



# Introduction to the Plumbing Profession



## OVERVIEW

Plumbers protect the health, safety, and comfort of people. Training and critical-thinking skills are essential to being a good plumber. A professional work ethic and good safety habits go a long way toward adding to the success of a plumber.

## Module 02101

# Introduction to the Plumbing Profession

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# 02101

## INTRODUCTION TO THE PLUMBING PROFESSION

### Objectives

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Successful completion of this module prepares trainees to:

1. Describe the plumbing profession.
  - a. Describe the history of the plumbing profession.
  - b. Describe the plumbing profession today.
2. Identify the responsibilities of a person working in the plumbing industry.
  - a. State the personal characteristics of a professional.
  - b. Identify career opportunities in plumbing.

### Performance Tasks

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This is a knowledge-based module; there are no Performance Tasks.

### Trade Terms

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Aboveground rough-in	Leadership in Energy and Environmental Design (LEED)
Appurtenances	Model codes
Aqueduct	On-the-job learning (OJL)
Aquifer depletion	Plumbarius
Backflow	Plumber
Backflow preventer	Plumbing
Bioswale	Plumbum
Chlorine	Polyvinyl chloride (PVC)
Code	Potable
Cross-connection	Rainwater harvesting
Disinfection	Reclaimed water
Drain, waste, and vent (DWV)	Softening
Ethics	Solar hot water
Filtration	Thermoplastic
Finish	Thermoset
Fixtures	Underground rough-in
Geothermal	United States Green Building Council (USGBC)
Graywater	Water efficiency
Journey plumber	

## Industry Recognized Credentials

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### CODE NOTE

Codes vary among jurisdictions. Because of the variations in code, consult the applicable code whenever regulations are in question. Referring to an incorrect set of codes can cause as much trouble as failing to reference codes altogether. Obtain, review, and familiarize yourself with your local adopted code. Safety codes are developed by the US Occupational Safety and Health Administration (OSHA).

## Contents

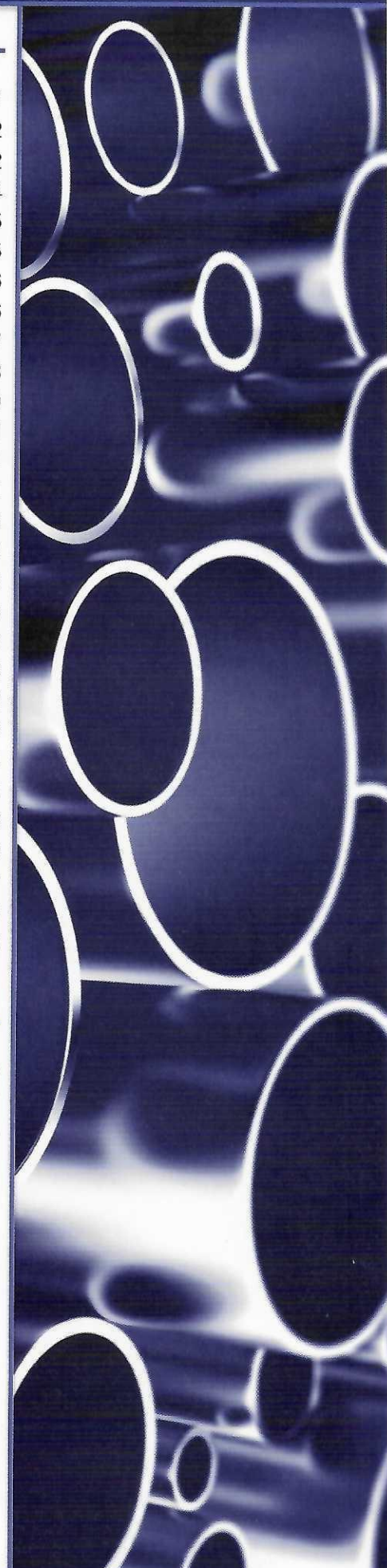
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<b>1.0.0</b>	The Plumbing Profession.....	1
<b>1.1.0</b>	History of Plumbing.....	2
1.1.1	Early Plumbing Systems.....	2
1.1.2	A New Professional Organization .....	4
1.1.3	Plumbing in the Twentieth Century.....	5
<b>1.2.0</b>	Plumbing Today.....	5
1.2.1	Responsibilities in the Plumbing Profession .....	6
1.2.2	What is Plumbing? .....	6
1.2.3	Protecting Public Health, Safety, and Comfort .....	7
1.2.4	The Three Phases of a Plumbing Project.....	8
1.2.5	Plumbing Codes and Licenses.....	9
<b>2.0.0</b>	Responsibilities of a Plumbing Professional.....	11
<b>2.1.0</b>	Keys to Professional Success.....	11
2.1.1	Positive Attitude .....	11
2.1.2	Honesty .....	12
2.1.3	Loyalty .....	12
2.1.4	Willingness to Learn .....	12
2.1.5	Responsibility.....	12
2.1.6	Cooperation.....	13
2.1.7	Attention to Rules and Regulations.....	13
2.1.8	Promptness and Reliability .....	13
2.1.9	Other Important Qualities.....	13
<b>2.2.0</b>	Career Opportunities in Plumbing.....	14
2.2.1	Formal Construction Training.....	15
2.2.2	Youth Apprenticeship Program .....	16
2.2.3	Apprenticeship Standards .....	16
2.2.4	What You Should Expect from Your Employer or Sponsor.....	17
2.2.5	What You Should Expect from a Training Program .....	18
2.2.6	What You Should Expect from the Apprenticeship Committee....	18

## Figures

---

Figure 1	The evolution of plumbing. ....	3
Figure 2	Examples of plumbing licenses.....	9
Figure 3	Opportunities in the construction industry.....	15



Contents

1.00 The Plumbing Profession ..... 1

1.10 History of Plumbing ..... 2

1.11 Early Plumbing Systems ..... 3

1.12 A New Professional Organization ..... 4

1.13 Plumbing in the Twentieth Century ..... 5

1.14 Plumbing Today ..... 6

1.15 Responsibilities in the Plumbing Profession ..... 7

1.16 What is Plumbing? ..... 8

1.17 Plumbing: Health, Safety, and Comfort ..... 9

1.18 The Three Phases of a Plumbing Project ..... 9

1.19 Plumbing Codes and Licenses ..... 9

2.00 Responsibilities of a Plumbing Professional ..... 11

2.10 Keys to Professional Success ..... 11

2.11 Positive Attitude ..... 11

2.12 Honesty ..... 12

2.13 Loyalty ..... 12

2.14 Willingness to Learn ..... 12

2.15 Responsibility ..... 12

2.16 Cooperation ..... 12

2.17 Attention to Detail ..... 12

2.18 Progress and Persistence ..... 12

2.19 Good Personal Qualities ..... 13

2.20 Career Opportunities in Plumbing ..... 14

2.21 Formal Education Training ..... 15

2.22 Your Apprenticeship Program ..... 15

2.23 Apprenticeship Standards ..... 16

2.24 What You Should Expect from Your Employer or Sponsor ..... 17

2.25 What You Should Expect from a Training Program ..... 18

2.26 What You Should Expect from the Apprenticeship Committee ..... 18

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Figure

Figure 1 The evolution of plumbing ..... 2

Figure 2 Examples of plumbing licenses ..... 3

Figure 3 Opportunities in the construction industry ..... 16

## SECTION ONE

### 1.0.0 THE PLUMBING PROFESSION

#### Objective

Describe the plumbing profession.

- Describe the history of the plumbing profession.
- Describe the plumbing profession today.

#### Trade Terms

**Aboveground rough-in:** The second phase of a plumbing project. During this phase, holes are cut in walls, ceilings, and floors. Then, supply and waste pipes are attached or hung so they can be connected to fixtures. Also referred to as stack out, top out, or in-wall rough-in.

**Appurtenances:** Accessories or apparatus that require no demand from the water supply side and add no load to the waste side.

**Aqueduct:** A man-made channel used to carry water.

**Aquifer depletion:** The use of underground fresh water at a rate faster than it can be replenished.

**Backflow:** The flow of contaminated water into the freshwater system resulting from a cross-connection between potable and nonpotable water systems.

**Backflow preventer:** A device that prevents nonpotable water from entering a potable supply system.

**Bioswale:** A depression in the ground that filters pollutants from stormwater.

**Chlorine:** A heavy, greenish-yellow gas used as a disinfectant in water treatment. Chlorine should be handled only when wearing appropriate personal protective equipment.

**Code:** A requirement published by state and local governments to establish minimum standards for various types of construction. A code carries the force of law.

**Cross-connection:** An arrangement between a potable water system and a nonpotable water system in which an accidental pressure differential between the two systems causes backflow of contaminated water into the freshwater system.

**Disinfection:** The process of destroying harmful organisms in potable water.

**Drain, waste, and vent (DWV):** A piping system that combines sanitary drainage with venting.

**Filtration:** The process of cleansing water to remove particles and chemicals.

**Finish:** The third phase of a plumbing project. During the finish phase, plumbers install fixtures, appliances, water purification systems, water heaters, and controls. Also referred to as trim-out or trim finish.

**Fixtures:** Devices that receive water from a water supply line. Common fixtures include sinks, shower stalls, and toilets.

**Geothermal:** Heat that is generated below the earth's surface.

**Graywater:** Water that comes from baths and washing machines.

**Journey plumber:** A plumber who has successfully completed an apprenticeship-training program.

**Leadership in Energy and Environmental Design (LEED):** A system for certifying that buildings have been designed and constructed to environmental standards.

**Model codes:** Construction ordinances that are written by a national construction organization according to suggested national plumbing standards. Model codes that have not been adopted by a jurisdiction do not have the force of law.

**On-the-job learning (OJL):** Field experience used in conjunction with classroom lessons in an apprenticeship program. OFFICE OF APPRENTICESHIP requires 144 hours of classroom instruction per year and 2,000 hours of OJL per year.

**Plumbarius:** The Roman term for someone who works with lead. The root of the modern word plumber.

**Plumber:** One who installs or repairs plumbing systems and fixtures.

**Plumbing:** According to the National Standard Plumbing Code, plumbing is "the practice, materials, and fixtures within or adjacent to any building structure or conveyance, used in the installation, maintenance, extension, alteration, and removal of all piping, plumbing fixtures, plumbing appliances, and plumbing appurtenances..."

**Plumbum:** Latin word for lead.

**Polyvinyl chloride (PVC):** A thermoplastic material frequently used in tubing for cold water systems and the first type of plastic approved for use in plumbing.

