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**AC Motor Testing**  
**Performed With PdMA –MCE Offline Tester**

**Resistive Imbalance**

During this test a DC voltage is applied to the motor. From this voltage the actual resistances of the windings are measured. The three resistance readings of a three-phase induction motor are compared and calculated to obtain the resistive imbalance.

**Inductive Imbalance**

During the test, a high-frequency AC voltage is applied to the motor. This voltage produces a magnetic field around the windings which should be matched between phases. The inductance measurement for each phase is then compared to the other phases and calculated into an inductive imbalance.

The Percent of inductive imbalance is used to determine how well windings between phases are balanced. Although there are no specific standards, in a healthy motor it is generally accepted there should be less than 7% inductive imbalance for form wound motors and less than 12% for random wound motors.

**RTG Reading**

The resistance-to-ground (RTG) measurement indicates the cleanliness and health of the insulation system. As the insulation ages, cracks and small holes develop. It also becomes brittle over time, as the wiring expands due to heating and the contracts when it cools off. Aging and temperature variations also break down the molecular structure of the insulation. These factors allow contaminants and moisture, which collect on the surface of the insulation, to penetrate to the conductor. Since current follows the path of least resistance, some of the motor current is diverted from the motor circuit to these alternate paths, and ultimately to ground.

Resistance-to-ground (RTG) readings must be temperature corrected for trending and comparison purposes. Temperature correction of the reading is required because the temperature of the insulation system under test may vary depending on operating conditions prior to testing, atmospheric conditions, or ambient temperature. Insulation material has a negative temperature coefficient which means that the resistance characteristics vary inversely with temperature.



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**CTG (Capacitance to Ground)**

During the CTG measurement, the tester applies an AC potential between lead 1 and the ground lead. Circuit capacitance of the insulation system is measured. This capacitance value reflects the cleanliness of the windings and cables. A buildup of contamination on the surface of the windings and cables results in higher capacitance readings.

With a build up of contamination on the insulation surface, dirty windings and cables produce higher capacitance values than clean ones do. Over time, CTG values steadily increase, indicating an accumulation of dirt and that cleaning is necessary. This can be correlated with a lower RTG and higher CTG values.

This is important because dirt and contamination reduce the motor's ability to dissipate heat generated by its own operation, resulting in premature aging of the insulation system. A general rule of thumb is that a motor's life decreases by 50% for every 10°C increase in operating temperature above the design temperature of the insulation system. Heat raises the resistance of conductor materials and breaks down the insulation. These factors accelerate the development of cracks in the insulation, providing paths for unwanted current to flow to ground.

**Polarization Index and Dielectric Absorption**

During the PI and DA tests the MCE tester applies a DC potential between the phase 1 and the ground leads for a pre-determined amount of time, ten minutes for the PI test and 30 seconds for the DA test. During the test, RTG readings are taken every second. Every five seconds, the average of the previous five readings is plotted on the RTG (Megohms) versus time (seconds) display.

Taking the RTG reading at ten minutes and dividing it by the one minute RTG reading calculates the PI ratio. Taking the RTG reading at one minute and dividing it by the 30 second reading calculates the DA ratio.

$$\text{PI ratio} = 10 \text{ min} / 1 \text{ min}$$

$$\text{DA ratio} = 1 \text{ min} / 30 \text{ sec}$$

Erratic RTG values occurring at any time during the test is indicative of short-term current transients. These may be due to contamination or moisture. An important aspect in this situation is what level did the RTG values fall to during the test. The IEEE minimum RTG value is 100 Megohm for form wound coils.

The purpose of the PI test is to determine whether or not a motor's insulation system is suitable for operation.

PI and DA testing can both be used a single go-no-go, based on the minimum RTG readings established by IEEE 43-2000.



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**Step Voltage Test**

The Step Voltage test records the peak in-rush and decay of current as each increase (step) in DC voltage is applied to the circuit. The test allows the technician to observe how the insulation system responds to an over-voltage stress. The standard procedure is to increase voltage in one-minute increments. The leakage current is plotted against the stepped DC test voltages. Insulation condition is determined by evaluating the resultant graph of leakage current. Healthy insulation can be expected to withstand over-voltage stress. With each increase in applied voltage, leakage current will increase proportionally. Deteriorated insulation, however, exhibits an abrupt increase in current passing to ground as the higher voltages exploit structural flaws. The test can be applied to stator and rotor windings on asynchronous motors, stator and rotor windings on synchronous motors and the armature and field windings on DC motors.

**SUMMARY**

A summary report will be prepared for each motor and include the results with the actual values of each of these tests.

<b>Test</b>	<b>Performed</b>
Resistance To Ground	X
Capacitance To Ground	X
Phase Resistance	X
Resistive Imbalance	X
Phase Inductance	X
Inductive Imbalance	X
Polarization Index	X
Dielectric Absorption	X
Step Voltage Testing	X