

Electrical Level 4



Motor Operation and Maintenance 26410-14



Objectives

When trainees have completed this lesson, they should be able to do the following:

1. Recognize the factors related to motor reliability and life span.
2. Measure motor winding insulation resistance and compensate for temperature.
3. Identify motors needing replacement.

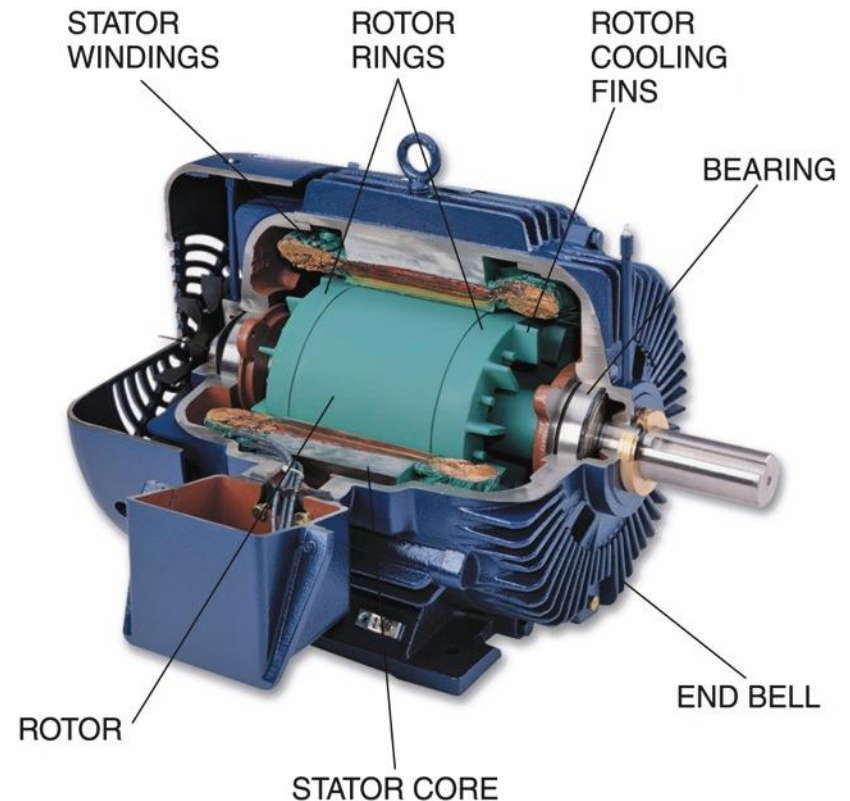
This is a knowledge-based module; there are no Performance Tasks.



1.0.0 – 2.2.0

Introduction; Squirrel Cage Motors

- Three-phase, squirrel cage induction motors are the most common motors in heavy commercial and industrial use.
- Motor failures can be caused by worn or tight bearings, vibration, moisture, dust and dirt, insulation deterioration, overloading, and single-phasing.



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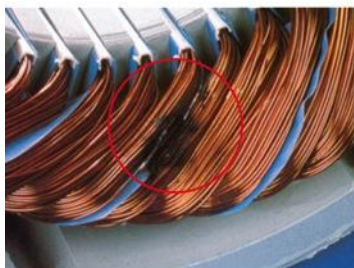
Stator Winding Failures and Causes



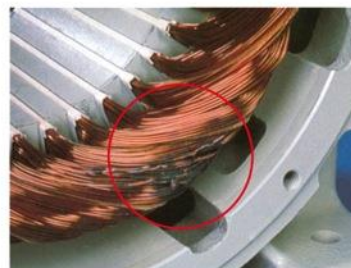
Single-phased undamaged winding (caused by a missing voltage phase in a wye-connected motor)



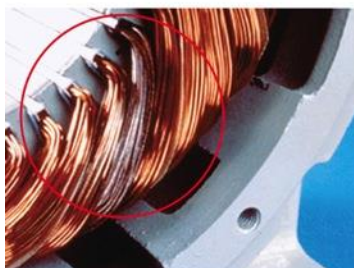
Single-phased damaged winding (caused by a missing voltage phase in a delta-connected motor)



Phase-to-phase short (caused by contamination, abrasion, vibration, or voltage surge)



Turn-to-turn short (caused by contamination, abrasion, vibration, or voltage surge)



