Incident Summary #II-1665852-2024 (#43817) (FINAL)

SUPPORTING INFORMATION			
Incident Date			January 21, 2024
Location			Aldergrove, BC
Regulated industry sector			Electrical - Low voltage electrical system (30 to 1000V)
Impact	Injury	Qty injuries	0
		Injury description	N/A
		Injury rating	None
	Damage	Damage description	A 2000kVA unit substation transformer was damaged beyond repair after a phase to ground fault in the secondary low voltage compartment.
		Damage rating	Major
Incident rating			Major
Incident overview			The outdoor unit substation feeding a community centre was damaged beyond repair after a conductor installed with improper bend radius suffered abrasion from expected vibrational friction against a sharp surface on the interior of the secondary compartment resulting in exposed wire and a phase to ground short.

INVESTIGATION CONCLUSIONS	
Site, system and components	The 2000kVA unit substation that supplied power to a city community centre consisted of the following components (as per engineering report): • A 25kV incoming power supply • A 25kV load break switch (ABB NAL-24-6) complete with 65E fuses. • A FR3 oil-filled 2000kVA transformer which converted power from 24.9 kV to 600/347 V. • The secondary (lower voltage) side of the transformer, which was connected with 8 x 4, 750kcmil aluminum conductors.
Failure scenario(s)	During regular transformer operation, vibrations are generated from the equipment and over time, the constant friction, compounded by the stress from the excessive bend radius, progressively damaged the insulation around the conductor. The exposed conductor ultimately led to insulation failure, creating an electrical arc to the transformer casing resulting in a phase-to-ground fault. The initial fault caused significant damage and triggered cascading faults across all phases, compounding the damage to the unit substation and its components. The fuses did eventually operate. however, high voltage fuses do not function quite the same way as a circuit breaker in a house. They are not as sensitive to in rush currents from large loads and line surges. Although we know the type of fuse used (65E) we do not know the speed rating. Depending on the selected speed rating when purchased, 65E fuses can take up to 300 seconds to operate during an overcurrent condition.

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Facts and evidence	**Professional Engineer Report** Provided information in line with the description of events provided in this report. **Field Safety Representative (FSR)** listed on the Operating Permit for the community centre held by the Township of Langley (TOL). **The Electrical Safety Officer (ESO)** met the FSR at TOL's storage yard where the damaged equipment was moved to after the incident for further examination. Damage to the enclosure was observed but wiring was cut, disconnected, and disposed of prior to arrival at the yard. **Regulations / Electrical Code Part 1** **12-110** Radii of bends in insulated conductors and cables the radii of bends in insulated conductors and cables shall be sufficiently large to ensure that no damage is done to the conductors or cables or to their insulation, covering, or sheathing. Pictures were provided to Electrical Safety Officer by Township Of Langley from a time prior to the incident and shortly after the time of the incident as per: • Image 1 - Sharp bend radius of conductors causing them to be pressed against enclosure wall. • Image 2 - The route taken to install the two red phase conductors that were in close proximity to where the fault occurred (Provided by FSR). • Image 3 – Shows conductor damage after rubbing on sharp surface (Provided by FSR). • Image 4 - Possible initial fault location just past the "A" phase terminal block insulator and directly below where the bottom left bolt would have been if it had not melted off. • Image 5 - Secondary compartment at time of incident. Shows soot and damage from outside looking into transformers. • Image 6 – Interior of secondary compartment at time of incident.
Causes and contributing factors	Conductors were in direct contact with sharp surfaces of an enclosure's secondary compartment which is typically prevented with installation techniques and adequate bend radius where conductors are more isolated from edges. It is likely through normal operation, the common vibration of the transforming equipment combined with improper installation created conditions where the conductors either had or were prone to physical stress and abrasion, creating enough friction that it cut through and broke down the insulation of the conductor causing an exposed wire and phase to ground fault with a subsequent catastrophic failure of the equipment and outage to the facility.

