Énergie NB Power

NERC RELIABILITY STANDARD TPL-001-4

SUMMARY OF NB POWER PLANNED USE OF NON-CONSEQUENTIAL LOAD LOSS FOR THE 2021 PLANNING ASSESSMENT

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STUDY PERSONNEL

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report documents the planned use of Non-Consequential Load Loss (NCLL) by New Brunswick Power Corporation (NB Power) for its 2021 Planning Assessment performed in accordance with NERC Reliability Standard TPL-001-4 [1]. NB Power is a registered Planning Coordinator and Transmission Planner in New Brunswick.

Planned use of NCLL under TPL-001-4 footnote 12 must be reviewed through an open and transparent stakeholder process, and information regarding the intended purpose and scope of the proposed NCLL must be made available to stakeholders in accordance with Attachment I Section II of TPL-001-4 [1]. This report provides the NCLL information required by Attachment I Section II of TPL-001-4, and it also provides NB Power's rationale for why its use of NCLL does not result in any Adverse Reliability Impacts.

The 2021 Planning Assessment contains two planned uses of NCLL, neither of which results in any Adverse Reliability Impacts. They are as follows:

1. NCLL at Manawagonish Road substation
   - Planned NCLL usage is for Year 2 (2023) and beyond
   - Undervoltage load shedding of 58 MW at winter peak is used to resolve local low voltage below 0.9 p.u
   - Estimated frequency of planned NCLL occurrence is 0.000056 events/year, or once every 17,900 years.

2. NCLL at Pennfield terminal and Milltown terminal
   - Planned NCLL usage is for Year 1 (2022) and beyond.
   - Undervoltage load shedding of 48 MW at winter peak is used to resolve local low voltage(s) below 0.9 p.u.

- Estimated frequency of planned NCLL occurrence is 0.0116 events/yr, which equates to a probability of a planned NCLL event happening once every 86 years.

NCLL AT MANAWAGONISH ROAD SUBSTATION

Manawagonish Road substation is owned by Saint John Energy, a municipal distribution utility serving the city of Saint John, NB. This substation is supplied by NB Power via 138 kV line 1104. Beginning in 2023, the NCLL at this location is provided through undervoltage load shedding of the Manawagonish Road substation if the source 138 kV voltage goes below 90%, or 0.9 per unit.

