

# CAMT Training:

## Heating Systems Maintenance and Repair Course



Electric Furnace Heating | Electric Baseboard Heating | Gas Furnace Heating | Hydronic Heating

# INSTRUCTOR RESOURCE GUIDE



# CAMT Online Training

## Don't Forget...Take the Online Training for this CAMT Course!

To continue your education, you can also complete a brief online course on Heating Systems Maintenance and Repair.

This course will take approximately 30 minutes. You can access the course on your home computer, a computer in a public place such as a library, or a computer at work.

1. Go to the following web site: <http://www.naahq.org/cps>
2. Type the username and password you received.
3. Once you are logged in, you should see your **Dashboard**.
4. Your classes are listed under **Required Training**. You should be able to click on each learning track to access the modules.
5. Go through each learning track, and click on **Launch** to review each module within them. If the course does not open after clicking Launch, please make sure your pop up blocker is turned off.
6. After you complete each course, you are able to see it listed as **Complete** in the Learning track, as well as in Your Transcript.
7. If you have any issues, please contact [education@naahq.org](mailto:education@naahq.org).

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# CAMT Training: Heating Systems Maintenance and Repair Course

*The National Apartment Association Education Institute thanks you for attending today's Certificate for Apartment Maintenance Technicians (CAMT) course on Heating Systems Maintenance and Repair.*

*Whether you're a subject matter expert or lay person...a seasoned instructor or a new teacher...this guide will help you become an even more engaging and effective trainer.*

In this course on heating systems, you'll help maintenance technicians:

- Understand their role in heating repair and maintenance.
- Learn more about the most commonly used heating systems in apartment communities.
- Perform heating repairs with greater ability and confidence.
- Pursue the Certificate for Apartment Maintenance Technicians (CAMT) designation.

Although this course is targeted at technicians with one year of on-the-job experience, it can also be used to teach others who'd like to learn more about heating maintenance and repair.

## **Prerequisite: The CAMT Electrical Maintenance and Repair Course**

Participants need a solid foundation in electrical work to successfully understand and apply what's taught in this heating course. That's why we strongly recommend they complete the CAMT "Electrical Maintenance and Repair" course beforehand.

## **Guide Contents**

- Course overview
- Preparation instructions
- Course schedule
- Instructor script
- Appendix

# Fast Facts: The Heating Systems Maintenance and Repair Course

## Course Type

- Instructor-led classroom training
- Uses short presentations, photos, videos, demonstrations, participant discussions, hands-on activities, and question and answer sessions to teach course material

## Course Materials

- This instructor guide
- *The Heating Systems Participant Resource Guide* (also for use as an on-the-job reference)
- CAMT USB flash drive

## Course Length

Approximately 8 1/2 hours

## Best Way to Schedule

- Two five-hour sessions (include one 20-minute break in each session)

## Course Location

If your area doesn't have a CAMT training center, use the facility your affiliate provides and equip it with training and demonstration materials. (See the "Training Kit" section on the next page.)

Also consider touring a local apartment community so participants can see heating systems in their real-world context. Not only will this enrich the training, but it will also help the learning stick.

## Subject Matter Experts

Invite a subject matter expert—a current or retired heating contractor or a trade school instructor—to volunteer his or her time to participate in the instruction. Experts are especially helpful for answering participants' questions, giving real-world tips and tricks, and talking about industry trends. (Check with your affiliate if the expert requires compensation for helping with the course.)

## Demonstrations and Hands-on Practice

Several topics in this course include a brief demonstration or a suggested hands-on activity to let participants actually see or do the repair.

If you can include these elements in your training, it will elevate the participants' learning experience. Hands-on practice is especially valuable because participants will get a chance to try out the skills they've learned in a safe environment, where mistakes do not have potentially serious consequences.

Demonstrations and hands-on practice, however, will require more planning and preparation on your part—and most likely, support from your NAA affiliate.

# **Fast Facts:** **The Heating Systems Maintenance and Repair Course** (continued)

## **Training Kit**

If you choose to conduct the recommended demonstrations and hands-on practice activities, work with your NAA affiliate to put together a kit of tools, materials, and equipment for the training. This kit won't be expensive, but it'll take some planning and time to complete.

Refer to the appendix for more details.

## **Online Training Scenarios**

To reinforce what they've learned in the classroom, participants will complete 30 minutes of online training at home or back on the job. In this training, participants will troubleshoot two common but challenging heating system problems.

For more details on this training—and how to present it to participants—please see page 65 of this guide.

# Preparing to Teach the Course

*To give course participants a first-rate learning experience, plan to spend several hours preparing to teach this class.*

## When to Prepare

Depending on your experience with this course, begin preparing one to two weeks before the scheduled course date. That's enough time to absorb the material without feeling rushed.

## How to Prepare

- **Read the instructor guide carefully.** Get familiar with the organization and flow of the course, as well as the content and the leader's instructions.
- **Look for ways to personalize the instruction.** Add your own stories, examples, and insights. Make the material come alive for the participants.
- **Mark up this guide. Write notes throughout.** Write notes throughout. Highlight passages you want to emphasize. Add prompts for your examples and explanations.
- **Practice.** Do a dry run of the material (or at least some of it) in front of willing colleagues or family members. Get their feedback. Find out: What are you doing well? What's one thing you could improve?

## When It's Time to Teach the Course

- **Use this instructor guide.** Refer to it often to keep the class on track. Using notes will make you look natural, relaxed, and confident.
- **Approach the course as a conversation, not as a presentation.** Keep things open and easygoing. Pick yourself up if you make a "mistake." Answer the questions you can. Most important, avoid the temptation to be the expert—simply share what you've learned.
- **Keep participants actively involved.** Allow participants to ask questions, share ideas with one another, and get as much hands-on experience as possible. Remember: telling isn't training.
- **Be yourself.** Participants appreciate (and learn more from) instructors who are not only knowledgeable, but also approachable, personable, and dedicated.

# Preparing the Classroom

*To complete your final preparations, arrive at the training site at least one hour before class begins.*

## Find the Location of these Public Facilities or Services

- Rest rooms
- Kitchen facilities or vending machines
- Emergency exits

## Prepare Materials

- *Heating Systems Participant Resource Guide* for each participant
- *Heating Systems Instructor Guide* (with all your preparation notes in it)
- CAMT USB flash drive
- Training kit (make sure you have the right tools, materials, and demonstration equipment for this class)
- Sign-in form (to be turned in to the affiliate office after class)

## Prepare and Test Equipment

- Computer with projector
- Flipchart with stand or whiteboard
- Markers
- Microphone or sound system (if needed)

## Prepare a Learning-Friendly Classroom

- Arrange the tables and chairs in the room so that participants will be able to easily see and hear the videos, take notes, and talk with one another.
- Make sure the room isn't too hot or cold.
- Ensure there's adequate lighting.
- Write the day's training agenda on the flipchart or whiteboard.

## Course Schedule-at-a Glance

*The total classroom training time for the Heating Systems Maintenance and Repair course is approximately 8 1/2 hours, typically delivered in two half-day sessions.*

*The schedule below will help you plan your sessions.*

<b>Day 1</b>	<b>Time Needed</b>	<b>Topic</b>
	30 minutes	Welcome and Introduction
	30 minutes	Heating: You Are Here
	30 minutes	Heating Safety
	15 minutes	Key Heating Tools
	15 minutes	Heating Basics
	1 hour	Air Distribution
	30 minutes	Basic Heating System Components
	15 minutes	Heating Systems Basics
<b>Day 2</b>	<b>Time Needed</b>	<b>Topic</b>
	1 hour	Electric Furnaces
	45 minutes	Electric Baseboard Heating
	1 hour	Gas Furnace Heating
	1 hour 30 minutes	Hydronic Heating
	30 minutes	Key Takeaways, Action Plan, and Wrap-Up



# Instructor Script:

## Welcome and Introduction (30 minutes)

*In this brief opening section, you'll welcome participants, introduce yourself, and set the stage for the "Heating Systems Repair and Maintenance" course.*

### Leader's Instructions:

Welcome participants to the course. Introduce yourself to the class, and then proceed with the script below.

Dive in...you're going to do just fine!

Welcome. My name is \_\_\_\_\_, and I'll be your instructor for this CAMT course on repairing and maintaining heating systems.

This course contains a little general science, a little mechanical reasoning, and a good dose of practical application to help you tackle the most common issues related to heating systems. When you've completed the course, you'll be well on your way to heating systems mastery.

While this course will touch on the key types of heating systems used in apartment communities, we may spend more time on topics that fit your particular situation. So let me take a quick poll now.

### Leader's Instructions:

Conduct a quick show-of-hands poll to find out which types of heating systems participants have in their apartment communities. Ask about:

- Electric baseboard heating
- Electric furnace heating
- Gas furnace heating
- Hydronic heating

The poll results will help you understand where to best spend the course time.

Thank you for helping me out.

With that brief introduction, we've set the stage for the course. Now, I'd like to get to know a little more about you.

# Instructor Script:

## Welcome and Introduction (continued)

### Participant Introductions

#### Leader's Instructions:

It's time to go around the room and conduct those beginning-of-the-course introductions. This activity has three parts:

1. Ask participants to share their name, the name and location of their employer, and their experience with heating systems during their time as a technician. This will give you a sense of the depth and breadth of knowledge in the room.
2. Introduce any subject matter experts who may be participating in the class. Have the experts share a few words about themselves.
3. And finally, tell participants more about yourself. Talk about your experience in the apartment industry, with training, or with heating systems. Talk a little about your life away from work, too.

Thanks for doing that. It's nice to get to know all of you better.

### A Closer Look at the Training

Now, let's take a few minutes to look more closely at this heating systems training.

Turn to page Welcome i in your *Resource Guide*, so we can see how this entire course lays out.

#### Leader's Instructions:

1. Cover the course schedule, which you'll find on page vi of this guide.
2. Go over the day's agenda, which you will have written on the flipchart or whiteboard.
3. Let participants know about the scheduled breaks and lunches for the day—and how you'd like participants to handle any "unscheduled" breaks, such as the need to make a phone call.
4. Ask for any questions.

Throughout the course, we'll be doing a variety of things to help you master the material:

- Using the *Resource Guide*
- Watching in-class demonstrations and videos
- Having group discussions
- And doing hands-on activities

All I ask is that you participate fully. That means stay with us, both mentally and physically. Ask questions. Share your tricks and tips, as well as your own experiences. Tell us about the things that have worked well on the job, and the things that haven't.

You'll only get out of this class what you put into it, so give everything you can.

### Housekeeping Items

We're almost ready to dive into today's activities, but before we can do that, I need to cover a few housekeeping items, just to answer any logistical questions that may be lingering in your mind.

#### Leader's Instructions:

Cover any other remaining housekeeping items, such as the location of the rest rooms, emergency exits, and kitchen or vending machine facilities—as well as any registration or sign-in activities. Ask for any questions before moving on.

# You Are Here: Heating Maintenance and Repair

## (30 minutes)

*In this part of the training, you'll bring it all home to the aspiring CAMTs by talking about their roles and responsibilities as they relate to heating maintenance and repair.*

### Leader's Instructions:

Instead of just lecturing participants on their heating repair and maintenance responsibilities, ask them to give you the answers. By allowing participants to talk, they use (and show off) their experience—and you actively involve them in the course. That's important, because involvement is key to an engaging classroom experience.

By the way, this ask-a-question approach is easier for you, too. Rather than having to convey all sorts of information, you only need to fill in what the participants missed. But have a little patience—it may take participants a while to formulate their answers after you've asked your questions.

Just follow the script below, and you'll be great!

Let's set the stage for everything you'll be learning in this course by relating it back to what you do on the job. In other words, let's talk about a maintenance technician's roles and responsibilities as they relate to maintaining and repairing heating systems.

I'm going to start things off by talking about one important responsibility: working safety. Heating repairs can be a dangerous thing, and you'll always need to follow the safety procedures we'll be covering today, as well as those that your company has instituted.

**No matter how busy you may be, you can never take shortcuts.** Your personal safety depends on it. Your residents' safety depends on it. And keeping the building in excellent shape depends on it, too.

So safety is one of your key roles and responsibilities. Now, it's time to tell me about your other responsibilities by sharing your experiences with us.

Turn to page 1 in your *Resource Guide*, and take notes as the discussion unfolds.

### Leader's Instructions:

1. Ask participants: "Besides working safely, what are your other key roles and responsibilities as they relate to maintaining and repairing heating systems?"
2. Accept all reasonable answers, but make sure participants touch on these:
  - Doing requested and *permitted* repairs (e.g., replacing switches, etc.)
  - Completing preventive maintenance tasks
  - Completing "make-ready" maintenance when an apartment turns
  - Performing unscheduled or emergency maintenance
  - Educating residents on heating issues as needed; answering their questions
  - Complying with state and local regulations and building codes
  - Following company policies and procedures related to handling and documenting service requests, keeping maintenance records, and working with outside contractors like heating contractors
3. When the responses are no longer forthcoming, fill in any answers you may need to.

Thanks for helping me build such a complete and accurate list of your roles and responsibilities.

# You Are Here: Heating Maintenance and Repair (continued)

## When to Call a Heating Specialist

Now, let's tackle a related question: when to call a heating contractor or repair specialist. Follow along on page 2 of your *Resource Guide*.

