

# KACC-0255 Refrigeration Applications

## Author

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## Competency and Learning Objectives

1. Demonstrate the refrigeration piping skills needed to install and repair HVAC equipment.
  - Identify types and sizes of copper tubing.
  - Demonstrate proper use of tubing cutter.
  - Demonstrate proper use of tubing bender.
  - Demonstrate the steps needed to make swaged connections.
  - Demonstrate the steps needed to make flared connections.
  - Demonstrate the steps needed to make steel pipe connections.
  - Demonstrate the steps needed to make plastic pipe connections.
  - Describe the proper soldering alloys and fluxes used in soldering copper tubing connections.
  - Demonstrate proper soldering techniques.
  - Describe the proper brazing alloys and fluxes used in brazing copper tubing connections.
  - Demonstrate proper brazing techniques.
2. Demonstrate how to adjust and service the different types of refrigeration system metering devices.
  - Describe and demonstrate how to adjust automatic expansion valves.
  - Describe and demonstrate the operation of a capillary tube system.
  - Describe and demonstrate the operation of a fixed orifice system.
  - Describe and demonstrate how to adjust thermostatic expansion valves.
3. Demonstrate the application of some of the special purpose refrigerant control valves used in refrigeration systems.
  - Identify hand valves and describe their installation and use.
  - Identify check valves and describe their installation and use.
  - Identify solenoid valves and describe their installation and use.
  - Describe and demonstrate how to adjust evaporator pressure regulating (EPR) valves.
  - Describe and demonstrate how to adjust crankcase pressure regulating (CPR) valves.
  - Describe and demonstrate how to adjust hot gas bypass valves.
  - Identify head pressure control valves and describe their installation and use.
  - Explain how to troubleshoot and correct problems with refrigerant flow control valves.
4. Describe the application of different compressors used in operation of refrigeration equipment, and compressor lubrication.
  - Identify the five types of compressors and their operation and application used in the refrigeration field.

- Explain how to replace, size, align and adjust V-belts used in the refrigeration field.
  - Identify and describe the refrigeration lubricants used in refrigeration compressors and their applications and properties.
  - Demonstrate how to change oil in a refrigeration compressor.
  - Explain refrigeration compressor load capacity control.
5. Evaluate refrigeration equipment performance.
- Perform refrigeration system recovery.
  - Perform refrigeration system evacuation.
  - Perform refrigeration system recharge
  - Operate and test a capillary tube refrigeration system.
  - Operate and test a thermal expansion valve (TXV) refrigeration system.

## Orientation to Course

### Course Description

This course introduces the piping skills needed to install and repair refrigeration systems. This course also will examine more in depth the use and operation of metering devices, special purpose valves, and compressors used in refrigeration systems. The lubrication and accessories needed for proper compressor operation will also be examined. Students will demonstrate the process of recovery, evacuation, recharging, operation and testing on refrigeration.

### Competencies

Upon completion of the course, you will be rated as MC (Mastered Competency) or NM (Not-Mastered Competency) based on your demonstrated ability of the course's established competencies. You will:

- Demonstrate the refrigeration piping skills needed to install and repair HVAC equipment.
- Demonstrate how to adjust and service the different types of refrigeration system metering devices.
- Demonstrate the application of some of the special purpose refrigerant control valves used in refrigeration systems.
- Describe the application of different compressors used in operation of refrigeration equipment, and compressor lubrication.
- Evaluate refrigeration equipment performance.

### Assessment

You will be given a written progress exam and/or a lab practical to see if you are on track in progressing toward the required competencies at the end of each module. You must pass these progress exams with a score of at least 80% before you can move on to the next module. At the end of the course you will again be given a written exam and final lab practical that you must pass with at least a score of 80% before you will be rated with an MC as your grade for the course.

## Labs

You will have 21 labs as a part of this course. There is a schedule for labs and other opportunities to work with instructors. Sign up ahead of time for labs, about a week before you want to work on a lab. Make sure you come at that time or reschedule it.

## Syllabus and Textbooks

Read the syllabus to understand the expectations for this course. The instructor will go through the syllabus and review the textbook with you on your first day of class.

- Heating and Cooling Essentials, 4th Edition, Crawshaw, ISBN: 978-1-63126-059-9
- Heating and Cooling Essentials Lab Workbook, 4th Edition, Crawshaw, ISBN: 978-1-63126-063-6

## Course Navigation

In the left navigation bar is a Course Tools menu. It provides information about what tools you need for the course, and how to navigate in Canvas. Start the course with the first module below. You can also click on the **Modules** link in the left navigation bar to navigate through the course.

