

PREVIEW ONLY

Course 206

HVAC Systems
Inspection and Maintenance

Module 1:
Motors

INSTRUCTOR GUIDE

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PREVIEW ONLY

Slide 3

Inspection and Maintenance of HVAC Systems

Objectives

- Demonstrate knowledge of AC and DC Motors used in Transit Rail Car HVAC Systems
- Demonstrate knowledge of inspection and maintenance of AC Motors
- Demonstrate knowledge of inspection and maintenance of DC Motor and Brushes
- Demonstrate knowledge of inspection and maintenance of Motor Couplings
- Demonstrate ability to inspect Motor Overload Devices

 RAIL CAR TRAINING CONSORTIUM 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 |
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Slide 4

Inspection and Maintenance of HVAC Systems

Key Terms

- Electric Motors
- DC Power
- Single Phase Power (AC)
- Three Phase Power (AC)
- DC Motors
- Armature
- Field Winding
- Brushes
- Commutator
- AC Motors
- Rotor
- Stator
- Thermal Overload Relays

MODULE 1

Motors

Outline

- 1.1 Overview
- 1.2 Motor is DFMAC
- 1.3 Three-Phase
- 1.4 Motor Components of DC Motor
- 1.5 Motor Components of AC Motor
- 1.6 Thermal Overload Relay Function
- 1.7 Motor Motor Protection Maintenance and Repairs
- 1.8 Summary

Purpose and Objectives

Participants of this module to provide participants with the knowledge of AC and DC motors and components of DC and AC motors and the purpose and maintenance of DC and AC motors.

Learning Objectives

At the end of this module, the participant should be able to complete the following tasks in accordance with the given:

- Describe the construction of DC and AC motors and the Three-Phase Power
- Describe the construction of AC motor and maintenance of AC Motor
- Describe the construction of AC motor and maintenance of DC, Motor and Brush
- Describe the construction of AC motor and maintenance of Three-Phase Power

Key Terms

| | | |
|---------------------|-----------------|--------------------------|
| • DC Motor | • Stator | • Thermal Overload Relay |
| • AC Motor | • Commutator | |
| • Three-Phase Power | • Rotor | |
| • Armature | • Field Winding | |
| • Field Winding | • Motor | |

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.**

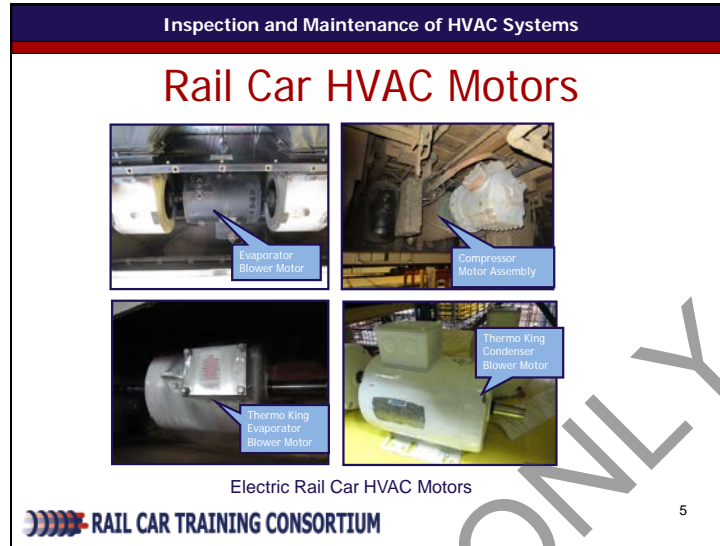
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Motors in HVAC

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.

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Thermal Overload Relay Protection


Slide 15

Inspection and Maintenance of HVAC Systems

Thermal Overload Relay Protection

The compressors, condenser fan motors, and evaporator fan motors are protected by external thermal overload relays, which are combined with circuit breakers.

They are protective devices designed to **cut power if the motor draws too much current for an extended period of time**. To accomplish this, thermal overload relays contain a normally closed (NC) relay. When excessive current flows through the motor circuit, the relay opens due to increased motor temperature, relay temperature, or sensed overload current, depending on the relay type.


RAIL CAR TRAINING CONSORTIUM
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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


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Slide 20

Inspection and Maintenance of HVAC Systems

HVAC Motor Preventive Maintenance and Inspection

- Basic Guidelines to Motor Maintenance (2)
 - Motor mount inspection
 - Motor temperature control
 - Record keeping

 RAIL CAR TRAINING CONSORTIUM 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.

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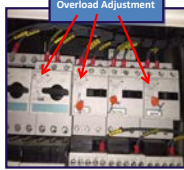
Slide 22

Inspection and Maintenance of HVAC Systems


HVAC Motor Preventive Maintenance and Inspection

Basic Guidelines to Motor Control Maintenance

- Cleanliness
- Moving parts inspection
- Contact inspection
- Contact resistance testing
- Overload relay/circuit breaker inspection



Overload Adjustment



RAIL CAR TRAINING CONSORTIUM

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

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Slide 23

Inspection and Maintenance of HVAC Systems

Electrical Tests in Motors

- Testing Supply Voltage
- Testing Voltage between Phases
- Testing Current Draw
- Testing Continuity
- Testing for Shorts and Grounds
- Testing Phase Rotation

Warning: Safety Precautions!

The most important element of motor testing is safety. Always use lockout/tagout procedures for any equipment you test. Remember that motors and the equipment they drive pose mechanical hazards, such as turning shafts or fan blades and the danger of electric shock.

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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.

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