**Potable:** Water that is safe for cooking and drinking.

**Rainwater harvesting:** The collection and storage of rainwater for irrigation.

**Reclaimed water:** Wastewater that has had impurities and solids removed from it so that it can be reused for non-potable purposes.

**Softening:** The process of removing magnesium and sodium salts that cause scale on the inside of pipes and fittings.

**Solar hot water:** Water that has been directly or indirectly heated by sunlight.

**Thermoplastic:** A plastic material used in plumbing and sanitary systems that is soft and pliable when heated and hard and rigid when cooled.

**Thermoset:** A plastic material used in plumbing and sanitary systems that becomes substantially infusible and insoluble when treated by heat or chemicals.

**Underground rough-in:** The phase of a plumbing project during which the plumber locates all supply and waste connections from the building systems to public utilities, and establishes where these systems will enter or leave the building.

**United States Green Building Council (USGBC):** The non-profit construction trade organization responsible for the development of LEED.

**Water efficiency:** The managed use of drinkable water to reduce waste.

**P**lumbing has profoundly influenced the development of modern society by improving public health and safety. Plumbing systems allow people to have safe, healthy, fresh water for drinking, washing, cooking, and many other uses. Additionally, plumbing reduces the spread of disease by safely draining away wastewater that contains harmful organisms. Improved sanitation contributes to longer life expectancies for men, women, and children. Plumbing systems also allow people to fight fires, water their lawns, fill their pools, and perform many daily activities.

### 1.1.0 History of Plumbing

Plumbing is the result of thousands of years of improvements, inventions, and innovations. *Figure 1* illustrates how plumbing systems have evolved since ancient times.

Plumbing systems, including **drain, waste, and vent (DWV)** systems, have been essential to the protection of public health and safety. These systems have evolved over time to the point where, today, many common water-borne diseases are rare in the United States.

### 1.1.1 Early Plumbing Systems

Archaeologists have determined that rudimentary plumbing systems were in use as early as 2900 BC. Earthenware pipes, masonry sewers, water closets, and drainage systems have been found in Mesopotamia (modern-day Iraq) to prove this.

In 312 BC, the Romans began bringing water into Rome through an **aqueduct** system, or a system of channels used to carry water. Most aqueducts were open, stone-lined trenches that used gravity to move water downhill. The more famous arched aqueducts were not nearly as commonly used as the simpler trench systems. By 100 AD, the aqueduct system was so advanced that Rome built and maintained public bathhouses and fountains throughout the city. The aqueducts were also used to drain wastes and discharge them into the river downstream from the city.

Archaeologists and historians believe that the widespread use of lead pipe in ancient Roman cities may have contributed to the downfall of the Roman Empire. Lead is harmful to the brain, the nervous system, and vital organs such as the liver. Water carried through lead pipes may have gradually poisoned many people in the Roman Empire.

The Romans also gave us the word that we use today to describe people who install and maintain water supply and waste systems. The Latin word for lead is **plumbum**, and a person who worked with lead was called a **plumbarius**. Over the centuries, this ancient word has come down to us as a word you know very well: **plumber**.

During the fifth century AD, the Goths invaded Rome and the Roman Empire came to an end. Roman cities and their infrastructure fell into disrepair. Much of the science, math, and technology of the Roman and Greek golden age were gradually forgotten. The period after the fall of Rome (500 AD to 1400 AD) is often referred to as the Dark Ages because of the social and cultural decline that resulted from this loss.

During that time, people neglected sanitation and hygiene. They emptied sewage into the streets and did not store or prepare their food in a healthful way. As a result, more people died from disease than from wars during those years. Some historians estimate that one-third of the population of Europe died from diseases spread by unsanitary living conditions and led to widespread epidemics like the Bubonic plague and smallpox, which killed hundreds of thousands across the continent.

By the mid-1300s, however, sanitation began to return to the cities of Europe. The first water supply pipe was laid in London during that time.



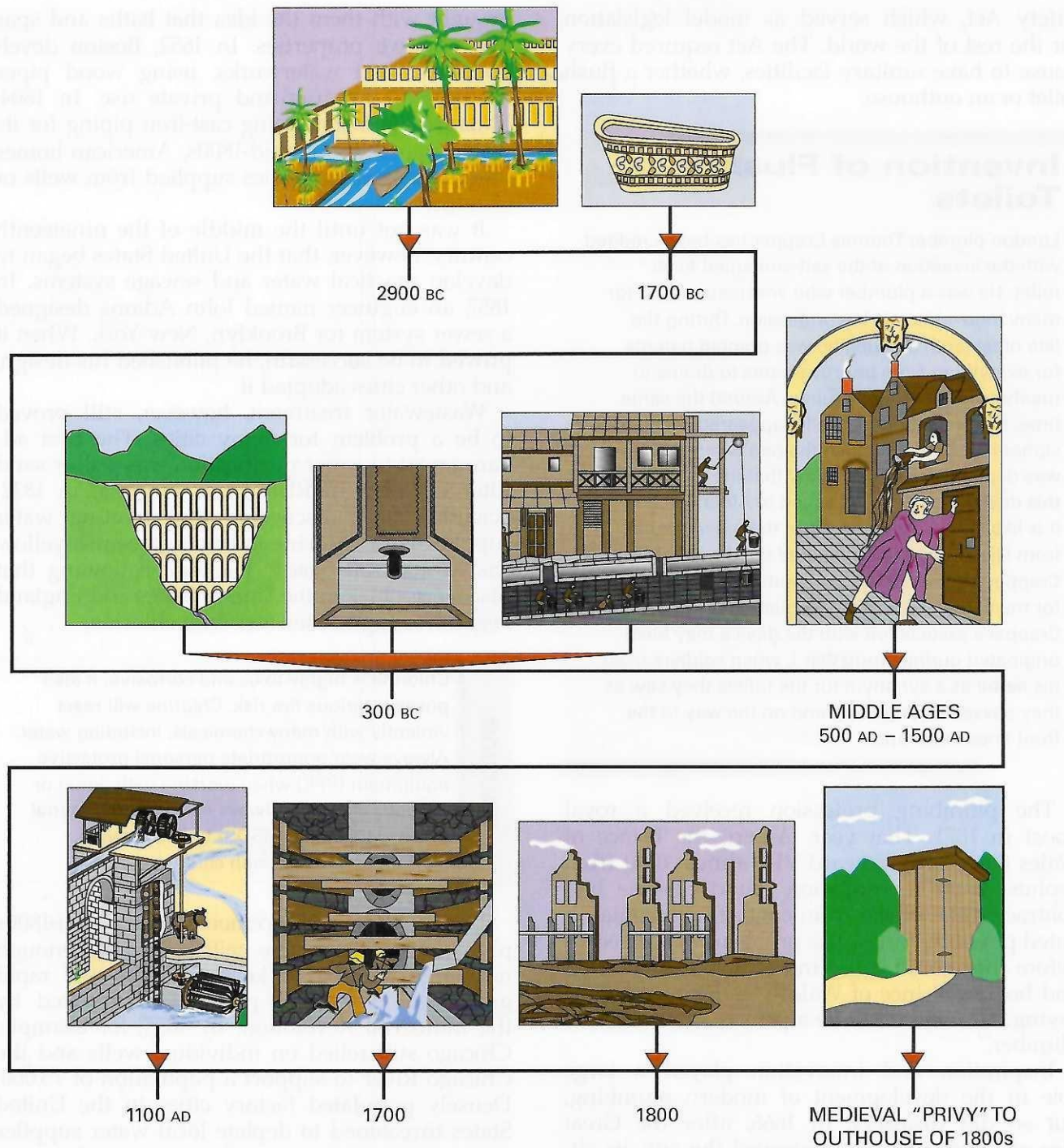


Figure 1 The evolution of plumbing.

The ancient baths and spas built by the Romans in England were put to use again during the sixteenth century. During that time, plumbing re-emerged as a profession. In 1625, the first apprenticeship laws for plumbing were enacted in England. Other countries began to develop water supply systems. A new era of sanitary awareness slowly emerged.

One of the first known water closets was built in England in 1596 by a godson of Queen

Elizabeth I, Sir John Harrington. However, it was another 200 years before the use of this invention became widespread. In 1775, Alexander Cumming invented the S-trap, the precursor of the toilet traps used today. Three years later, Joseph Bramah patented an improved version of Cumming's device that incorporated two hinged valves. The original is still in use today in the House of Lords in London's Parliament building. In 1848, England passed the National Public

Safety Act, which served as model legislation for the rest of the world. The Act required every house to have sanitary facilities, whether a flush toilet or an outhouse.

## Invention of Flush Toilets

London plumber Thomas Crapper has been credited with the invention of the self-contained flush toilet. He was a plumber who was responsible for many innovations in his profession. During the late nineteenth century, he was granted patents for everything from improvements to drains to manhole covers to pipe joints. Around the same time, the first “modern” toilet appeared: a U-bend siphoning system to flush the pan where waste was deposited. Records show that the patent for this device was actually issued to Albert Giblin. It is likely that Crapper bought the patent rights from Giblin and then marketed the device himself. Crapper also served as the sanitary engineer for many members of the English royal family. Crapper’s association with the device may have originated during World War I, when soldiers used his name as a synonym for the toilets they saw as they passed through England on the way to the front lines in Europe.

The plumbing profession received a royal boost in 1871. That year, Albert, the Prince of Wales (later King Edward VII), almost died from typhus. Later investigation found that he had contracted the illness from contact with contaminated plumbing lines. The problem was corrected before they could cause more illness. A relieved and healthy Prince of Wales was later quoted as saying, “If I could not be a prince, I’d rather be a plumber.”

Inspiration and innovation played a large role in the development of modern plumbing, but so did disasters. In 1666, after the Great Fire of London nearly destroyed the city, its citizens organized the first firefighting brigades and expanded the city’s water supply system. In the United States, deadly cholera epidemics in Philadelphia in 1793 and New York City in 1832 spurred construction of improved water supply systems. Earthquakes in California led to the modernization of municipal water systems there as well.

The United States, in fact, has been responsible for many of the most notable advances in plumbing technology as well as in health and safety standards. Early settlers of North America

brought with them the idea that baths and spas had curative properties. In 1652, Boston developed the first waterworks, using wood pipes for both firefighting and private use. In 1804, Philadelphia began using cast-iron piping for its water mains. By the mid-1800s, American homes often had outdoor privies supplied from wells or cisterns.

It was not until the middle of the nineteenth century, however, that the United States began to develop practical water and sewage systems. In 1857, an engineer named John Adams designed a sewer system for Brooklyn, New York. When it proved to be successful, he published his design, and other cities adopted it.

