The Dreaded Saturday Phone Call

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What's worse than a slip ring flashover on a critical wound rotor motor? A slip ring flashover on a critical wound rotor motor…on a Saturday!!! Yes, the dreaded Saturday phone call came to Flanders Electric from a local mine when a coal conveyor motor blew the slip rings. Unfortunately the motor was not repairable in the field. However, the mine was in luck. They had a spare motor in place and ready for exactly this type of situation. The mine personnel were thinking that the problem was behind them and it couldn't get any worse. At least until they pushed the start button.

The conveyor motor at the heart of this problem is a 4160 volt, 805 HP, wound rotor motor. On the bright side, the wound rotor motor is perfect for a belt application as it provides good speed control and plenty of torque at low rpm. Looking at the other, not so bright side, the wound rotor motor is expensive and requires significantly more maintenance to ensure reliability.

At 2:30 p.m. on Monday following the failure, the crane was finally in place and the damaged motor was lifted off the deck in preparation for replacement with the spare motor. By 7:00 p.m. the coupling had been removed from the failed motor and was being installed on the new motor. At 12:00 midnight the motor was aligned, wired up for high voltage, and ready to start. This moment would have been an ideal time to apply the first start rule: *On the first start of a motor always let the new guy push the start button.*

The motor growled, blew a fuse, and appeared as if it was trying to turn in reverse of the desired direction. The rotation was changed and another start was attempted. Another $1000 fuse blew in a different phase. The resistor bank and relays were op tested satisfactory. The rotation was reversed again for a third start resulting in a growl, followed by what appeared to be a near start, followed by another $1000 fuse blowing in phase B.

At 4:30 a.m. Tuesday morning more advice was requested resulting in the removal of the capacitors to no avail. At 2:00 p.m. low voltage (480v) three phase power was applied to the stator windings with the brushes lifted to check for a balanced induction on the three phase wound rotor. Sure enough there was an electrical imbalance on the rotor, but it shifted phases with rotor rotation creating uncertainty as to the root cause. At 7:00 p.m. Tuesday night it was determined that the spare motor needed to be sent to the shop for further inspection. However, one more idea was presented before going through the long arduous effort of bringing a crane back on site to remove the spare motor. The technicians at Flanders Electric utilize the MCEMAX electric motor test equipment for reliability testing and troubleshooting and they were hoping that the wound rotor motor testing module would offer some assistance in determining the root cause of the fuse blowing party.

The MCEMAX performs tests on electric motors while the motor is running or when de-energized. With the motor de-energized, the test equipment applies high and low frequency AC as well as high and low voltage DC for a variety of analysis techniques. With the motor running the MCEMAX enters a passive

mode acquiring AC and DC voltage and current signals to facilitate analysis of the motor, power circuit, and power supply. Fault zones analyzed during this testing include the power quality, power circuit, stator and rotor ground wall insulation, stator and rotor turn insulation, rotor bar and lamination integrity (squirrel cage induction motor), and air gap symmetry.

With hopes high the MCEMAX arrived on scene at 8:30 a.m. Wednesday morning. The very first test using de-energized equipment on the stator windings indicated a large inductive imbalance. Finally a break in what seemed like a steady stream of failed attempts to identify a problem. Another key piece of information was that the imbalance was not varying with rotor position. This locked the focus squarely on the stator windings. Knowing the problem must be stemming from the stator windings, prompted a detailed visual inspection of the stator winding connections resulting in an eye opening discovery. Rather than the normal wye configured connection, the #2 and #5 leads were reversed causing a phase inversion. This error creates a reverse torque opposing the normal rotation which explains the motors inability to start rotating from a stand still.

The leads were corrected and a follow up test was performed with the MCEMAX to verify the balance of the stator windings. Aha! A perfect balance on the de-energized stator windings was now being reported by the MCEMAX. The only thing left now was to start the motor with fingers crossed. With the MCEMAX connected for energized testing and following a realignment the motor was re-started with great success. All voltage and current values were normal, balanced, and flowing in the right direction.

Ask the tired technicians, who just spent the last four days in an effort to troubleshoot and repair not one, but two wound rotor motors, what they would do different. You might hear that performing MCEMAX quality control testing of the spare wound rotor motor would be a good start. In fact, the right approach for motor reliability using the MCEMAX includes the triangulated attack of quality control, trending, and troubleshooting. Quality control verifies the manufactured or repair integrity of the motor upon receipt. Trending gives you advance notice of conditions conducive to failures so they can be corrected early, thereby extending the life of the motor. And finally there will be a time, usually a Saturday, when something fails and you need a troubleshooting tool to rapidly diagnose and isolate the root cause to minimize production losses. Without the MCEMAX, use the first start rule: *On the first start of a motor always let the new guy push the start button.*