RESIDENTIAL PLUMBING OVERVIEW

The purpose of this publication is to provide accurate and useful information for home inspectors in order to perform an inspection of the plumbing system at a residential property. This manual covers the components of common residential plumbing systems, and also refers to the *InterNACHI Residential Standards of Practice* with regard to recommended inspection protocols. This publication is a useful tool as a portable guide for inspectors on the job. It also serves as a study aid for InterNACHI's online *Residential Plumbing Overview* course and exam. Visit www.NACHI.org for more information.

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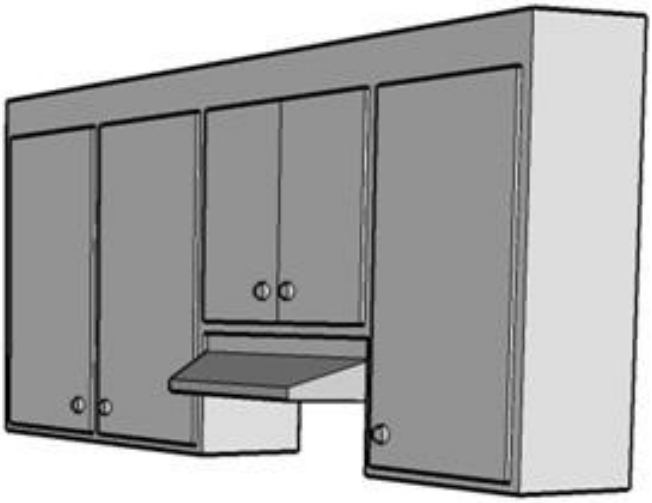
RESIDENTIAL PLUMBING OVERVIEW

SECTION 1: GENERAL COMMENTS

This is not a code-compliance course. There are many plumbing codes, and they change regularly. This course should provide you with a sound introduction to standards and requirements for the proper installation and inspection of residential plumbing. You will learn the components of a plumbing supply and drainage system. You will learn about water heaters, fixtures and faucets. An inspection report should describe and identify, in written format, the inspected plumbing system of the dwelling, and should also identify material defects observed.



Introduction

The term "plumbing" refers to the practice, materials, and the collective system of piping, fixtures, appliances, equipment, fittings and components within a structure that are related to the sanitary drainage system, storm drainage, venting systems, and public or private water supply systems.

The word "plumbing" comes from the Latin word *plumbum*, which is the element lead, and was so named because lead was used extensively in the development of piping systems. The practice of installing pipes and using the piping materials became known as plumbing.

Piping, fittings, devices, faucets, tanks, containers and receptacles that are used to supply, distribute, receive and transport potable water, liquid wastes and solid wastes are now considered plumbing.

A plumbing fixture could refer to a receptacle or device that is either permanently or temporarily connected to the water distribution system of the property, and which demands a supply of water. Or the fixture could discharge wastewater, liquid-suspended waste materials or sewage to the drainage system of the property. The fixture could also require both a water supply connection and a discharge to the drainage system of the property. Plumbing fixtures include water closets, urinals, bidets, lavatories, sinks, showers, bathtubs and floor drains.

A separate class of plumbing fixtures defined as plumbing appliances includes clothes washers, dishwashers, water heaters, water softeners, hot water dispensers, garbage disposals, and water purifiers.

Four Defects

There are four basic defects that can exist in a plumbing system that should be identified in an inspection. They include:

1. a leak;
2. inadequate water supply;
3. water contamination; and/or
4. the incorrect installation of a component.

Photo above by InterNACHI member William Warner

QUIZ on SECTION 1

1. T/F: This is a code-compliance plumbing course.

- True
- False

2. "Plumbing" comes from the Latin word meaning _____.

- "lead"
- "toilet"
- "aluminum"

3. T/F: Water contamination is considered a defect.

- True
- False

Answer Key to Quiz on Section 1

1. T/F: This is a code-compliance plumbing course.
   Answer: False

2. "Plumbing" comes from the Latin word meaning "lead."

3. T/F: Water contamination is considered a defect.
   Answer: True

SECTION 2: InterNACHI STANDARDS of PRACTICE

The following is excerpted from the *InterNACHI Standards of Practice*, effective December 7, 2004.

2.6. Plumbing

I. The inspector shall:

A. inspect and determine if the water supply is public or private;

B. verify the presence of and identify the location of the main water shut-off valve;

C. inspect the water heating equipment, including venting, connections, energy-source supply system, and seismic bracing, and verify the presence or absence of temperature-pressure relief valves and/or Watts 210 valves;

D. flush toilets;

E. water-test a representative number of sinks, tubs and showers for functional drainage;

F. inspect the interior water supply, including all fixtures and faucets;

G. inspect the drain, waste and vent systems, including all fixtures;

H. describe any visible fuel-storage systems;

I. inspect the drainage sump pumps, and test pumps with accessible floats;

J. inspect and describe the water supply, drain, waste and main fuel shut-off valves, as well as the location of the water main and main fuel shut-off valves;

K. inspect and report as in need of repair deficiencies in the water supply by viewing the functional flow in two fixtures operated simultaneously;

L. inspect and report as in need of repair deficiencies in installation and identification of hot and cold faucets;

M. inspect and report as in need of repair mechanical drain stops that are missing or do not operate if installed in sinks, lavatories and tubs; and

N. inspect and report as in need of repair commodes that have cracks in the ceramic material, are improperly mounted on the floor, leak, or have tank components which do not operate.

II. The inspector is not required to:

A. light or ignite pilot flames;

B. determine the size, temperature, age, life expectancy, or adequacy of the water heater;

C. inspect interiors of flues or chimneys, water softening or filtering systems, well pumps or tanks, safety or shut-off valves, floor drains, lawn sprinkler systems or fire sprinkler systems;

D. determine the exact flow rate, volume, pressure, temperature, or adequacy of the water supply;

E. determine the water quality or potability or the reliability of the water supply or source;

F. open sealed plumbing access panels;

G. inspect clothes washing machines or their connections;

H. operate any main, branch or fixture valve;

I. test shower pans, tub and shower surrounds or enclosures for leakage;

J. evaluate the compliance with local or state conservation or energy standards, or the proper design or sizing of any water, waste or venting components, fixtures or piping;

K. determine the effectiveness of anti-siphon, backflow prevention or drain-stop devices;

L. determine whether there are sufficient cleanouts for effective cleaning of drains;

M. evaluate gas, liquid propane or oil storage tanks;

N. inspect any underground or concealed fuel supply systems;

O. inspect any private sewage waste disposal system or component thereof;

P. inspect water treatment systems or water filters;

Q. inspect water storage tanks, pressure pumps or bladder tanks;

R. evaluate time to obtain hot water at fixtures, or perform testing of any kind to water heater elements;

S. evaluate or determine the adequacy of combustion air;

T. test, operate, open or close safety controls, manual stop valves and/or temperature or pressure-relief valves;

U. examine ancillary systems or components, such as, but not limited to, those relating to solar water heating, or hot water circulation; or

V. determine the existence or condition of polybutylene plumbing.

QUIZ on SECTION 2

1. The inspector is required to _____ all the toilets.

- unbolt and lift
- flush
- use
- clean

2. T/F: The inspector is required to light or ignite a pilot light.

- True
- False

3. T/F: An inspector is not required to determine whether the water supply is public or private.

- True
- False

4. T/F: According to the *InterNACHI Standards of Practice*, the existence of polybutylene plumbing in a dwelling is required to be determined by the inspector.

- True
- False

Answer Key to Quiz on Section 2

1. The inspector is required to flush all toilets.
2. T/F: The inspector is required to light or ignite a pilot light.
   Answer: False
3. T/F: An inspector is not required to determine whether the water supply is public or private.
   Answer: False
4. T/F: According to the *InterNACHI Standards of Practice*, the existence of polybutylene plumbing in a dwelling is required to be determined by the inspector.
   Answer: False

SECTION 3: GLOSSARY OF TERMS

- **ABS (acrylonitrile butadiene styrene):** rigid, black plastic pipe used for drain, waste and vent lines.

- **access panel:** an opening in the wall or ceiling near the fixture that allows access for servicing the plumbing/electrical system.

- **accessible:** different from "readily accessible" in that there is some obstruction, such as a door, access panel, ladder, etc.

- **access cover:** removable plate to permit access to a pipe or pipe fitting for the purposes of inspection, maintenance, repair or replacement.

- **activate:** to turn on, supply power, or enable systems, equipment, or devices to become active by normal operating controls. Examples include turning on the gas or water supply valves to the fixtures and appliances, and activating electrical breakers or fuses.

- **adaptor:** a fitting that unites different types of pipe together, such as ABS to cast-iron pipe.

- **adversely affect:** constitute, or potentially constitute, a negative or destructive impact.

- **aerator:** an apparatus that mixes air into flowing water; it is screwed onto the end of a faucet spout to help reduce splashing.

- **air-admittance valve:** one-way valve designed to admit air into the plumbing system to protect the traps from siphonage; a device used as an alternative to vents for individual fixtures and branches in the plumbing drainage system.

- **air gap:** an unobstructed vertical distance through the free atmosphere between the outlet of the waste pipe and the flood-level rim of the receptacle into which the waste pipe is discharging.

- **air chamber:** a vertical, air-filled pipe that prevents water hammer by absorbing pressure when water is shut off at a faucet or valve.

- **anti-scald:** a valve that restricts water flow to help prevent burn injuries. See **pressure balancing valve** and **thermostatic valve**. In some areas, plumbing codes require anti-scald valves. Speak to a professional in your area for more information and help with code requirements.

- **anti-siphon:** a device that prevents wastewater from being drawn back into supply lines and possibly contaminating the water supply.

- **aperture:** an opening in a pipe.

- **appliance:** an apparatus, device or equipment operated by use of electricity or fuel gas to produce heat, light, power, refrigeration or air conditioning.

- **approved:** accepted by the code official, third-party agency, authority having jurisdiction (AHJ), or conforming to a standard, such as ANSI.

- **backflow:** the flow of liquids in potable water distribution piping in reverse of their intended path. There are two types of pressure conditions that cause backflow: back-siphonage and back-pressure.

- **backflow preventer:** a device or means to prevent backflow into the potable water supply.

- **back-pressure:** pressure created in a non-potable system in excess of the water supply mains causing backflow. Back-pressure can be created by mechanical means (such as a pump), by static head pressure (including an elevated tank), or by thermal expansion from a heat source (such as a water heater).

- **back-siphonage:** the backflow of water caused by system pressure falling below atmospheric pressure. Atmospheric pressure supplies the force that reverses the flow.

- **basket strainer:** basket-shaped strainer with holes allowing water to drain while catching food or other solids; can also be closed to fill the sink with water.

- **bell reducer:** in plumbing, a fitting shaped like a bell which has one opening of a smaller diameter used to reduce the size of the pipe in the line, and the opposite opening of larger diameter.

- **bidet:** a toilet-like plumbing fixture designed to promote posterior hygiene; not a toilet.

- **building drain:** the part of the drainage system that receives the discharge from inside the dwelling and transports it to the building sewer, and ends 30 inches outside the dwelling's foundation wall.

- **building sewer:** that part of the drainage system that extends from the end of the building drain onward.

- **cistern:** reservoir for water; common in houses built prior to the 1950s in the Midwest.

- **cleanout:** a plug in a trap or drain pipe that provides access for the purpose of clearing an obstruction.

- **closet bend:** a curved fitting that connects the closet flange to the toilet drain.

- **closet bolts:** bolt whose head is fitted to a closet flange and protrudes up through a toilet base. A nut is tightened around it on the toilet base. Two (or four) bolts serve one toilet.

- **closet flange:** an anchoring ring secured to the floor, and the base of the toilet is secured to this ring with bolts.

- **combustion air:** the air provided to fuel-burning equipment, including air for fuel combustion, draft-hood dilution, and ventilation of the equipment enclosure.

- **compression fitting:** used to join or connect pipes and conduit by causing a ring to compress against the connecting tube when tightening with a wrench.

- **component:** a permanently installed or attached fixture, element or part of a system.

- **condensate drain pipe:** condensate drainage from air-conditioning equipment must be drained properly. This drainage pipe must be sized and designed as an indirect waste pipe, with a minimum ¾-inch in diameter, and a water trap installed on the line.

- **condition:** the visible and conspicuous state of being of an object.

- **console lavatory:** a table-like lavatory in which the basin is attached to a wall at the back and by table or piano legs at the front.

- **copper pipe types:** Type K has the heaviest or thickest wall and is generally used underground. It has a green stripe. Type L has a medium wall thickness and is most commonly used for water service and for general interior water piping. It has a blue stripe. Type M has a thin wall, and many codes permit its use in general water piping installation. It has a red stripe.

- **CPVC (chlorinated polyvinyl chloride):** rigid plastic pipe used in water supply systems where code permits.

- **cut-off valves:** valves used to shut water off, generally located under sinks and behind bathtub and shower access panels. They cut off hot and/or cold water at the source without cutting water off all throughout the house.

- **describe:** report, in writing, a system or component, by its type or other observed characteristics, to distinguish it from other components used for the same purpose.

- **determine:** to arrive at an opinion or conclusion pursuant to examination.

- **developed length:** the distance measured along the centerline of a pipe.

- **dismantle:** to open, take apart or remove any component, device or piece that would not typically be opened, taken apart or removed by an ordinary occupant.

- **disposer:** a device that grinds food sufficiently to enter drains for disposal without clogging them. See also **food waste grinder** and **garbage disposal**.

- **diverter:** valves which have a single inlet and direct water to one of two outlets. Diverters are used with hand showers, shower risers, tub-and-shower combinations, and kitchen faucet sprayers.

- **drainage system:** piping within a dwelling that conveys sewage, rainwater, or other liquid wastes to a point of disposal. It does not include the main of a public sewer system or a private or public sewage treatment or disposal plant. A sanitary drainage system carries sewage and excludes storm, surface, rain, and groundwater.

- **dwelling:** a single unit providing complete, independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking and sanitation.

- **DWV (drainage, waste and vent system):** refer to **drainage system**.

- **elbow:** an angled fitting that alters the direction of the line; also called an "L" *(ell)*. It comes in a variety of angles, from 22½° to 90°.

- **escutcheon:** a trim piece or decorative flange that fits beneath the faucet handle to conceal the faucet stem and the hole in the fixture or wall.

- **evaluate:** to assess the systems, structures or components of a dwelling.

- **examine:** to visually look.

- **fall/flow:** the proper slope or pitch of a pipe for adequate drainage.

- **faucet:** a device for regulating the flow of liquid from a reservoir, such as a pipe or drum.

- **fitting:** a general term that usually refers to faucets, shower valves, tub fillers, and various piping parts, such as tees and elbows.

- **fixture:** in plumbing, the devices that provide a supply of water and/or its disposal, e.g. sinks, tubs and toilets.

- **food waste grinder:** a device that grinds food sufficiently to enter drains for disposal without clogging them. See also **disposer** and **garbage disposal**.

- **flex hose:** a flexible pipe or tube usually made of braided stainless steel, commonly used with widespread or Roman tub faucets to provide variable centers.

- **flood-level rim:** the edge of the fixture or receptacle above which liquid will flow over and out of that fixture or receptacle.

- **flow rate:** the rate at which water is discharged from an outlet. For example, the standard flow rate of a showerhead is 2.5 gallons per minute.

- **flue:** a pipe used to exhaust smoke, gas or air.

- **flue lining:** fired clay or terracotta pipe, round or square, usually made in all ordinary flue sizes and in 2-foot lengths, used for the inner lining of chimneys with the brick or masonry work around the outside. Flue lining in chimneys runs from about a foot below the flue connection to the top of the chimney.

- **flush valve:** the valve separating the water in the tank from the bowl.

- **flux:** a material applied to the surface of copper pipes and fittings to assist in the cleaning and bonding process.

- **function:** the action for which an item, component or system is specially fitted or used, or for which an item, component or system exists; to be in action or perform a task.

- **garbage disposal:** a device that grinds food sufficiently to enter drains for disposal without clogging them. See also **disposer** and **food waste grinder**.

- **gaskets:** pre-formed shapes, such as strips, grommets, etc., of rubber or rubber-like composition, used to fill and seal a joint or opening, either alone or in conjunction with the supplemental application of a sealant.

- **gate valve:** a valve that permits you to completely stop, but not modulate, the flow within a pipe.

- **GPM (gallons per minute):** the unit of measurement by which the flow rate of faucets and showerheads is measured and regulated.

- **groundwater:** water from an aquifer or sub-surface water source.

- **hose bib:** an outdoor faucet with hose threads on the spout, also commonly used to supply washing machines and wash basins.

- **hot water:** water at a temperature equal to or greater than 110° F (43° C).

- **ID (inside diameter):** the diameter measurement taken from the inside of a pipe; a common method for sizing pipe.

- **inspect:** to visually look at readily accessible systems and components safely, using normal operating controls, and accessing readily accessible panels and areas, in accordance with the *InterNACHI Standards of Practice.*

- **lavatory:** bathroom or washroom sink.

- **installed:** attached or connected such that the installed item requires the use of a tool for removal.

- **lead:** a malleable metal that was used for drainage pipes and was installed for water service entry pipes.

- **main vent (or stack):** principal vent to which branch vents may be connected.

- **mixing valve:** a valve that mixes hot and cold water in the valve to obtain a set temperature prior to delivery.

- **non-vitreous:** a relative term as applied to ceramic products based on their water-absorbing characteristics; that degree of vitrification evidenced by relatively high water absorption, usually more than 10% water absorption, except for tile materials that are considered non-vitreous when water absorption exceeds 7%.

- **notch:** a crosswise rabbet at the end of a board.

- **O-ring:** round rubber washer or gasket that is compressed to create a watertight seal, typically in a compression fitting.

- **oakum:** loose hemp or jute fiber that is impregnated with tar or pitch and used to caulk large seams or for packing plumbing pipe joints.

- **observe:** to see through visually directed attention.

- **operate:** to cause systems to function or turn on with normal operating controls.

- **PB (polybutylene):** flexible plastic tubing used in water supply systems.

- **P-trap:** P-shaped section of drain pipe that prevents sewer odors from escaping into the home. Water is trapped in the pipe, blocking gases from escaping through the drain.

- **pedestal lavatory:** a lavatory in which the bowl is supported by a single pedestal leg.

- **percolation test (perc test):** tests that a soil engineer performs on earth to determine the feasibility of installing a leach field-type sewer system on a lot; a test to determine if the soil on a proposed building lot is capable of absorbing the liquid effluent from a septic system.

- **plumbing boots:** metal saddles used to strengthen a bearing wall/vertical stud(s) where a plumbing drain line has been cut through and installed.

- **plumbing rough:** work performed by the plumbing contractor after the rough heat is installed. This work includes installing all plastic ABS drain and waste lines, copper water lines, bathtubs, shower pans, and gas piping to furnaces and fireplaces. Lead solder should not be used on copper piping.

- **plumbing stack:** a plumbing vent pipe that penetrates the roof.

- **plumbing trim:** work performed by the plumbing contractor to get the home ready for a final plumbing inspection; includes installing all toilets (water closets), hot water heaters, sinks, and connecting all gas pipes to appliances, disposal, dishwasher, and all plumbing items.

- **plumbing waste line:** see **drainage system**.

- **polyvinyl chloride (PVC):** polymer formed by polymerization of vinyl chloride monomer, sometimes called vinyl; a type of white plastic pipe commonly used for DWV systems.

- **potable water:** drinkable water fit for human consumption; fit to drink.

- **pressure tank:** used in conjunction with wells to maintain pressure.

- **pressure-reducing valve:** valve installed in the water service line where it enters the building to reduce the pressure of water in the line to an acceptable pressure used in buildings (40 to 55 psi desired).

- **readily accessible:** an item or component is readily accessible if, in the judgment of the inspector, it is capable of being safely observed without movement of obstacles, detachment or disengagement of connecting or securing devices, or other unsafe or difficult procedures to gain access.

- **relative humidity:** the amount of water vapor in the atmosphere, expressed as a percentage of the maximum quantity that could be present at a given temperature; the actual amount of water vapor that can be held in space increases with the temperature.

- **reducer:** a fitting that connects pipes of different sizes.

- **report:** a written communication (possibly including digital images) of any material defects seen during the inspection.

- **riser:** a vertical assembly of fittings and pipes that distributes water upward.

- **rough-in:** the portion of a plumbing installation that includes running the water supply lines and drain, waste and vent lines to the proposed location of each fixture.

- **run:** a complete or secondary section(s) of pipe that extend from supply to fixture, or from drain to stack.

- **sanitary fitting:** fitting that joins the assorted pipes in a drain, waste and vent system, designed to allow solid material to pass through without clogging.

- **sanitary drainage system:** a drainage system that carries sewage and excludes storm, surface, rain and groundwater.

- **scupper:** an outlet in the wall of a building or a parapet wall for drainage of water from a flat roof.

- **seat:** the fixed part of a valve. The stem assembly will move up and down against the seat to open and close the valve.

- **self-rimming:** a style of bathroom lavatory or kitchen sink with a finished lip or rim that installs on top of a counter without requiring a metal sink rim.

- **sewage:** a general term referring to the discharge from all plumbing fixtures, and primarily includes human bodily wastes, and the wastes associated with cleaning, washing, bathroom use, and food preparation.

- **sewage ejector:** a pump used to lift wastewater to a gravity sanitary sewer line, usually used in basements and other locations that are situated below the level of the side sewer.

- **sewer lateral:** the portion of the sanitary sewer which connects the interior wastewater lines to the main sewer lines. The side sewer is usually buried in several feet of soil and runs from the house to the sewer line. It is usually owned/operated by the sewer utility, must be maintained by the owner, and may be serviced only by utility-approved contractors; sometimes called a side sewer.

- **sewer stub:** the junction at the municipal sewer system where the home's sewer line is connected.

- **sewer tap:** the physical connection point where the home's sewer line connects to the main municipal sewer line.

- **shut down:** turned off, unplugged, inactive, not in service, not operational, etc.

- **shut-off valve:** the valve that allows the water supply to be cut off to one fixture without affecting the water supply to the entire house or building, commonly used at bathroom sinks and toilets.

- **side sewer:** the portion of the sanitary sewer which connects the interior wastewater lines to the main sewer lines. The side sewer is usually buried in several feet of soil and runs from the house to the sewer line. It is usually owned/operated by the sewer utility, must be maintained by the owner, and may be serviced only by utility-approved contractors; sometimes called a sewer lateral.

- **sillcock:** an exterior water faucet (hose bib).

- **sleeve:** pipe installed under the concrete driveway or sidewalk, and that will be used later to run sprinkler pipe or low-voltage wire.

- **sludge:** term for the waste material found in sump pump pits, septic systems and gutters.

- **soil pipe:** pipe that transports waste that includes fecal matter.

- **stack:** a vertical drain pipe that extends more than one floor level or story in a dwelling, carrying liquid or air.

- **stack vent:** a vent extension of the soil or waste stack above the plumbing fixtures.

- **stem:** a small shaft or rod that projects through the faucet valve and to which the handle is installed.

- **stop valve:** a valve that controls the flow of water to an individual fixture, allowing the water supply to be stopped to one fixture without affecting water supply to other fixtures.

- **storm sewer:** a sewer system designed to collect storm water and which is separated from the wastewater system.

- **straight stop:** a shut-off valve that is installed on a supply line between the floor and the faucet or toilet. Unlike an angle stop, a straight stop does not change the direction of water flow.

- **sump pump:** a submersible pump in a sump pit that pumps any excess groundwater to the outside of the home.

- **system:** an assembly of various components that function as a whole.

- **tailpiece:** the tubular part of a drain that runs from the plumbing fixture to the trap.

- **tee:** a T-shaped fitting with three openings used to create branch lines.

- **trap:** a fitting or device that provides a liquid seal to prevent the emission of sewer gases without affecting the flow of sewage or wastewater through the trap.

- **trap seal:** the vertical distance between the crown weir and the top dip of the trap. The crown weir is the lowest point in the cross-section of the horizontal waterway at the exit of the trap.

- **tub trap:** a curved, U-shaped section of a bathtub drain pipe that holds a water seal to prevent sewer gases from entering the home through a tub's water drain.

- **underground plumbing:** the plumbing drain and waste lines that are installed beneath a basement floor.

- **union:** three-piece fitting that joins two sections of pipe, but allows them to be disconnected without cutting the pipe, used primarily with steel pipes, but never in a DWV system.

- **unsafe:** a condition in a readily accessible, installed system or component which is judged to be a significant risk of personal injury during normal, day-to-day use. The risk may be due to damage, deterioration, improper installation, or a change in accepted residential construction standards.

