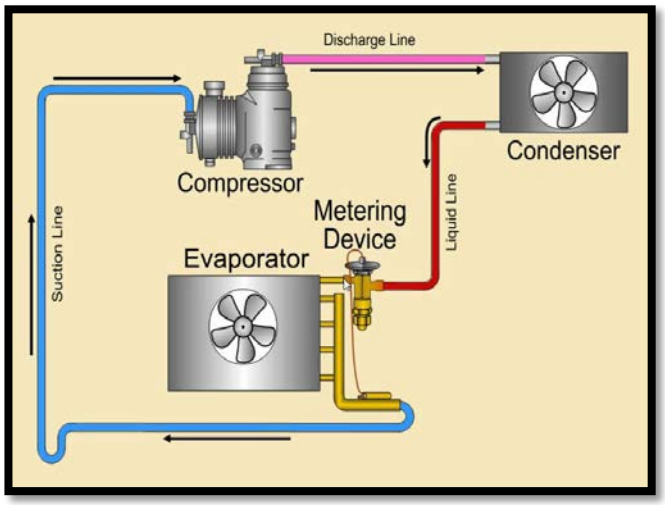


Course 106

HVAC Systems
Introduction and Overview

Module 2:
Background Knowledge

INSTRUCTOR GUIDE

RAIL CAR TRAINING CONSORTIUM

Table of Contents

Best Practices for Delivering Training

1. Read through this entire Instructor Guide. Make your own notes as necessary.
2. Pre-view the PowerPoint presentation that comes with this course. Practice what you will say and do during each slide. Note ways in which you will customize how each slide will be delivered. For example, you may have comments to add, additional take-aways or other ways you can enhance learning.
3. Make sure that embedded links to videos work.
4. Arrive early on class day. Give yourself plenty of time to get organized.
5. Circulate the Attendance Sign-in Sheet each day. Be sure all participants sign-in.
6. Start on time and stay on track. Always start on time, even if only one participant is in the room. Keep exercises within their time limits.
7. End discussions when they cease to be productive. Lead participants away from digressions and tangents and back to the lesson.
8. Be available for questions during breaks, after class, and during lab or hands-on activities.
9. Mentor participants during the activities. Walk among groups in class and during labs as they work on their activities, and answer questions and offer guidance as appropriate. Ensure participants are on track as they work. Give constructive feedback during the presentations and discussions.
10. Review Questions: Review the content of each lesson throughout the course to reinforce the learning outcomes for that lesson and to connect to upcoming material. Avoid YES or NO questions and try to use open-ended questions to draw participants into the material. Sample review questions are available in the Instructor's guide; however, you can also develop additional questions, as appropriate. Make sure all questions directly relate to and support the learning outcomes.
11. Learning Objectives: At the beginning of each lesson, review that lesson's outcomes. Make sure participants are fully aware of the topics to be addressed in the lesson. At the end of each lesson, review the outcomes once again using review questions or an activity/exercise to ensure the outcomes were met.

Overview to Module 2

- Duration of this module: 240 minutes (4 hours including field trip)
- PowerPoint slides: 56
- This module has a quiz.

Videos, Handouts, Job Aids, Take-aways

Links to three (3) videos is made available to enhance participants' learning:

- ✓ Video – Refrigeration Cycle by Michael Glover
- ✓ Video – How Air Conditioning Works Animation by Mike Ermann (Optional)
- ✓ Video – Importance of Capillary Action in Brazing by Lucas-Milhaupt.

The Instructor should bring the following materials/equipment if applicable:

