

---

# How to Set Up a Modern HVAC Training Program

---



# INTRODUCTION

*“Interested in HVACR? Train for one of the HOTTEST careers around!”*

*“Ready to train for a really COOL job? Learn to be an HVACR technician!”*

As these two slogans show, the easiest part of setting up a modern HVACR training program is coming up with a punny catchphrase to draw interest. If you’re a career and technical education (CTE) instructor or a trainer in industry looking to train the next generation of HVACR technicians, you probably already know that starting a new HVACR training program from scratch can be challenging.

Fortunately, the experts at Amatrol are here to help you. With more than 30 years of experience, Amatrol remains the world’s leader in hands-on technical training. Our HVACR training systems and eLearning curriculum are second to none.

In the pages that follow, we will walk you through step-by-step how to set up a modern HVACR training program that will ensure that your students or workers possess the knowledge and hands-on HVACR skills they need to succeed in the workplace.

# CONTENTS

04	CHAPTER 1: WHY TEACH HVACR?
08	CHAPTER 2: WHAT SKILLS DO MODERN HVACR TECHNICIANS NEED?
14	CHAPTER 3: WHY ARE INDUSTRY 4.0 SKILLS A CRITICAL PART OF A MODERN HVACR TRAINING PROGRAM?
19	CHAPTER 4: OUT WITH THE OLD AND IN WITH THE NEW: WHY MODERN HVACR TRAINING PROGRAMS NEED TO EVOLVE
23	CHAPTER 5: HOW DO I GET STARTED BUILDING A MODERN HVACR TRAINING PROGRAM?



# CHAPTER 1

## **WHY TEACH HVACR?**

To lay the groundwork, we will begin by focusing on the basics of HVACR, including the need for highly-skilled HVACR technicians, as well as the role HVACR training plays in today's CTE programs or workplace. With a clear vision of the need for HVACR training, subsequent chapters will explore a variety of topics, including which skills HVACR technicians need, how to teach advanced smart HVACR controls, and much more!

## What Does HVACR Stand for?

If you're reading this, you probably already know that HVACR stands for heating, ventilation, air conditioning, and refrigeration. But it never hurts to start with the basics when you're building a training program.

For many years, the technicians that installed, maintained, and repaired residential heating and cooling systems were known as HVAC technicians, reflecting the focus on heating, ventilation, and air conditioning. Many people still use HVAC as a preferred acronym today.

However, this field is increasingly known as HVACR (sometimes written HVAC-R) to reflect the importance of commercial refrigeration in addition to residential heating and cooling systems. You know the freezer case in your local grocery store and the "beer cave" in your corner convenience store? Those are also installed, maintained, and repaired by HVACR technicians.

So what does an HVACR technician do? As we've already alluded to, HVACR technicians install, maintain, and repair the electrical and mechanical climate-control systems that heat, cool, and ventilate indoor environments, as well as commercial refrigerators and freezers in business environments.

HVACR technicians work with a variety of systems, including air conditioners, furnaces, air ducts, thermostats, and a wide variety of piping and vents. Technicians must also work with liquid refrigerants, as well as oil, gas, and/or electrical systems that generate heat.



## How Quickly is the HVACR Industry Growing?

The question posed at the beginning of this chapter — why teach HVACR? — can most simply be answered by looking at supply and demand. Highly-skilled HVACR technicians are in high demand today and the industry continues to grow rapidly. The world needs more HVACR technicians.

With heat wave after heat wave and temperatures setting new records year after year, the demand for qualified HVACR installers and technicians is greater than ever. Unfortunately, supply isn't keeping up with demand, creating a critical shortage of these important workers.

In addition to simply not having enough HVACR workers, modern advancements in smart technologies being incorporated into HVACR products has created a need for HVACR workers with new, cutting-edge technology skills. For example, many new HVACR systems can be connected to the Internet and controlled remotely via smartphone apps. Technicians must know how to install, operate, and maintain these new systems. Unfortunately, an HVACR skills gap has left many companies scrambling to find the highly-skilled workers they so desperately need.

According to an Emerson Climate Conversations blog article by Don Gillis, “[n]early 40 percent of the jobs available in the HVACR industry are unfilled. That’s about 80,000 good-paying positions for technicians who can install, maintain and repair...critical refrigeration equipment.”

Experts believe the problem is only going to worsen in the future. According to a San Joaquin Valley College Blog article, “the Bureau of Labor Statistics expects the number of [HVACR] mechanic and installer jobs to increase significantly [in coming years].”

Indeed, an article by The Air-Conditioning, Heating, and Refrigerating Institute (AHRI) in The Future of Business and Tech blog reports that “[t]he Bureau of Labor Statistics estimates [HVACR] jobs will increase 15 percent per year through 2026; more than twice the average for all other occupations.”

Gillis sums up the bleak situation succinctly: “If we do not hire and train new technicians, our industry could potentially face a deficit of 100,000 workers within the next five years.” With a clear need for more highly-skilled HVACR technicians, instructors and employers have plenty of motivation to focus on HVACR training.

## What Role Does HVACR Play in Modern Career and Technical Education?

Many of today's career and technical education programs have begun to focus on the advanced automation technologies creating a new "Industrial Revolution" throughout every industry. Known frequently as "Industry 4.0," these technologies are changing the way industry works, leading to huge leaps in productivity and efficiency.

However, students and workers must learn to walk before they can run. Fundamental skills in a variety of areas, including electrical and mechanical, still form the solid foundation of any CTE training program. Moreover, there is much to be gained by preparing students and workers for careers in growing industries where they can hit the ground running, putting their skills to use to make a good living.

As the San Joaquin Valley College Blog article notes, "[t]he [HVACR] industry offers good pay – average salaries are over \$49,000, plus bonuses and overtime. But despite the potential appeal of working as an HVACR technician, the number of new entrants in the field is failing to keep pace with America's growing demand."

Gillis points out that students should consider a career in HVACR, because "[t]he reality is that there's an abundance of lucrative opportunities for young people who want a long-term career path without the time commitment and cost of a four-year college education." In particular, Gillis notes that HVACR careers should appeal to students looking to "make an impact," "work with cutting-edge tools and technologies," "achieve job security," and "earn while they learn" through apprenticeship programs.

Focusing a CTE training program on HVACR doesn't preclude teaching advanced Industry 4.0 skills, however. As Gillis notes, "[m]odern refrigeration and air conditioning applications utilize advanced controls, software and remote diagnostics capabilities."

Sadly, the chance to work with cutting-edge tools and technologies is a benefit of HVACR careers that actually contributes to the ongoing HVACR skills gap. Why? There simply aren't enough workers with these advanced skills to keep up with demand. That's why the AHRI notes that "the HVACR industry is committed to finding a new pool of dedicated people to begin a career that offers positions that can never be outsourced and will remain on the cutting edge of new technology."