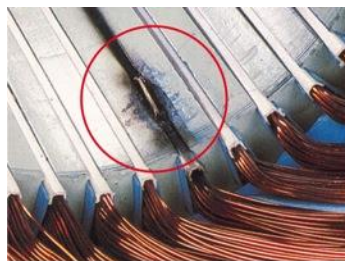
Shorted coil (caused by contamination, abrasion, vibration, or voltage surge)



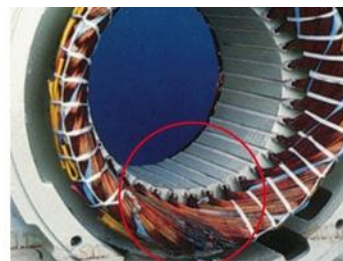
Winding grounded at edge of slot (caused by contamination, abrasion, vibration, or voltage surge)

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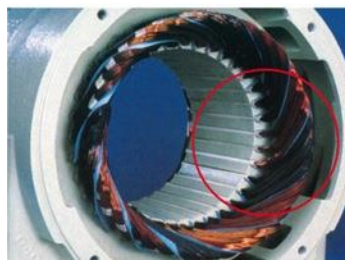
Stator Winding Failures and Causes



Winding grounded in slot (caused by contamination, abrasion, vibration, or voltage surge)



Shorted connection (caused by contamination, abrasion, vibration, or voltage surge)



Unbalanced voltage damage (severe for one phase, slight for another phase, and caused by unbalanced power source loads or poor connections)



Overload damage to all windings
Note: Under-voltage and over-voltage (exceeding NEMA standards) will result in the same type of insulation deterioration.



Locked rotor overload damage to all windings (may also be caused by excessive starts or reversals)



Voltage surge damage (caused by lightning, capacitor discharges, voltage kickbacks caused by de-energizing large inductive loads, or voltage disturbances caused by solid-state devices)

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Motor Maintenance



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- The frequency of motor testing and maintenance depends on the hours of operation, nature of service, environmental conditions, and how critical the motor is to the system.
- Most heavy-duty motors are totally enclosed and fan-cooled for use in wet, dirty, or corrosive environments.

3.0.0 – 3.3.0

Tools and Test Equipment for Electrical Maintenance

Tools or Equipment	Application
Multimeters, voltmeters, ohmmeters, clamp-on ammeters, wattmeters, clamp-on power factor meter	Measure circuit voltage, resistance, current, and power. Useful for circuit tracing and troubleshooting.
Potential and current transformers, meter shunts	Increase range of test instruments to permit the reading of high-voltage and high-current circuits.
Motor rotation and phase tester	Determines the proper three-phase connections for the desired rotation direction of a motor prior to connecting the motor. Also checks the phasing of the power source so that the motor can be connected to the desired phases.
Tachometer	Checks rotating machinery speeds.
Recording meters	Provide a permanent record of voltage, current, power, temperature, etc., on charts for analytic study.
Insulation resistance tester, thermometer, psychrometer	Test and monitor insulation resistance; use a thermometer and psychrometer for temperature and humidity correction.
Vibration testers and transistorized stethoscope	Detects faulty rotating machinery bearings and leaky valves.
Milli or microhmmeter	Precise measurement of coil resistance.
Dial indicator with mounting devices	Used to check for bent motor shafts and performing shaft alignment for directly coupled motor loads.



3.0.0 – 3.3.0

Infrared Thermometer

- Inspect the motor for loose components/connections, dirt, alignment, and airflow obstructions.
- Observe the motor during operation for proper running speed and signs of overheating. An infrared thermometer can be used to check the bearing housing and motor for excess rise as listed on the motor nameplate.



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Vibration Tester



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- A vibration tester can be used to make comparisons with previously logged data to see if a motor is beginning to exhibit excessive vibration.
- Place an identifying mark on the equipment where the vibration test is made to ensure that future testing is done in the same spot.

3.0.0 – 3.3.0

Next Session... Motor Analysis Instrument

- Online (dynamic) testing is performed on an operating motor. Offline (static) tests are made when the motor is de-energized, locked out and tagged.
- Online testing can be performed using computerized portable test equipment to monitor power quality, motor/load conditions, and performance.