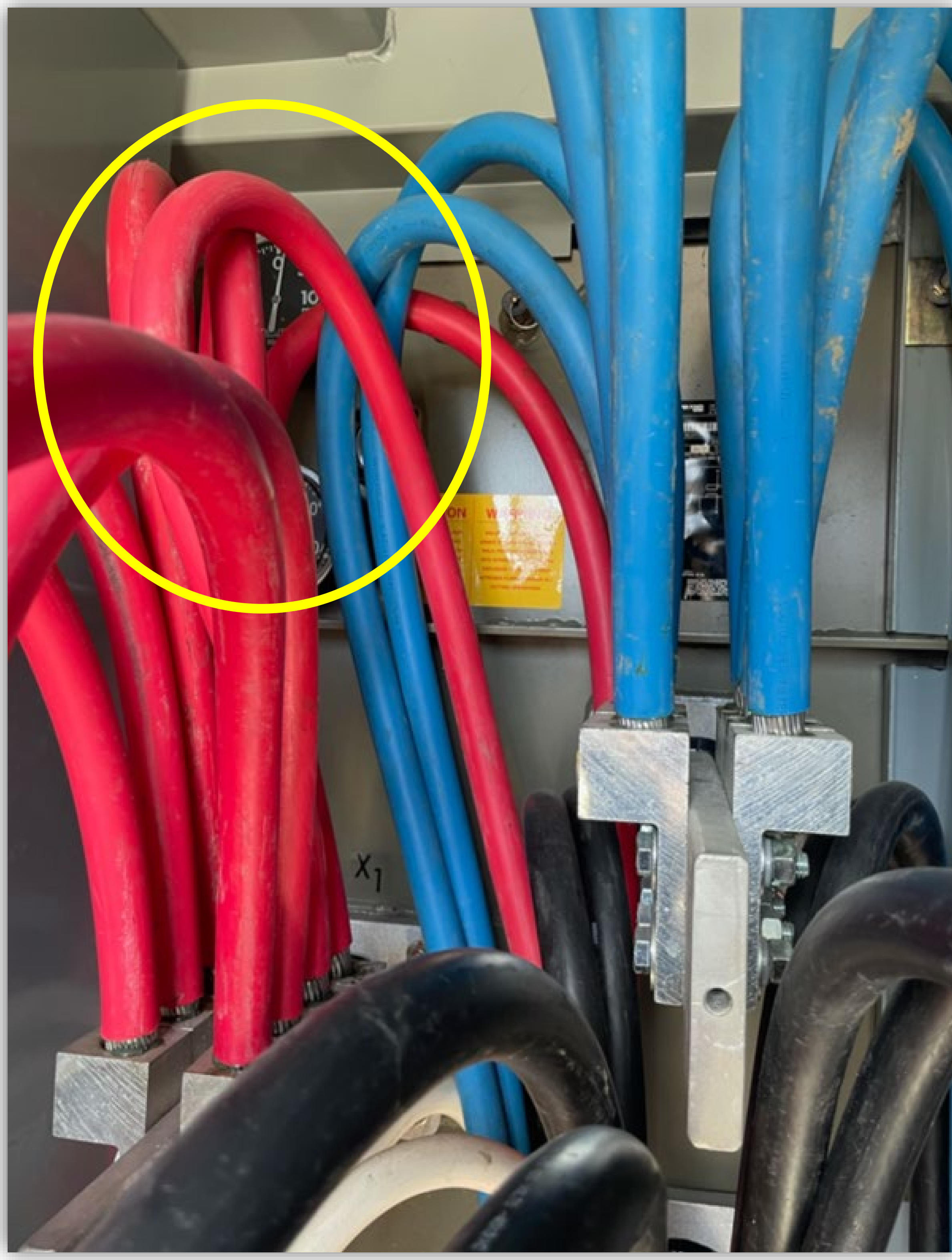

Image 1 - Sharp bend radius of conductors causing them to be pressed against enclosure wall.

Image 2 - The route taken to install the two red phase conductors that were in close proximity to where the fault occurred (Provided by FSR).

