**Building Science Education Solution Center—Plumbing**

## Proficiency Level 1: Remember

### Learning Objective 1.1

* List the two primary purposes of plumbing and the three overall parts of a plumbing system.

### Lecture Notes 1.1

The primary purposes of a water plumbing system are

1. To bring an adequate and potable supply of hot and cold water to the inhabitants of a house, and
2. To drain all wastewater and sewage discharge from fixtures into the public sewer or a private disposal system.

A water plumbing system consists of three overall parts: 1) an adequate, potable water supply system; 2) a safe, adequate wastewater system, including wastewater vent lines; and 3) appropriate fixtures and equipment.

### Learning Objective 1.2

* Describe the difference between a building code, a building standard, and a plumber’s license.

### Lecture Notes 1.2

When designing, installing, or remodeling a water plumbing system, it is essential to work with a state-licensed plumber and to follow local and state building codes and plumbing standards for your specific climate zone.

Forty-four states require plumbers to be licensed plumbing contractors. To become licensed in a specific area a contractor must pass exams and meet certain criteria to prove competency in a trade.

Building codes – specify how buildings must be constructed or perform, and are written in mandatory, enforceable language. States or local governments adopt and enforce codes for their jurisdictions. Plumbing codes are a subset within building codes.

Building standards – describe how buildings should be constructed to save energy, improve health and improve safety. They are published by - organizations such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). They are not mandatory, but serve as national recommendations, with some variation for regional climate. States and local governments frequently use standards as the technical basis for developing their energy codes. Some standards are written in mandatory, enforceable language, making it easy for jurisdictions to incorporate the provisions of the energy standards directly into their laws or regulations.

Primary code organizations that provide codes related to plumbing are as follows. (Note that these summaries are from the code websites.)

* The International Residential Code (IRC)—This comprehensive, stand-alone residential code establishes minimum regulations for one- and two-family dwellings and townhouses using prescriptive provisions. It is founded on broad-based principles that make possible the use of new materials and new building designs. The IRC contains a complete set of code provisions, covering all aspects of construction in a single source, including: building, energy conservation, plumbing, mechanical, fuel gas provisions included through an agreement with the American Gas Association, and electrical provisions from the 2014 National Electrical Code® (NFPA 70). The principles of the IRC are based on protection of public health, safety and welfare
* The Uniform Plumbing Code (UPC)—This code includes all potable water, building supply, and distribution pipes; all plumbing fixtures and traps; all drainage and vent pipes; and all building drains, and building sewers, including their respective joints and connections, devices, receptors, and appurtenances within the property lines of the premises and shall include potable water piping, potable water treating or using equipment, medical gas and medical vacuum systems, liquid and fuel gas piping, and water heaters and vents for same. The UPC established minimum requirements and standards for the protection of the public health, safety and welfare. The provisions of this code shall apply to the erection, installation, alteration, repair, relocation, replacement, addition to, use, or maintenance of plumbing systems within this jurisdiction.
* International Energy Conservation Code (IECC)—This comprehensive energy conservation code establishes minimum regulations for energy-efficient buildings using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new energy-efficient designs. This IECC is fully compatible with the Family of International Codes. The International Energy Conservation Code is in use or adopted in 47 states, the District of Columbia, the U.S. Virgin Islands, New York City and Puerto Rico.
* International Plumbing Code (IPC)—This code is a proven, comprehensive model plumbing code that works seamlessly with ICC’s family of building codes. It sets minimum regulations for plumbing systems and components to protect life, health and safety of building occupants and the public. The IPC is available for adoption by jurisdictions ranging from states to towns, and is currently adopted on the state or local level in 35 states in the United States.

Learn more about the International Residential Code (IRC) at <https://www.iccsafe.org/codes-tech-support/codes/2015-i-codes/irc/> , the Uniform Plumbing Code (UPC) at <http://codes.iapmo.org/home.aspx?code=UPC>, the International Energy Conservation Code at <https://www.iccsafe.org/codes-tech-support/codes/2015-i-codes/iecc/> and the International Plumbing Code (IPC) at <https://www.iccsafe.org/codes-tech-support/topics/plumbing-mechanical-and-fuel-gas/international-plumbing-code-ipc-home-page/>

### Learning Objective 1.3

* Define key plumbing terms, including backflow, back siphonage, branch, building drain, drain, inceptor, potable water, septic tank, trap, vent stack, water flow controls, and water supply system.

### Lecture Notes 1.3

#### Definitions

The following definitions and types of water control valves are from Center for Disease Control and Prevention (CDC) and U.S. Department of Housing and Urban Development (HUD). *Healthy Housing Reference Manual*. 2006 [with 2012 pdf link but 2006 date in report]. U.S. Department of Health and Human Services, Atlanta, GA. <https://www.cdc.gov/nceh/publications/books/housing/housing_ref_manual_2012.pdf>

Air chambers—Pressure-absorbing devices that eliminate water hammer. Air chambers should be installed as close as possible to the valves or faucet and at the end of long runs of pipe.