- ✓ Thermal switch/fuse/fusible link or circuit breaker from your property

Outline of PowerPoint Presentation

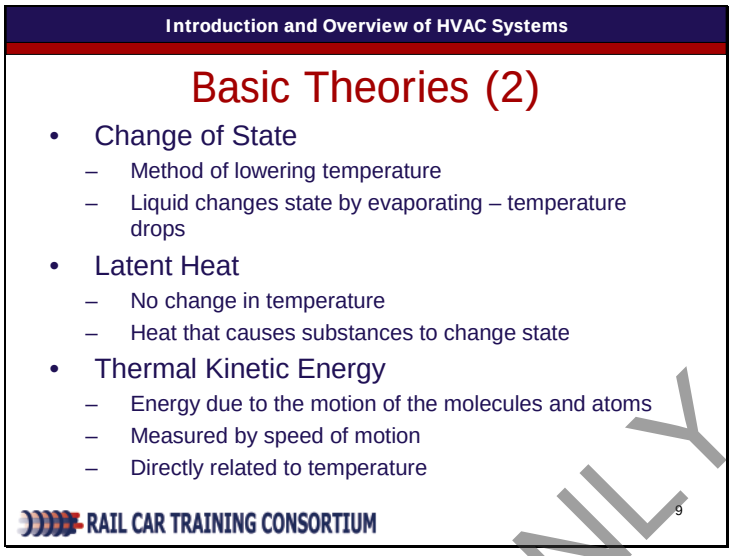
Topic Title	Slides	Duration (Minutes)
Overview	1-5	10
Basic Theories of Heat	6-14	40
Refrigeration and Air-conditioning	15-25	65
Heating System	26-39	25
HVAC Piping and Tubing	40-53	25
Field Trip	54	60
Summary and Quiz	55-56	15
		240 minutes (4 hours including Field Trip)

Learning Objectives for Module 2

Following the completion of this module, the rail car technician should be able to:

- Demonstrate knowledge of the basic theories of heat
- Describe the basic concepts of refrigeration and air conditioning
- Describe the basic components and basic concepts of a typical heating system
- Demonstrate basic knowledge of HVAC piping and tubing

Slide 9



INSTRUCTIONAL EVENT: Present the content

TIME: 2 minutes

SAY: Change of state is another method of lowering temperature. It occurs when water or some other liquid changes state by evaporating, causing the temperature to drop.

Latent heat is heat that causes a change in state with no change in temperature. Latent heat is the addition or removal of heat that causes substances to change states. For example, solids can become liquids (ice to water) and liquids can become gases (water to vapor). However, because the heat causes the change in state, the substance remains at the same temperature.

Thermal Kinetic Energy is energy due to the motion of molecules and atoms. It is measured by the speed of motion of these particles and is directly related to temperature.

DO: Review slide

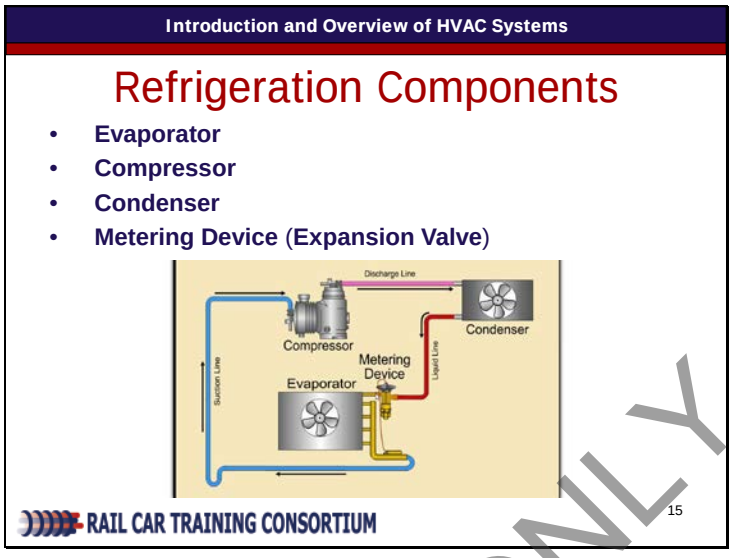
PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes

Refrigeration and Air-conditioning

Slide 15



INSTRUCTIONAL EVENT: Present the content

TIME: 2 minutes

SAY: Air conditioners use refrigeration to cool indoor air. Refrigeration is the process of cooling or lowering the temperature of a space or a substance to a level below that of the surrounding area. First, air conditioners use one of basic laws of thermodynamics which is that when a liquid converts to gas it absorbs heat. As mentioned earlier, this process is called change of state or phase conversion. Second, in the unit's closed system of coils refrigerants evaporate and condense over and over again. The AC unit fans move warm interior air over these cold, refrigerant-filled coils. When hot air flows over the cold coils, the refrigerant insides absorbs heat as it changes from a liquid to a gaseous state. Third, the AC unit converts the refrigerant gas back to a liquid again. There are four main components in the refrigeration process: Evaporator, Compressor, Condenser, and Metering Device (Expansion Valve).

