OUR PLANTS

MINNESOTA RIVER STATION

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49 MW dual-fuel natural gas and oil plant that consists of an electric generation plant and a distribution substation located in Chaska, Minnesota. The facility sits on seven acres approximately 500 feet from the Minnesota River.

Dry Air Injection System Solves Humidity-Related Electrical Problem at MMPA Minnesota River

By Bob Burchfield – Plant Manager, MMPA Minnesota River and Faribault Energy Park

Team photo: MMPA staff who had a hand in this Best of the Best (left to right): Shawn Flake, Justin Herman, Mike Pavek, Plant Manager Bob Burchfield, Steve Gare, Bob Flicek and Bill Schrot.

The Challenge

Two electrical faults occurred on a 13.8 kV bus within a five-year timespan at MMPA's Minnesota River Power Station (figure 1). In both incidents, the solid copper bus and ductwork sustained extensive damage, resulting in lengthy forced outages. Figure 2 shows the burned red insulator boots at the fault location.

DETAILS

LOCATION	Chaska, MN
OWNER	Minnesota Municipal Power
TYPE	Simple Cycle
FACILITY SIZE	49MW
NERC REGION	MRO

Figure 1: Normal view of bus section

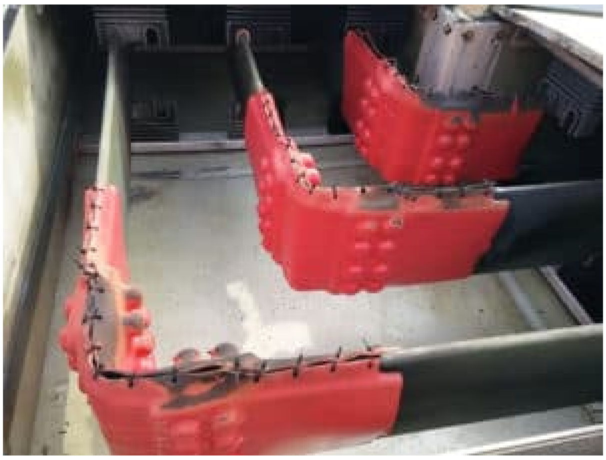

Figure 2: Insulator Boots Burned By Electrical fault

During the first incident, the team coordinated with the OEM and determined that the section of bus that faulted didn't have sufficient duct heaters installed. We installed two new heaters and scheduled more frequent inspections. Five years later, a fault at a different location in the bus required a more extensive investigation and more robust defense. Both events occurred during conditions of extreme humidity with heavy rainfall and dew points above 73° F. A third-party engineering firm determined that the bus was designed for relative humidity of 95 percent. However, relative humidity levels routinely exceed 95 percent during the spring and summer months in our region. The ductwork is vented to atmosphere through small screened holes, exposing the bus to ambient weather conditions.

While making repairs after the second incident, we noticed that the OEM had modified the replacement parts. The red insulating boots now had the tie-wraps at the sides rather than on top (figure 3). Previously, they had allowed moisture accumulated on the upper cover to drip into the seams onto exposed copper bus. The OEM had also modified the metal duct covers to create more overlap, particularly on the corners. After we had completed the repairs with improved OEM parts and added another space heater, the insulation readings still remained below acceptable values. Infrared imagery revealed that the heaters added negligible heat to the actual duct (figure 4). We also noted on new heaters we purchased from the OEM that they had begun installing them inside the duct with minimal clearances from the bus, apparently in an effort to make them more effective.

Figure 3: New style insulating boots with tie-wraps on side

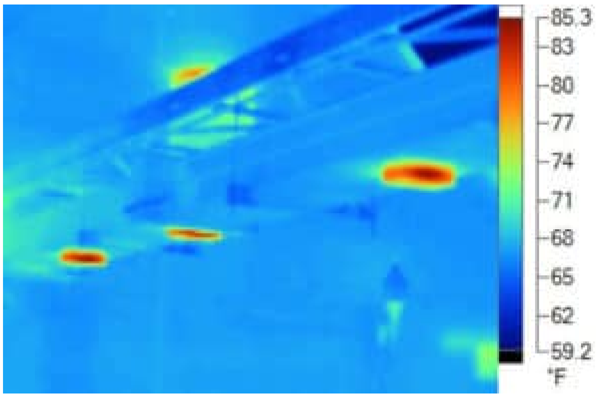

Figure 4: Infrared image of bus duct and space heaters

The Solution

After heating the bus for a prolonged period following repairs, we found that phase-to-ground resistance readings remained below acceptable limits. We then injected dry air overnight using a makeshift regulator and hose, which significantly improved insulation and permitted the bus to be safely energized. Given the success we had with this arrangement, our technicians designed a dry-air supply system for permanent installation and wrote an operating narrative explaining multiple safeguards and interlocks to prevent over-pressure and use of a permanent dry-air injection system to prevent moisture entry. The slight positive pressure created by injecting air, they noted, is an added benefit of the injection system.

