NorthPoint's Electric Motor Reliability Courses are designed to help Maintenance and Plant Engineering personnel reduce motor failures.

The courses are two, 2-day intensive and practical courses. The first two days are aimed at electrically trained persons – Electricians, Technicians and Technologists, and Electrical Engineers. The second two days are aimed at mechanically trained persons – Millwrights, Machinists, Technicians and Technologists, and Mechanical Engineers. **However, it is recommended that if personnel can be spared from their work environments, that they attend all four days,** because in reality mechanical causes result in many electrical failures, and electrical causes result in many mechanical failures.

The courses have been designed based upon decades of experience repairing and maintaining electrical machines. The approach is to identify the main types of failures, and then to identify the available options available to companies to reduce or prevent each type of failure.

The courses are practical, including shop inspection of various repairs and procedures in progress. Elements of shop and on-site electrical testing and vibration analysis are included in each course.

The objective is that personnel can return to their plants, equipped to identify situations which place their motors at risk thus giving them the option of doing something to improve reliability

Electric Motor Reliability - Electrical

"Preventing Motor Burnout"

Squirrel Cage Induction Motors (SCIM), 500HP to 5,000HP

With references to smaller and larger SCIM's, Wound Rotor, Synchronous, & DC

Insulation failure, rotor failure

3-phase AC motor stator winding: Stator slots, windings - random and form wound. Insulation – conductor, ground, phase. Squirrel Cage Induction motor rotor construction – cast aluminum & fabricated rotor bars & resistance rings.

Preventing electrical failures and burnout - Maintenance strategies

Preventive; Predictive; Proactive; Corrective

Root causes of motor failures, factors influencing insulation life

Heat

Temperature rise, hot spot temperature, classes of insulation, insulation lifetime. Causes and effects of high temperature. Sources of heat – I2R copper loss; Iron losses - hysteresis, eddy current; friction and windage; rotor losses. Dissipation of heat - types of enclosures, vents – stator & rotor, fans. Efficiency.

Poor Power quality

Using the SCIM equivalent circuit to understand what poor power quality does to an electric motor. Harmonics, voltage imbalance (negative sequence component), over / under voltage, frequency deviation. Effect on motor lifetime and motor efficiency. Dollar cost of poor efficiency.

Harmonics
Effect on waveform. Third harmonic - causes – non-linear loads. Other harmonic voltages - variable frequency drives. The proper way to measure non-sinusoidal voltages and currents. Beware of unintentional overvoltage.

Negative and Zero sequence components
Negative sequence: physical interpretation - Measurement, using voltmeter, ammeter, flux coil, computer. Determining if the problem is in the motor or power system. Single phasing.
Zero sequence: physical interpretation. Types of zero sequence current transformers. Supply transformer connection.

Operating at over / under voltage
Negative resistance: use the equivalent circuit to explain why increasing the voltage causes the current to decrease. The relationships between voltage, current, flux density, iron & copper losses, heat and efficiency.

Operating at over / under frequency
The relationship between voltage, flux and frequency, “Volts / Hz”.

Voltage surges
Causes and effects on electric motors. Non-linear voltage drop across the windings. Turn to turn insulation damage.

Damage during starting - Starting duty limitations - SCIM
Using the SCIM equivalent circuit to understand the speed torque curve, amp draw. Magnetic forces on stator end turn conductors. Heat generation during start in the SCIM stator and rotor – stator limited, rotor limited. SCIM rotor sparking. Damage to rotor bars and end rings, rotor iron. Differential expansion.

Transient re-energization of an induction motor
Use the equivalent circuit and circle diagram to understand how an induction motor becomes an induction generator. Voltage and speed decay. Reconnecting out of phase - damage to windings, shaft, coupling, etc.

Vibration
Winding damage, chaffing of insulation, iron looseness, damage to mechanical fits, effect on air gap.

Chemical attack
On stator windings; on rotor materials. Solutions.

Faulty repairs & design inadequacies
Iron repair, damage to / wear of critical fits, frame warp, cracked welds, flux density, bearing insulation, resonance.

Derating
Temperature, Altitude, Voltage, Frequency. Service factor. Overload and misapplication.

The Air Gap
Magnetic force between stator and rotor. Air gap problems – Unequal air gap, out of round stator, rotor runout, and non-concentric rotor. Rotor pullover. Normal air gap dimensions and tolerances. How to measure air gap. The effect of increasing the air gap during a repair (amps, power factor, efficiency, starting inrush and vibration).

Adjustable Speed Drive Considerations

Voltage / Frequency (Volts per Hertz, flux), Over speed – Centrifugal force, Balance, Bearing life, Under speed - External cooling, Constant torque loads – effect on current draw. Harmonic generation – which harmonics and why not others. “Odds without thirds” Use of SCIM equivalent circuit to understand the effects of harmonics on torque and losses. Harmonics - Losses, motor sizing, service factor, measuring RMS voltage and current. Bearing currents
Insulation - long lead considerations, filtering, Over voltage. Corona. Turn to turn insulation failure. Detection and measurement. Torsional and lateral resonance problems – even though this is an electrical course, the damage done by operating at a torsionally resonant speed can be very destructive and costly. Hence, mention of mechanical resonance is important.

Testing electric motors - Detailed discussion

Recommended Service Shop Tests

Vibration, winding resistive unbalance corrected to 25C, winding inductance unbalance; no load amps, power, speed at rated frequency and voltage; hi pot test and leakage current (NEMA), surge test, Rotor Influence Check (RIC).

On site tests

Current and flux analysis - spectrum, air gap analysis, power analysis; efficiency measurement on site, trending normalized temperature rise, PD (partial discharge), surge testing, AC & DC Hipot testing - Step Test, PI & DA – 500, 1000, 5000volt, capacitance, absorption, conduction, trending.

Testing SCIM rotors

Voids and porosity in cast aluminum rotor bars and end rings; Broken bars

Monitoring & instrumenting motors

Periodic monitoring; continuous monitoring

For more information or to register email adoyle@northpointts.com