- **vacuum breaker:** an anti-siphon device that prevents wastewater from being drawn back into supply lines, potentially contaminating the water supply.

- **vent:** a passageway for conveying flue gases from fuel-burning appliances to the outside air.

- **vent stack:** the vertical, upper portion above the top-most fixture through which gases and odors escape the sanitary drainage system. This pipe carries no liquids or solids.

- **vent system:** piping that prevents trap siphonage and back-pressure, or equalizes the air pressure within the sanitary drainage system.

- **verify:** to confirm or substantiate.

- **waste and overflow:** a bathtub drain assembly that has an outlet at the top to remove overflow water when filling the tub, and an outlet at the bottom to remove wastewater when the tub is drained.

- **waste stack:** vertical pipe that carries liquid or air through one or more stories of a dwelling.

- **waste (wastewater):** drainage discharge that does not contain fecal matter.

- **water closet:** A water closet is referred to by many other names, including "toilet" and "commode." It is the most recognizable and most used plumbing fixture. "Toilet" is the term most commonly used in the United States.

- **water tap:** the connection point where the home water line connects to the main municipal water system.

- **wax ring job:** removing a toilet from the floor so that a blockage can be manually removed, or to replace a degraded wax ring; replacing a wax ring on the bottom of the toilet to create a seal.

- **well casing:** a steel or plastic pipe which serves as the lining of a well, preventing it from caving in, and protecting groundwater from contamination by surface water.

- **whirlpool bathtub:** a plumbing appliance consisting of a bathtub fixture that is equipped and fitted with a circulating piping system designed to accept, circulate, agitate and discharge bathtub water for relaxation and therapeutic purposes.

- **wye:** a Y-shaped fitting with three openings used to create branch lines.

- **yoke:** the location where a home's water meter is installed between two copper pipes, and located in the water meter pit in the yard.

- **zone valve:** a device, usually placed near the heater or cooler, which controls the flow of water or steam to parts of the building; a zone thermostat controls it.

QUIZ on SECTION 3

1. ABS stands for _____.

- acryline butta styrofoam
- alkaline byrene stratiene
- acrylonitrile butadiene styrene

2. The unobstructed vertical distance through the free atmosphere between an outlet and the rim best describes _____.

- one of the methods used in fixture measurement values
- an air gap in a drainage system
- a connection problem
- an indirect drainage space
- the best way to vent contaminated water

3. Air-admittance valves protect traps from _____.

- siphonage
- leaking
- admitting water into the drain pipe
- admitting air into the vent pipe
- clogging

4. The vertical, upper portion above the top-most fixture through which gases and odors escape the sanitary drainage system, carrying no liquids or solids, best describes _____.

- a vent stack
- a supply vent
- an air-admittance valve
- a non-liquid ventilation pipe
- a sewer drain pipe

(continued)

5. A lavatory is _____.

- any type of sink
- a bathroom with a toilet but no sink
- a bathroom
- a bathroom or washroom sink

6. A _____ is an anchoring ring secured to the floor, and a toilet is secured to this ring with bolts.

- water closet flange
- toilet ring
- wax ring device

7. A toilet or commode is referred to in plumbing standards as a _____.

- toilet fixture
- toilet receptacle
- water closet

8. The flow of liquids in potable water distribution piping in reverse of its intended path caused by back-siphonage or back-pressure best describes _____.

- backflow
- vertical lift of waste material
- siphoning drainage pressure defects
- contamination

9. Hot water is _____.

- water at a temperature between 85° F and 110° F
- water at a temperature equal to or greater than 110° F
- water at a temperature equal to 110° F (43° C)
- water at a temperature equal to or greater than 120° F (49° C)

Answer Key is on next page.

Answer Key to Quiz on Section 3

1. ABS stands for acrylonitrile butadiene styrene.

2. The unobstructed vertical distance through the free atmosphere between an outlet and the rim best describes an air gap in the drainage system.

3. Air-admittance valves protect traps from siphonage.

4. The vertical, upper portion above the top-most fixture through which gases and odors escape the sanitary drainage system, carrying no liquids or solids, best describes a vent stack.

5. A lavatory is a bathroom or washroom sink.

6. A water closet flange is an anchoring ring secured to the floor, and a toilet is secured to this ring with bolts.

7. A toilet or commode is referred to in plumbing standards as a water closet.

8. The flow of liquids in potable water distribution piping in reverse of its intended path caused by back-siphonage or back-pressure best describes backflow.

9. Hot water is water at a temperature equal to or greater than 110° F.

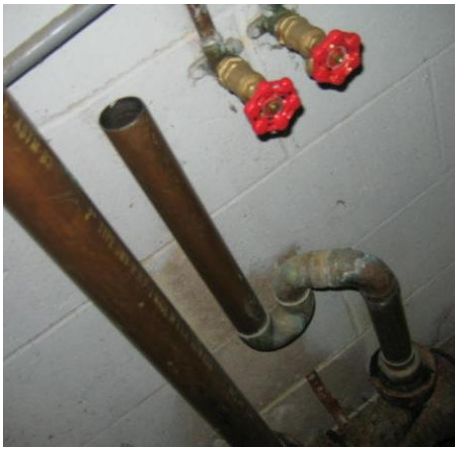
SECTION 4: FIXTURES

General Comments

A dwelling should have the proper number of fixtures of a specific quality. The fixtures should be properly installed to be both accessible and usable by the occupants. There are standards to which each fixture's design and quality must conform.

Minimum Number of Plumbing Fixtures

For one- and two-family residential dwellings (R-3), each dwelling is required to have at least one water closet (toilet), one lavatory (bath sink), one bathtub or shower, one kitchen sink, and one automatic clothes washer connection.



Access for Cleaning

Plumbing fixtures should be installed so as to provide access for cleaning. Every fixture should be capable of being cleaned. There must not be any concealed spaces that do not facilitate proper cleaning.

Connections, Flanges and Joints

A floor flange should be used in the connection between the drain and the floor outlet plumbing fixture. The flange should be securely attached to the drain and anchored to the structure. A wall-mounted water closet should be bolted to the hanger with corrosion-resistant bolts or screws. Joints should be sealed with an approved elastomeric gasket, a flange-to-fixture connection, or a setting compound. The most commonly used setting compound is a wax ring made of beeswax or synthetic wax.

Closet bolts are usually made of brass because of its strength and corrosion-resistance. They alone hold the closet to the flange. A water closet floor flange receives the closet bolts. The flange attaches the closet firmly to the structure. The flange should be secured to the structure with corrosion-resistant screws. The flange firmly holds the closet to the structure without putting any load on the drainage pipe that is attached to the flange. A wall-hung water closet bowl should be supported to the wall structure with a concealed carrier so that no load is transferred to the drainage pipe or connection.

Fixture Tailpieces

Tailpieces are short lengths of pipe attached directly to a fixture by means of a flange for connection to other piping or traps. Tailpieces should be at least 1½ inches (38 mm) in diameter for sinks, dishwashers, laundry tubs, bathtubs and similar fixtures, which is consistent with the minimum sizes for fixture drains, traps and trap arms. Tailpieces should be at least 1¼ inches (32 mm) in diameter for bidets, lavatories and similar fixtures.

Some standards limit the maximum vertical length of a tailpiece to between 24 and 36 inches (610 and 914 mm).

Faucets and Other Fixtures

There are many standards to which faucets and other fixture fittings should conform. There are specific standards with which faucets and fixture fittings that supply drinking water for human ingestion must comply. Faucet and supply fittings should comply with the water consumption requirements shown in the table below.

Maximum Flow Rates and Consumption	
Fixture or Fixture Fitting	**Maximum Flow Rate or Quantity**
lavatory	2.2 gpm at 60 psi
showerhead	2.5 gpm at 80 psi
sink faucet	2.2 gpm at 60 psi
urinal	1 gallon per flush
water closet	1.6 gallons per flush

Faucet and Fixture Temperature Control

A temperature-control valve protects against rapid temperature fluctuations by automatically maintaining the discharge temperature to +/- 3° F (+/- 2° C) of the selected temperature. Every shower and combination tub/shower must have a control valve that is capable of protecting an individual from being scalded while taking a shower. Such a control valve must be installed at the point of use. To prevent an accidental scald, a maximum set-point feature is required for the valves. The valve can be adjusted to prevent the water temperature from rising above 120° F (49° C). (See table to follow.)

Temperature Burn Chart		
Water Temperature	**Time it takes for an adult to become scalded with a third-degree burn:**	**Time it takes for a child to become scalded with a third-degree burn:**
155° F (68° C)	1 second	0.5 seconds
133° F (56° C)	15 seconds	4 seconds
120° F (49° C)	5 minutes	2:30 minutes
100° F (38° C)	safe temp. for bathing	safe temp. for bathing

The hot water supplied to the bathtub and whirlpool bathtub valves should be limited to a maximum temperature of 120° F (49° C) by a control valve.

Fixture fittings and faucets that are supplied with both hot and cold water should be installed and adjusted so that the left-hand side of the water temperature control (when facing the outlet) represents the flow of hot water.

Sauna Temperature Control

Sauna heaters should be equipped with a thermostat that limits the room temperature to no greater than 194° F (90° C). Where the thermostat is not an integral part of the heater, the heat-sensing element should be located within 6 inches (152 mm) of the ceiling.

Overflows

An overflow is designed to prevent fixtures from flooding (or overflowing into) the area when the stopper is closed or the drain is obstructed. A stopper must not interfere with the overflow opening or the water overflowing from the fixture.

Bathtubs and Sinks

Bathtubs and lavatories can have overflows installed. These two fixtures are often used without close observation. A person preparing to take a bath will typically turn on the water and leave while the tub is filling up. If left for a long time, the tub water may rise to a level where the overflow will take the excess water to the drain, preventing flooding of the area. Many tubs are capable of supplying water at rates greater than the flow rate of the overflow. With such fixtures, overflowing and flooding may not be prevented.

Inlet Side

An overflow discharges on the inlet side (or fixture side) of the water trap. The overflow is installed so as to prevent sewer gases from the drainage system from entering the dwelling. The exception is the overflow from a flush tank serving a water closet that discharges into the fixture served. Flush tanks normally have an open standpipe inside the tank that allows overflow to drain directly into the water closet.

Clearance for Water Closets and Lavatories

There should be at least 15 inches of space from the center of a water closet, lavatory or bidet to any sidewall, partition, cabinet or any other obstruction. There should be at least 30 inches of space between adjacent fixtures. There should be a space of at least 21 inches in front of the water closet, lavatory or bidet to any wall, fixture or door. This clearance is for comfortable, adequate space for cleaning and use of the fixture.

Water Closets

A water closet in the U.S. is commonly referred to as a toilet. The term "water closet" originates from the time when plumbing was brought indoors, and defecation took place in a small, closet-size room with a pot.

Water Closet Styles

There are three styles of water closets: close-coupled, one piece, and flushometer valve. The most common is the close-coupled water closet, which has a bowl and separate gravity-type tank or flushometer tank that is supported by the bowl. A one-piece water closet is constructed with the gravity-type tank or flushometer tank and bowl as one integral unit. A flushometer valve water closet is a bowl with a flushometer valve.

Water closet bowls come in six styles: blow-out, siphon jet, reverse trap, wash-down, siphon vortex, and siphon wash.

Flushing Devices for Water Closets and Urinals

There are three types of devices that are required to flush a water closet or urinal: a flush tank, a flushometer valve, and a flushometer tank. The flush tank works with gravity, using only the pressure of the water inside the tank. The flushometer valve is a device used to discharge water at the full-line pressure of the water supply. The flushometer tank incorporates a hydropneumatic tank that flushes the fixture at full-line pressure.



Water Closet Measurements

A water closet has a water consumption limit of a maximum average of 1.6 gallons (6.1 L) of water per flush.

The general bowl rim height above the floor is between 14 inches minimum and 15 inches maximum (356 mm to 381 mm). Other rim heights may be needed for water closets used by children (10 inches or 254 mm maximum), the elderly (18 inches or 457 mm maximum), and persons with physical disabilities (18 inches or 457 mm maximum).

Elongated water closet bowls are required for public or employee use, but are often installed in residential dwellings. An elongated bowl is 2 inches (51 mm) longer than a regular bowl.

Connection to Drainage

To connect a water closet to the drainage line, a 4-inch by 3-inch (102-mm by 76-mm) closet bend should be allowed, and it is not considered a reduction in the drainage pipe size. If a 3-inch (76-mm) bend is used, then a 4-inch by 3-inch (102-mm by 76-mm) flange can be installed to receive the horn of the water closet.

Defects at Water Closets

The water closet (toilet) may have a clogged drain. While flushing the toilet, watch the flush performance. As part of the inspection, some inspectors put about 4 feet of toilet paper in a water closet and flush the toilet. There should not be excessive odors around the water closet. Check the flooring around the toilet with your foot. Using the side of your leg, you can check to see if the toilet is securely attached to the floor. Look for dampness around the bottom of the toilet base. Toilets sometimes run continuously. Check for a water shut-off valve. Some toilets are mistakenly connected to the hot water system. Tank lids are often cracked.

Urinals

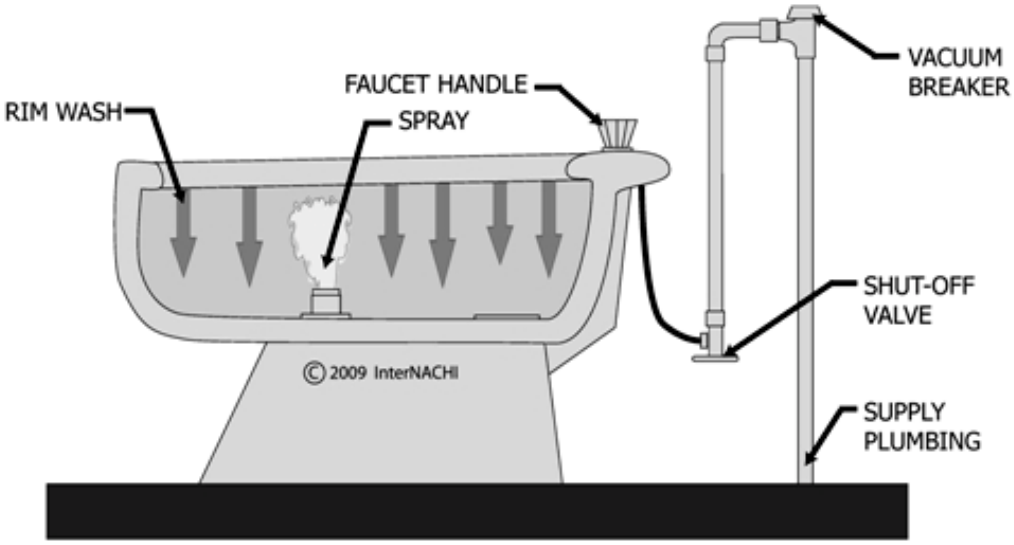
A urinal is a fixture that has been designed for urination, as opposed to a water closet (toilet) that is designed for defecation. There are four types of water-supplied urinals: stall, siphon jet, wash-down, and blow-out. The water consumption limit for a urinal is 1 gallon (3.785 L) per flush. Waterless urinals are becoming popular, considering sustainable "green" building methods. Wall and floor space must be waterproofed to a point 2 feet (610 mm) in front of a urinal lip, 4 feet above the floor, and at least 2 feet to each side of the urinal. Waterproofing material should be smooth, readily cleanable and non-absorbent.

Bidets

The bidet is a small bathing fixture used by both sexes. It is not designed for the elimination of human waste, but for cleaning the perineal area, and other body parts, including feet. It is typically equipped with a water spray that directs water upward in a jet towards a body part.

Most bidets present back-siphonage problems because the spray nozzle is located below the flood-level rim of the fixture. The water supply to a bidet should have protection against backflow. The temperature of the discharging water from a bidet should be limited to a maximum temperature of 110° F (43° C) by a water temperature-limiting device. This temperature device is required because of the potential for scalding sensitive parts of the body.

BIDET



Lavatories and Washbasins

A lavatory is a washbasin or sink located in a bathroom or washroom. "Lavatory" means washbasin or sink, and is derived from the Latin word *lavatorium,* which means "washing vessel," and the French word *laver,* meaning "to wash." Lavatories come in a variety of shapes and sizes. They are available in enameled cast-iron, vitreous china, stainless steel, porcelain-enameled formed steel, plastic, and non-vitreous ceramic. They can be wall-mounted, hanger-mounted, under-mounted, pedestal, rimmed, and above-center basin types.

Counter tops integrated with lavatories are constructed of a variety of materials, including ABS, PVC, gel-coated fiberglass-reinforced plastic, acrylic, polyester, and cultured marble. Plastic vanity tops should be impregnated with fire-resistant chemicals to reduce the fuel contribution of the lavatory during a house fire or the accidental fire from a plumber's torch. They are also made to resist the effect of a burning cigarette left unattended on the vanity top.

Lavatories should have a waste outlet of at least 1¼ inches (32 mm) in diameter. Each lavatory must have a strainer, a pop-up stopper, a crossbar, or other mechanism to prevent items such as rings, toothbrushes and cosmetic items from dropping into the drain.

Lavatory Overflows

In the past, the standard required lavatories to have an overflow. That is no longer the standard. The overflow is now an option of the manufacturer. The reason for not requiring an overflow at a lavatory is because of the lack of use of the overflow. The lack of use causes bacterial and micro-organism growth.

Where a lavatory does have an overflow installed, the cross-sectional area of the overflow should have a minimum of 1⅛ inches (726 mm). This minimum prevents the overflow from being too small, which could promote bacterial and micro-organism growth. The overflow should be able to prevent overflowing of the sink for a minimum of five minutes when tested from the onset of water flowing into the overflow's opening.

Lavatory Rims

The rim of the lavatory can be used to determine the number of fixtures for which the sink is designed, with 20 inches of rim to one lavatory fixture. A rim greater than 20 inches is designated as a group wash-up fixture.

Sinks

Sinks are plumbing fixtures which include kitchen sinks, service sinks, bar sinks, mop sinks and wash sinks. A sink is considered a different item than a lavatory (or a bathroom sink), although the terms are often used interchangeably.

Sinks can be made of enameled cast-iron, vitreous china, stainless steel, porcelain-enameled formed steel, non-vitreous ceramic, and plastic materials.

Sink waste outlets should have a minimum diameter of 1½ inches (38 mm). Most kitchen sinks have an opening of 3½ inches (89 mm) in diameter. A food waste grinder has a standard opening of 3½ inches, and so do most kitchen sink basket strainers. A strainer or crossbar should be provided to restrict the clear opening of the waste outlet.

Food Waste Grinders

Food waste grinders (also known as garbage disposals and disposers) are designed to grind foods, including bones, into small-sized bits that can flow through the drain line. Using them to dispose of fibrous and stringy foods, such as corn husks, celery, banana skins and onions, is not recommended because fibers tend to pass by the grinder teeth, move into the drain pipe, and cause drains to clog.

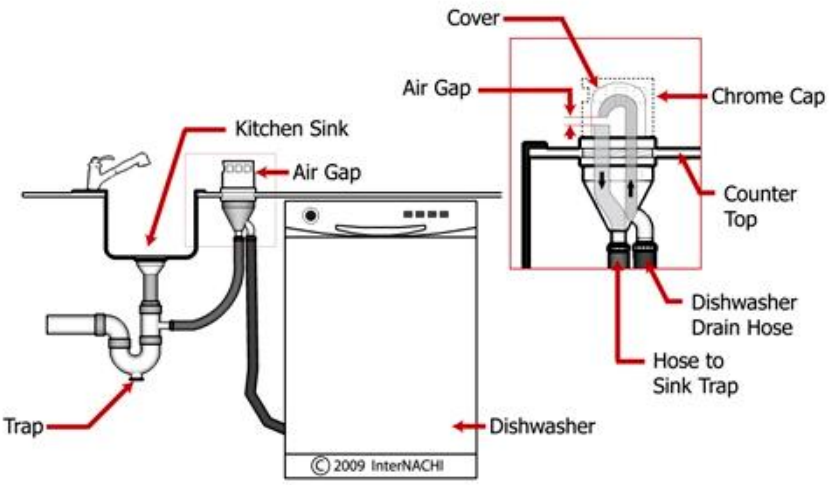
Water must be supplied to the grinder to assist during its operation in transporting waste. The water flushes the grinder chamber and carries the waste down the drain pipe. Blockage may result if the grinder is used without running the water during operation. Grinders should be connected to a drain of not less than 1½ inches (38 mm) in diameter. Food waste grinders are supplied with water from the sink faucet. They do not add to the load used to compute drainage pipe sizing. The drain size required for a grinder is consistent with that for a kitchen sink.

Dishwashing Machines

The water supply to a residential dishwashing machine should be protected against backflow by an air gap or backflow preventer. The machine must be equipped with an integral backflow mechanism, or the potable water supply must have either a backflow preventer or an air gap.

The ASSE 1006 standard for residential and domestic-type dishwashing machines is the requirement for the protection of the potable water supply against backflow. If the unit conforms to the standard, there is an internal integral backflow prevention device installed, and additional precautions are unnecessary. Prior to installing, the installer should confirm that the machine conforms to the standard. The discharge pipe from the dishwasher should be increased to a minimum of ¾-inch (19-mm) in diameter. It should be connected with a wye fitting to the sink tailpiece. Before connecting to the sink tailpiece, the dishwasher waste line should rise and be securely fastened to the underside of the counter. The combined discharge from a sink, dishwasher and waste grinder is allowed to discharge through a single 1½-inch (38-mm) trap.

Dishwasher Air Gap



Bathtubs

Bathtubs are made from many different types of materials, including enameled cast-iron, porcelain-enameled steel, and plastic. Plastic tubs are made from materials such as ABS, PVC, fiberglass, fiberglass-reinforced plastic, acrylic, and cultured-marble acrylic. Bathtubs that are equipped with shower fixtures should be manufactured with slip-resistant surfaces. Bathtubs should have a drainage outlet (tailpiece) with a minimum diameter of 1½ inches (38 mm). Every tub should be equipped with a stopper. The bathtub should have an overflow outlet installed. The overflow prevents flooding if the tub is being filled while unattended, and prevents overflow of the water when a person enters a tub that is full.

Fire-Resistance

Bathtubs made of plastic are tested for fire ignition. They are made with fire-resistant chemicals to reduce their fuel contribution in a house fire, or an accidental exposure to a plumber's torch.

Large Bathtub Loads

Some bathtubs are so large that they can accommodate more than one person at a time. These larger bathtubs may need special and additional structural support underneath them to adequately support the load.

A 3-foot by 4-foot bathtub may have a capacity to hold 200 gallons or more. The weight of the bathtub, water and occupants may total over 1 ton, considering:

200 pounds for the bathtub
+ 1,600 pounds of water
+ 350 pounds for two people
= 2,150 pounds

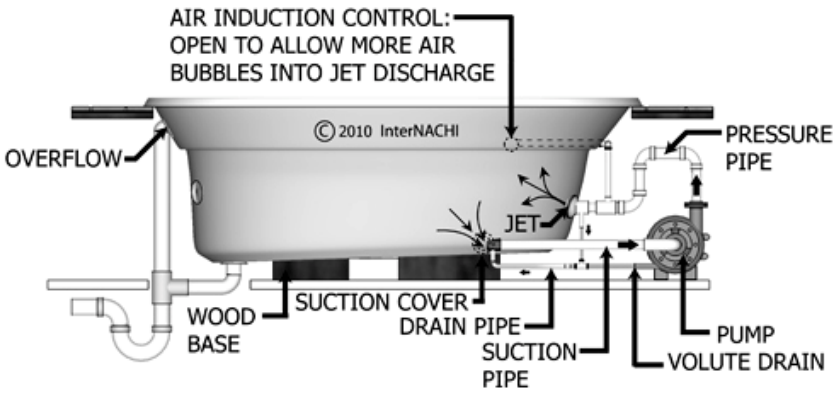
A very large tub may cause structural problems, because live loading for a typical residential home is 40 pounds per square foot. The live load for a 3-foot by 4-foot occupied tub may be assumed to be only 480 pounds, but may weigh over 2,000 pounds while it is in use.



Whirlpool Tubs

Whirlpool bathtub fixtures must be installed according to the manufacturer's recommendations. The bathtub should be filled with water and tested during the rough-in plumbing inspection. The pump must be located above the tub trap weir so that the pump drains each time that the tub is drained. The tub, pump and the piping should all be sloped to drain water completely after every use. Standing water will cause bacterial growth.