We learned from our repair contractor that many sites in our region had experienced similar failures – and that in some cases, they were simply doubling the number of space heaters as a corrective action. However, we eventually ruled out the 'additional heaters' option due to the OEM's new location of space heaters inside the bus with less than four inches' clearance from the bus and ground. As mentioned, the IR images showed the heaters to be less than effective at increasing temperature inside the duct, even at that proximity.

To be on the safe side, we had the technicians' proposed air-injection system reviewed by a third-party qualified engineering firm and by our management. Injecting dry air is typically reserved for iso-phase bus ducts, so there were concerns about applying this solution to a non-segregated bus duct – especially since non-segregated bus covers are fastened with screws and not necessarily designed for positive pressure. Iso-phase bus ducting, on the other hand, generally is constructed of welded tube with only one conductor per duct.

In their narrative, the technicians explained how they would set equal flow to each injection point using instrument throttling valves and a flow meter to measure the incremental air-flow increase at each injection point (figure 5). At the same time, they confirmed low pressure with sufficient air flow by observing a small amount of the air exiting the duct from each vent/drain hole.

Figure 5: Stainless steel tubing with throttling valve at each heater box

Our team took a three-pronged approach to prevent water from entering via the supplied-air system:

- The team recognized that any malfunction of a regenerating dryer tower could allow water to enter the instrument air piping from the air compressors. We didn't completely trust the installed plant dryer tower, so the technicians proposed adding a tap to the top of the instrument air receiver tank and another dryer tower dedicated solely to the non-segregated bus duct (figure 6).
- We also procured and installed a dedicated dew-point

analyzer that we programmed to shut off the air-supply solenoid at a predetermined set point. The normal dew-point temperature downstream of two dryer towers is very low, so we opted for a conservative shutoff set point of 0° F. Part of our logic in being this conservative was that the dew point remains relatively constant in the new system, so a change of any appreciable amount could indicate a problem.

- Since the air is injected at each space heater box located below the bottom bus cover, dry air enters the bus duct through perforated holes above the heater. If water reaches this box from the air supply, it has a last chance of removal through the bottom screened hole (figure 7).

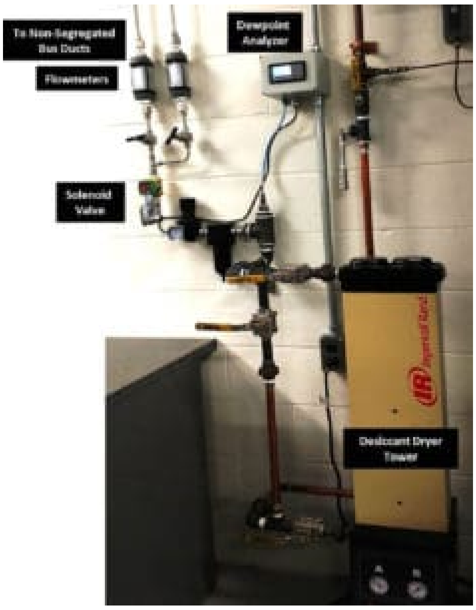

Figure 6: Dry air injection and protection equipment


Figure 7: Perforated heater box with air injection tubing penetration

The sheer size of this particular bus factored into our solution. The ducting measures approximately 200 feet long and consists of three different sections. It's heated by 25 space heaters that are powered by two separate 120V circuits, and each heater draws slightly more than 1 amp. The team also procured and installed a current monitoring device. If any one heater open-circuits, the amp draw will drop by 1 amp (figure 9). If an entire heater circuit trips, the new panel will display a loss of current. We didn't program an alarm because a thermostat will periodically shut off heaters at 95° F, causing nuisance alarms.

The Results

The dry-air injection system has been in place for two years now. During a series of severe storms last year that brought heavy rains, 80-100 mph winds and many days of high relative humidity, we had no arc-tracking and found no evidence of moisture. Phase-to-phase and phase-to-ground insulation resistance readings remain much higher than pre-installation values. A nationally recognized bus contractor wrote a highly favorable letter acknowledging the system's benefits and the ingenuity of our technicians. We'll need more time to fully determine the new system's effectiveness, but if it had not been in operation during last year's extreme weather, we think it likely that there would've been another electrical fault.

Plant photo: MMPA Minnesota River aerial view