1600h	7,200
December 1	1600h	2,200
December 2	1800h	1,400
December 3	0700h	750

CUSTOMER SERVICE RESPONSE

This storm produced the most social media interaction of any storm or other event experienced by the Company. Company personnel received phone calls and monitored its various social media platforms – Twitter and Facebook – as well as all other media outlets on a 24/7 basis from early on November 29 through to the final customer reconnection on December 3. In total, the Company had 62,000 website hits, 25,000 phone calls, and over 100,000 social media hits.

SAFETY ISSUES

Five safety issues were identified during the storm restoration. Four related to communication between ECC and field staff carrying out work in substations and during patrols. Investigations and reports have been generated for these incidents. The fifth incident was snow falling off the roof of the Sherbrooke Service Centre, hitting an employee. No injuries were sustained.

¹ Figure is slightly higher than previous evening due to switching operations occurring at that time of the morning. Actual number of customers without power at this time was lower.

ESTIMATED TOTAL COSTS

The impacts on the Company's system were significant. A total of 149 poles were replaced along with over 2.5 km of conductor and eight transformers. The largest financial impact was the cost of labour, both internal and external. As in all similar events, crews worked 16-hour days from November 29 until the last customer was reconnected on December 3. The table below summarizes the costs:

Item	Total Cost
MECL Line Crews and Spotters - Labour & Vehicle	\$ 282,000
Contractors - Labour & Vehicle	\$ 388,500
Mutual Aid - NS Power	\$ 90,500
Mutual Aid - NB Power	\$ 80,000
Mutual Aid - Fortis Ontario	\$ 119,500
Labour – Storm Super's/Customer Service Reps	\$ 16,000
Food and Lodging	\$ 44,500
Material (poles, wire, transformers)	\$ 103,500
Flagging	\$ 20,000
Storm Costs Subtotal	\$ 1,144,500
Retirement Adjustment (15% of Labour Costs)	\$ 149,475
Storm Costs Total	\$ 995,025
Operational Cost	\$ 133,729
Capital Cost	\$ 861,296

Appendix 'A'

Summarized Sequential Event Log

Summarized Sequential Event Log

Below is a high-level sequence of events from the commencement of the storm, through the restoration efforts, ending when all four submarine cables were re-energized:

- 0050h – The first outages of the storm occurred on the distribution system in Charlottetown. Additional outages occurred throughout the early morning hours, primarily in eastern and central PEI.
- 0220h – The Contact Centre was opened.
- 0600h – The first outage in western PEI occurred in Tignish.
- 0626h – One of two 138 kV transmission lines connecting central and eastern PEI to western PEI (Y-111) tripped as a result of a tree contact.
- 0728h – The 2nd 138 kV transmission line between central/eastern PEI and western PEI (Line Y-109) also tripped as a result of a tree contract. The loss of both transmission lines Y-111 and Y-109 caused the loss of all supply to central and eastern PEI. Crews were dispatched from the West Royalty Service Centre ('WRSC') to locate the line faults.
- 0755h – Following the loss of Y-111 and then Y-109 the Company's Combustion Turbine #3 ('CT3') located at the Charlottetown plant site was started via the Company's blackstart procedures. CT3's start-up proceeded normally.
- 0804h – CT3 breaker closed, connecting CT3 to the system. Within seconds, the unit tripped off due to an issue with the associated switchgear.
- 0821h – The first of four transmission lines supplying NB Power's Memramcook substation tripped due to a phase-to-phase fault. The Memramcook substation is the source of supply for all four submarine cables between NB and PEI.
- 0846h – The 2nd of four transmission lines into Memramcook substation tripped on a phase-to-ground fault that resulted from snow and ice built-up on conductors and overhead ground wire. This left one remaining dedicated transmission line feeding the Memramcook substation and a secondary transmission line. A remedial action scheme ('RAS') was automatically initiated to protect the remaining transmission lines. As part of the RAS, NB Power requested that Nova Scotia and PEI dispatch generation in order to alleviate loading on the remaining transmission lines.
- 0854h – CT3 was started a second time. However, during its start up sequence the supply was lost from New Brunswick, causing a system wide blackout and causing CT3 to trip off.
- 0858h – Prior to the PEI and Nova Scotia generation coming online, the final transmission lines feeding Memramcook substation tripped off on thermal protection, cutting all supply from New Brunswick to PEI and Nova Scotia.