Wastewater treatment, however, still proved to be a problem for many cities. The first advancement in water purification was a slow sand filter installed in Richmond, Virginia, in 1832. Scientists later discovered that treating water supplies with **chlorine** (a heavy, greenish-yellow gas) would kill deadly bacteria. Following that discovery, cities in the United States and England began treating wastewater with chlorine.

### CAUTION

Chlorine is highly toxic and corrosive. It also poses a serious fire risk. Chlorine will react violently with many chemicals, including water. Always wear appropriate personal protective equipment (PPE) when working with liquid or gaseous chlorine. Always consult the material safety data sheet (MSDS) before moving, storing, or working with chlorine.

Despite these advancements, by the mid-1800s plumbing systems were neither complex enough nor large enough to keep up with the rapid growth of cities and populations spurred by the Industrial Revolution. By 1855, for example, Chicago still relied on individual wells and the Chicago River to support a population of 75,000. Densely populated factory cities in the United States threatened to deplete local water supplies and overwhelm rivers and streams with wastewater. The plumbing profession had to change with the times to meet these new demands.

### 1.1.2 A New Professional Organization

By the late nineteenth century, plumbing technology and practices were recognizably modern. Manufacturers and wholesale dealers of new plumbing devices sold them over the counter as separate components. They ignored the fact that these components would have to be combined and installed into a properly designed plumb-

ing system in order to work. Dealers claimed no responsibility for the proper installation of plumbing systems. The results were predictable. People suffered from shoddy and unsafe plumbing systems that possibly made sanitary conditions worse instead of better. And plumbers were usually blamed—unfairly—when things went wrong. Plumbers had the knowledge and ability to install safe and efficient plumbing systems, but the manufacturers and dealers completely dominated the trade.

Accordingly, at the association's second annual convention in Baltimore in 1884, the attendees adopted a set of professional guidelines that became famous as the Baltimore Resolutions. The resolutions succeeded at last in putting plumbers in charge of the profession. They helped ensure that plumbing installations in the United States would be safe and sanitary, and that plumbers would be held to rigorous professional standards.

### 1.1.3 Plumbing in the Twentieth Century

Sanitation, along with medical science, continues to be largely responsible for the maintenance of public health. In the United States, great progress in the development of plumbing methods and technologies has been made since 1910. The reliability of traditional piping materials, such as copper and cast iron, has been dramatically improved. A new plastic compound called **thermoplastic** (which is soft and pliable when heated) and **thermoset** (which becomes solid when heated) have been developed. The physical properties of these plastics make them ideal for use in sanitary systems. **Polyvinyl chloride (PVC)**, developed in the 1930s, was the first plastic used in plumbing. PVC is a rigid pipe with high-impact strength that is manufactured from a thermoplastic material. The material has an indefinite life span under most conditions. Plumbers frequently use PVC in cold water systems. Manufacturers have also improved plumbing **fixtures**, which are devices that receive water from a water supply line. Common fixtures include sinks, faucets, shower stalls, and toilets.

In 1911, the Kohler Company developed the first one-piece recessed bath. Before this, baths had been built in two separate sections: the tub itself and the surrounding apron. Kohler's one-piece tub was much more sanitary and attractive. In 1926, Kohler introduced the electric sink, a combination of a conventional sink and electric dishwasher.

Other inventors established companies whose names are familiar to today's plumbers. Al Moen, who held more than 75 patents, invented the single-handle mixing faucet. In 1906, William Sloan

developed a flush valve in which water flows under pressure from the supply pipe directly to the fixture, so that it is always ready to be used. Halsey W. Taylor established the company that bears his name in 1912 to manufacture and sell hygienic drinking fountains.

### 1.2.0 Plumbing Today

Fresh water accounts for only about 3 percent of the water on Earth. In many places, the overuse of groundwater supplies has led to **aquifer depletion**, the use of underground fresh water at a rate faster than it can be replenished. Many areas of the United States are dependent on aquifers such as the Ogallala, which stretches from Texas to South Dakota.

Moving into the twenty-first century, societies worldwide began to recognize the need to make wise use of natural resources, especially fresh water. The efforts to do so will continue to impact the plumbing profession for many years to come. Those efforts include practices such as **rainwater harvesting** (the collection and storage of rainwater for reuse), the reuse of **graywater** (laundry and bath water), and technologies such as the creation of a **bioswale**, which is a constructed depression in the ground that filters pollutants from stormwater. Many places are also using **reclaimed water** for reuse in systems that are not meant for drinking, such as flushing fixtures. Reclaimed water has had impurities and solids removed from it.

Founded in 1993, the non-profit **United States Green Building Council (USGBC)** developed the **Leadership in Energy and Environmental Design (LEED)** green building certification system in 2000. LEED provides a way for contractors to identify and implement improved methods for the design, construction, operation, and maintenance of green buildings. Out of 110 possible points on the LEED rating scale, between 10 and 14 fall under the category of **water efficiency**, or the managed use of drinkable water to reduce waste, with water management addressed in other categories as well. Both federal agencies and state governments have adopted LEED certification as a requirement for new construction, so it is important for plumbers to know and be able to work within these standards.

In some areas of the country, plumbers are also responsible for installing and maintaining **geothermal** (heated by energy from below the earth's surface) and **solar hot water** (water that has been heated directly or indirectly by the sun) systems. Refer to your local applicable **code** to determine whether plumbers in your area install and maintain these systems.

### 1.2.1 Responsibilities in the Plumbing Profession

Plumbing is practically everywhere: in kitchens and bathrooms; at golf courses; in parks; and at municipal sanitary, sewage, and water systems. Because the manmade environment relies on plumbing, plumbers play a very important role in society. The systems that plumbers install do many things, including the following:

- Make drinking water safe and pure
- Protect homes and businesses from fires
- Help keep basements dry
- Help keep lawns and gardens green

The plumbing profession is made up of talented craftworkers who draw on a set of skills that are well suited to the field. Plumbers are good at working with their hands. They can use precise measuring and testing tools with skill. They get a lot of satisfaction from solving complex problems. Plumbers take pride in their work.

A plumber must have critical thinking skills to be able to read and interpret construction drawings, review manufacturer's specifications, understand and apply legal standards, rough-in entire plumbing systems, and troubleshoot problems. Plumbers must have a firm grasp of basic mathematics. They need to be fairly fit and flexible, because their work can be physically demanding. Plumbers often work in cramped spaces and do a lot of work while standing up.

Plumbers need these skills because they perform a wide range of tasks. Plumbers design, install, repair, and maintain **potable** (drinkable) water supply lines and piping layouts; drainage systems; drain, waste, and vent (DWV) systems; and gas systems. There are many professions related to plumbing that require the same base knowledge that a plumber has, including the following:

- Sprinkler fitters, who install fire-sprinkler and other fire-protection systems in buildings
- Pipefitters, who install piping for steam, water heating and cooling, lubrication, and other uses
- Steamfitters, who install pipe systems to move liquids or gases under high pressure
- Irrigation system installers, who design, install, and maintain irrigation systems for small areas such as residential gardens and large areas such as golf courses

Plumbers also specialize in commercial and residential design, construction, remodeling, renovation, and maintenance. Plumbers can own and operate their own contracting business. They

can also branch out into related fields by becoming plumbing inspectors, instructors, estimators, or safety managers.

Many plumbers specialize in servicing specific types of systems, such as air conditioning, heating, and water distribution systems. They become experts in troubleshooting and repairing malfunctioning equipment. If you specialize in the service and repair of specific systems, you will always be in demand.

Whatever their specialty, plumbers work with the latest technology, tools, and equipment. Being a plumber means keeping up-to-date on the technological developments in plumbing, on better methods to do plumbing work, on the qualities and advantages of new materials, and on changes to the codes and standards that govern plumbing. A code is a legal document adopted by a jurisdiction that establishes the minimum acceptable standards, rules, and regulations for all materials, practices, and installations used in buildings and building systems.

Most states and localities require plumbers to be licensed as a **journey plumber**, master plumber, and/or plumbing contractor. Refer to your local code for the guidelines that apply where you work.

### 1.2.2 What is Plumbing?

Plumbing has different meanings to different people. The National Standard Plumbing Code (NSPC) defines plumbing as follows:

- The practice, materials, and fixtures within or adjacent to any building structure or conveyance, used in the installation, maintenance, extension, alteration, and removal of all piping, plumbing fixtures, plumbing appliances, and plumbing **appurtenances** (accessories that don't require water supply or add a load to the waste side) connected with the following:
  - a. sanitary drainage systems and related vent systems;
  - b. storm water drainage facilities and venting systems;
  - c. public or private potable water supply systems;
  - d. the initial connection to a potable water supply upstream of any required **backflow** prevention devices (which prevent nonpotable water from entering the potable supply system) and the final connection that discharges indirectly into a public or private disposal system;

- e. medical gas and medical vacuum systems;
- f. indirect waste piping, including refrigeration and air conditioning drainage;
- g. liquid waste or sewage, and water supply, of any premises to their connection with the approved water supply system or to an acceptable disposal facility.

Both the *International Plumbing Code (IPC)* and the *Uniform Plumbing Code (UPC)* define plumbing as:

- The practice, materials and fixtures utilized in the installation, maintenance, extension and alteration of all piping, fixtures, plumbing appliances and plumbing appurtenances, within or adjacent to any structure, in connection with sanitary drainage or storm drainage facilities; venting systems; and public or private water supply systems.

You can see that these definitions largely cover the same range of activities, although the NSPC definition is more specific in including medical gas and vacuum systems and refrigeration and air conditioning drainage systems.

### 1.2.3 Protecting Public Health, Safety, and Comfort

The goal of plumbers is to provide adequate piping systems that protect the health, safety, and comfort of the nation. Plumbers accomplish this goal in two ways:

- By installing safe, reliable plumbing systems
- By properly maintaining and repairing existing systems

Federal agencies such as the Environmental Protection Agency (EPA) enforce rules and regulations related to environmental issues. Laws such as the Clean Water Act and the Clean Drinking Water Act have been passed to develop programs to help ensure the enforcement of these rules and regulations. State and local health agencies also establish their own complementary standards and regulations that apply to their jurisdictions. A plumber's responsibility is to follow all of the rules and safeguards related to the work. Plumbers should also report any accidents or events that may be hazardous to health or to the environment.