WHIRLPOOL BATHTUB



Whirlpool Tub Access

The pump must be accessible to make repairs or maintenance. One should have access to the mounting bolts, pipe unions and electrical connections in order to physically remove the pump, all without damaging the tub or surrounding finished walls or ceiling. A 12-inch by 12-inch (305-mm by 305-mm) minimum sized opening should be installed to provide access to the circulation pump. If the pump is located more than 2 feet (609 mm) from the access opening, an 18-inch by 18-inch minimum sized opening should be installed.

Whirlpool Tub Inspection Procedure

Fully open the hot and cold water faucets and fill the whirlpool tub with water at least 1 to 3 inches above the whirlpool jets. Do not operate the pump until all jets are submerged. Direct the jets downward before activating the pump. Inspect the amount of bubbling with the controls. The suction inlets typically have very small openings, less than ⅛-inch in diameter, to prevent catching hair and pulling someone's head under water. This has happened in the past and some suction inlets have been recalled. If dirty water comes out of the jets, the circulation system is probably dirty and the tub is not sanitary, and the inspector should recommend a professional cleaning. There should not be any odor emanating from the tub. All whirlpool tubs should have a dedicated electric circuit protected by a GFCI (ground-fault circuit interrupter). Inspect and measure the area of the access panel.

Showers

Plastic, pre-fabricated shower units are constructed of various synthetic materials, including ABS, PVC, gel-coated fiberglass-reinforced plastic, cultured marble, cast-filled fiberglass, polyester, cultured marble acrylic, and acrylic. These shower units are impregnated with fire-retardant chemicals to reduce the fuel contribution during a fire, and protection against an accidental burn by a plumber's torch.

The showerhead height is not typically regulated by building codes, but the head is commonly installed 70 to 80 inches above the shower floor.



Shower Water Pipes

Water-supply pipes from the shower valve to the showerhead outlet -- referred to as the shower riser pipes -- whether exposed or not, must be firmly attached to a structural component to prevent the pipes from leaking caused by stress fractures or joint failures. Movement of the showerhead may move the riser piping, possibly causing failure of the piping. The risers must be firmly secured in an approved manner.

The common practice for installing the riser pipe is to place a drop-ear elbow at the top of the riser pipe. The elbow has two wing connections. They can be screwed to a structural backing board, such as a 2x4. A pipe strap can be used instead of a drop-ear elbow. When the riser is exposed, the manufacturer will typically provide a strap or attachment device to match the finish of the fixture and pipe. The strap or attachment device should be firmly secured to a structural component.



Shower Outlets

The waste outlet for a shower should have minimum diameter of 1½ inches (38 mm). The shower outlet should have a strainer that is at least 3 inches (76 mm) in diameter, with dimensional openings in the strainer of at least a ¼-inch (6.4 mm). The strainer should be removable. In gang or multiple showers, the shower room floor should be sloped toward the respective shower drains to prevent wastewater from flowing from one shower floor area to another.

Shower Area

A shower compartment should have an interior cross-sectional area of at least 900 square inches (0.58 m^2). This will allow an average-sized adult to clean the lower body while bending over. A shower any smaller would be inadequately sized. Shower compartments should be at least 30 inches (762 mm) in minimum dimension. This measurement is based on the movement of an adult body inside a shower. This is measured from the finished interior dimension of the compartment, excluding fixture valves, showerheads, soap dishes and grab bars. There are exceptions for showers having fold-down seats, and those with compartments at least 25 inches wide and 1,300 square inches in cross-sectional area.

The exception allows for a shower with one dimension being 25 inches, provided the compartment has at least 1,300 square inches (0.838 m^2) of cross-sectional area. This is useful to contractors who remove an old bathtub and install a standup shower fixture in the same space.

Shower Walls

Showers and bathtubs with installed showerheads shall be finished with a non-absorbent surface that shall extend to a height of not less than 6 feet (1,829 mm) above the floor level of the room, or 70 inches (1,778 mm) above the floor. It should be constructed of smooth, corrosion-resistant and non-absorbent materials to protect the structural components from moisture damage. The gypsum or cement wallboard behind ceramic tiles of a shower wall should be water-resistant. The water-resistant material is not required in the rest of the bathroom, although it is a common practice to use water-resistant gypsum wallboard in other areas of the bathroom because of the moisture levels.

Shower Access and Egress Opening

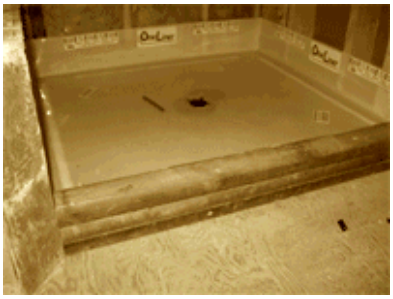
Many injuries in a dwelling are related to accidents in the bathtub or shower. The minimum opening requirements for access and egress allows an adult enough room to safely step into and exit the shower area without having to twist or turn through a narrow opening. The shower opening (or access and egress opening) should be at least 22 inches (559 mm) of clear and unobstructed finish-width. The 22-inch width is based on the approximate shoulder width of an average-sized adult. This minimum opening dimension also provides comfortable access to service the valves, showerheads and drain. It allows for emergency response and rescue access, and emergency egress.

Shower Floors and Pans

The shower floor surface must be watertight with smooth, corrosion-resistant, non-absorbent, waterproof materials. Joints between the floor and walls of the shower must be sealed or flashed to prevent water penetration. Ideally, there should be some type of slip-resistant floor surface. The shower floor structure needs proper support by a smooth and structurally sound base. The base of the shower floor should be designed for dead and live loads.

Shower floors that are built in place and not prefabricated require a shower pan under the shower's finished floor. The floor should be lined and made watertight, utilizing various materials, including sheet lead, sheet copper, polyethylene sheet, chlorinated polyethylene sheet or preformed ABS. The liner, such as a 40-mil PVC plastic sheet, should turn up on all sides at least 2 inches (51 mm) above the finished threshold level. The liner should not be nailed or perforated at any point below the flood-level rim of the shower compartment. Liners should have a slope of a ¼-inch per 12 inches (2% slope) towards the fixture drain.

The pan is designed to catch water that penetrates through the finished floor. The shower pan must securely connect to the shower drain outlet with a flashing flange or clamping device, and weep holes or seepage openings. This will allow the penetrating water to enter the drainage system. The flange or clamping device will make a watertight joint between the outlet and the waterproof membrane liner.



Shower Liners

A PVC sheet that is installed as a shower liner must be 0.040 inches (1.02 mm) thick, commonly referred to as 40 mil. It is a flexible plastic membrane that is fitted into a shower compartment on top of the subfloor to catch water penetration and prevent moisture damage.

CPE (chlorinated polyethylene) sheets are manufactured as one piece. They are impervious to water and resistant to permeation of water vapor. They should be a minimum 0.040 inches (1.02 mm) thick.

Sheet lead liners should not weigh less than 4 pounds per square foot (19.5 kg/m^2). They are coated with an asphalt paint or other approved coating. Sheet lead should be joined by burning or hot-mopping.

Sheet copper liners should not weigh less than 12 ounces per square foot (3.7 kg/m^2). The copper should be joined by brazing or soldering. Annealed copper sheets are typically used for pan liners.

Shower Glazing

Glass doors enclosing the shower should be made of safety glazing. If a window is installed in the shower, the window should be made of safety glazing to provide protection. If a person slips or falls inside the shower, s/he may be seriously injured by broken glass if the glass is not made of safety glazing. The safety glazing should be correctly labeled by being permanently marked in a corner, legible, and visible after installation, and indoor applications should be marked "indoor use only." For glass, the glazing for human-impact loads should meet CPSC 16-CFR, Part 1201 requirements. For plastic, the glazing should meet CPSC 16-CFR, Part 1201.4(c)(2)(ii) requirements. The glazing label for polished wire glass should meet ANSI Z97.1 requirements.

Glazing

Windows and doors within the area of a tub, shower and sauna require safety glazing. Those areas are specific hazardous locations because the occupant could break the glazing, causing serious injury. Glass wall partitions and windows that enclose tub and shower areas are also specific hazardous locations that should have safety glazing. A glass door enclosing a tub or shower area should be of safety glazing. An exterior window at an exterior wall must be of safety glazing unless the bottom exposed edge of the glass is 60 inches or more above the tub floor's surface.

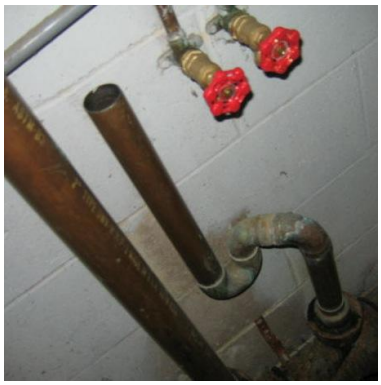
In some bathrooms, there is a sitting ledge or other horizontal surface around the tub with large glass windows. The ledge may not decrease the hazard potential; therefore, safety glazing is required. If the width of the ledge or surface surrounding the tub is widened significantly to become a walking surface, then safety glazing may have to be evaluated by other safety glazing standards. With regard to tubs and showers, safety glazing does not depend upon the size of the glass area. Safety glazing is important wherever the possibility exists of someone falling into or thrusting through glass around the tub or shower area.

Automatic Clothes Washer

An automatic clothes washer protects the potable water supply by having an air gap or backflow preventer installed. The waste from an automatic clothes washer must discharge its water through an air break into a standpipe or into a laundry tub. Without an air break, a blockage in the drain would allow the sewer to back up and enter the washer

Discharge

A washer typically discharges into an individually trapped standpipe or laundry sink/tub. The use of a laundry sink/tub is common. If a standpipe is used, the standpipe and its trap should be at least 2 inches in diameter. The clothes washer drain should connect to a fixture branch, horizontal branch, or drainage stack that should be at least 3 inches in diameter. If it is less than 3 inches, there might be a problem, because the discharge rate for a modern automatic clothes washer is 21 gallons per minute. Where a clothes washer discharges into a laundry sink/tub, there is no problem, because the size or holding capacity of the laundry sink/tub should hold the accumulated discharged water and allow drainage with a slow flow rate into the drainage pipe.



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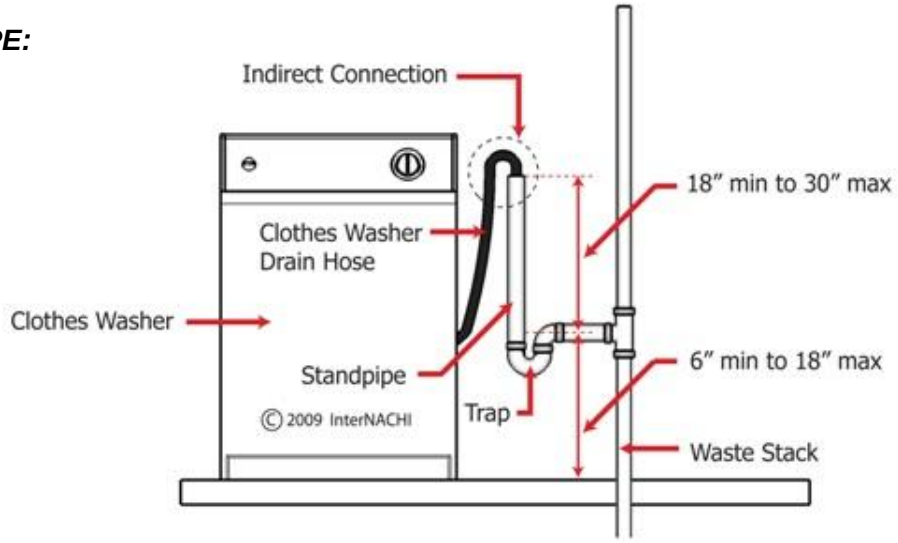


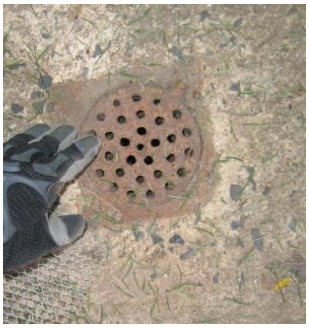
Laundry Tubs and Trays

A laundry tray is essentially a sink used in a laundry room of a dwelling. The material of the tray can be enameled cast-iron, stainless steel, non-vitreous ceramic, plastic or soapstone. Laundry trays made of concrete are not permitted because they do not provide a smooth, impervious, sanitary surface. The laundry tray is commonly used to receive the discharge of an automatic clothes washer.

The laundry tray should have a waste outlet with a minimum of 1½ inches (38 mm) in diameter, and a strainer or crossbar to restrict the clear opening of the waste outlet to catch debris and materials that could be discharged into the sink and cause drain clogging.

Floor and Trench Drains

Floor drains are typically installed as an emergency fixture to prevent flooding a room or space. They should be constructed of cast iron, ductile iron, bronze, aluminum alloy, copper alloy, ABS, PVC, PE, PP or stainless steel. Floor drains are usually installed at the discretion of the design professional in areas where standing water is common and may represent a hazard or cause damage to the dwelling. Such drains do not add to the load used to compute drainage pipe sizing because their sole purpose is to serve only in the event of an emergency.



Floor drains must be installed or constructed such that they can be properly cleaned so that the drain will continue to function properly. Floor drains should have a minimum 2-inch-diameter (50-mm) drain outlet. For central washing facilities of multiple-family dwellings, the room containing clothes washers should be provided with a floor drain with a minimum 3-inch-diameter (76-mm) outlet. Floor drain installations must be trapped. The actual floor drain body may have an integral trap. Floor drains should have strainers, and they should be removable. The strainer can be flush with the floor surface or may have a dome grate. The free area of the strainer or grate should not be less than the transverse area of the connecting pipe. Floor drains with funnels may extend above the floor surface about an inch, and these do not need a grate or strainer.

QUIZ on SECTION 4

1. There should be a space of at least _____ in front of the water closet, lavatory and bidet to any wall, fixture and door.

- 15 inches
- 1 foot
- 21 inches
- 18 inches

2. Closet bolts are often made of _____ because they resist corrosion.

- aluminum
- brass
- chromed galvanized steel

3. The waste from an automatic clothes washer must discharge its water through a/n _____ into a standpipe or into a laundry tub.

- trap seal
- air-admittance vent
- air break or air gap
- 1½-inch diameter discharge hose

4. If a standpipe for an automatic clothes washer is used, the standpipe and its trap should be at least ___ inches in diameter.

- 1
- 2
- 3

5. Plastic bathtubs are made with _____ in case of accidental exposure to a plumber's torch.

- fire-resistant chemicals
- metallic particles and shavings
- reinforced mesh

(continued)

6. An exterior window at an exterior wall must be made of safety glazing unless the bottom exposed edge of the glass is _____ above the tub floor's surface.

- 24 inches
- 60 inches or more
- two-thirds the width of the window

7. Laundry trays made of _____ are no longer permitted because they do not provide a smooth, impervious, sanitary surface.

- formed plastic
- concrete
- galvanized steel

8. The shower opening (or access and egress opening) should be at least _____ of clear and unobstructed finish-width.

- 36 inches (658 mm)
- 22 inches (559 mm)
- 18 inches (442 mm)

9. If a pump at a whirlpool bathtub is located more than 2 feet (609 mm) from the access opening, a minimum size opening of _____ should be installed.

- 22 inches by 22 inches
- 12 inches by 12 inches
- 18 inches by 18 inches
- 24 inches by 36 inches

10. _____ are best described as short lengths of pipe attached directly to a fixture by means of a flange for connection to other piping or traps.

- Trap arms
- Trap primers
- Standpipes
- Tailpieces

Answer Key is on next page.

Answer Key to Quiz on Section 4

1. There should be a space of at least 21 inches in front of the water closet, lavatory and bidet to any wall, fixture and door.

2. Closet bolts are often made of brass because they resist corrosion.

3. The waste from an automatic clothes washer must discharge its water through a/n air break or air gap into a standpipe or into a laundry tub.

4. If a standpipe for an automatic clothes washer is used, the standpipe and its trap should be at least 2 inches in diameter.

5. Plastic bathtubs are made with fire-resistant chemicals in case of accidental exposure to a plumber's torch.

6. An exterior window at an exterior wall must be made of safety glazing unless the bottom exposed edge of the glass is 60 inches or more above the tub floor surface.

7. Laundry trays made of concrete are no longer permitted because they do not provide a smooth, impervious, sanitary surface.

8. The shower opening (or access and egress opening) should be at least 22 inches (559 mm) of clear and unobstructed finish-width.

9. If a pump at a whirlpool bathtub is located more than 2 feet (609 mm) from the access opening, a minimum size opening of 18 inches by 18 inches should be installed.

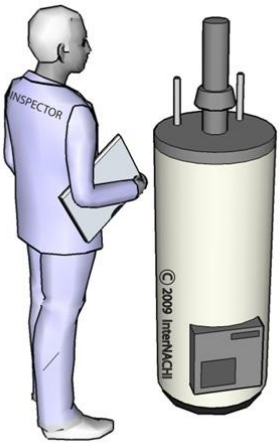
10. Tailpieces are best described as short lengths of pipe attached directly to a fixture by means of a flange for connection to other piping or traps.

SECTION 5: WATER HEATERS

General Comments

A water heater is any appliance that heats potable water and supplies heated water to the distribution system. Some water heaters can be used for space heating. Water heaters are potential explosion hazards if not properly installed. There are instances where hot water tanks with improperly installed safety devices have propelled through floor and roof structures and over 100 feet into the air. Because of the potential hazards, there are standards that regulate the materials, design and installation of water heaters and their related safety devices. Certification marks from approved agencies on water heaters are required to indicate compliance with approved standards.

Most tanks are insulated steel cylinders with an enamel coating on the inner surface. They are referred to as glass-lined tanks. The lining helps prevent corrosion. Conventional residential water heaters have life expectancies that vary greatly.



Water Heater as Space Heater

If a water heater has a dual purpose of supplying hot water and serving as a heat source for a hot water space heating system, the maximum outlet water temperature for the potable hot water system is limited to 140° F (60° C). A master thermostatic mixing valve should be installed to limit the water temperature to 140° F (60° C) or less. A water heater used as a part of a space heating system, such as for an under-floor radiant system, must be protected from any conditions that could cause contamination of the potable water system. If the water heater is part of the potable water system, materials used in the heating system must be approved for use in a potable water system. The water potability must be maintained throughout the system. Chemicals of any type must not be added to the heating system because this would directly contaminate the water supply.

Sacrificial Rods

Water circulating through a hot water circulation system becomes chemically inert and does not rust the piping. But water heaters have a constant supply of fresh water with lots of corrosion-causing oxygen. Because of this, water heaters are prone to corrosion. As a result, water heaters usually have an anti-corrosion rod or sacrificial rod installed. Sacrificial anodes are typically made of magnesium or aluminum. The rod is immersed inside the water heater tank, allowing the chemical reaction from the fresh water to attack it rather than the tank. In some areas, rods are replaced regularly.

Drain Valves

A water heater must have a drain valve installed for service, maintenance, sediment removal, repair and replacement. The valve inlet is a ¾-inch (19-mm) nominal pipe size. The outlet is a standard ¾-inch (19-mm) male hose thread and a straight-through waterway of at least a ½-inch (13 mm) in diameter.

Access

Water heaters should be accessible for routine inspections, maintenance, adjustment, repairs and replacements. Manufacturers usually make access recommendations. "Access" means to be able to reach the water heater by possibly first removing a panel, door or similar enclosure. "Accessible" does not include or imply the removal or destruction of finish materials, such as drywall, paneling or built-in cabinets. A walkway, work space or platform may be necessary to provide a safe path to travel to and work on a water heater.

Water Heater Labeling

All water heaters must be certified by an approved third-party agency, such as ANSI and UL (Underwriters Laboratories). The certification mark indicates that the heater has been tested and has been determined to perform safely when installed and operated properly, in accordance with the manufacturer's recommendations.

Tankless Water Heaters

Tankless (point-of-use) water heaters have become increasingly popular in recent years for heating potable water in residential homes in the U.S. There are several major factors in the trend of installing tankless water heaters. One is an increasing demand for continuous, unlimited streams of hot water for simultaneous operation of hot water-consuming appliances and fixtures. Another is a desire to save floor space and to conserve energy by reducing standby losses. There are many different models of fuel-gas and electric tankless water heaters, each having a specific rating. Tankless water heaters are rated at gallons per minute (gpm) and degrees of water temperature rise.

Tankless Temperature Control

Since tankless water heaters can discharge water at an uncertain range of temperatures at any given time, depending on the use, a temperature-control device is needed to protect the user from scalding water being discharged. A tempering valve can be adjusted to deliver water at a maximum temperature of 140° F (60° C), or the heater can be equipped with a temperature-limiting device or thermostat that has the maximum setting. When a tankless water heater supplies a shower or tub-shower combination, the maximum temperature of the outlet control valve of the shower or tub-shower must be set at 120° F (49° C).

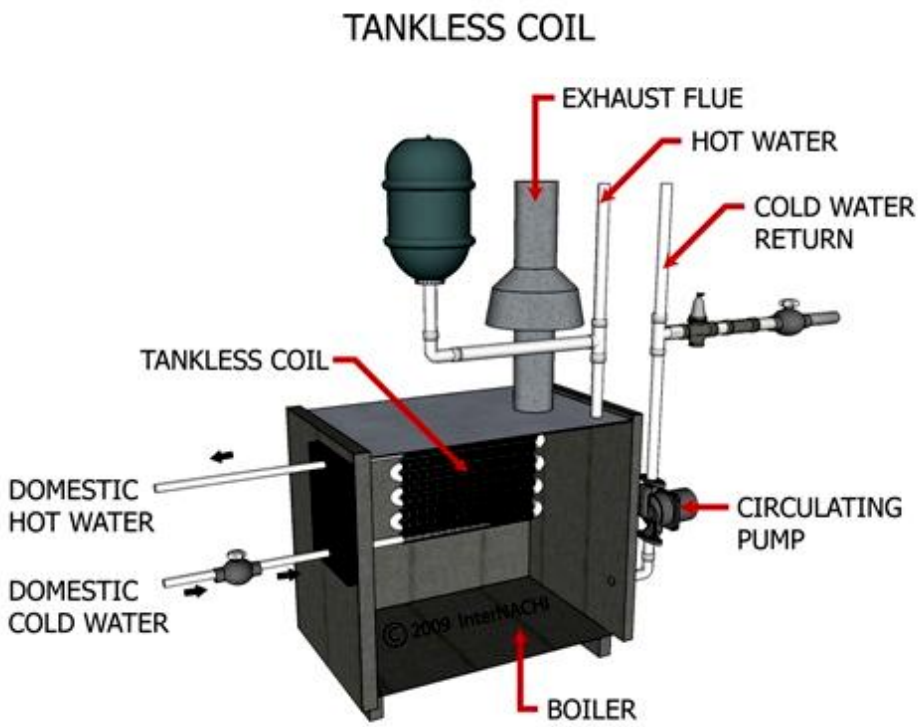
Tankless Size

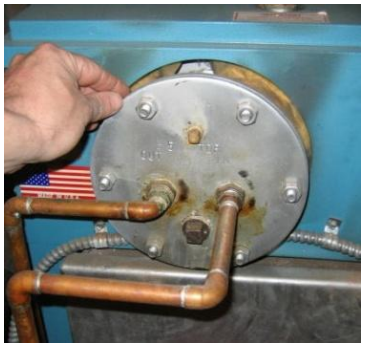
One challenge in sizing a tankless water heater is to determine the demand in gallons per minute. The second challenge is determining what temperature rise is required for that flow. Because tankless water heaters are designed to accommodate a given maximum flow, there is a pressure loss associated with flows in excess of a unit's usable flow rating.

In a house with a tankless water heater, it's possible to have a fixture with almost no flow of water if too many faucets are opened simultaneously. Occupants may have to adjust their expectations concerning when and to what extent simultaneous demands for hot water can be made before temperature and flow of hot water are affected.

Tankless Coils from Boilers

Tankless coils are indirect water heaters that take their heat from the steam or hot water boiler that is used to heat the house. A cold-water supply pipe extends into the hottest part of the boiler water. The water in the copper tube is kept hot by the boiler water. When there is demand for hot water, water flows through the tube through the hot boiler water, and water is delivered to the fixture.