You'll need to call a heating specialist when:

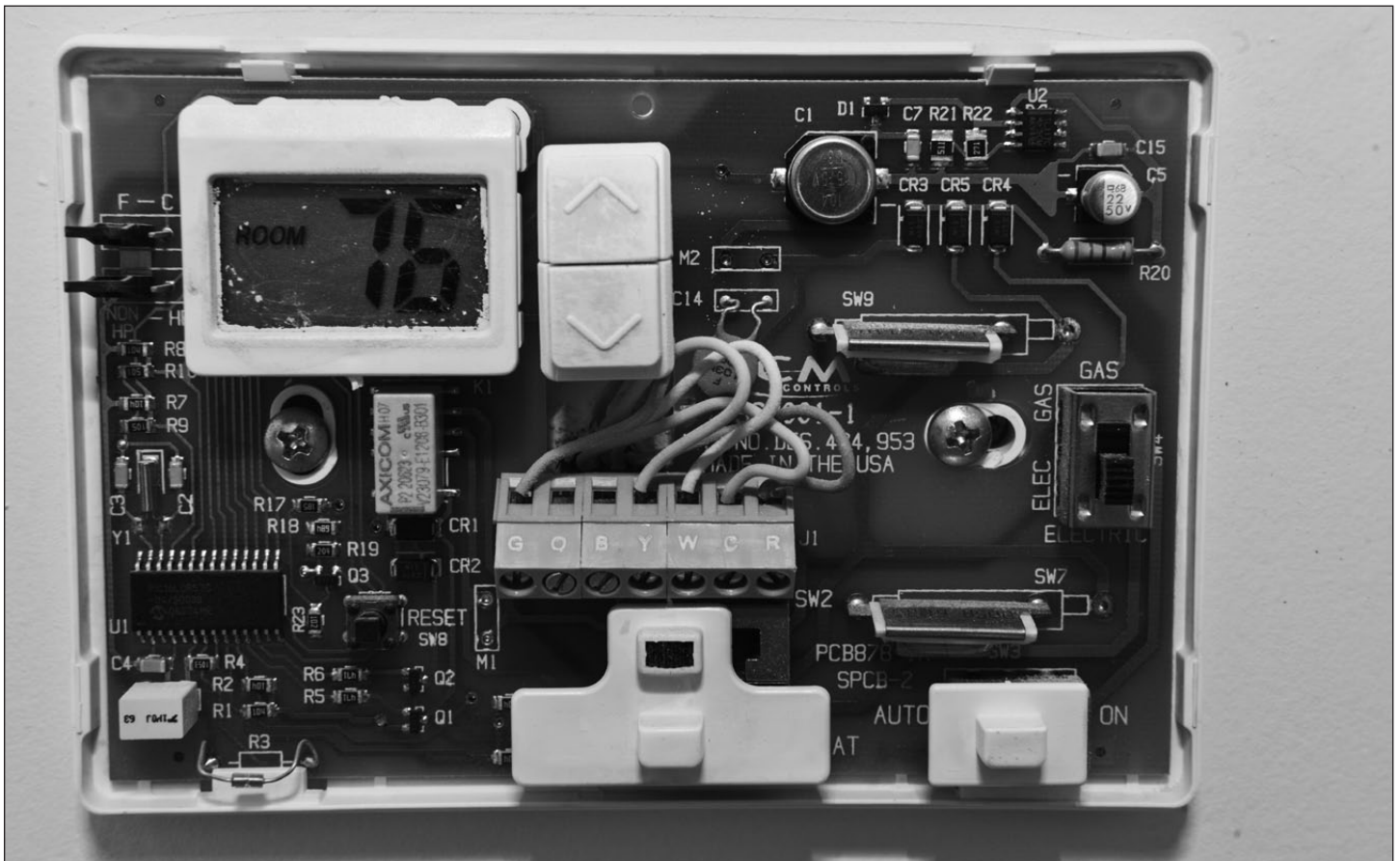
- State or local regulations require it.
- You don't know how to do the repair—or feel uncomfortable doing it.
- Your workload is too heavy, or you can't do the repair quickly enough to satisfy a resident.
- The job is physically too big for one person.
- When the broken item is still under a warranty.

If a specialist comes on site to do a repair or replacement, watch what they're doing and ask questions—you might be able to do some or all of the work if it happens again.

### Leader's Instructions:

Ask participants: "Can you think of any other times when you might need a heating specialist?" Accept all reasonable answers, and then move on.

That concludes our discussion on roles and responsibilities. Can I answer any questions before we move on?



## Heating Systems Safety (30 minutes)

 Slides 4 - 6

*In this part of the training, you'll teach participants how to work safely as they perform heating maintenance and repairs.*

### Leader's Instructions:

To keep participants involved in the learning—and again, to take advantage of their experience—consider teaching this information by asking them about it.

Have participants close their *Resource Guides*, then ask: “When you’re repairing heating systems, what sort of safety precautions do you take?”

Let participants tell you what they do, then fill in any gaps using the safety information that follows.

### Introduction

There are a number of hazards—primarily related to gas and electricity—to take seriously when you’re repairing heating systems.

You need to be aware of these hazards and protect yourself from them.

Turn to page 3 in your *Resource Guide*, so we can go over the key safety rules.

### Safety Rule #1: When performing repairs on equipment, always turn off any source of energy

This may mean more than just turning the power off at the breaker. It will include gas or water depending on the type of equipment being serviced.

Once the energy source has been removed and before any service can continue, a technician verifies that any “hidden” energy, such as electricity, has in fact been removed. To perform this verification, use a Multimeter, or voltage tester.



## Heating Systems Safety (continued)

### Safety Rule #2: Wear Personal Protective Equipment (PPE)

Wear the proper personal protective equipment to protect yourself from sparks, chemicals, cuts and scrapes, and burns.

This equipment includes:

- Gloves
- Eye shields or goggles
- Masks to cover your nose and mouth.

In addition, wear appropriate footwear. Make sure you have a sturdy shoe with a protective toe box and a non-slip sole.



# Heating Systems Safety (continued)

## Safety Rule #3: Follow Lockout/Tagout Procedures

Lockout/Tagout is a safety procedure to make sure that power and energy sources, such as gas, water or electricity, are properly shut off and secured.

You'll use lockout/tagout procedures when doing heating repairs, such as when you're working on an electric baseboard heater.

### Lockout Devices and Tags

The typical lockout devices you'll use include:

- Padlocks
- Gate and ball valve lockouts
- Circuit breaker lockouts
- Chains
- Cable
- Plug lockouts

Lockout tags are usually brightly colored so you can immediately see and identify them.

Your company may have lockout/tagout kits they want you to use. Check with your supervisor when you're back on the job.



### Where to Place Lockout Devices and Tags

Lockout devices and tags are typically applied to shut-off valves, plugs, or main service panels.

### How to Lock and Tag Out

Your employer is required to train you on the complete lockout and tagout process. But here's a high-level look at how it's done:

1. Shut off the source of the electrical or water power.
2. Attach a lockout device to this source, then lock and tag it.
3. Release or drain any energy left in the electrical or plumbing lines or equipment.
4. Test to be sure the energy is turned off and removed from the pipes, circuits, or equipment.

Once these lockout/tagout steps are complete, you can go ahead with the repair.

## Heating Systems Safety (continued)

### Safety Rule #4: Keep Tools and Equipment in Good Working Order

You'll use a variety of tools to maintain and repair heating systems. Keep your tools, and their safety features, in good working order.



### Safety Rule #5: Do Not Take Shortcuts or Bypass Safety Features in Heating Systems

It may be tempting to bypass or remove a safety device in a heating system to speed up repair time. Don't ever take these shortcuts, because they could lead to a heating fire.

Heating fires are caused by functioning or malfunctioning central heating units, fixed or portable units, fireplaces, chimneys, and water heaters. They are the second leading cause of home fires; only cooking-related fires are more frequent.

In the United States, a home fire is reported every 79 seconds and takes the life, on average, of ten people each day. More shockingly, **fixed and portable heaters are involved in 74% of fire-related deaths.**





## Group Discussion on Heating Systems Safety

*Now that you've covered the baseline information on heating safety, capitalize on a key benefit of classroom learning—that is, the chance for people to learn from one another—by conducting a spirited and focused group discussion.*

### **Leader's Instructions:**

Hold a 10-minute discussion on heating safety. You can do this in a variety of ways, such as:

- Presenting additional material on heating safety, or having an invited subject matter expert do it. For example, you may discuss the National Fire Protection Agency (NFPA) codes that affect heating repair.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best “tips and tricks” related to heating safety.

Let participants know the how the discussion will work, and encourage them to take notes on page 7 of their *Resource Guide*.

## Key Tools for Heating Repairs (15 minutes)



The aspiring CAMT needs to be well and safely equipped to perform heating maintenance and repairs. In this part of the training, you'll explain the key repair and testing tools every technician needs.

### Leader's Instructions:

You'll need several tools to repair and maintain the heating systems in your apartment community.

The good news is you can do many repairs with the hand tools you already have. Just add a few specialty tools, and you'll be well-equipped for any heating repair that may come your way.

Turn to page 8 in your *Resource Guide*.

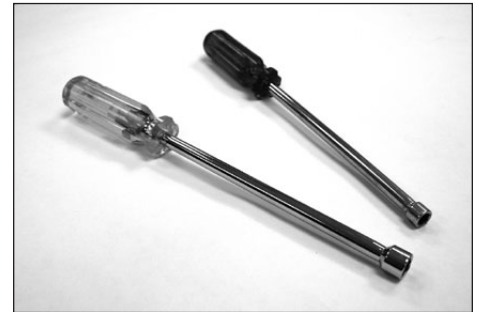
### The Basic Hand Tools



**Slotted and Phillips screwdrivers**, or a 6-in-1 tool, can help you with many repair tasks.



An **adjustable wrench** has a movable jaw that lets you fit the wrench to many sizes of nuts and bolts.



A **nut driver** is the same as a screwdriver, except that it has a hexagonal socket on the end. You'll find the 1/4" and 5/16" sizes especially helpful.



A **tongue and groove pliers** has a movable handle that lets you adjust the jaws for maximum gripping strength.



A **needle-nose pliers** has thin jaws for grabbing small things.



A **utility knife** has a sharp single-edge razor that can be used to cut a variety of materials.

# Key Tools for Heating Repairs (continued)

## The Basic Hand Tools



**Lockout/tagout kits** identify that a power source, such as a main shut-off valve or circuit breaker, is shut off and secured.

A **wire splicer** or crimper can help you complete repair tasks that involve splitting, connecting, or bending wire.

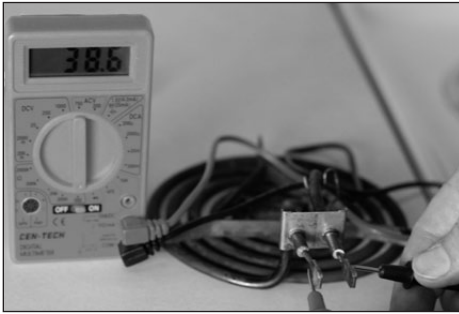
### Leader's Instructions:

Ask participants: "What other hand tools would you recommend for heating repairs?"

Add your own recommendations, too.

# Key Tools for Heating Repairs (continued)

## Specialty Heating Repair Tools



### Leader's Instructions:

Ask participants: "Are you unfamiliar with any of these tools?"

Be sure to show participants how to use key tools, such as the multimeter, if they haven't previously used them.

A **multimeter** is a "must-have" tool used to measure electrical voltage, test for continuity, and test resistance in devices like heating elements.

A **special tool for opening baseboard or other terminal units** often comes with the unit itself. A screwdriver can be substituted in its absence.

A **carbon monoxide tester** may be handy when working on gas furnaces.

## Heating Basics (15 minutes)

*Heat is an absolute necessity in many parts of the country during seasons where low temperatures occur. Its presence or absence can have a huge effect on a resident's comfort level in their apartment. In order to have a positive effect on our residents' comfort, we have to understand some fundamentals before we can study individual systems.*

### Leader's Instructions:

Earlier, you asked participants what types of heating systems their apartment communities have. As you begin this “nuts and bolts” part of the training, focus the time on the systems participants actually work with, but at least touch on all types.

## Heat

The basic definition for the term “heat” is simply a measurement of the amount of energy that a substance contains. The numerical value that we give to how much heat is contained is called temperature.

When heat energy is applied to a substance, the molecules of that substance start to move more rapidly. They collide with each other, and this friction causes the temperature of the substance to rise. Conversely, when the heat energy is removed, the molecules slow down and the amount of friction decreases.

Heat energy cannot simply appear or disappear without a form of mechanical help; in other words, we must use some method to add or subtract heat in the living space. To accomplish this we must understand that **heat will always move from a higher temperature to a lower temperature**. This means that in order for the temperature of a room to increase, there must be something with a higher temperature than the room adding heat to it. This higher temperature item is referred to as a heating system or heater.

Once a heating system produces heat, that heat must leave the heater and enter the living space to increase its temperature. The heat will move by one of 3 methods:

- Conduction: Heat moving through a solid object
- Convection: Heat transfer by way of air or water movement
- Radiation: Heat transfer through direct energy waves

## Heat vs. Comfort

Have you ever gone into a room and heard someone remark that they wished the heat would be turned up... while others in the same room would make the exact opposite request? As maintenance technicians we must have a basic understanding of the difference between heat and comfort.

While heat is a specific number, comfort is much more subjective, meaning that each resident may have a different opinion about the way a room “feels”. This difference can be caused by several factors, some of which are affected by our HVAC equipment. A few of these factors are:

- Temperature – Quantity of heat in the space (warm or cool)
- Humidity – Quantity of moisture in the air of the space (damp or dry)
- Air Circulation – The rate at which the air moves in, into, and out of a room (stale or drafty)
- Filtration – The removal of irritants in the air (dusty or clean)

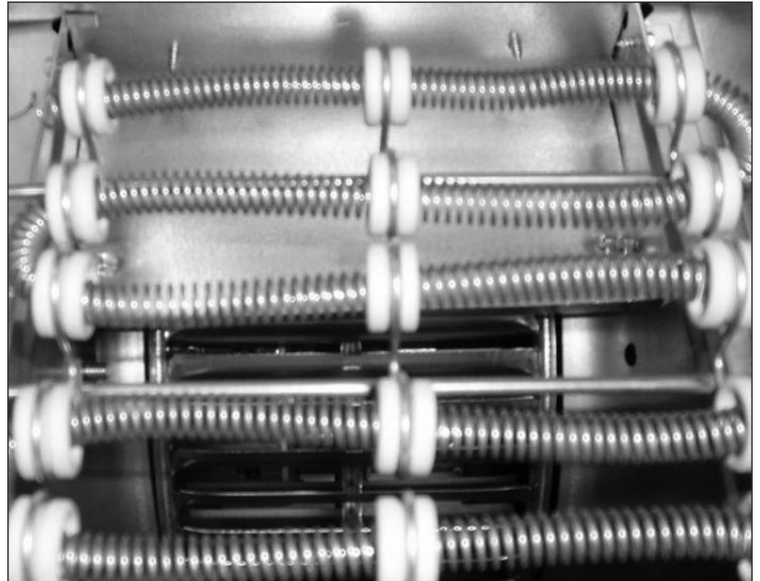
## Heating Basics (continued)

### Heat vs. Comfort (continued)

Factors that affect our residents' comfort that are beyond our control as Maintenance Technicians are biological in nature and may include:

- Age
- Gender
- Body size
- Medical

We must focus on correcting the mechanical heating system with the understanding that we cannot change our residents' biology.



### Types of Heating Systems

Although there are many different types of heating systems, we're going to focus on the following:

- Electric furnace (forced-air)
- Electric baseboard
- Gas furnace (forced-air)
- Hydronic

Electric systems are relatively simple to maintain and repair, while gas and hydronic systems are more complex.

The type of heating system used in a building depends on its age, the cost of electricity versus fossil fuels in the area, and the type of utility billing system the community uses.



Each of these systems relies on air to carry the heat throughout the living space. Some of the systems rely on forced-air circulation, while others may only use convection to heat up the room.

Before we look at each system with any specific depth, let's take a look at air distribution and the common components that a Technician will see in each of these systems.