One of the biggest health and safety issues facing plumbers today is contamination caused by an improper **cross-connection** between plumbing systems. A cross-connection is an

arrangement between a potable water system and a nonpotable water system in which an accidental pressure differential between the two systems causes backflow of contaminated water into the freshwater system. Backflow can force wastes through a cross-connection. Several things can cause backflow:

- Cuts or breaks in the water main
- Failure of a pump
- Injection of air into the system
- Accidental connection to a high-pressure source

When wastewater or other liquids are siphoned into the fresh water supply, they can cause contamination, sickness, and even death. *Escherichia coli*, also known as *E. coli*, and *Legionella* (the bacteria that causes Legionnaire's disease) can be spread through backflow from contaminated systems. A safety device called a **backflow preventer** keeps wastewater from entering the water supply system. You will learn more about backflow and backflow prevention later in the Plumbing curriculum.

To prevent the spread of harmful organisms, chemicals, and materials through water supply systems, water is made safe through **disinfection**, **filtration**, and **softening**. To disinfect water means to destroy harmful organisms in the water. Filtration is the process of cleansing water to remove particles and chemicals. Softening removes magnesium and sodium salts that cause scale on the inside of pipes and fittings. You will learn more about these methods of water treatment later in the Plumbing curriculum.

The safety and health of the plumber is just as important as that of the customer. One of the dangers facing plumbers is injury caused by scalding. For many years, plumbing codes have usually required water to be available at temperatures of up to 140°F (60°C). The American Society of Plumbing Engineers (ASPE) has found that this temperature is necessary to prevent the growth of *Legionella* bacteria. At this temperature, however, water can scald exposed skin almost immediately. In response to this danger, many codes include specific requirements to reduce the threat of scalding.

#### CAUTION

Incorrectly sized pipe in a plumbing system can cause the system to work incorrectly and could even damage the pipe and fixtures. Ensure that all pipe used in a plumbing system is sized according to the applicable local code. Codes include sizing charts that should be used for reference.



## Low-Flow Fixtures

As you have learned, one of the most important goals of the plumbing profession is to protect the health, safety, and comfort of the nation.

Another important goal is to act as a steward of the environment. Water conservation is one of the most important environmental issues, and water-conserving fixtures, such as toilets and showerheads, help preserve this vital natural resource.

Toilets consume about 30 percent of the water in a typical household. In 1992, the federal government required that toilets installed in new and renovated plumbing systems use no more than 1.6 gallons per flush, or about half as much as older toilets. These low-flow toilets have since been followed by high-efficiency toilets that use as little as 1.28 or even 1.1 gallons per flush. Advocates of low-flow toilets claim that the water savings from low-flush toilets can save millions of gallons a year and extend the operating life of water treatment facilities. Waterless urinals use a cartridge filter containing a liquid seal rather than water to remove waste and odor. They are installed in locations where access to a water supply is difficult, or when water conservation considerations require their use.

However, these fixtures must be properly sized and installed to work. When low-flow or high-efficiency toilets are connected to DWV systems that are designed for higher flow rates, the systems may clog and overflow, or they may require multiple flushes to empty the bowls, defeating the purpose of the fixture. The installation of low-flow fixtures may even require replacement of the sewer lines to accommodate the lower fluid flows—an expensive proposition. Contractors report that they receive more callbacks regarding low-flow toilets than for any other reason.

Always refer to your local code when installing plumbing fixtures. Read the manufacturer's instructions and follow the installation instructions carefully. Getting the installation right the first time will help save the contractor time and money and will ensure satisfied customers.

### 1.2.4 The Three Phases of a Plumbing Project

Plumbing can be divided into three broad phases:

- **Underground rough-in**
- **Aboveground rough-in** (also called *top-out*, *stack-out*, or *in-wall rough-in*)
- **Finish** (also called *trim-out* or *trim finish*)

During the underground rough-in phase, the plumber locates all supply and waste connections from the building systems to public utilities and establishes where these systems enter or leave the building. During the aboveground rough-in phase, the plumber cuts holes in walls, ceilings, or floors to attach or hang pipe for connection to fixtures. Then the plumber installs the pipe for the building's various supply and waste systems. To join pipe runs, a plumber might use welding tools, soldering equipment, or special chemicals for plastic pipe. The plumber may operate power threading machines, propane torches, and other power tools during this phase.

#### NOTE

Many plumbing terms are used interchangeably in some areas. Be sure you are using the terms the way they are typically used where you work.

Finally, in the finish phase, the plumber installs fixtures such as sinks, showers, and toilets, and appliances such as dishwashers, water purification systems, and water heaters. The plumber may be called upon to install the automatic controls that regulate pressurized pipe systems as well.

During each of the three stages, you must ensure that the system is tight and safe. Do not let your customers discover leaks behind the walls after you have completed your work. Callbacks are expensive and can hurt your reputation as a professional.

Regardless of how well a plumbing system is installed, it must be maintained and periodically repaired. You could even think of service and maintenance as a fourth phase of a plumbing project. Plumbers perform a variety of tasks as part of service and maintenance, including the following:

- Checking lubrication levels in pumps, test gauges, and meters
- Repairing faulty fixtures and components
- Verifying operating systems
- Regulating flow and usage rates

Additionally, plumbers must ensure that the drain, waste, and vent (DWV) system for each project is installed and working properly. DWV systems, which are discussed in greater depth later, are essential to protect public safety.

### 1.2.5 Plumbing Codes and Licenses

Plumbing codes have grown increasingly comprehensive to accommodate new developments in technology and materials. Municipalities throughout the United States adopt ordinances based on suggested national plumbing standards, called **model codes**. They often modify or interpret these model codes to reflect local conditions. For instance, a city that is prone to earthquakes, such as Los Angeles, would incorporate standards to protect installations from earthquake damage. Likewise, a city that is subject to flooding, such as Houston, would add special requirements to guard against contamination from floodwater.

The three primary model codes associated with plumbing are the International Plumbing Code (IPC), the Uniform Plumbing Code (UPC), and the National Standard Plumbing Code (NSPC). You will learn how codes are developed and implemented later in the Plumbing curriculum.

Although model codes act as guidelines, municipal ordinances have the force of law. As an apprentice plumber, you need to know the applicable plumbing code that applies to the area where you work. Your local plumbing code covers the installation, alteration, repair, replacement, additions to, and use of plumbing systems. It establishes standards for many things, including the following:

- Materials commonly used in plumbing systems
- Fixtures, joints, and connections
- Hangers and supports
- Water supply and distribution
- Vents
- Storm water and sanitary drainage systems
- Potable water supply systems

All states require plumbers to be licensed. Many states require completion of an apprenticeship program and/or **on-the-job learning (OJL)**, or field experience, before testing for a license. When you apply for a license (*Figure 2*), you will be tested on your knowledge of both your profession and the local plumbing ordinances.



Figure 2 Examples of plumbing licenses.

## Additional Resources

*Plumbing a House*, 1998. Peter A. Hemp. Newtown, CT: Taunton Press.

*The National Standard Plumbing Code*, current edition. Falls Church, VA: Plumbing-Heating-Cooling Contractors Association.

### 1.0.0 Section Review

1. Philadelphia began using cast-iron piping for water mains in the early \_\_\_\_\_.
  - a. 1600s
  - b. 1700s
  - c. 1800s
  - d. 1900s
2. Softening may be added to a water supply in order to \_\_\_\_\_.
  - a. prevent scale
  - b. improve flavor
  - c. reduce bacteria
  - d. prevent tooth decay



## SECTION TWO

### 2.0.0 RESPONSIBILITIES OF A PLUMBING PROFESSIONAL

#### Objective

Identify the responsibilities of a person working in the plumbing industry.

- a. State the personal characteristics of a professional.
- b. Identify career opportunities in plumbing.

#### Trade Terms

**Ethics:** A set of principles and values that guide an individual's conduct.

To be a successful plumber, you must be able to produce finished products of high quality in a minimum amount of time. You have probably heard the phrase "on time and on (or under) budget." Take a moment to really think about what this phrase means. It means that the job is completed by the deadline, and that it does not cost more than what was originally expected.

#### 2.1.0 Keys to Professional Success

Successful plumbers must be flexible enough to adapt their methods of working to the particular needs of each job. As you gain experience as a plumber, you will develop the flexibility necessary to meet changing job requirements. You will also improve your knowledge of the different tools and materials needed to accomplish certain jobs, and you will learn more about the technologies and methods that are available. Over time, you will improve your ability to do your job on time, on budget, and to the satisfaction of your customers. Satisfied customers mean repeat business.

Keep current with the latest methods, materials, and equipment in the plumbing profession. This knowledge will help you and the company you work for stay competitive. You should never stop learning. When you complete your apprenticeship, you will simply be moving into a bigger classroom: the world.

Never take chances with your own safety or the safety of others. Always demonstrate a high level of professionalism. Remember, you are part of a proud heritage, and you represent a profession that is vital to modern society. As a plumber, you will want your customers to think well not

only of your work as an individual, but also of the profession in general.

Construction professionals adhere to a code of professional **ethics**. Ethics are principles and values that guide conduct. As a plumber, you are responsible for understanding and following the code of ethics for your chosen profession. Appendix A lists the ethical principles that are followed by members of the construction trades.

Successful plumbers exhibit all of the following qualities:

- Positive attitude
- Honesty
- Loyalty
- Willingness to learn
- Responsibility
- Cooperation
- Attentiveness to rules and regulations
- Promptness and reliability

You were introduced to many of these concepts in the *Core Curriculum*. In this module, you will learn how they apply specifically to the plumbing trade. In the classroom and on the job, you will see that the successful plumbers you meet will demonstrate all of these qualities. Learn from them and become a better plumber.

#### 2.1.1 Positive Attitude

A positive attitude entails being energetic, motivated, attentive, and alert. It means understanding the importance of safety and responding well to change. A positive attitude will help you fulfill your obligations and take pride in your job.

An employee with a positive attitude contributes to others' productivity by setting an example. You can probably recall a situation where you had to work with someone who was complaining and slacking off. Do you remember how difficult and unpleasant it was to work in a situation like that? Try to keep that in mind when you are on the job, and ask yourself: Am I demonstrating a positive attitude?

A positive work environment not only leads to greater productivity, but also makes the job more enjoyable. Employers pay attention to your attitude. Supervisors see your attitude in your approach to the job, in your reactions to instructions, and in the way you handle problems, especially unforeseen ones.

## Tips for a Positive Attitude

Here is a short checklist of things that you should keep in mind to help you develop and maintain a positive attitude:

- Remember that your attitude follows you wherever you go.
- Helpful suggestions and compliments are much more effective than negative ones.
- Look for the positive characteristics about your teammates and supervisors.
- Focus on the good things about your job and the place where you work.