## The Next Step

If you're an instructor or employer looking to train the next generation of HVACR technicians, you've come to the right place. Amatrol can help you customize your training program to teach the hands-on skills employers truly need. In the next chapter, we'll take a closer look at the particular skills modern HVACR technicians must have to be successful in the workplace.



## CHAPTER 2

# WHAT SKILLS DO MODERN HVACR TECHNICIANS NEED?

The world needs more HVACR technicians. With good pay and the chance to work in an interesting, evolving field, it's important to build modern HVACR training programs that will lure students and workers to this growing field and equip them with the skills to succeed.

But what exactly are those skills students and workers need? If you intend to help produce the next generation of highly-skilled HVACR technicians, then you need to ensure that you're teaching them the knowledge and hands-on skills that employers need.

In this chapter, we will focus on the skills that form the foundation of any HVACR program, as well as the key basic and advanced skills specific to HVACR that future technicians will need to master. With a clear vision of the skills HVACR technicians will need, subsequent chapters will explore a variety of topics, including how to teach advanced smart HVACR controls, what to look for in terms of curriculum and training equipment, and much more!



## Which Fundamental Skills are Important for all HVACR Technicians?

When individuals look at HVACR as a potential career choice, they might worry that it will take many years to learn all the ins and outs of modern HVACR equipment, such as air conditioners, furnaces, air ducts, thermostats, refrigerators, freezers, pipes, and vents.

Instructors and trainers might have similar fears about putting together a comprehensive program that teaches all the key hands-on skills. But let us reassure you that there's no need to worry unnecessarily. With the right knowledge and training tools, trainees can hit the ground running in a new HVACR career quickly.

Before diving into the nitty gritty of basic to advanced HVACR skills, however, we need to start at the beginning. Underlying all of modern HVACR work is a core set of fundamental skills that form the foundation that all subsequent HVACR-specific instruction will be built upon, including:

### **Basic Electrical**

Probably the most fundamental set of skills useful throughout industry is basic electrical. Not only do HVACR technicians need solid knowledge of electricity and hands-on skills, such as wiring and using gauges and meters, in order to install and repair HVACR systems, but being competent in basic electrical is also critical for safety.

### **Basic Mechanical**

Whether it's threading a gas pipeline or installing ventilation ductwork, a wide range of basic mechanical skills will be a key to success for any HVACR technician. This set of skills also includes familiarity and comfort with a wide range of tools. While some parts of HVACR systems are high-tech, others are simple and mechanical. HVACR technicians must be able to work skillfully with both.

### **Print Reading**

HVACR technicians must be comfortable reading and interpreting HVACR system blueprints and schematics. These skills will be put to the test on a regular basis whether installing a new system or troubleshooting a malfunctioning one.

### **Troubleshooting**

Speaking of troubleshooting, many HVACR tasks will begin with either a summer phone call proclaiming "My air conditioning isn't working!" or a winter plea to "Please get my furnace working again! I'm freezing!" When these calls come, a competent HVACR technician must be able to quickly diagnose and isolate the problem for a timely repair.

### **Communication & Time Management**

Although they're often overlooked, so-called "soft skills" like communication and time management are critical to success as an HVACR technician. When given multiple service calls to make, an HVACR technician must know how to manage time in order to complete tasks in an efficient manner. Likewise, clear and concise communication with home or business owners will be the key to setting realistic expectations about installation or repair costs and timelines.

## What Basic HVACR Skills do Students and Workers Need to Know?

With a solid foundation in basic electrical, mechanical, and print reading, as well as soft skills like communication and time management, it's time to move on to the basic skills that are specific to HVACR technicians. These are the skills that will prove to be a good starting point for an introduction to or overview of HVACR.

In this section, we'll highlight a variety of the basic skill areas any HVACR technician will find invaluable in the modern workplace, including:

### *Thermal Science*

Although most HVACR technicians will not need to explain the laws of thermodynamics on a daily basis, a healthy understanding of the basics of thermal science will prove to be important, especially when troubleshooting. When diagnosing and repairing HVACR systems, it's helpful to understand how and why the systems are supposed to work.

Thermal science covers a lot of ground, but here are a few of the key topics you'll want to be sure to touch upon:

- Thermal energy
- Ideal gas law & phase changes
- Thermodynamics
- Heat transfer
- Insulation

### *Basic Refrigeration*

As previously mentioned, the "R" in HVACR stands for refrigeration. All HVACR technicians need a skillset that includes the basics of refrigeration. Key topics related to refrigeration include the following:

- Temperature & pressure measurement
- Compressors
- Condensers & evaporators
- Thermostats
- Mass flow rate

## ***Air Conditioning & Heat Pumps***

With the exception of the far northern states, the majority of homes throughout the United States rely upon air conditioning systems to make life livable in the warm months. The same is true of businesses that want to keep employees and customers comfortable. Of course, the flip side of that coin is keeping everyone nice and warm when winter returns.

A thorough understanding of air conditioning and heat pump concepts is critical for all HVACR technicians. Key topic areas include:

- Gauge manifold operation
- Electrical current, voltage, & resistance measurement
- Troubleshooting blockages & restrictions
- Evaluating system charge levels
- Testing system components, such as compressors, capillary tubes, expansion valves, reversing valves, & blowers
- Humidity control
- Air handling systems
- Insulation applications & effectiveness

## ***Residential Heating & Cooling Systems***

In addition to the air conditioning and heat pump topics discussed previously, HVACR technicians must also possess a thorough understanding of how to install, operate, maintain, troubleshoot, and repair the wide variety of residential heating and cooling systems available on the market today.

For example, HVACR technicians should have a good grasp of topics and skills, such as:

- Forced air heat pump systems
- Mini-split heat pump systems
- Electronic thermostat connections
- Heating and cooling modes
- Superheat & subcooling methods
- Outdoor fans
- Defrost controls
- Systems troubleshooting

## ***Refrigerant Recharging***

The use of refrigerants is foundational to air conditioning and refrigeration systems, but they're also highly regulated. HVACR technicians must be certified to work with refrigerants. Certified HVACR technicians must become familiar with refrigerants and how to recover them and charge systems. Key skills and topics include:

- R-134a & R-410 refrigerants
- Environmental regulations
- Leak detection
- Pressure & temperature measurement
- Refrigerant recovery
- Refrigerant system charging

## Which Advanced HVACR Skills are Important to Learn?

Once students or workers have established a good foundation in basic HVACR skills, they will want to pursue more advanced HVACR skills in order to ensure that they're prepared for any and every situation they may face as a technician.