Motor Bearing Maintenance



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4.0.0 – 4.3.0

Motor Bearing Maintenance

YEAR _____ EQUIPMENT LUBRICATION SCHEDULE

Equipment Location and/or Number	Lubricant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

LUBRICATION TAG

EQUIPMENT No. _____
DESCRIPTION _____
LOCATION _____
JOB No. _____
LUBRICANT TYPE & VISCOSITY _____
QUANTITY OF LUBE _____
PART LUBRICATED _____
SIGNATURE _____
DATE _____

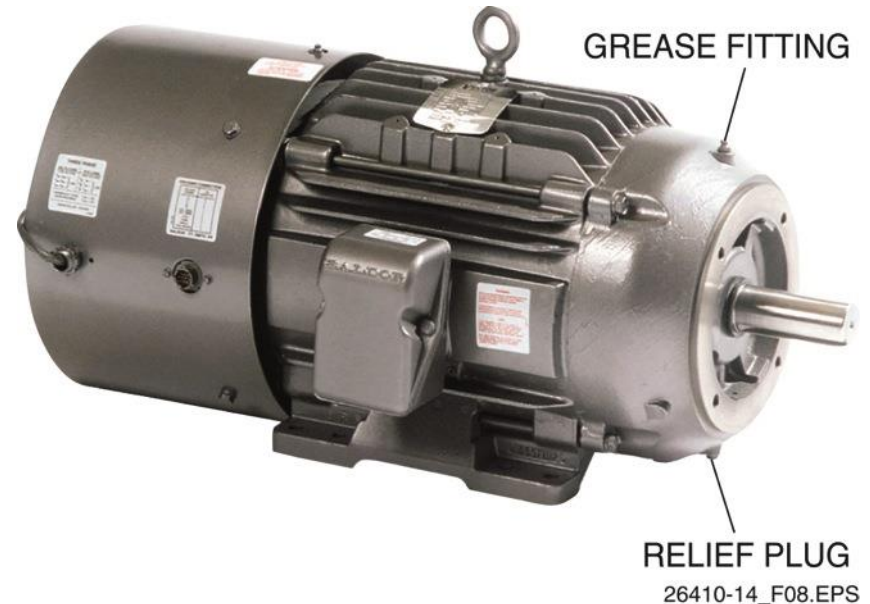
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4.0.0 – 4.3.0

Grease Fitting and Relief Plug for a TEFC Motor

- To lubricate a motor, remove the relief plug from the bottom of the bearing housing.
- Run the motor and add grease to the grease fitting until it begins to run out of the relief hole.



4.0.0 – 4.3.0

Grease Gun and Meter

- Some manufacturers list a specific amount of grease to be injected in the bearing housing.
- A grease gun and meter can be used to precisely measure the amount of lubricant.

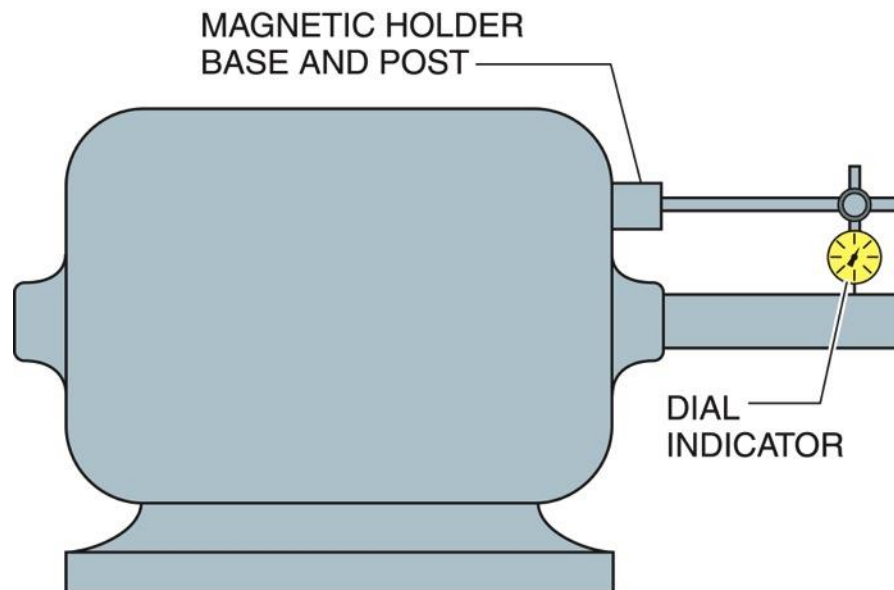


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4.0.0 – 4.3.0

Checking for a Bent Shaft on a Motor

- Motors should also be checked for excessive endplay, proper belt tension, and bent or misaligned shafts.
- A magnetic base dial indicator can be used to check for a bent shaft on an uncoupled motor or driven load.

