C23 Outdoor Bus Duct - Maintenance, Diagnostics, and Failures

This presentation will impact the forensic community and/or humanity by demonstrating to forensic electrical engineers faced with outdoor bus duct failures awareness of some newly discovered causes of bus duct failure and the manner of detecting incipient failures.

Modern bus duct operating at 120/208/480 and 600 Volts at current rating of 400 – 4000 Amps is generally of the low impedance type, feeder or plug-in-type utilizing one or two bolts per joint type of construction. The conductor is flat ¼" thick plated copper or plated aluminum 3, 4 or 5 wire insulated with PVC or epoxy and sometimes with an additional Mylar sheet or tape. The enclosure is often powder coated, painted aluminum or painted steel.

The newer versions of bus duct are constructed in a ''sandwich configuration" and consist primarily of bus bars coated or dipped in either an epoxy or PVC resin. This type of construction has certain benefits and disadvantages. For instance, one draw back is that certain material defects are not readily detectable using commissioning / maintenance test procedures.

The bus duct is constructed to one or more of the following Standards UL 857 or CSA C22.2, No. 27.

Outdoor bus duct does not accept plug-in switches.

Outdoor bus duct is usually installed in a vertical or horizontal manner between transformer and buildings. Outdoor bus duct is expected to be weather sealed except for certain drainage features.

1.0 Failure Modes and Reasons

- 2.1 A common failure mode is the hot spot fault at a joint or connection. It is often attributed to misalignment, defective manufacture and loose or corroded connections.
- 2.2 Insulation failure near or at the joints due to defective manufacture, lack of clearances or damaged insulation.
- 2.3 Damage caused by entry of water, cement, slurry rain and defective weatherproofing.
- 2.4 Multiple pinholes in the insulation in the presence of water in horizontal installations.
- 2.5 Bolt hole penetration not waterproofed.
- 2.6 Incorrect orientation of the bus duct.
- 2.7 Condensation of moisture.

2.0 Older Bus Duct

Older bus duct is often of the higher impedance type with larger spacing between phases. It may be enclosed or ventilated. The conductors are often supported on separate insulating spacers exposed to rain, snow, etc. Failures have occurred at support points.

3.0 Injuries

Injuries seldom occur on outdoor bus unless being worked on while energized. In these instances, workers are very close to the fault, which usually manifests itself as a sustained electrical arc, which produces intense searing heat along with molten metal ejecta. The incidence of shock and electrocution occurs less often on outdoor bus duct than indoor bus duct.

4.0 Consequential Damages

The most serious outdoor bus duct failures usually result in major building fires and lengthy business interruptions. Sometimes a particular defect exists in an incipient form throughout the entire bus duct system, necessitating shutdown with resulting business interruption in order to take corrective actions on the entire run. Malfunction of protective equipment such as circuit breakers and relays usually increase the degree of damage.

5.0 Tests

Infrared scans, heat runs, insulation resistance, capacitance and dissipation factor/power factor, conductor resistance, plating and insulation thickness, alignment, correct installation, weather and water resistance tests and ''holiday" tests are a menu of tests often used by the forensic engineer.

6.0 Case Studies of Bus Duct Failures

- 6.1 Cement and water slurries
- 6.2 Tools
- 6.3 Insulation failure and holidays
- 6.4 Manufacturing defects
- 6.5 Hot spots
- 6.6 Misalignment
- 6.7 Condensation

Electrical Bus Duct, Arcing, Product Liability

 ** Presenting Author*