## Air Distribution (1 hour)



Slides 8 - 9

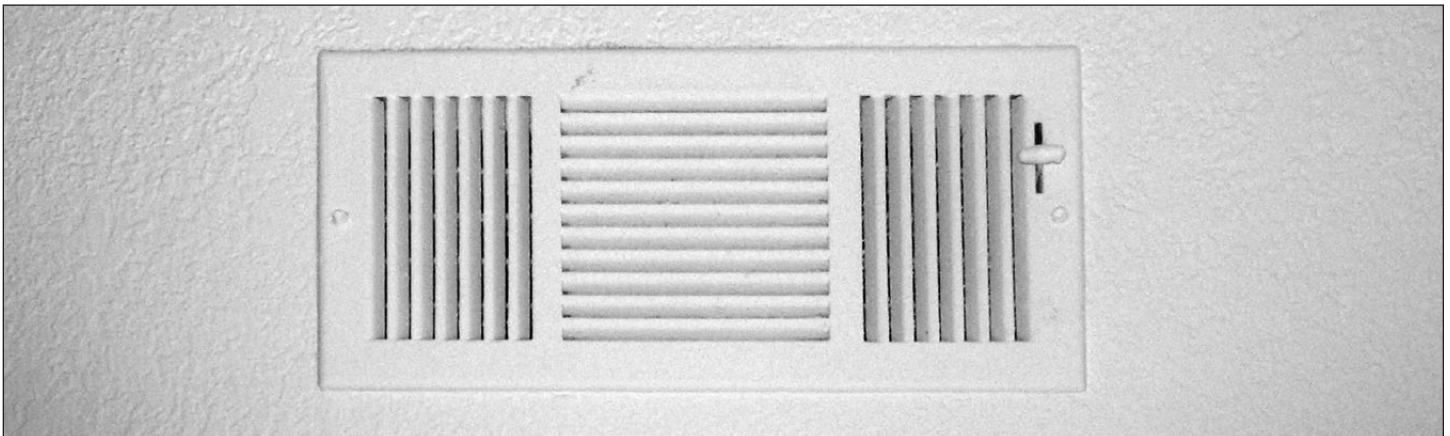
*As noted in this section, air circulation and distribution is an important part of removing heat from a living space. Let's take a look at the specific function of air movement and common air flow problems and solutions.*

### Leader's Instructions:

Work with your local affiliate to obtain a direct drive blower to support this instruction. You can work with various suppliers, who may be willing to donate new, used, or ready-to-recycle blowers.

Spend about 30 minutes comparing the diagram in this section to the actual unit. That way, participants will "experience" each part of the blower as you describe it.

### The Big Picture



Turn to page 13 in your *Resource Guide*.

When the living space in an apartment requires for the temperature level to decrease or for the humidity to be removed, one of the first operations to occur is for the fan to be turned on. This action achieves the desired result because air is used as the "carrier" for heat or moisture removal. In a standard air conditioning system, whether it is a small window type unit, split system, or even a large chiller, the movement of air is required for any conditioning to occur.

Inside the apartment, air is removed by a blower from the living space and forced through the evaporating coil. This will enable the air to lose heat, as the coil is a lower temperature (heat always transfers from a higher temperature to a lower temperature). In addition to this heat transfer, moisture in the air condenses out of the air onto the surface of the coil. The moisture, or condensate, runs down the evaporating coil where it is drained into a condensation pan. The lower-temperature, drier air is then circulated back to the living space in the apartment, thereby lowering the temperature of the apartment.

On the outside of the apartment or living space, air circulation is just as important. Outside air is pulled or pushed by a fan through the condensing coil. Due to this coil's higher temperature than the outside air, heat is removed from the coil and is carried away by the air. This explains why you feel warm or hot air coming off of the top of this outside unit.

In truth both inside and outside units are self-contained, meaning that they don't share any air. Instead, the only thing that moves from inside to the outside is heat.

In this part of the training you'll learn more about the systems that cause this air movement, particularly the blower assembly and the key operations of the motors that are used in air distribution.

## Air Distribution (continued)

Inside a blower assembly there are 2 types of motors that may be found. It is important to be aware of these types as troubleshooting each of them has separate procedures.

- PSC motor: Permanent Split Capacitor motor
  - A PSC motor is the most common type of motor currently in use for blowers found in the apartment industry.
  - This motor type is identifiable by the capacitor that is connected to the motor and must be present for this motor to operate.
  - Speed is determined by individual circuits. Common speed circuit colors(on the motor\*\*\*):
    - Black = High
    - Blue = Medium
    - Red = Low
- ECM: Electronically Commutated Motor
  - An ECM is a more efficient motor that is replacing PSC motors in many applications
  - This motor type is identifiable by the control module that is attached to the back end of the motor
  - Speed is determined by the programming of the control module. (120v or 240v Power\*\*\* is constantly supplied, control voltage determines program, program is set by mfg.)

\*\*\*verify to manufacturer specifications

### **ATTENTION!**

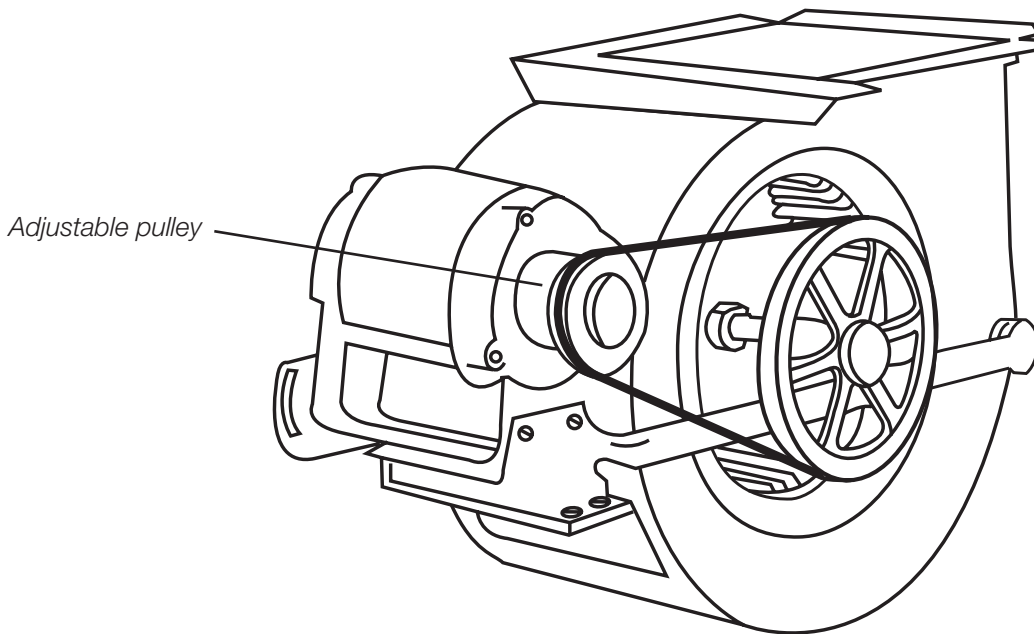
Both ECM and PSC Motors require a capacitor for operation. Before performing ANY service on a motor, follow Lock Out Tag Out procedures, and verify that the capacitor is discharged. Failure to do so is extremely dangerous.



## Air Distribution (continued)

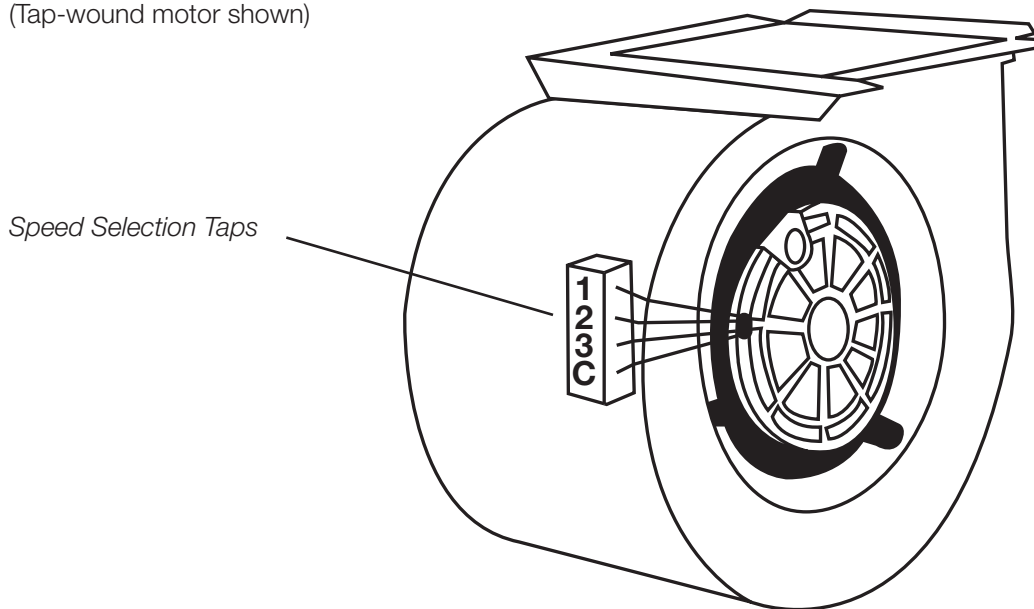
There are two types of blowers: belt drive and direct drive. In this training, we'll be focusing on direct drive motors, the type most commonly found in apartment communities.

### Belt Drive



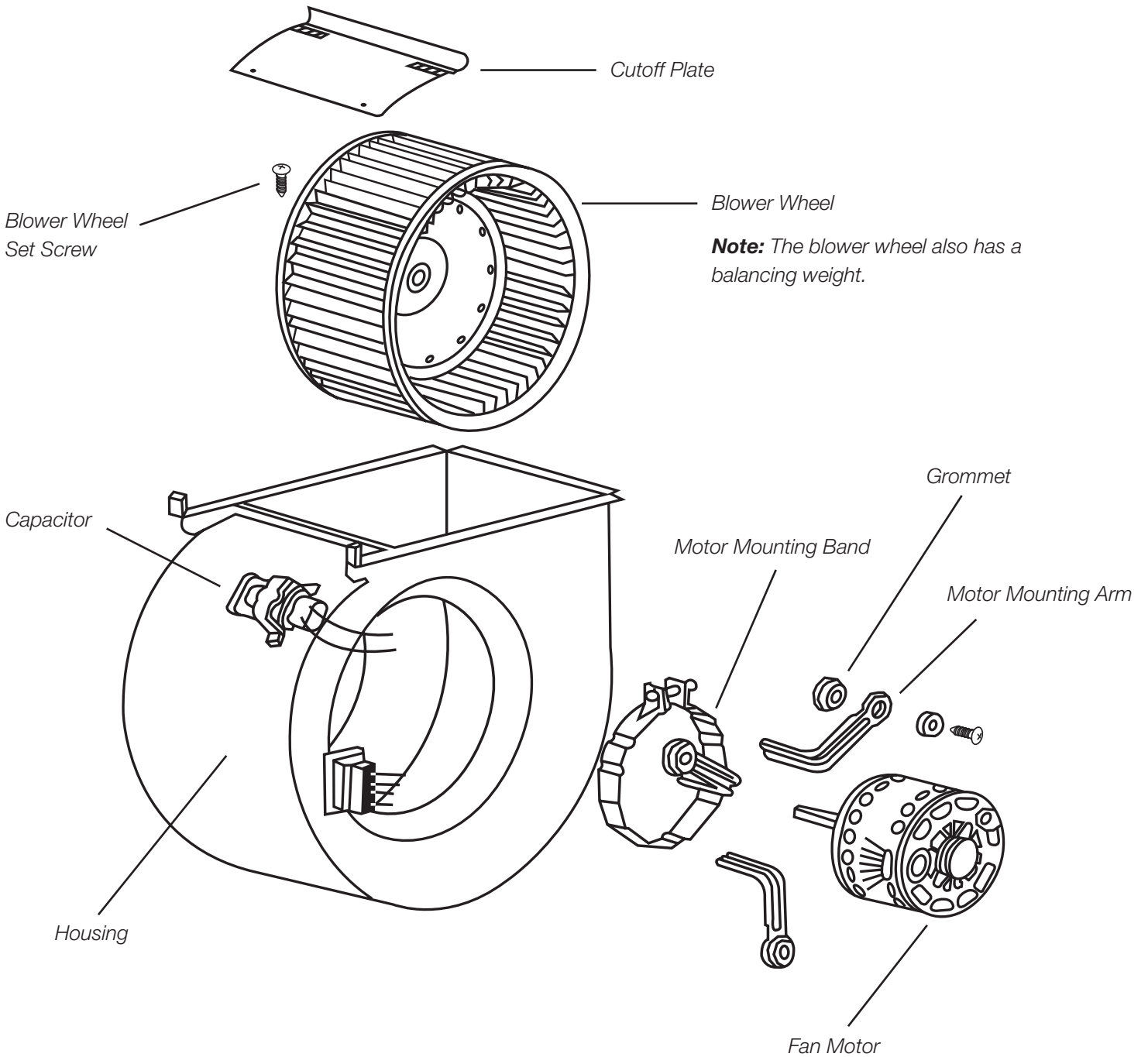
### Direct Drive

(Tap-wound motor shown)



# Air Distribution (continued)

## Components of a Direct Drive Motor



## Replace an Air Filter

*Sometimes, little things cause big problems. A dirty air filter can reduce airflow through the system, meaning less heat for the apartment.*

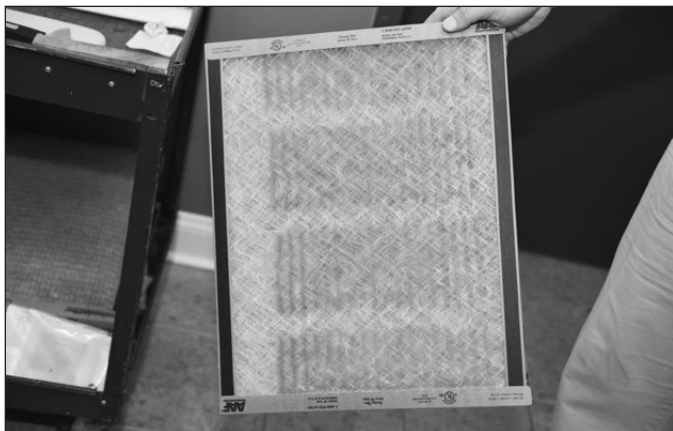
*What's more, dirty air filters increase the furnace temperature, which can lead to fan limit switch problems.*

### Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 17 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

### Safety

Wear eye and mouth protection.



### Tools and Materials Needed

- Replacement filter (disposable, reusable, or electronic)
- Screwdriver (to open the access panel, if needed)

### How-to Steps

1. Find the filter on the furnace.
2. Carefully remove the old filter. Clean or replace it as needed. Some filters can be washed while others require replacement.

### An Ounce of Prevention...

To keep both electric and gas furnances operating at peak efficiency, check air filters regularly, at least every other month.

# Test a Blower Motor

When you suspect the blower motor is broken, follow the testing steps below.

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 18 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power to the furnace is turned off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout tagout device
- Screwdriver
- Multimeter

## How-to Steps for PSC Motor

### If a PSC Motor is not working

1. Turn off the power at the main service panel.
2. Lock and tag out the service panel.
3. Remove the access panels to the blower.
4. Remove the motor wire leads. Identify the wires for later reinstallation.
5. Carefully discharge and disconnect the capacitor.

**WARNING:** A capacitor acts like a high-voltage battery that can shock you even when it is disconnected. Make sure it is fully discharged before proceeding.

6. Test the motor for the proper electrical resistance.
  - a. Make sure the power cord wires are disconnected from the motor. If it is easy to do, remove the motor from the appliance, though motors can be tested in place.
  - b. Set the multimeter to R X 1.
  - c. Attach one of the multimeter's probes to the motor's common lead, usually white.
  - d. Attach the other probe in turn to each of the other wires on the motor. A low or moderate reading (in ohms) means the motor is working. A zero or infinite reading means the motor's windings or another component has a short.
7. If the motor is faulty, replace it.



