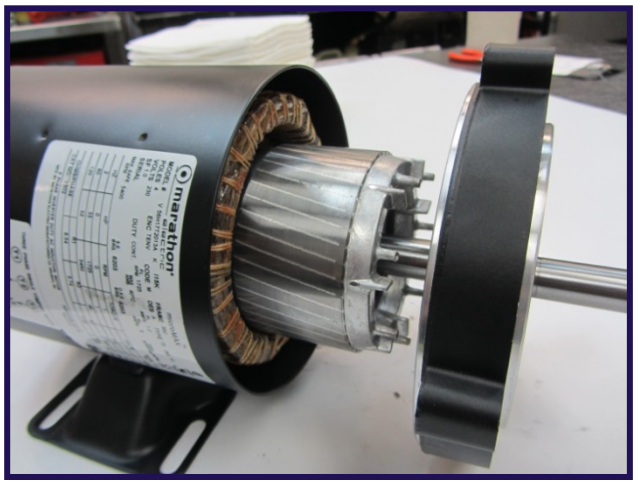
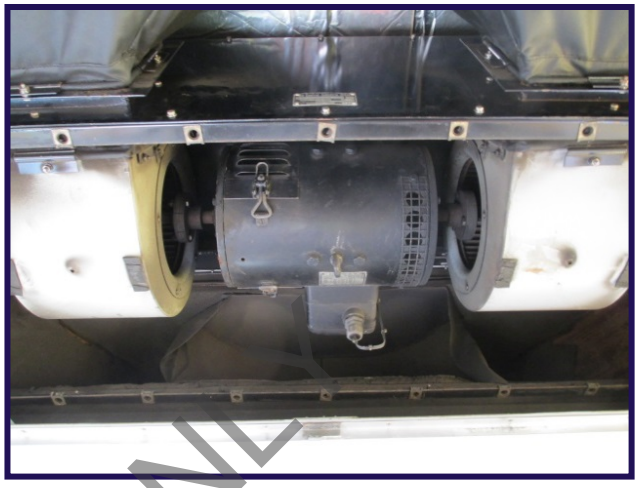




Course 206

HVAC Systems Inspection and Maintenance

Module 1: Motors

INSTRUCTOR GUIDE

RAIL CAR TRAINING CONSORTIUM

Table of Contents

Slide 3

INSTRUCTIONAL ACTIVITY: List objectives for Module 1

TIME: 1 minute

INSTRUCTION METHOD: Lecture

SAY: Module 1 has 5 learning objectives. Each is animated in the slide. Read each objective to participants then mouse-click to the next.

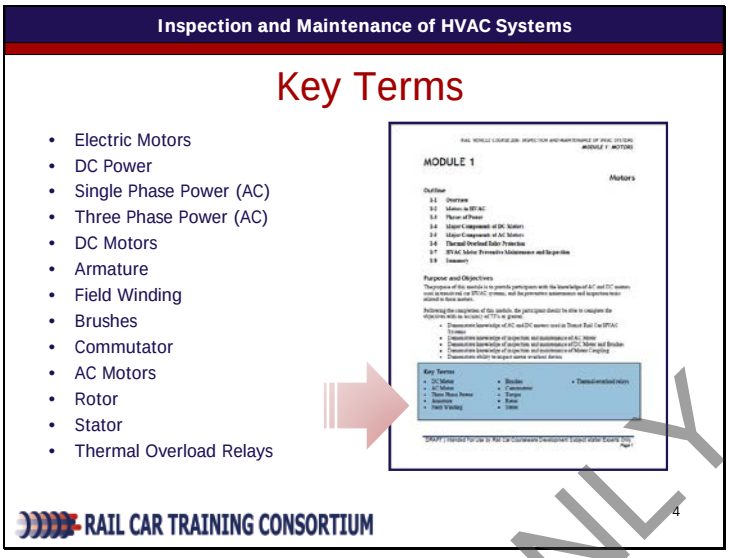
DO: Read (or ask for a volunteer to read) each objective. **Click on mouse to advance to next objective.**

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: __

ADVANCE SLIDE

Instructor Notes

Slide 4



INSTRUCTIONAL ACTIVITY: List objectives for Module 1

TIME: 2 minutes

INSTRUCTION METHOD: Lecture with discussion

SAY: This module contains several key terms. They are listed on the bottom of the Page __ in the Participant Guide. Some you may know and some you may not know. I am going to pull up the list of each key term. As I do so, make a note of which term you would like to know more about by circling that in your Participant Guide.