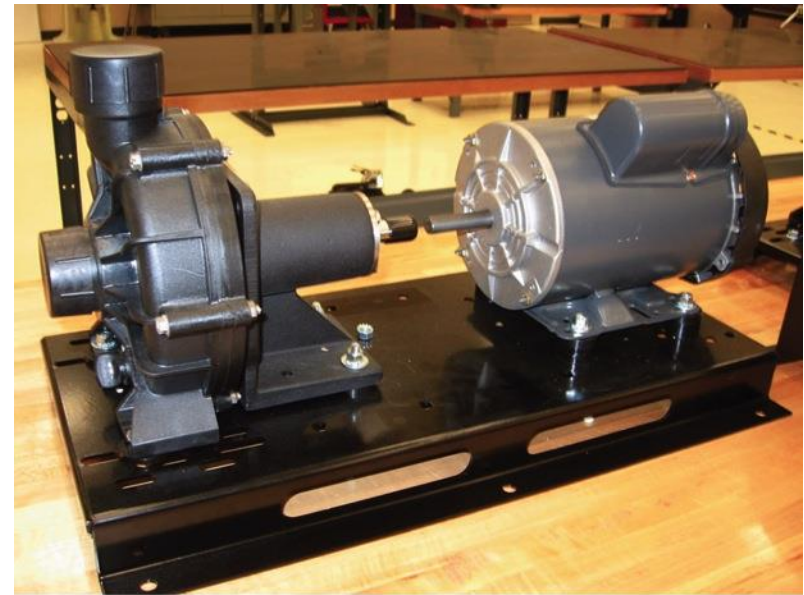


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4.0.0 – 4.3.0

Typical Direct-Drive Configuration Without Coupling

Parallel or angular misalignment (runout) of an uncoupled motor can be checked using a magnetic V-base holder or clamp base holder with a dial indicator at the rear of one of the shafts.

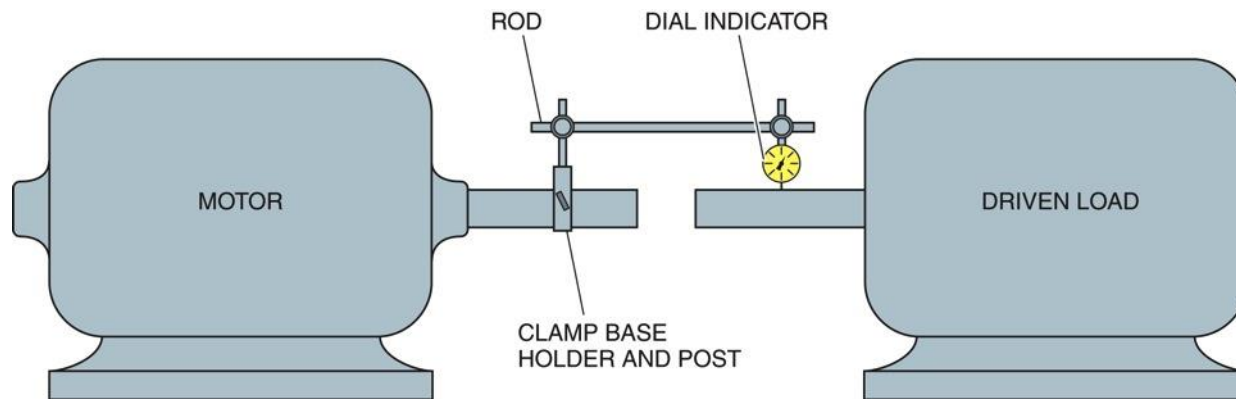


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4.0.0 – 4.3.0

Checking Shaft Alignment Between a Motor and Directly-Driven Load

- Rotate the base holder shaft and note the locations of the minimum/maximum readings on the other shaft. Move the indicator to the front of the shaft and repeat.
- Equal readings represent a parallel misalignment and unequal readings represent an angular misalignment. Correct runout by adjusting the motor position or shimming.