## Modules

### Module 1: Piping Skills - Part 1: Copper Tubing and Steel Pipe

#### Piping Skills Overview

One of the top skills that HVAC companies look for in their employees, along with customer soft skills and troubleshooting, is having good piping skills. This includes how to install and repair broken refrigerant copper lines. Developing these piping skills takes time, but practice make perfect. You will learn how to cut and bend copper lines, and how to make flare and swage connections.

When you have completed this module, you will know how to:

- Identify types and sizes of copper tubing.
- Demonstrate proper use of tubing cutter.
- Demonstrate proper use of tubing bender.
- Demonstrate the steps needed to make swaged connections.
- Demonstrate the steps needed to make flared connections.
- Demonstrate the steps needed to make steel pipe connections.
- Demonstrate the steps needed to make plastic pipe connections.

#### Copper Tubing and Steel Pipe Assignments

One of the biggest expenses in the HVAC industry is the cost of refrigerants. Leaks in refrigeration or air conditioning systems can result in a number of different problems. One problem is the cost of replacing the refrigerant. Also, refrigerants can destroy the ozone layer in the atmosphere which is correlated with global warming. Leaks in refrigeration or air

conditioning systems can also introduce air into the system which can cause its own problems. So having the skills to repair these leaks or to make sure that installations of refrigerant lines are tight to begin with is so important. In this section of the module you will learn how to cut, bend, flare, and swage copper tubing.

#### Instructions

1. Read chapter 4 Working with Copper Tubing in your Heating and Cooling Essentials textbook.
2. Take the Check Your Knowledge: Chapter 4 Quiz.
3. Watch the following videos:
  - a. Tube Cutting
  - b. Tube Bending
  - c. Tube Swaging
  - d. Tube Flaring
4. Read chapter 5 Working with Pipe in your Heating and Cooling Essentials textbook.
5. Take the Check Your Knowledge: Chapter 5 Quiz.
6. Complete the 5 Lab Projects for this section of the module.

#### Check Your Knowledge: Chapter 4 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

##### Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

#### Check Your Knowledge: Chapter 5 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

##### Testing Procedures:

4. Click **Take this Quiz** link.
5. Read each question and choose the best answer(s).
6. When you have answered all the questions, click the **Submit** button. You will be shown your score.

#### Lab Project 4: Working with Copper Tubing

For this lab you will be using your Heating and Cooling Essentials Lab Workbook. In this lab you will be identifying copper tubing fittings, and the make and size of copper tubing. You will then work on learning how to use a tubing cutter and deburring tool.

#### Instructions

1. You will need to remove the lab sheets for Lab 4 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. You will only need to complete Activity 4-1, 4-2, 4-3 and 4-4 for this lab.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.

6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: Bending Tubing**

For this lab you will be working with a hand bender to bend pieces of copper tubing to match different designs. Being able to bend different bends in refrigeration tubing can help reduce installation costs by limiting the number of elbow fittings and labor time that would be needed for installation jobs.

#### **Instructions**

1. Print out the Bending Tubing lab worksheet.
2. Print out these instruction on how to use the tubing bender.
3. Ask your instructor to show you how to use the bender.
4. Get some scrap tubing from the instructor and do some practice bends before you start the lab assignment.
5. Using the worksheet, follow the instructions for the lab.
6. Have your instructor sign off that you have completed the lab.
7. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: Flaring Tubing**

In this lab you will be learning how to make flaring connections in copper tubing. This skill is also one that requires practice to master. Improper flaring connections are one of the leading causes of refrigerant leaks in refrigeration and air conditioning systems. Remember practice make perfect.

#### **Instructions**

1. Print out the Flaring Tubing lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: Swaging Tubing**

Like the skill of tubing bending that can reduce the number of copper elbow fittings needed for an installation, the skill of swaging can help to reduce the number of couplings that are needed in an installation. Swaging is a skill that requires less amount of time to master. In this lab you will be learning how to use both a hand punch style of swaging tool as well as an hydraulic style of swaging tool.

#### **Instructions**

1. Print out the Swaging Tubing lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## Lab Project 5: Working with Pipe

For this lab you will be using your Heating and Cooling Essentials Lab Workbook. In this lab you will be identifying the tools and fitting used with steel and plastic pipe. You will then be learning how to cut, thread and join both plastic and steel pipe.

### Instructions

1. You will need to remove the lab sheets for Lab 5 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## Module 2: Piping Skills Part 2: Soldering and Brazing Copper Tubing

### Soldering and Brazing Copper Tubing Overview

The most important skill for an HVAC tech is soldering and brazing of refrigerant copper lines. Even after you have completed this module, I would encourage you whenever you have some spare time to keep practicing your piping skills especially your soldering and brazing skills.