DO: Read each key term. **Click on mouse to advance to next term.**

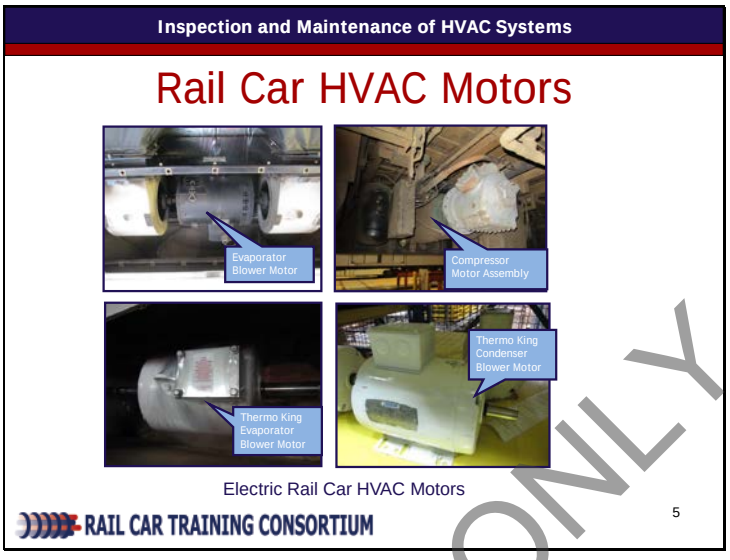
PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: __

ADVANCE SLIDE

Instructor Notes

Motors in HVAC

Slide 5



INSTRUCTIONAL ACTIVITY: Overview of HVAC Motors in transit rail

TIME: 5 minutes

INSTRUCTION METHOD: Lecture

SAY: Electric motors are used to turn the prime movers of air, water, and refrigerant, which are the fans, pumps, and compressors. These motors provide the speed, torque, and horsepower necessary to operate the application. The motor changes one form of energy (electrical) to rotational or linear motion (mechanical).
AC and DC motors are the two major types in use today that are related to the industrial HVAC applications. In rail car HVAC units, AC motors are generally used in newer equipment. Some systems have retrofitted their motors from DC to AC in recent years. To understand the differences of AC and DC motors, it is important to first review different phases of power.

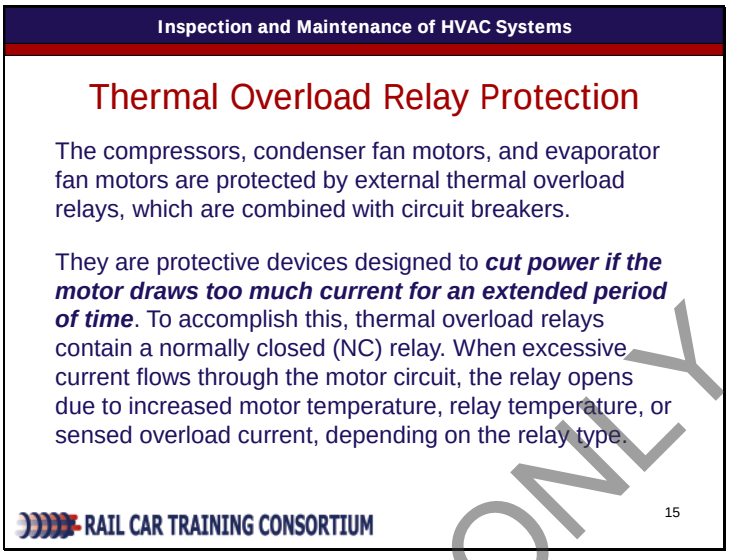
PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: __

ADVANCE SLIDE

Instructor Notes

Thermal Overload Relay Protection

Slide 15



INSTRUCTIONAL ACTIVITY: Explain definition and function of Thermal Overload Relay Protection

TIME: 2 minutes

INSTRUCTION METHOD: Lecture

SAY: Thermal overload relays are similar to circuit breakers in construction and use, but most circuit breakers differ in that they interrupt the circuit if overload occurs even for an instant. Thermal overload relays are conversely designed to measure a motor's heating profile; therefore, overload must occur for an extended period before the circuit is interrupted.

