Universal Heat Pump Training Curriculum Map

MassCEC Heat Pump & HVAC Training Network

Project:	MassCEC Heat Pump & HVAC Training Network
Contractor:	Technical Education Products, Inc.
Document Type:	Universal Heat Pump Training Curriculum Map
eLearning Source:	Amatrol eLearning Library

Curriculum Overview

This curriculum map provides a comprehensive overview of the MassCEC Heat Pump & HVAC Training Network universal heat pump curriculum. Each module includes eLearning objectives (knowledge-based content delivered through direct or self-paced instruction) and associated hands-on lab activities where applicable.

This curriculum is designed as a turn-key yet flexible resource. Programs may adapt this structure based on available time, equipment configurations, and student needs.

Note: This curriculum is supported by two primary hands-on resources that align with the curriculum modules. The first is an equipment-agnostic lab toolkit, available to instructors outside of the Amatrol platform, which covers the hands-on skills in an equipment-neutral format. Rather than referencing specific brands or model numbers, it uses general equipment categories so any program can adapt the labs to its available training systems, field equipment, or component kits. The second is the set of Amatrol lab activity PDFs, which will be made available to all participating colleges and provide step-by-step procedures designed to align with Amatrol's industrial training equipment. Together with the Amatrol eLearning curriculum modules, these PDFs also contain diagrams, charts, and detailed visuals that serve as valuable references for instructors. When developing equipment-specific activities tailored to their lab, instructors are encouraged to review both resources for guidance on component identification, system layouts, and procedural illustrations.

40-Hour Pathway
The 40-Hour Pathway presents a suggested structure for programs targeting the standard 40-hour benchmark. It includes all eLearning content across Modules 1–20, foundational hands-on labs (Modules 1–11, 15–18), and component testing and troubleshooting modules (12, 14, 19, 20) delivered as instructor-led demonstrations with student observation and assistance.

Extended Practice
Extended Practice labs provide additional hands-on opportunities for programs with time beyond 40 hours, incumbent worker upskilling, individual student development, and institutions with fault insertion equipment or equivalent diagnostic training capabilities.

Supplemental Theory
Modules designated as Supplemental Theory (Modules 6 and 13) provide eLearning content that deepens understanding of heat pump control systems and emerging technology. These modules do not have associated hands-on labs.

Geothermal Heat Pump Systems (Instructor-Led, Introduced as Needed)
Modules 21–24 cover geothermal heat pump systems and are included as instructor-led supplemental content to be introduced as needed based on program focus and regional relevance. These modules provide eLearning theory and do not have associated labs in this toolkit. However, optional hands-on labs are available through the Amatrol eLearning platform for programs that have access to geothermal training equipment. Instructors may incorporate this content at their discretion to provide students with a foundational understanding of geothermal technology.

Timing Summary

Component	Estimated Time
Core eLearning / Direct Instruction (Modules 1–20)	760–1,060 min (~13–18 hrs.)
40-Hour Pathway Labs	810–1,120 min (~14–19 hrs.)
Extended Practice Labs	805–1,030 min (~14–18 hrs.)
Geothermal eLearning (Modules 21–24, Instructor-Led)	350–410 min (~6–7 hrs.)
40-Hour Pathway Total (eLearning + Pathway Labs)	**~27–37 hrs.**
Full Curriculum Total (with Extended Practice)	**~40–54 hrs.**

Curriculum Structure

Modules 1–14: Refrigerant fundamentals, ducted/forced-air heat pump systems, and supplemental theory

Modules 15–20: Ductless mini-split heat pump systems

Modules 21–24: Geothermal heat pump systems (instructor-led, introduced as needed)

Lab Designations

Designation	Description
40-Hour Pathway	Foundational labs included in the suggested 40-hour structure
Extended Practice	Additional hands-on practice for programs with extended time or upskilling focus
Instructor-Led Demo / Extended Practice	Component testing and troubleshooting labs (Modules 12, 14, 19, 20) delivered as instructor-led demonstrations during the 40-hour pathway, available as independent practice for extended programs
Supplemental Theory	eLearning-only modules providing additional theoretical depth (no associated labs)
A2L Content	Labs specific to A2L refrigerant systems (R-454B)
Geothermal	Instructor-led supplemental eLearning content introduced as needed; optional Amatrol labs available for programs with geothermal equipment

Prerequisites

Students should have EPA 608 certification (or work under direct supervision of a certified instructor) and understand basic circuit theory and multimeter operation prior to beginning this curriculum.