Water Heater Tank Locations

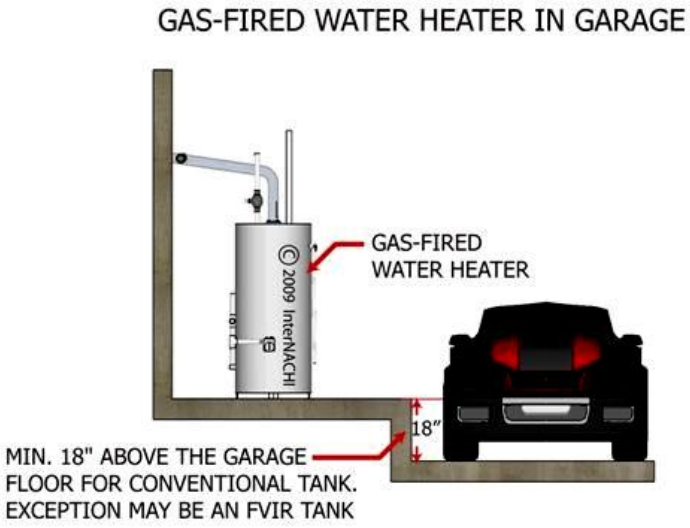
Installation of water heater tanks that use solid, liquid or gas fuel should not be permitted in a room containing air-handling machinery when such room is used as a plenum. If there's a malfunction of the water heater or its venting system, there is a potential for toxic combustion byproducts to spread throughout the dwelling. The air-handling system can also produce negative and positive air pressures, and affect the drafting or venting of the water heater. The negative pressure produced by a plenum could overcome the natural draft of the heater's venting system and pull flue gases into the room.

Located in Storage Closets, Bedrooms and Bathrooms

Fuel-fired water heaters should not be installed in a room used as a storage closet. Fuel-fired water heaters cannot obtain combustion air from sleeping rooms, bathrooms or toilet rooms. There are two exceptions: 1) a water heater located in a bedroom or bathroom could be installed in a sealed enclosure so that combustion air will not be taken from the living space, and a solid, weatherstripped door with a self-closing device should be provided; and 2) a water heater could be installed in a room that is not a confined space and the building is not of unusually tight construction.

Located in Garages

Gasoline leakage or spillage in a garage is a possible danger. Gasoline vapors will evaporate from liquid puddles at the floor level. Any potential ignition source should be elevated to keep open-flame, spark-producing elements and heating elements above the gasoline vapor level. A hot water tank with a source of ignition should be elevated not less than 18 inches (457 mm) above the floor of a garage. There is an exception for appliances that are listed as flammable vapor ignition-resistant.



Located in Attics

A suitable access opening, passageway and work space are required when a water heater is installed in an attic. The opening, passageway and work space should be large enough to accommodate the removal and replacement of a water heater. The passageway should not be less than 30 inches (762 mm) high or less than 22 inches (559 mm) wide. The access opening should be at least 20 inches by 30 inches (508 mm by 762 mm) to allow the removal of the water heater. It should not be longer than 20 feet when measured along the centerline of the passageway from the opening to the water heater. The passageway should have continuous, solid flooring not less than 24 inches (610 mm) wide. There should be a work space that is level, and at least 30 inches (762 mm) deep and 30 inches (762 mm) wide in front of the water heater.

Confined Space and Combustion Air

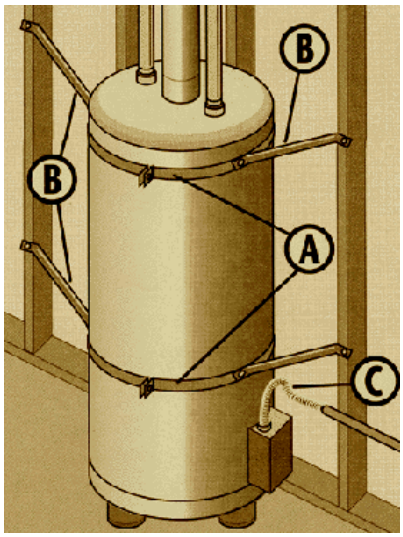
If the volume of space in which the appliance is located is not greater than 50 cubic feet per 1,000 BTU/h (4.83 L/W) of the aggregate input-rating of the appliance, then it is considered a confined space. Two permanent openings to adjacent spaces could be provided so that the combined volume of all spaces meets the criterion. If the building is sealed so tightly that infiltration air is not adequate for combustion, combustion air could be obtained from outdoors.

If all combustion air is taken from the inside of the dwelling, then two permanent openings should be installed. One opening should be within 12 inches (305 mm) of the top, and the other within 12 inches (305 mm) of the bottom of the space. Each opening shall have a free area equal to a minimum of 1 square inch per 1,000 BTU/h (2,201 mm^2/kW) input-rating of all appliances installed within the space, but not less than 100 square inches (64,415 mm^2).

If all combustion air is taken from the outdoor air, then one opening should be within 12 inches (305 mm) of the top, and the other within 12 inches (305 mm) of the bottom of the space. The openings are permitted to connect to spaces directly communicating with the outdoor air, such as a ventilated crawlspace or ventilated attic space. Each opening should have a free area of at least 1 square inch per 4,000 BTU/per hour (550 mm^2/kW) of total input rating of all appliances in the space when using vertical ducts (2,000 BTU/per hour if using horizontal ducts).

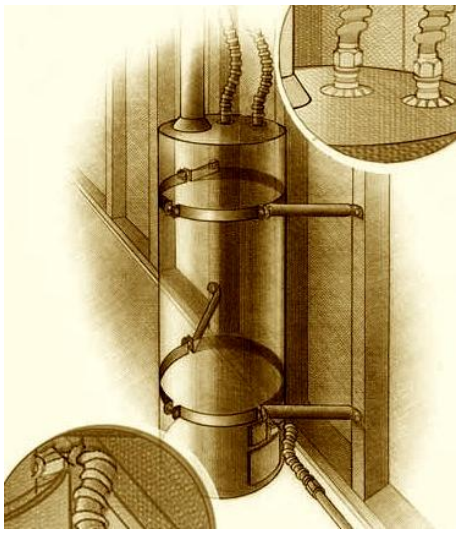
Seismic Supports for Tanks

In those areas determined to have a high earthquake risk, it is important that a water heater be fastened in place to avoid damage. Strapping should be done at points within the top and bottom thirds of the tank's vertical dimensions. At the lower point, the strapping should maintain a minimum distance of 4 inches (102 mm) above the controls. Water heater supports and piping supports should be designed to resist seismic loads. Failure of water heater supports has been shown to be a threat to health and safety. In addition to strapping, approved flexible connectors should be used. (See A, B and C in diagram.)



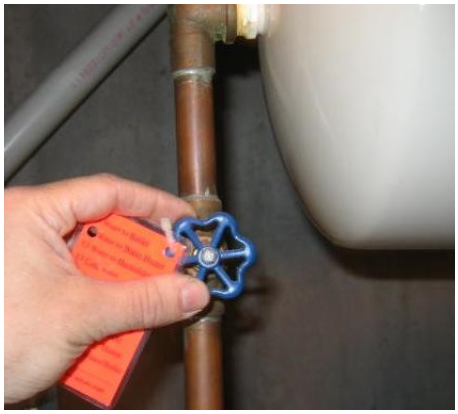
At left: Points for secured seismic support straps for water heater tank can be seen at A and B; flexible conduit is seen at C.

At right: A cutaway shows the support straps and conduit.



Water Valves for Tanks

A valve should be installed on the cold-water branch line from the main water supply line to each hot water storage tank or water heater. The valve should be conspicuously located and near the water heater, accessible from the same floor level as the water heater that it serves. The valve is to be installed so that if the heater is taken out of service, the other areas of the water distribution system are not disrupted.

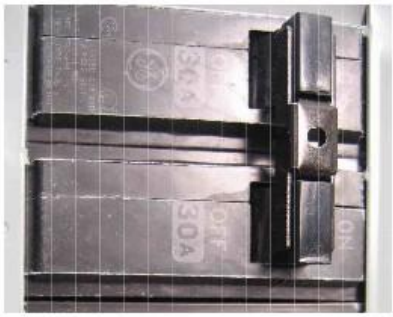


Dip Tube Hole Inside Tanks

A typical design of a water heater tank includes a cold-water "dip" tube. The tube directs the cold water to the bottom of the tank. At the top of the tank, a hole is installed in the dip tube to prevent water from being siphoned from the tank through the tube. The hole is required to be located within 6 inches of the top of the tank. A vacuum relief valve may be installed in lieu of an anti-siphoning hole in the dip tube.

Fuel Shut-Off Valves or Electric Disconnect

A fuel shut-off valve is required for all fuel-fired water heaters. An electric disconnect should be installed for all electric water heaters. They are necessary for service, repair and emergency shut-down.



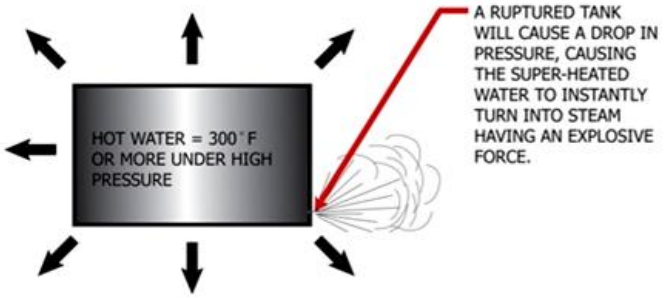
TPR Valves

Temperature and pressure-relief (TPR) valves should be installed on all storage water heaters operating above atmospheric pressure. Tankless water heaters must have TPR valves installed. Water heaters without this protection can produce explosions. They have been responsible for many deaths. A pressure-relief valve relieves excessive pressure that may develop in a closed storage tank. A temperature-relief valve responds to excessive temperatures and discharges scalding water from the storage tank.

A TPR valve should be installed in the shell of a water heater tank. It should be located in the top 6 inches of the tank. Typically, water heater tanks have an opening in the tank shell installed by the manufacturer. The TPR valve is located at the top of the tank, which contains the hottest water in the tank.

The valve must be set to open at the maximum working pressure of the water heater, or 150 pounds per square inch or psi (1,035 kPa), whichever is less. An undersized valve would not be able to prevent pressure from exceeding the maximum capacity, and a dangerous situation could result. The consequences could include an explosive tank rupture accompanied by an instantaneous release of enormous thermal energy, which is stored in super-heated water inside the tank. It could propel a water heater like a rocket through multiple stories, including the roof of a dwelling.

A boiler should be equipped with a pressure-relief valve with a minimum rated capacity for the equipment served. A boiler operates at a maximum water pressure of 160 psig, and at a maximum water temperature of 250° F (121° C).



A pressure-relief valve should be set at the maximum rating of the boiler. Discharge should be piped to drains by gravity to within 18 inches (457 mm) of the floor or to an open receptor.

Relief valves must be third-party tested. The certification mark is the indicator that the valve has been tested. Temperature-relief valves must be set to discharge at a temperature not higher than 210° F (99° C). The valve is designed to dissipate energy at a rate equal to or greater than the energy/heat input rate of the water heater. A relief valve opens in proportion to the temperature and pressure forced upon its closure disk. The higher the temperature or pressure, the greater the force, and the more the valve opens.

Discharge Pipe on TPR Valve

The following are 13 requirements for a discharge pipe serving a TPR valve:

1. the pipe should not be directly connected to the drainage system;
2. the pipe should discharge through an air gap located in the same room as the water heater;
3. the pipe should be constructed of materials tested, rated and approved for such use;
4. the pipe should not be smaller than the diameter of the outlet of the valve served, and should discharge full size to the air gap;
5. the pipe should not have valves or tee fittings installed;
6. the pipe should not have a threaded end;
7. the pipe should serve a single relief device, and should not connect to piping serving any other relief device or equipment;
8. the pipe should discharge to the floor, to an indirect waste receptor, or to the outdoors. Where discharging to the outdoors in areas subject to freezing, discharge piping should be first piped to an indirect waste receptor through an air gap located in a conditioned space;

9. the pipe should not terminate more than 6 inches (152 mm) above the floor or waste receptor;

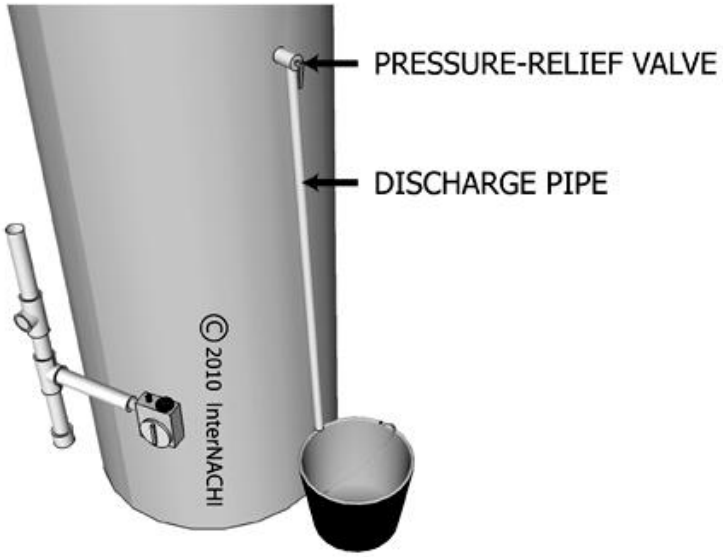
10. the pipe should discharge in a manner that does not cause personal injury or structural damage;

11. the pipe should be installed so as to flow by gravity;

12. the pipe should discharge to a termination point that is readily observable by the building occupants; and

13. the pipe should not be trapped.

DISCHARGE PIPE ON TPR VALVE



The termination of a relief valve discharge pipe should always be visible and conspicuous. An air gap is necessary to prevent backflow and contamination of the potable water system. The discharge pipe must not be reduced in size, and must not be less than the size of the relief valve outlet. A reduction in size will act as a restriction and would impede the flow rate of the discharge. Relief valves must not be exposed to freezing temperatures. The slow drip of a leaking valve in freezing temperatures could cause ice to form and restrict the discharge, and eventually disable the valve.

The discharge pipe should have a minimum pressure rating of 100 psi (690 kPa) at 180° F (82° C). Water heater temperature-relief valves are usually set to open and discharge at 210° F (99° C).

Expansion Tank on Boiler

Hot water boilers should be provided with expansion tanks. There are two types of expansion tanks designated for use with a residential boiler system. A non-pressurized tank is simply a cylinder filled with air set at atmosphere pressure. A pressurized tank is a sealed cylinder divided by a flexible diaphragm. An expansion tank provides space for the water to expand as it is heated, and it keeps the water pressure within the normal operating range while the boiler is working.

Water Leak Catch Pan

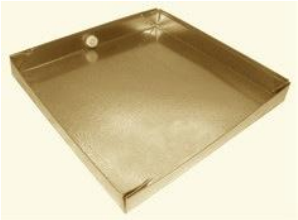
A water heater tank should be installed inside a pan in locations in a dwelling where a leak from the tank could cause damage to the structure or property. The pan is intended to catch water leaks from the tank or associated connections, or condensate from the tank. The pan should be made of galvanized steel or other material approved for that use. Pre-fabricated aluminum and plastic pans are common and widely used. Aluminum and plastic pans may not be allowed by every authority having jurisdiction (AHJ) or code official because they are not made of galvanized steel, and some tank manufacturers require the use of a metal pan only.

A relief-valve pipe terminating into a water leak catch pan is not permitted because the pan is not an indirect waste receptor. Most pans have only a ¾-inch-diameter (19-mm) drain outlet, which is not capable of using gravity to drain the pressurized discharge of the relief valve at full flow.

The pan should not be less than 1½ inches (38 mm) deep. The pan should be of sufficient size and shape to catch all dripping water or condensate leaks. The pan should be drained by an indirect waste pipe having a minimum diameter of ¾-inch (19 mm). The pan drain must not be reduced in size over its entire length because a reduction will act as a restriction and will impede the discharge.

The pan must not connect directly to the drainage system. The pan should terminate over a suitably located indirect waste receptor or floor drain, or extend to the exterior. An air gap must be provided to prevent backflow when the pan drain terminates into an indirect waste receptor or a floor drain.

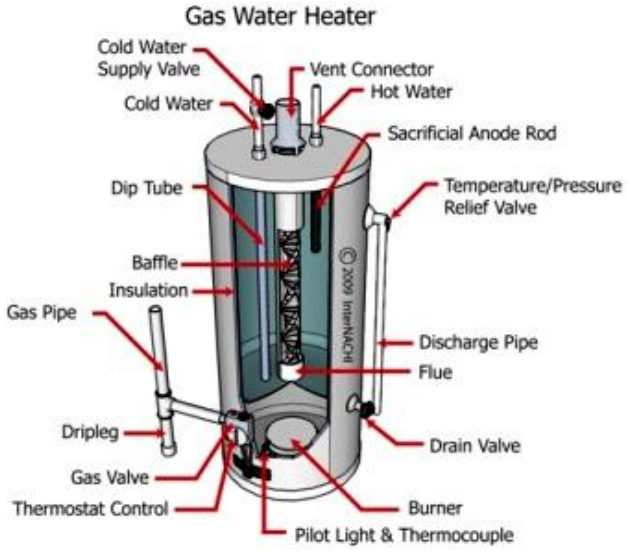
When the pan terminates to the exterior of the dwelling, it should terminate at least 6 inches (152 mm), and, at most, 24 inches (610 mm), above the adjacent ground surface. This makes the pan low enough not to be a nuisance, and high enough to prevent the pan drain from becoming blocked by vegetation, snow or ice.

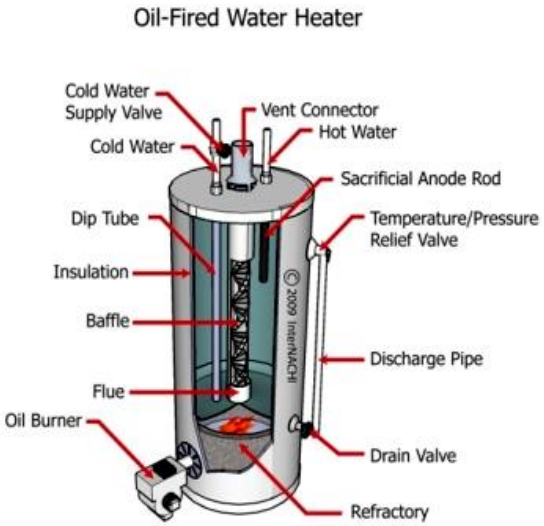


Hot Water Tank Defects

Check for physical damage to the tank, particularly rust and corrosion on the bottom of the tank. Check for water marks on the floor of the tank. Check for a leaking TPR valve. The covers at the electric heating elements should not be disturbed. Corrosion can be found where the water pipes are connected to the top of the tank. The electricity or the fuel may be shut off. There could be scorching at the burner cover area. The heat rollout shield should be in place. Confirm that the drip tube is installed. The draft hood and vent connector are often loosely attached. All tanks should be accessible with at least 24 inches (609 mm) of working space around them. Check the burner and flame. A damaged baffle (turbulator) could fall down on the burner.

Tankless coils inside boilers can leak. The coil can damage the boiler. The coil is prone to clogging. There should be a temperature-control valve installed to control the scalding water coming from the coil in the boiler.





QUIZ on SECTION 5

1. Fuel-fired water heaters cannot obtain combustion air from _____.

- an open window
- sleeping rooms, bathrooms or toilet rooms
- air-to-air changing devices
- automatic damper controls

2. A suitable access opening, passageway and work space is required when a water heater is installed in _____.

- a sleeping room
- a bathroom
- a toilet room
- an attic

3. If the volume of space in which the appliance is located is not greater than 50 cubic feet per 1,000 BTU/h (4.83 L/W) of aggregate input rating of the appliance, then it is designated as a _____ space.

- confined
- 50 / 1000 BTU
- unusually tight construction
- combustion-air dependent

4. T/F: Fuel shut-off valves are required for all electric water heaters, and electric disconnects are required for all fuel-fired water heaters.

- True
- False

5. _____ must be set to discharge at a temperature not higher than 210° F (99° C).

- Temperature-isolation valves
- Fuel-gas valves
- Backflow pressure valves
- Temperature pressure-relief (TPR) valves

(continued)

6. The TPR discharge pipe should discharge through _____ located in the same room as the water heater.

- a Schrader valve
- a sump pump system
- a sewer drain pipe
- an air gap

7. A relief-valve pipe terminating into a water leak catch pan is not permitted because the pan is not _____.

- an indirect waste receptor
- shallow enough
- designed for hot temperatures
- intended to catch leaking water from a fixture

Answer Key to Quiz on Section 5

1. Fuel-fired water heaters cannot obtain combustion air from sleeping rooms, bathrooms or toilet rooms.
2. A suitable access opening, passageway and work space is required when a water heater is installed in an attic.
3. If the volume of space in which the appliance is located is not greater than 50 cubic feet per 1,000 BTU/h (4.83 L/W) of aggregate input rating of the appliance, then it is designated as a confined space.
4. T/F: Fuel shut-off valves are required for all electric water heaters, and electric disconnects are required for all fuel-fired water heaters. *Answer:* False
5. Temperature pressure-relief (TPR) valves must be set to discharge at a temperature not higher than 210° F (99° C).
6. The TPR discharge pipe should discharge through an air gap located in the same room as the water heater.
7. A relief-valve pipe terminating into a water leak catch pan is not permitted because the pan is not an indirect waste receptor.

SECTION 6: POTABLE WATER

General Comments

Potable water is a precious commodity. The U.S. Environmental Protection Agency's (EPA) Office of Drinking Water controls the quality requirements for water to be classified as potable. Requirements in relation to levels of contaminants allowed in potable water are becoming increasingly restrictive. Manufacturers of plumbing equipment carefully select the materials that are exposed to potable water. All materials are tested for their potential effects on potable water. There are standards and requirements for the delivery of potable water from the source to the point of use that apply to both public water sources and private water supplies, including wells, springs, streams and cisterns.

Potable water should be provided to every dwelling that is intended for human occupation or habitation. Potable water should be supplied to all plumbing fixtures unless non-potable water, otherwise known as gray water, is used for other purposes, such as irrigation and flushing water closets and urinals. The use of non-potable water supplies may become increasingly pervasive as a means to conserve water resources. Today, non-potable water is typically used in factory and industrial buildings.

Wells

Inspection of private water sources, such as a well, is beyond the scope of a home inspection.

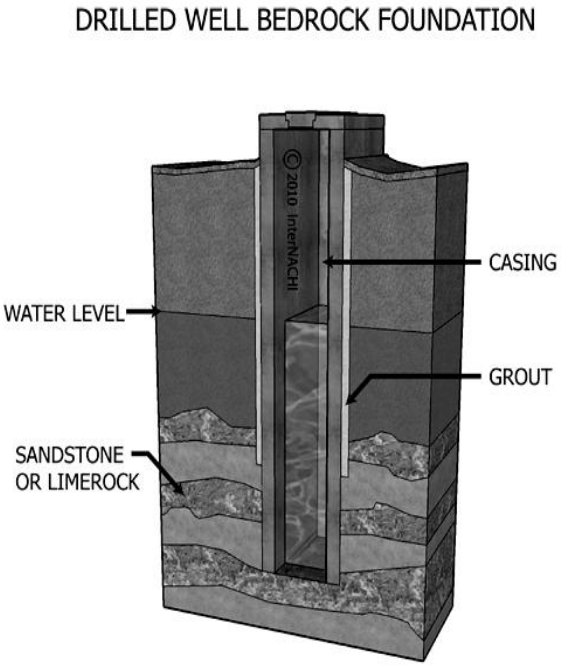
A private water source must provide water that is potable. Wells are the most common source of individual water supplies today. A well pump must be accessible for service, repair and replacement without requiring the removal or movement of any panel, door or obstruction, and without the use of a portable ladder. When a pump and its components are in direct contact with the potable water, they must be rated for use in potable water systems, or the pump must be located so as to prevent contamination of the well. When located in a basement, the pump should be elevated. Pumps outside a dwelling must be protected from freezing.

A well must be separated from sources of contamination, such as a sewer drainage field and tank, to reduce the possibility of affecting the potability of the water supply. The ground surface around the well area should be sloped and drained positively away. Surface water should be directed away from the well, since one of the greatest threats to a well is the risk of contamination from surface drainage. The depth of the well should be at least 10 feet deep. High water tables and shallow wells are susceptible to contamination.

Well Casings

Casings should be watertight to at least 10 feet below the ground surface. When a well is drilled and the casing is inserted, the space between the outside of the casing and the earth is typically filled with slurry to prevent surface water from running down the well casing and contaminating the water supply.

