Voltage Conversion from 4.16kV to 27.6kV

[redacted] Overhead Subdivision

[redacted] Ontario

Submitted to: OACETT

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Introduction:

[redacted] is the Local Distribution Company (LDC) which services the customers of [redacted] Ontario with all of their electrical distribution requirements. Local Distribution Companies across Ontario convert higher voltages such as 230kV to lower more common voltages such as 120/240V which can be used by residential customers through various equipment.

In Ontario, Local Distribution Companies are required to follow certain Regulations, the Electrical Safety Authority, Canadian Standards Association, etc. and any relevant procedures that are unique to the distribution company and the municipality. *Regulation 22/04* sets out objective-based electrical safety requirements for distribution companies to get *Approval of Electrical Equipment*, *Approval of Plans*, *Drawings*, and *Specifications for Installation Work*, and *Inspection and Approval of Construction* before crews are able to put systems into service.

Among Regulations 22/04, there is also *CSA Standard CAN3-C235-83 (Preferred Voltage levels for AC Systems, 0 to 50,000V)* that applies directly to the distribution system, which affects residential, commercial and industrial customers.

The voltage level at the point of service must be between certain maximum and minimum values as set by the *Canadian Standards Association (CAN3-C235-83)* and the LDC is to ensure there are no fluctuations in voltages outside of those specified ranges.

Problem Statement:

The 4.16kV infrastructure is gradually being phased out, due to its limited capacity, inability to serve load growth, and high system losses associated with it; as well as inadequate ability to switch customers over to another feeder in the event of an outage.

As a part of [redacted] on-going 4.16kV conversion program, there needed to be a plan of action on how to best convert from legacy voltages such as 4.16kV system to the newer industry 27.6kV system.

In this Technology Report, the issues that will be covered include the various challenges involved when redesigning an existing overhead electrical distribution system which is now outdated in regards to legacy standards, placements of structures such as transformers below secondary bus on the pole, rear-yard primary conductor, open secondary bus, etc. for the purposes of a primary voltage conversion project.

This report will outline the steps involved [redacted] is required to follow by *ESA*, *CSA*, *Reg. 22/04* and various internal procedures that are unique to [redacted] when doing primary voltage conversion projects.

Methodology:

The techniques used in this Report will outline existing internal design procedures as laid out by [redacted] with regards to the redesigning of an existing overhead electrical distribution circuit for the purpose of a primary voltage conversion project. The following procedures will be followed:

- **Pole Health Index**
    - [redacted] conducts yearly pole testing on various parts of the system to ensure that these assets have a remaining strength of more than 60%. As per *CSA C22.3 1-16 Overhead Systems 8.3.1.3*, if any asset is under 60%, it is deemed unacceptable and requires replacement. Areas supporting legacy voltages tend to have more structures nearing their end of life cycle and require replacement prior to being deemed unsatisfactory.
- **Transformer Load Reports**
    - Through the use of our Customer Information System, transformer load report data can be collected and analysed to properly size new assets according to demand.
- **Secondary Voltage Drop Calculations**
    - Converting primary voltages is an excellent time to consolidate transformers to reduce the amount of overhead equipment in the area which will add to the overall aesthetics. Reducing the amount of transformers establishes more of an emphasis on secondary voltage drop calculations to ensure these voltage levels meet the requirement of *CSA Standard CAN3-C235-83 - Table 3*.
- **Field Data Collection**
    - Data collection includes, locations of poles, anchors, down-guys, conductor sizes and attachment heights on poles, as well as various communication companies (joint-use) in which are attached to the poles.

- **Non-linear Structural Analysis**
    - Poles affected directly by voltage conversion projects are placed within a nonlinear structural analysis program such as, SpidaCalc. This program aids the designer in determining if any additional guying, up-sizing pole classes, etc. is required according to *CSA Standard C22.3 No. 1-15*.
- **Fuse Coordination**
    - Upon performing primary voltage conversions projects, there are instances where a new fuse is required on a radial feed such as, a subdivision to alleviate a ripple effect which could cause a disruption on a main feeder resulting in a much larger outage.

Hypothesis:

My speculation is that all necessities of *Reg. 22/04*, secondary voltage requirements of CSA Standard *CAN3-C235-83 - Table 3* and maintaining passing structural analysis in the SpidaCalc software will be fulfilled for the purposes of an overhead primary voltage conversion.