When you have completed this module, you will know how to:

- Describe the proper soldering alloys and fluxes used in soldering copper tubing connections.
- Demonstrate proper soldering techniques.
- Describe the proper brazing alloys and fluxes used in brazing copper tubing connections.
- Demonstrate proper brazing techniques.

### Soldering Piping Skills Assignments

In this section of the module you will explore and demonstrate the piping skill of soldering copper tubing. The skill of soldering is used to join copper fittings and tubing together by the use of torches and filler rods (or alloys). The soldering alloys melt at temperatures below 840°F. You will be learning how to setup and operate air-acetylene torches, which are used for soldering. As was started before, even after you have completed this module, I would encourage you whenever you have some spare time to keep practicing your piping skills especially your soldering and brazing skills.

To begin with please watch the video on [Soldering and Brazing Safety](#).

### Instructions

1. Read chapter 6 Soldering in your Heating and Cooling Essentials textbook.
2. Take the Check Your Knowledge: Chapter 6 Quiz.
3. Watch the Soldering and Brazing videos.
  - a. [Soldering & Brazing Setup Video](#)
  - b. [Soldering & Brazing Preparation Video](#)
  - c. [Soldering Procedure Video](#)
4. Complete the 2 Lab Projects for this section of the module.

## Check Your Knowledge: Chapter 6 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

### Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

## Lab Project 6: Soldering

For this lab you will be using your Heating and Cooling Essentials Lab Workbook. In this lab you will be identifying the components of an air-acetylene torch set. You will then be learning how to assemble, use and solder with the air-acetylene torch set.

### Instructions

1. You will need to remove the lab sheets for Lab 6 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. You will not be doing Activity 6-5 during this lab but will use it in a different lab later.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## Lab Project: 95/5 Soft Solder Training

In this lab you will be continuing your training and practice in soldering together with copper tubing. After some more practice you will be soldering together a lab project and testing it to make sure it does not leak.

### Instructions

1. Print out the 95/5 Soft solder Training lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## Brazing Piping Skills Assignments

In this section of the module you will explore and demonstrate the piping skill of brazing together copper tubing. The skill of brazing is used to join copper fittings and tubing together by the use of torches and filler rods (or alloys). The brazing alloys melt at temperatures above 840°F. You will be learning how to setup and operate oxyacetylene torches, used for brazing. As was started before, even after you have completed this module, I would encourage you whenever you have some spare time to keep practicing your piping skills especially your soldering and brazing skills.

### Instructions

1. Read chapter 7 Brazing and Flame Cutting in your Heating and Cooling Essentials textbook.

2. Take the Check Your Knowledge: Chapter 7 Quiz.
3. Watch these videos.
  - a. [Brazing Procedure Part 1 Video](#)
  - b. [Brazing Procedure Part 2 Video](#)
  - c. [Brazing Procedure Part 3 Video](#)
  - d. [Brazing Procedure Part 4 Video](#)
  - e. Brazing for HVAC Technicians (*Instructor has permission to stream this video through the LMS*)
4. Complete the 4 Lab Projects for this section of the module.

### Check Your Knowledge: Chapter 7 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

#### Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### Lab Project 7: Brazing and Flame Cutting

For this lab you will be using your Heating and Cooling Essentials Lab Workbook. In this lab you will be identifying the temperature characteristics of the flux used for brazing, the parts of a oxygen regulator and different types of brazing tips. You will then be learning how to assemble, use and braze with the oxyacetylene torch set. You will also learn how to braze using an air-acetylene torch set.

#### Instructions

1. You will need to remove the lab sheets for Lab 7 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. You will only use Activity 7-1, 7-2 and 7-3 along with Activity 6-5 during this lab.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### Lab Project: 15% Silver Brazing Training

In this lab you will be continuing your training and practice in brazing together copper tubing. After some more practice you will be brazing together a lab project and testing it to make sure it does not leak.

#### Instructions

1. Print out the 15% Silver Brazing Training lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: 45% Silver Brazing Training**

In this lab you will be continuing your training and practice in brazing together copper tubing but this time you will be using 45% silver brazing alloy. After some more practice you will be brazing together a lab project and testing it to make sure it does not leak.

#### Instructions

1. Print out the 45% Silver Brazing Training lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: Building a Heat Exchanger**

In this lab you will be building a heat exchanger that you will be using later in your education. This heat exchanger will be used when you start building your project boards in KACC 0445 Commercial Refrigeration.