Air gap (drainage system)—The unobstructed vertical distance through the free atmosphere between the outlet of a water pipe and the flood level rim of the receptacle into which it is discharging.

Air gap (water distribution system)—The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle.

Backflow—The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable water supply from any source or sources other than the intended source. Back siphonage is one type of backflow.

Back siphonage—The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a potable water supply because of negative pressure in the pipe.

Branch—Any part of the piping system other than the main, riser, or stack.

Branch vent—A vent connecting one or more individual vents with a vent stack.

Building drain—Part of the lowest piping of a drainage system that receives the discharge from soil, waste, or other drainage pipes inside the walls of the building (house) and conveys it to the building sewer beginning 3 feet outside the building wall.

Drain—Any pipe that carries wastewater or waterborne waste in a building (house) drainage system.

Flush valve—A device that controls a relatively large amount of water (usually more than 1 gallon) to a toilet or urinal.

Hot water—Potable water heated to at least 120°F–130°F (49°C–54°C) and used for cooking, cleaning, washing dishes, and bathing.

Interceptor—A device to separate and retain deleterious, hazardous, or undesirable matter from normal waste and permit normal sewage or liquid waste to discharge into the drainage system by gravity.

Main vent—The principal artery of the venting system, to which vent branches may be connected.

Potable water—Water having no impurities present in amounts sufficient to cause disease or harmful physiologic effects and conforming in its bacteriologic and chemical quality to the requirements of the U.S. Environmental Protection Agency’s Safe Drinking Water Act or meeting the regulations of other agencies having jurisdiction.

P & T (pressure and temperature) relief valve—A safety valve installed on a hot water storage tank to limit temperature and pressure of the water.

P-trap—A trap with a vertical inlet and a horizontal outlet.

Public sewer—A common sewer directly controlled by public authority.

Relief vent—An auxiliary vent that permits additional circulation of air in or between drainage and systems.

Sensors for Demand-Initiated Systems – Sensors that are installed at the fixtures to automatically adjust standing ambient temperatures in the hot water recirculation loop of a demand-initiated recirculation systems.

Septic tank—A watertight receptacle that receives the discharge of a building’s sanitary drain system or part thereof and is designed and constructed to separate solid from liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open-joint or perforated piping or through a seepage pit.

Sewerage system—A system comprising all piping, appurtenances, and treatment facilities used for the collection and disposal of sewage, except plumbing inside and in connection with buildings served, and the building drain.

Soil pipe—The pipe that directs the sewage of a house to the receiving sewer, building drain or building sewer.

Soil stack—The vertical piping that terminates in a roof vent and carries off the vapors of a plumbing system.

Stack vent—An extension of a solid or waste stack above the highest horizontal drain connected to the stack, sometimes called a waste vent or a soil vent.

Storm sewer—A sewer used for conveying rain water, surface water, condensate, cooling water, or similar liquid waste.

Trap—A fitting or device that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or wastewater through it.

Vacuum breaker—A device to prevent backflow (back siphonage) by means of an opening through which air may be drawn to relieve negative pressure (vacuum).

Vapor lock—A bubble of air that restricts the flow of water in a pipe.

Vent stack—The vertical vent pipe installed to provide air circulation to and from the drainage system and that extends through one or more stories.

Water hammer—The loud thump of water in a pipe when a valve or faucet is suddenly closed.

Water service pipe—The pipe from the water main or other sources of potable water supply to the water-distributing system of the building served.

Water supply system—Consists of the water service pipe, the water-distributing pipes, the necessary connecting pipes, fittings, control valves, and all appurtenances in or adjacent to the building or premises.

Wet vent—A vent that receives the discharge of waste other than from water closets.

Yoke vent—A pipe connecting upward from a soil or waste stack to a vent stack to prevent pressure changes in the stacks.

#### Types of Water Flow Controls

The inadvertent contamination of a public water supply as a result of incorrectly installing plumbing fixtures is a potential public health problem in all communities. Continuous surveillance by environmental health personnel is necessary to know whether such public health hazards have developed as a result of additions or alterations to an approved system. All environmental health specialists should learn to recognize the three general types of defects found in potable water supply systems: back flow, back siphonage, and overhead leakage into open potable water containers. If identified, these conditions should be corrected immediately to prevent the spread of disease or poisoning from high concentrations of organic or inorganic chemicals in the water.

It is essential that valves be used in a water system to allow the system to be controlled in a safe and efficient manner. The number, type, and size of valves required will depend on the size and complexity of the system. Most valves can be purchased in sizes and types to match the pipe sizes used in water system installations. Listed below are some of the more commonly encountered valves with a description of their basic functions.

*Shutoff Valves.* Shutoff valves should be installed between the pump and the pressure tank and between the pressure tank and service entry to a building. Globe, gate, and ball valves are common shutoff valves. Gate and ball valves cause less friction loss than do globe valves; ball valves last longer and leak less than do gate valves. Shutoff valves allow servicing of parts of the system with- out draining the entire system.