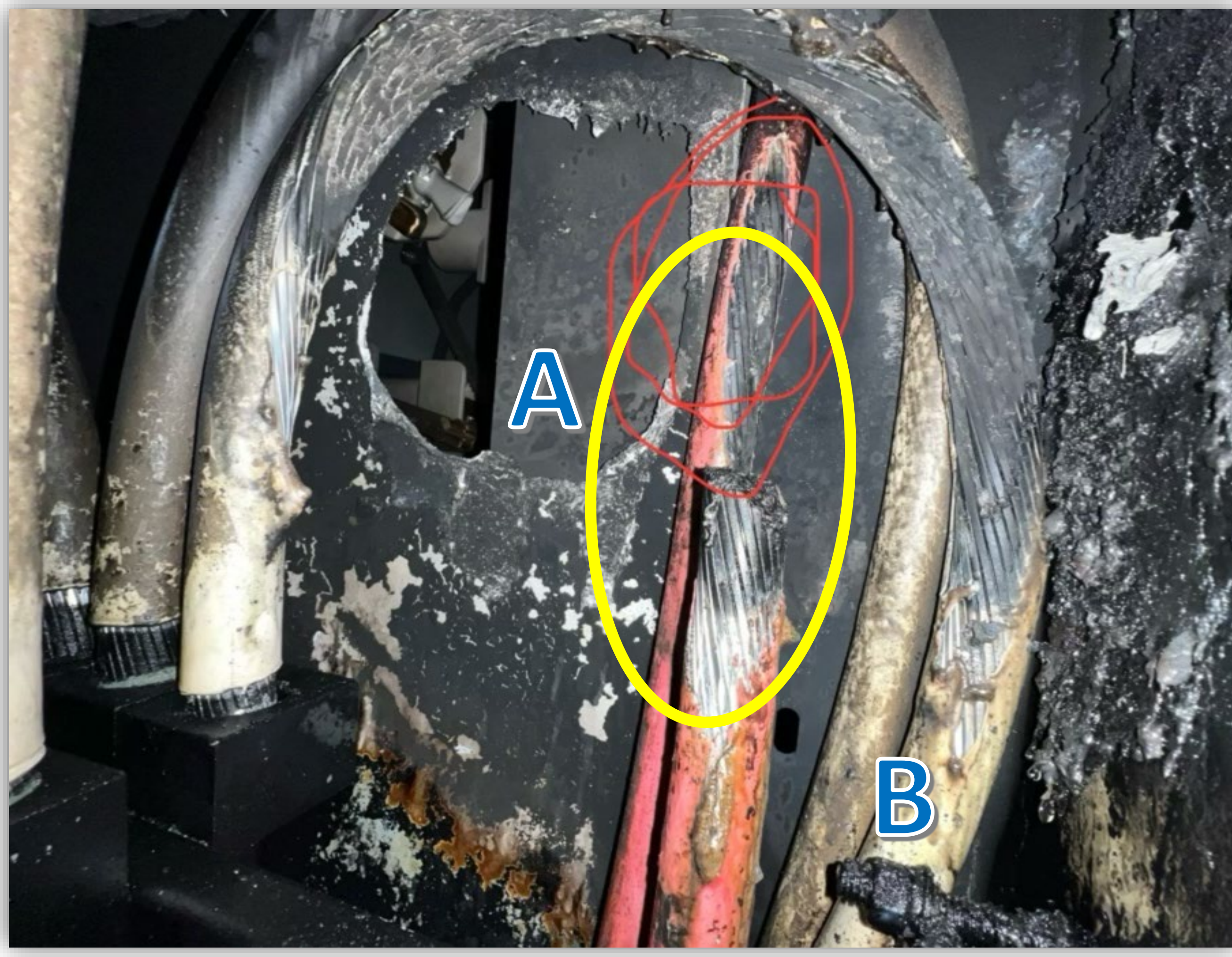

Image 3 – Shows conductor damage after rubbing on sharp surface (Provided by FSR).

Image 4 - Possible initial fault location just past the “A” phase terminal block insulator and directly below where the bottom left bolt would have been if it had not melted off.

Image 5 - Secondary compartment at time of incident. Shows soot and damage from outside looking into transformers.

Image 6 – Interior of secondary compartment at time of incident.