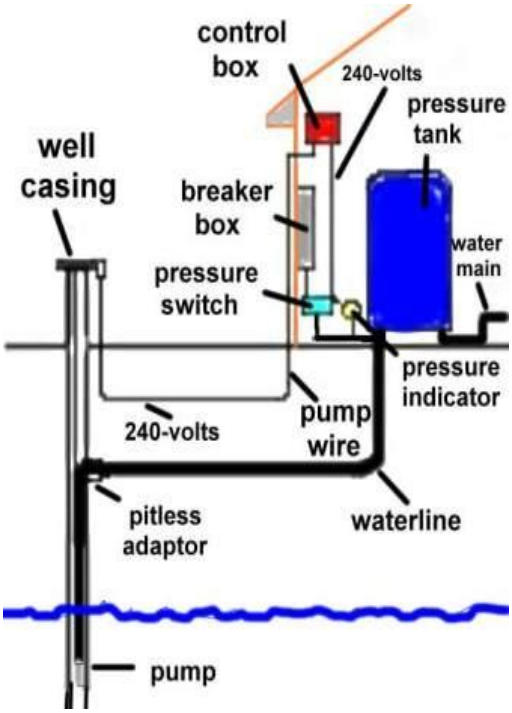
The casing should extend above the ground surface 6 to 12 inches (152 to 304 mm). The well casing cover should be overlapping and watertight. Covers should extend downward at least 2 inches (51 mm) over the outside of the well casing.



Well Pumps

There are deep wells (more than 25 feet deep) and shallow wells (25 feet or less). A typical well pump can pull up about 25 feet of water. If the well is deeper than 25 feet, the pump will have to be installed at the bottom of the well to push the water up. Pumps are better at pushing than pulling.

The most powerful pump is a submersible pump that is installed in a deep well, and it won't always be visible. A single-line jet pump indicates a shallow well. A two-line jet pump indicates a deep well where the pump is visible.



Well Pressure Tanks

A well pressure tank functions to deliver water at a relatively consistent pressure to the dwelling fixtures. A pressure tank can be a simple cylindrical tank filled with air or a tank with a bladder or diaphragm inside. Pressure tanks can be as small as 5 gallons or as large as 80 gallons. These tanks usually sweat condensate; therefore, insulating a tank's lower half is recommended.

There should be a pressure gauge installed at the tank. A pressure switch that operates the pump should be installed. The main water shut-off valve should be nearby. An air valve of some type is usually installed on the tank’s top.

There should be a 20-psi differential minimum between the cut-in and cut-out points. Submersible pumps are typically set at 40 and 60 psi.

Well System Defects

Inadequate water supply is a defect for a well system. Wells can be tested with draw-down, capacity, flow-rate and recovery tests. Water quality of a private water source should be tested every year for bacteria such as coliform. Contamination of the water supply is a health hazard and a defect. There could be poor surface grading around the well head. The casing could be too short. The cover could be damaged or not watertight. The pump may not be working properly. If the pump is visible, observe and listen to the pump while it is operating.

Check the pump system with a voltage-meter detector before touching it. Inspect all components. The electrical wiring at the pump may be damaged, loose or incorrectly installed. Check for over-fusing. Check for incorrect type of wire or incorrect wire size. Check grounding. The tank may be rusted, leaking, producing excessive condensate, water-logged, or unstable.

Potable Water Contamination

The potable water supply should be protected from contamination from non-potable liquids, solids and gases introduced into the potable water supply through cross-connections and any other piping connections to the system. Backflow preventers should be installed accordingly.

Throughout history, there have been numerous occurrences of sickness and disease caused by an unprotected water supply. It is important at all times to maintain a safe-for-drinking quality of the potable water supply at all actual and potential connections and outlets. Understanding how backflow can occur and how to prevent it are necessary for protecting the water supply.

Backflow

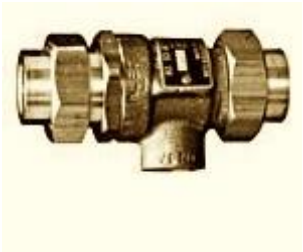
Backflow is the reverse flow of the intended direction of the flow of potable water distribution piping. There are two conditions that cause backflow: back-siphonage and back-pressure. Back-siphonage is the backflow of water caused by system pressure falling below atmospheric pressure. Back-pressure is pressure created in a non-potable system in excess of the water supply mains causing backflow.

All water supply lines and fittings for every plumbing fixture should be installed in way that prevents backflow. All potable water outlets and openings should be protected against backflow, including faucets, hose bibs, plumbing fixtures and plumbing appliances. All appliances, water filters, tanks, softeners, treatment systems, and other devices that connect to the water supply system should be protected against backflow and contamination of the water system. Backflow preventers should be readily accessible.

Backflow can be prevented by one of four ways:

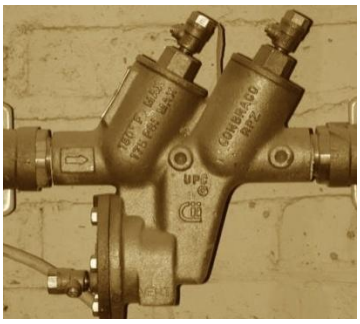
1) an air gap:

2) a backflow preventer with an intermediate atmospheric vent;



3) a vacuum breaker; or

4) a reduced pressure-principle backflow preventer.



A boiler should be protected from backflow. Because boilers are pressurized, backflow can be caused by back-pressure. If the pressure of the potable water supply drops below the boiler pressure, backflow can occur.

Automatic fire sprinkler systems connected to the potable water supply need to protect the water supply from backflow by a double check-valve.

The potable water supply to a lawn irrigation system should be protected against backflow.

Cross-connections between a private water source (including a well, spring or surface source) and a public potable water source are not permitted. In a dwelling where more than one water supply system is installed, each system should be identified by color marking or metal tags, including the contents of the piping system, with arrows indicating the direction of flow.

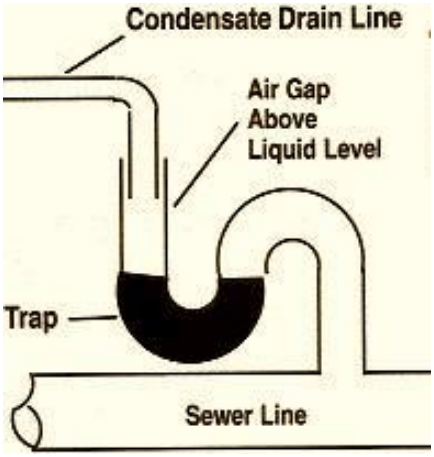
Air Gaps

An air gap is not a device and has no moving parts. An air gap is the most effective and dependable method of preventing backflow. The potable water opening or outlet is terminated at an elevation above the level of the source of contamination.

The minimum air gap should be measured from the lowest end of a water supply outlet to the flood-level rim of the fixture into which such potable water outlet discharges. The minimum air gap should be twice the diameter of the effective opening of the outlet.

Condensate Drain Connections

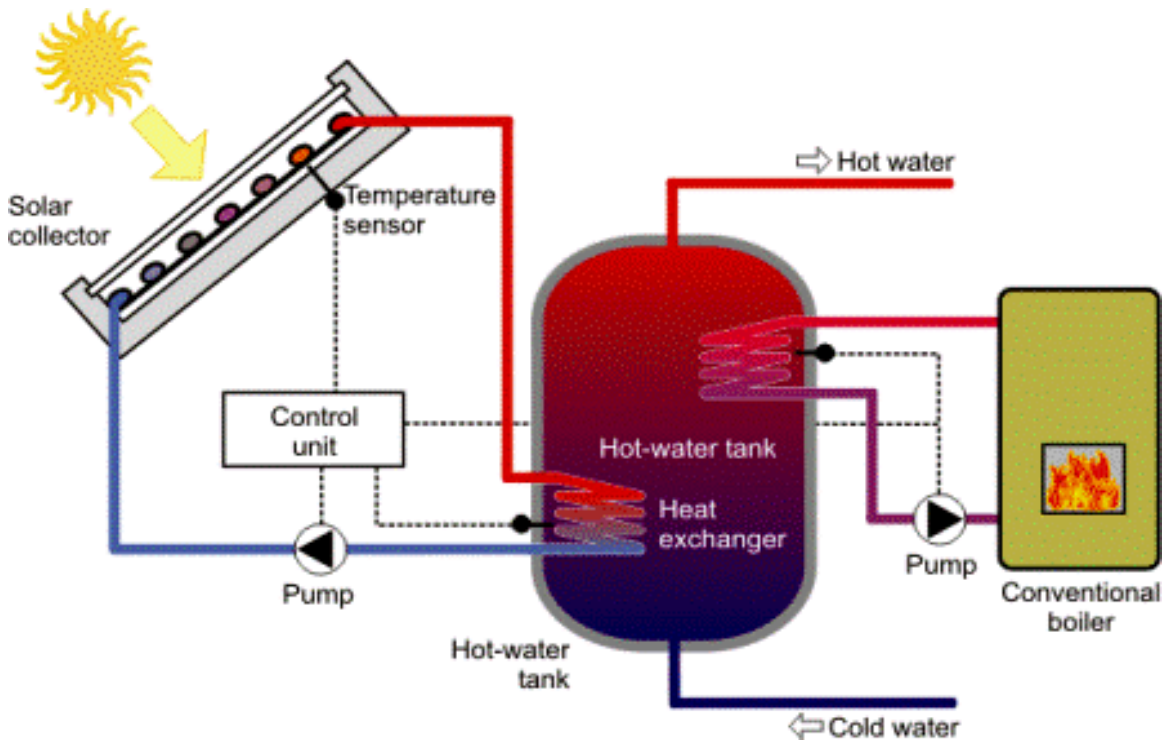
Condensate drains from air conditioner coils, condensing furnaces, and heat-recovery ventilators should not drain directly into a DWV pipe. An indirect drain using an air gap should be installed. In some locations, the direct connection of a condensate drain line into a stack is not permitted, even with a trap. The potential danger is that sewer gases may enter the house through the condensate drain line. It is not a cross-connection problem, but it is unsafe and unhealthy.



Solar Energy

The use of solar energy should not compromise the requirements regarding cross-contamination or the protection of the quality of the potable water supply. There are two basic types of solar heating systems: direct and indirect.

In a direct-connection system, the heat-transfer fluid is potable water, so the system has potential safety problems that must be addressed with regard to design, inspection and maintenance. Direct-connection systems are typically limited to solar water-heating systems where the potable water is directly heated by the solar collectors and circulated through the water supply system.



In an indirect-connection system, a freeze-protected, heat-transfer fluid is circulated through a closed loop to a heat exchanger. The heat is then transferred indirectly to the potable water supply of the dwelling.

System components containing fluids should be protected with pressure and temperature-relief valves. Expansion tanks in solar energy systems should be installed in closed fluid loops that contain heat-transfer fluid.

Solar energy collectors, controls, dampers, fans, blowers and pumps should be accessible for inspection, maintenance, repair and replacement. Where mounted on or above the roof coverings, the collectors and supporting structure should be constructed of non-combustible materials or fire retardant-treated wood equivalent to that required for the roof construction.

Water Service Pipe

The water service pipe moves the water from the source to the dwelling. It is typically underground. In areas having a winter-design temperature of 32° F (0° C) or lower, a water pipe should not be installed outside of a building, in exterior walls, in attics, in crawlspaces, or in any other place subjected to freezing temperatures unless adequately protected from freezing by insulation or heat, or both.

Water service pipe installed outside or underground must be at least 12 inches below grade or 6 inches below the frost-line depth, whichever is greater. This minimum coverage protects the pipe against freezing, as well as from exterior damage.

The minimum diameter of the water service pipe is ¾-inch (19.1 mm), based on the nominal pipe size of the material. Hence, a ¾-inch cross-linked polyethylene (PEX) plastic pipe has a different inside diameter than a ¾-inch galvanized steel pipe. There are 19 different types of piping materials that can be used as a water service pipe.

With few exceptions, the water service pipe and the dwelling's sewer pipe should be separated by 5 feet of undisturbed or compacted earth. The separation is intended to reduce the possibility of the sewer contaminating the potable water supply. Contamination can occur when there's a leak in the building's sewer located near the water service pipe. The soil around it can become contaminated. If the water service pipe has a break in it, then contamination could occur. The water service pipe should not be located in, under or above cesspools, septic tanks, septic drainage fields or seepage pits.

Pipe Material for Water Service Pipe

An inspector may discover all types of pipe material for water service pipe, including copper, galvanized steel, lead, PVC plastic, CPV plastic, polyethylene (PE) plastic, polybutylene plastic, cast iron, asbestos cement, and brass. Copper is the most common water service pipe material, and has been used since the 1930s. Galvanized steel was common until the 1950s; the pipes rust inside and out. Lead has not been used for water service piping since around 1950; lead contaminates potability. PVC water service pipe is typically blue or white, and has been used since the 1960s.

PE Plastic Pipe and Tubing

Polyethylene is an inert polyolefin material. It is resistant to chemical reaction, making joining using solvent cement not possible. PE pipe for use as water service pipe is blue or black. Orange PE pipe is used for gas installations. PE cannot be used for hot water distribution systems.

PVC Plastic Pipe

PVC water service pipe is different than PVC drainage pipe, although both are white.

Water Distribution Pipe Material

Not all water service pipe material can be used for water distribution. For example, PVC pipe is not usable for water distribution because it cannot tolerate hot water temperatures. Therefore, water service piping materials that are not certified for water distribution should terminate at or before the full-open valve located at the entrance to the dwelling. CPVC and PEX are permitted for both water service and water distribution and, therefore, a termination and a change in pipe material would not be required.

Copper or Copper-Alloy Tubing

Copper tubing is available in Type K, L and M, which indicate wall thickness. Type K is the thickest and typically used for underground water service. Type M is the thinnest and most commonly used in water distribution systems. Type L is high-quality. Types of copper tubing are identified with color markings on the tubing: Type K is green; Type L is blue; and Type M is red. Copper pipe is soldered, but flare connections and compression fittings can also be used.

Some plumbers prefer not to use compression fittings because they sometimes leak at the connection.

Inspectors should closely inspect these under-sink connections, since movement of piping is very likely. Recommend to clients that they periodically monitor these connections for leaks.

Above: a compression-fitting isolation valve, 15mm pipe diameter, screwdriver-turn

CPVC Plastic Pipe

CPVC is chlorinated polyvinyl chloride. It is typically ivory-colored and it is suitable for both hot and cold water systems. It has been used since the 1960s. CPVC is solvent-welded.

Galvanized Steel Pipe

A wide variety of pipe is classified as galvanized steel pipe. It is available in different wall thicknesses: Schedule 40, 80 and 160. Galvanized steel pipe is sometimes called "wrought-iron pipe," but wrought-iron pipe has not been manufactured in the U.S. since the 1950s. Galvanized steel pipe rusts through from the inside.

PB Plastic Pipe and Tubing

PB pipe has been the subject of much attention because of the manufacturer's settlement of a multimillion dollar lawsuit. They have never admitted that it's defective, but they have agreed to fund the class-action settlement. It has been assumed that oxidants in public water supply systems, such as chlorine, react with the polybutylene piping and fittings. This reaction causes them to scale, flake and become brittle. Micro-fractures are created as a result, and the structural integrity of the pipe is compromised. If the pipe system becomes weak, it may fail without warning and cause major damage to the building and personal property.

PB pipe will no longer be manufactured and will no longer be available once current supplies run out. Polybutylene pipe can often be identified by its gray color. However, it was also made in white, blue, black and ivory. One of the easiest ways to identify this pipe is to locate the "PB" lettering on the printed label. PB pipe is typically blue or gray. Blue usually indicates that the pipe is intended for underground water-main service use only. Gray indicates that the pipe can be used for water-main service and for interior water distribution inside the house. Home inspectors should not rely only on the color to identify the material.

The designation "PB 2110" indicates the quality of the material. The material must be of Type 2, Category 1 polybutylene, which is identified as PB 21. "Type 2" indicates density, and "Category 1" indicates extrusion flow rate. The last two digits ("10") indicate the hydrostatic design stress of 1,000 psi (6,895 kPa).

Cross-Linked PEX Plastic Tubing

PEX is polyethylene cross-linked plastic tubing. The cross-linked structure prevents the pipe from rupturing over a wide range of temperatures and pressures. PEX is resistant to solvents and cannot be joined by solvent cementing. PEX is flexible and can be bent. PEX can be hot-bent with a hot-air gun. The minimum hot-bending radius is 2½ times the outside diameter. PEX can be cold-bent, too (at room temperature) to a minimum radius of six times the outside diameter.

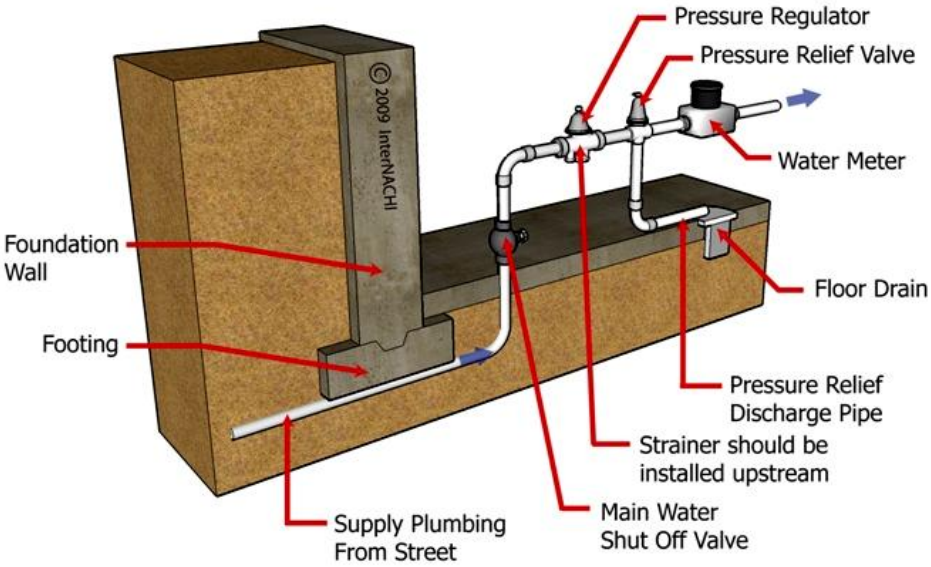
Water Pressure Regulator

The minimum static pressure at the dwelling entrance for either public or private water service (as determined by the local water authority) should be 40 psi (276 kPa). The maximum static pressure should be 80 psi (552 kPa).

When the pressure from the public water main or private well exceeds 80 psi, a pressure-reducing valve or regulator should be installed at the point where the water service pipe enters the dwelling. The pressure regulator should be installed immediately downstream of the main shut-off valve. To allow a continuous flow of water to the dwelling, the water pressure-reducing valve is designed to remain in an open position if the component fails.

All water pressure-reducing valves should be designed to allow repair and removal of parts without requiring the removal of the valve from the water supply pipe, or breaking the pipeline. The strainer for the valve must also be available for inspection and periodic maintenance without removing the valve or breaking the pipeline.

Pressure Regulator



Water Pressure, Friction and Other Performance Factors

The amount of water supply at a fixture depends on a few factors, including:

- pipe size;
- pipe friction;
- changes in direction of the pipe;
- pressure; and
- elevation.

Pressure is one of the key variables in a water supply system. Pressure should be adequate to overcome pressure losses that occur in the system from friction and elevation. All of the plumbing fixtures should operate properly with adequate pressure.

Pipe friction can cause pressure loss. Pressure loss is made when water particles rub against the inside of the water pipe (friction), or when there are changes in the direction of the water flow (friction). The amount of pressure loss caused by friction is affected by:

- the velocity of the water;
- the roughness of the water;
- the developed length of the pipe; and
- the diameter of the pipe.

As the pipe diameter increases, the effects of friction decrease. The bigger the pipe, the better. As velocity, roughness and pipe length increase, the effects of friction increase. Fittings can cause a greater loss of pressure than the pipe itself.

Friction caused by equipment, such as backflow preventers, check valves, water meters, strainers, filters, tankless water heaters and softeners, can also cause pressure loss.

Velocity

With an increase in velocity comes an increase in friction, and the abrasive and erosive effects of water are subsequently increased. The water supply system's velocity must be high enough to minimize the potential for suspended materials from depositing, as well as to avoid the destructive effects of erosion-corrosion, cavitation and pressure surges. The maximum velocity in the water supply pipe should be 8 feet per second (2.4 m/s).

Roughness

A scale or buildup on the inner walls of the water supply pipe can form when the supplied water contains dissolved mineral salts, such as sulfates, bicarbonates, chlorides of calcium, sodium and magnesium. Caking can affect the capacity of a pipe over time. Because higher temperatures of water increase the solubility of minerals, caking occurs more rapidly in hot water distribution pipes. Different levels of pH can accelerate the effects of caking and corrosion.

Changes in Direction

Pressure loss also happens when the direction of water flow changes. Cavitation is caused by sharp changes in the direction of the water flow at high velocities. In a change of direction, vapor bubbles form (boiling occurs) and then collapse (or condense). The noise of popping sounds is produced inside the pipe.

"Water hammering" is a term used to describe noise produced by a destructive force known as hydraulic shock. Water hammering develops in a piping system when an instantaneous change in the velocity of flowing water occurs, or when water flowing at a given velocity is stopped abruptly. Water hammering can occur without audible sounds. A quick closure of a valve, for example, creates some form of shock, with or without noise. The shock wave is accompanied by a pressure surge that can expand the wall of the pipe. The velocity of the flowing water, the rate at which the water flow is stopped, and the diameter and material of the pipe affect the intensity of water hammer. To prevent adverse effects from water hammering, the standard requires that the intensity of the water hammer be controlled with water-hammer arrestors, installed according to the manufacturer's recommendations. Many water-hammer arrestors are now permanently charged and factory-sealed, and require no maintenance and, therefore, need no access.

Elevation

The difference in elevation between the water supply source and the highest water supply fixture has a result in an increase or decrease in available pressure. There's typically a loss in pressure because the water supply is usually located below the outlet fixture. The loss is the result of the pressure required to overcome the weight of the water in order to deliver water to the fixture.

To push water up from the basement through the first floor to the showerhead in the second-floor master bathroom, there may be about 25 vertical feet to overcome. There would be a pressure loss of between 10 and 11 psi (pounds per square inch) or 69 to 76 kPa (kilopascals). If the static pressure at the basement were 60 psi (413 kPa), the static pressure at the master bedroom would be 49 psi (337 kPa).

Static pressure is the pressure exerted by the water on the interior walls of the water supply pipe when no water is flowing. It is how hard the water is being pushed.

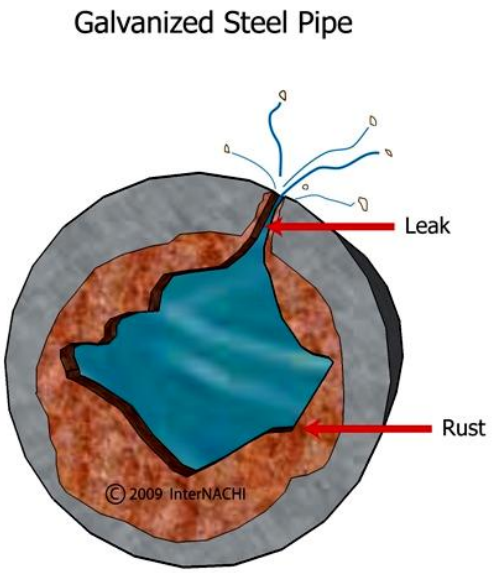
Water Pressure Defects

In order to get the most meaningful results, it is good practice to inspect the plumbing fixtures at the highest point in the house. Many inspectors will run all of the fixtures in one bathroom at the same time and observe performance. It is helpful to demonstrate to clients how the shower performs when multiple fixtures are running simultaneously. Clients will be able to determine for themselves whether the performance is acceptable or not. When it is not acceptable, inspectors typically call for correction and further investigation by a professional.

Undersized Piping

In some old houses, the supply pipe diameter may be as small as ⅜-inch, while ¾-inch is considered the minimum diameter.

Steel Piping



Galvanized steel piping rusts from the inside out. Eventually, the pipe will leak. The water pressure drops because the rough surface inside the pipe creates friction loss. The accumulation of rust on the inside of the pipe restricts the flow. The effective diameter of the pipe is reduced.

Pipe Length

Pressure loss is relative to the length of the pipe. The longer the pipe, the greater the pressure loss due to friction as the water flows through the pipe. If we wanted to move 3 gallons of water per minute through 100 feet of ½-inch diameter pipe, there would be a pressure drop of about 7 psi.