Extended Curriculum Resources

Colleges using the Amatrol curriculum modules will also have access to the broader Amatrol eLearning library, which extends well beyond the heat pump content covered in this map. The library includes foundational mechanical fabrication topics (such as fastener identification, hand tool use, and torque application), core AC/DC electrical theory (including circuit fundamentals, electrical measurement using a digital multimeter, series and parallel circuits, and circuit protection), and refrigeration installation craft (including copper tubing selection and routing, brazing and soldering, leak testing, line insulation, and basic wiring techniques).

This broader library covers core fundamentals of the HVAC trade, including practical skills like proper torque wrench use, accurate DMM measurement, and copper brazing. Having this content available allows schools to adapt their instructional models to their student population and program structure, maximizing the outcomes of the 40-hour pathway.

Course Outline

The following table lists all 24 modules in sequence with estimated eLearning time. Detailed objectives and lab activities for each module follow.

#	Module	eLearning
1	Refrigerant Fundamentals	50–65 min
2	Introduction to HVACR Refrigeration Circuit Installation	30–45 min
3	Introduction to Residential Heat Pump Systems	45–60 min
4	Leak Detection	30–45 min
5	Heat Pump System Wiring	25–40 min
6	Heat Pump Control Circuits	25–40 min
7	Refrigerant Recovery Preparation	30–45 min
8	Refrigerant Recovery and Recycling	50–65 min
9	Refrigerant System Charging	25–40 min
10	Heat Pump Thermostat Operation	25–40 min
11	Pressure and Temperature Measurements	40–55 min
12	Heat Pump Component Tests	60–75 min
13	Electronic Expansion Valves	25–40 min
14	Troubleshooting Residential Heat Pump Systems	60–75 min
15	Introduction to Residential Mini-Split Heat Pumps	55–70 min
16	Mini-Split Heat Pump Operation	25–40 min
17	Mini-Split System Recovery and Charging	40–55 min
18	Mini-Split Pressure and Temperature Measurements	35–50 min
19	Mini-Split Heat Pump Component Tests	60–75 min
20	Troubleshooting Residential Mini-Split Heat Pump Systems	25–40 min
21	Introduction to Geothermal Heat Pump Systems	85–100 min
22	Geothermal Closed-Loop Source Circuit Operation	100–115 min
23	Geothermal Heat Pump Control and Operation	80–95 min
24	Geothermal Heat Pump Performance	85–100 min

Module 1: Refrigerant Fundamentals

Module Overview

Introduces students to refrigerant properties, types, environmental regulations, blends, temperature glide, fractionation, and pressure-temperature relationships. This module provides the foundational refrigerant knowledge required for all subsequent modules.

eLearning Objectives (Direct Instruction)

Estimated Time: 50–65 minutes

Upon completion of the eLearning content, students will be able to:

1. Define Refrigerant
2. Describe the Properties of Refrigerants
3. Describe the Common Types of Refrigerants and Their Applications
4. Describe the Impact of Environmental Regulations on Refrigerant Use
5. Describe the Types of Refrigerant Blends and Their Applications
6. Define Temperature Glide and Fractionation and Explain Their Importance
7. Describe How to Use a Refrigerant Pressure-Temperature Chart

Classroom Activity

Use a Refrigerant Pressure-Temperature Chart *(10–15 min)*

Students practice using printed or digital P-T charts to determine saturation temperatures and pressures for common refrigerants.

Module 2: Introduction to HVACR Refrigeration Circuit Installation

Module Overview

Introduces students to refrigerant circuit diagrams, system components, and the tools required for HVACR installation. Students learn to interpret manufacturer documentation and identify connection points for refrigerant piping.

eLearning Objectives (Direct Instruction)

Estimated Time: 30–45 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Purpose of a Refrigerant Circuit
2. Describe Refrigerant Circuit Components
3. Describe Tools and Supplies Required for Installation of a Refrigeration System
4. Describe How to Interpret HVACR Refrigerant Circuit Diagrams

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Interpret HVACR Refrigerant Circuit Diagrams	25–35 min	40-Hour Pathway