In this section, we'll highlight some of the advanced HVACR topic areas that students or workers will want to pursue, including:

### **Refrigeration Installation**

Installing modern refrigeration systems requires a thorough understanding of basic electrical and mechanical skills, as well as thermal science. Some of the key topic areas and related skills HVACR technicians must master include the following:

- Refrigeration circuit diagrams
- Copper tubing
- Refrigerant line routing & bending
- HVACR system joints & fittings
- Flaring & swaging copper tubing
- Brazing & soldering refrigerant lines
- Tubing insulation
- Electrical wiring schematics
- Wire selection & routing
- Circuit protection

### **Commercial & Industrial Refrigeration**

Commercial and industrial refrigeration systems present challenges beyond those of basic refrigeration systems. HVACR technicians working in a commercial or industrial setting will need an array of advanced HVACR skills related to these types of systems. Relevant topics areas and skills include the following:

- Semi-hermetic compressors
- Commercial & industrial refrigeration controls
- Electric expansion valves
- Multi-evaporator refrigeration
- Defrost control
- Hot gas bypass control
- Water-to-air refrigeration systems
- Variable frequency drives
- Chiller systems
- Multi-zone systems
- Component- & system-level troubleshooting

## Geothermal

The word geothermal comes from the Greek words geo (earth) and therme (heat). Therefore, geothermal energy is energy that comes from the heat inside the earth. Geothermal energy is present in the earth because of the heat generated at its core and the solar energy absorbed at its surface.

While not as common as traditional heating and cooling systems, geothermal systems remain popular in different regions of the world. HVACR technicians in these areas will want to familiarize themselves with the geothermal skills and topic areas required to install and troubleshoot these systems, including:

- Geothermal heat pump systems
- Pressurized & non-pressurized source circuits
- Open- and closed-loop systems
- Geothermal system components
- Desuperheaters

## Steam

Some HVACR technicians may run across steam systems from time to time, particularly in industrial settings. These systems have their own unique components and considerations that require a specialized set of advanced skills in topic areas, such as:

- Steam power
- Boiler operation
- Air & condensate control
- Pressure control & regulation
- Heat exchangers

## What About Smart Technologies?

In the next chapter, we'll take a closer look at why Industry 4.0 skills are a critical part of a modern HVACR training program, including which advanced Industry 4.0 skills the HVACR technicians of today and tomorrow need to succeed.





## CHAPTER 3

# WHY ARE INDUSTRY 4.0 SKILLS A CRITICAL PART OF A MODERN HVACR TRAINING PROGRAM?

In the last chapter, we took a deep dive into exactly what skills students and workers need, including the skills that form the foundation of any HVACR program, as well as the key basic and advanced skills specific to HVACR that future technicians will need to master.

We're not quite done focusing on skills, though. There's one emerging area we haven't yet given its due: Industry 4.0. Are the smart automation technologies revolutionizing the rest of industry relevant to HVACR, too?

In this chapter, we will focus on why Industry 4.0 skills are a critical part of a modern HVACR training program. We'll explain exactly what Industry 4.0 is, as well as highlight how advanced automation technologies are being used in modern HVACR systems and what advanced Industry 4.0 skills the HVACR technicians of today and tomorrow need to succeed.

## What is Industry 4.0?

If you've spent any time around the world of manufacturing over the past several years, then you've probably heard the term "Industry 4.0" from time to time. But what does it mean exactly? In a nutshell, Industry 4.0 refers to the Fourth Industrial Revolution, which also goes by a variety of other phrases, such as the Industrial Internet of Things (IIoT), Smart Factory, Smart Automation, Smart Manufacturing, etc.

The Fourth Industrial Revolution describes the technological revolution taking place today in factories around the world. During the original (First) Industrial Revolution, steam mechanized production. Then electricity enabled mass production during the Second Industrial Revolution. Eventually, the Third Industrial Revolution saw computers spur automated production.

Some people believed computers were the final frontier. Could anything truly revolutionize industry once again? The Internet said, "Watch this!" We now live in a "smart" world in which countless devices communicate with other devices via the Internet to make life more convenient in seemingly-endless ways. This infinite web of connected devices even has a name: the Internet of Things.

Industries around the world are combining the Internet of Things with cyber-physical systems and advanced automation technologies to create new smart factory environments. Together, these new technologies hold huge potential for a major leap in productivity and efficiency.

Examples of the new technologies spurring the Fourth Industrial Revolution include: "smart" or connected product identification (barcode, RFID, and vision) and sensors (ultrasonic, photoeye, vacuum, etc.); Ethernet and wireless networking and network security; data analysis and production monitoring software; and manufacturing execution software that automates maintenance tasks via smartphone apps.

The synergies created by these exciting new Industry 4.0 technologies promise huge gains in industrial efficiency and productivity. That's why HVACR companies around the world have started incorporating them into a wide variety of products.

As author Don Gillis notes in an Emerson Climate Conversations blog article, "[m]odern refrigeration and air conditioning applications utilize advanced controls, software and remote diagnostics capabilities." Today's HVACR technicians need advanced skills to keep up with these new cutting-edge technologies.

## How Common are Smart HVACR Systems Today?

Some may think that smart HVACR technologies are nothing more than a future possibility, but the truth is that they're already here and more prevalent than you probably realize. In fact, a visit to your local electronics superstore or home supply warehouse will reveal a wide selection of devices that'll turn your humble abode into a smart home.

Indeed, if you're an early adopter of new technologies, your home may already feature one of these devices, such as a smart thermostat. Unexpected cold front move in during the afternoon while you were at work? No worries! Just open your smartphone app and kick the temperature up a couple notches, so it's nice and toasty when you get home.

To get a better idea of how smart technologies are already being included in modern HVACR systems, consider HVACR giant Carrier. As author Mary K. Pratt notes in a recent CSO article, Carrier is "one of the most recognizable brands in the HVAC[R] space" with "more than 80 brand businesses manufacturing thousands of components, products, and complex systems. Its products include industrial control systems, building management systems, automation systems, smoke detectors and commercial refrigeration...operational technology, firmware, and software."

Pratt points out that "[l]ike other manufacturers, Carrier has been adding digital technologies to its mechanical products, connecting them to the internet and making them 'smart' in the process." "For example, one of the Carrier business lines makes transport refrigeration equipment and cold chain tracking and monitoring solutions to keep items, including vaccines, cold as they make their way around the globe. The company also makes smart smoke and carbon monoxide detectors with indoor air quality monitors."

Carrier isn't the only HVACR manufacturer embracing smart technologies. HVACR leader Trane also offers "a state-of-the-art thermostat and zoning control system" that allows homeowners to "remotely control your home, comfort and energy use...from your smartphone, tablet or computer," according to a Trane blog post.

According to Trane, its "zoning and automation hub" confers three significant benefits:

- "Monitor your home: A network of sensors monitors and optimizes the humidity and temperature in your home, adjusting compressor and fan speeds in real time to give you the most comfortable air operating efficiency possible."
- "Take control: Trane's connected controls combine zone-by-zone comfort control with a smart home hub that connects to a variety of smart devices."
- "Run real-time diagnostics: [Trane's software] can monitor your HVAC system diagnostics in real time and alert your Trane dealer if there's an issue. You even have the option to set it up so your dealer can troubleshoot by remotely viewing details on how your heating and air conditioning system is performing."