- 1000h – CT3 started a third time, and this time the start-up sequence was successful.
- 1030h – ECC used CT3 to slowly pick up load on downtown Charlottetown circuits starting with King Street (which feeds the Charlottetown Thermal Generating Station ('CTGS')). CTGS staff began the process of bringing Heating Boiler #2 back online, which is the first step in bringing the plant back online. All remaining circuits supplied from the Charlottetown substation were brought online by 1105h.
- 1120h – Transmission line T-15, connecting the Charlottetown Substation (and CT3) to West Royalty, was energized, followed by the energization of the West Royalty substation.
- 1134h – The first distribution circuit from West Royalty was energized (Queens Arms), followed by Inkerman and University circuits. Several city circuits had broken poles and could not be reconnected until repairs were completed. In addition, the CT3 output voltage was low and could not be increased, limiting the amount of output from the machine to existing levels.
- 1346h – NB Power informed the Company that the Memramcook substation was available to supply the Island. The Company's engineering personnel began working with NB Power Technicians to enable reenergization of the interconnection.
- 1426h – Combustion Turbine #2 ('CT2') located at the Borden Generating Station was started via the Company's blackstart procedure and was connected to the system, and the Albany station was energized shortly thereafter. ECC then began closing the four circuits out of the Albany Substation, and found one of the circuits could not be energized. ECC then attempted to synchronize (connect) CT2 and CT3 operations by reenergizing the 138 kV system. Issues were encountered and ECC decided to forgo further 138 kV energization until the supply was restored from New Brunswick.
- 1600h – NB Power began testing the transmission lines between Memramcook substation and the new submarine cables #3 & #4. Testing confirmed that the lines were operational.
- 1612h – The NB transmission line and Cable #3 were energized. This was followed by energizing the transmission between Borden and Sherbrooke substations and subsequently the Sherbrooke substation.
- 1613h – Transmission line, T-5, feeding West out of Sherbrooke was energized. St. Eleanor's and Wellington substations were energized.
- 1615h – CT3 tripped offline (low voltage trip), cutting supply to all customers in Charlottetown. Upon a trip CT3 should automatically begin a cool down cycle. However, another issue with the Dorman Diesel blackstart generator did not allow this to happen. This issue was investigated immediately but the delay restricted CT3 from starting its cool down cycle, forcing it into a 4-hour cool down lockout. This restricted CT3 from restarting until after 2040h.
- 1620h – Cable #4 was energized and connected to the Borden Riser Station.
- 1625h – O'Leary and Alberton substations were energized and ECC started to reconstitute distribution circuits in western PEI.
- 1638h – ECC energized the Bedeque substation.

- 1646h – One of the two main transmission lines between western PEI and central/eastern PEI, Y-109, was closed connecting the West Royalty Substation to the NB interconnection. Attempts to close the 2nd transmission line (Y-111) were unsuccessful.
- 1648h – ECC began to reenergize load in the Charlottetown area.
- 1707h – Attempts to close Cable #2 at Murray Corner were unsuccessful.
- 1800h – ECC energized the Crossroads substation. Load restoration continued on loads supplied from West Royalty and Crossroads substations, as well as substations in central PEI.
- 1828h – ECC energized the transmission line T-11, which supplies the City of Summerside.
- 2050h – Cable #3 and the associated NB transmission line tripped due to a fault on the transmission line. Only one line and cable (Cable #4) remained between New Brunswick and PEI. Extreme low voltages caused ECC to cut load in order to maintain system stability.
- 2150h – CT2 was stopped by ECC. Albany substation was then fed from the system.
- 2219h – CT3 was brought online (following the completion of its 4-hour cool down lockout) and began ramping up output. This allowed additional eastern PEI load to be connected due to eastern PEI voltage support. Additional load supplied from West Royalty was also connected.
- 2220h – Attempts to close Cable #2 continued to be unsuccessful.
- 2256h – ECC energized the transmission line T-10 to Victoria Cross and Dover substations.
- 2317h – ECC energized the transmission line Y-104 to Scotchfort, West St. Peters and Church Road Substations.
- 0257h (November 30) – ECC was able to energize Cable #2.
- 1017h (November 30) – ECC was able to energize Cable #1.
- 1333h (November 30) – Cable #3 returned to service after NB Power crews worked to remove the fault condition on line L1143.