Module 3: Introduction to Residential Heat Pump Systems

Module Overview

Covers the fundamentals of mechanical refrigeration and heat pump operation. Students learn to identify components of forced air residential heat pump systems and perform safe startup/shutdown procedures.

eLearning Objectives (Direct Instruction)

Estimated Time: 45–60 minutes

Upon completion of the eLearning content, students will be able to:

1. Define Mechanical Refrigeration and Explain Its Importance
2. Describe the Basic Operation of a Mechanical Refrigeration System
3. Describe the Basic Operation of a Heat Pump System
4. Describe the Basic Operation of a Forced-Air Residential Heat Pump System
5. Describe Refrigeration System Safety

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Identify the Components of a Forced-Air Residential Heat Pump System	25–35 min	40-Hour Pathway
2	Start Up and Shut Down a Forced-Air Residential Heat Pump System	25–35 min	40-Hour Pathway

Module 4: Leak Detection

Module Overview

Covers multiple methods for detecting refrigerant leaks including visual inspection, dye detection, gas pressurization, electronic sniffers, ultrasonic detection, and soap bubble testing.

eLearning Objectives (Direct Instruction)

Estimated Time: 30–45 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Use a Visual Inspection to Detect Leaks in a Refrigerant System
2. Describe How to Use a Dye Leak Detector to Check for Refrigerant System Leaks
3. Describe How to Use Gas Pressurization to Check for Refrigerant System Leaks
4. Describe the Basic Operation of a Refrigerant Sniffer
5. Describe the Basic Operation of an Ultrasonic Leak Detector
6. Describe How to Use Leak Detector Bubble Solution to Check for Refrigerant System Leaks

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Use Soap Bubble Solution to Check for Refrigerant System Leaks	20–30 min	40-Hour Pathway

Module 5: Heat Pump System Wiring

Module Overview

Covers the electrical circuits of heat pump systems including control transformers, thermostats, motor contactors, and reversing valves. Students learn to wire and verify heat pump control systems.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Electrical Circuit of a Heat Pump System
2. Describe How to Wire a Control Transformer
3. Describe How to Wire an Electronic Heat Pump Thermostat
4. Describe How to Wire a Motor Contactor
5. Describe How to Wire a Reversing Valve
6. Describe How to Verify the Wiring of a Heat Pump System

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Wire a Control Transformer	30–40 min	40-Hour Pathway
2	Wire an Electronic Heat Pump Thermostat	30–40 min	40-Hour Pathway
3	Wire a Motor Contactor	25–35 min	40-Hour Pathway
4	Wire a Reversing Valve	25–35 min	40-Hour Pathway
5	Verify the Wiring of a Heat Pump System	30–40 min	40-Hour Pathway

Module 6: Heat Pump Control Circuits

SUPPLEMENTAL THEORY: This module provides eLearning content only and does not have associated hands-on labs.

Module Overview

Covers reversing valve operation and testing, heat pump control circuit operation, and control circuit troubleshooting procedures. This module provides supplemental theory to deepen understanding of heat pump control systems introduced in Module 5.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Operation of a Reversing Valve
2. Describe How to Connect and Test a Reversing Valve
3. Describe the Operation of a Heat Pump Control Circuit
4. Describe How to Troubleshoot a Heat Pump Control Circuit

This module does not have associated hands-on labs.

Module 7: Refrigerant Recovery Preparation

EPA 608 Certification: Labs in this module involve refrigerant handling. Students should hold EPA Section 608 certification or work under direct supervision of a certified instructor.

Module Overview

Covers EPA-required refrigerant recovery, recycling, and reclamation processes. Students learn proper refrigerant handling, service valve procedures, and recovery tank preparation.

eLearning Objectives (Direct Instruction)

Estimated Time: 30–45 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Refrigeration Recovery, Recycling, and Reclamation Process
2. Describe How to Determine Whether a Refrigerant Should Be Recovered, Recycled, or Reclaimed
3. Describe Refrigerant Handling and Storage Procedures
4. Describe How to Remove a Service Valve Core
5. Describe How to Prepare a Recovery Tank

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Remove a Schrader Valve Core from a Service Port	20–30 min	40-Hour Pathway
2	Prepare a Recovery Tank to Store Refrigerant	20–30 min	40-Hour Pathway

Module 8: Refrigerant Recovery and Recycling

> **EPA 608 Certification:** Labs in this module involve refrigerant handling. Students should hold EPA Section 608 certification or work under direct supervision of a certified instructor.