Elevation

Dwellings built far above street level may have low water pressure and water flow. Pressure drops as water is pushed up vertically.

Dirt

Sometimes there are particles in the water supply, and a reduction in the water flow at the fixture is observed. Often, a simple cleaning of the screen at the lavatory outlet is all that is required.

Water Consumption

There are maximum water consumption flow rates and quantities for all plumbing fixtures and fixture fittings. The intention of the maximum rates and quantities is to conserve water resources by limiting the consumption and flow rates of plumbing fixtures and outlets.

Maximum Flow and Consumption Rates for Plumbing Fixtures and Fittings	
lavatory, private	2.2 gpm at 60psi
showerhead (or hand-held shower spray)	2.5 gpm at 80 psi
sink faucet	2.2 gpm at 60 psi
urinal	1 gallon per flushing cycle (3.785 L)
water closet (toilet)	1.6 gallons per flushing cycle

Federal law mandates that sink faucets have a maximum flow rate of 2.2 gpm at 60 psi, and that water closets (toilets) limit their consumption to 1.6 gallons per flushing cycle. There are few exceptions.

Size of Water Supply Pipe to Fixture

The minimum size of a fixture supply pipe should be as shown in the following table. Fixture pipe sizes in traditional plumbing trade-sizing designations correspond to the internal diameter of the pipe. Each pipe size number is the minimum size permitted for the supply pipe from the point of source to the fixture. But in the last 30 inches, the pipe can be reduced in size. This is common when connecting faucets to sink supply lines. A flexible water connector installed between the supply pipe and the fixture may reduce the size. Flexible connectors are considered fixture fittings.

Minimum Size of Fixture Water Supply Pipes	
bidet, lavatory, flush-tank water closet, flushometer water closet	3/8-inch
dishwasher, hose bib, kitchen sink, laundry, single-head shower,* bathtub, one-piece water closet	1/2-inch
flush-valve urinal	3/4-inch
flush-valve water closet	1 inch
** can be reduced if it is an individual distribution pipe served by a manifold*	

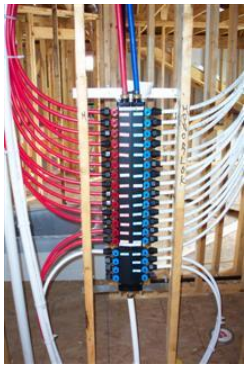
Thermal Expansion Control

In the connection of a water distribution system to water-heating appliances, there is the potential for the migration of heated water into the water distribution piping. In a typical water distribution system, the water will expand into the public water service. If the expansion of water is not accommodated in the system, dangerously high pressures can develop that can cause damage to piping, components and the water heater.

For water system sizes up to and including 2 inches (51 mm), a device for controlling pressure should be installed where the pressure on the downstream-side of a pressure-reducing valve exceeds the pressure-reducing valve setting. This is because of thermal expansion. Where a backflow-prevention device, check valve, or other device is installed on a water supply system using storage water heating equipment (such that thermal expansion causes an increase in pressure), a device for controlling pressure should be installed. This device can be an expansion tank with a flexible diaphragm inside it.

Gridded and Parallel Water Distribution

Gridded and parallel water distributions systems use individual supply pipes that extend to each fixture from a central supply point. The central point is a manifold to which the individual supply pipes connect. These systems have advantages over the traditional branch distribution system. Individual shut-off valves installed at the manifold should be identified as to the fixture being supplied, since the control function of valves at the manifold would not be apparent.



Lead Content of Pipes and Fittings

The EPA enacted a ban on lead solder in June 1986. It also limited the lead content of pipes and fittings to a maximum of 8%. The limitation also applies to the various qualities of brass used in producing faucets, fittings and valves. The amount of lead in brass pipe is less than 1%.

Water Distribution Pipe

Pipe used for water distribution is required to conform to NSF 61 standards. Pipe used for distribution of hot water must be capable of withstanding high temperatures. All hot-water-distribution pipe and tubing must have a minimum pressure rating of 100 psi at 180° F (689 kPa at 82° C). The maximum temperature of a hot water distribution system is 180° F (82° C). CPVC, PEX and PB plastic pipe are often identified as rated for 180° F at 100 psi (82° C at 690 kPa). These pipes can actually withstand temperatures in excess of 212° F (100° C).

Solvent-Cement Joint

A solvent-cement joint is a homogeneous chemical bond between a pipe and fitting. The bond is accomplished when the chemical composition of both joining surfaces is the same. If the materials are different, the joint will not form a proper chemical bond. Solvent-cementing between ABS and PVC pipe is prohibited. This prohibition extends to solvent-cementing between PVC and CPVC, and between CPVC and ABS, as well. The difference between ABS, CPVC and PVC solvent-cement joints is based on the type of solvent cement, and the fact that CPVC and PVC joints must first be primed. There are few exceptions to the rule of using a primer for CPVC. Failure to use a primer will result in a failed joint and may affect the manufacturer's warranty. Solvent cement for CPVC is orange in color, indicating that the appropriate solvent cement has been used.

Solder Joint

A soldered joint is the most common method of joining copper pipe and tubing. The copper pipe must be cut square. All cut tube ends of copper pipe should be reamed to the full inside diameter of the tube end to remove the burr. All joint surfaces should be cleaned. A flux should be applied before soldering. Flux is a chemically active material that removes and excludes oxides from the joint area during the heating process, and allows the melted solder to spread out on the joining surfaces. The joining of water-supply piping should be made with lead-free solder and fluxes. "Lead-free" means a chemical composition equal to or less than 0.2% lead content.

Lead-bearing solder can sometimes be visually identified because the solder tends to darken over time. The solder will flow by capillary action toward the heat. Heat causes the copper atoms to move farther apart from each other, and the solder atoms enter the spaces between the copper atoms, creating a strong bond when solidified.

Galvanic Joint

When copper pipe is joined with galvanized steel pipe, protection against the galvanic corrosion is needed. Galvanic corrosion occurs when two different metals come into contact in the presence of an electrolyte, such as water. The more reactive metal at a joint is called the "anode" (galvanized steel pipe), and the less reactive metal is called the "cathode" (copper pipe). Two methods of protecting against galvanic corrosion are by using dielectric fittings and brass fittings.

Valves

Full-Open Valves

Full-open valves are shut-off valves that, in the full-open position, have a straight-through flow passageway. But, unlike shut-off valves and stops, full-open valves add little resistance to flow and have little effect on supply pressure. Full-open valves are referred to as "water-service valves."

The valves at the street curb, which are called curb valves or "corporation cocks," are installed by the water utility company and are usually a lubricated rotor or plug-type valve.

The building entrance valve, or the main water valve, is usually installed before the water meter, when the meter is to be located inside the dwelling. It is usually a ball or gate valve. Valves installed on either side of the meter allow the meter to be removed and replaced without having to drain the distribution system.

Shut-Off Valves

A shut-off valve is different from a full-open valve. There is a pressure drop through a shut-off valve. There is little friction loss through a full-open valve. Shut-off valves are commonly referred to as "stops," and include globe valves, straight stops and angle stops. One can replace a shut-off valve with a full-open valve, but not vice versa.

Shut-off valves should be installed:
1) on the water supply pipe to each plumbing fixture, other than showers and bathtubs;
2) on the water supply pipe to each sillcock; and
3) on the water supply pipe to each appliance or mechanical equipment.

Showers and bathtubs typically do not have shut-off valves because they would not be accessible for maintenance. Sillcocks can be damaged, vandalized, abused, and prone to freezing (even when the hose bib is frost-proof). Without valves at the previously mentioned locations, the main water shut-off valve in the dwelling would have to be shut off for long periods of time until repairs are made.

Access to all shut-off and full-open valves is required. Water service valves and valves for hose bibs should be identified or should have an identification tag. All other valves should be identified if the valve's purpose is not obvious, or if the fixture, appliance or equipment served by the valve is not readily visible. Identification is helpful and sometimes critical in certain situations.

Stop and Waste Valves

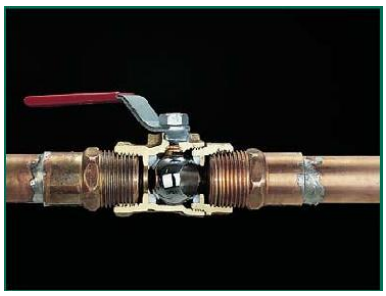
Many shut-off valves are stop and waste valves. At these valves, there is a small bleed or drain outlet on the downstream side of the valve. The purpose of this valve is to drain all the water out of the piping.

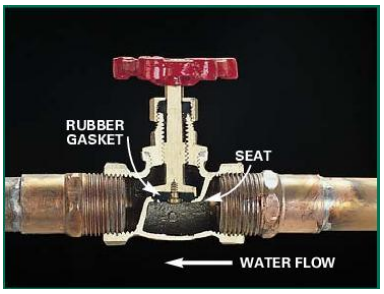
Globe, Ball and Gate Valves

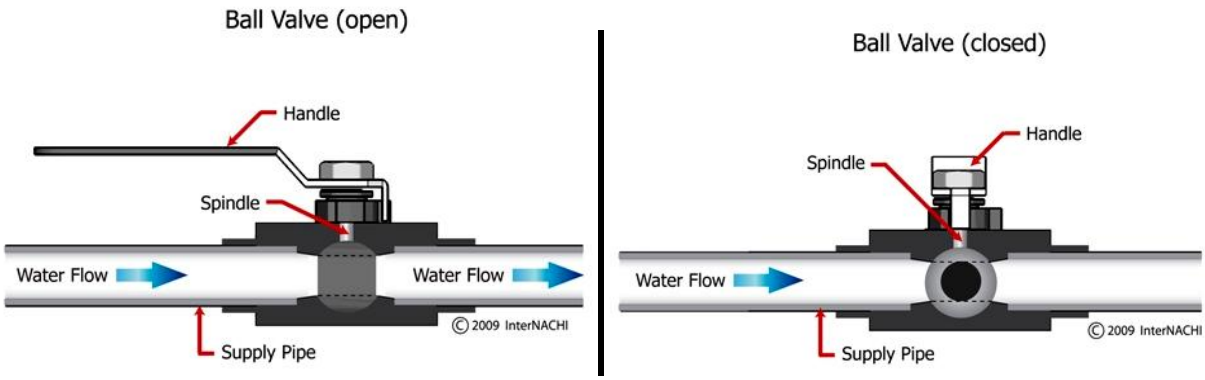
Globe valves tend to be restrictive, but can be used to control water flow.

Ball valves are less restrictive to flow than other valves. The handle clearly indicates whether the valve is open or closed. Ball valves do not control water flow.

Gate valves are meant to be fully open or closed. Since the seal is metal-to-metal, corrosion can cause these valves to fail.







Valve Defects

Home inspectors are not required to operate all the valves in a dwelling. Old valves have brittle packing washers that will crack and cause the valve to leak. Common problems with valves include leaking valves, missing valves, inaccessible valves, damaged or missing handles, or rusted or partially closed valves.

Hot Water

Hot water is defined as water of a temperature of 110° F (43° C) or hotter. Tempered water ranges from 85° F to 110° F (29° C to 43° C), and the device supplying the tempered water must limit the temperature to 110° F (43° C).

If the distribution piping distance between the hot water source and any fixture is greater than 100 feet, then the hot water supply system should have a method of maintaining the temperature of the water. Otherwise, water is wasted at the point of use while the user is waiting for the desired temperature to be reached. Pipe insulation is not required on all hot water distribution pipes, but insulation of the hot water distribution pipes on a return circulation system should be installed.

QUIZ on SECTION 6

1. T/F: A shut-off valve is the same as a full-open valve.

- True
- False

2. T/F: The U.S. Environmental Protection Agency's (EPA's) Office of Drinking Water controls the quality requirements for water to be classified as potable.

- True
- False

3. The casing should extend above the ground surface _____ inches.

- 24 to 48
- 1 to 3
- 6 to 12
- 36 to 48

4. There are _____ wells (more than 25 feet deep) and _____ wells (25 feet or less).

- dry.....wet
- drilled.....irrigated
- shallow.....deep
- deep.....shallow

5. All water supply lines and fittings for every plumbing fixture should be installed in way that prevents _____.

- backflow
- indirect venting
- friction
- defective pressure reduction
- inadequate clearance to combustibles

(continued)

6. _____ is the most effective and dependable method of preventing backflow.

- An air gap
- An inoperative conjunction
- An over-fusing

7. The minimum diameter of a water service pipe is typically _____.

- ½-inch (14.7 mm)
- ¾-inch (19.1 mm)
- 1¾-inches (37.9 mm)

8. Type K copper tubing is the _____ and typically used for underground water service.

- kilo flow pipe
- Kpa/1,000 value
- thinnest
- thickest

9. In order to get the most meaningful results, it is good practice to inspect the plumbing fixtures at the _____ point in the house.

- lowest
- most used
- highest

10. Dwellings built far above street-level may have _____ water pressure and water flow. Pressure _____ as water is pushed up vertically.

- high.....drops
- low.....drops
- low.....increases
- constant.....evens out
- great.....builds

11. T/F: Solvent-cementing between ABS and PVC pipe is prohibited.

- True
- False

Answer Key is on next page.

Answer Key to Quiz on Section 6

1. T/F: A shut-off valve is the same as a full-open valve.
   Answer: False

2. T/F: The U.S. Environmental Protection Agency's (EPA) Office of Drinking Water controls the quality requirements for water to be classified as potable.
   Answer: True

3. The casing should extend above the ground surface 6 to 12 inches.

4. There are deep wells (more than 25 feet deep) and shallow wells (25 feet or less).

5. All water supply lines and fittings for every plumbing fixture should be installed in way that prevents backflow.

6. An air gap is the most effective and dependable method of preventing backflow.

7. The minimum diameter of a water service pipe is typically ¾-inch (19.1 mm).

8. Type K copper tubing is the thickest and typically used for underground water service.

9. In order to get the most meaningful results, it is good practice to inspect the plumbing fixtures at the highest point in the house.

10. Dwellings built far above street-level may have low water pressure and water flow. Pressure drops as water is pushed up vertically.

11. T/F: Solvent-cementing between ABS and PVC pipe is prohibited.
    Answer: True

SECTION 7: SANITARY DRAINAGE

General Comments and Testing Standards

Modern plumbing, including proper sanitary drainage, is one of the reasons that diseases such as typhoid fever, cholera and dysentery have been eliminated. Modern plumbing has improved human health and longevity.

The drainage, waste and vent (DWV) system consists of all piping for conveying wastes from:

- plumbing fixtures and appliances, including fixture traps;
- above-ground drainage piping;
- below-ground drainage piping within the building (building drain);
- below- and above-ground venting systems; and
- piping to the public sewer or private septic system.

All plumbing and drainage work should be tested to verify that it is leak-free. The DWV system of the dwelling should be tested with a minimum 10-foot head of water for 15 minutes, equivalent to the working pressure of the system. Each section should be filled with water to a point not less than 10 feet above the highest fitting in that section. When doing an air test on rough-in plumbing, the portion being tested shall be maintained at 5 psi for 15 minutes.

The design and installation of a DWV system in a dwelling should function reliably, should not be under-sized or over-sized, and should be constructed of materials, fittings and connections listed and approved.

Trenching

Trenches should have solid and continuous load-bearing support at the bottom of the trench, forming a bed for the pipe. Rocks or blocks at any point should not support piping. Detrimental forces induced from pressure points are placed on the piping when the pipe is resting on this type of material.

Pipe is protected from damage by proper back-filling. Back-filling is done in 6-inch layers, with each layer being tamped into place. The material used for backfill must be evenly distributed to avoid pipe movement. Large rocks and chunks of dirt should not be located within 12 inches of the pipe.

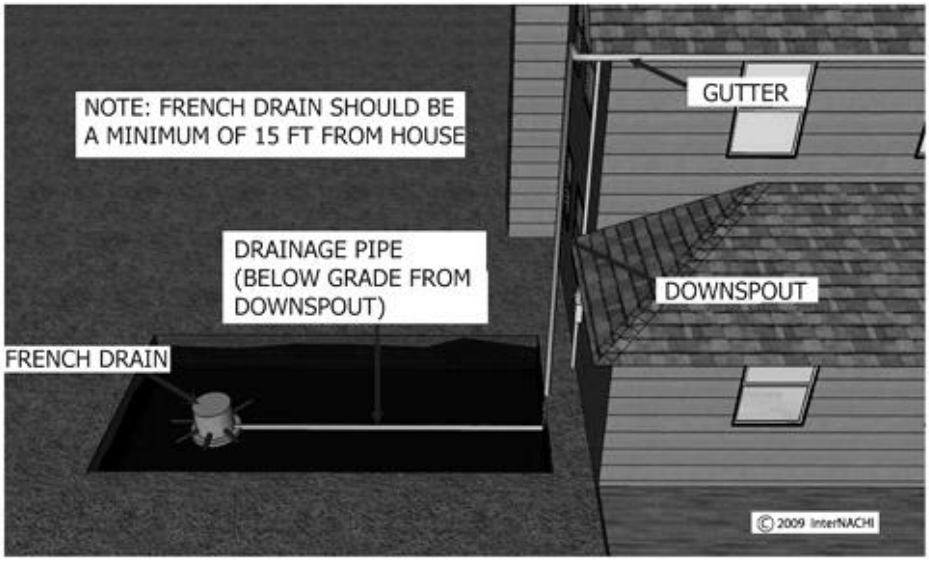
Separate Sewers

The combining of sewers (prior to connection to the public sewer system) which serve different buildings under different ownership is not permitted. The exception is when the sewers from different buildings on the same lot or parcel of land are combined and each building is under the same ownership.

Sewage Treatment

Sewage should not discharge on the ground surface, into the ground, or into any waterway, unless it has been first rendered innocuous through an approved form of treatment. The discharge of untreated waste and sewage from a drain, waste and vent (DWV) system is an environmental and human health hazard. The local code official, state health department, or the EPA should approve the form of treatment.

FRENCH DRAIN



Sanitary Drainage Pipe Material

Materials used in a drain, waste and vent (DWV) system should be approved and regulated by ASTM or CSA standards. Pipe materials are listed in the table that follows.

Sanitary Drainage Pipe Materials			
Material	**Above-ground, inside dwelling**	**Underground, inside dwelling**	**Underground, outside dwelling**
abcrylonitrile butadiene styrene (ABS) plastic pipe (Schedule 40)	permitted	permitted	permitted
asbestos-cement pipe (not commonly used)	**not** permitted	permitted	permitted
cast-iron pipe (no hub)	permitted	permitted	permitted
concrete pipe	**not** permitted	**not** permitted	permitted
copper or copper-alloy pipe	permitted	permitted	permitted
galvanized steel pipe	permitted 6 inches above ground	**not** permitted	**not** permitted
polyethylene (PE) plastic pipe	**not** permitted	**not** permitted	permitted
polyvinyl chloride (PVC) plastic pipe (Schedule 40)	permitted	permitted	permitted
stainless steel drainage pipe	permitted	permitted	permitted
vitrified clay pipe	**not** permitted	**not** permitted	permitted

Slope of Drainage Pipe

The minimum velocity in a horizontal drain pipe is 2 feet per second (0.61 m/s). This is called the "scouring velocity." The velocity is intended to keep solids in suspension. If the velocity is too low, the solids will tend to drop out of suspension and stop on the pipe bottom. This will lead to blockages and stoppages. Minimum slopes of horizontal drain pipes are listed in the following table.

Slope of Horizontal Drainage Pipe	
Size (in inches)	**Minimum Slope (inch per foot)**
2½ or less	1/4
3 to 6	1/8
8 or larger	1/16
1 inch = 25.4 mm	*1 inch per foot = 83 mm per m*

Change in Drain Pipe Size

The size of the drainage pipe cannot be reduced in the direction of the drainage flow. A reduction will create an obstruction of the flow, resulting in blockage or stoppage.

Breakage and Corrosion of Pipes

Pipes passing through or under walls should be protected from breakage. Sheathing or wrapping should allow for expansion and contraction of the pipes to prevent any rubbing action. The minimum wall thickness of the material should be 0.025 inches (0.64 mm).

Any pipe installed within or under a footing or foundation wall must be protected from any transferred load from the footing or wall. A relieving arch or pipe sleeve may be installed. When a sleeve is used, it should be sized so that it is two pipe sizes larger than the penetration pipe. This space allows for movement of the pipe. Ring-like spaces between sleeves and pipes need to be filled or tightly caulked. Pay special attention to where the pipe penetrates through a fire-resistant assembly. A listed fire-stop system may be needed. The purpose of this is to structurally protect the pipe so that it will not be subjected to undue stresses that may cause the pipe to break.

Pipes located in concealed spaces within the interior of the dwelling should be protected from breakage if installed through holes or notches in studs, joists, and similar framing components. Where the hole or notch is less than 1½ inches (38.1 mm) from the nearest member's edge, steel protective shield plates are required.

Pipes made of brass, copper, cast iron and steel are subject to corrosion when exposed to the lime and acidity of concrete, cinder, soil/dirt and other corrosive materials. A sheathing, coating or wrapping (or other means) is needed around such pipes. Typical protective coatings include coal-tar wrapper with paper, epoxy and plastic coatings.

Fittings

Fittings should be approved and compatible with the type of piping being used, and should be of a sanitary or DWV design for drainage and venting. The design of a drainage system is based on uniform flow in the drainage piping. Particular fittings have been designed with patterns providing the least resistance to flow. Drainage fittings should be designed to maintain a grade of one-quarter unit vertical in 12 units horizontal (2% slope).

Prohibited Joints

The following joints and connections are not permitted:

1) cement or concrete joints;
2) mastic or hot-pour bituminous joints;
3) joints made with unapproved fittings;
4) joints between different diameters of pipes made with elastomeric rolling O-rings;
5) joints between different types of plastic pipes made with solvent cement; or
6) saddle-type fittings.

Cement and concrete are inflexible. Bituminous material is unreliable and not permanent. An O-ring has no resistance and can be pushed out of the joint. The joint between different types of plastic made with solvent cement is not reliable because the chemical composition of the joint will not be homogeneous. Solvent-cementing is not permitted between ABS and PVC, between PVC and CPVC, or between ABS and CPVC. Saddle-fittings may move out of alignment.

Cleanouts

All cleanouts should be accessible or reachable without having to remove a permanent portion of the structure. Cleanouts are designed to make the interior of a drainage system accessible for clearing stoppages without inconvenience, dismantling wall or ceiling finishes, or disturbing the sanitary drainage system.

Cleanout plugs are very common. They are usually located at changes in direction in a drain line and at the bottom of stacks. Cleanouts should be installed to open and allow cleaning in the direction of the flow of the drainage pipe, or at right angles thereto. They must be water-tight and gas-tight. A cleanout plug can be made of brass or plastic. A cleanout plug should have a raised square or a counter-sunk square head where a trip hazard may exist. The square shape minimizes the possibility of stripping the plug during removal.

Drainage pipe cleanouts should be installed not more than 100 feet apart in horizontal drainage lines, as measured from the upstream entrance of the cleanout.

A cleanout should not be covered with cement, plaster or other finish material. Where it is necessary for a cleanout to be concealed, an approved type of cover plate or access door should be provided. The minimum clearance in front of cleanouts should be 18 inches (457 mm) on pipes 3 inches and larger, and 12 inches (305 mm) on smaller pipes.

Cleanouts should be installed at each change in direction greater than 45° (0.79 rad) in the building sewer, building drain, and horizontal waste or soil line. A cleanout is not required for each and every change in direction. If a 90° change in direction is made with a single fitting, then a cleanout is needed. If the same change in direction is made with two bends, a cleanout is not required because rodding equipment should be able to easily pass through fittings having a change in direction of 45° or less.

A cleanout cannot be removed in order to install a new fixture or additional drainage piping. A cleanout fitting is commonly removed to allow a new connection; however, a substitute cleanout must be installed in the same capacity as the original cleanout that was removed. For this reason, many cleanout fittings have only a few threads and are unable to securely receive a threaded pipe or male adapter.

Cleanouts in the finished floor are often improperly converted into floor drains. Such an opening would not have a water trap, and sewer gases would enter the dwelling's interior.

With few exceptions, cleanouts should be the same size as the pipe they serve, up to 4 inches (102 mm). For pipes larger than 4 inches, the cleanout size should be at least 4 inches.