With more and more HVACR products incorporating advanced Industry 4.0 technologies, the need for highly-skilled technicians who can operate, maintain, repair, and troubleshoot these systems is greater than ever. Are your students prepared for HVACR 4.0?

## What Types of Advanced Industry 4.0 Skills do HVACR Technicians Need Today and into the Future?

Making HVACR products “smart” ups the ante when it comes to the advanced skills today’s technicians will need. In addition to a wide variety of electrical, mechanical, and HVACR-specific skills, the HVACR technicians of today and tomorrow must expand their skillsets to include expertise with connected systems, Ethernet and wireless communications, smart sensors, etc.

Here’s a quick look at just a few of the advanced Industry 4.0 skills that will be important to teach the next generation of HVACR technicians:

### ***Smart Thermostats***

As mentioned previously, smart thermostats are changing the way homeowners monitor and control their residential HVACR systems, and it’s easy to see why. With heating and cooling costs continuing to rise year after year, the ease and convenience of keeping an eye on the thermostat via a smartphone app is a no-brainer for those wanting to reign in their utility bills.

HVACR technicians need to learn how to install, operate, maintain, and troubleshoot smart thermostats. Necessary skills will include how to install and operate related smartphone apps, as well as teaching homeowners how to use key features.

### ***Smart Sensors & Probes***

As HVACR systems get “smarter,” traditional ways of measuring and monitoring critical factors, such as temperature and pressure will be replaced with a variety of smart sensors and probes that can communicate not only system issues but also routine maintenance reminders and requests.

HVACR technicians will need to know how to install and troubleshoot a range of smart sensors and probes, especially those used commonly with the latest generation of digital gauge manifolds. They will also need to become familiar with configuring the devices that will receive critical communications from connected probes and sensors.

### ***Smart Refrigeration & Chiller Controllers***

Today’s advanced smart refrigeration systems, as well as air- and water-cooled chiller systems, feature advanced controllers that enable users to optimize energy use throughout the entire system. This is especially important in the commercial setting. With a smart controller, users can monitor and manipulate key components of the system, such as evaporator and condenser fans, compressors, and even lights.

HVACR technicians working with advanced refrigeration and chiller systems will need to know how to install, operate, and troubleshoot smart controllers. Key skills will include configuring a controller for single- and multi-zone operation, configuring a controller for use with an electronic expansion valve, configuring a smart chiller controller using Bluetooth and/or a mobile/cloud app, and monitoring controller function via software.

## **Smart Communications**

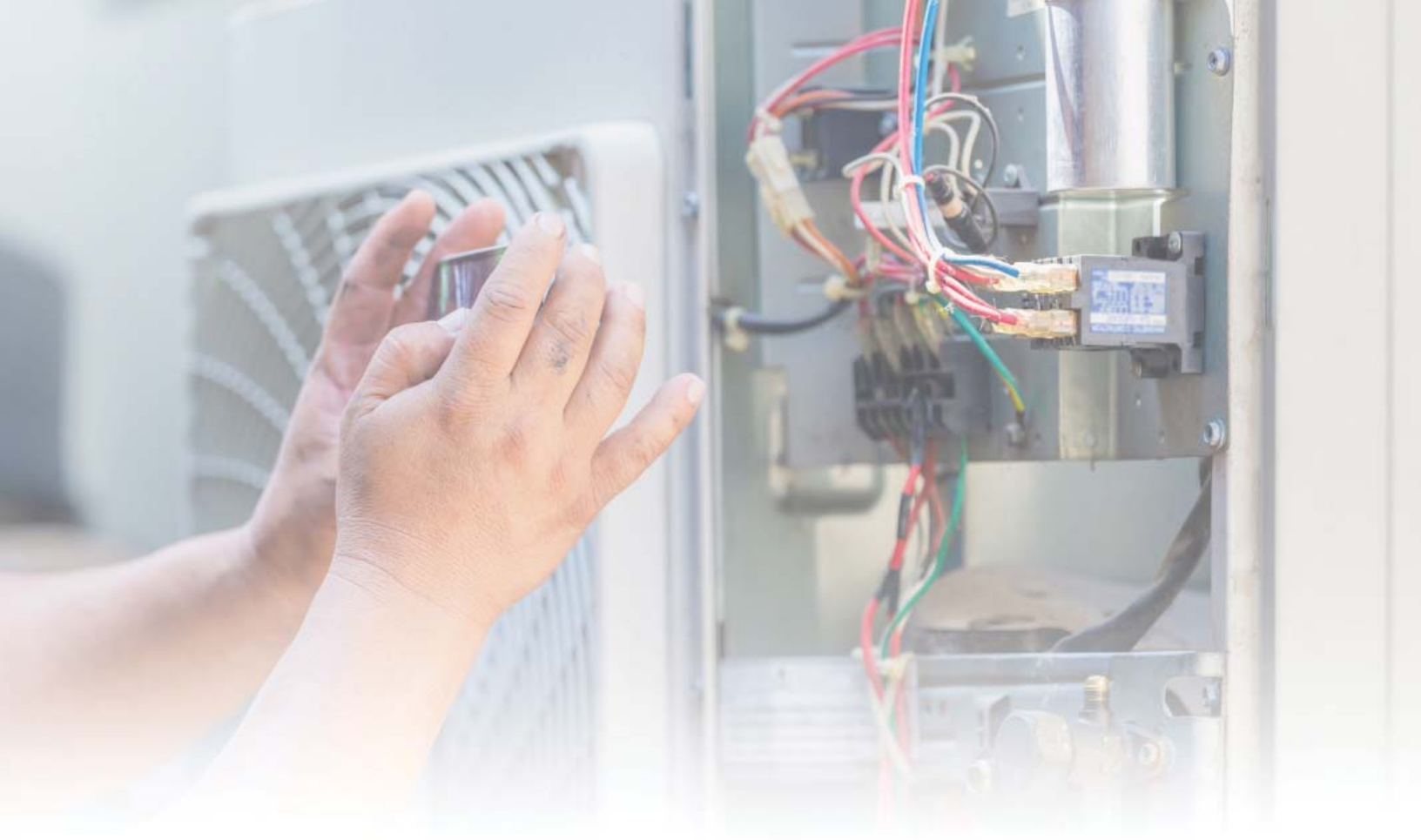
Last, but certainly not least, HVACR technicians must become fluent in the installation, configuration, operation, and troubleshooting of the advanced technologies used to connect HVACR components together and to the Internet. After all, advanced smart communications technologies lie at the very heart of Industry 4.0.

For example, HVACR technicians must learn how to set up Ethernet and WiFi networks, including configuring and testing Ethernet network addressing for connected HVACR devices. Once smart devices, components, sensors, and probes are connected, monitoring and communication must be configured via a variety of technologies and user interfaces, including software, mobile/cloud apps, and Bluetooth communications.