*Flow-control Valves*. Flow-control valves provide uniform flow at varying pressures. They are sometimes needed to regulate or limit the use of water because of limited water flow from low-yielding wells or an inadequate pumping system. They also may be needed with some treatment equipment. These valves are often used to limit flow to a fixture. Orifices, mechanical valves, or diaphragm valves are used to restrict the flow to any one service line or complete system and to assure a minimum flow rate to all outlets.

*Relief Valves.* Relief valves permit water or air to escape from the system to relieve excess pressure. They are spring-controlled and are usually adjustable to relieve varying pressures, generally above 60 psi. Relief valves should be installed in systems that may develop pressures

exceeding the rated limits of the pressure tank or distribution system. Positive displacement and submersible pumps and water heaters can develop these excessive pressures. The relief valve should be installed between the pump and the first shutoff valve and must be capable of discharging the flow rate of the pump. A combined pressure and temperature relief valve is needed on all water heaters. Combination pressure and vacuum relief valves also should be installed to prevent vacuum damage to the system.

*Pressure-reducing Valves*. A pressure-reducing valve is used to reduce line pressure. On main lines, this allows the use of thinner walled pipe and protects house plumbing. Sometimes these valves are installed on individual services to protect plumbing.

*Altitude Valves*. Often an altitude valve is installed at the base of a hot water tank to prevent it from overflowing. Altitude valves sense the tank level through a pressure line to the tank. An adjustable spring allows setting the level so that the valve closes and prevents more inflow when the tank becomes full.

*Foot Valves*. A foot valve is a special type of check valve installed at the end of a suction pipe or below the jet in a well to prevent backflow and loss of prime. The valve should be of good quality and cause little friction loss.

*Check Valves*. Check valves have a function similar to foot valves. They permit water flow in only one direction through a pipe. A submersible pump may use several check valves. One is located at the top of the pump to prevent backflow from causing back spin of the impellers. Some systems use another check valve and a snifter valve. They will be in the drop pipe or pitless unit in the well casing and allow a weep hole located between the two valves to drain part of the pipe. When the pump is started, it will force the air from the drained part of the pipe into the pressure tank, thus recharging the pressure tank.

*Frost-proof Faucets*. Frost-proof faucets are installed outside a house with the shutoff valve extending into the heated house to prevent freezing. After each use, the water between the valve and outlet drains, provided the hose is disconnected, so water is not left to freeze.

*Frost-proof Hydrants*. Frost-proof hydrants make outdoor water service possible during cold weather without the danger of freezing. The shutoff valve is buried below the frost line. To avoid submerging it, which might result in contamination and back siphoning, the stop-and-waste valve must drain freely into a rock bed. These hydrants are sometimes prohibited by local or state health authorities.

*Float Valves*. Float valves respond to a high water level to close an inlet pipe, as in a tank-type toilet.

*Miscellaneous Switches*. Float switches respond to a high and/or low water level as with an intermediate storage tank. Pressure switches with a low-pressure cutoff stop the pump motor if the line pressure drops to the cutoff point. Low-flow cutoff switches are used with submersible pumps to stop the pump if the water discharge falls below a predetermined minimum operating pressure. High-pressure cut-off switches are used to stop pumps if the system pressure rises above a predetermined maximum. Paddle-type flow switches detect flow by means of a paddle placed in the pipe that operates a mechanical switch when flow in the pipe pushes the paddle.

### Problem Set 1.3

Match the correct term with its definition.

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| a. P&T relief valve | 1. \_\_\_\_\_A fitting or device that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or wastewater through it. |
| b. potable water | 1. \_\_\_\_\_Consists of the water service pipe, the water-distributing pipes, the necessary connecting pipes, fittings, control valves, and all appurtenances in or adjacent to the building or premises. |
| c. trap | 1. \_\_\_\_\_A safety valve installed on a hot water storage tank to limit temperature and pressure of the water. |
| d. interceptor | 1. \_\_\_\_\_The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a potable water supply because of negative pressure in the pipe. |
| e. water supply system | 1. \_\_\_\_\_Water having no impurities present in amounts sufficient to cause disease or harmful physiologic effects and conforming in its bacteriologic and chemical quality to the requirements of the U.S. Environmental Protection Agency’s Safe Drinking Water Act or meeting the regulations of other agencies having jurisdiction. |
| f. sewerage system | 1. \_\_\_\_\_A device to separate and retain deleterious, hazardous, or undesirable matter from normal waste and permit normal sewage or liquid waste to discharge into the drainage system by gravity. |
| g. water hammer | 1. \_\_\_\_\_A system comprising all piping, appurtenances, and treatment facilities used for the collection and disposal of sewage, except plumbing inside and in connection with buildings served, and the building drain. |
| h. back siphonage | 1. The loud thump of water in a pipe when a valve or faucet is suddenly closed. |

Answers: 1=c, 2=e, 3=a, 4=h, 5=b, 6=d, 7=f, 8=g