#### Instructions

1. Print out the Building a Heat Exchanger lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Piping Skills Written Progress Exam**

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapters 4,5,6, and 7 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

### **Piping Skills Lab Practical**

As stated at the beginning of this module: "One of the top skills that HVAC companies look for in their employees, along with customer soft skills and troubleshooting, is having good piping skills. This includes how to install and repair broken refrigerant copper lines. Developing these piping skills takes time, but practice make perfect. You will learn how to cut and bend copper lines, how to make flare and swage connections. But the most important skill is soldering and brazing of refrigerant copper lines. Even after you have completed this module, I would encourage you whenever you have some spare time to keep practicing your piping skills especially your soldering and brazing skills."

When you have completed both module 1 and 2, you will know how to:

- Identify types and sizes of copper tubing.
- Demonstrate proper use of tubing cutter.
- Demonstrate proper use of tubing bender.
- Demonstrate the steps needed to make swaged connections.
- Demonstrate the steps needed to make flared connections.
- Demonstrate the steps needed to make steel pipe connections.
- Demonstrate the steps needed to make plastic pipe connections.

- Describe the proper soldering alloys and fluxes used in soldering copper tubing connections.
- Demonstrate proper soldering techniques.
- Describe the proper brazing alloys and fluxes used in brazing copper tubing connections.
- Demonstrate proper brazing techniques.

For this lab practical you will be assessed on your skills with tubing, cutting, bending, swaging, flaring, soldering and brazing by building a lab project to match the model one and also it must not leak.

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab, your instructor will enter your score into Canvas.

## Module 3: Metering Devices

### Metering Devices Overview

In this module we will be taking a closer look at the operation and application of metering devices. Whether you are working on a refrigeration system or an air conditioning system, the metering devices operate the same. Metering devices serve two major purposes. The first one is to make sure the evaporator has the proper amount of refrigerant in it to get the proper heat transfer and absorption. The second purpose is to make sure the compressor only receives vapor at its inlet and not liquid which can harm the compressor. Each metering device we will be looking at, operates a little differently but still performs the job described above. You will learn how to test and adjust these different metering devices.

When you have completed this module, you will know how to:

- Describe and demonstrate how to adjust automatic expansion valves.
- Describe and demonstrate the operation of a capillary tube system.
- Describe and demonstrate the operation of a fixed orifice system.
- Describe and demonstrate how to adjust thermostatic expansion valves.

### Metering Devices Assignments

Making sure that the metering device in a refrigeration or air conditioning system is working correctly is vital to the proper operation of these systems. As you work through this module pay close attention to your testing and adjusting procedures while you work with these metering devices.

Instructions

1. Read chapter 17 Working with Metering Devices in your Heating and Cooling Essentials textbook.
2. Take the Check Your Knowledge: Chapter 17 Quiz.
3. Complete the 3 Lab Projects for this module.



## Check Your Knowledge: Chapter 17 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

### Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

## Lab Project 17: Working with Metering Devices

In this lab you will be adjusting an automatic expansion valve and a thermostatic expansion valve for proper operation. You will also be checking the operation of a capillary tube system and replacing a filter-drier on a capillary system.

### Instructions

1. You will need to remove the lab sheets for Lab 17 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. You will not be doing Activity 17-3, 17-4, and 17-6 during this lab.
5. You will be using the blue Amatrol air conditioning and heat pump trainer for this lab.
6. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
7. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## Lab Project: Working with Fixed Metering Orifices

For this lab you will be inspecting the fixed metering orifice in an air conditioning system. You will also be testing what effect an overcharge and undercharge can have on the operation of an air conditioning system with a fixed orifice as the metering device.

### Instructions

1. Print out the Fixed Metering Orifices lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. You will be using air handler/air conditioner #6 for this lab.
4. Have your instructor sign off that you have completed the lab.
5. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## **Lab Project: Checking and Adjusting TXV's**

For this lab you will be testing and adjusting 5 TXV's on lab equipment. Being able to adjust a TXV to the proper setting is very important in making sure that the metering device is feeding the evaporator with the proper amount of refrigerant.

### **Instructions**

1. Print out the Checking and Adjusting TXV's lab worksheet.
2. Using the worksheet, follow the instructions for the lab.
3. Your instructor will assign the lab equipment to work on.
4. Have your instructor sign off that you have completed the lab.
5. Scan the lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

## **Metering Devices Written Progress Exam**

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapter 17 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

## **Metering Devices Lab Practical**

As stated at the beginning of this module: "We will be taking a closer look at the operation and application of metering devices. Whether you are working on a refrigeration system or an air conditioning system, the metering devices operate the same. Metering devices serve two major purposes. The first one is to make sure the evaporator has the proper amount of refrigerant in it to get the proper heat transfer and absorption. The second purpose is to make sure the compressor only receives vapor at its inlet and not liquid which can harm the compressor. Each metering device we will be looking at operates a little differently but still performs the job described above. You will learn how to test and adjust these different metering devices."