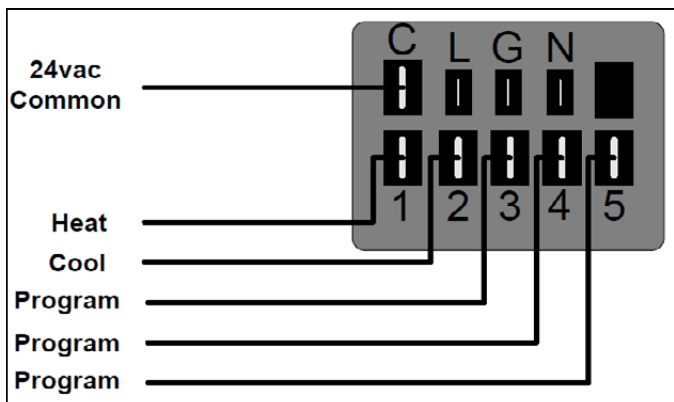
# Test a Blower Motor (continued)

## How-to Steps for Electrically Commutated Motor (ECM)

### If an Electrically Commutated Motor is not working

1. Gain access to the blower motor compartment and the motor
2. Verify proper voltage at connector terminals using a volt meter
  - L or N - terminals for power (120 or 240 as needed)
  - G - Ground
3. Verify proper low voltage (control) connections by setting the thermostat for an action and verifying 24v at thermostat connections on the control module\*\*\*
  - Control voltage connections occur on terminals identified as C and 1-5*
4. Turn off Power at the main service panel
5. Lock and tag out the service panel
6. Wait 5 minutes for capacitor to discharge through the circuitry of the control module
7. Verify that the motor shaft spins freely (if it does not, replace the motor assembly)
8. Remove the control module from the back of the motor (removal of the complete motor assembly from the system is sometimes required)
9. Unplug the 3-pin connector from the inside of the control by squeezing the latch and gently pulling on the connector
10. Test the coils of the motor with an Ohm meter
  - a. Insert leads from the meter into each terminal of the 3 pin connector.
  - b. Test all 3 pins (pin 1-2, pin 1-3, pin 2-3)
  - c. There should be less than 20 Ohms of resistance
11. If Motor resistance tests properly, and all voltage levels are correct (steps 1-3 above) than the control module is bad and must be replaced. (Note: Since each manufacturer requires a different program using ECM, the motor must be obtained from a supplier able to provide the exact program on the replacement module.)

\*\*\* verify using Manufacturer Schematics or Diagram



# Replace a Blower Motor

If a blower motor is faulty, replace it, following the steps below.

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 20 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power to the furnace is turned off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver
- Penetrating oil
- Replacement blower motor (Be sure it has the same frame, horsepower, speeds, and amperage draw as the motor you're replacing.)

## How-to Steps: Removing the Old Motor

1. Remove the blower assembly from the furnace.
2. Loosen the squirrel cage setscrews.
3. Remove the motor support bracket screws.
4. Pull the motor free from the squirrel cage. (You may need to apply some penetrating oil to loosen the squirrel cage from the shaft.)
5. Loosen the belly band.
6. Remove the motor from the bracket.



## How-to Steps: Installing the New Motor

1. Install the new motor on the motor bracket.
2. Install the motor shaft into the blower assembly.
3. Secure the blower assembly to the motor housing.
4. Center the squirrel cage in the housing and then secure the blower assembly to the motor shaft.
5. Install the blower assembly into the furnace.
6. Make the proper wiring connections.
7. Turn the motor on and check it for the proper rotation.

## Group Discussion on Air Distribution

*Once again, hold a group discussion to extend and enrich the classroom training experience.*

### **Leader's Instructions:**

Hold a 10-minute discussion on air distribution. Again, you can do this in a variety of ways, such as:

- Presenting additional material on air distribution, or having an invited subject matter expert do it.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best “tips and tricks” related to electric furnace repair.

Let participants know the how the discussion will work, and encourage them to take notes on page 22 of their *Resource Guide*.

# Controlling Residential HVAC Equipment

Residential HVAC equipment is commonly controlled by a device called a thermostat.

The thermostat at its most basic level is a switch or switches that are controlled by the temperature that surrounds it. It is a device that is operated by the user (our resident) selecting the temperature that they want the air to stay at (called the set point). This is the point at which the switch will open and close on whichever operation is required for the HVAC system to perform. For instance:

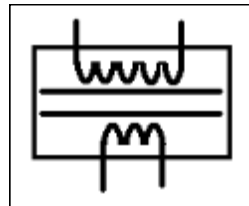
- If the temperature is too warm (or the set point is lower), and the thermostat is set to “cool” the switch will close on components that send power to the condensing unit and the high speed of the indoor blower.
- If the temperature is not warm enough (or the set point is higher), and the thermostat is set to “heat” the switch will close on components that will send power to the heating equipment and the low speed of the indoor blower.

Frequently, a thermostat does not directly control the equipment that does the work. For example, it doesn't send power to the fan motor when that fan motor needs to operate. Instead, to allow the system to be smaller and fit into different applications, a much lower voltage is used to control the various functions of an HVAC system. This lower voltage is provided by the transformer.



## Transformer

The transformer is a component that decreases electrical power to the voltage level used for HVAC controls. The standard level for residential HVAC control circuits is 24volts. In electrical diagrams it will look similar to this:



A transformer operates by the coil that is attached to a line, or input (called Primary) producing a magnetic field that the coil on the Load, or output (called Secondary) receives as a greater or smaller voltage amount, based upon the design. The equipment's schematic or diagram will specify both Primary and Secondary voltages.



## Basic Heating System Components (30 minutes) Slides 12 - 15

*Heating is essential for survival in many areas of the country.*

*From building a campfire to harnessing the sun's warmth with solar panels, the underlying concept is the same: increasing the temperature of a specific space.*

### Key Parts Commonly Used in Heating Systems

#### Blower

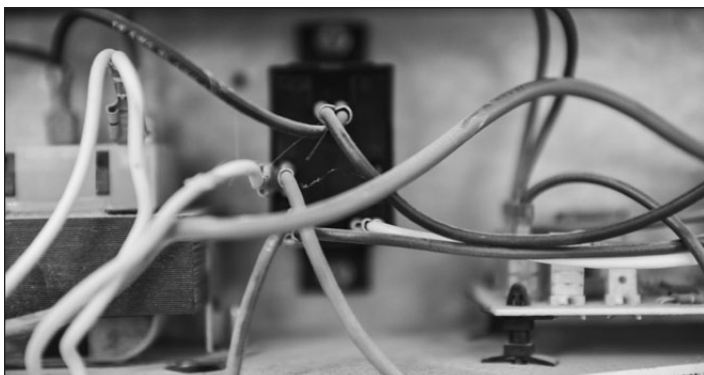
The indoor fan blower operates when the call for it is given. The fan operates at high speed during the cooling mode and at low speed during the heating mode.

#### Interlock

An interlock is any condition or set of conditions that must be met before an unrelated or separate electric circuit can be energized. For instance, air movement through the duct system must be established before power is supplied to the heating elements.

#### Fan Relay

The fan relay is designed to be a switching point for the fan. In addition to acting as a switch that can control the operation (on or off) the relay also controls the speed of the fan motor. (Note: in heating mode, frequently the fan relay does not switch at all.)



#### Sequencer

The sequencer energizes the blower motor and the multiple heating elements at regular time intervals by opening and closing electrical contacts.

#### Safety Switches

- **Limit switch**—In case of air flow obstruction, the limit switch is designed to open when the temperature exceeds the desired operating temperature of the furnace. The contacts close if the temperature returns to an acceptable level.
- **Fusible link**—This safety device melts if the temperature exceeds safe levels. It provides back-up protection to the limit switch. If the fusible link goes bad, it needs to be replaced. But be sure to check the other safeties in the circuit since a fusible link breakdown means at least one of the other safeties has failed.

#### Fan Switches

The fan switch cycles the blower on and off at the appropriate times.

#### Limit Switch

The limit switch is a safety device and should always be in a closed position unless there is a problem within the furnace. Some limit controls have a manual reset button on them.

# Heating Systems Basics (15 minutes)



## Creating Heat

Turn to page 19 in your *Resource Guide*.

When heat energy is applied to a substance, the molecules of that substance start to move more rapidly. They collide with each other, and this friction causes the temperature of the substance to rise. Conversely, when the heat energy is removed, the molecules slow down and the amount of friction decreases.

Heat can be transferred from one place to another by three methods: conduction in solids, convection of fluids (liquids or gases), and radiation through anything that will allow radiation to pass.

The heating systems we'll cover today use a convection transfer method to transfer heat. That is, they transfer heat using a flowing medium, such as air or water.

## Types of Heating Systems

Although there are many different types of heating systems, we're going to focus on the following:

- Electric furnace (forced-air)
- Electric baseboard
- Gas furnace (forced-air)
- Hydronic

Electric systems are relatively simple to maintain and repair, while gas and hydronic systems are more complex.

The type of heating system used in a building depends on its age, the cost of electricity versus fossil fuels in the area, and the type of utility billing system the community uses (for example, it's easier to bill residents individually for utilities if electric heating is used).

## Thermostats and Heating

A common misconception about heating is that a room will heat faster if the thermostat is set higher than the desired temperature.

Setting the temperature higher wastes energy, and drastic temperature swings can make residents uncomfortable.

The rate at which a room is heated is determined by the size of the heating appliance (BTU output), not the temperature set on the thermostat.

# Electric Furnace Heating (1 hour)

*Electric, resistive-type heating is the most efficient heating system.  
Resistive electrical loads primarily generate light, heat, or both.*

## Leader's Instructions:

Work with your local affiliate to obtain an electric furnace to support this instruction. You can work with various suppliers, who may be willing to donate new, used, or ready-to-recycle electric furnaces.

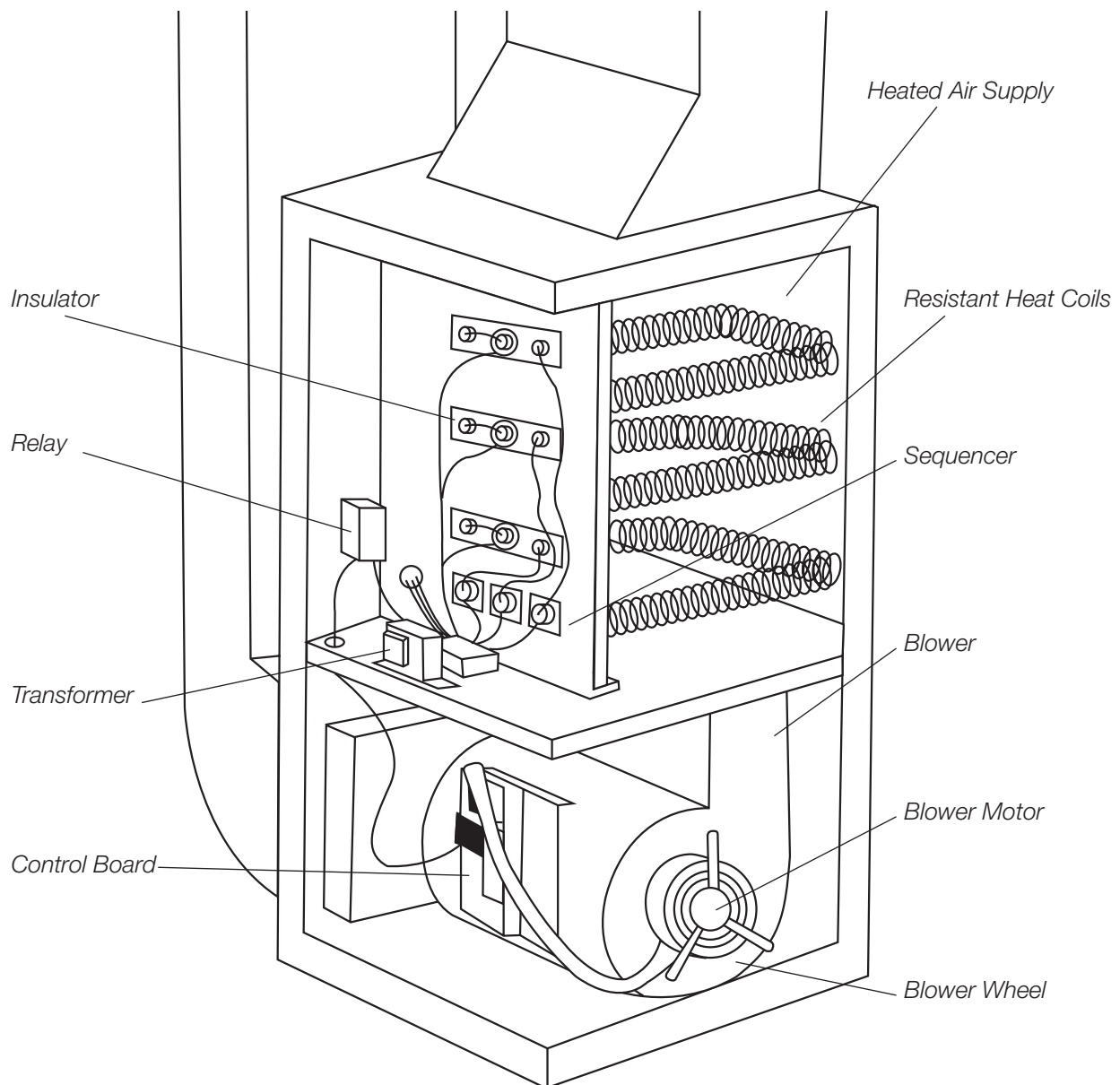
Spend about 30 minutes comparing the diagram and key parts information in this section to the actual unit. That way, participants will "experience" each part of the furnace as you describe its use.

## Introduction

Turn to page 24 in your *Guide*.

Depending on where your apartment community is located, the electric furnace may be heavily tasked.