## **Modern HVACR Training: Evolving to Meet Future Demands**

In the next chapter, we'll take a closer look at how HVACR skills have been taught in the past. We'll also examine why new training systems are vital to modern HVACR training, including teaching critical Industry 4.0 skills.





## CHAPTER 4

# **OUT WITH THE OLD AND IN WITH THE NEW: WHY MODERN HVACR TRAINING PROGRAMS NEED TO EVOLVE**

In the previous chapter, we focused on why Industry 4.0 skills are a critical part of a modern HVACR training program. With the way Industry 4.0 technologies are revolutionizing industries everywhere, including HVACR, it's a good time to reevaluate HVACR training in general. Has the way HVACR skills have been taught in the past become outdated? Are there new tools and methods that can take HVACR training to the next level?

Whether you're updating a current HVACR training program or planning to build a new one from scratch, it's important to take a step back and try to see the bigger picture. It's very easy to get stuck in a rut and always do things the same way, but sometimes we need to take our focus off the trees and try to see the whole forest.

In this chapter, we will take a closer look at how HVACR skills have been taught in the past and highlight why it's so important for modern HVACR training programs to evolve, including the importance of giving the next generation of HVACR technicians practical, hands-on experience with modern equipment they'll encounter in the field.

## How Have HVACR Skills been Taught in the Past?

As we've covered in previous chapters, HVACR technicians must master a wide range of skills that span a variety of disciplines, including electrical, mechanical, print reading, etc. So how can schools and employers better prepare workers for the many HVACR technician positions available today and into the future?

Technical training is the answer. Unfortunately, not all training is created equal. The technical training for HVACR skills that has been around for many years often resembles a patchwork of pieces of courses stitched together into something instructors hope covers everything.

Teaching all the necessary skills HVACR technicians must possess to succeed requires a comprehensive approach. Future HVAC technicians need to learn troubleshooting skills using an approach that combines practical hands-on skills with theoretical knowledge. However, as instructors have learned, quality HVACR training is not a one-size-fits-all proposition.

As the Advanced Technology Institute (ATI) notes, “[p]eople learn in different ways. Some people learn by interacting with other students; some learn by getting their hands on real pieces of technology; others learn best by listening to a professor or instructor.”

According to the ATI, “[m]any people interested in a respected trade like HVAC[R] assume they can learn everything they need by just taking apart (and putting together) compressors, air handlers, heat pumps, furnaces and the like. In our age of computer-controlled devices, this is not true. Some theory is necessary.”

In addition to basic electrical and mechanical skills, HVACR technicians also need problem-solving skills that involve understanding computers, mathematics, logic, and science. For example, the ATI notes that, “[o]nce you understand things like the Ideal Gas Law and the various Laws of Thermodynamics, you can see them operate every day in cooling systems and heating plants.”

Too many HVACR training programs focus on either theoretical knowledge or hands-on skill development, but not both. As ATI concludes, “[a]n effective [HVACR] instructional strategy is to balance classroom time with hands-on lab time.”

Frequently, the hands-on skill development many students and workers receive comes in the form of working on old, broken equipment that has been donated for training purposes. In fact, many HVACR training labs resemble HVACR graveyards littered with the bones of obsolete systems. As we'll see in the next section, relying on donations of outdated equipment to teach hands-on skills only goes so far.

## Why are New Systems Vital to Modern HVACR Training?

While troubleshooting and repairing junk systems can certainly teach some important skills, these old pieces of equipment don't come with curriculum and they don't address the new technologies creating disruption in the HVACR world. That's why instructors get excited when they're fortunate enough to receive new equipment for training purposes.

Take Buckeye Career Center (BCC) in New Philadelphia, Ohio, for example. In 2018, a local company donated two heating and cooling units to BCC's HVACR lab. Instructor Matt McGraw notes how important such systems are for training: "I'm extremely grateful. It gives them (students) the ability to work on something new. The things that were in here were older and outdated. For them to see things that are up and coming in the industry, things that they're going to go out and see when they get jobs, it's extremely beneficial."

Unfortunately, not all HVACR training programs are as lucky as BCC. Nevertheless, all HVACR training programs can benefit from cleaning out the HVACR graveyard and investing in modern HVACR training systems that make high-quality training possible.

Students need hands-on experience with modern equipment with advanced technologies if they're going to make an immediate impact in the workplace. At its core, being a skilled HVACR technician is all about problem solving. Technicians must be able to arrive on site, inspect and diagnose a system to determine what's wrong, and then recommend the best solution for repair or replacement.

That's why HVACR troubleshooting skills are so critical. The rusty junk systems populating the HVACR graveyards in training labs across the country can provide a limited amount of troubleshooting skill development. But why settle for limited practice with a few obsolete systems?

For those who think it's enough just to teach the basics, it's important to remember that, while the basics are necessary and essential building blocks, students need to be prepared to work with advanced technologies they'll encounter on the job. HVACR companies need highly-skilled workers who can hit the ground running without extensive additional training.

## Can Industry 4.0 Skills be Taught with Old Equipment?

Today, HVACR technicians must be able to install, service, troubleshoot, and repair a wide variety of different types of modern components, including furnaces, air conditioners, boilers, heat pumps, refrigerators, coolers, freezers, humidifying units, and air filtration systems, many of which will feature advanced Industry 4.0 technologies.

What does that mean for modern HVACR training programs? It means that you can't rely upon outdated, obsolete systems to teach modern Industry 4.0 HVACR skills. If you were going to teach a modern class on electronics repair, would you fill your classroom with rotary phones and VHS VCRs? Of course not!

New HVACR technologies are becoming more and more complex. According to a recent article by Kevin Burns in The ACHR News, "many [modern] HVAC[R] systems are connected to the Internet of Things (IoT), with computers handling tasks for automatic temperature control and air quality...These days HVAC[R] technicians need more than the tools in their literal tool belt to deal with installation and maintenance — they need an education and understanding of the electronics and networks associated with modern systems."

Burns concludes, "[t]he best HVAC[R] technicians are those who have changed with the times; bringing a solid understanding of HVAC[R] mechanics to the table, while also pursuing training opportunities to stay up-to-date with the latest trends. While current HVAC[R] technicians aren't in danger of being replaced by robots, they may be outpaced by more tech-savvy peers if they don't pursue continued education. Above all, HVAC[R] technicians must be flexible and willing to learn in order to keep up with the fast-paced industry."

## Building Your Modern HVACR Training Program

In the next and final chapter, we'll provide a framework for building a modern HVACR training program. While it might seem like a daunting task, we'll explain why, with a trusted partner like Amatrol, starting or upgrading a modern HVACR training program is within the reach of any school or business.



## CHAPTER 5

# HOW DO I GET STARTED BUILDING A MODERN HVACR TRAINING PROGRAM?

In the previous chapters, we've focused on the critical role HVACR training plays in modern career and technical education, as instructors and trainers look to prepare the next generation of technicians for a quickly-growing HVACR industry.