Module Overview

Covers active refrigerant recovery methods, system evacuation procedures using micron gauges, and techniques for returning recovered refrigerant to systems.

eLearning Objectives (Direct Instruction)

Estimated Time: 50–65 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe Two Methods for Refrigerant Recovery
2. Describe How to Perform Active Refrigerant Recovery
3. Describe How to Measure Refrigeration System Evacuation
4. Describe How to Evacuate a Refrigeration System
5. Describe Factors That Affect Returning Recovered Refrigerant to a System
6. Describe How to Return Recovered Refrigerant to a Refrigeration System

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Recover Refrigerant from a System	35–45 min	40-Hour Pathway
2	Use a Micron Gauge to Check System Evacuation Level	25–35 min	40-Hour Pathway
3	Charge a System with Recovered Refrigerant	30–40 min	40-Hour Pathway

Module 9: Refrigerant System Charging

EPA 608 Certification: Labs in this module involve refrigerant handling. Students should hold EPA Section 608 certification or work under direct supervision of a certified instructor.

Module Overview

Covers system charging methods including weigh-in, superheat, and subcooling techniques. Students learn to determine proper system charge using industry-standard methods.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Define Refrigeration System Charge and Explain Its Application
2. Describe How to Use the Weigh-in Method to Charge a Refrigeration System
3. Describe How to Use the Superheat Method to Determine Refrigeration System Charge
4. Describe How to Use the Subcooling Method to Determine Refrigeration System Charge

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Use the Weigh-In Method to Charge a System	30–40 min	40-Hour Pathway
2	Use the Subcooling Method to Verify System Charge	30–40 min	40-Hour Pathway

Module 10: Heat Pump Thermostat Operation

Module Overview

Covers electronic thermostat operation, wiring connections, and user interface settings. Students learn to adjust thermostat settings and operate heat pumps in heating and cooling modes.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Basic Operation of an Electronic Thermostat
2. Describe Electronic Thermostat Wiring Connections
3. Describe How to Adjust Thermostat Settings Using a User Interface
4. Describe How to Operate a Heat Pump in Heating and Cooling Modes

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Adjust Thermostat Settings Using a User Interface	20–30 min	40-Hour Pathway
2	Operate a Heat Pump in Heating and Cooling Modes	25–35 min	40-Hour Pathway

Module 11: Pressure and Temperature Measurements

A2L REFRIGERANT MODULE: This module includes content specific to A2L refrigerant systems (R-454B). A2L-compatible equipment and enhanced safety protocols are required.

Module Overview

Covers gauge manifold operation, pressure and temperature measurement techniques, and system diagnostics using superheat and subcooling calculations. Includes A2L refrigerant considerations.

eLearning Objectives (Direct Instruction)

Estimated Time: 40–55 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Operation of a Gauge Manifold Used to Measure Thermal System Pressure
2. Describe How to Connect a Gauge Manifold to Measure Thermal System Pressure
3. Describe How to Test for a Restriction or Blockage
4. Describe How to Measure Thermal System Temperatures
5. Define Superheat and Subcooling and Explain Their Importance
6. Describe How to Use Subcooling as a Method to Determine If a System Is Properly Charged

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Prepare the Gauge Manifold for Use	20–30 min	40-Hour Pathway
2	Use a Gauge Manifold to Measure System Pressures	25–35 min	40-Hour Pathway
3	Test for a Restriction or Blockage	30–40 min	40-Hour Pathway
4	Measure Thermal System Temperatures	25–35 min	40-Hour Pathway
5	Determine If a System Is Properly Charged Using Subcooling	25–35 min	40-Hour Pathway

Module 12: Heat Pump Component Tests

40-HOUR PATHWAY NOTE: Labs in this module are designated as Instructor-Led Demo / Extended Practice. For programs following the 40-hour pathway, this content is delivered as instructor-led demonstrations with student observation and assistance.