## Anatomy of an Electric Furnace

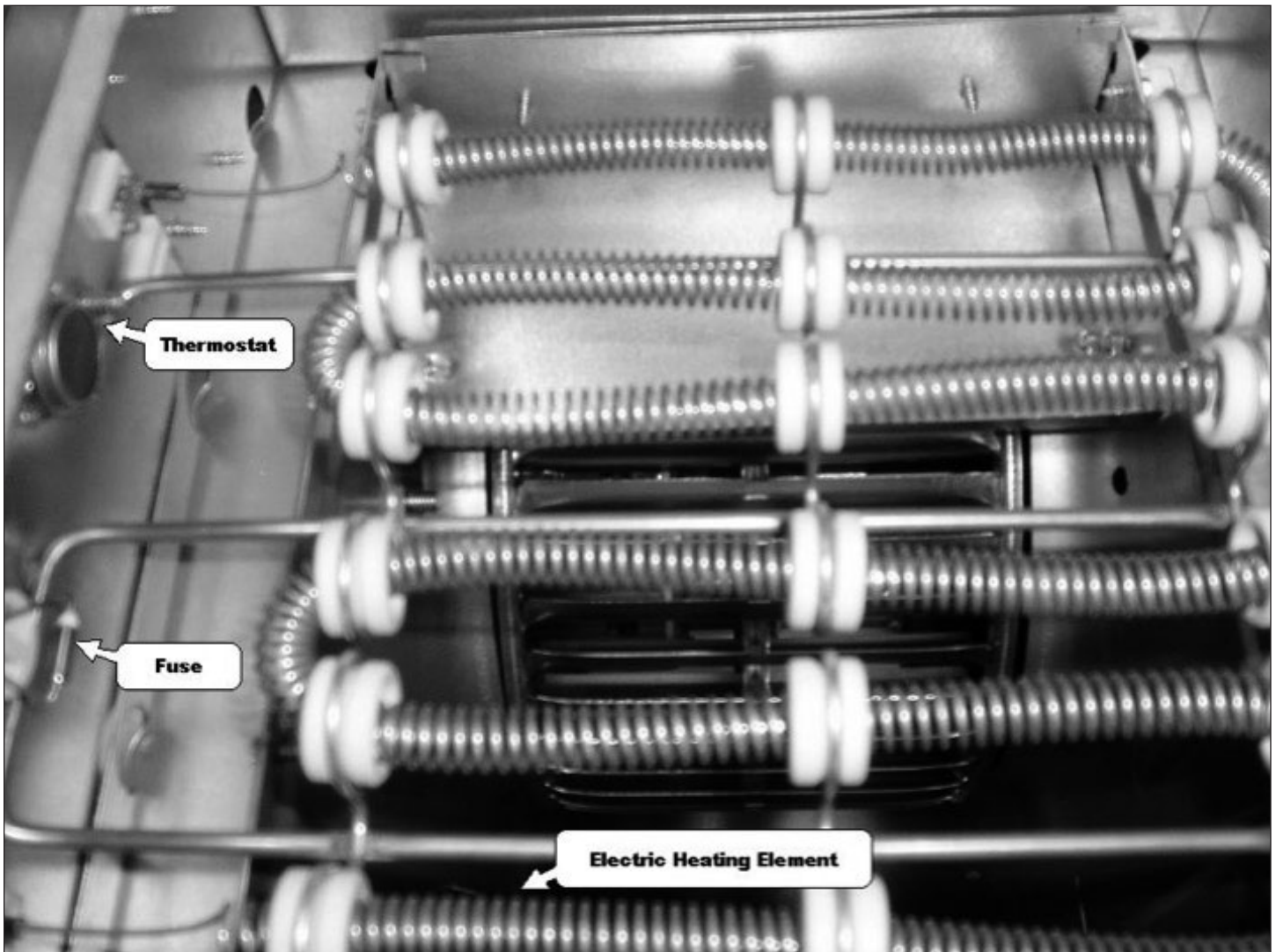


## Key Parts of an Electric Furnace

*In terms of their operational parts, forced-air electric furnaces are relatively simple to understand. In addition to the key parts commonly used in a heating system (p. 23), the main component of an electric furnace is described below.*

### Heating Coils

Heating coils (or elements) are high-resistance components that don't conduct electricity well. This resistance generates heat that is transferred to the space. There can be multiple heating elements in an electric furnace.



## Common Electric Furnace Problems and Solutions

*Most of the time, residents will report furnace problems with five words: “It’s too cold in here!” Consider these possible causes as you troubleshoot.*

Problem	Solution
<b>Operational issues</b>	<ol style="list-style-type: none"> <li>1. Be sure the thermostat in the apartment is set to “heat” and is turned up to an appropriate temperature.</li> <li>2. Make sure the power switch on or near the furnace is turned on.</li> </ol>
<b>Airflow issues</b>	<ol style="list-style-type: none"> <li>1. See the information in the “Air Distribution” section.</li> </ol>
<b>Electrical issues</b>	<ol style="list-style-type: none"> <li>1. Check the service panel for a tripped breaker or blown fuse. Reset or replace as necessary.</li> <li>2. One of the safeties may be faulty: the limit switch (see page 28), or the fusible link (see page 28).</li> <li>3. The heating elements may not be working. See page 29 for directions on testing and replacing them.</li> </ol>

# Diagnose and Replace the Limit Switch

*The limit switch is a safety device that will only open its contacts if the temperature exceeds the pre-set limit.*

## Leader's Instructions:

1. Introduce the topic.
2. Debrief the video. What did participants learn? What's still unclear? What would participants add or change?
3. Reinforce the video by quickly covers the how-to information below. (This information is also on page 27 of the participants' *Resource Guide*.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power to the furnace is off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver
- Multimeter
- Replacement limit switch

## How-to Steps

1. Turn off the power at the main service panel.
2. Lock and tag out the service panel.
3. Remove the cover panel from the furnace.
4. Disconnect the wires from the limit switch.
5. Gently pull out the switch.
6. Test the limit switch for continuity.
  - a. Set the multimeter to R X 1.
  - b. Touch each probe to one of the terminals (or poles) of the switch.
  - c. If the reading changes from infinity to zero (or close to zero), the switch has continuity and is good. If the reading is above zero, the switch needs to be replaced.
7. If the limit switch is bad, replace it with one that has the same temperature settings and probe length.
  - a. Place the new switch into the hole, push it gently in, and secure it with the bolts.
  - b. Reconnect the wires.
  - c. Replace the cover.

## Replacing the Fusible Link

If there is no continuity through a fusible link, it must be replaced.

If you find a bad fusible link, carefully check the limit switch, too, because it's probably defective.

Follow the steps for replacing a limit switch to replace the fusible link.

# Test and Replace an Electric Furnace Heating Element

*If you're replacing a heating element, make sure you know its part number, size, resistance (in ohms), current capacity (in amps), and how much wattage it requires.*

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 28 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power to the furnace is turned off.

Use lockout/tagout procedures.

Wear eye protection.

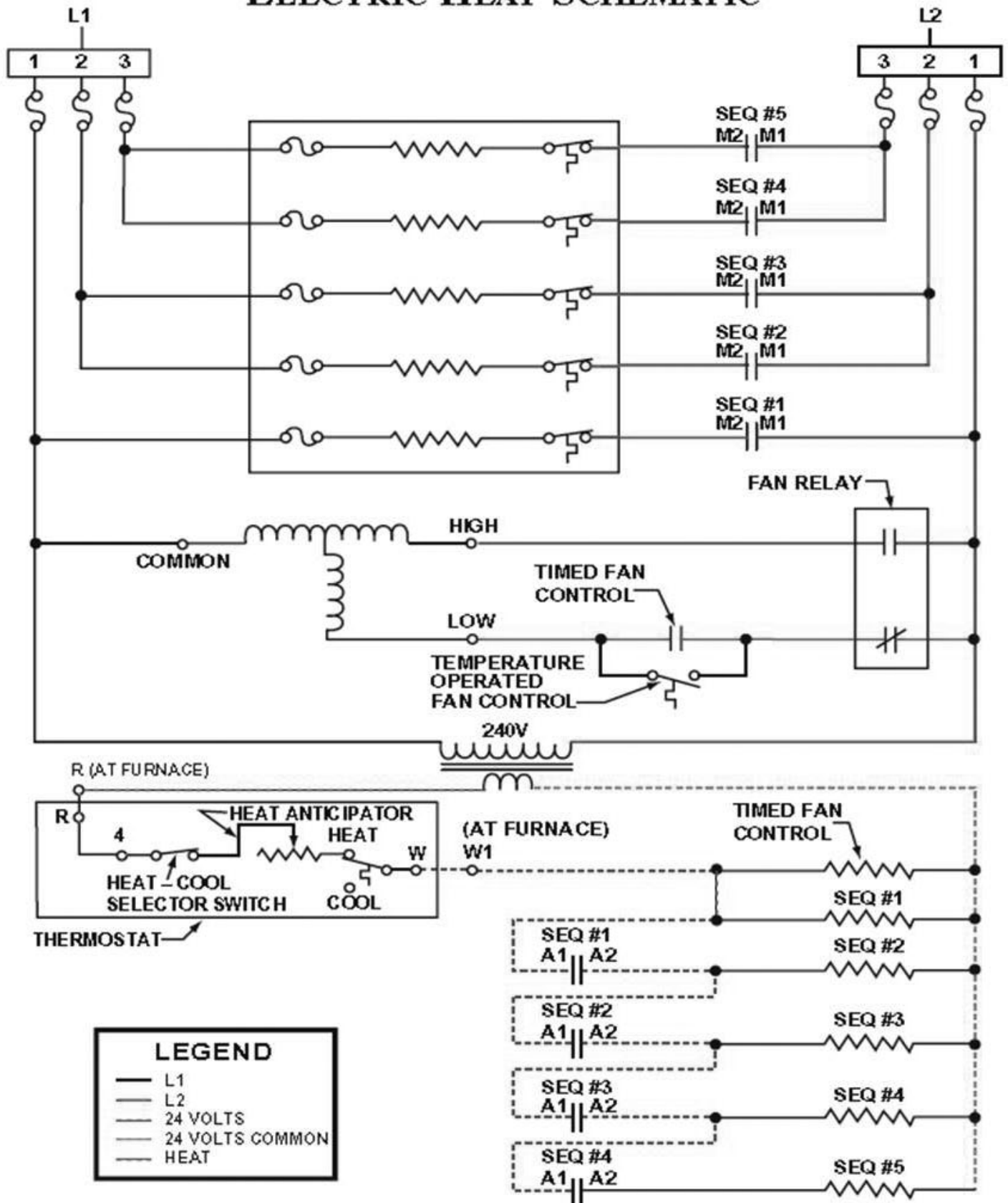
## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver
- Multimeter
- Replacement heating element

## How-to Steps

1. Turn off the power at the main service panel.
2. Lock and tag out the service panel.
3. Disassemble the furnace to access the heating element. (This will depend on the specific make and model of the furnace.)
4. Test the heating element for the proper resistance.
  - a. Remove the wires attached to either end of the element.
  - b. Set the multimeter to R X 1.
  - c. Touch the multimeter probes to each end of the element.
  - d. High resistance (kilo-ohms or thousands of ohms) indicates the heating element is working. A reading of infinite resistance indicates a broken element.
5. If the heating element is faulty, replace it with one of the exact size, shape, power rating, and resistance.
6. Reassemble the furnace.
7. Turn the furnace back on to make sure it is working.

# ELECTRIC HEAT SCHEMATIC





## Group Discussion on Electric Furnaces

Once again, hold a group discussion to extend and enrich the classroom training experience.

### Leader's Instructions:

Hold a 10-minute discussion on electric furnaces. Again, you can do this in a variety of ways, such as:

- Presenting additional material on electric furnace maintenance and repair, or having an invited subject matter expert do it.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best “tips and tricks” related to electric furnace repair.

Let participants know the how the discussion will work, and encourage them to take notes on page 30 of their *Resource Guide*.

## Electric Baseboard Heating (45 minutes)

*Because this type of heating is expensive, it is generally found in areas of the country where the climate is moderate and electricity is relatively cheap: that is, in the Pacific Northwest and in parts of the Midwest.*

### Leader's Instructions:

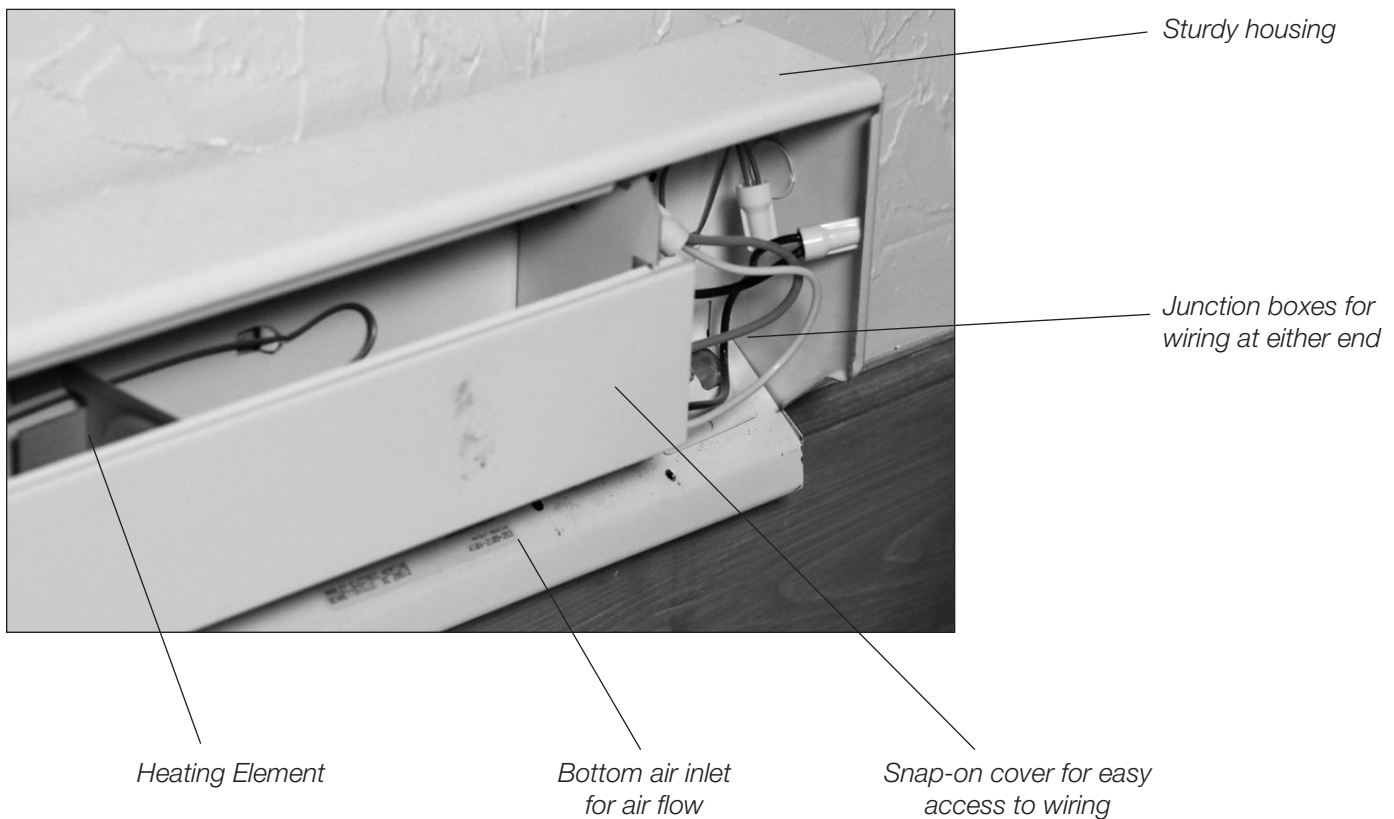
Obtain an electric baseboard heater (they're inexpensive), and use it as a "show and tell" prop throughout this section. Be sure to open the panel on the baseboard heater and show the heating element and the thermostat.

### Introduction

Turn to page 31 in your *Resource Guide*.

Baseboard heating systems are set up so that each baseboard is responsible for heating a particular room or area. Each unit is controlled by a thermostat, which can be located on the wall or on the unit itself. This means residents are able to control the temperature in each room themselves.

### Anatomy of a Baseboard Heater



## How an Electric Baseboard Heater Works

There are two basic components of an electric baseboard heating system: the heating element and the thermostat. The element produces heat when electricity passes through it. Each element contains a series of metal plates called fins, which help send heat to a broader area. The thermostat simply tells the element when to activate and for how long.

To heat an area, cold air is drawn over the heated fins from the bottom of the baseboard and directed into the room by a deflector hood. The heated air rises and forces the cold air to the floor.

