**Q. Pages 63-67, Substation Spare Power Transformer Inventory Project.**
**a) On page 65, Newfoundland Power notes that utilities currently manage power transformers through a combination of portable substations and spare transformers. Has Newfoundland Power considered the use of portable batteries or power-grade batteries as an alternative to portable substations and transformers in its management of the electrical grid? If not, why not?; and**
**b) Appendix B of 2.2 - Substation Power Transformer Strategy indicates that several of the power transformer failures that occurred in the last decade were classified as imminent failures. Please provide an overview of Newfoundland Power's criteria and methodology for determining whether a power transformer is classified as an imminent failure.**

**A.** a) Newfoundland Power has not considered the use of portable batteries or power-grade batteries as an alternative to portable substations and spare transformers in its electrical grid management practices in response to power transformer failures. The back-up function served by portable substations and spare power transformers cannot be met by portable batteries or power grade batteries when transformer capacity is lost on the grid.

Portable substations can temporarily replace an entire substation, providing voltage transformation, switching, and system protection at transmission, distribution, or generation voltages. Newfoundland Power's portable substations have capacities up to 50MVA and can operate at voltages as high as 138kV. They can be transported, installed, and placed in service to restore power to customers within 36 hours, and can remain in service for extended durations without the need for refueling or recharging.

Similarly, spare power transformers can step-up or step-down system voltages for the purpose of generating, distributing, or transmitting electricity. Newfoundland Power's spare transformer fleet includes units with capacities up to 41.6 MVA and voltages up to 138kV. These assets can be used for medium to long-term restoration of service following a power transformer failure.

Portable batteries or power-grade batteries are typically used for peak shaving, short-duration backup, grid stability, or deferring distribution feeder upgrades. Portable batteries produce output in DC voltages and therefore require portable power inverters and a portable substation to integrate into the electrical grid at different interconnection points on the system. Batteries require recharging after discharge and while they can provide short-duration energy support typically within the range of hours, they cannot replace the long-term voltage transformation and supply capabilities of portable substations and power transformers.

While batteries can supplement emergency response capabilities, they are not a replacement for portable substations and spare power transformers, which can supply large customer loads reliably over periods of months or years.

b) Newfoundland Power classifies imminent power transformer failures based on a combination of condition-based indicators, operational history, visual inspections and data analysis of fleet-wide assessments of power transformer condition using a diagnostic tool that produces a multi-factored profile of each transformer.

*Condition-based Indicators*
Transformers are monitored through dissolved gas analysis and standard oil testing, performed at least annually and more frequently for aging units or those showing signs of deterioration. Newfoundland Power utilizes independent analytical laboratory testing to perform dissolved gas analysis and standard oil tests on all its power transformers to understand the condition of a unit.

Routine transformer electrical testing is another condition-based indicator which typically includes insulation resistance testing, transformer turns ratio testing, winding resistance testing, power factor testing, and sweep frequency response analysis. Industry standards such as *IEEE C57.152 IEEE Guide for Diagnostic Field Testing of Fluid-Filled Power Transformers, Regulators, and Reactors* support the interpretation of these results to assess overall health.

*Operational History*
The assessment considers the operation of protective devices such as gas and temperature monitors, digital relay event information (when available), system stresses such as lightning events, as well as historical records of failures and repairs of the unit and comparable units.

*Visual Inspection*
Each of Newfoundland Power's 131 substations is inspected 8 times per year. During these inspections, the exteriors of transformers are inspected to identify tank distortion, oil leaks, and signs of physical deterioration. When necessary, internal inspections are conducted to evaluate the condition of internal components.

*Assessment Tools*
In recent years, Newfoundland Power has utilized Electric Power Research Institute's Power Transformer Expert System to diagnose and assess the condition of its power transformer fleet. This assessment tool yields a set of indices for each transformer, providing insight into the condition of the cellulose insulation system and the potential for any abnormal incipient fault.

A transformer is classified as an imminent failure when the results from the activities above indicate a high probability of near-term failure, such that continued operation would pose an unacceptable risk to system reliability.