



St. Johnsbury X15 VT Failure Root Cause Investigation

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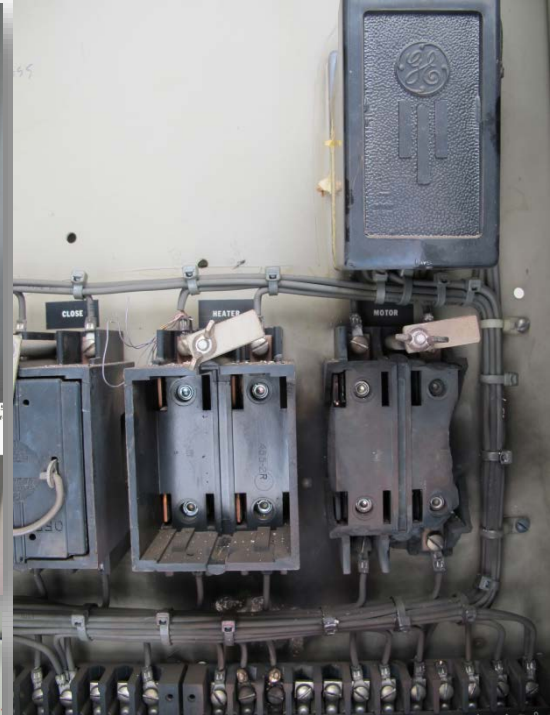
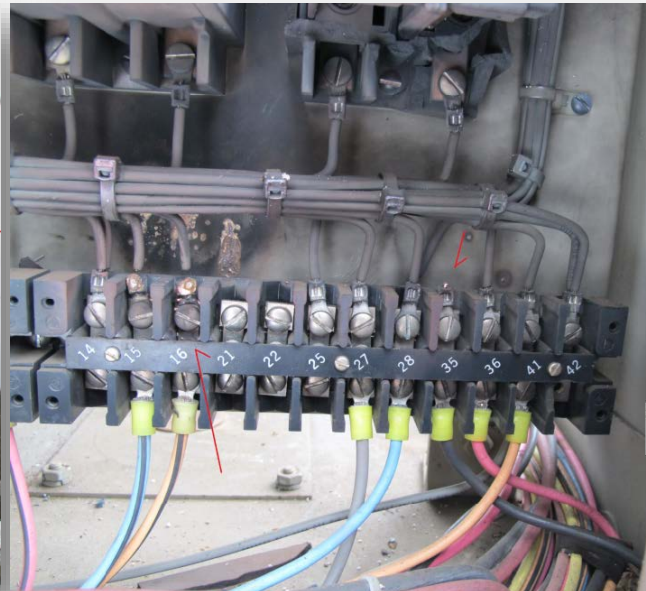
vermont electric power company



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- X15 line voltage transformer failed, resulting in significant damage to the X15 circuit breaker and miscellaneous substation protection and control equipment in the substation control house
- During the event, the X15 breaker control cabinet became energized, resulting in electrical flashover onto the X15 control cables allowing fault currents to migrate to the control house protection and control panels where the end connected equipment was exposed to high voltages and currents
- 7,028 Customers Impacted





Root Cause and Contributing Factors

The X15 circuit breaker 4/0 pigtail was not connected to the ground grid at the time of the incident

An unconnected grounding pigtail can be caused by:

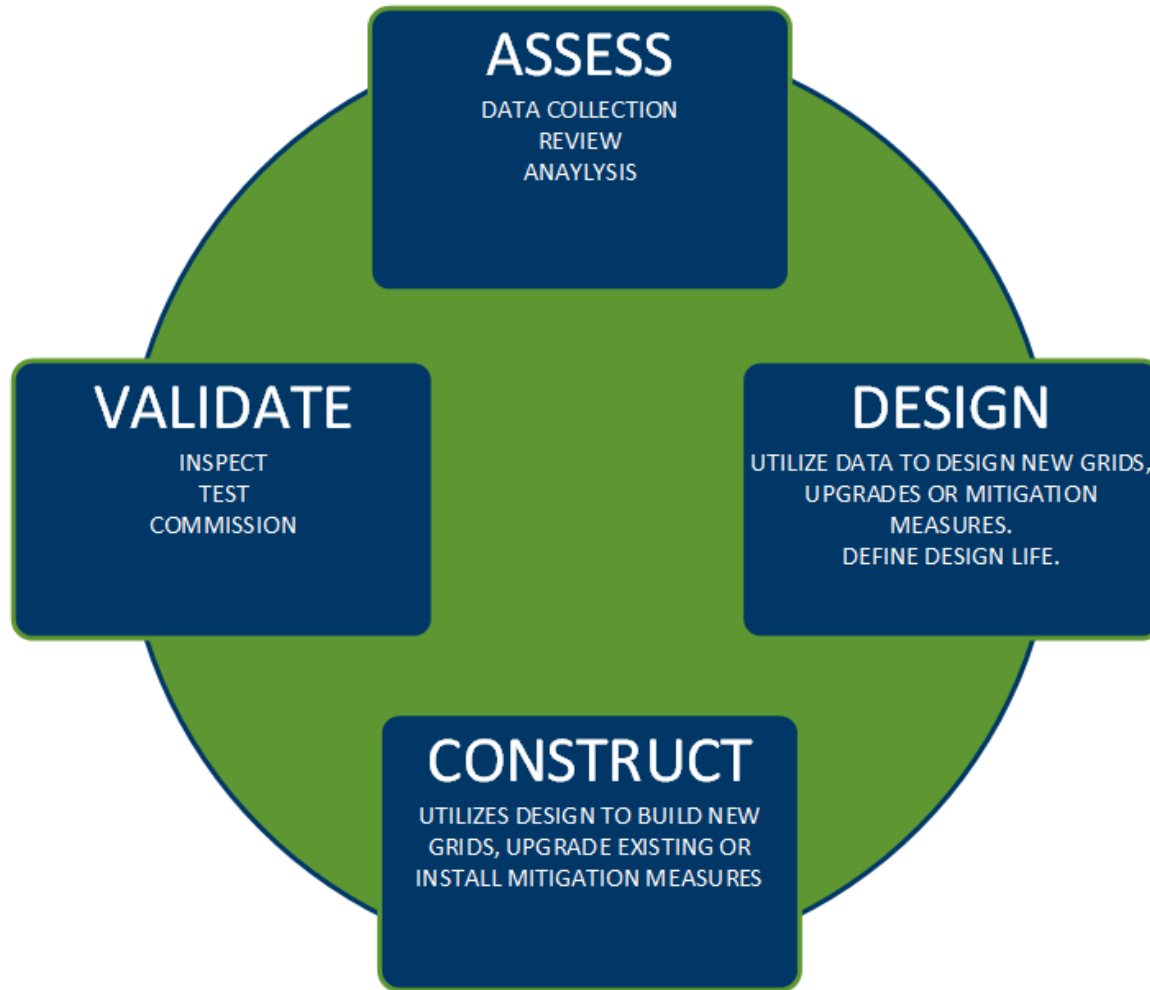
- Not being connected, either initially or during a subsequent activity
- Damaged resulting from adjacent activities such as excavation
- Deterioration or another condition related failure

The existing processes around the construction, acceptance testing and condition assessment of the ground grid require more definition and clarity on when testing is required, what tests are required, how test results are interpreted and how those interpretations are acted upon

Immediate Actions

- Safely isolated compromised equipment
- Executed primary and secondary P&C equipment replacement, commissioning and system restoration. All P&C functional tested
- Engineering prescribed additional grounding enhancements for St. Johnsbury and all pigtails were tested within the yard
- Inventoried Substation ground grid testing results for anomalies or missing data
- Performed subsequent pigtail testing at (10) substations

Ground Grid Life Cycle



Corrective Actions

- The existing VELCO Substation Test Standards (VSTS) shall be reviewed to provide clarity on when and how post-construction ground grid testing shall be executed, reviewed and reported, for newly installed grounds
- The existing testing standards shall be reviewed and establish a severity weighting criteria and testing acceptance peer review process for accepting field test results. The process shall consider test day acceptance procedures, contracting of ground grid testing and the overall peer review process
- Develop training and qualifications for personnel performing oversight of testing, to ensure items of high severity can be temporarily remediated on the same day of testing

Corrective Actions (Cont.)

- Develop a documented asset management strategy for substation assets, (for example ground grids, structural steel and concrete). An asset maintenance strategy shall identify the expected life of an asset, modes of failure, the type and frequency of testing, and escalating, assigning and tracking testing results that require follow-up action
- Revise and update the existing construction specifications to clarify when pre and post excavation ground grid testing is required. The construction specification review shall re-evaluate the visual inspection criteria for ground grids, who should be notified of anomalies and how repairs shall be executed, and accepted

Lessons Learned

- VELCO has developed strong program over the years for commissioning and accepting new systems
- The RCI team recognized that assets such as grounding grids, steel, concrete and the like that do not fall under the scope of a NERC standard currently lack a documented maintenance program
- A maintenance program for such assets shall identify the expected life of the asset, modes of failure, the type and frequency of testing, and a peer review process for assessing testing results
- The benefits of such a program raises the knowledge and confidence in the health of assets and that maintenance work on these assets will be planned, pro-active initiatives versus reactive restoration efforts

Lessons Learned (cont)

- Conducted a lessons learned on the restoration effort
- Conduct a VELCO Pre-Evaluation of Large Contingencies (PELC) study. The disaster recovery review shall encompass transmission line events, substation events and communications
- OP56 Notifications will be updated to include Telecomm and other personnel as needed
- Operations conduct a presentation on contingency analysis what role it plays the restoration decision making process

Questions?