Compared to other heating systems, electric baseboard heating is relatively safe. The surface temperatures are low, reducing the risk of fire. No fan is needed to pull air over the coil, which means that there is nothing to fail and cause the unit to overheat. Additionally, there is no flame and therefore no chance of carbon monoxide buildup.

As you can see, it's a simple system. That's why we're going to move straight to the common problems and solutions now.

## Common Electric Baseboard Problems and Solutions

*Again, residents will mostly likely report baseboard heating problems by complaining that the room is too cold. Consider these possible causes as you troubleshoot.*

Possible Causes	What to Check
<b>Operational issues</b>	<ol style="list-style-type: none"> <li>1. Be sure the thermostat is set to “heat” and is turned up to an appropriate temperature.</li> <li>2. Verify that there are no large pieces of furniture directly in front of the heater.</li> </ol>
<b>Electrical issues</b>	<ol style="list-style-type: none"> <li>1. The heating element is malfunctioning (see page 35).</li> <li>2. The thermostat is no longer working (see page 36).</li> <li>3. The entire baseboard heater needs to be replaced (see page 37).</li> </ol>

# Test and Replace the Heating Element

*Are residents feeling the chill? Here's how to test (and if need be, replace) the heating element in an electric baseboard heater.*

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 34 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice:

## Safety

Make sure the power to the heater is off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver or special tool to open the terminal unit
- Multimeter
- Replacement heating element

## How-to Steps

1. Turn off the power at the main service panel.
2. Lock and tag out the service panel.
3. Disconnect the heating element from the housing.
4. Use a multimeter to check for continuity between the heating element and the ground.
  - a. Set the multimeter to  $R \times 1$ .
  - b. Place one probe on the terminal and the other on the ground.
  - c. If the meter shows continuity, there is a short circuit, and the element needs to be replaced.
  - d. If the meter does NOT show continuity, disconnect both ends of the heating element. Test for continuity. If the meter shows open (infinity) the element needs to be replaced.
5. If a heating element is faulty, replace it with one of the exact size, shape, power rating, and resistance.
6. Reassemble the heater housing.
7. Test the heater.



## Repair or Replace?

If the heating element has melted into the side of the unit, be sure to weigh the cost of replacing the entire unit with the cost of repairing the existing unit. Many baseboard units are less than \$100 and can be quickly replaced.

# Diagnose and Replace a Baseboard Heater Thermostat

*Baseboard heaters are often hard-wired to the thermostat for the entire apartment. But if they're not—and the heater isn't performing up to snuff— you may need to replace the heater's thermostat.*

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 35 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power to the heater is off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver or special tool to open the terminal unit
- Multimeter
- Replacement thermostat

## How-to Steps

1. Turn off the power at the main service panel.
2. Lock and tag out the service panel.
3. Disconnect the thermostat and its wiring from the housing.
4. Test the thermostat for continuity.
  - a. Set the multimeter to R x 1.
  - b. Touch a probe of the multimeter to each terminal.
  - c. Check the reading. It should be zero, or close to it. If not, the thermostat is not working and needs to be replaced.
5. If the thermostat is faulty, replace it with one that is exactly the same.
6. Reassemble the heater housing.
7. Test the unit.

# Install a New Baseboard Heater

*When a baseboard heater goes kaput, install a new one.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 36 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Follow manufacturer installation instructions.

Make sure that the power to the heater is off.

Use lockout/tagout procedures.

Wear eye protection.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver or special tool to open the terminal unit
- Wire stripper
- Wire nuts
- Replacement electric baseboard heater

## How-to Steps

1. Turn off the power at the main service panel.
2. Lock and tag out the panel.
3. Remove the old baseboard heater and set it aside.
4. Go to the existing wiring. Remove the wire nuts and run the wires through the baseboard heater clamp.
5. Connect the ground wire to the appropriate terminal on the heater.
6. Strip approximately 5/8" of insulation from the wires, and connect the heater wires to the house wires. Secure the connection with wire nuts.
7. Tuck the wires into the back of the heater and attach the panel.
8. Secure the heater to the wall with screws and replace any trim pieces. You may need to cut your trim to accommodate the new heater.
9. Test the new baseboard unit.



## Group Discussion on Electric Baseboard Heaters

*Wrap up the electric heater segment by holding a “shocking” group discussion.*

Hold a 10-minute group discussion on electric baseboard heating to enrich participants' knowledge. Depending on your location, participants may have limited experience.

Again, you can do this in a variety of ways, such as:

- Presenting additional material on electric baseboard heating, or having an invited subject matter expert do it.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best “tips and tricks” related to electric baseboard heating.

Let participants know the how the discussion will work, and encourage them to take notes on page 37 of their *Resource Guide*.



## Gas Furnace Heating (1 hour)

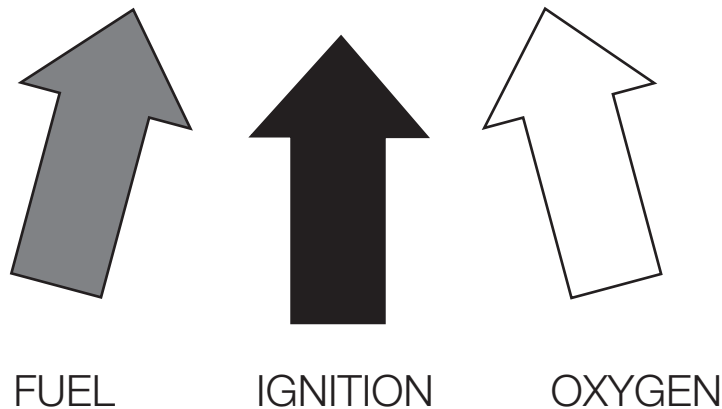
*A gas furnace must burn fuel to generate heat. A certain amount of heat is lost as a result of this burning process, so the efficiency of fuel-burning furnaces is lower than that of electric heating systems.*

### Introduction

Turn to page 38 in your *Guide*.

Gas furnaces use a principle called combustion to create energy and heat. During combustion, fuel ignited by a flame, spark, or heat and is allowed to burn until a desired temperature is reached. Oxygen is also combined with the fuel so that the stored energy in the fuel can be released. All three elements—fuel, ignition, and oxygen—must be present for combustion to occur.

## COMBUSTION



The efficiency of the combustion is determined by comparing the amount of useful heat produced with the total heat produced, including the amount that is lost up the chimney vent. If a furnace operates at 85% efficiency, approximately 15% of the heat produced by the burning fuel is lost up the stack. (Electric heating, by the way, is 100% efficient.)

# Gas Furnace Heating (continued)

## Combustion and Safety

Ideally, when combustion happens, all the fuel burns and the resulting byproducts don't harm people or the environment.

Complete combustion occurs when carbon, which is released during the combustion process, bonds with oxygen to form carbon dioxide. All of the byproducts created during complete combustion—carbon dioxide, water vapor, and nitrogen—are non-toxic and can be safely vented into the atmosphere.

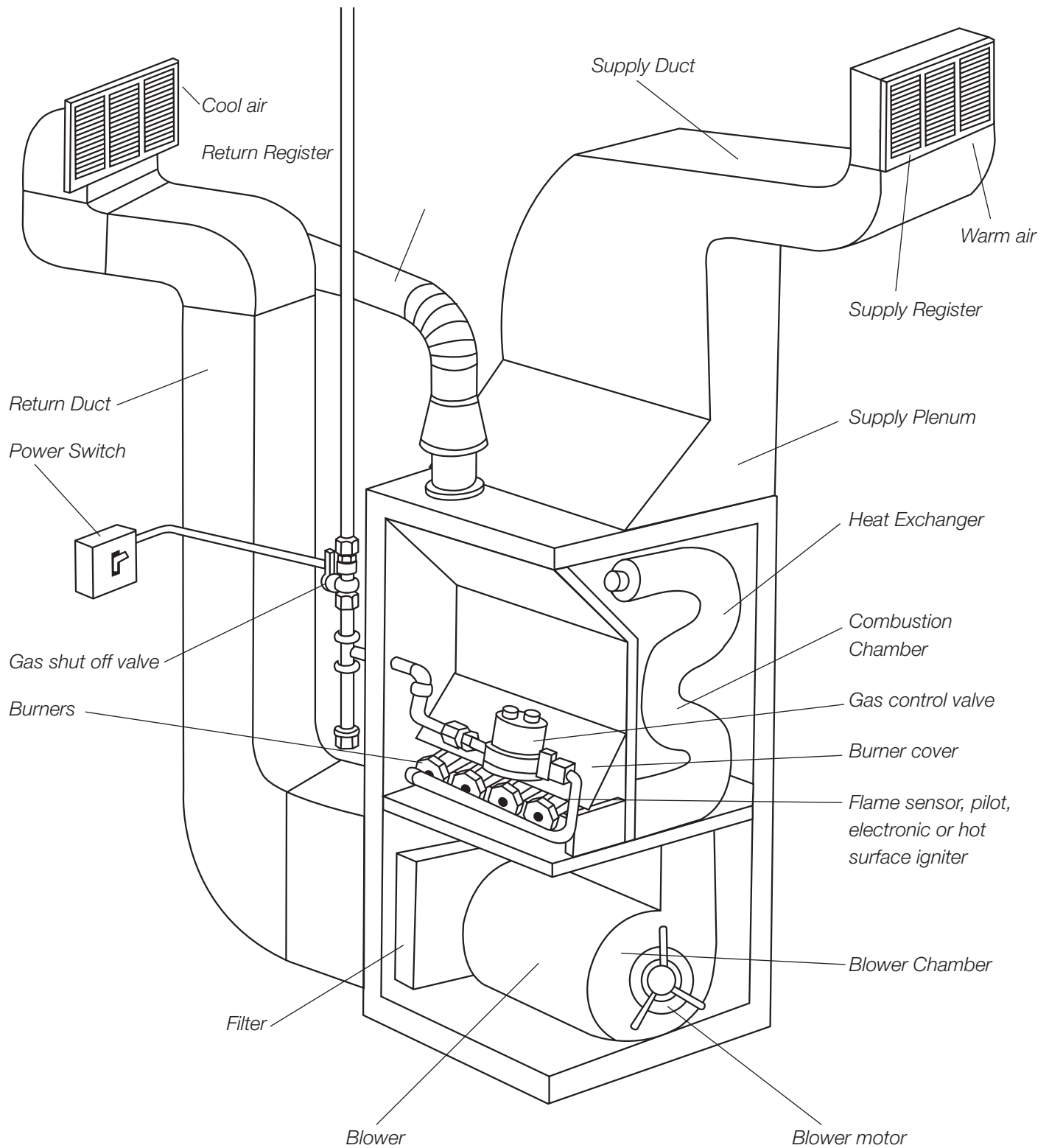
Incomplete combustion occurs when there is insufficient oxygen during combustion, causing excessive carbon accumulation in the heating system. Two toxic byproducts are created: carbon monoxide and aldehyde. These toxins are vented out of the heater via the flue pipe.

## Safety First

Whenever you're completing a make-ready inspection—or are in an apartment servicing a gas appliance or heating unit—check carbon monoxide testers if present to make they're in good working order.

# Gas Furnace Heating (continued)

## Anatomy of a Gas Furnace



# Key Parts of a Gas Furnace

*Forced-air gas furnaces have a more complex system of operational parts than electric furnaces.*

## Gas Control Valve

This valve is busy! It allows you to manually shut off the gas to the furnace, regulates gas pressure at the furnace, acts as a safety cutoff, and automatically opens and closes in response to system requirements.

## Gas Manifold

Gas flows to the burners through a pipe called the manifold, which is connected to the gas valve. At the end of each branch of the manifold is a fitting called a spud. A hole, or orifice, is drilled into each spud, which permits a specific amount of fuel to flow from the branch of the manifold to the burners.

## Gas Burners

Combustion takes place at the burners. There are several burner configurations: slotted ports (produce many individual flames), ribbon burners (single “ribbon” of flame), upshot, and inshot (both single-port burners).

## Heat Exchanger

The heat exchanger provides a heat transfer surface from which heat is transferred to the air in the apartment, as well as keeping the byproducts of combustion separate from this air.

There are two types of heat exchangers:

- **Individual section (Clamshell)**—This exchanger has openings at both the top and the bottom to provide common ignition of the fuel and common venting of the byproducts. This is a more favorable style, since there is a larger surface area allowing greater heat transfer between the heat exchanger and the air passing over it.
- **Cylindrical**—This configuration has only one chamber in which combustion takes place.

## Ignition System

Ignition systems ignite the gas as it passes through the valve. Common methods include: standing pilot, intermittent pilots, direct spark ignition, and hot surface ignition.

## Thermocouple/Power Pile

Ignition systems that use a pilot light use a safety control called a thermocouple. The thermocouple creates a small electrical current that tells the combination control that the pilot light is burning. If the pilot light goes out, the thermocouple will shut off the gas supply to the furnace. A power pile (750 millivolts) is a more powerful version of a standard thermocouple.

## Blower

The blower distributes the heated air through the duct system to the apartment. It operates when the heat exchanger has reached the desired temperature, as well as at the end of the heating cycle to allow the heat exchanger to cool.

## Gas Furnace Parts (continued)

### Flue Pipe

The flue pipe is the vent responsible for directing the byproducts of combustion from the furnace to outside the building.

### Vent Blower

The vent blower is designed to operate before the burner ignites. Its operation forces the poisonous combustion fumes into the flue pipe.

### Rollout Switch

The rollout switch is an extremely sensitive switch that is normally closed. This switch is located nearby the burner housing or heat exchanger opening. Its job is to open (break the circuit) and cut power to the gas valve in the event of the flame “rolling out” of its designated area. Many of these have a small reset switch.



# Common Gas Furnace Problems and Solutions

*Fortunately, gas furnaces are quite reliable.*

*Performing routine maintenance such as checking the air filter, cleaning the blower blades, and lubricating the blower motor will reduce the number of service calls.*

Problem	Solution(s)
<b>The furnace doesn't operate at all</b>	<ol style="list-style-type: none"> <li>1. Be sure the thermostat in the apartment is set to "heat" and is turned up to an appropriate temperature.</li> <li>2. Make sure the power switch on or near the furnace is turned on.</li> <li>3. Check the service panel for a tripped or blown breaker or fuse.</li> <li>4. Verify that the blower door is in its proper place (interlock)</li> </ol>
<b>The pilot or standing pilot light is out or does not stay lit</b>	<ol style="list-style-type: none"> <li>1. The pilot light may have gone out. Relight it (see page 45).</li> <li>2. The pilot opening may be dirty. Use a fine wire to clean the pilot opening.</li> <li>3. The flame may be set too low. See page 46 to adjust the flame's height.</li> <li>4. If the pilot light does not stay lit, test the thermocouple and replace it if needed (see page 47).</li> </ol>
<b>There is not enough heat</b>	<ol style="list-style-type: none"> <li>1. See the information in the air distribution section.</li> <li>2. The primary burner air shutter may need to be adjusted (see page 48).</li> <li>3. The removable burner tubes and ports may be dirty (see page 49).</li> </ol>
<b>The blower won't stop running</b>	<ol style="list-style-type: none"> <li>1. The thermostat on the heater may be set incorrectly. Be sure it is set to AUTO rather than ON.</li> <li>2. The limit control may need to be adjusted.</li> </ol>

## Light a Standing Pilot

*The directions for lighting a pilot light are generally attached to the furnace itself. If those instructions aren't available, follow the steps below.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 44 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

### Safety

Wear eye protection.