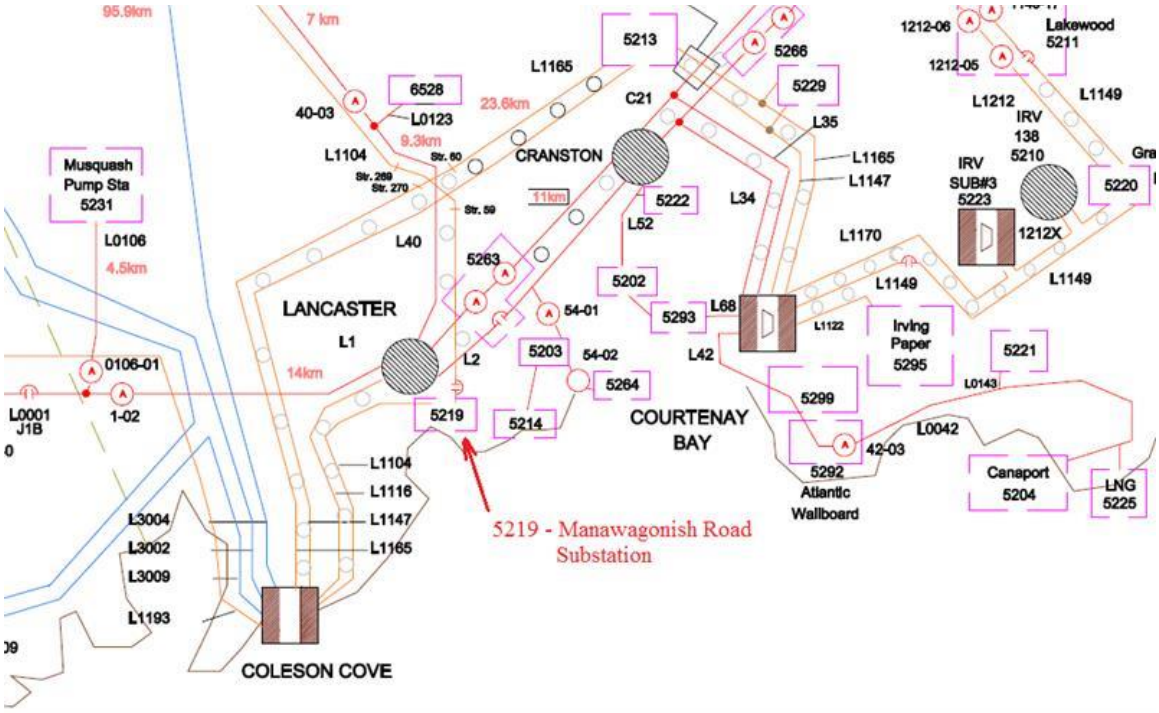

Figure 1 - Area Transmission Map Near Manawagonish Road substation

1. Conditions under which Non-Consequential Load Loss under footnote 12 would be necessary:
   a. System Load level and estimated annual hours of exposure at or above that Load level

By 2023, Saint John Energy is targeting the completion of the 42 MW Burchill Wind Energy Project on its distribution system as well as new 66 kV substation development. These changes result in additional generation and additional load at Manawagonish Road substation starting in Year 2 (2023). A description of the Burchill Wind Energy Project and timeline is available at: https://www.sjenergy.com/pages/burchill-wind-energy

These changes do not impact Year 1 (2022) of NB Power's 2021 Planning Assessment, but they are modeled in Year 5 (2026) and Year 10 (2031).

There is no planned use of NCLL at Manawagonish Road substation in Year 1 (2022). There is planned use of NCLL at Manawagonish Road substation for Year 2 (2023) and beyond.

The System Load level above which NCLL would be necessary at Manawagonish Road is 2,620 MW. The estimated annual hours of NCLL exposure is 100 hours per year for 2023 and beyond, and it is based on 2019 New Brunswick load data with a relatively flat 10-year load forecast [2]. This is a very conservative estimate because it assumes zero wind generation from the 42 MW Burchill Wind Energy Project.

b. Applicable Contingencies and the Facilities outside their applicable rating due to that Contingency

There is one applicable contingency for the planned use of NCLL at Manawagonish Road substation. It is a Category P2 – Single Contingency – Opening of a line section without a fault event, and it requires the open-ending of line 1104 at the Coleson Cove terminal.

The only Facility outside of its limits, assuming the contingency occurs during one of the estimated 100 hours per year of exposure, is the Manawagonish Road substation, where a low voltage below 90%, or 0.9 per unit (p.u.) would result in NCLL provided by undervoltage load shedding of the substation load.

2. Amount of Non-Consequential Load Loss with:
   a. The estimated number and type of customers affected

The estimated NCLL at Manawagonish Road substation at winter peak is 58 MW consisting of 9,475 residential and commercial customers. This estimate is for Year 2 (2023) and beyond due to a relatively flat 10-year load forecast [2].

b. An explanation of the effect of the use of Non-Consequential Load Loss under footnote 12 on the health, safety, and welfare of the community

The risk of NCLL occurring at Manawagonish Road substation is insignificant with no real probability of ever occurring, and therefore has no measurable impact to the health, safety, and welfare of the community. As shown in part 3 below, the estimated risk of NCLL occurring at Manawagonish Road substation is once every 17,900 years.

If the event were to occur (i.e. Category P2 – Single Contingency – Opening of line 1104 without a fault at the Coleson Cove terminal), it is also very likely that operator action at the Energy Control Centre can quickly reclose line 1104 back into the Coleson Cove terminal which mitigates the event duration.

3. Estimated frequency of Non-Consequential Load Loss under footnote 12 based on historical performance

There is no record of NCLL at Manawagonish Road substation ever occurring, and its use in the 2021 Planning Assessment for Year 2 (2023) and beyond is dependent on Saint John Energy completing its 66 kV substation development.

Over a six-year period from 2015-2021, NB Power recorded just two line open without a fault events occurring on its 138 kV bulk electric system network of 68 line terminations into transmission terminals.