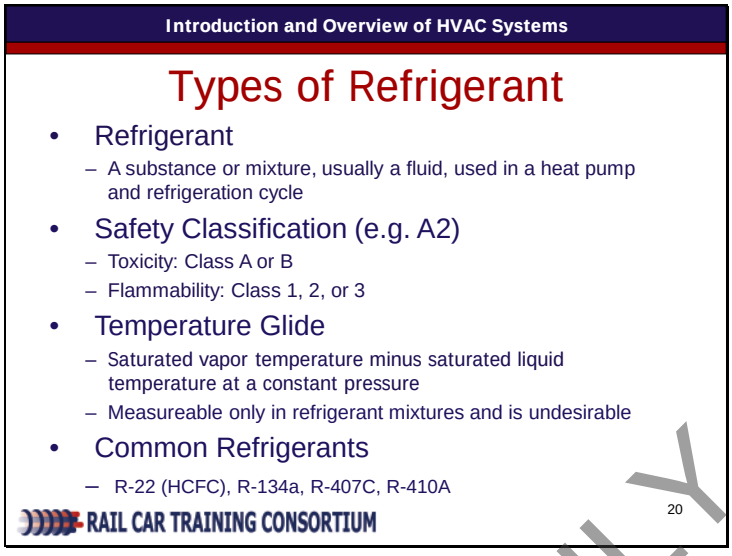
DO: Review slide

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes

Slide 20



INSTRUCTIONAL EVENT: Present the content

TIME: 5 minutes

SAY: A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle.
The safety classification of refrigerant consists of a letter and a number. The letter categorizes toxicities into Class A and B. The number categorizes the flammability into classes 1, 2, and 3. There are examples of the safety classifications of refrigerants in Figure 2.4.

To understand temperature glide, think back to when we discussed saturated temperature – the maximum temperature before a substance changes state. When a liquid passes this point, it begins to boil into a gas at the saturated liquid temperature. It finishes boiling at the saturated vapor temperature. Temperature glide is the difference between these two temperatures at constant pressure.
Temperature glide is only measurable in refrigerant mixtures and is undesirable.

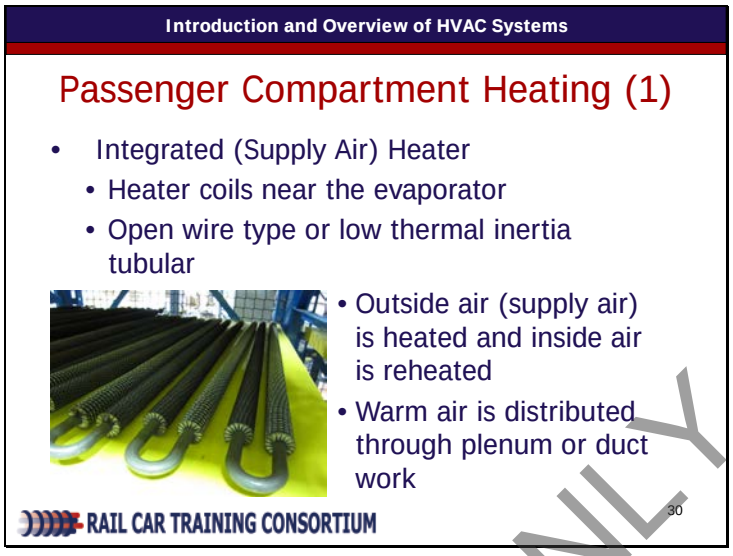
Examples of common refrigerants include refrigerants include R-22 (HCFC), R-134a, R-407C, R-410A, R-22 (HCFC), R-134a, R-407C, and R-410A

DO: Review slide.
PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: Coursebook

Instructor Notes

Slide 30



INSTRUCTIONAL EVENT: Present the Content

TIME: 1 minute

SAY: Rail vehicles typically use two methods to heat the passenger compartment. Some train HVAC units have supply air heaters, or coils near the evaporator (Figure 2.8 and Figure 2.9) that generate heat. Open wire type or low thermal inertia tubular type heater elements are generally used to minimize high temperature overshoots when power is interrupted suddenly. Outside air - the supply air - is heated and inside air is reheated, then distributed throughout the car body via the plenum or duct work.