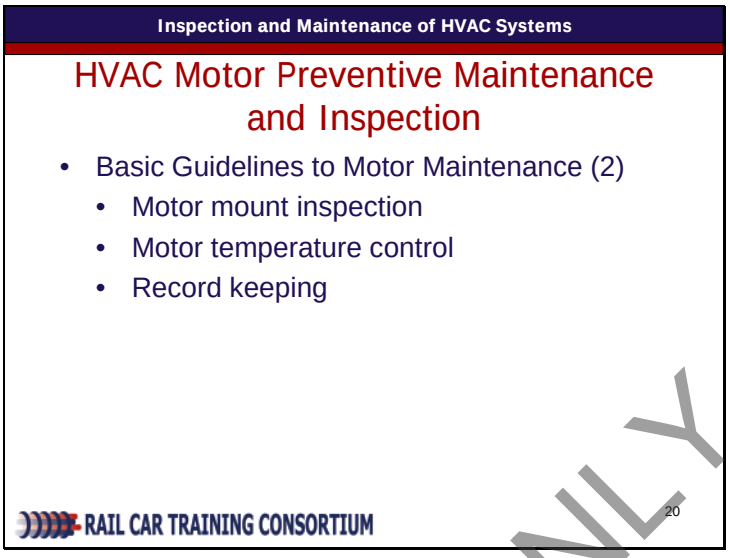
PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: __

Other Tools/Media/Materials: Bring a property specific Thermal Overload Relay Protection and explain its mechanism.

ADVANCE SLIDE

Instructor Notes

Slide 20



INSTRUCTIONAL ACTIVITY: Explain Motor PM and Inspection Procedures

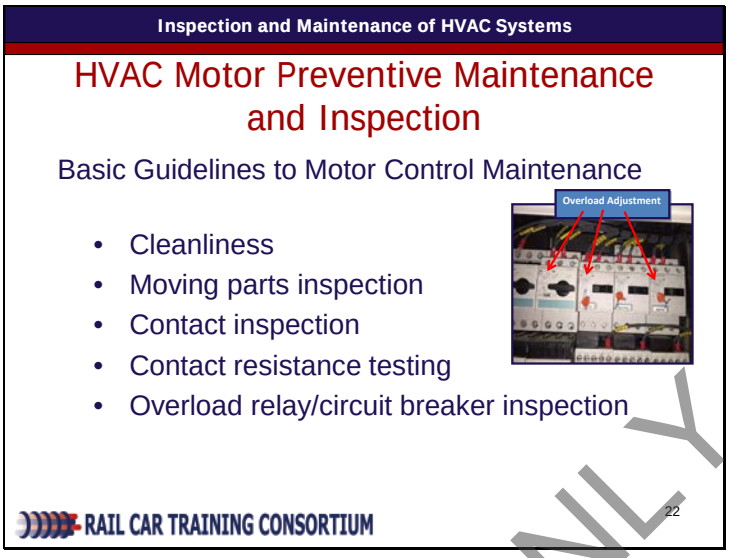
TIME: 5 minutes

INSTRUCTION METHOD: Lecture with hands-on demonstration in lab or during field trip

SAY: Motor mount inspection. Check mounting bolts, steel base plates for possible warping.
Annually, perform vibration-analysis tests. Excessive vibration may be hard to detect by hand, but it could be enough to shorten motor life significantly. It can cause bearing failure, metal fatigue of parts, or failure of windings. The cause of vibration is usually mechanical in nature, such as excessive belt tension, defective sleeve or ball bearings, misalignment, or improper balance. The most common cause is the unbalance of a rotating member (the motor rotor, rotating load, or other drive train component). Electrical problems also can cause vibration. Simple testing of the motor is done by uncoupling the load and then running the motor and listening to the motor noise and feeling for the vibration.
Motor temperature control. Restricted ventilation will cause a motor to operate at a higher than desired temperature. Excessive ambient temperatures will shorten motor life.