The estimated frequency of NCLL at Manawagonish Road substation is calculated as follows:

Exposure risk:	= (100 hours/yr)/(8760 hours/yr)
	= 1.14%
Contingency risk:	= (2 events)/(68 event possibilities)/(6 years)
	= 0.0049 events/yr
Estimated frequency of NCLL	= (Exposure Risk) x (Contingency Risk)
	= 1.14% x 0.0049 events/yr
	= 0.000056 events/yr

For an estimated frequency of 0.000056 events per year, this equates to a probability of a planned NCLL event happening once every 17,900 years.

4. Estimated duration of Non-Consequential Load Loss under footnote 12 based on historical performance

The expected duration of a planned NCLL event at Manawagonish Road substation is based on the expected duration of a line open without a fault event occurring for line 1104 at Coleson Cove terminal. With NB Power only experiencing two of these event types in the last six years, the estimated duration is one hour which provides sufficient time to both determine the cause of the event and mitigate the event with operator action at the Energy Control Centre to reclose line 1104.

5. Future plans to alleviate the need for Non-Consequential Load Loss under footnote 12.

There are no future plans to alleviate the need for NCLL at Manawagonish Road substation.

6. Verification that TPL Reliability Standards performance requirements will be met following the application of footnote 12.

The use of NCLL at Manawagonish Road substation will trigger undervoltage load shedding of the substation load for low voltages below 0.9 p.u. This action ensures that the TPL Reliability Standards performance requirements will be met because it directly resolves a low voltage violation at Manawagonish Road substation.

7. Alternatives to Non-Consequential Load Loss considered and the rationale for not selecting those alternatives under footnote 12.

An alternative to NCLL at Manawagonish Road substation is the installation of a 25 MVAR capacitor bank at the Manawagonish Road substation. The estimated cost of the capacitor bank and associated control equipment is approx. $1.5 million. The rationale for not selecting this alternative is its high cost with a very low benefit.

8. Assessment of potential overlapping uses of footnote 12 including overlaps with adjacent Transmission Planners and Planning Coordinators.

There are no potential overlapping uses of footnote 12 for NCLL at Manawagonish Road substation, including overlaps with adjacent Transmission Planners and Planning Coordinators. NB Power's load loss limits with ISO New England vary from 375 MW to 450 MW, so any potential loss of 58 MW of load at Manawagonish Road substation is well within that limit.

NB Power's rationale for why its use of NCLL at Manawagonish Road substation does not result in any Adverse Reliability Impacts.

The Glossary of Terms Used in NERC Reliability Standard defines Adverse Reliability Impact as:
"The impact of an event that results in frequency-related instability; unplanned tripping of load or generation; or uncontrolled separation or cascading outages that affects a widespread area of the Interconnection."

NCLL of 58 MW at Manawagonish Road substation is well within NB Power's load loss limit with ISO New England of 375 to 450 MW. The amount is also no greater than the Consequential Load Loss associated with tripping of line

1104 that creates load loss at Manawagonish Road substation plus other substations tied to line 1104. This use of planned NCLL has no impact on the Eastern Interconnection with respect to frequency-related instability; unplanned tripping of load or generation; or uncontrolled separation or cascading outages.

NCLL AT PENNFIELD TERMINAL AND MILLTOWN TERMINAL

Both Pennfield terminal and Milltown terminal are 138/69 kV terminals located in southwest New Brunswick. The planned NCLL for Pennfield terminal is provided by undervoltage load shedding at local 69 kV substations when the Pennfield terminal 69 kV voltage goes below 0.9 p.u. The local 69 kV substations affected by this planned NCLL at Pennfield terminal are as follows:

- 69 kV St George substation
- 69 kV Deer Island substation
- 69 kV Campobello substation
- 69 kV Grand Harbour substation

The planned NCLL for Milltown terminal consists of undervoltage load shedding at 69 kV breaker CM-1 which feeds the Eastern Maine Electric Coop via radial 69 kV line 0059.