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4.0.0 – 4.3.0

Typical Dial Indicator with Various Holders and Stainless-Steel Slotted Shims



MAGNETIC BASE HOLDER



CLAMP HOLDER WITH POST



TYPICAL DIAL INDICATOR



SLOTTED SHIMS

26410-14_F13.EPS



5.0.0 – 5.3.0

Motor Insulation Testing

- Insulation resistance tests can be used to test the condition of the motor insulation to indicate possible breakdown and/or moisture or dirt contamination.
- Insulation resistance is measured using a megohmmeter. Only trained and qualified individuals may use this equipment.

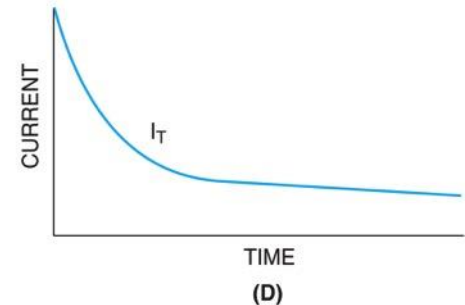
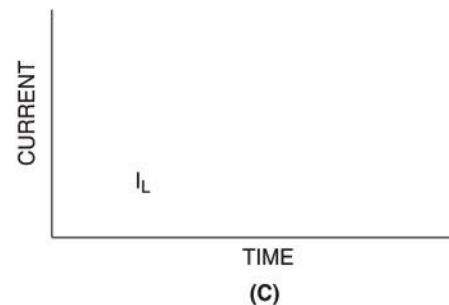
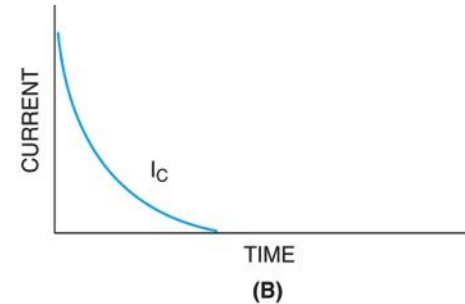
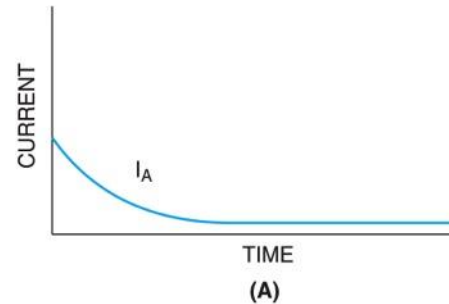


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5.0.0 – 5.3.0

Current Curves Related to Insulation Testing

- Absorption current consists of polarization current and electron drift.
- Wound motors are subject to dielectric absorption, which must be allowed to decay so it is negligible with regard to leakage current in order to make accurate insulation measurements.