Instructor Notes

Slide 22



INSTRUCTIONAL ACTIVITY: Explain Motor PM and Inspection Procedures

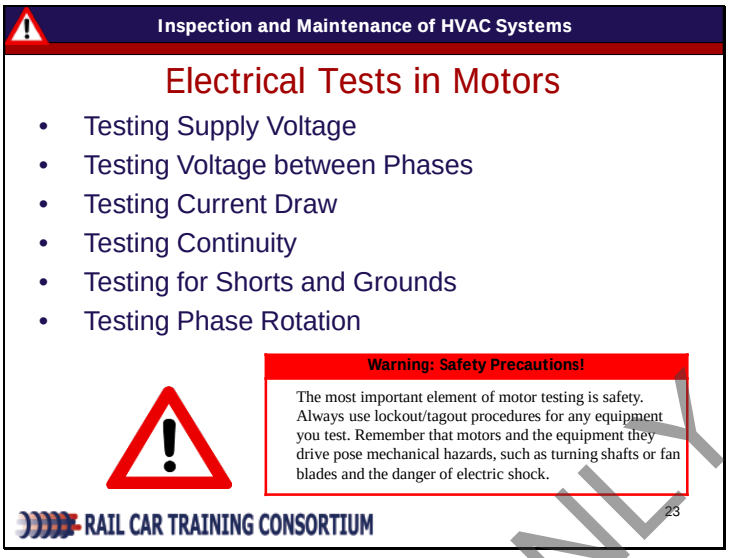
TIME: 10 minutes

INSTRUCTION METHOD: Lecture with hands-on demonstration in lab or during field trip

SAY: Follow these guidelines for inspecting and maintaining motor controls.
Cleanliness. Blow out dirt regularly according to the maintenance schedule. Make sure that dust or contamination is kept off high-voltage equipment. This is important because dust may contain conducting materials that could form unwanted circuit paths, resulting in current leakage or possible grounds or short circuits.
Moving parts inspection. Moving parts should operate easily without excessive friction. Check operation of contactors and relays by hand, feeling for any binding or sticking. Look for loose pins, bolts, or bearings. If the control is dirty, it should be wiped or blown clean.
Contact inspection. Check contacts for pitting and signs of overheating, such as discoloration of metal, charred insulation, or odor. Be sure contact pressure is adequate and the same on all poles; verify with manufacturer's specification. Watch for frayed flexible leads.
Contact resistance testing. On essential controls, perform contact-resistance tests with a low-resistance ohmmeter on a regular basis. Proper contact resistance should be

Instructor Notes

Slide 23



INSTRUCTIONAL ACTIVITY: Explain Motor PM and Inspection Procedures

TIME: 10 minutes

INSTRUCTION METHOD: Lecture with hands-on demonstration in lab or during field trip

SAY: After performing mechanical tests, such as visual inspection, as well as inspections for free rotation and proper alignment, the following electrical tests should be performed. Because most electrical tests require a live circuit, it may be necessary to remove the lockout/tagout devices. Exercise caution when performing electrical tests, and reinstall lockout/tagout devices as soon as possible.

Testing Supply Voltage: First determine the proper voltage required to operate the motor. The most accurate source for motor voltage information is generally the nameplate. Once the proper voltage has been determined, use a voltmeter to check the voltage potential (between all three legs for AC motors). If there is no voltage or incorrect voltage, check the supply circuit.

Testing Voltage between Phases: When disassembled, a motor that has an unbalanced system will have a noticeably darker stator winding on one or two phases. To test for a voltage imbalance, check the voltage between all legs while the motor is running.

Instructor Notes