MINIMUM SEPARATION BETWEEN UNDERGROUND PIPELINES AND ELECTRIC SUPPLY LINES
The Canadian standard CAN/CSA-C22.3 no. 6 recommends a 10-m horizontal separation between pipelines and power lines when shield wires are present based on the historical “conservative safe distance”, while the British and European standard BS EN 50443 recommends 20 m separation for grounded systems greater than 50 kV.
The History Behind GLIG 3715

- In 2014 the CEATI Grounding and Lightning Interest Group (GLIG) defined GLIG 3715 to study “The Minimum Separation Between Underground Pipelines And Electric Supply Lines”
- August 2015 - GLIG initiated GLIG 3715 Phase 1 to determine how system and soil parameters may affect the safe separation distance between underground pipelines and transmission line tower footings. The overarching objective of this project was to provide a set of resources for determining the safe separation distance between HV power line tower/pole footings and underground pipelines to avoid pipeline wall rupture
• Past related research studies have had the weakness on reliance on “small scale” test data

• A competent review of any proposed new model for lightning ionization of soil should be carried out at the 30- to 100-kA impulse level on real electrodes.

• Extension from 1 A to 100 kA is speculative without 100-kA testing experience to confirm.
Initial Project 3715 Definition
Pipeline/Power Line Mitigation Issues

- Minimum Separation Distances
  - Distance to prevent an arc due to GPR caused by an LG fault (Case B)
  - Distance to prevent the power system from sustaining a lightning induced arc (Case B)
  - Distance to prevent an arc due to a lightning strike (Case A)
Initial Project 3715 Definition
Pipeline/Power Line Mitigation Issues

Case A - Lightning Strike

Cause:
- Lightning strike to the power line structure or the overhead shield wires.

Effect:
- Voltage rise at the structure base initiates arcing through the soil to the nearby pipeline resulting in damage to the pipeline insulation. Pipeline damage is considered to be a puncture to the pipeline coating as well as damage to the cathodic protection system. Damage to the coating can result in corrosion and pipeline rupture over the long term.
Case B – Fault Conditions

Cause:

• Line to ground (LG) faults at the power line structure may be caused by lightning strikes or other insulation system failures. The LG fault will result in a ground potential rise (GPR) at the base of the structure. The GPR may induce arcing to a nearby pipeline.

Effect:

• In cases where arcing to the pipeline is initiated by the GPR under fault conditions, it is anticipated that the arc will be sustained until the fault clears. Damage to the pipeline (coating and pipe wall damage) will be significantly more extensive than damage due to a lightning induced arc alone.

• In cases where the arc to the pipeline has been initiated by a lightning strike to the power line, an LG fault may follow. The power line fault may or may not sustain the arc causing more damage to the pipeline. The system’s ability to sustain the arc will be influenced by separation distance and soil conditions between the pipeline and the power line structure.
Phase 1 of this project included the following tasks:

- Review the existing assessment methods for minimum arcing distance including, but not limited, to standards, studies, papers and reports listed in the reference section.
- Identifying key method(s) to calculate and determine the distance in soil between a pipeline and an electric transmission structure. Three distances are considered as follows:
  - Case A is the distance beyond which a lightning strike will not initiate an arc through the soil.
  - Case B considers two criteria:
    - First is the distance beyond which a line to ground fault will not initiate a power system frequency arc through the soil. The incident of concern is a power system single line to ground fault that occurs on the transmission structure. The single line to ground fault may be initiated by a lightning strike, or may be due to other non-lightning conditions.
    - Second is the distance beyond which a lightning-initiated arc will not be sustained by a fault at power system frequency.
- Define analytical studies to be undertaken to validate the method(s).
- Develop a test plan to validate the methodology(s). The test plan may include laboratory and/or field test components.
Project 3715 Progress To Date

- August 2015: GLIG 3715 – Phase 1 Initiated
- November 2015: Milestone Report 1 submitted
- April 2017: Milestone 2 submitted
- March 2017: Draft Final Report submitted
  - A number of issues were identified as part of the initial peer review which are in the process of being resolved.
- May 2018: Conference call with project sponsors to discuss next steps towards finalising the study

- GLIG 3715 Phase 1 Draft Final Report will also receive additional review by
  - GLIG funding member utilities
  - Peer review by subject matter experts (4 have been identified)
GLIG 3715 – Next Steps to be taken

• May 2018 – Conference call with project sponsors

• Likely outcome - Recommended initial second phase testing
  1. Lightning impulse tests with high moisture soil (V-I curve)
  2. Lightning impulse test to very rocky/dry soil (V-I curve)
  3. AC voltage test to high moisture soil (V-I curve)
  4. AC voltage test to very rocky/dry soil (V-I curve)
  5. Lightning impulse current to high moisture soil (V-I curve)
  6. Lightning impulse current to very rocky/dry soil (V-I curve)

These tests would be limited to a small number of tests e.g. five tests per condition, not the extensive tests proposed in the PDS. These tests should establish the validity of the model and the repeatability of the test. These would be a much reduced Phase 2 series of tests first to establish the validity of the work in Phase 1. Once that is established, the program can be reviewed again to determine if and how to proceed.
Project 3715 Phase 1 Study Results are Summarized in Two Documents

Technical paper titled “Transmission Tower to Pipeline Arcing”
In September 2016 at the Down to Earth Conference in Australia – Presented by Peter Dick
(available in public domain)

METSCO PowerPoint Presentation on “Arcing Studies for Co-existence of Pipelines and Power Lines”
In October 2017 at the CEATI 9th Annual Grounding and Lightning Conference by Kurtis Martin-Sturmey
CEATI and PRCI Collaboration Flowchart

MINIMUM SEPARATION BETWEEN PIPELINE AND POWERLINE STRUCTURES

- RFP EC 6-8 on development of a field manual for the determination of proper spacing between pipelines and AC grounding systems.
- RFP on Excel Software Assessment Tool

PRCI

PROJECT 3715 PHASE 1
The Minimum Separation Between Underground Pipelines and Electric Supply Lines

CEATI

Project 3715 Phase 2A
Investigation & Laboratory Initial Testing

Project 3715 Phase 2B
Investigation & Laboratory Final Testing

Tentative Modified Plan

- Spring 2019?
- Spring 2020?
- Fall 2020?

Software Tool customized to meet Pipeline needs

Project 3715 Phase 3
Development of tool for determination of safe separation distance between power line and underground pipelines.
This tool is to address arcing distance while also considering the following issues:

- Corrosion of tower footings and grounding conductors.
- Puncture of pipeline coatings due to faults.
- Flashover damage to pipeline isolation flanges.
- Possible hazardous step and touch potentials to pipeline and utility workers.