

# Descriptions of Semiannual Tests for Electrical Motors

## Polarization Index Test

This ten-minute DC test is performed at one third of the total test voltage as prescribed by IEEE Std 95. A megohm reading is taken at one minute and again at ten minutes to determine the elasticity of the ground insulation. When placed in an electric field, molecules of the ground insulation should align with that field. If the insulation is aged, hard, and brittle, no polarization can occur. The Polarization index is the ratio of the ten-minute insulation resistance reading divided by the one-minute reading. Over the ten minute period this reading should increase by a factor of two or more giving a “PI” of two or more. If the insulation is very brittle the polarization index will be one or very slightly more than one, indicating no polarization took place. This test also looks at only the ground insulation and will not see the problems in the turn-to-turn insulation.

## DC Step Voltage Test / High Potential Test

The DC Step Voltage / HiPot test can uncover insulation weaknesses that might not necessarily be detected in a PI procedure. In addition to measuring overall insulation resistance to ground, it can detect insulation weaknesses that are likely to fault to ground if subjected to the high transient voltage surges that commonly occur on industrial power systems. With this test, the motor frame is grounded, and a dc voltage gradually applied in step increments up to the maximum recommended test voltage. IEEE Std 95 *Recommended Practice for Insulation Testing of Large AC Rotating Machinery With High Direct Voltage* recommends maximum test voltage at double the motor rated voltage plus 1000V. At each step up to this voltage, leakage current in microamperes is read and plotted against the corresponding dc test voltage.

The resulting plot should be a straight line. Magnitude of leakage current and resulting slope of the line is not the only consideration. The criterion of importance is that the plot be, in fact, a straight line. An abrupt upswing in the slope of the plot indicates an insulation flaw. The test should be immediately aborted to prevent the winding from failing under test. The motor can be returned to service, but winding reconditioning or replacement should be scheduled for the earliest convenient opportunity. The DC Step Voltage / HiPot is also a test that only looks at the ground wall and is of no value for the turn-to-turn insulation.

## Surge Test

Surge comparison testing detects turn-to-turn, coil-to-coil, and phase-to-phase insulation defects that cannot be discovered by other methods. Surge comparison testing is premised on the principle that in a stator with no winding defects, all three-phase windings are identical. Each phase is tested against the others – A-B, B-C, and A-C. The test instrument imposes a brief voltage pulses on the phase undergoing the test and reflected ringing pulses are displayed on the instrument’s oscilloscope screen. If the two windings are identical (as they should be), reflected images are identical and appear as a single trace.

## Conclusion

When testing a motor’s insulation system, it is important that the right tests are performed. It is important that the insulation system be capable of handling stress higher than its normal operating voltage. If high voltage testing is not performed it is nearly impossible to detect the weak insulation in advance of it’s failing.

Of the three tests discussed in this paper, two concern themselves with the groundwall insulation with no regard for the turn-to-turn. The Surge test is the only test that looks at the turn-to-turn insulation. This test simulates characteristics of a surge at start up, making it an appropriate test for early detection of weak insulation.