When you have completed this module, you will know how to:

- Describe and demonstrate how to adjust automatic expansion valves.
- Describe and demonstrate the operation of a capillary tube system.
- Describe and demonstrate the operation of a fixed orifice system.
- Describe and demonstrate how to adjust thermostatic expansion valves.

In this lab practical you will be adjusting and measuring the superheat of three types of metering devices you learned about in this module.

### **Instructions**

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.

3. Here is the checklist that will be used to grade you on your lab.
4. After the lab, your instructor will enter your score into Canvas.

## Module 4: Special Purpose Valves

### Special Purpose Valves Overview

Many refrigeration systems use special accessory flow control valves to increase system efficiency, provide safeguards, facilitate repairs, or add system features. The valves we are going to study in this module are optional valves, meaning that they may or may not be installed on a refrigeration or air conditioning system. It depends on the system design, desired operation, and cost. We will look at the application and operation of these special purpose valves. Some are manual valves designed to help shut off or isolate components in the system, while others are used to monitor and maintain various pressures in a system. Knowledge of these valves will prevent time-consuming mistakes.

When you have completed this module, you will know how to:

- Identify hand valves and describe their installation and use.
- Identify check valves and describe their installation and use.
- Identify solenoid valves and describe their installation and use.
- Describe and demonstrate how to adjust evaporator pressure regulating (EPR) valves.
- Describe and demonstrate how to adjust crankcase pressure regulating (CPR) valves.
- Describe and demonstrate how to adjust hot gas bypass valves.
- Identify head pressure control valves and describe their installation and use.
- Explain how to troubleshoot and correct problems with refrigerant flow control valves.

### Special Purpose Valves Assignments

As you work through this module you will want to pay close attention to the different applications of these valves. Some valves will look almost identical but operate completely opposite of each other. Understanding where these valves are installed in the system as well as their operation will help to determine their use and purpose. Knowing what valve to shut off to isolate a part of a refrigeration or air conditioning system can help to save time and cost during repairs. Knowing how to test and adjust these valves is a very important skill to master.

#### Instructions

1. Read chapter 18 Special Purpose Valves in your Heating and Cooling Essentials textbook.
2. Take the Check Your Knowledge: Chapter 18 Quiz.
3. Read chapter 19 Troubleshooting Refrigerant Flow Controls in your Heating and Cooling Essentials textbook.
4. Take the Check Your Knowledge: Chapter 19 Quiz.
5. Complete the 2 Lab Projects for this module.

### **Check Your Knowledge: Chapter 18 Review Quiz**

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Check Your Knowledge: Chapter 19 Review Quiz**

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Lab Project 18: Special Purpose Valves**

In this lab you will be adjusting an EPR valve, observing the operation of a pump-down solenoid valve and adjust a CPR valve for proper operation. You will also be adjusting a discharge bypass valve. You will be using the Yellow Scots Refrigeration Trainer.

#### **Instructions**

1. You will need to remove the lab sheets for Lab 18 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. You will be using the blue Amatrol air conditioning and heat pump trainer for this lab.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project 19: Troubleshooting Refrigerant Flow Controls**

In this lab you will be troubleshooting the following refrigerant flow controls, an AEV valve, capillary tube system, TXV valve, solenoid valve and head pressure control valve.

#### **Instructions**

1. You will need to remove the lab sheets for Lab 19 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.

3. Use the lab manual sheets for the lab.
4. You will be using the blue Amatrol air conditioning and heat pump trainer for this lab.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Special-Purpose Valves Written Progress Exam**

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapters 18 and 19 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Special Purpose Valves Lab Practical**

As stated at the beginning of this module: “Many refrigeration systems use special accessory flow control valves to increase system efficiency, provide safeguards, facilitate repairs, or add system features. The valves we are going to study in this module are optional valves, meaning that they may or may not be installed on a refrigeration or air conditioning system. It depends on the system design, desired operation, and cost. We will look at the application and operation of these special purpose valves. Some are manual valves designed to help shut off or isolate components in the system, while others are used to monitor and maintain various pressures in a system. Knowledge of these valves will prevent time-consuming mistakes.”