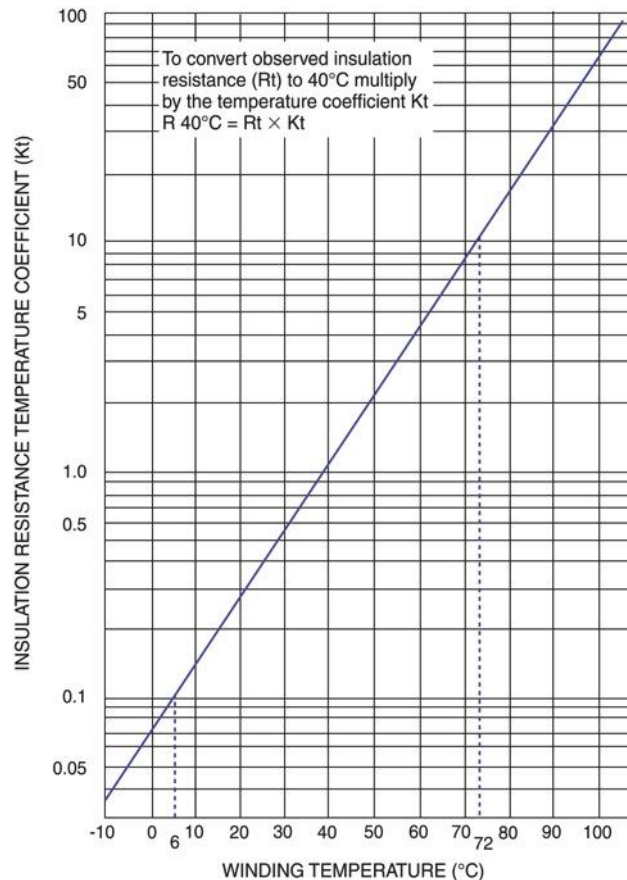


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5.0.0 – 5.3.0

Approximate Temperature Coefficient for Insulation Resistance

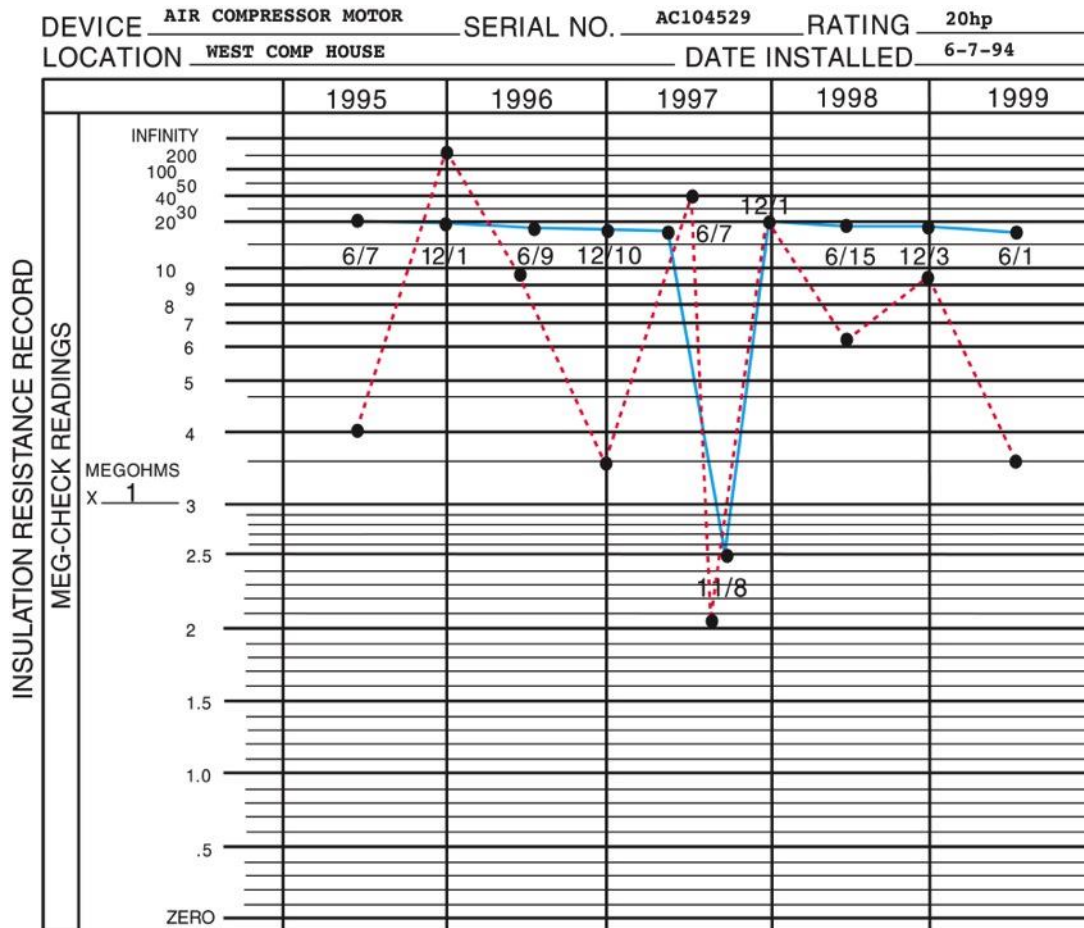


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5.0.0 – 5.3.0

Chart of Insulation Resistance Readings



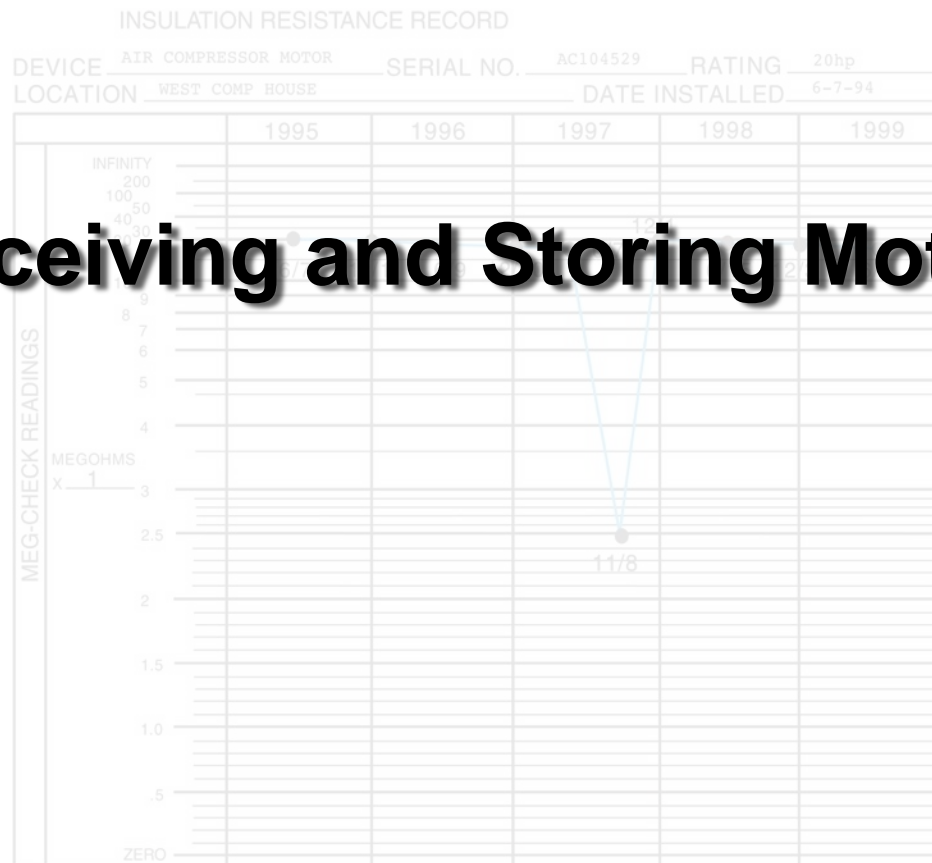
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5.0.0 – 5.3.0

Next Session... Temperature Compensation Record for a Motor

Receiving and Storing Motors



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6.0.0

Receiving and Storing Motors

- Uncrate and inspect all motors when they are received. Never start a wet or damp motor.
