SUBJECT: Field Winding Failure on Old DC Elevator Motors

Issue: Field Winding Insulation Quality on Old DC Elevator Motors

The insulation quality of DC motor field windings is questionable in machines that have been in service for 20-50 years. The windings themselves were manufactured many years ago with less than perfect materials. They have been well baked and exposed to chemical and dirt contamination over the years. Insulation materials have become brittle and possibly cracked.

Previous Methods of Elevator DC Motor Field Excitation

Previous methods of field excitation were usually from a 1 or 3 phase full-wave rectifier with a current limiting adjustable resistor(s). The raw voltage came from a step-down transformer and was close to what was required to produce rated current. There was no closed loop field current regulator. When the utility voltage was high, so was the field current. Voltage applied to the motor field was rectified AC, but was 1/2 sinusoidal in shape. It did not contain any sharp voltage steps. This is conducive to long insulation life.

Operation of the Magnetek DSD 412 DC Elevator Drive Motor Field Power Supply

Motor fields have an L/R time constant of 0.5 to 2 seconds. Think of this as a low pass filter. The 1-phase full-wave SCR control on the Magnetek DSD 412 DC drive produces voltage pulses to the motor field at a 120 Hz rate. The method of voltage adjustment is essentially PWM at a 120 Hz rate. These voltage pulses are easily filtered by the time constant of the motor field down to a DC current flow with a negligible amount of ripple. The filtering ratio 8.3/500 (milliseconds) does a good job of attenuating 120 Hz pulsations. Actual peak-peak current ripple is usually less than 1% of rated current.

Failure of Old Elevator Field Winding Insulation

The DSD 412 Elevator Drive SCR controlled closed loop current regulator modulates power via SCR phase control, a sort of PWM at 120 Hz. The SCR switch points do have sharp dv/dt jumps in voltage. This does cause minute currents to flow through the capacitance of turn-to-turn wire insulation. When applied to an old insulation system it can cause an accelerated completion of the aging process. The net result is an insulation failure within 4-12 weeks of installing the new drive. ***Note: This can result in the failure of the DSD 412 Field Rectifier Q7.***

Would Changing to a 3-phase Field Control be Better?

Changing the DSD 412 SCR field control from a 1-phase unit to a 3-phase unit will do nothing to resolve the problem of aged insulation. In fact it is likely to actually speed up the failure process, since the 3-phase SCR phase control will have SCR switching dv/dt at 180 or 360 Hz rather than 120 Hz.

What will help to resolve the issue?

1. Always inspect the motor field insulation system before connecting up new drive equipment. Look for brittle varnish. Look for evidence of overheating. Hi-pot the motor field circuit to frame at a minimum of 600 Vac or dc for at least 5 minutes. Leakage should be less than 5-10 ma. Measure the electrical resistance of the field to see if it matches expectations from nameplate data. Replace any field coils that show signs of baked or weakened insulation.

2. Check and service the machine motor (field, armature, commutator, bearings) early in the process while other electrical work is going on for modernization. This is preventative maintenance and should be built into the modernization schedule. Do not wait for a costly and untimely failure.

3. From a design application standpoint, ensure that the SCR control for the motor field works from a reasonable voltage potential source. This will minimize dv/dt stress on insulating components. **Magnetek recommends that the Vac input voltage to the DSD 412 field rectifier be selected to be between 1.7 and 2.5 X the Vdc required to produce rated field current. (See Magnetek DSD 412 Application Note DSD-112 for a complete explanation on selecting an external transformer for the DSD 412 Field Power Supply.)**