

44-kV Substation Grounding Tests Report Summary

Distribution Company Awareness

Due to interest in the completed study on issues associated with stand-alone factories, commercial or condominium developments fed from the 3 wire, 44 kV subtransmission system; the following Summary Bulletin has been issued. The study investigated a particular 44 / 0.6-kV transformer and switchgear cabinet (substation) supplying a retail store in an Ontario town.

Traditionally the 44kV subtransmission system supplied substations with 4-wire distribution feeder egress. The 44kV system was not intended to supply load directly, however relatively recently it is being used for this purpose. The multi-grounded neutrals provide an interconnected grounding system that helps to limit potential rise during ground faults. Concerns with the susceptibility of 3-wire, 44kV substations to high ground potential rise, including the associated step and touch potentials, in feeding customer loads has prompted the study summarized below.

Safety Awareness

The table summarizes the potentials that were measured at the store, scaled to the fault level of 1 682 A. The first column shows the potentials with the 4.16-kV neutral connected (as found). The second column has this connection opened. DC integrity tests showed that other utilities, such as gas, water, telco or cable TV connections still tied the store to the 4.16-kV neutral, probably through their service connections to neighbours. The last column was modelled for the substation and store completely isolated. The "neighbour grounded appliance touch" row refers to the use of case grounded equipment in the backyard, such as a barbeque with rotisserie.

Condition	Potential (V)	Potential (V)	Potential (V)
4.16-kV neutral connection	Yes	No	No
Gas / water / telco / cable TV connection	Yes	Yes	No
Ground Potential Rise	60	572	6 860
Substation Touch	10	142	1 700
Building Touch	43	444	5 300
Light Standard Touch	17	170	2 040
44-kV Riser Pole Touch	4	17	204
Neighbour Water faucet Touch	17	87	1 040
Neighbour Energy Meter Touch	17	106	1 270
Neighbour Grounded Appliance Touch	19	345	4 140

These potentials may be compared to the tolerable touch voltage limit of 188 V when standing on moist soil with 0.5s fault duration, from Table 52 of the Ontario Electrical Safety Code. The testing shows this substation requires a neutral interconnection for safety. Opening the neutral and relying on other utilities to provide inadvertent connections can lead to electrical fires due to high currents flowing through unrated conductors. Completely isolating the store would require extensive placement of gradient control conductors, including at neighbouring residences. Note that the existing grid at the substation and the 44-kV riser pole are insufficient to achieve touch coordination for the substation and store completely isolated. This substation has a modest fault level since it is located 33 km from the supplying 44-kV transformer station. Other substations close to the supply would have greater difficulty achieving coordination.