### 2.1.2 Honesty

Honesty and personal integrity are important traits of the successful professional. Honesty means more than just telling the truth and never cheating or stealing. It also means doing a fair day's work for a fair day's pay. It means holding up your side of a bargain. It means backing up promises with action.

You should take pride in performing a job well and you should never cut corners. Never lie to clients, supervisors, or co-workers. Respect the property of others. Ensure that the tools and materials belonging to your employer (or sponsor), customers, and other trades are not damaged or stolen from the shop or the job site. Treat their property with the same respect that you give to your own.

Your reputation will always precede you. A reputation for honesty and integrity will make employers want to hire you because they know that you can be trusted. On the other hand, if you lie, cheat, or steal, that reputation will precede you wherever you apply for work and your career will suffer accordingly.

If you want to be gainfully employed, earn a good salary, and be well regarded by teammates and supervisors, then you should start by being honest. It's that simple.

### 2.1.3 Loyalty

As an employee, you expect your employer or sponsor to look out for your interests, keep you steadily employed, and promote you as job openings occur. Your employers and sponsors, in turn, have a right to expect your loyalty in return.

Remember, however, that loyalty cannot be demanded from someone; it can only be earned.

Loyalty means different things to different people, but in a professional setting, loyalty usually means the following:

- Keeping the interests of your employer or sponsor in mind
- Speaking well of your employer or sponsor to others
- Keeping any minor troubles strictly within the job site
- Respecting the confidentiality of all matters that pertain to your employer's or sponsor's business

A loyal employee fulfills commitments and meets obligations. Never go to work for someone else without first ensuring that you have met all of your commitments to your current employer or sponsor. A prospective employer will be impressed with your commitment and be willing to wait for you. If not, you might want to reconsider whether you should work for that company.

### 2.1.4 Willingness to Learn

A good plumber never stops learning. New machines, tools, materials, and methods are constantly being introduced. Even experienced plumbers need to be willing to learn about these advancements. If you keep your methods and tools up-to-date, your company will be able to use your skills to compete successfully with other companies. The better a company competes, the more profit it makes. The more profit the company makes, the more likely it is to stay in business, provide jobs, and raise salaries, all of which benefit you as an employee.

In addition, each workplace has its own way of doing things. Your employer or sponsor will expect you to learn how things are done where you work. You must be able to adapt to change and be willing to learn new methods and procedures as quickly as possible.

### 2.1.5 Responsibility

As a trainee, your primary responsibility is to do what is asked of you. As a professional plumber, however, your responsibility will extend beyond assigned tasks. You should be able to see what needs to be done and do it without having to be asked. Your supervisor expects you to do the work well without being asked twice. Assuming responsibility makes a favorable impression on an employer/sponsor.

Always take responsibility for your actions, including any work done under your supervision. Do not make excuses or blame others when you make an error. Doing so will cause people to distrust you and lose respect for you. If that happens, the quality of your work, and that of everyone who works with you, will suffer.

### **2.1.6 Cooperation**

As a plumber, you will probably work with other people as part of a team. Every day, you interact with members of your work crew and with your supervisor. The ability to cooperate with your teammates is an important skill in the construction industry, but simply working and playing well with others is not enough. The success of any team depends on all of its members doing their parts. Everyone must contribute to the team to ensure that it achieves its goals. Such cooperation will help get projects done on time and on budget.

### **2.1.7 Attention to Rules and Regulations**

Employers want workers who respect the rules and regulations that apply to their company, their work, and their profession. Rules and regulations exist to keep people safe and to keep a project on schedule. Companies establish rules pertaining to work times, administrative issues, and professional conduct. Local, state, and federal authorities develop regulations that apply to a wide range of issues, including safety and health, materials, tools and equipment, and legal issues.

People can work well together only if they all understand the work that needs to be done, when it needs to be done, and who will perform the work. Rules and regulations are necessary in any work situation. The rules might vary from employer to employer, so it is important to make sure you understand your employer's or sponsor's regulations each time you start a new job.

### **2.1.8 Promptness and Reliability**

Imagine that you are a member of a three-person team that is laying pipe. According to the schedule, you must lay a certain amount of pipe in two weeks. If a member of your team were absent the whole time, you and the other team member would have to do that person's work in addition to your own, which means that each of you would have to do 50 percent more work than anticipated over the two-week period. However, if your teammate notified your supervisor, then arrangements could be made to provide another worker or to extend the completion date of the pipe-laying task.

Professionals are always prompt and reliable when they report to work. A prompt employee shows up to work on time; a reliable worker shows up every day. Employees who are chronically late or absent have poor work habits. They are being unprofessional and are showing that they lack commitment.

The clock governs your work life. Everyone is required to be at work and ready to start at a definite time. Failure to get to work on time results in confusion, lost time, and the resentment of your teammates. The good news, however, is that bad habits can be changed. If you are chronically late for work, then change your morning routine to leave earlier or get up earlier to take care of your personal responsibilities.

Sometimes you need to take time off from work because you or a family member are sick, you have suffered a death in your family, or you might get stuck in a traffic jam or have car trouble. When something like this happens, let your employer or sponsor know as soon as possible so that your supervisor can make arrangements to replace you while you are out.

Your employer or sponsor has the right to expect you to be on the job unless you have a good reason. You have an obligation to your supervisor and your teammates to be at your job because they are relying on you. Indeed, you should be proud of this; it means that they trust you and respect you. When you fulfill that obligation, you will be trusted by your co-workers and valued by your supervisor.

### **2.1.9 Other Important Qualities**

Demonstrate personal integrity and the courage of your convictions by doing what is right even where there is pressure to do otherwise. Do not sacrifice your principles because it seems easier. Be fair and just in all dealings. Do not take undue advantage of another's mistakes or difficulties. Fair people are open-minded and committed to justice, equal treatment of individuals, and tolerance for and acceptance of diversity. Be courteous and treat all people with equal respect and dignity. Abide by laws, rules, and regulations relating to all personal and business activities.

Pursue excellence in performing your duties, be well informed and prepared, and constantly try to increase your proficiency by gaining new skills and knowledge. By your own conduct, seek to be a positive role model for others.

## 2.2.0 Career Opportunities in Plumbing

The construction industry employs more people and contributes more to the nation's economy than any other industry. Our society will always need people to build new homes, roads, airports, hospitals, schools, factories, and office buildings, maintain existing structures, and replace old and damaged ones. This means there will always be a source of well-paying jobs and career opportunities for construction trade professionals, including plumbers. Both large and small contracting firms employ plumbers. Plumbers who master the principles of small-business management and develop and hone their entrepreneurial skills can be self-employed.

Plumbers can choose from a number of career paths depending on their skills and interests (see *Figure 3*). Where you go depends on the pride and professionalism you show in your work. How well you succeed depends on your willingness to develop your skills and obtain the right training. With time and experience, plumbers progress from apprentices to one or more different specialties. These are some of the many positions and careers in the plumbing profession. Note that the career paths shown in *Figure 3* are examples; your path may end up being different from those shown.

An apprentice is someone who is learning the plumbing trade. As you have learned, when a plumber successfully completes an apprenticeship, he or she becomes a journey plumber. Journey plumbers can remain at that level or advance in the profession. Journey plumbers might supervise less experienced plumbers or be called on to estimate the materials and labor for a specific job. With larger companies and on larger jobs, journey plumbers often become specialists.

Foremen are leaders who direct a single team of apprentices and/or journey plumbers. Large construction projects with more than one team require supervisors who oversee the work of all teams. They are responsible for assigning, directing, and inspecting the work of each team.

A master craftsman is someone who consistently demonstrates the highest level of skill at a profession. Master plumbers are proven experts in the plumbing profession. They can act as mentors and teachers to less experienced members of the profession. Master plumbers often start their own businesses, no matter what role they play.

The safety manager is another key, on-site person. Safety managers are responsible for the safety and health of the workers on a project. They are responsible for developing a safety plan and procedures, training workers in safety

procedures, and ensuring that the project is in compliance with applicable health and safety regulations.

Project managers, often called project administrators, control the scope and direction of a plumbing business. Managers ensure that the right workers are being assigned to each task and are responsible for handling project finances. Large contracting firms may have several project managers.

Plumbing estimators work for contractors and building supply companies. They assess the materials and labor required to complete a project and contractors submit bids for jobs based on these estimates. Plumbing estimators must have a thorough understanding of construction methods as well as knowledge of the availability and prices of materials and supplies.

Plumbing estimators are experienced plumbers with superior mathematical abilities and the patience to prepare detailed, accurate estimates. Today's estimators also need solid computer skills. Estimators have a great deal of responsibility, because errors in estimates can cost the contractor significant amounts of money. Depending on the size and type of the business, the estimating job may also be done by the contractor or the project manager.

Mechanical engineers research, develop, design, manufacture, and test a wide range of mechanical devices, including the following:

- Machine tools
- Internal combustion engines
- Electric generators
- Steam and gas turbines
- Refrigeration and air conditioning equipment
- Material-handling systems
- Elevators and escalators
- Industrial production equipment
- Robots used in manufacturing

Construction contractors and owners establish and run contracting businesses. Typically, they hire apprentices, journey plumbers, and master plumbers. Depending on the size of their business, contractors may work with the crew or may manage the business full-time. Small contractors may have only one or two employees who manage the business, prepare estimates, obtain supplies, and perform the actual contracted work. Subcontractors and contractors/owners may specialize in installing particular systems, such as sprinkler systems, high-pressure pipe systems, or municipal water-treatment facilities.