We've also examined in-depth the foundational skills and basic to advanced HVACR-specific skills today's HVACR technicians must possess to succeed. In particular, we've stressed the need to teach modern Industry 4.0 skills, as the HVACR industry continues to incorporate advanced automation technologies into HVACR systems.

Given the changes taking place throughout the HVACR industry, it's time for instructors and trainers to take a fresh look at how they're teaching the knowledge and skills future workers will need. We've pointed out how relying on an HVACR "graveyard" of old equipment is no longer enough, especially to teach modern Industry 4.0 skills.

So what are instructors and trainers to do? Fear not. In this chapter, we bring everything together to explain how the experts at Amatrol can help you design and build a modern HVACR program, whether you're starting from scratch or revamping a current program.



## Do I Need to Recreate the Wheel?

Building a modern HVACR program from scratch or revamping a program that's been around for a while can both seem like monumental tasks, especially for busy instructors and trainers. Many people faced with such a task simply don't know where to start.

Fortunately, there's no need to recreate the wheel. Amatrol's unique combination of real industrial training equipment paired with cutting-edge eLearning curriculum can be used to create a modern HVACR training program that will set up students or workers for success.

With over 30 years of experience, Amatrol remains the world's leader in technical education. The experts at Amatrol regularly guide educational institutions and industry clients through the process of customizing training programs to achieve specific goals.

So, rest assured, you don't have to walk this road alone. Partnering with a proven expert in career and technical education is the first step toward creating a modern HVACR program that will prepare your students or workers for success in the workplace. The experts at Amatrol are ready to give you all the help you need.

## How Can I Create an HVACR Training Program That's Flexible?

If there's one old adage that instructors and trainers agree with wholeheartedly, it's this one: when it comes to learning, one size does not fit all. Students and workers will have a variety of learning styles and preferences.

Moreover, to prepare students and workers for modern HVACR careers, instructors and trainers must teach both theoretical knowledge and practical, hands-on skills. Finally, as the COVID-19 pandemic showed the world, a training program must also be flexible to accommodate remote learning when necessary.

Sound like a tall order? Setting up a flexible program that teaches all the relevant knowledge and skills could certainly be a daunting task if you had to do it all by yourself. Fortunately, Amatrol's approach to career and technical education boasts a unique combination of physical, hands-on training systems with multimedia eLearning curriculum.

Amatrol's eLearning offers flexible technical training through superb content with strong interactivity for skill development with 24/7 access. Eye-popping graphics, 3D simulations, videos, and complete explanations combine to develop technical skills for modern jobs.

Amatrol's hands-on training systems are designed by engineers and subject matter experts and loaded with real-world, industrial components for the closest possible experience to working on-the-job. They are heavy-duty and ready to stand up to frequent use and inexperienced users. For times when access to equipment is limited, learners can still gain hands-on experience using Amatrol's virtual simulators.

Amatrol's virtual simulators replicate hands-on equipment in such great detail that learners will feel like they are using the actual equipment. Learners perform essentially the same tasks using virtual simulators that they would using the hands-on systems.

Amatrol's training systems combined with eLearning curriculum and virtual simulators provides instructors and trainers a flexible framework to teach all of the relevant theoretical knowledge and hands-on skills students and workers need to hit the ground running in a modern HVACR career.

## How Can I Effectively Teach HVACR Skills?

The most effective way to teach the range of skills modern HVACR technicians need is by using a variety of technical training systems designed specifically to teach relevant knowledge and practical hands-on skills. Amatrol has been manufacturing such systems for decades.

In the paragraphs that follow, we'll take a brief look at the technical training systems Amatrol makes to teach foundational skills, as well as basic to advanced HVACR-specific skills. Let's start with some of the foundational building blocks we highlighted in a previous chapter:

### ***Basic Electrical***

Amatrol's Portable AC/DC Electrical Learning System (990-ACDC1) teaches the fundamentals of AC and DC electrical systems used for power and control in industrial, commercial, agricultural, and residential applications. The 990-ACDC1 offers industry-relevant skills including how to operate, install, design, and troubleshoot basic AC and DC electrical circuits for various applications.

### ***Basic Mechanical***

Amatrol's Mechanical Drives 1 Learning System (970-ME1) covers mechanical drive installation, mechanical drive operation, motor drive alignment, and applications of various motor drive systems. Learners will use the mechanical drives training system and the interactive online mechanical drives curriculum to gain theoretical knowledge and hands-on skills for shaft, belt, gear, and chain drives using real-world motor drive components. This hands-on mechanical drives skill-building system covers topic areas like mechanical drive systems, key fasteners, power transmission systems, v-belt drives, chain drives, spur gear drives, and multiple shaft drives.

### ***Print Reading***

Print Reading is a foundational skill used throughout many industries. Amatrol's Print Reading eLearning Courseware (M12207) covers topics like print dimensioning, assembly drawings and fasteners, and geometric dimensioning & tolerancing (GD&T). Learners using Amatrol's print reading training course will study sketching, multiview drawings, dimensioning rules, first-angle projection, holes and fasteners, assembly drawings, assembly tolerances, and feature control frames. From this building block, learners can practice industry-relevant skills like selecting the appropriate number of views for an object, interpreting information blocks on a print, and calculating the limits of a dimension given its tolerance.