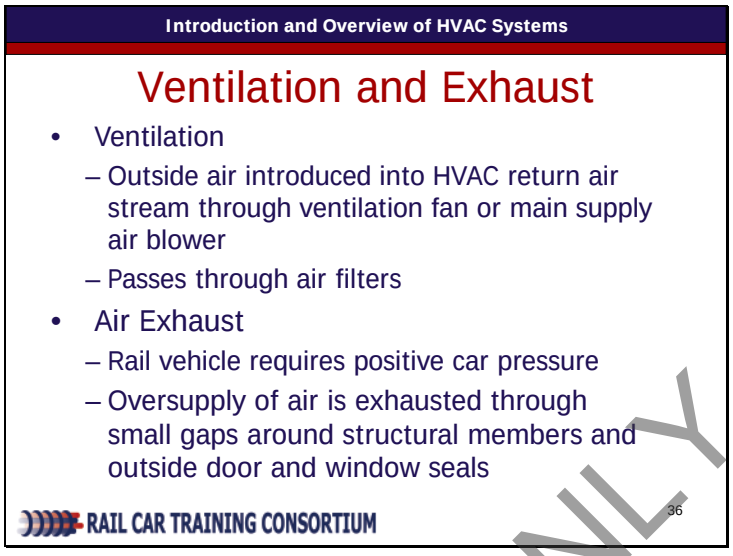
DO: Review slide.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: Coursebook

Instructor Notes

Slide 36



INSTRUCTIONAL EVENT: Present the Content

TIME: 1 minute

SAY: Outside air is introduced into a rail passenger vehicle's HVAC system return air stream by means of a separate ventilation fan or is drawn into the return air stream by the HVAC system's main supply air blower. The outside air passes through separate outside air filters or combined outside/recirculated air filters prior to entering the HVAC system cooling, dehumidification, and heating apparatus.

Most rail transit vehicles are required to have a positive pressure passenger compartment. The oversupply of air is a result of the introduction of outside ventilation; fresh air. It is normally exhausted through small gaps around structural members and outside door and window seals.

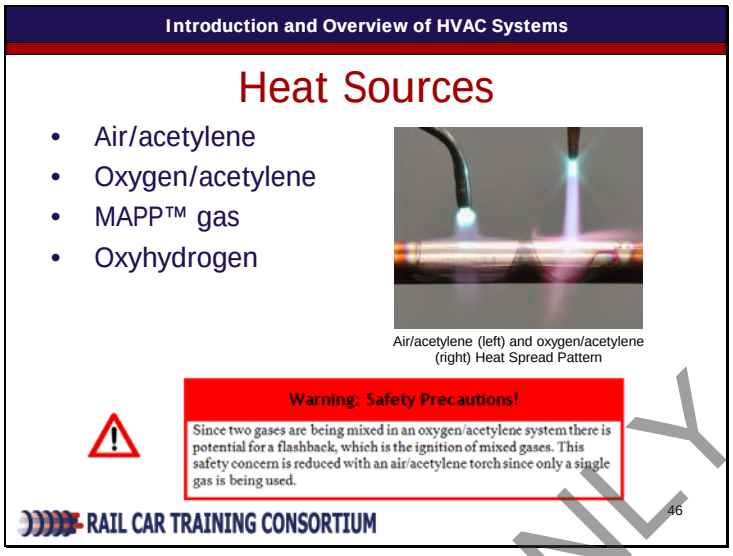
DO: Review slide.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes

Slide 46



INSTRUCTIONAL EVENT: Present the Content

TIME: 2 minutes

SAY: The most common torches used in brazing are Air/acetylene and Oxygen/acetylene. MAPP gas can also be used, but generally does not burn as hot as acetylene torches. Oxyhydrogen torches are less common because they are expensive, but heat metal quickly.