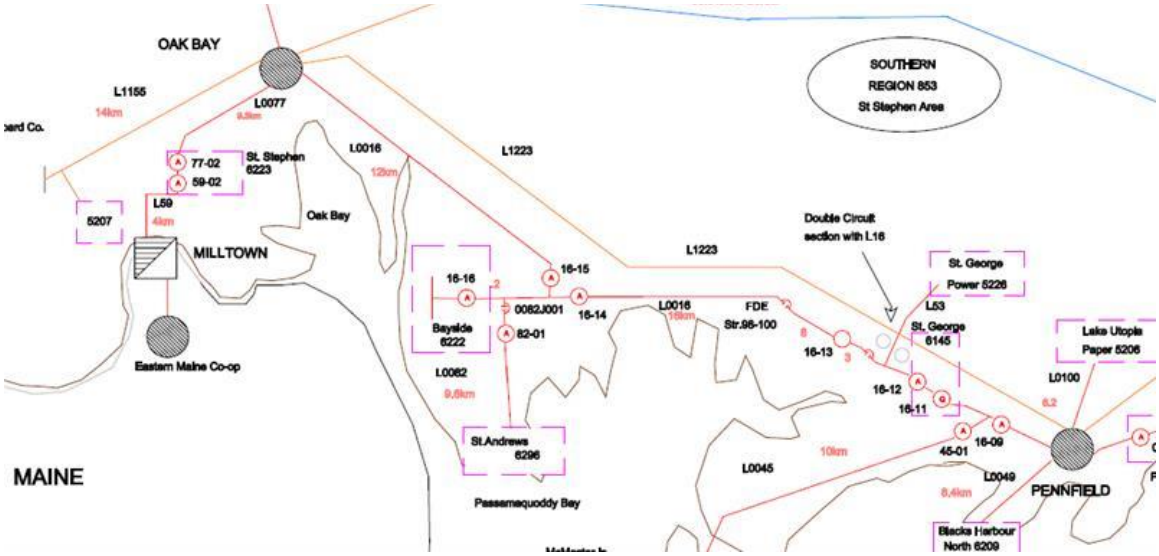

Figure 2 - Area Transmission Map for Pennfield Terminal and Milltown Terminal

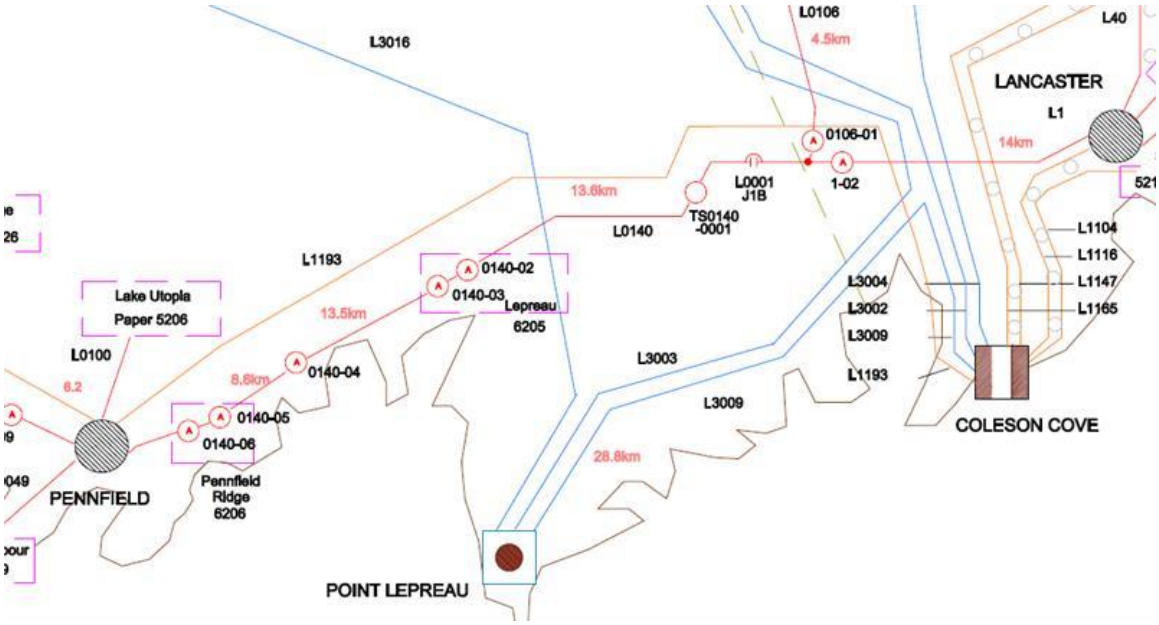

Figure 3 - Area Transmission Map from Coleson Cove to Pennfield

The planned NCLL for both Pennfield terminal and Milltown terminal are triggered by similar events, so they are combined in this document as one usage of planned NCLL.