Module Overview

Covers diagnostic testing procedures for major heat pump components including compressors, TXVs, thermostats, reversing valves, blower motors, and defrost controls. In a 40-hour pathway, these are typically delivered as instructor-led demonstrations.

eLearning Objectives (Direct Instruction)

Estimated Time: 60–75 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Test a Compressor
2. Describe How to Test a Thermostatic Expansion Valve (TXV)
3. Describe How to Test an Electronic Thermostat
4. Describe How to Test a Reversing Valve
5. Describe How to Test an AC Blower and Outdoor Fan
6. Describe How to Test an ECM Blower
7. Describe How to Test a Defrost Control

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Test a Compressor	45–55 min	Instructor-Led Demo / Extended Practice
2	Test a Thermostatic Expansion Valve (TXV)	30–40 min	Instructor-Led Demo / Extended Practice
3	Test an Electronic Thermostat	35–45 min	Instructor-Led Demo / Extended Practice
4	Test a Reversing Valve	25–35 min	Instructor-Led Demo / Extended Practice
5	Test Blower Motors and Outdoor Fan	30–40 min	Instructor-Led Demo / Extended Practice
6	Test a Defrost Control	35–45 min	Instructor-Led Demo / Extended Practice

Module 13: Electronic Expansion Valves

SUPPLEMENTAL THEORY: This module provides eLearning content only and does not have associated hands-on labs.

Module Overview

Covers the operation of electronic expansion valves (EEVs), refrigeration system operation with EEVs, smart controller configuration, and monitoring EEV operation using smart controllers. This module provides supplemental theory on emerging technology used in modern heat pump systems.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Operation of an Electronic Expansion Valve
2. Describe the Basic Operation of a Refrigeration System with an Electronic Expansion Valve
3. Describe How to Configure a Smart Controller for Use with an EEV
4. Describe How to Monitor Electronic Expansion Valve Operation Using a Smart Controller

This module does not have associated hands-on labs.

Module 14: Troubleshooting Residential Heat Pump Systems

40-HOUR PATHWAY NOTE: Labs in this module are designated as Instructor-Led Demo / Extended Practice. For programs following the 40-hour pathway, this content is delivered as instructor-led demonstrations with student observation and assistance.

Module Overview

Covers systematic troubleshooting procedures for common heat pump problems including no cooling, insufficient cooling, no heating, insufficient heating, short cycling, and system cut-out. In a 40-hour pathway, these are typically delivered as instructor-led demonstrations.

eLearning Objectives (Direct Instruction)

Estimated Time: 60–75 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Troubleshoot No Cooling
2. Describe How to Troubleshoot Insufficient Cooling
3. Describe How to Troubleshoot No Heating
4. Describe How to Troubleshoot Insufficient Heating
5. Describe How to Troubleshoot Short Cycling
6. Describe How to Troubleshoot System Cut-Out

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Troubleshoot No Cooling	45–55 min	Instructor-Led Demo / Extended Practice
2	Troubleshoot Insufficient Cooling	35–45 min	Instructor-Led Demo / Extended Practice
3	Troubleshoot No Heating	40–50 min	Instructor-Led Demo / Extended Practice
4	Troubleshoot Insufficient Heating	35–45 min	Instructor-Led Demo / Extended Practice
5	Troubleshoot Short Cycling	40–50 min	Instructor-Led Demo / Extended Practice
6	Troubleshoot System Cut-Out	35–45 min	Instructor-Led Demo / Extended Practice

Module 15: Introduction to Residential Mini-Split Heat Pump Systems

Module Overview

Introduces mini-split heat pump technology including components, operation, and safety. Students learn to identify components and perform safe startup/shutdown procedures for ductless systems.

eLearning Objectives (Direct Instruction)

Estimated Time: 55–70 minutes

Upon completion of the eLearning content, students will be able to:

1. Define Mechanical Refrigeration and Explain Its Importance
2. Describe the Basic Operation of a Mechanical Refrigeration System
3. Describe the Basic Operation of a Heat Pump System
4. Describe the Components of a Mini-Split Heat Pump System
5. Describe the Basic Operation of a Residential Mini-Split Heat Pump System
6. Describe Refrigeration System Safety

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Identify Mini-Split System Components	15–20 min	40-Hour Pathway
2	Start Up and Shut Down a Mini-Split System	15–20 min	40-Hour Pathway