- Keep stored motors clean and dry, and use supplemental heaters where required. Rotate the shafts as recommended by the manufacturer and maintain a rotation log.

SHAFT ROTATION LOG

EQUIPMENT No. _____
DESCRIPTION _____
LOCATION _____
JOB No. _____

DATE ROTATED	CRAFTSMAN'S SIGNATURE
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

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7.0.0 – 7.3.0

Troubleshooting Motors

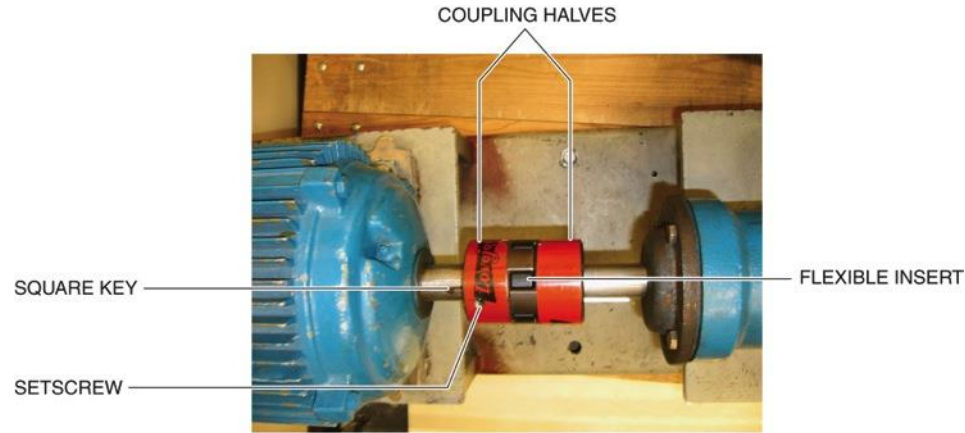
- Motors are tested for grounded windings, open circuits, shorts, and reverses.
- Before testing or troubleshooting a motor, the power must be disconnected and proper lockout/tagout procedures followed.
- Special equipment can be used for sophisticated motor insulation tests, such as that shown here.