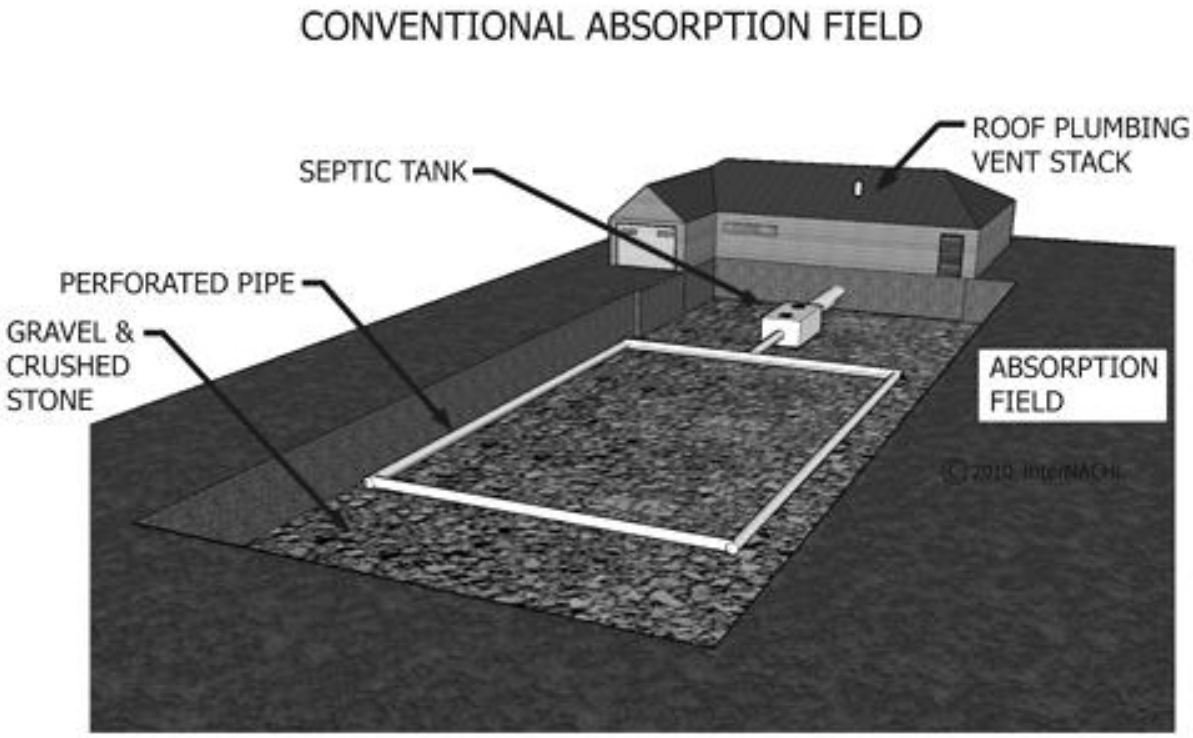
Drainage System Sumps and Ejectors

Where the drainage system cannot drain by gravity to the sewer, an automatic pump or ejector can be used to discharge the soil and waste. The cover for the pump should be tightly sealed (gas-tight). Sumps, other than pneumatic ejectors, should be vented with a minimum 1¼-inch diameter vent pipe. Pumps use mechanical methods to discharge, and pneumatic ejectors use air pressure. Grinder pumps and ejectors pulverize solids to a near-liquid state and pump the slurry to the drainage system.

The capacity of the sump should not exceed one-half of a day’s (12 hours') discharge load from the piping system connected to the sump under normal use. The retention period should be short to prevent the pump from acting like a septic tank. The minimum capacity of the sump should be such that the pump operates for at least 15 seconds per pumping cycle to prevent short-cycling and overuse of the equipment. The level of the effluent in the pit should not rise within 2 inches (51 mm) of the gravity drainage pipe entering the pit.

The sump pit should not be less than 18 inches (457 mm) in diameter or 24 inches (610 mm) deep. The pit should be accessible. All drainage to the pit should flow by gravity only. The pit bottom should be solid and should provide stable support for the pump. The pit's cover should be able to structurally support anticipated weight loads in that area of use.

The discharge pipe should have a check valve installed to prevent previously pumped discharge from returning to the pump. A full-open valve should be installed on the discharge side of the check valve. This valve is used to prevent waste and gases from coming back toward the pump when maintenance or repair is performed on the check valve or the pump/ejector unit. The valves must be accessible.



QUIZ on SECTION 7

1. The joint between different types of plastic made with solvent cement will not be reliable because the chemical composition of the joint will not _____.

- be homogeneous
- have chemical dissimilarity
- be chemically porous

2. The square shape of a cleanout _____ the possibility of stripping the plug during removal.

- minimizes
- increases
- eliminates

3. T/F: It is permitted, in certain situations, to discharge untreated sewage or wastewater on the ground surface.

- True
- False

4. T/F: Rocks or blocks at any point could support drainage piping inside a trench.

- True
- False

5. Particular drainage fittings have been designed with patterns providing _____ resistance to flow.

- the greatest
- the least
- a frictional

6. The minimum slope of a horizontal drain pipe that is sized between 3 and 6 inches is _____.

- 1/8-inch per foot
- 3/16-inch per foot
- 1/16-inch per foot
- 1 inch per foot

(continued)

7. The drain, waste and vent (DWV) system of the dwelling should be tested with a minimum _____ head of water for 15 minutes.

- 10-foot
- 100-foot
- 1-foot

8. Drainage pipe cleanouts should be installed not more than _____ apart in horizontal drainage lines measured from the upstream entrance of the cleanout.

- 10 feet
- 150 feet
- 100 feet

9. T/F: A cleanout is required for each and every change in direction of the sewer drainage pipe.

- True
- False

10. The sump pit should not be less than ____ inches in diameter and ____ inches deep.

- 24.....18
- 24.....36
- 18.....24

11. The discharge pipe on a sump pump should have _____ installed to prevent previously pumped discharge from returning to the pump.

- a check valve
- a drain hole
- a smooth-walled pipe
- a wye fitting
- a float-ball valve

12. T/F: Solvent-cementing is permitted between ABS and PVC pipe.

- True
- False

Answer Key is on next page.

Answer Key to Quiz on Section 7

1. The joint between different types of plastic made with solvent cement will not be reliable because the chemical composition of the joint will not be homogeneous.

2. The square shape of a cleanout minimizes the possibility of stripping the plug during removal.

3. T/F: It is permitted, in certain situations, to discharge untreated sewage or waste water on the ground surface.
   Answer: False

4. T/F: Rocks or blocks at any point could support drainage piping inside a trench.
   Answer: False.

5. Particular drainage fittings have been designed with patterns providing the least resistance to flow.

6. The minimum slope of a horizontal drain pipe that is sized between 3 and 6 inches is 1/8-inch per foot.

7. The drain, waste and vent (DWV) system of the dwelling should be tested with a minimum 10-foot head of water for 15 minutes.

8. Drainage pipe cleanouts should be installed not more than 100 feet apart in horizontal drainage lines measured from the upstream entrance of the cleanout.

9. T/F: A cleanout is required for each and every change in direction of the sewer drainage pipe.
   Answer: False

10. The sump pit should not be less than 18 inches in diameter and 24 inches deep.

11. The discharge pipe on a sump pump should have a check valve installed to prevent previously pumped discharge from returning to the pump.

12. T/F: Solvent-cementing is permitted between ABS and PVC pipe.
    Answer: False

SECTION 8: VENTS

Vent Basics

Every trap and trap fixture should be vented. The purpose of venting is to protect the trap seal of each trap. The vent system reduces pressure differences in the drainage system. Venting protects the trap seals from positive pressures and siphonage. There should be at least one vent pipe that extends to the outdoor air for a dwelling.

The minimum size of any vent is half of the required size of the drain pipe, but not less than 1¼ inches (32 mm). All vent and branch vent pipes should be sloped and connected in order to drain back to the drainage pipe using gravity.

The most common way of venting is to install a separate or individual vent for each trap or trapped fixture which is then connected to the dwelling's main venting system. The other methods of venting include common venting, wet-venting, waste-stack venting, circuit venting, combination drain-and-vent, and island-fixture venting.

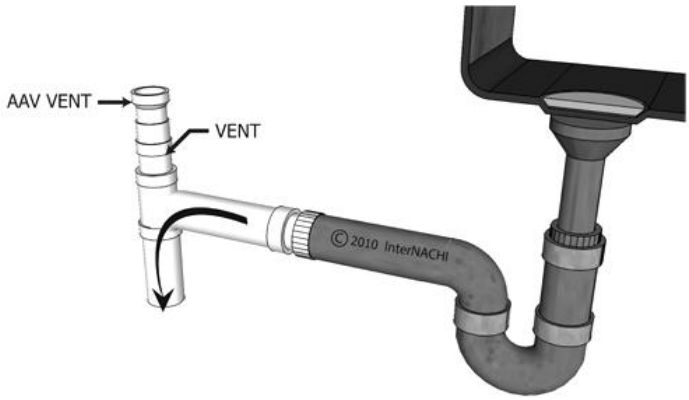



A common vent is one vent that serves more than one fixture, functioning as an individual vent for each fixture. Wet-venting is venting single or double bathroom groups or combinations thereof, where one vent pipe may serve all the fixtures connected to the wet vent. Waste-stack venting is venting individual fixtures through a drainage stack, and the oversized stack functions as the vent. Circuit venting is venting up to eight fixtures with a single vent pipe. A combination drain-and-vent system is restricted to floor drains, sinks and lavatories, and relies on the oversized drain pipe. Island-fixture venting has a vent installed below the flood-level rim of the fixture before rising to connect to another vent.



Air Valves

Individual, branch and circuit vents are permitted to terminate with a connection to an individual or branch-type air-admittance valve. Stack vents and vent stacks should be permitted to terminate to stack-type air-admittance valves. Access should be provided to all air-admittance valves. The air-admittance valve should be rated according to the size of the vent to which it is connected.



Vent Distances

The table below lists the maximum distance of a fixture trap from a vent, according to size of the trap and the slope of the drainage pipe. The developed length of the fixture drain from the trap weir to the vent fitting for self-siphoning fixtures, such as water closets, is not limited.

Maximum Distance of Fixture Trap from Vent		
Size of Trap (in inches)	**Slope (in inches per foot)**	**Distance from Trap (in feet)**
1¼	1/4	5
1½	1/4	6
2	1/4	8
3	1/8	12
4	1/8	16

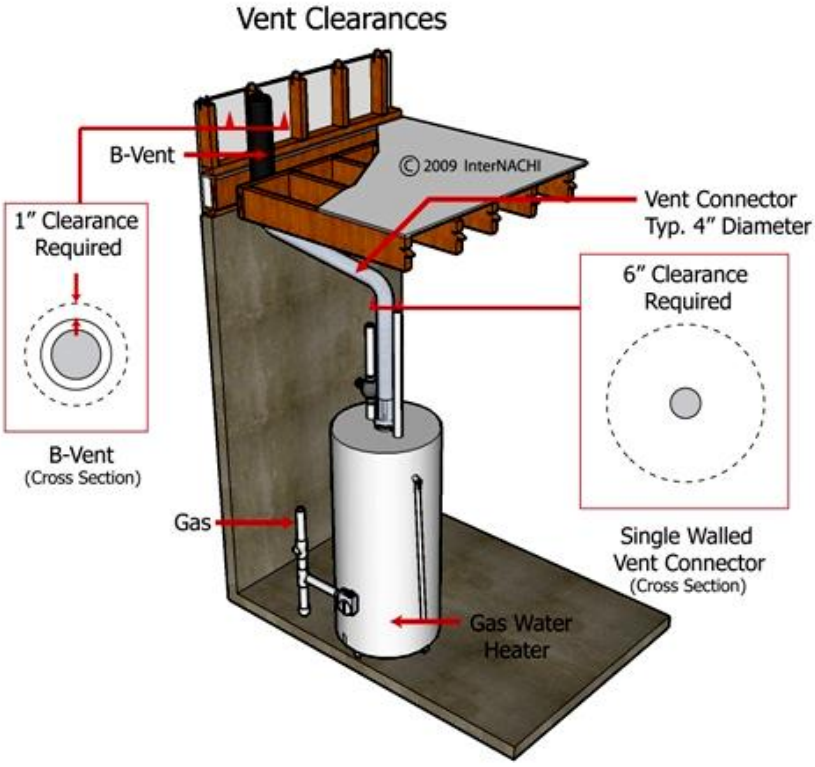
Vent Terminations

The vent system for a dwelling should have at least one vent pipe that extends outdoors to the open air. The vent pipe that passes through a roof should end at least 6 inches (152 mm) above a roof to protect the end of the vent pipe from being blocked by snow, and to allow a sufficient length of pipe for proper roof flashing. Where the roof area can be occupied, the vent should extend at least 7 feet above the roof to prevent noxious sewer gases from harming people.

The possibility of frost closure occurs in areas of the country having cold climates, with winter outdoor 97½% design temperatures of 0° F (-18° C) or less; therefore, a minimum 3-inch (76 mm) diameter vent will be needed. Vent pipes installed at the dwelling's exterior in cold climates should be protected against freezing by insulation, heat, or both.

The opening of a vent terminal should be located away from any air-intake opening to prevent sewer gases from entering the dwelling. It should not be located directly beneath any door, openable window, or other air-intake opening of the dwelling, or of any adjacent dwelling. Any such vent terminal should be at least 10 feet horizontally away from such an opening, unless it is at least 2 feet above the top of the opening.

Vent terminals extending through the wall should terminate at least 10 feet from the lot line and 10 feet above the ground level. They should not end under a soffit overhang. A side-wall vent should have a screen or protection over the opening to prevent birds from building nests or rodents from entering the drainage system.



QUIZ on SECTION 8

1. The vent pipe that passes through a roof should end at least _____ above a roof.

- 1 foot (268 mm)
- 6 inches (152 mm)
- 3 inches (76 mm)
- 12 inches (304 mm)

2. There should be at least ____ vent pipe/s that extend/s to the outdoor air for a dwelling.

- one
- half of a
- one 4-inch diameter
- two 1-inch diameter

3. _____ installed on the dwelling exterior in cold climates should be protected against freezing by insulation, heat, or both.

- Vent pipes or vent stacks
- Chimney vents
- Pressure-relief valves

Answer Key to Quiz on Section 8

1. The vent pipe that passes through a roof should end at least <u>6 inches (152 mm)</u> above a roof.

2. There should be at least <u>one</u> vent pipe/s that extend/s to the outdoor air for a dwelling.

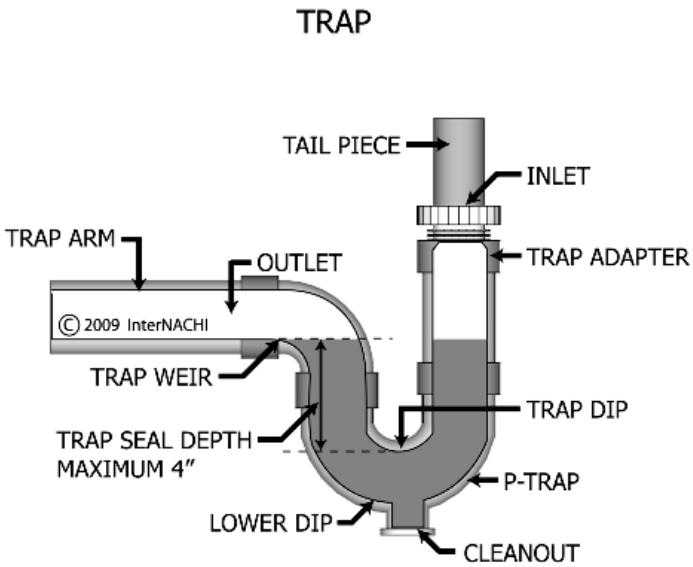
3. <u>Vent pipes or vent stacks</u> installed on the dwelling exterior in cold climates should be protected against freezing by insulation, heat, or both.

SECTION 9: TRAPS

Traps: The Basics

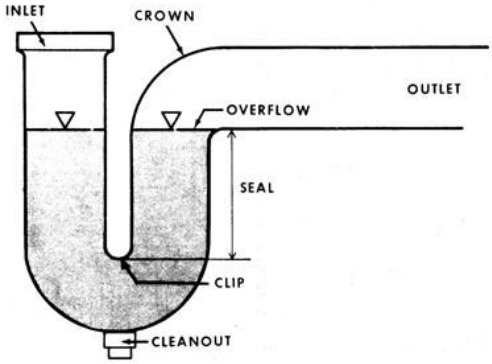
A trap is designed to keep sewer gases and airborne bacteria from escaping the drainage system and entering the dwelling. Each plumbing fixture should be separately trapped by a water-seal trap, except as otherwise permitted by the plumbing standard. Fixtures such as water closets and urinals that have integral traps do not require an additional trap installed.

The vertical distance from the fixture outlet to the trap weir should not exceed 24 inches (610 mm). The vertical distance controls the drainage-flow velocity. If the trap has an excessively long vertical separation from the fixture, the velocity of the flow at the trap inlet can create siphoning.



The horizontal distance should not exceed 30 inches (610 mm), as measured from the center line of the fixture outlet to the centerline of the inlet of the trap. The horizontal distance from a fixture to the trap limits the amount of bacterial growth and odor. It is desirable to locate the trap as close to the fixture as possible. A fixture should not be double-trapped.

Standpipes should be individually trapped. Standpipes, such as for a clothes washer, should have a minimum height above the trap of 18 inches (457 mm), and a maximum of 42 inches. Access to all standpipes should be provided for cleaning and rodding.



Minimum Trap Size

Fixtures and their minimum trap sizes are listed in the following table. Note that a 1¼-inch (32 mm) drain is the minimum acceptable size to permit proper, open flow in a pipe for sanitary drainage. The minimum trap size is based on this pipe size.

Drainage Fixture and Minimum Trap Size	
automatic clothes washer (residential)	2 inches (50.8 mm)
bathtub (with or without overhead shower or whirlpool attachment)	1½ inches (38.1 mm)
bidet	1¼ inches (31.8 mm)
clothes washer standpipe	2 inches (50.8 mm)
dishwashing machine (domestic)	1½ inches (38.1 mm)
floor drain	2 inches (50.8mm)
kitchen sink (with or without food waste grinder and/or dishwasher, one or two traps)	1½ inches (38.1mm)
laundry tub/tray (one or more compartments)	1½ inches (38.1mm)
lavatory	1¼ inches (31.8mm)
shower (based on total flow rate through showerheads and body sprays) *flow rate:* • 5.7 gpm and less • more than 5.7 gpm, up to 12.3 gpm • more than 12.3 gpm, up to 25.8 gpm • more than 25.8 gpm, up to 55.6 gpm	• 1½ inches (38.1mm) • 2 inches (50.8mm) • 3 inches (76.2mm) • 4 inches (101.6mm)
water closet (private) (1.6 gallons per flush or greater)	trap size consistent with fixture outlet size

A water seal of 2 inches (51 mm) is standard for most traps. Each fixture trap should have a liquid seal of at least 2 inches and, at most, 4 inches (102 mm) or deeper for specially designed fixtures. Traps that do not periodically receive waste discharge will evaporate their seal. Fixtures such as floor drains typically have trap seals that lose their water by evaporation and, therefore, should be provided with seal primers. A trap seal primer will be either water supply-fed or of a drainage type.

Prohibited Traps

There are traps that impede drainage flow by moving parts, design flaws, flow pattern or the ability to lose a trap seal.

The following types of traps are not permitted:

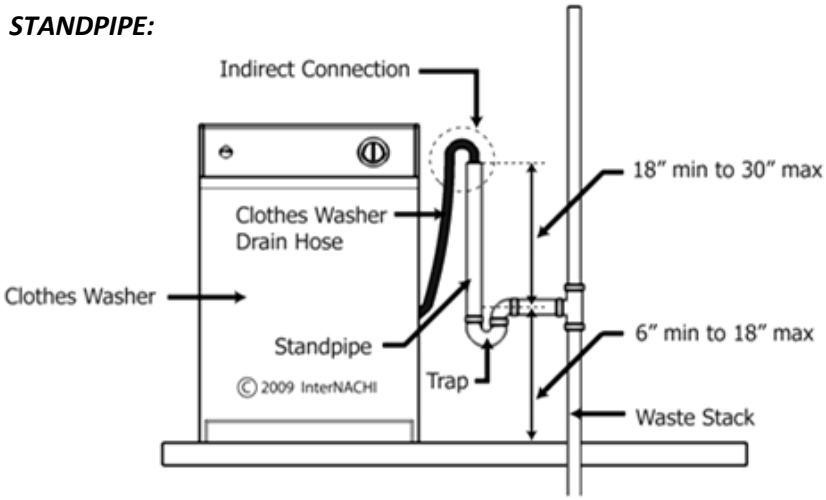
- traps that depend on moving parts;
- bell traps;
- crown-vented traps;
- traps not integral with a fixture and that depend on interior partitions for the seal (except for those traps constructed of an approved material that is resistant to corrosion and degradation);
- "S" traps; and
- drum traps (except when used for intercepting solids and chemical waste).

Trap Cleanout

A cleanout plug or removable trap section should be installed on traps located below laundry tubs, sinks and washbasins used for cleaning.

Trap Defects

STANDPIPE:



Inspectors should check for traps under each fixture. Toilets never have traps. Leaks at traps are common due to loose connections and damaged pipes. In cold climates, check for traps that are subject to freezing. A common occurrence is when an unqualified person has unsuccessfully tried to repair a trap. Check for staining, water damage and buckets. Many old tailpieces and traps are made of soft brass with chrome or nickel-plating. They are sometimes so thin that a gentle touch will cause them to break into pieces.

QUIZ on SECTION 9

1. Standpipes, like that for a clothes washer, should have a minimum height above the trap of _____.

- 4 inches
- 18 inches
- 2 feet

2. Each fixture trap should have a liquid seal of at least _____ and, at most, 4 inches (102 mm) or deeper for specially designed fixtures.

- 1/2-inch
- 1 inch (26 mm)
- 2 inches (51 mm)

3. _____ traps are not permitted because they impede drainage flow.

- Tubular
- Drum
- Upside

4. Many old tailpieces and traps are made of soft brass with chrome or nickel-plating and are sometimes so thin that a gentle touch will cause them to _____.

- make noises
- stain your fingers
- break into pieces

Answer Key to Quiz on Section 9

1. Standpipes, like that for a clothes washer, should have a minimum height above the trap of 18 inches.
2. Each fixture trap should have a liquid seal of at least 2 inches (51mm) and, at most, 4 inches (102 mm) or deeper for specially designed fixtures.
3. Drum traps are not permitted because they impede drainage flow.
4. Many old tailpieces and traps are made of soft brass with chrome or nickel-plating and are sometimes so thin that a gentle touch will cause them to break into pieces.

SECTION 10: PROTECTION

Protection Against Pipe Damage

It is critical that piping which passes through holes and notches in joists, studs, rafters and other structural members in concealed locations less than 1½ inches (38 mm) from the nearest edge of the member be protected from damage which can typically be caused by wallboard fasteners and/or wood structural panels. Shield plates are to be utilized. They should be a minimum of 1/16-inch thick (1.6 mm) and made of steel. They should cover the area of the pipe where the member is notched or bored, and should extend a minimum of 2 inches (51 mm) above the sole plates and below the top plates.

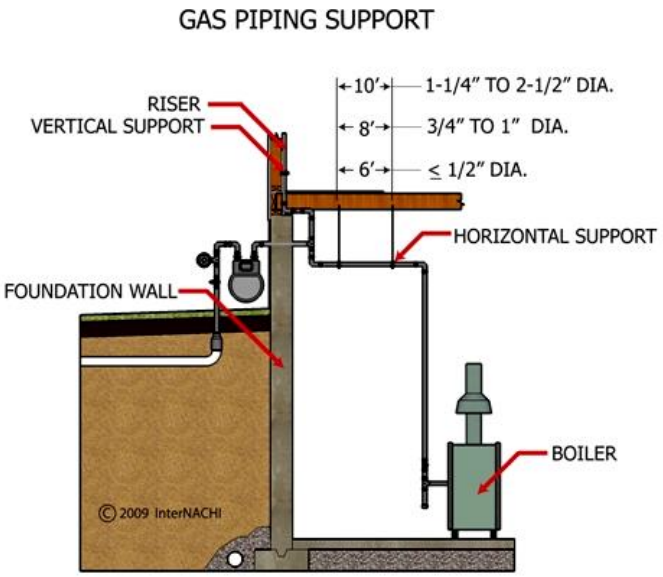
For fuel-gas piping, the plate should extend a minimum of 4 inches (102 mm) above sole plates, below top plates, and to each side of a stud, joist or rafter.