Module 16: Mini-Split Heat Pump Operation

Module Overview

Covers mini-split system operation including comfort settings, heating/cooling modes, LED indicators, emergency operation, and preventive maintenance procedures.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Adjust Mini-Split Comfort Settings
2. Describe How to Operate a Mini-Split in Heating and Cooling Modes
3. Describe the Functions of Mini-Split System LED Indicators
4. Describe the Function of Mini-Split Emergency Operation Mode
5. Describe Mini-Split Heat Pump Preventive Maintenance

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Adjust Mini-Split Comfort Settings	15–20 min	40-Hour Pathway
2	Operate a Mini-Split in Heating and Cooling Modes	20–25 min	40-Hour Pathway
3	Use the Emergency Operation Switch	20–25 min	40-Hour Pathway
4	Perform a Preventive Maintenance Inspection	25–30 min	40-Hour Pathway

Module 17: Mini-Split System Recovery and Charging

> **EPA 608 Certification:** Labs in this module involve refrigerant handling. Students should hold EPA Section 608 certification or work under direct supervision of a certified instructor.

Module Overview

Covers refrigerant recovery and charging procedures specific to mini-split systems, including the superheat method for charge assessment and weigh-in charging techniques.

eLearning Objectives (Direct Instruction)

Estimated Time: 40–55 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe Why the Superheat Method Is Used to Assess Charge in a Mini-Split System
2. Describe How to Use the Superheat Method to Assess Charge
3. Describe How to Recover Refrigerant from a Mini-Split System
4. Describe How to Charge a Mini-Split System with Recovered Refrigerant
5. Describe How to Charge a Mini-Split System with Virgin Refrigerant

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Use the Superheat Method to Assess Charge	20–30 min	40-Hour Pathway
2	Recover Refrigerant from a Mini-Split System	20–30 min	40-Hour Pathway
3	Charge a Mini-Split System with Recovered Refrigerant (Weigh-In)	20–30 min	40-Hour Pathway
4	Charge a Mini-Split System with Virgin Refrigerant	20–30 min	40-Hour Pathway

Module 18: Mini-Split Pressure and Temperature Measurements

Module Overview

Covers pressure and temperature measurement techniques specific to mini-split systems, including pump-down procedures and the total superheat method for system evaluation.

eLearning Objectives (Direct Instruction)

Estimated Time: 35–50 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Connect a Gauge or Gauge Manifold to Measure Compressor Pressure
2. Describe How to Pump Down a Mini-Split Heat Pump
3. Describe Types of Mini-Split System Temperature Measurement Devices
4. Describe How to Take Mini-Split System Temperature Measurements
5. Define Superheat and Explain Its Importance
6. Describe How to Use Superheat to Determine If a System Is Operating Correctly

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Pump Down a Mini-Split Heat Pump	35–45 min	40-Hour Pathway
2	Measure Vapor and Liquid Line Temperatures	30–40 min	40-Hour Pathway
3	Use Total Superheat to Evaluate System Performance	25–30 min	40-Hour Pathway

Module 19: Mini-Split Heat Pump Component Tests

40-HOUR PATHWAY NOTE: Labs in this module are designated as Instructor-Led Demo / Extended Practice. For programs following the 40-hour pathway, this content is delivered as instructor-led demonstrations with student observation and assistance.

Module Overview

Covers diagnostic testing procedures for mini-split components including compressors with inverter controls, linear expansion valves, thermistors, reversing valves, and fan motors. In a 40-hour pathway, these are typically delivered as instructor-led demonstrations.

eLearning Objectives (Direct Instruction)

Estimated Time: 60–75 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Interpret Controller Fault Codes
2. Describe How to Test a Compressor and Inverter Control
3. Describe How to Test a Linear Expansion Valve
4. Describe How to Test a Defrost Heater
5. Describe How to Test Thermistors
6. Describe How to Test a Reversing Valve
7. Describe How to Test an Indoor Fan and Outdoor Fan

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Test a Compressor and Inverter Control	40–50 min	Instructor-Led Demo / Extended Practice
2	Test a Linear Expansion Valve (LEV)	30–40 min	Instructor-Led Demo / Extended Practice
3	Test Thermistors (Including Defrost)	30–40 min	Instructor-Led Demo / Extended Practice
4	Test a Reversing Valve	25–35 min	Instructor-Led Demo / Extended Practice
5	Test Indoor and Outdoor Fan Motors	30–40 min	Instructor-Led Demo / Extended Practice

Module 20: Troubleshooting Residential Mini-Split Heat Pump Systems

40-HOUR PATHWAY NOTE: Labs in this module are designated as Instructor-Led Demo / Extended Practice. For programs following the 40-hour pathway, this content is delivered as instructor-led demonstrations with student observation and assistance.