Plumbing inspectors may work for a contractor or for a municipal jurisdiction such as a local or state government. Inspectors ensure that all

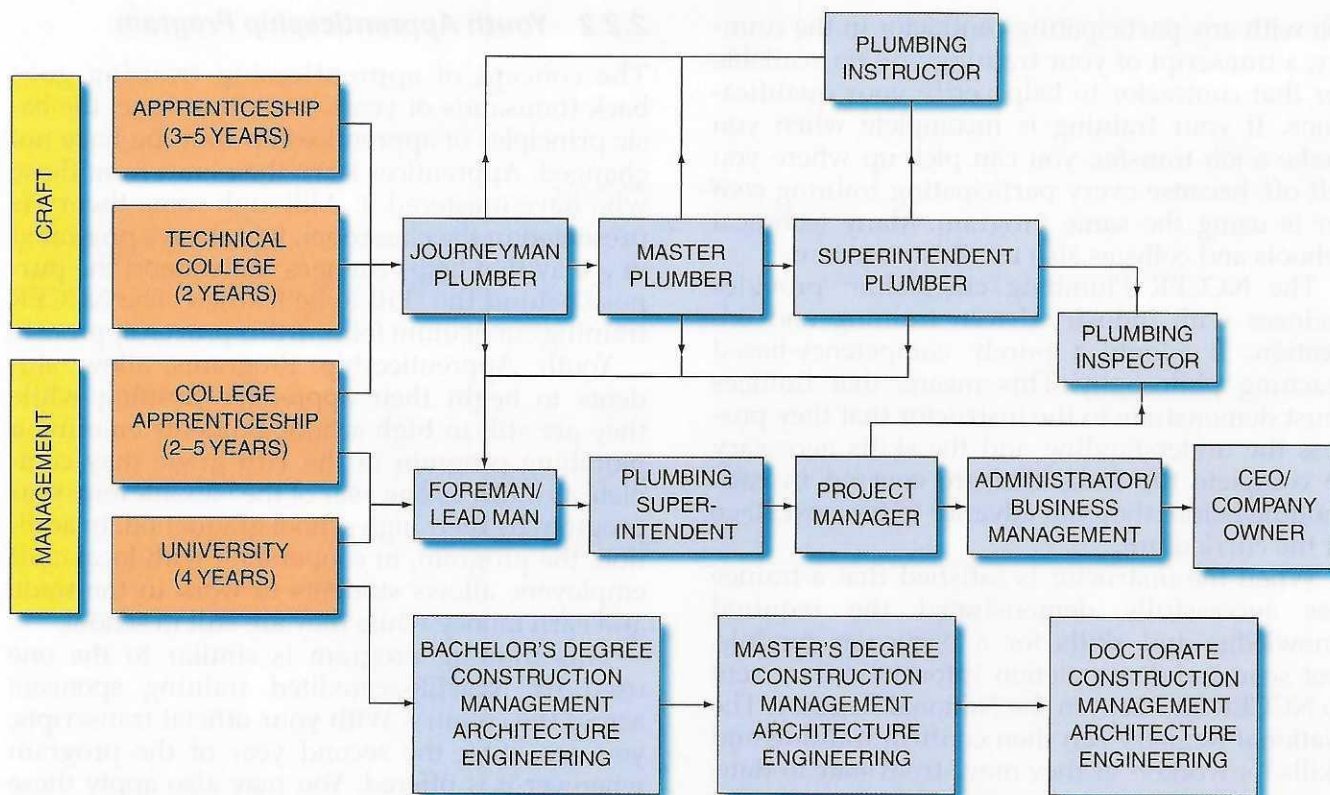


Figure 3 Opportunities in the construction industry.

plumbing installations follow applicable codes and quality requirements. Plumbing inspectors review and approve work at various stages of construction, depending on the installation.

Plumbing instructors train apprentices to become the next generation of journey and master plumbers, managers, inspectors, and engineers. Many dedicated and experienced plumbers find that becoming an instructor is a natural evolution in their career. Master plumbers often become instructors as their careers progress.

No matter what career path you choose, you will be embarking on a lifelong learning process. Effective plumbers along any career path need to keep up-to-date with new tools, materials, and methods. If you choose to become a manager or if you intend to start your own construction business someday, you will need to learn the appropriate skills and continue to hone your skills as a plumber.

Apprenticeship is your first step down an exciting and challenging career path. Remember, every successful manager and business owner started as an apprentice. Successful plumbers have at least one thing in common: a willingness to keep on learning. That process of learning begins with apprentice training.

### 2.2.1 Formal Construction Training

The Department of Labor's Office of Apprenticeship sets the minimum standards for training programs across the country. Office of Apprenticeship programs rely on mandatory classroom instruction and OJL. Office of Apprenticeship requires 144 hours of classroom instruction per year and 2,000 hours of OJL per year. In a typical Office of Apprenticeship program, trainees spend 576 hours in classroom instruction and 8,000 hours in OJL before receiving journey plumber certificates.

To address the training needs of the professional communities, NCCER developed a four-year plumbing training program. NCCER uses the minimum Office of Apprenticeship standards as a foundation for comprehensive curricula that provide trainees with in-depth classroom and OJL experience.

The primary goal of NCCER is to standardize construction craft training throughout the country so that employers and employees benefit from it, no matter where they are located. As a trainee in an NCCER program, you receive benefits to help you prepare for your career in the plumbing profession. You will become part of the National Registry. You will receive a certificate for each level of training you complete. If you apply for a

job with any participating contractor in the country, a transcript of your training will be available for that contractor to help verify your qualifications. If your training is incomplete when you make a job transfer, you can pick up where you left off, because every participating training center is using the same program. Many technical schools and colleges also use this program.

The NCCER Plumbing curriculum provides trainees with industry-driven training and education. It adopts a purely competency-based teaching philosophy. This means that trainees must demonstrate to the instructor that they possess the understanding and the skills necessary to complete the tasks that are covered in each module before they can advance to the next stage of the curriculum.

When the instructor is satisfied that a trainee has successfully demonstrated the required knowledge and skills for a particular module, test scores and completion information are sent to NCCER and kept in the National Registry. The National Registry can then confirm training and skills for workers as they move from state to state, company to company, or even within a company (see Appendix B).

Whether you enroll in an NCCER program or another Office of Apprenticeship -approved program, ensure that you work for an employer or sponsor who supports a nationally standardized training program that includes credentials to confirm your skill development.

A good apprenticeship program effectively combines competency-based, hands-on training with classroom instruction. This combination is the most effective way for a beginning plumber to learn and advance through the plumbing profession. Successful apprentices will develop the skills and knowledge they need to carry out a wide range of tasks.

If you possess these professional and personal skills, you can become a top-notch, highly productive journey plumber. Journey plumbers have successfully completed an apprenticeship-training program. The term comes from the fifteenth-century word journeyman. Journeymen were apprentices who left their masters after learning their craft and worked alone or for someone else.

Successful journey plumbers who practice their craft with pride and skill are valued employees and co-workers. Once you have mastered the professional and personal skills necessary, you will be a good candidate to advance to an exciting and challenging career as a master plumber, superintendent plumber, plumbing supervisor, instructor, inspector, project manager, or contractor and business owner.

## **2.2.2 Youth Apprenticeship Program**

The concept of apprenticeship training goes back thousands of years. Over that time, the basic principles of apprenticeship training have not changed. Apprentices learn their craft from those who have mastered it. Although some theory is presented in the classroom, it is always presented in a way that helps trainees understand the purpose behind the skill to be learned. The NCCER training curriculum follows this proven approach.

Youth Apprenticeship Programs allow students to begin their apprentice training while they are still in high school. Students entering a plumbing program in the 11th grade may complete as much as one year of the NCCER four-year program by their high school graduation. In addition, the program, in cooperation with local craft employers, allows students to work in the trade and earn money while they are still in school.

This training program is similar to the one used by NCCER-accredited training sponsors across the country. With your official transcripts, you can enter the second year of the program wherever it is offered. You may also apply these credits to a two- or four-year college that offers degree or certificate programs in the construction profession.

You may become an employee at age 16, but the US Department of Labor (DOL) limits your work to occupations that are not specifically defined as hazardous. Hazardous jobs include such things as explosives manufacturing, mining, meatpacking, and power-driven sheet metal work. You may work on a project site as an apprentice or journey plumber when you are 16, but only if you are enrolled and in good standing in a plumbing apprenticeship program.

You must be at least 18 before you can legally work in a hazardous occupation. When you have graduated from your apprenticeship program, you can enter the industry at a higher level and with more pay than people who are just starting the apprenticeship program.

## **2.2.3 Apprenticeship Standards**

All apprenticeship standards call for certain work-related training, or OJL. OJL is broken down into specific tasks in which the apprentice receives hands-on training. Each task requires a specified number of hours. The total number of hours in a plumbing apprenticeship is traditionally 8,000, which amounts to four years of training. In a competency-based program, this time may be shortened by testing out of specific tasks through a series of performance exams.

## Child Labor Laws

Federal law establishes the minimum standards for workers under age 18. Some municipal jurisdictions may enforce stricter regulations. Employers are required to abide by the laws that apply to them.

The Child Labor Provisions of the Fair Labor Standards Act forbid employers from using illegal child labor, and also forbid companies from doing business with any other business that does. DOL investigates alleged abuses of the law. In such cases, employers have to provide proof of age for their employees.

In addition to the Child Labor Provisions, employers in the construction trades are required to follow DOL's Child Labor Bulletin No. 101, Child Labor Requirements in Nonagricultural Occupations Under the Fair Labor Standards Act. Bulletin No. 101 does the following:

- Explains the coverage of the Child Labor Provisions
- Identifies minimum age standards
- Lists the exemptions from the Child Labor Provisions
- Sets employment standards for 14- and 15-year-old workers
- Defines the work that can be performed in hazardous occupations
- Provides penalties for violations of the Child Labor Provisions
- Recommends the use of age certificates for employees

In a traditional program, you may complete the required OJL at the rate of 2,000 hours per year. If you are laid off or get sick, it may take longer.

Sponsors need to receive, log in, and report an apprentice's time records, and have them reviewed by the federal government and/or the state apprenticeship program. Therefore, apprentices should keep accurate and up-to-date time records; after the first 144 classroom hours and 1,000 hours of related work, and then for each subsequent 1,000 hours, the standards entitle an apprentice to a pay increase.

Apprentices may not always receive classroom instruction and OJL at the same time. Apprentices with special job experience or other coursework may obtain credit toward their classroom requirements. This reduces the time they are required to spend in the classroom while meeting the 8,000-hour OJL requirement. These special

cases depend on the type of program and its regulations and standards.

For those entering an apprenticeship program, a high school or technical school education is desirable, with courses in plumbing, shop, mechanical drawing, and general mathematics. Manual dexterity, good physical condition, and a good sense of balance are important. It is essential to be able to solve math problems quickly and accurately and to work closely with others.

If you want to become an apprentice, you must submit to the Apprenticeship Committee certain information, which may include the following (the actual requirements may vary by state):

- The results of your aptitude test (General Aptitude Test Battery [GATB] or GATB Form Test, normally administered by the local Employment Security Commission)
- Letters of reference and recommendation from your past employers or sponsors
- Proof of your age (e.g., driver's license)
- For veterans of the Armed Forces, a copy of your Form DD-214
- A record of any technical training you received that is related to the construction industry and/or a record of any training you received before applying for the apprenticeship
- Your high school diploma or General Educational Development (GED) credential

Once you are in an apprenticeship program, you must do the following:

- Wear proper safety equipment on the job.
- Buy and maintain tools of the trade as needed and as required by the contractor.
- Submit a monthly OJL report.
- Report any change in your employment status or change in sponsor.
- Attend classroom instruction and follow all regulations for the classroom, correspondence study, or distance learning.