1. Conditions under which Non-Consequential Load Loss under footnote 12 would be necessary:
   a. System Load level and estimated annual hours of exposure at or above that Load level

The System Load level above which NCLL would be necessary at Pennfield terminal and Milltown terminal is 2,600 MW.

The estimated annual hours of NCLL exposure for Pennfield terminal and Milltown terminal is 115 hours per year for 2022 and beyond, and it is based on 2019 New Brunswick load data with a relatively flat 10-year load forecast [2].

   b. Applicable Contingencies and the Facilities outside their applicable rating due to that Contingency

The applicable contingencies all result in the tripping of 138 kV line 1193 between Coleson Cove and Pennfield, and are as follows:

- Trip of line 1193 (Category P1 – Loss of a transmission circuit)
- Trip of Coleson Cove T1 (Category P1 – Loss of a transformer)

- Breaker failure of CO1-2 (Category P4 – Loss of a transmission circuit caused by a stuck breaker)
- Breaker failure of CO3-11 (Category P4 – Loss of a transmission circuit caused by a stuck breaker)

The Facilities outside of their applicable ratings due to these contingencies are the 69 kV Pennfield terminal voltage and the 69 kV Milltown terminal voltage, assuming the event occurs during one of the 115 hours per year of exposure. A low voltage below 0.9 p.u. at either location results in undervoltage load shedding of the local 69 kV load.

2. Amount of Non-Consequential Load Loss with:
    a. The estimated number and type of customers affected

The estimated NCLL at winter peak is 29 MW for Pennfield Terminal and 19 MW for Milltown Terminal, for a total of 48 MW of load affecting 17,800 residential and commercial customers. This estimate is consistent for 2022 and beyond due to a relatively flat 10-year load forecast [2].

    b. An explanation of the effect of the use of Non-Consequential Load Loss under footnote 12 on the health, safety, and welfare of the community

The use of NCLL at Pennfield Terminal and Milltown terminal, with approx. 115 hours per year of exposure to limited contingencies affecting line 1193, is not significant in terms of risk of occurring. It is estimated in part 3 below that the probability of a line 1193 trip is 0.88 outages per year, and it is not likely to overlap with these low exposure hours. It's also insignificant compared to the local load exposure to Consequential Load Loss for 8760 hours per year from contingencies affecting the local 69 kV radial lines. As such, there is no measurable negative impact to the health, safety, and welfare of the community due to this use of NCLL at Pennfield terminal and Milltown terminal.

3. Estimated frequency of Non-Consequential Load Loss under footnote 12 based on historical performance

There is no record of NCLL at Pennfield Terminal or Milltown Terminal ever occurring.

The estimated frequency of NCLL at Pennfield Terminal and Milltown Terminal is calculated as follows:

Exposure risk: = (115 hours/yr)/(8760 hours/yr)

= 1.31%

Contingency risk:

For the applicable contingencies, the following statistics are taken from the 2016 Canadian Electricity Association report for Forced Outage Performance of Transmission Equipment, shown as reference [3] of this document.

Trip of 138 kV line 1193	=	(0.8052 outages per 100 km per year) x (49.5 km length of line 1193)
	=	0.3986 outages per year
Trip of Coleson Cove T1	=	0.2122 outages per year
Breaker failure of CO1-2	=	0.0685 outages per year
Breaker failure of CO3-11	=	0.2026 outages per year
Total	=	0.3986 + 0.2122 + 0.0685 + 0.2026
	=	0.8819 outages per year

Estimated frequency of NCLL = (Exposure Risk) x (Contingency Risk)
= 1.31% x 0.8819 events/yr
= 0.0116 events/yr

For an estimated frequency of NCLL equal to 0.0116 events per year, this equates to a probability of an NCLL event at Pennfield terminal and Milltown terminal happening once every 86 years.