Module Overview

Covers systematic troubleshooting procedures for mini-split systems using LED indicators and diagnostic techniques for non-running units, cycling problems, and communication faults. In a 40-hour pathway, these are typically delivered as instructor-led demonstrations.

eLearning Objectives (Direct Instruction)

Estimated Time: 25–40 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Use LED Indicators to Troubleshoot a Mini-Split System
2. Describe How to Troubleshoot a Mini-Split System Where Outdoor Unit Does Not Run
3. Describe How to Troubleshoot a Mini-Split Outdoor Unit That Cycles Frequently
4. Describe How to Troubleshoot a Mini-Split System Where Indoor Unit Does Not Run
5. Describe How to Troubleshoot a Communication Failure in a Mini-Split System

Associated Labs (Hands-On Skills)

Lab	Lab Title	Duration	Designation
1	Use LED Indicators to Troubleshoot a Mini-Split System	35–45 min	Instructor-Led Demo / Extended Practice
2	Troubleshoot a Non-Running Outdoor Unit	35–45 min	Instructor-Led Demo / Extended Practice
3	Troubleshoot a Frequently Cycling Outdoor Unit	30–40 min	Instructor-Led Demo / Extended Practice
4	Troubleshoot a Non-Running Indoor Unit	25–35 min	Instructor-Led Demo / Extended Practice
5	Troubleshoot Communication Faults	30–40 min	Instructor-Led Demo / Extended Practice

Module 21: Introduction to Geothermal Heat Pump Systems

INSTRUCTOR-LED SUPPLEMENTAL CONTENT: This geothermal module is included for instructors to introduce as needed based on program focus and regional relevance. It provides eLearning theory and does not have associated labs in this toolkit. Optional hands-on labs are available through the Amatrol eLearning platform for programs with geothermal training equipment.

Module Overview

Introduces geothermal heat pump technology including geothermal energy applications, mechanical refrigeration principles as applied to geothermal systems, types of geothermal source circuits (closed-loop, open-loop, direct exchange), and load circuit configurations (forced-air, domestic hot water, hydronic).

eLearning Objectives (Direct Instruction)

Estimated Time: 85–100 minutes

Upon completion of the eLearning content, students will be able to:

1. Define Geothermal Energy and Give an Application
2. Define the Mechanical Refrigeration Cycle and Explain Its Importance
3. Describe the Basic Operation of a Heat Pump
4. Describe the Basic Operation of a Geothermal Heat Pump System
5. List Common Geothermal Heat Pump Applications
6. Describe the Basic Operation of a Closed-Loop Geothermal Source Circuit
7. Describe the Basic Operation of an Open-Loop Geothermal Source Circuit
8. Describe the Basic Operation of a Direct Exchange Geothermal Source Circuit
9. Describe the Basic Operation of a Geothermal Heat Pump Forced-Air System
10. Describe the Basic Operation of a Geothermal Heat Pump Dedicated Domestic Hot Water System
11. Describe the Basic Operation of a Geothermal Heat Pump Supplemental Domestic Hot Water System
12. Describe the Basic Operation of a Geothermal Heat Pump Hydronic System

This module does not have associated hands-on labs.

Module 22: Geothermal Closed-Loop Source Circuit Operation

INSTRUCTOR-LED SUPPLEMENTAL CONTENT: This geothermal module is included for instructors to introduce as needed based on program focus and regional relevance. It provides eLearning theory and does not have associated labs in this toolkit. Optional hands-on labs are available through the Amatrol eLearning platform for programs with geothermal training equipment.