When you have completed this module, you will know how to:

- Identify hand valves and describe their installation and use.
- Identify check valves and describe their installation and use.
- Identify solenoid valves and describe their installation and use.
- Describe and demonstrate how to adjust evaporator pressure regulating (EPR) valves.
- Describe and demonstrate how to adjust crankcase pressure regulating (CPR) valves.
- Describe and demonstrate how to adjust hot gas bypass valves.
- Identify head pressure control valves and describe their installation and use.
- Explain how to troubleshoot and correct problems with refrigerant flow control valves.

In this lab you will be adjusting and setting these special purpose valves: EPR, CPR, discharge hot gas bypass valve.

Instructions

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab, your instructor will enter your score into Canvas.

## Module 5: Compressor Applications

### Compressor Applications Overview

If your heat stops working, we all know what will happen. Well the same thing goes for a refrigeration or air conditioning system. If the heart of the system stops working the whole system stops working even if all of the other components are working just fine. In this module we will be exploring the heart of the refrigeration and air conditioning systems, the compressor. We will be digging deeper into the five different types of compressors, their application, operation and design. We will also take a look at the lubrication systems used on compressors and the other accessories that can be added to a system if needed.

When you have completed this module, you will know how to:

- Identify the five types of compressors and their operation and application used in the refrigeration field.
- Explain how to replace, size, align and adjust V-belts used in the refrigeration field.
- Identify and describe the refrigeration lubricants used in refrigeration compressors and their applications and properties.
- Demonstrate how to change oil in a refrigeration compressor.
- Explain refrigeration compressor load capacity control.

### Compressor Applications Assignments

Another reason to make sure you pay attention to this module is that not only is the compressor the heart of the refrigeration and air conditioning system, it is also the most expensive component in the system. Messing up on a \$150.00 fan motor might be bad, but messing up on a \$1000.00 compressor is much worse. You need to know how to test and diagnose compressor operations. You don't want to be the one who condemns and replaces a bad compressor just to find out there wasn't anything wrong with it in the first place.

Instructions

1. Read chapter 20 Compressors in your Heating and Cooling Essentials textbook.
2. Take the Check Your Knowledge: Chapter 20 Quiz.
3. Read chapter 21 Compressor Lubrication and Accessories in your Heating and Cooling Essentials textbook.
4. Take the Check Your Knowledge: Chapter 21 Quiz.
5. Complete the 2 Lab Projects for this module.

### **Check Your Knowledge: Chapter 20 Review Quiz**

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Check Your Knowledge: Chapter 21 Review Quiz**

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Lab Project 20: Compressors**

For this lab you will be identifying the five types of compressors along with installing and aligning V-belts. You will also be opening and examining hermetic and semi-hermetic compressors.

1. You will need to remove the lab sheets for Lab 20 from your lab manual.
2. Print out this additional worksheet that goes with this lab.
3. Print your name and the date on the top of the first lab sheet.
4. Use the lab manual sheets for the lab.
5. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project 21: Compressor Lubrication and Accessories**

In this lab you will be working on lubrication systems used in a compressor system, by checking oil level and pressure, checking for acid in the oil, and replacing oil in a semi-hermetic compressor.

1. You will need to remove the lab sheets for Lab 21 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.

5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Lab Project: Compressor Compression Ratios**

For this lab you will be calculating the compressor compression ratios on paper problems and lab equipment. Remember to change the pressure readings to absolute pressure by adding 14 psig to the pressure readings.

#### Instructions

1. Print out the worksheet for this lab.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab worksheets sheets for the lab.
4. Have your instructor sign off your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Compressor Applications Written Progress Exam**

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapter 20 and 21 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

#### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

## Module 6: Refrigeration System Performance

### **Refrigeration System Performance Overview**

In this module you will be taking the information and training you have received in KACC 0235 Basic Refrigeration and put them to use working on a couple of lab refrigeration board trainers. In this module you will be working with both capillary tube refrigeration systems and thermostatic expansion valve systems. Whether you are working on a home air conditioning system or a small commercial refrigeration system, the refrigeration cycle theory is the same. The knowledge you will gain from this module can be applied to all systems both small and large.

When you have completed this module, you will know how to:

- Perform refrigeration system recovery.
- Perform refrigeration system evacuation.
- Perform refrigeration system recharge.

- Operate and test a capillary tube refrigeration system.
- Operate and test a thermal expansion valve (TXV) refrigeration system.