### Tools and Materials Needed

- Screwdriver
- Match
- Fine wire

### How-to Steps

1. Remove the furnace panel.
2. Find the pilot light assembly. It typically is a gas valve with on, off, and pilot settings.
3. Turn the valve to the OFF setting. Wait three minutes.
4. Switch the valve to the PILOT setting. Hold a lit match to the pilot opening while you push the reset button on the pilot control panel. Keep pressing this button until the pilot flame burns brightly, then set the valve to ON position.
5. If the pilot won't stay lit, the opening may be clogged. Turn the gas valve off, then clean the opening with a piece of fine wire.
6. If the pilot still won't stay lit, call a professional service person.

## Adjust the Pilot Light

*The pilot light should be approximately two inches long. If you need to adjust the size of the flame, follow these steps.*

### Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 45 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

### Safety

Wear eye protection.

### Tools and Materials Needed

- Screwdriver

### How-to Steps

1. Remove the furnace panel.
2. On the pilot control knob, remove any cap covering the pilot adjusting screw.
3. Turn the adjusting screw counterclockwise to increase the flame or clockwise to decrease it. It is correctly adjusted when the flame envelops the thermocouple bulb by  $\frac{1}{2}$ -inch and appears dark blue with a small yellow tip.
4. Replace the cap for the screw and replace the furnace panel.



# Test and Replace a Thermocouple

*If that standing pilot will not stay lit, investigate the thermocouple. If it is faulty, replacing it will most likely solve your pilot problems.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 46 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Wear a face shield or goggles to protect your eyes.

Make sure you shut off the gas supply line and electrical power (if you replace the thermocouple).

Use lockout/tagout procedures (if you replace the thermocouple).

## Tools and Materials Needed

- Screwdriver
- Multimeter
- Wrench
- Lockout/tagout device
- Replacement thermocouple

## How-to Steps

1. Remove the furnace panel.
2. Hold the control knob to PILOT and light the pilot.
3. Unscrew the thermocouple fitting with an open-ended wrench.
4. Set a multimeter to the DVC (lowest voltage) scale.
5. Clip one multimeter probe to the end of the thermocouple tube nearest the pilot and the other probe to the fitting on the other end of the tube.
6. If the multimeter shows a reading above 15, the thermocouple is functioning. Place the thermocouple tube back in the furnace. (A power pile thermocouple, by the way, should register a reading close to 700 millivolts on the meter.)
7. If there is no reading, you'll need to clean or replace the thermocouple, following steps 8 through 14.
8. Release the control knob and shut off the main gas valve on the gas-supply pipe that leads into the burner. Shut off power to the burner at the electrical service panel.
9. Lock and tag out the gas supply line.
10. Lock and tag out the electrical service panel.
11. Remove the thermocouple from its mounting bracket.
12. Wipe the combination control clean and install a new thermocouple, tightening it by hand, then give it a one-quarter turn with a wrench.
13. Insert the thermocouple into the pilot bracket, being careful to not crimp the tubing.
14. Turn the power and gas back on to the furnace, then relight the pilot, following manufacturer instructions.

# Adjust an Adjustable Primary Air Burner Shutter

*When there is not enough air reaching the heat exchanger, one result is incomplete combustion; another is reduced heat output. Try adjusting the burner air shutter.*

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 47 of the participants' *Resource Guide*.)
3. If possible, demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Wear eye protection.

Wear gloves.

## Tools and Materials Needed

- Screwdriver

## How-to Steps

1. Set the thermostat to its highest setting to keep the burner running.
2. Once the furnace has heated up, remove the burner access panel and loosen the locking screw.
3. Open the shutter by turning it to the right until the blue base of the flame appears to lift slightly from the burner port surface.
4. Close the shutter until the flame reseats itself on the surface.
5. Replace the furnace panel.

## Clean Removable Burner Tubes and Ports

*When carbon and other debris clog the burner tubes and ports, the furnace is unable to function properly and less heat is generated.*

*Cleaning the tubes and ports will get the furnace back in tip-top shape.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 48 of the participants' *Resource Guide*.)
3. If possible, Demonstrate the technique, using the tools and materials indicated. (Or, have a participant demonstrate the technique as you describe it.)
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

### Safety

Make sure the gas and the power to the furnace is shut off.

Use lockout/tagout procedures.

Wear eye protection.

### Tools and Materials Needed

- Lockout/tagout device
- Screwdriver
- Brush or vacuum
- Fine wire

### How-to Steps

1. Shut off both the gas and the power to the furnace.
2. Lock and tag out the gas supply line.
3. Remove the furnace panel.
4. Unscrew or loosen and remove the burner tubes from the supporting bracket.
5. Carefully clean the tubes with a brush or vacuum, making sure not to damage the burner ports.
6. Use a fine stiff wire to clear any debris from clogged ports.
7. Replace the furnace panel.

## Group Discussion on Gas Furnaces

*Open it up again to participants and talk about repairing and maintaining gas furnaces.*

### **Leader's Instructions:**

Hold a 10-minute group discussion on gas furnaces to enrich participants' knowledge. Again, you can do this in a variety of ways, such as:

- Presenting additional material on gas furnaces, or having an invited subject matter expert do it.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best "tips and tricks" related to gas furnace repair.
- Discussing specific safety precautions when working with gas furnaces.

Let participants know the how the discussion will work, and encourage them to take notes on page 49 of their *Resource Guide*.

## Hydronic Heating Systems (1 hour, 30 minutes)



*In this part of the training, you'll help participants understand the what, why, and how of hydronic heating systems.*

*Hydronic heating is sometimes referred to as hot water boiler heating.*

### **Leader's Instructions:**

If possible, locate an affiliate apartment community in the area that has a hydronic heating system.

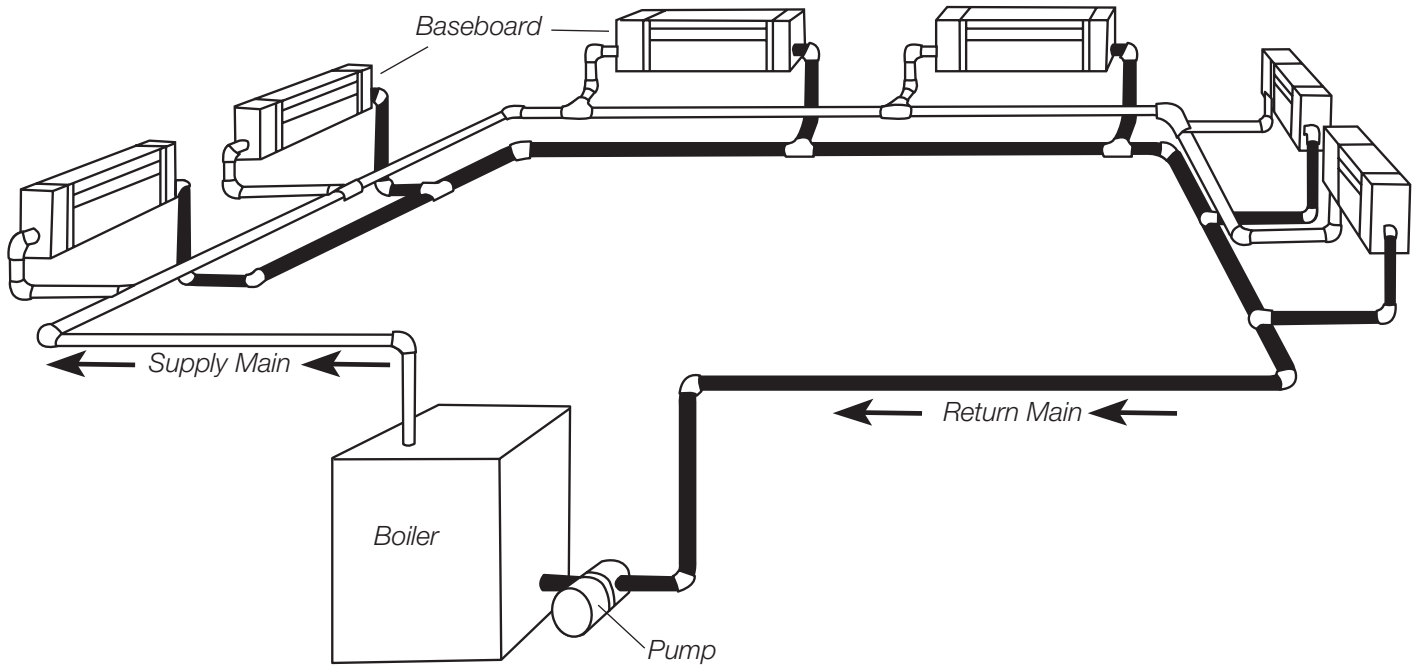
Again, the training experience will become so much richer and useful for participants if they can see what they need to learn.

If access to a hydronic heating system isn't possible, allow participants and experts time to discuss the specific systems they've worked with in the past.

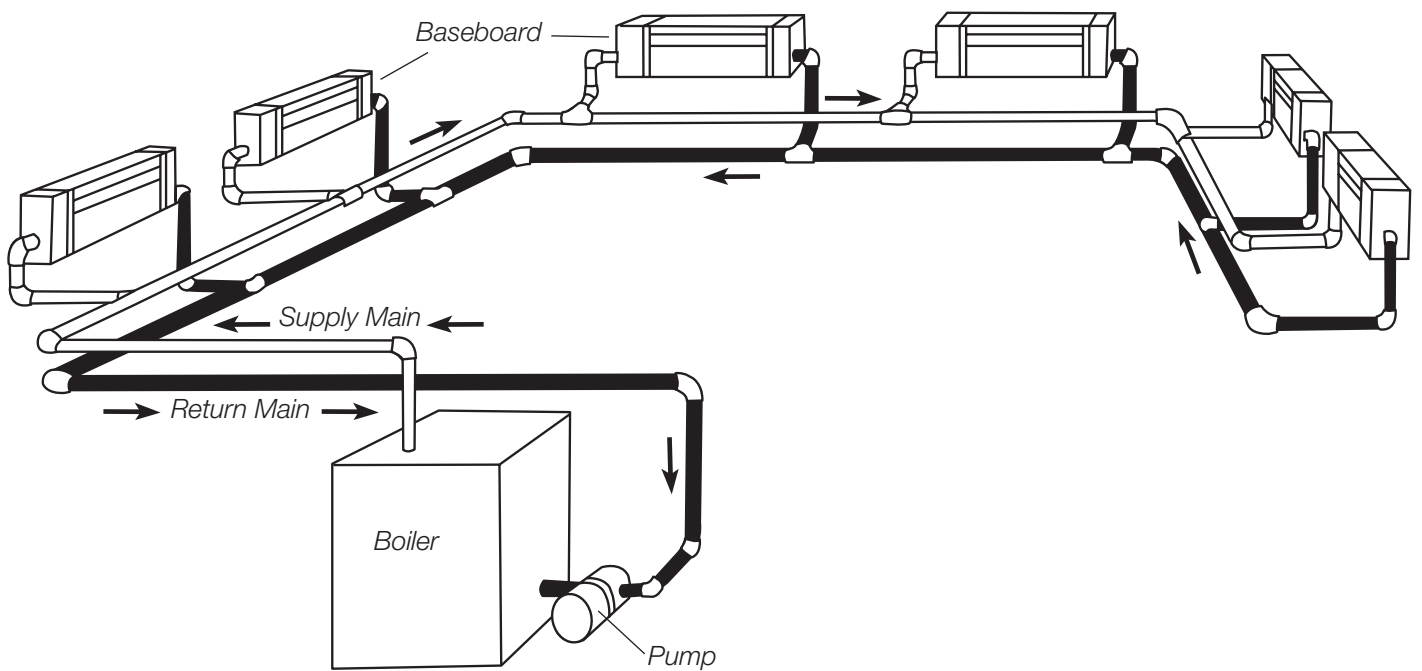
You've already learned how furnaces heat air using electricity or gas. Now, we'll turn our attention to another method for heating an apartment: hydronic (or water) heating.

Turn to page 51 in your *Resource Guide*, and we'll "shower" you with more detailed information.

# Hydronic Heating Systems (continued)

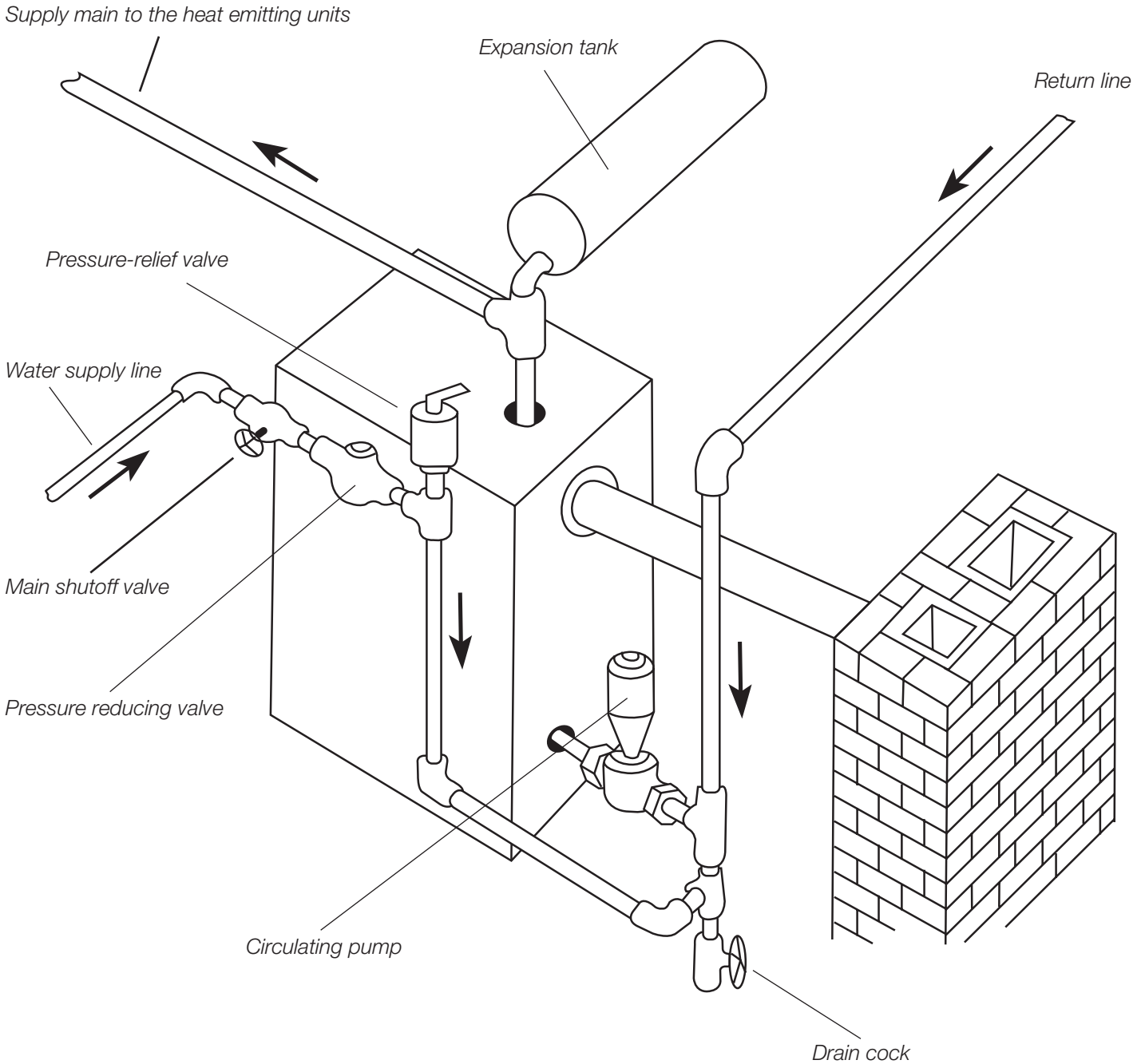


## (Water Flow in a Two Pipe Direct Return System)



# Hydronic Heating Systems (continued)

## Anatomy of a Hydronic Heating System (The Boiler and Its Associated Parts)



# Hydronic Heating Systems (continued)

## How Hydronic Heating Systems Work

Hydronic systems rely on circulating water to deliver heat to the locations where heating is desired. Instead of using large air ducts, like furnaces, water is heated at one location and then pumped to other places via piping. The heat is transferred to the space by heat exchangers located within the space. These heat exchangers are usually radiators or baseboards and are also called terminal units.