### 2.2.4 What You Should Expect from Your Employer or Sponsor

Once the Apprenticeship Committee selects an applicant to be an apprentice, the employer or sponsor hires the apprentice. The apprentice's job has the same potential for career advancement as a non-apprentice employee. In return, the employer or sponsor requires the apprentice to make satisfactory progress in OJL and related classroom instruction throughout the duration of the apprenticeship program.

The employer or sponsor agrees not to employ the apprentice in a way that may violate the

apprenticeship standards. The employer or sponsor may also pay a share of the cost of operating the apprenticeship program.

### **2.2.5 What You Should Expect from a Training Program**

Employers and sponsors who take the time and initiative to provide quality training are willing to invest in their workforce and improve the abilities of their workers. Nevertheless, you should take the time to find a program that will train you well.

Select an employer who has an approved apprenticeship program and who is willing to act as your sponsor. The employer's training program should be comprehensive, standardized, and based on developing and demonstrating competencies, not just on the amount of time you spend in a classroom. Before you enroll in a training program, find out how many employers in the area use the same program. The training program should have a well-defined compensation ladder so that your pay will increase in recognition of your new skills and experience.

The program should be nationally recognized and should provide you with transcripts and completion credentials. As an employee in the construction profession, you may end up working for several different contractors over the course of your career. Contractors in other cities and states must be able to recognize the experience and qualifications that you obtained through your training program.

Finally, the training program's curriculum should be complete and up-to-date. The curriculum should feature the latest developments in plumbing techniques, materials, tools, and equipment. The program should also take advantage of modern interactive training technology, such as multimedia tools and the Internet. As a plumber, you know how important it is to stay current; the same applies to training programs.

### **2.2.6 What You Should Expect from the Apprenticeship Committee**

The Apprenticeship Committee is the local administrative body to which apprentices are assigned. It is responsible for the appropriate training of apprentices. Every apprenticeship program, whether state or federal, is covered by the following standards that have been approved by appropriate government agencies:

- The Committee is responsible for enforcing standards and for making sure that training is conducted properly. This ensures that graduates are fully qualified in those areas of training designated by the standards.
- The Committee screens and selects individuals for apprenticeship and refers them to participating training programs.
- The Committee places apprentices under written agreement for participation in the program.
- The Committee establishes minimum standards for related classroom instruction and OJL and monitors the apprentice to see that these standards are followed during the training period.
- The Committee hears all complaints of violations of apprenticeship agreements, whether by employer/sponsor or apprentice, and takes action within the guidelines of the standards.
- The Committee notifies the registration agencies of all enrollments, completions, and terminations of apprentices.



## Additional Resources

*The National Standard Plumbing Code*, current edition. Falls Church, VA: Plumbing-Heating-Cooling Contractors Association.

### 2.0.0 Section Review

1. Which of the following is true with regard to professionalism?
  - a. It is okay to speak poorly of your employer as long as you are being honest.
  - b. It is acceptable to cheat if it benefits your employer.
  - c. It is better to maintain the same procedures rather than adapt to new methods.
  - d. You should do what is right even when there is pressure to do otherwise.
2. The Department of Labor's Office of Apprenticeship program requires \_\_\_\_\_.
  - a. 500 hours of OJL per year
  - b. 750 hours of OJL per year
  - c. 1,000 hours of OJL per year
  - d. 2,000 hours of OJL per year

## SUMMARY

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History has taught us that plumbing is vital to public health, safety, and comfort. Today, the plumbing profession is more important than ever. As the world's population grows, the built environment is expanding to accommodate it. The world needs more skilled and experienced plumbers to ensure that the public stays safe, healthy, and comfortable.

The plumbing profession relies upon a range of skills and a broad base of knowledge. Plumbers are responsible for installing and maintaining a wide variety of supply and drainage systems. Plumbers carefully follow local codes and regulations to ensure that systems are safe.

Because the plumbing profession is always evolving, successful plumbers never stop learning about new techniques, materials, tools, and

standards. In addition to staying current with their technical skills and knowledge, successful plumbers also follow high ethical standards. They maintain a positive attitude, are honest and loyal, and are responsible for their actions. They cooperate with their teammates and supervisors, pay attention to rules and regulations, and are always prompt and reliable employees.

As an apprentice embarking on your plumbing career, you have the right to expect a quality education that serves you well. Your employer or sponsor and your Apprenticeship Committee should do their best to ensure that you are well prepared for the responsibilities you will take on. Ultimately, though, the decision is yours as to whether you will try hard to become the best professional plumber that you can be.

# Review Questions

1. The modern word plumber is derived from the Latin word for \_\_\_\_\_.
  - a. the water channels that supplied Rome
  - b. a person who works with lead
  - c. doctors who treated lead poisoning
  - d. a person who repaired bathhouses
2. LEED applies to all areas of the plumbing profession, *except* \_\_\_\_\_.
  - a. construction
  - b. design
  - c. maintenance
  - d. renovation
3. Water that comes from laundry and bathtubs and reused is known as \_\_\_\_\_.
  - a. blackwater
  - b. stormwater
  - c. graywater
  - d. potable water
4. Suggested national plumbing standards are called \_\_\_\_\_.
  - a. ordinances
  - b. model codes
  - c. regulations
  - d. uniform codes
5. You are offered a job by another contractor before you have fulfilled your current obligations. The professional response is to \_\_\_\_\_.
  - a. ask the contractor to wait until you have met your obligations
  - b. notify your current employer of your intention to leave immediately
  - c. ask your current employer to let you divide your time between both projects
  - d. determine if your current employer is willing to negotiate better terms
6. Your supervisor points out that you forgot to complete a step in the assembly of a drain in a DWV system. One of the apprentices that you are supervising was the person installing the drain. The responsible action is to \_\_\_\_\_.
  - a. explain that one of the apprentices was responsible
  - b. ask the apprentice to explain to your supervisor
  - c. explain to your supervisor why the apprentice did the work that way
  - d. take responsibility for work done under your supervision
7. People who develop, design, manufacture, and test mechanical devices are called \_\_\_\_\_.
  - a. contractors or owners
  - b. inspectors
  - c. mechanical engineers
  - d. master estimators
8. Project managers are responsible for \_\_\_\_\_.
  - a. assessing the materials and labor needed on projects
  - b. ensuring that projects are in compliance with safety regulations
  - c. controlling the scope and direction of a plumbing business
  - d. instructing all new apprentices on a job site
9. The minimum standards for training programs in the United States are set by \_\_\_\_\_.
  - a. NCCER
  - b. NEMA
  - c. OSHA
  - d. Office of Apprenticeship
10. Participants in an NCCER training program receive all of the following, *except* \_\_\_\_\_.
  - a. training transcripts for your employer
  - b. a listing in the National Registry
  - c. certification as a master plumber
  - d. certificates for each completed training level

11. The non-profit \_\_\_\_\_ developed a system in 2000 that will certify a building as “green,” meaning it is energy efficient.
- United States Green Building Council
  - United States Energy Conservation Association
  - United States Green Construction Council
  - United States Energy and Environmental Design Association
12. Which of the following does not cause backflow?
- Failure of a pump
  - Injection of air into the system
  - Cuts in the water main
  - Insufficient levels of water
13. A student must complete \_\_\_\_\_ hours of OJL per year, according to the Office of Apprenticeship.
- 200
  - 2000
  - 100
  - 1000
14. \_\_\_\_\_ is the highest level of skill a craftsman can become in their craft profession.
- Master craftsman
  - Elite craftsman
  - Certified pro craftsman
  - Site foreman

# Trade Terms Quiz

Fill in the blank with the correct term that you learned from your study of this module.

1. During the \_\_\_\_\_ phase of a plumbing project, plumbers locate all supply and waste connections from the building systems to public utilities.
2. \_\_\_\_\_ is the process of cleansing water to remove chemicals and particles.
3. You can use \_\_\_\_\_ thermoplastic pipe as tubing for cold water systems.
4. Someone who installs or repairs plumbing systems and fixtures is called a(n) \_\_\_\_\_.
5. Water supply systems provide fresh water; \_\_\_\_\_ systems remove wastewater.
6. Always wear appropriate personal protective equipment when disinfecting water with \_\_\_\_\_, a heavy, greenish-yellow gas.
7. You are \_\_\_\_\_ water when you remove magnesium and sodium salts from it.
8. Office of Apprenticeship requires apprentices to have 2,000 hours of \_\_\_\_\_ per year.
9. Water that is safe to drink is referred to as \_\_\_\_\_.
10. Construction ordinances written by national construction organizations and based on suggested national plumbing standards are called \_\_\_\_\_.
11. During the \_\_\_\_\_ phase of a plumbing project, plumbers install fixtures, appliances, water purification systems, water heaters, and controls.
12. When a potable water system and a non-potable water system are arranged so that an accidental pressure differential between the two systems would cause contaminated water to flow into the freshwater system, it is called a(n) \_\_\_\_\_.
13. Plumbers destroy harmful organisms in potable water through \_\_\_\_\_.
14. During the Roman Empire, a(n) \_\_\_\_\_ were used to carry water from rivers and lakes to cities.
15. In ancient Rome, a person who worked with lead was called a(n) \_\_\_\_\_.
16. As a construction professional, you must ensure that your conduct is in accordance with your profession's principles and values, which are called \_\_\_\_\_.
17. One of the most important safety concerns for plumbers is \_\_\_\_\_, which is the flow of contaminated water into the freshwater system through a cross-connection.
18. Plastic that becomes substantially infusible and insoluble when treated by heat or chemicals is called \_\_\_\_\_.
19. During the \_\_\_\_\_ phase of a plumbing project, plumbers cut holes in walls, ceilings, and floors to attached or hang pipe runs.
20. Plastic that is soft and pliable when heated and hard and rigid when cooled is called \_\_\_\_\_.
21. A(n) \_\_\_\_\_ is a legally binding requirement published by state and local governments to establish minimum standards for various types of construction.
22. Sinks, shower stalls, and toilets are common examples of \_\_\_\_\_.
23. The Latin word for lead is \_\_\_\_\_.
24. Plumbers install a \_\_\_\_\_ to keep nonpotable water from contaminating a potable supply system.
25. If you are installing piping for a system that is designed exclusively for environmental control, you are not engaged in \_\_\_\_\_.
26. To become a(n) \_\_\_\_\_, you must first complete an apprenticeship training program.