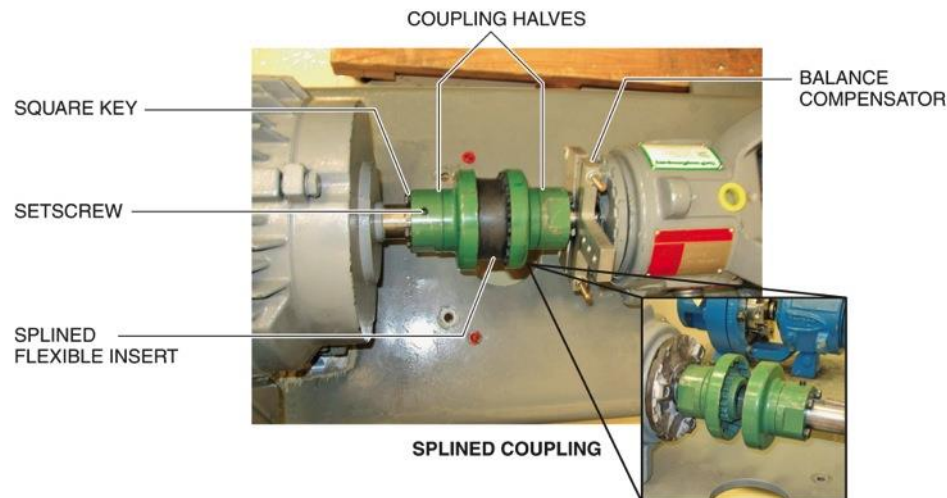
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8.0.0 – 8.5.0

Motor Installation and Commissioning Guidelines



JAW COUPLING



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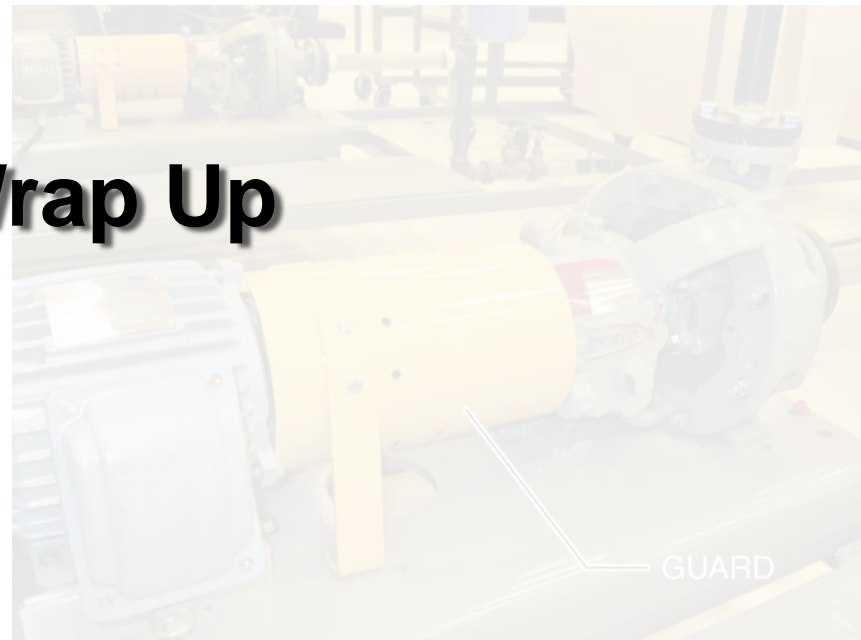


8.0.0 – 8.5.0

Next Session... Typical Coupling Guard Over Rotating Components

- Before starting a motor for the first time, check for proper installation and motor rotation. Verify that all coupling guards and protective devices are installed.
- After proper alignment is verified, doweling can be used to maintain the correct motor position should motor removal be required.

Wrap Up



26410-14_F22.EPS

Wrap Up

3-2-1

- 3 – Write 3 important things learned during class
- 2 – Write 2 questions you have about the material
- 1 – Write 1 thought you had about the material



Next Session...

MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.