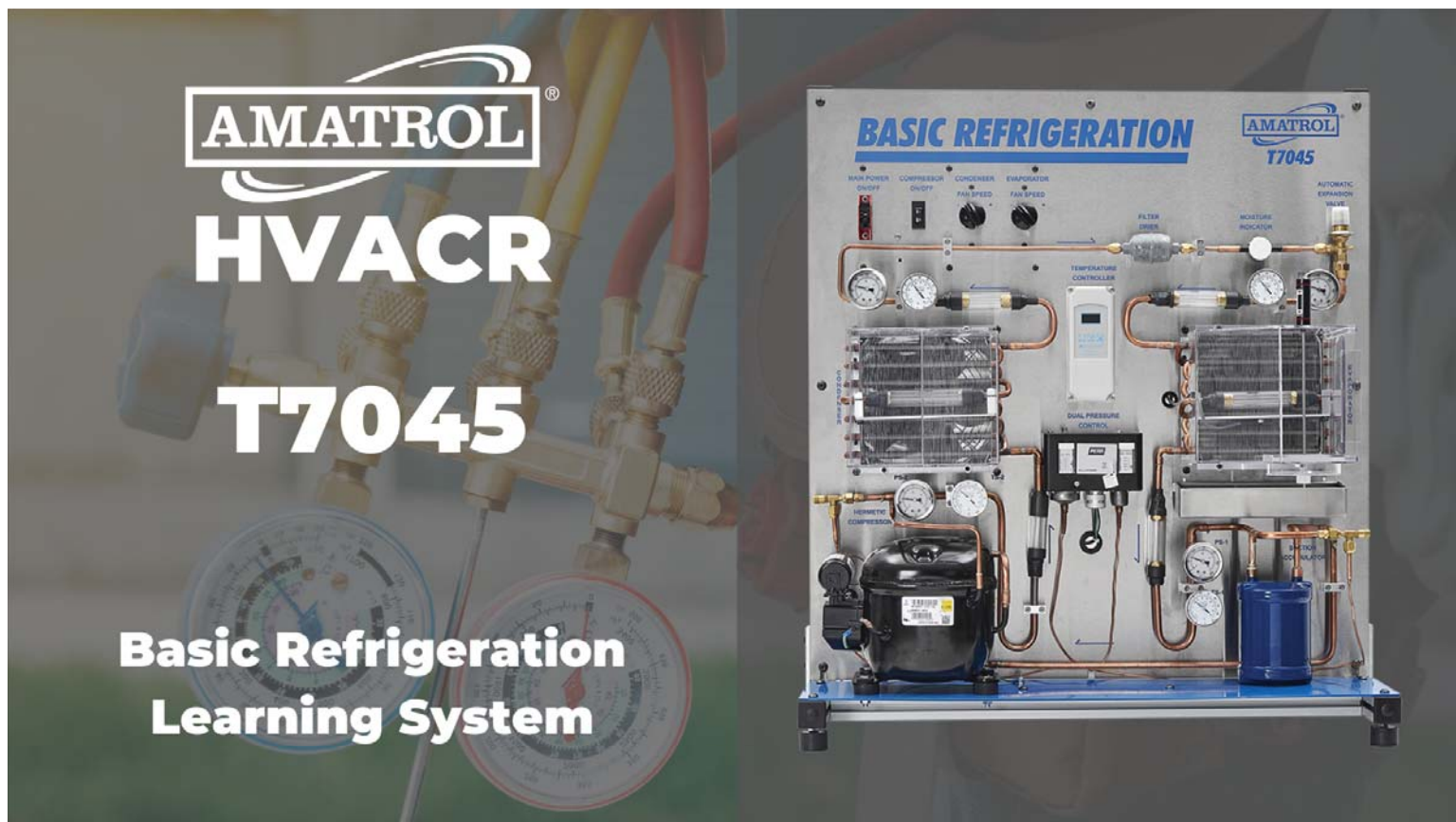
### ***Communication & Time Management***

Amatrol offers a variety of eLearning courses that teach so-called "soft skills," such as communication and time management, which are critical to success as an HVACR technician. For example, Amatrol's eLearning library features safety and workplace effectiveness courses, including: safety practices & regulations; hazardous communication; communication skills; conflict resolution; and working in groups.

In addition to these foundational subject areas, Amatrol has developed a range of training systems to teach basic to advanced HVACR-specific topics. Let's take a closer look at Amatrol's HVACR training systems:

### ***Thermal Science***

Amatrol's Thermal Science Learning System (T7081) provides the knowledge and equipment needed to comprehend the principles of modern thermal systems, such as HVACR, geothermal, refrigeration, and steam systems. As learners progress through the thermal science training curriculum, they will perform experiments demonstrating principles such as the ideal gas law, linear and volumetric thermal expansion, basic temperature measurement, latent and sensible heat, specific heat capacity, conduction, convection, radiation, evaporative cooling, and basic refrigeration.



### ***Basic Refrigeration***

Amatrol's Basic Refrigeration Learning System (T7045) teaches hands-on skills on a working refrigeration system in a compact tabletop unit. Skills delivered through this trainer are used by technicians in industrial, residential, and commercial HVACR settings, preparing learners for a continuously growing industry. This system is a fantastic starting point for future HVACR technicians as it covers both hands-on maintenance skills and technical refrigeration concepts and calculations.

## ***Air Conditioning & Heat Pumps***

Amatrol's Air Conditioning/Heat Pump Troubleshooting Learning System (T7082A) teaches valuable HVACR troubleshooting skills on a hands-on learning system that performs heat pump, air conditioning, and refrigeration operation. The T7082A utilizes FaultPro, the industry's only electronic troubleshooting system, to provide a hands-on experience for identifying faults such as blockages, leakage, and refrigerant overcharging and undercharging.

The Environmental Applications Learning System (T7083) adds on to the T7082A to teach a variety of additional skills. The T7083 is a model of a house complete with insulation, siding, shingles, and a window. Learners gauge how these features affect a home's temperature by checking digital thermometer outputs connected to various temperature probes throughout the trainer. Learners then use components such as a ceiling fan, attic exhaust fan, attic vents, and static cling window tint to change the home's temperature and to learn about concepts like heat loads, insulation effectiveness, humidity, air movement, heat transfer, psychometrics, and heat pump sizing.



### *Residential Heating & Cooling Systems*

Amatrol's Residential Heat Pump Troubleshooting Learning System (T7100) teaches critical HVACR skills related to residential HVACR systems that use a heat pump and traditional ducting. Learners will work with real industrial HVACR equipment, such as: a heat pump condenser, heat pump air handler, Wi-Fi-enabled thermostat, and ducting. The T7100 was also designed to include transparent housings, pipes, and ducting with LED illumination that allows learners to see inside the system.

The T7100's interactive multimedia eLearning curriculum covers a wide variety of fundamental residential heat pump topics, including: thermostat operation, pressure and temperature measurements, component tests, and system troubleshooting. The curriculum also focuses on the development of critical hands-on skills, including: operating a heat pump in heating and cooling modes, testing a thermostatic expansion valve, and troubleshooting insufficient cooling.





Amatrol's Residential Mini-Split Heat Pump Learning System (T7130) focuses on residential ductless ("mini-split") HVACR systems. Learners using the T7130 will work with real industrial HVACR equipment, such as: a heat pump condenser, evaporator unit, thermostat, panel-mounted gauges, and condensate pump. The T7130 also features transparent housings and pipes with LED illumination that allow learners to see inside the system.

The T7130's eLearning curriculum covers fundamental residential mini-split system topics, including: remote controller adjustments, heating and cooling modes, LED indicators, communication between units, and system troubleshooting. Learners can also expect to learn critical hands-on skills, including adjusting remote controller settings, verifying communication between indoor and outdoor units, and testing a four-way valve reversing valve coil.