27. Plumbing \_\_\_\_\_ are types of apparatus used in such trades as installing drainage systems.
28. Heat that comes from below the surface of the earth is called \_\_\_\_\_.
29. A system that directly or indirectly uses the heat of the sun to heat water is called a(n) \_\_\_\_\_ system.
30. The process of \_\_\_\_\_ is the consumption of fresh water from underground sources faster than the water can be naturally replenished.
31. The non-profit construction trade organization \_\_\_\_\_ developed a system for certifying that buildings have been designed and constructed to green standards called \_\_\_\_\_ that includes between 10 and 14 points that are categorized as \_\_\_\_\_, which is the managed use of drinkable water to reduce waste.
32. Efforts to preserve natural resources include a number of water preservation techniques including \_\_\_\_\_ to collect and store rainwater, the reuse of \_\_\_\_\_ from laundries and bath/showers, artificial depressions in the ground that filter pollutants from stormwater called a \_\_\_\_\_, and the use of treated wastewater called \_\_\_\_\_ in flushing fixtures and other non-potable systems.

## Trade Terms

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Aboveground rough-in	Filtration	Plumbum
Appurtenances	Finish	Polyvinyl chloride (PVC)
Aqueduct	Fixture	Potable
Aquifer depletion	Geothermal	Rainwater harvesting
Backflow	Graywater	Reclaimed water
Backflow preventer	Journey plumber	Solar hot water
Bioswale	Leadership in Energy and	Softening
Chlorine	Environmental Design (LEED)	Thermoplastic
Code	Model code	Thermoset
Cross-connection	On-the-job learning (OJL)	Underground rough-in
Disinfection	Plumbarius	United States Green Building
Drain, waste, and vent (DWV)	Plumber	Council (USGBC)
Ethics	Plumbing	Water efficiency

# Appendix A

## ETHICAL PRINCIPLES FOR MEMBERS OF THE CONSTRUCTION TRADES

**Honesty:** Be honest and truthful in all dealings. Conduct business according to the highest professional standards. Faithfully fulfill all contracts and commitments. Do not deliberately mislead or deceive others.

**Integrity:** Demonstrate personal integrity and the courage of your convictions by doing what is right even where there is pressure to do otherwise. Do not sacrifice your principles because it seems easier.

**Loyalty:** Be worthy of trust. Demonstrate fidelity and loyalty to companies, employers, sponsors, co-workers, and trade institutions and organizations.

**Fairness:** Be fair and just in all dealings. Do not take undue advantage of another's mistakes or difficulties. Fair people are open-minded and committed to justice, equal treatment of individuals, and tolerance for and acceptance of diversity.

**Respect for others:** Be courteous and treat all people with equal respect and dignity.

**Obedience:** Abide by laws, rules, and regulations relating to all personal and business activities.

**Commitment to excellence:** Pursue excellence in performing your duties, be well informed and prepared, and constantly try to increase your proficiency by gaining new skills and knowledge.

**Leadership:** By your own conduct, seek to be a positive role model for others.

# Appendix B

## NCCER CREDENTIALS



# NCCER

The Standard for Developing Craft Professionals

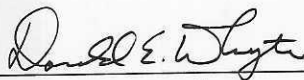
*This is to certify that*

*Steven Whitaker*

*has fulfilled the requirements for*

*Plumbing Level One*

*in NCCER's standardized training curriculum  
on this Sixteenth day of September, 2012*



Donald E. Whyte  
President, NCCER



# NCCER CREDENTIALS (CONTINUED)



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## Official Transcript

January 17, 2012

**NCCER Card #:** 1720726

**Trainee Name:** John Q Smith

**Sponsor:** Austin Industrial Incorporated

**Address:** 2801 E 13th St  
La Porte, TX 77571

**Current Employer/School:**  
Solomon Plumbing Company

Module	Description	Instructor	Training Location	Date Completed
00101-04	Basic Safety	Kevin Jenkins	Solomon Plumbing Company	2/20/2008
00102-04	Introduction to Construction Math	Dave Buck	Building Trades Institute, LLC	8/8/2008
00103-04	Introduction to Hand Tools	Kevin Jenkins	Solomon Plumbing Company	1/1/2008
00104-04	Introduction to Power Tools	Dave Buck	Building Trades Institute, LLC	8/8/2008
00105-04	Introduction to Blueprints	Kevin Jenkins	Solomon Plumbing Company	3/20/2008
00106-04	Basic Rigging	Dave Buck	Building Trades Institute, LLC	8/8/2008
00108-04	Basic Employability Skills	Rod Blackburn	Utility Contractors, Inc.	3/15/2009
02101-05	Introduction to the Plumbing Profession	Kevin Jenkins	Solomon Plumbing Company	3/22/2008
26101-02	Electrical Safety	Don Whyte	National Center for Construction Education &	7/29/2002
26102-02	Hand Bending	Don Whyte	National Center for Construction Education &	7/29/2002
26103-02	Fasteners and Anchors	Don Whyte	National Center for Construction Education &	7/29/2002
26104-02	Electrical Theory One	Don Whyte	National Center for Construction Education &	7/29/2002
26105-02	Electrical Theory Two	Don Whyte	National Center for Construction Education &	7/29/2002
26106-02	Electrical Test Equipment	Don Whyte	National Center for Construction Education &	7/29/2002
26107-02	Introduction to the National Electrical Code	Don Whyte	National Center for Construction Education &	7/29/2002
26108-02	Raceways, Boxes, and Fittings	Don Whyte	National Center for Construction Education &	7/29/2002
26109-02	Conductors	Don Whyte	National Center for Construction Education &	7/29/2002

Page 1

*Donald E. Whyte*  
President, NCCER

## Trade Terms Introduced in This Module

**Aboveground rough-in:** The second phase of a plumbing project. During this phase, holes are cut in walls, ceilings, and floors. Then, supply and waste pipes are attached or hung so they can be connected to fixtures. Also referred to as stack out, top out, or in-wall rough-in.

**Appurtenances:** Accessories or apparatus that require no demand from the water supply side and add no load to the waste side.

**Aqueduct:** A man-made channel used to carry water.

**Aquifer depletion:** The use of underground fresh water at a rate faster than it can be replenished.

**Backflow:** The flow of contaminated water into the freshwater system resulting from a cross-connection between potable and nonpotable water systems.

**Backflow preventer:** A device that prevents nonpotable water from entering a potable supply system.

**Bioswale:** A depression in the ground that filters pollutants from stormwater.

**Chlorine:** A heavy, greenish-yellow gas used as a disinfectant in water treatment. Chlorine should be handled only when wearing appropriate personal protective equipment.

**Code:** A requirement published by state and local governments to establish minimum standards for various types of construction. A code carries the force of law.

**Cross-connection:** An arrangement between a potable water system and a nonpotable water system in which an accidental pressure differential between the two systems causes backflow of contaminated water into the freshwater system.

**Disinfection:** The process of destroying harmful organisms in potable water.

**Drain, waste, and vent (DWV):** A piping system that combines sanitary drainage with venting.

**Ethics:** A set of principles and values that guide an individual's conduct.

**Filtration:** The process of cleansing water to remove particles and chemicals.

**Finish:** The third phase of a plumbing project. During the finish phase, plumbers install fixtures, appliances, water purification systems, water heaters, and controls. Also referred to as trim-out or trim finish.

**Fixtures:** Devices that receive water from a water supply line. Common fixtures include sinks, shower stalls, and toilets.

**Geothermal:** Heat that is generated below the earth's surface.

**Graywater:** Water that comes from baths and washing machines.

**Journey plumber:** A plumber who has successfully completed an apprenticeship-training program.

**Leadership in Energy and Environmental Design (LEED):** A system for certifying that buildings have been designed and constructed to environmental standards.

**Model codes:** Construction ordinances that are written by a national construction organization according to suggested national plumbing standards. Model codes that have not been adopted by a jurisdiction do not have the force of law.

**On-the-job learning (OJL):** Field experience used in conjunction with classroom lessons in an apprenticeship program. Office of Apprenticeship requires 144 hours of classroom instruction per year and 2,000 hours of OJL per year.

**Plumbarius:** The Roman term for someone who works with lead. The root of the modern word plumber.

**Plumber:** One who installs or repairs plumbing systems and fixtures.

**Plumbing:** According to the National Standard Plumbing Code, plumbing is "the practice, materials, and fixtures within or adjacent to any building structure or conveyance, used in the installation, maintenance, extension, alteration, and removal of all piping, plumbing fixtures, plumbing appliances, and plumbing appurtenances... "

**Plumbum:** Latin word for lead.

**Polyvinyl chloride (PVC):** A thermoplastic material frequently used in tubing for cold water systems and the first type of plastic approved for use in plumbing.

**Potable:** Water that is safe for cooking and drinking.

**Rainwater harvesting:** The collection and storage of rainwater for irrigation.

**Reclaimed water:** Wastewater that has had impurities and solids removed from it so that it can be reused for non-potable purposes.

**Softening:** The process of removing magnesium and sodium salts that cause scale on the inside of pipes and fittings.

**Solar hot water:** Water that has been directly or indirectly heated by sunlight.

**Thermoplastic:** A plastic material used in plumbing and sanitary systems that is soft and pliable when heated and hard and rigid when cooled.

**Thermoset:** A plastic material used in plumbing and sanitary systems that becomes substantially infusible and insoluble when treated by heat or chemicals.

**Underground rough-in:** The phase of a plumbing project during which the plumber locates all supply and waste connections from the building systems to public utilities, and establishes where these systems will enter or leave the building.

**United States Green Building Council (USGBC):** The non-profit construction trade organization responsible for the development of LEED.

**Water efficiency:** The managed use of drinkable water to reduce waste.

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## Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

*Plumbing a House*, 1998. Peter A. Hemp. Newtown, CT: Taunton Press.

*The National Standard Plumbing Code*, current edition. Falls Church, VA: Plumbing-Heating-Cooling Contractors Association.

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## Figure Credits

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# Section Review Answer Key

## SECTION 1.0.0

Answer	Section Reference	Objective
1. c	1.1.1	1a
2. a	1.2.3	1b

## SECTION 2.0.0

Answer	Section Reference	Objective
1. d	2.1.9	2a
2. d	2.2.1	2b

Section 1.0.0

Question	Section Reference	Answer
1a	1.1.1	1. a
1b	1.1.2	2. a

Section 2.0.0

Question	Section Reference	Answer
2a	2.1.1	1. a
2b	2.1.2	2. a

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