After the water has passed through the terminal units, it is returned to the heat source, where the process repeats itself until the space reaches the desired temperature.

There are many configurations for hydronic systems. We'll cover the general information first, then ask you to describe your specific experiences with it.

## Heating Water

Before residents can enjoy hydronic heating, the water must be heated. There are a variety of ways to do this: burning fuel, solar energy, electrical energy, or heat pumps. The most common method for heating water is burning a fuel such as natural gas, manufactured gas, or oil.

The fuel heats the water in the boiler, which is usually made of cast iron or steel and divided into individual sections. The more sections, the higher the capacity; there are more heat exchange surfaces between the water and burning fuel.

Due to the use of iron, the exposure to air, and the presence of water, regularly inspect the hydronic heating system for signs of corrosion.

## The Piping System

There are four types of piping configurations that hydronic heating systems use:

- **Series loop:** All the heaters are piped in a series with each other. A drawback of this system is that the terminal units receiving the water last are often at a lower temperature than those fed first.
- **One-pipe:** One main piping loop extends around or under the space to be heated and connects the supply of the boiler back to the boiler's return.
- **Two-pipe direct return:** Two pipes, one supply (carries the water to the terminal units) and the other return (brings the water back to the boiler) work to feed water to the closest terminal unit and then return it to the boiler. Balancing valves are used to regulate the water to the other baseboard sections.
- **Two-pipe reverse return:** Opposite of the two-pipe direct return system, the reverse return system supplies the water first to the farthest baseboard section.

One important thing to remember about piping is that return pipes must slope toward the boiler to work correctly.



# Hydronic Heat Video

## Leader's Instructions:

Continue the introduction to hydronic heating with a video clip.

1. Show the "*Maintaining a Hydronic Heat System*" video.
2. Debrief afterwards by asking these questions:
  - "What did you find most helpful?"
  - "What is still unclear?"
  - "What information would you add or change?"
3. Ask the invited subject matter expert to add his or her remarks.

# Key Parts of Hydronic Heating Systems

*Hydronic heating systems have many configurations. Here are the most common components.*

## Terminal Units

The system's heat exchangers: radiators or sections of baseboard.

## Boiler

A large tank that heats water with natural gas or oil providing the fuel.

## Aquastat

The aquastat, like a thermostat in other systems, is a temperature-sensing device responsible for cycling the boiler on and off to keep water at the desired temperature.

## Low-water Cutoff

The low-water cutoff is a safety device that de-energizes the boiler if its water falls below a certain level.

## Standard Expansion Tank/Extrol Tank

Water expands when it is heated. The expansion tank creates the extra space needed to hold the heated water.

## Circulators

Circulators move water through the hydronic system. They are made up of a motor, a linkage, and an impeller, and they operate on centrifugal force.

The impeller slaps against the water and throws it toward the outside of the housing where it is forced from the pump at a higher pressure. The pressure increase from here pushes water around the piping circuit until it eventually returns..

## Air Separators

Air is the enemy of the hydronic heating system. Air separators collect tiny air bubbles from water and pass them to the automatic or manual air vents where they are removed.

## Point of No Pressure Change

This is the one point in the piping system where the pump cannot affect the pressure in the system.

## Pressure-Reducing Valve

This valve automatically drops the pressure of the water to the level at which the boiler was designed to operate. If the pressure drops below a certain level, the valve opens to give the boiler more water.

## Key Parts of Hydronic Heating Systems (continued)

### Pressure-Relief Valve

This valve opens if the pressure in the system reaches the set point on the valve. When the pressure drops to an acceptable level, the valve will close. Building codes require that a pressure relief valve is installed on every hot water boiler.

### Zone Valve/Dial Valve (Dan Floss Dials)

Zone valves open and close in response to the temperature in the coordinating space. When a zone calls for heat, the zone valve opens and trips the switch that starts the circulator. The circulator runs until the thermostat is satisfied.

### Flow Check Valve

This valve prevents hot water from flowing through a heating loop when no heat is desired in that space.

### Balancing Valve

This valve helps keep an even water flow through each branch of the circuit.

## Common Hydronic Heating Problems and Solutions (continued)

*The most common problems with hydronic systems are with the expansion tank or a circulator rather than the boiler.*

Problem	Solution(s)
<p><b>There is no heat or little heat</b></p>	<ol style="list-style-type: none"> <li>1. Be sure the thermostat is set to “heat” and is turned up to an appropriate temperature.</li> <li>2. Check the main service panel for a tripped or blown breaker or fuse.</li> <li>3. Check the water level; it may be too low. Add water as necessary.</li> <li>4. Check the combination gauge on the boiler to make sure the pressure is in an acceptable range.</li> <li>5. Repair any pipe that is leaking.</li> <li>6. Check the operation of the expansion tank. See page 59 for instructions.</li> <li>7. Flush rusty water from the boiler. See page 60.</li> </ol>
<p><b>Only some of the terminal units are working</b></p>	<ol style="list-style-type: none"> <li>1. There may be air in the radiator or baseboard unit. To remove air from the vent, see page 61.</li> <li>2. The circulator itself may require repair. Call a service professional.</li> </ol>

# Troubleshoot an Expansion Tank/Extrol Tank

*When a hydronic heating system fails to produce adequate heat, one component to check is the expansion tank.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 58 of the participants' *Resource Guide*.)
3. If you have a hydronic heating system available, show as much of the technique as you can. Even pointing out the key parts described will help.
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Wear eye protection.

Wear gloves.

## Tools and Materials Needed

- Hose

## How-to Steps

1. Check the pressure-relief valve. If water is spurting from it, there is too much water and not enough air in the tank.
2. Look through the view glass to see how full the expansion tank is. If it is more than two-thirds full, drain it to the one-half level.

**Note:** If an Extrol tank is filled, the air bladder has broken and needs replacing. Call a heating service professional.

3. Return all valves to their normal settings and start the boiler.
4. Check the system's pressure on the combination gauge. If it is not within normal operating range, call for professional service.



# Flush a Boiler of Rusty Water

*Watching for signs of rust in the boiler, pipes, and terminal units and addressing them quickly can prevent bigger problems down the road...or should we say, "down the pipe?"*

## Leader's Instructions:

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 59 of the participants' *Resource Guide*.)
3. If you have a hydronic heating system available, show as much of the technique as you can. Even pointing out the key parts described will help.
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Make sure the power is off.

Use lockout/tagout procedures.

Wear eye protection.

Wear gloves.

## Tools and Materials Needed

- Lockout/tagout device
- Screwdriver or special tool to open terminal unit
- Bucket

## How-to Steps

1. Shut off the power.
2. Lock and tag out the service panel.
3. Open the drain and the air vents on the highest radiator or baseboard units.
4. If the boiler has a manual feed, open it.
5. When the water runs clear, close the drain and vents and wait until pressure reaches 20 pounds per square inch (psi).
6. Bleed each radiator/baseboard unit until the pressure reaches 20 psi, then drain off the water. If the pressure falls below 12 psi, add more water.
7. Turn the power back on and test the system.

# Bleed a Hot-water Radiator

*When only some radiators are working, the problem could be air trapped within the closed circuit system. You need to get this air out of the radiator using a process called bleeding.*

1. Introduce the topic.
2. Cover the how-to information below. (This information is also on page 60 of the participants' *Resource Guide*.)
3. If you have a hydronic heating system available, show as much of the technique as you can. Even pointing out the key parts described will help.
4. Ask for questions.
5. Have participants and any invited subject matter experts share their best ideas and advice.

## Safety

Wear eye protection.

Wear gloves.

## Tools and Materials Needed

- Screwdriver
- Bucket

## How-to Steps

1. Open the vent with a screwdriver or special tool supplied with the radiator.
2. When water (instead of air) comes out, close the vent.
3. If the pressure falls below 12 psi, then add more water.

## Group Discussion on Hydronic Heat

*Wrap up the subject of hydronic heating with a group discussion.*

### **Leader's Instructions:**

Hold a 10-minute group discussion on hydronic heat to enrich participants' knowledge.

You can do this in a variety of ways, such as:

- Presenting additional material on hot water heating systems, or having an invited subject matter expert do it.
- Asking participants to share their stories and experiences.
- Holding a question and answer session.
- Asking participants to share their best “tips and tricks” related to hydronic heat.

Let participants know the how the discussion will work, and encourage them to take notes on page 61 of their *Resource Guide*.



## Key Takeaways (30 minutes)

*It's time for participants to make the most of their newfound knowledge by taking action on what they have learned.*

*In this final part of the training, participants will briefly review the key takeaways for this course, write a brief "Start/Stop/Continue" action plan, and then be introduced to the supplemental online training.*

You've come a long way. In just a short period of time, we've covered all of these topics related to heating systems:

- Your roles and responsibilities
- Safety
- Tools and equipment for heating repairs
- Air distribution
- Electric furnace basics and repairs
- Electric baseboard heating basics and repairs
- Gas furnace basics and repairs
- Hydronic heating basics and repairs

To cross the finish line for this course, we have just three things to do:

1. Take a look at the key takeaways for this course
2. Have you write a simple action plan
3. And introduce you to the supplemental online training for this course

Let's start with the key takeaways. Turn to page 58 in your *Resource Guide*.

## Key Takeaways

*It's not easy to sum up a course that has covered as much ground as this one. But we've tried, by identifying several key takeaways you can use once you get back on the job:*

### Heating Safety Takeaways

- Follow the correct safety procedures whenever you work with any heating system. Do not cut corners or take risks.
- When testing or repairing a heating system, turn off any electrical power. Use a circuit tester or multimeter to make sure the power is off.
- Follow lockout/tagout procedures.
- Wear the correct personal protective equipment—in most cases, eye protection and gloves—and wear non-slip soled shoes with a protective toe box.
- Call a heating professional to do work for which you are not qualified.

### Heating Repair and Maintenance Takeaways

- Use the repair techniques you've learned today to improve the speed and quality of your work.
- Keep up with the latest advances in tools, technology, and techniques as they relate to heating system maintenance and repair.
- Feel free to use this *Resource Guide* when you're back on the job.

#### **Leader's Instructions:**

Ask participants if they'd like to add any key takeaways. Write them on the flipchart or whiteboard, and invite participants to write them in their *Resource Guide*.

With these takeaways in mind, let's move on to your action plan. Turn to the next page in your *Resource Guide*.

## “Start/Stop/Continue” Action Plan

The point of an action plan is simple. It gets you thinking about what you’ve learned in this course, and then asks you to write down a few things you’ll do differently back on the job.

You’ll be doing a simple and realistic action plan today called “Start/Stop/Continue.” All you need to do is reflect on the things you’ve learned in this course, and based on that, write at least one thing you want to start doing, stop doing, and continue doing when you return to your apartment community.

Then, if you can work on these things for the next month, you’ll most likely improve your on-the-job skills, feel more confident, and just enjoy your time as a maintenance technician even more.

I’m going to give you ten minutes now to work on your “Start/Stop/Continue” plan, and remember, this plan is for you and you alone. You don’t need to share with it anyone, unless you’d like to.

### Leader’s Instructions:

Give participants ten minutes to work on their “Start/Stop/Continue” action plans, and answer any questions along the way.

Thank you for taking the time to work on your plan. I wish you all the best as you work on it over the next month.

## Supplemental Online Training

Before we bring this course to its official close, I want to tell you about another way you can build on—and reinforce—what you’ve learned today.

As part of this course, you can also complete a brief online training course on Heating Maintenance and Repair. The course will take approximately 30 minutes, and it will cost you nothing extra. You can access and take the course on your home computer, a computer in a public place like a library, or a computer at work as long as you have your supervisor’s permission to do so.

In this online course, you’ll get to complete two practice scenarios, in which you’ll play the role you know best, that of a maintenance technician.

These realistic scenarios will let you prioritize, diagnose, and repair heating system problems, just as you would on the job. You’ll also be able to ask questions and get feedback as you go along.

You can find the instructions for accessing the course on the inside cover of this *Resource Guide*.

## Closing

Thank you for being a part of this Heating Systems Maintenance and Repair course.

I wish you the best of luck as you pursue your CAMT designation; and all the best back on the job, too. It’s been my pleasure to be your instructor.

### Leader’s Instructions:

If there are no further questions or comments, dismiss the participants.

On behalf of the NAA and your local affiliate, thank you for teaching the “*Heating Maintenance and Repair*” course.

## **Appendix: Suggested Training Kit for this Course**

*Work with your NAA affiliate to put together a training kit of tools and materials you can use in the course. This kit won't be expensive, but it'll take a little planning and time to complete.*

### **Safety Equipment**

Lockout/tagout kits  
Pairs of goggles  
Pairs of gloves  
Nose and mouth masks

### **Tools**

Screwdrivers  
Nutdrivers  
6-in-1 Tools  
Tongue and groove pliers  
Needlenose pliers  
Adjustable wrenches  
Utility knives  
Inexpensive digital multimeters  
Soft brushes  
Fine wire  
Bucket  
Hose  
Vacuum

### **Materials**

Soft cloths  
Matches

### **Demonstration Equipment**

Direct drive blower  
Electric furnace  
Electric baseboard heating unit  
Gas furnace  
Hydronic radiator or baseboard unit

# Acknowledgments

## Subject Matter Experts

*The NAA Education Institute wishes to thank the following apartment industry professionals for contributing their time and expertise to the rewrite of the Certificate for Apartment Maintenance Technicians program:*

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*NAAEI would like to thank the following individuals for their time and expertise in updating the CAMT Job Task Analysis:*

Ed Kiper / David Jolley / Keith Gibson

*NAAEI would like to credit the following companies for use of photos:*

**Carrier Corporation**  
[www.Carrier.com](http://www.Carrier.com)

**Wilmar Industries**  
[www.Wilmar.com](http://www.Wilmar.com)





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