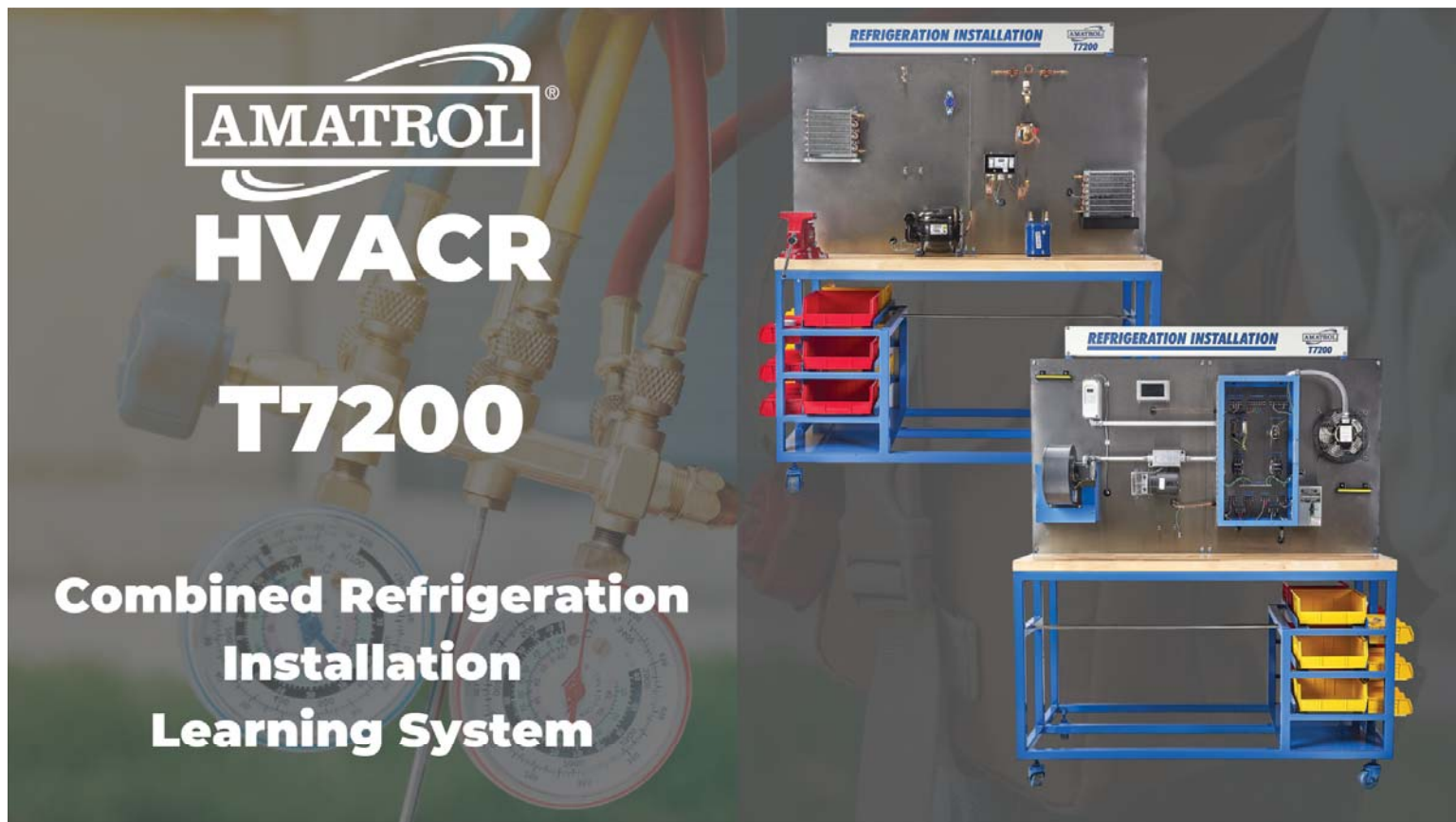




### ***Refrigerant Recharging***

Amatrol's Refrigerant Recovery and Charging Learning Systems for R-134a (T7031) and R-410a (T7032) teach future HVACR technicians critical hands-on skills related to system charging and refrigerant recovery. Learners using these systems will work with real industrial equipment, such as: a recovery machine, submersible cooler, temperature probe, filter dryer, electronic refrigerant scale, charging hose set, vacuum pump, and micron vacuum gauge.

The eLearning curriculum for the T7031 and T7032 covers relevant refrigerant recovery and charging topics, including: refrigerant fundamentals, leak detection, pressure and temperature measurement, refrigerant recovery and recycling, and refrigerant charging. Learners using these systems can also expect to learn critical hands-on skills, including using a compound gauge to measure refrigeration system pressure and removing a service valve core.



### ***Refrigeration Installation***

Amatrol's Combined Refrigeration Installation Learning System (T7200) offers a comprehensive hands-on workstation and interactive multimedia curriculum to teach installation of electrical and mechanical refrigeration/air conditioning components in residential or light commercial applications.

The Combined Refrigeration Installation Learning System includes evaporator and condenser coils, a hermetically-sealed compressor, a filter/drier, and many more real-world industrial components that allow learners to practice skills with components that they'll find on-the-job. The included multimedia curriculum covers topics like: copper tubing, refrigerant line routing and bending, flaring and swaging copper tubing, brazing and soldering refrigerant lines, and copper tubing insulation.

## **Commercial & Industrial Refrigeration**

Amatrol's engineering department is hard at work putting the finishing touches on three new advanced HVACR trainers coming soon, including:

- T7300: Smart HVACR Controls
- T7400: Commercial Refrigeration Troubleshooting
- T7500: Industrial Refrigeration Troubleshooting

## **Geothermal**

Amatrol's Geothermal Troubleshooting Learning System with Desuperheater (950-GEO2D) uses an exposed component layout so that learners can see each component's role in a geothermal system. Learners can easily observe, monitor, and test each component mounted and labeled on a vertical panel. Sight glasses installed in the 950-GEO2 allow the learner to see the refrigerant's changing state as it passes through the system. Amatrol also includes pressure and temperature gauges at key points to show the system's performance at a glance. Additionally, the system includes a custom designed, temperature-controlled ground simulator so the system can run continuously.

## **Steam**

Amatrol's Steam System Training System (950-SH1) introduces learners to the operation, installation, maintenance, and repair of steam systems and their application in paper mills, commercial and residential settings, power companies, and even nuclear submarines. Amatrol's exceptionally thorough curriculum covers a comprehensive range of steam system topics, including both practical applications such as how to operate a boiler and theoretical knowledge like the coefficient of volume and thermal expansion.

## Let Amatrol Help

Are you ready to either build a modern HVACR program from the ground up or clean out your HVACR graveyard and take your training program to the next level? If so, contact Amatrol today to learn more about its complete lineup of HVACR training systems.

A technical training expert will consult with you to determine how you can incorporate Amatrol's systems into a training program that will help you bridge the HVACR skills gap and prepare students or workers to succeed in the HVACR jobs of the present and future!

### *About Duane Bolin*

Duane Bolin is a former curriculum developer and education specialist. He is currently a Marketing Content Developer in the technical training solutions market.



2400 Centennial Blvd. • Jeffersonville, Indiana 47130 U. S. A.  
Phone: 812.288.8285 • Fax: 812.283.1584 • Toll Free in USA & Canada: 800.264.8285  
[www.amatrol.com](http://www.amatrol.com)