### Refrigeration System Performance Assignments

In this module you will be increasing your skills in the areas of refrigeration system, recovery, evacuation, recharging and calculating superheat and subcooling. You will also be testing and evaluating the performance of capillary tube and TXV systems in the areas of:

- Undercharged systems
- Normally charged systems
- Low evaporator airflow
- Low condenser airflow
- Restricted refrigerant flow
- Overcharged systems
- Air in the refrigeration system

#### Instructions

1. Reread chapters 15 “Refrigerant Recovery and Recycling” and 16 “System Evacuation, Leak Detection, and Recharging” in your Heating and Cooling Essentials Textbook.
2. Review the PowerPoint video presentation “Intro to Refrigeration Systems” **Note:** There is no audio with this presentation.
3. Perform the 2 lab assignments.

### Lab Project Capillary Tube Refrigeration System

In this lab you will be testing and analyzing a capillary tube refrigeration system for system performance. You will be looking at how a capillary tube refrigeration system performs in the following conditions: undercharge, overcharge, low air flow and refrigerate flow restriction. You will also be using the skills of system recovery, evacuation and recharge you learned in a previous course.

#### Instructions

1. Print off the worksheet for this lab.
2. Print your name and the date on the top of the first lab sheet.
3. Instructor will assign you what Project Board trainer to use.
4. Have your instructor sign off on your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### Lab Project Thermal Expansion Valve Refrigeration System

In this lab you will be testing and analyzing a thermal expansion valve refrigeration system for system performance. You will be looking at how a thermal expansion valve refrigeration system performs in the following conditions: undercharge, low air flow and refrigerate flow restriction. Three different types of system controls will be explored: thermostat control, pressure switch control and pump-down system control. You will also be using the skills of system recovery, evacuation and recharge you learned in a previous course.

#### Instructions



1. Print off the worksheet for this lab.
2. Print your name and the date on the top of the first lab sheet.
3. Instructor will assign you what Project Board trainers to use.
4. Have your instructor sign off on your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

### **Refrigeration System Performance Lab Practical**

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab, your instructor will enter your score into Canvas.

## Final Competency Exam and Practical Assessment

### **Final Competency Exam and Practical Assessment Overview**

As stated at the beginning of this course the competencies for this course, are to be able to:

- Demonstrate the refrigeration piping skills needed to install and repair HVAC equipment.
- Demonstrate how to adjust and service the different types of refrigeration system metering devices.
- Demonstrate the application of some of the special purpose refrigerant control valves used in refrigeration systems.
- Describe the application of different compressors used in operation of refrigeration equipment, and compressor lubrication.
- Evaluate refrigeration equipment performance.

For this Written Exam and Lab Practical you will demonstrate mastery for this course's competencies.

### **Refrigeration Applications Written Final Exam Form A** *(There is a Form B in case the student does not pass Form A)*

This assessment will measure your knowledge of refrigeration application principles. Topics include piping skills, metering devices, special purpose valves, and compressor applications. The assessment consists of 51 multiple-choice questions. To pass this assessment, you will need a score of 80% (41 out of 51 points).

If you do not pass on the first attempt, you will have the opportunity to meet with your instructor, study and practice the content further, and retake a different version of the assessment.

### **Testing Procedures:**

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

### **Refrigeration Applications Final Lab Practical** *(There is a Form B in case the student does not pass Form A)*

This lab practical consists of 4 parts that will be completed in sequence. This assessment represents the culmination of the competencies for this course. Topics include piping skills, metering devices, special purpose valves, and refrigeration system performance.

The lab practical will be evaluated according to a checklist and must receive a minimum of 80% to pass (46 points out of 57). If you do not pass on the first demonstration, you will receive feedback and have the opportunity to take an alternate version of the lab.

**This lab practical must be performed in the presence of your Instructor.**

Piping Skills Lab Practical Checklist

Student Name: \_\_\_\_\_

Piping Skills										
Aspect	See Scoring Below	Used proper components	Bending done correct	Flaring done correctly	Soldering done correctly	Brazing done correctly	Size match's model	Does not leak	Overall appearance of project	Comments
		Score (0-2)								
Lab Project	Testing Piping Skills									

Note: Change in point scale above. Not 0-1 but 0-2.