4. Estimated duration of Non-Consequential Load Loss under footnote 12 based on historical performance

The expected duration of an NCLL event at Pennfield terminal and Milltown terminal is based on the expected duration of a trip to line 1193. Using reference [3], the estimated mean duration for an outage to 138 kV line 1193 is 13.29 hours, while the estimated median duration is 0.30 hours.

5. Future plans to alleviate the need for Non-Consequential Load Loss under footnote 12.

There are no future plans to alleviate the need for NCLL at Pennfield terminal and Milltown terminal.

6. Verification that TPL Reliability Standards performance requirements will be met following the application of footnote 12.

The use of NCLL at Pennfield terminal and Milltown terminal will trigger undervoltage load shedding of the local 69 kV load for low 69 kV voltages below 0.9 p.u. This action ensures that the TPL Reliability Standards performance requirements will be met because it directly resolves a low voltage violation(s) at Pennfield terminal and Milltown terminal.

7. Alternatives to Non-Consequential Load Loss considered and the rationale for not selecting those alternatives under footnote 12.

An alternative to NCLL at Pennfield terminal and Milltown terminal is the installation of a 35 MVAR capacitor bank at the Pennfield terminal. The estimate cost of the capacitor bank and associated control equipment would be approx. $1.5 million. The rationale for not selecting this alternative is its high cost with a very low benefit.

8. Assessment of potential overlapping uses of footnote 12 including overlaps with adjacent Transmission Planners and Planning Coordinators.

There are no potential overlapping uses of footnote 12 for NCLL at Pennfield terminal and Milltown terminal, including overlaps with adjacent Transmission Planners and Planning Coordinators. NB Power's load loss limits with ISO New England vary from 375 MW to 450 MW, so any potential loss of 48 MW of load at Pennfield terminal and Milltown terminal is well within that limit.

NB Power's rationale for why its use of NCLL at Manawagonish Road substation does not result in any Adverse Reliability Impacts.

The Glossary of Terms Used in NERC Reliability Standard defines Adverse Reliability Impact as:
"The impact of an event that results in frequency-related instability; unplanned tripping of load or generation; or uncontrolled separation or cascading outages that affects a widespread area of the Interconnection."

NCLL of 48 MW at Pennfield Terminal and Milltown Terminal is well within NB Power's load loss limit with ISO New England of 375 to 450 MW. This use of planned NCLL has no impact on the Eastern Interconnection with respect to frequency-related instability; unplanned tripping of load or generation; or uncontrolled separation or cascading outages.

CONCLUSION

The 2021 Planning Assessment contains two planned uses of NCLL, neither of which results in any Adverse Reliability Impacts. They are as follows:

1. NCLL at Manawagonish Road substation
   - Planned NCLL usage is for Year 2 (2023) and beyond
   - Undervoltage load shedding of 58 MW at winter peak is used to resolve local low voltage below 0.9 p.u
   - Estimated frequency of planned NCLL occurrence is 0.000056 events/year, or once every 17,900 years.

2. NCLL at Pennfield Terminal and Milltown Terminal
   - Planned NCLL usage is for Year 1 (2022) and beyond.
   - Undervoltage load shedding of 48 MW at winter peak is used to resolve local low voltage(s) below 0.9 p.u.
   - Estimated frequency of planned NCLL occurrence is 0.0116 events/yr, which equates to a probability of a planned NCLL event happening once every 86 years.

REFERENCES

[1] NERC Reliability Standard TPL-001-4 Transmission System Planning Performance Requirements
https://www.nerc.com/pa/Stand/Reliability%20Standards/TPL-001-4.pdf

[2] NB Power Integrated Resource Plan 2020
https://www.nbpower.com/media/1490323/2020-irp-en-2020-11-17.pdf

[3] Canadian Electricity Association, Equipment Reliability Information System, Forced Outage Performance of Transmission Equipment 2016, August 24, 2017.
https://electricity.ca/wp-content/uploads/2017/09/2016-All-Canada-ERIS-Report.pdf