The flame of an oxygen/acetylene torch has a higher temperature and is highly focused, so the torch must be kept in motion to distribute heat evenly. Due to the temperature, the torch should be kept further away from the metals. Additionally, the chemical reaction poses the risk of flashback.

Air/acetylene torches burn at a lower temperature and have a broader flame.

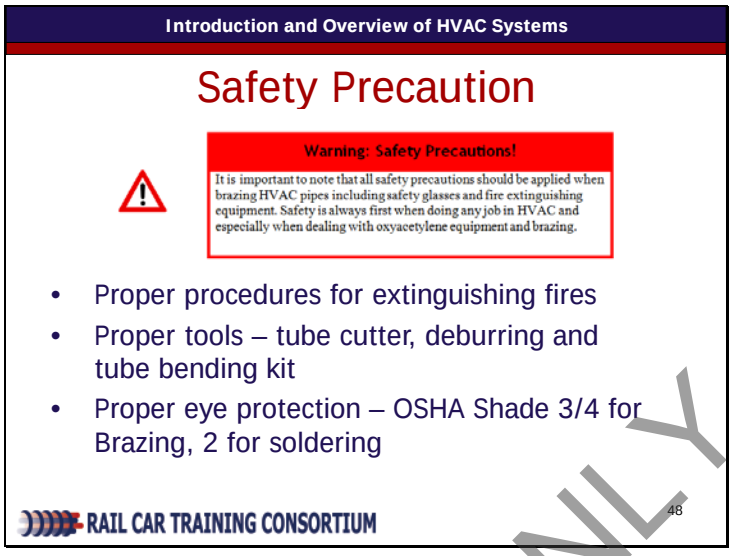
DO: Review slide.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes

Slide 48



INSTRUCTIONAL EVENT: Present the Content

TIME: 1 minute

SAY: Always follow proper safety procedures. Before brazing, check the procedures for extinguishing flames, directions on how to use equipment, and wear proper eye protection.

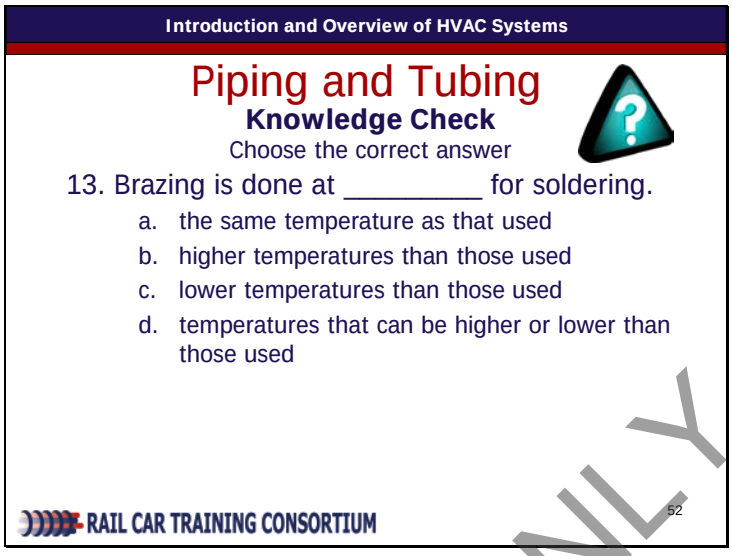
DO: Review slide.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes

Slide 52



INSTRUCTIONAL EVENT: Elicit Performance (Application/Feedback 2).

TIME: 2 minutes

SAY: Here's the Knowledge Check. What do you think the answer is?
This should be easily answered by all participants. When they decide on the answer, advance the slide to reveal the correct answer.
Answer: b. higher temperatures than those used

DO: Review slide.

PARTICIPANT GUIDE (COURSEBOOK) PAGE REFERENCE: _____

Other Tools/Media/Materials: N/A

Instructor Notes