Scoring:

Meets Expectations (Proficient): 2 Points,

Task Performed Correctly, but Unprofessional Appearance: 1 Point,

Does Not Meet Expectation: 0 points



Student Name: \_\_\_\_\_

**Part 1: Setting EPR Valve**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV and EPR	40° Temperature Calculated Correctly	45° Temperature Calculated Correctly	50° Temperature Calculated Correctly	40° Temperature Adjusted Correctly	45° Temperature Adjusted Correctly	50° Temperature Adjusted Correctly	Comments
		Score (0-1)							
EPR Valve Adjustment	Adjusting EPR Valve for Proper Evaporator Temperature								

**Part 2: Adjusting Hot Gas Bypass Valve**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV, EPR and Hot Gas	35° Suction Temperature Adjusted Correctly	Suction Pressure Recorded Correctly	40° Suction Temperature Adjusted Correctly	Suction Pressure Recorded Correctly	Readjusted EPR and Hot Gas Bypass	Comments
		Score (0-1)						
Hot Gas Bypass Valve Adjustment	Adjusting Hot Gas Bypass Valve for Proper System Control							

**Part 3: Adjusting CPR**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV, EPR, Hot Gas and CPR	Nameplate Amps Recorded Correctly	CPR Suction Pressure Recorded Correctly	1st Valve Adjustment made Correctly	2nd Valve Adjustment made Correctly	3rd Valve Adjustment made Correctly	Comments
		Score (0-1)						
CPR Valve Adjustment	Adjusting CPR Valve for Compressor Protection							

Refrigeration System Performance Lab Practical Checklist for Evaluation

Student Name: \_\_\_\_\_

**Part 1: Capillary Tube System; Normal Operation**

Aspect	Meets Expectations (Proficient) 1 Point	Correct System Recovery	Correct System Evacuation	Correct System Recharge	Correct Amp Reading	Correct Pressure Readings	Correct Temperature	Correct Superheat and Subcooling	Comments
		Score (0-1)							
Recover, Evacuate, Recharge	Capillary Tube System Performance Test								
Normal System Operation									

**Capillary Tube System; Special Conditions Evaluations**

Aspect	Meets Expectations (Proficient) 1 Point	Correct Under Charge	Correct Over Charge	Correct Low Evaporator Airflow	Correct Low Condenser Air Flow	Correct Restricted Refrigerant Flow	Comments
		Score (0-1)					
Compressor Amps	Evaluating a Capillary Tube System Under Special Conditions						
Suction Pressure							
Superheat							
High Side Pressure							
Subcooling							

**Part 2: Thermal Expansion Valve System; Normal Operation**

Aspect	Meets Expectations (Proficient) 1 Point	Correct System Recovery	Correct System Evacuation	Correct System Recharge	Correct Amp Reading	Correct Pressure Readings	Correct Temperature	Correct Superheat and Subcooling	Comments
		Score (0-1)							
Recover, Evacuate, Recharge	Thermal Expansion Valve System Performance Test								
Normal System Operation									

**Thermal Expansion Valve System; Special Conditions Evaluations**

Aspect	Meets Expectations (Proficient) 1 Point	Correct Under Charge	Correct Over Charge	Correct Low Evaporator Airflow	Correct Low Condenser Air Flow	Correct Restricted Refrigerant Flow	Comments
		Score (0-1)					
Compressor Amps	Evaluating a Thermal Expansion Valve System Under Special Conditions						
Suction Pressure							
Superheat							
High Side Pressure							
Subcooling							



**Setting EPR Valve**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV and EPR	40° Temperature Calculated Correctly	45° Temperature Calculated Correctly	50° Temperature Calculated Correctly	40° Temperature Adjusted Correctly	45° Temperature Adjusted Correctly	50° Temperature Adjusted Correctly	Comments
		Score (0-1)							
EPR Valve Adjustment	Adjusting EPR Valve for Proper Evaporator Temperature								

**Adjusting Hot Gas Bypass Valve**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV, EPR and Hot Gas	35° Suction Temperature Adjusted Correctly	Suction Pressure Recorded Correctly	40° Suction Temperature Adjusted Correctly	Suction Pressure Recorded Correctly	Readjusted EPR and Hot Gas Bypass	Comments
		Score (0-1)						
Hot Gas Bypass Valve Adjustment	Adjusting Hot Gas Bypass Valve for Proper System Control							

**Adjusting CPR**

Aspect	Meets Expectations (Proficient): 1 Point	Trainer Setup Correctly for TXV, EPR, Hot Gas and CPR	Nameplate Amps Recorded Correctly	CPR Suction Pressure Recorded Correctly	1st Valve Adjustment made Correctly	2nd Valve Adjustment made Correctly	3rd Valve Adjustment made Correctly	Comments
		Score (0-1)						
CPR Valve Adjustment	Adjusting CPR Valve for Compressor Protection							

**Capillary Tube System**

Aspect	Meets Expectations (Proficient) 1 Point	Correct System Recovery	Correct System Evacuation	Correct System Recharge	Comments
		Score (0-1)			
Recover, Evacuate, Recharge	Capillary Tube System Performance Test				