Module Overview

Covers pressurized and non-pressurized closed-loop geothermal source circuits including flow centers, expansion tanks, prime tanks, interior and exterior piping configurations, and multi-heat pump installations. Also covers source circuit startup procedures and flow balance verification.

eLearning Objectives (Direct Instruction)

Estimated Time: 100–115 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Operation of a Pressurized Closed-Loop Geothermal Source Circuit
2. Describe the Operation of a Geothermal Pressurized Flow Center
3. Describe the Operation of an Expansion Tank
4. Describe the Operation of Geothermal Closed-Loop Source Circuit Exterior Piping
5. Describe the Operation of Pressurized Closed-Loop Source Circuit Interior Piping
6. Describe the Operation of Pressurized Closed-Loop Source Circuits with Multiple Heat Pumps
7. Describe the Operation of a Non-Pressurized Closed-Loop Geothermal Source Circuit
8. Describe the Operation of a Prime Tank
9. Describe the Operation of a Geothermal Non-Pressurized Flow Center
10. Describe the Operation of Non-Pressurized Closed-Loop Source Circuit Interior Piping
11. Describe the Operation of Non-Pressurized Closed-Loop Source Circuits with Multiple Heat Pumps
12. Describe the Safety Rules for Geothermal Source Circuit Operation
13. Describe How to Set Up and Operate a Geothermal Closed-Loop Source Circuit
14. Describe How to Check Operation of a Geothermal Source Circuit and Balance Flow

This module does not have associated hands-on labs.

Module 23: Geothermal Heat Pump Control and Operation

INSTRUCTOR-LED SUPPLEMENTAL CONTENT: This geothermal module is included for instructors to introduce as needed based on program focus and regional relevance. It provides eLearning theory and does not have associated labs in this toolkit. Optional hands-on labs are available through the Amatrol eLearning platform for programs with geothermal training equipment.

Module Overview

Covers geothermal heat pump thermostats, controllers, pilot-operated reversing valves, blower control (PSC and ECM), and system operation for single-capacity and two-capacity geothermal systems in heating and cooling modes.

eLearning Objectives (Direct Instruction)

Estimated Time: 80–95 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe the Operation of an Electronic Thermostat
2. Describe How to Configure a Programmable Electronic Thermostat
3. Describe How a Controller Is Wired in a Geothermal Heat Pump System
4. Describe the Operation of a Geothermal Heat Pump Controller
5. Describe the Operation of a Pilot-Operated Reversing Valve
6. Describe How to Configure a Geothermal Heat Pump Controller
7. Describe the Operation of a PSC Blower
8. Describe the Operation of an ECM Blower
9. Describe the Operation of a Single-Capacity Geothermal Heat Pump System
10. Describe the Operation of a Two-Capacity Geothermal Heat Pump System
11. Describe How to Operate a Water-to-Air, Two-Capacity, Geothermal Heat Pump System in Heating and Cooling Modes

This module does not have associated hands-on labs.

Module 24: Geothermal Heat Pump Performance

INSTRUCTOR-LED SUPPLEMENTAL CONTENT: This geothermal module is included for instructors to introduce as needed based on program focus and regional relevance. It provides eLearning theory and does not have associated labs in this toolkit. Optional hands-on labs are available through the Amatrol eLearning platform for programs with geothermal training equipment.

Module Overview

Covers geothermal heat pump startup checks (static and dynamic), heat duty calculations, coefficient of performance (COP), energy efficiency ratio, and overall system performance evaluation in heating and cooling modes including blower performance assessment.

eLearning Objectives (Direct Instruction)

Estimated Time: 85–100 minutes

Upon completion of the eLearning content, students will be able to:

1. Describe How to Perform a Pre-Startup Geothermal Heat Pump Static System Check
2. Describe How to Perform a Geothermal Heat Pump System Startup Dynamic Check
3. Define Refrigerant Mass Flow Rate and Give Its Units of Measurement
4. Describe How to Determine the Mass Flow Rate of a Geothermal Heat Pump System
5. Define Heat Duty and Give Its Unit of Measurement
6. Describe How to Calculate the Heat Duty of a Geothermal Heat Pump Heat Exchanger
7. Describe Factors That Affect Geothermal Heat Pump System Performance
8. Describe How to Calculate the Coefficient of Performance of a Geothermal Heat Pump System
9. Describe How to Calculate the Energy Efficiency Ratio of a Geothermal Heat Pump System
10. Describe How to Determine Overall Performance of a Geothermal Heat Pump System in Cooling Mode
11. Describe How to Determine Overall Performance of a Geothermal Heat Pump System in Heating Mode
12. Describe How to Check Geothermal Heat Pump System Blower Performance

This module does not have associated hands-on labs.