Fuel piping must not be installed in any solid concrete or masonry floor construction. The potential for pipe damage caused by settlement of the slab or the corrosive action of the floor material makes it crucial that the gas piping be installed in channels or casings, or similar protection.

SECTION 11: PLUMBING SUPPORT

The Fundamentals of Plumbing Support

Piping should be supported to ensure alignment and to prevent sagging. Piping in the ground should be laid on a proper bed. Piping above ground should be supported with hooks, straps, bands, brackets and/or hangers suitable for the size of the piping, of adequate strength and quality, and located at intervals so as to prevent sagging, damage and vibration. Other piping should not support piping. Piping should not put strain upon connected equipment or appliances.



Hangers and strapping should be of approved material that will not promote galvanic action.

Rigid-support sway-bracing should be installed at changes in direction greater than 45° (0.79 rad) for pipe sizes 4 inches (102 mm) and larger. Piping should be supported at distances not to exceed those in the following table. For large pipes, hangers alone may not be sufficient to resist the forces created by water movement inside the pipes, and rigid bracing may be needed. Vertical piping typically needs support only at each story height.

Piping Support		
material	**maximum horizontal spacing**	**maximum vertical spacing**
ABS pipe	4 ft	10 ft
aluminum tubing	10 ft	15 ft
brass pipe	10 ft	10 ft
cast-iron pipe	5 ft	15 ft
copper or copper-alloy pipe	12 ft	10 ft
copper or copper-alloy tubing (1¼-inch diam. and smaller)	6 ft	10 ft
copper or copper-alloy tubing (1½-inch diam. and larger)	10 ft	10 ft
cross-linked polyethylene (PEX) pipe	2.67 ft	10 ft
cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) pipe	2.67 ft	4 ft
CPVC pipe or tubing (1 inch and smaller)	3 ft	10 ft
CPVC pipe or tubing (1¼ inch and larger)	4 ft	10 ft
lead pipe	continuous	4 ft
PB pipe or tubing	2.67 ft	4 ft
polyethylene/aluminum/ polyethylene (PE-AL-PE) pipe	2.67 ft	4 ft
polypropylene (PP) pipe or tubing (1 inch and smaller)	2.67 ft	10 ft
polypropylene (PP) pipe or tubing (1¼ inch and larger)	4 ft	10 ft
PVC pipe	4 ft	10 ft
stainless steel pipe	10 ft	10 ft
steel pipe	12 ft	15 ft

QUIZ on SECTION 11

1. Hangers and strapping should be of approved material that will not promote _____ action.

- a wavey
- galvanic
- hard

2. The maximum horizontal spacing for PVC drainage pipe is _____ feet.

- 8
- 2½
- 4

3. The maximum horizontal spacing for supporting cast-iron pipe is _____ feet.

- 15
- 5
- 2

Answer Key to Quiz on Section 11

1. Hangers and strapping should be of approved material that will not promote galvanic action.
2. The maximum horizontal spacing for PVC drainage pipe is 4 feet.
3. The maximum horizontal spacing for supporting cast-iron pipe is 5 feet.

SECTION 12: STORM DRAINAGE

Storm Drainage Basics

Storm drainage is the system of collecting and transporting away from a dwelling the rainwater, groundwater, and storm water typically associated with rainfall. Connection of floor drains to the storm drainage system is not permitted. Storm water, rainwater and groundwater should not be drained into a sewer system. The rainwater should drain to an acceptable point of disposal, such as a retention basin, river, stream, pond, public storm sewer system, or to the surrounding land if it does not adversely affect the building.

Ground surface of the lot should be graded so as to drain surface water away from foundation walls. The grade should be dropped a minimum of 6 inches (152 mm) within the first 10 feet. Where the site does not allow for the necessary fall away from the structure, drains or swales could be used.

Gutters and downspouts, or other means, should prevent rainwater from washing soil away from the dwelling's foundation or building up around and increasing groundwater pressure on basement walls. The size of a drainage pipe should not be reduced in the direction of flow.

Note: In the photo above, the best practice would have the holes in the PVC downspout extension facing downward to facilitate draining.

QUIZ on SECTION 12

1. Storm water, rainwater or groundwater should not be drained into a _____.

- hole in the ground
- drain pipe
- outdoor drainage grate
- lake
- sewer system

2. Ground surface of the lot should be graded so as to drain surface water away from foundation walls. The grade should be dropped a minimum of _____ inches within the first 10 feet.

- 10
- 18
- 24
- 6

Answer Key to Quiz on Section 12

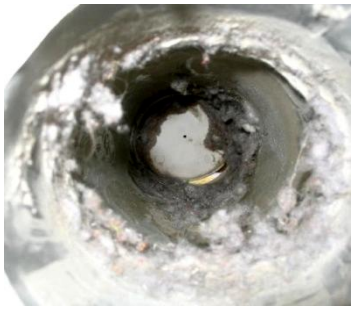
1. Storm water, rainwater or groundwater should not be drained into a sewer system.

2. Ground surface of the lot should be graded so as to drain surface water away from foundation walls. The grade should be dropped a minimum of 6 inches within the first 10 feet.

SECTION 13: DRYER SYSTEMS

Dryer Exhaust Systems: The Basics

Clothes dryer exhausts emit exhaust air that is laden with moisture and lint. The air must be vented to the outside. It must not be discharged into an attic or crawlspace because wood structural members could be adversely affected by excessive moisture, and the accumulation of lint could pose a fire hazard.



Photos above show clogged lint traps and vents, and dryer hoses that do not vent to the outside.

Length

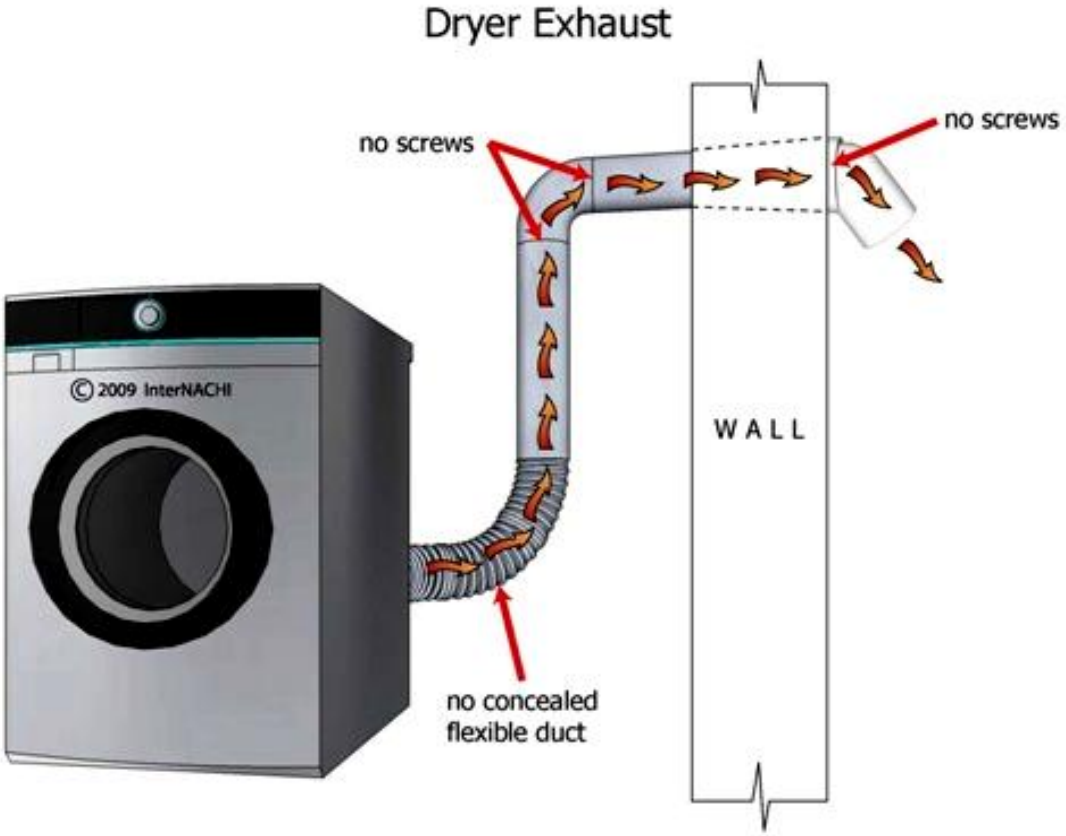
The maximum length of a clothes dryer exhaust duct should not exceed 25 feet from the dryer's location to the wall or roof termination. The maximum length is reduced by 2½ feet (762 mm) for each 45° (0.8 rad) bend, and 5 feet for each 90° (1.6 mm) bend. The maximum length does not include the transition duct. There are some exceptions to this rule, including powered-fan exhaust systems for dryers.

Terminations

Exhaust outlets should be equipped with backdraft dampers to prevent cold air, rain, snow, rodents and vermin from entering the vent. Screens are not permitted at the duct termination. The dryer exhaust should terminate not less than 3 feet in any direction from openings into buildings, including openable windows, doors and air intakes.

Connections

Ducts should not be connected or installed with sheet-metal screws or other fasteners that will obstruct the air flow. Ducts should not extend into or through ducts or plenums. The exhaust duct should be a minimum size of 4 inches (102 mm) in diameter. Transition ducts should not be concealed within construction.

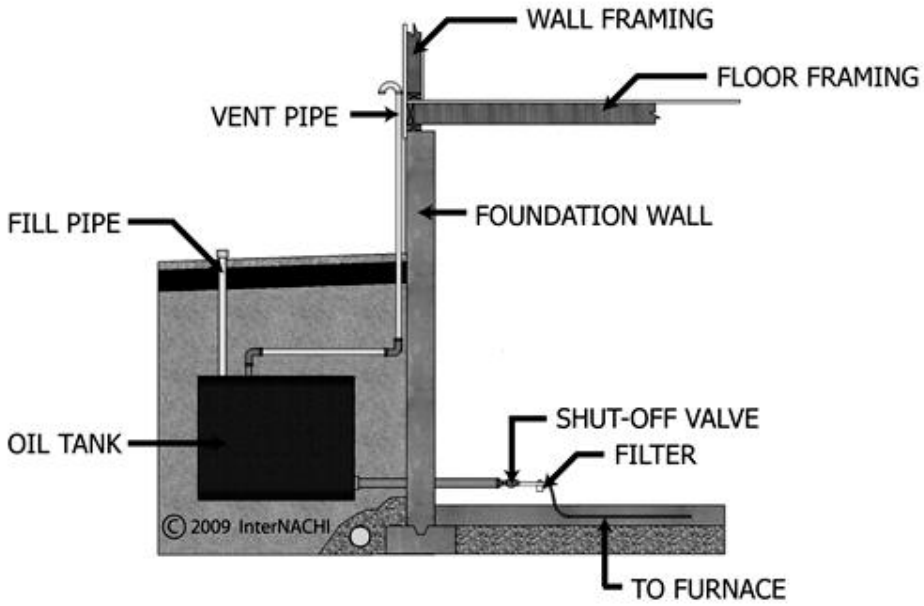


SECTION 14: FUEL

Oil Storage Tanks

Tanks should be listed and labeled, and conform to standards for underground and above-ground tanks. The maximum amount of fuel oil stored above ground or inside a dwelling should be 660 gallons (2,498 L). The cross-connection of two tanks is permitted if the total aggregate capacity does not exceed 660 gallons. Gravity flow from one tank to another is permitted, provided that the two tanks are on the same horizontal plane.

BURIED OIL STORAGE TANK

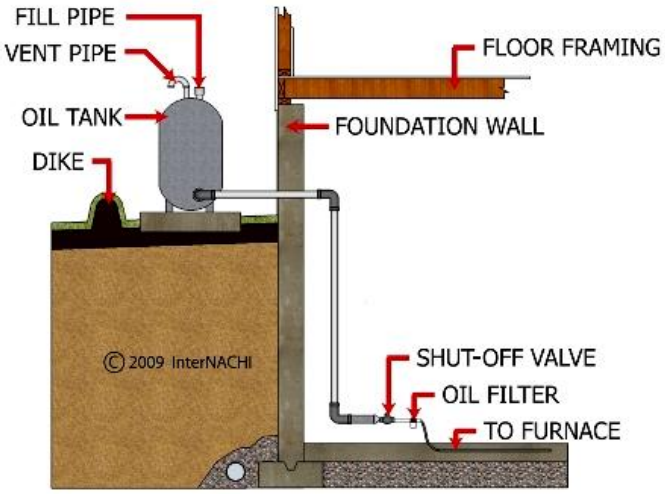


Inside and Outside

Tanks for use inside of dwellings should be of such size to permit installation and removal from dwellings as whole units. Any tank larger than 10 gallons (38 L) should be at least 5 feet from any fire or flame of any fuel-burning appliance.

Tanks located outside and above ground should be at least 5 feet from an adjoining property line. Tanks outside should be protected from the weather and from physical damage. Tanks should have a fuel-level gauge. Glass gauges should not be used. In areas prone to flooding, tanks should be installed at or above the flood elevation, or should be anchored to prevent floatation, collapse or lateral movement under flood conditions.

EXTERIOR ABOVE-GROUND OIL STORAGE TANK



Oil Tank Supply

Exterior above-ground fill and vent piping should be removed when tanks are abandoned or removed. Fill piping should terminate outside of the dwelling at a point at least 2 feet (610 mm) from any building opening at the same or a lower level. Supply piping should not be smaller than 3/8-inch (9 mm) pipe, or 3/8-inch outside-diameter tubing, and the copper tubing should be a minimum of Type L.

Oil Tank Vents

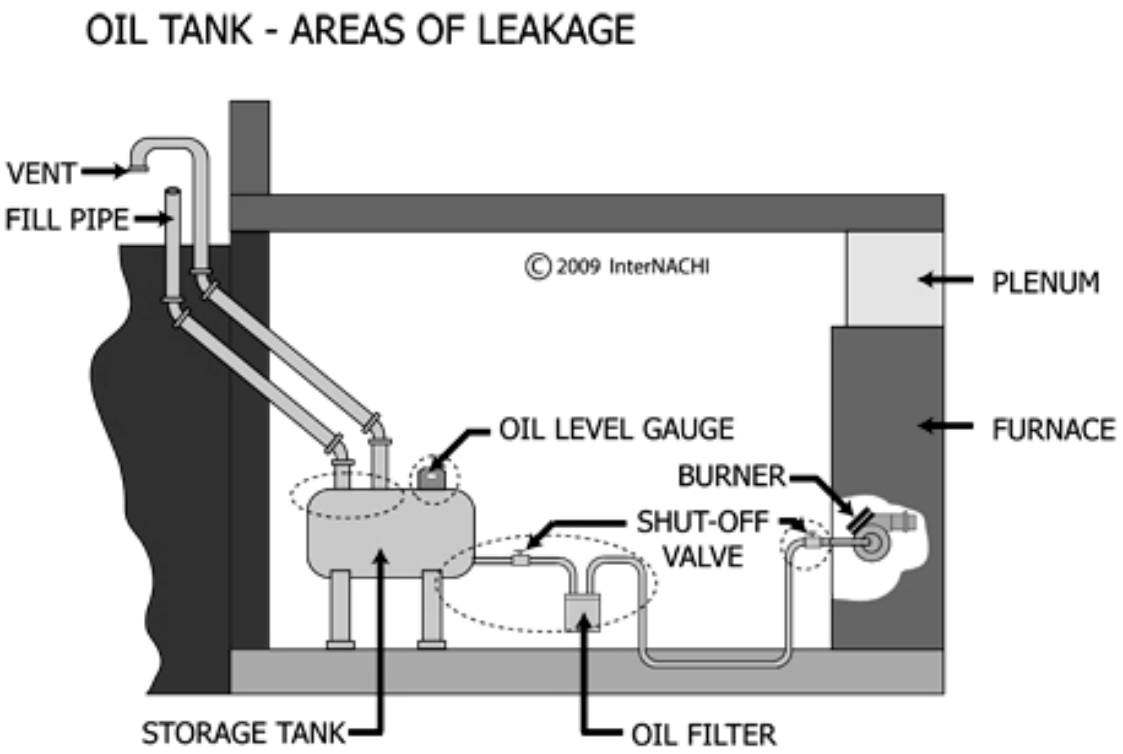
Vent piping should not be smaller than 1¼-inch (32 mm) pipe. Vent piping should slope toward the tank. The lower end of the vent pipe should enter through the top of the tank. Vent piping should terminate outside of dwellings at a point not less than 2 feet (610 mm) measured vertically and horizontally from any dwelling's opening.

Oil Supply Lines

Oil supply lines move the oil from the storage tank to the burner at the equipment or appliance. They are typically made of 3/8-inch copper tubing. Lines should be protected with a hard plastic sleeve. Lines should not be buried inside a concrete floor or a bed of mortar. An oil filter and a shut-off valve should be installed on the supply line coming from the oil storage tank.

Oil Tank Defects

Common problems include leaks at the oil tank, strong odors, improperly supported legs, rust and corrosion damage at the tank legs, missing caps at the pipes, a damaged gauge, and/or excessive rust and corrosion on the tank. An oil filter may be missing, leaking or dirty.


OIL TANK - AREAS OF LEAKAGE
VENT
FILL PIPE
© 2009 InterNACHI
PLENUM
FURNACE
OIL LEVEL GAUGE
BURNER
SHUT-OFF VALVE
STORAGE TANK
OIL FILTER

Underground Fuel-Gas Piping

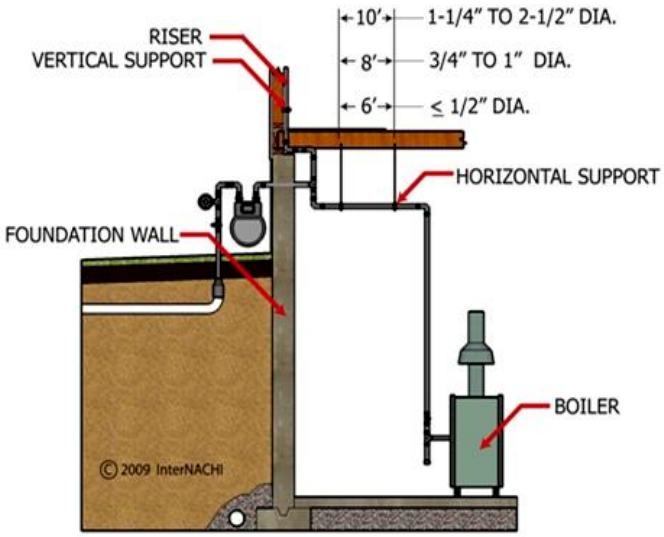
Underground piping for fuel gas should be installed at a minimum depth of 12 inches (305 mm) below the finish grade. A minimum of 8 inches is required for individual lines to outside lights, grills and other appliances. Metallic pipe and tubing exposed to corrosive elements, such as soil or moisture, should be protected in an approved manner.

Support for Fuel-Gas Piping

Fuel-gas piping should be supported at intervals not exceeding the spacing listed in the table below.

Support for Fuel-Gas Piping			
nominal size of steel pipe (in inches)	**spacing of supports (in feet)**	**nominal size of smooth-wall tubing (in inches per outside diameter)**	**spacing of supports (in feet)**
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1¼ or larger	10	7/8	8
1¼ or larger (vertical)	at every floor level	1 or larger (vertical)	at every floor level
1 inch = 25.4 mm; 1 foot = 304.8 mm			

GAS PIPING SUPPORT



Fuel-Gas Sediment Traps

Most fuel-gas appliance manufacturers require the installation of a sediment trap. Sediment traps prevent debris from entering the gas controls and causing hazardous malfunctions. A sediment trap should be installed downstream of the equipment's shut-off valve as close to the inlet of the equipment/appliance as possible. Sediment traps cause the gas flow to change direction 90° at the sediment-collection point. The solids and contaminants in the fuel will drop out of the gas flow at the collection point. The sediment trap could be constructed as a tee-fitting with a capped nipple at the bottom of the opening of the run of the tee.

Fuel-Gas Pressure Regulators

A line pressure regulator should be installed where the appliance is designed to operate at a lower pressure than the supply pressure. Access should be provided to all pressure regulators. They should be protected from physical damage. Pressure regulators that require vents should be vented directly to the outdoor air.

Pictured above: a fuel-gas pressure regulator

Shut-Off Valves for Fuel-Gas Appliances

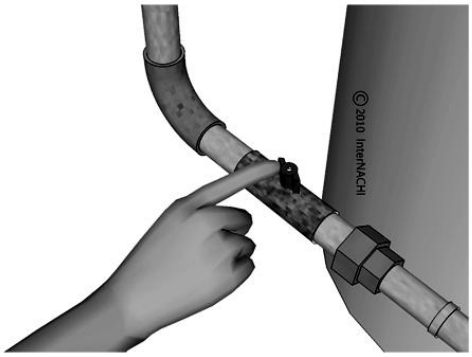
Each piece of equipment and appliance should be provided with a shut-off valve which is separate from the appliance to permit maintenance, repair, replacement and temporary disconnection. The shut-off valve should be adjacent to the appliance, no farther away than 6 feet, conspicuously located, and within reach.

Shut-off valves should not be located in concealed locations, and shall have access provided. They should be easily located and operated in the event of an emergency. For example, a gas shut-off valve for an appliance on the first floor should not be located in the basement. There is an exception for decorative appliances.

A shut-off valve should be installed ahead of any flexible (semi-rigid) appliance fuel connector. It should not be less than the nominal size of the connector.

Gas outlets that do not connect to appliances should be capped gas-tight in case the shut-off valve opens or fails.

Every gas meter should be equipped with a shut-off valve located on the supply-side of the meter.



Fuel Connectors

Flexible (semi-rigid) appliance fuel connectors are typically used with cooking ranges and clothes dryers where the gas connection is located behind the appliance. Some degree of flexibility is needed to facilitate the hook-up of the appliance. Flexible connectors are usually made of brass or stainless steel. They should be labeled with tags of metal rings placed over the tubing.

Connectors should have an overall maximum length of 3 feet, except for range and clothes dryer connections which should not exceed 6 feet in length. Only one connector should be used for each individual appliance. Connectors should not be concealed within or passed through walls, floors, partitions, ceilings or appliance housings, with the exception of fireplace inserts.

Fuel-Gas Venting Systems

Connectors should be used to connect an appliance and equipment to the vertical chimney or vent, except were the chimney or vent is attached directly to the appliance. The vent connector should be as short as practical, and the appliance should be located as close as practical to the chimney or vent.

All vent pipes should be listed and labeled. The type and size of the vent for each fuel-gas appliance are dictated by the appliance manufacturer's installation instructions. The design and installation instructions presented by the vent manufacturer should be followed when designing a vent system. Various types of vents are listed in the building standard, along with the corresponding types of appliances that can be served by the vent, which include, but are not limited to:

- Type B gas vents;
- single-wall metal pipes;
- Type L plastic vents for Category IV appliances; and
- Type BW vents.

Where two or more vent connectors enter a common gas vent, chimney flue, or single-wall metal pipe, the smaller connector should enter at the highest level consistent with the available head room or clearance to combustible material. Vent connectors serving Category I appliances (those with a natural draft and no condensate produced) should not be connected to any portion of a mechanical draft system operating under positive static pressure, such as those serving Category III and IV appliances (those with a draft-inducer fan and producing condensate).

Vent connectors should be installed without dips or sags and should slope upward toward the vent or chimney at least a ¼-inch per foot (21 mm/m). There's an exception for mechanical draft systems.

Insulation Shields

Insulation shields should be installed in attics to prevent the insulation from coming into contact with chimneys. The attic shield creates air space between the chimney and the insulation material. Where vents pass through insulated assemblies, an insulation shield constructed of not less than 26-gauge sheet metal (0.016 inch or 0.4 mm) should be installed to provide clearance between the vent and the insulation material. Where vents pass through attic space, the shield should terminate not less than 2 inches (51 mm) above the insulation materials, and should be secured in place to prevent displacement.

Factory-Built Chimneys Serving Fuel Gas

A factory-built chimney should be installed according to the manufacturer's instructions. All pre-fabricated chimneys must have a label from an approved agency. The label should state the type of appliance with which the chimney was tested for use, a reference to the manufacturer's instructions, and the minimum clearances to combustibles. The manufacturer's instructions should contain every aspect of the installation of the chimney, including component assembly, clearances, supports, terminations, fire-blocking or fire-stops, and connections.

Chimney Connections

Connector vent pipes should connect to a masonry chimney flue at a point not less than 12 inches (305 mm) above the lowest portion of the interior of the chimney flue. Abandoned inlet openings in chimneys and vents should be closed by an approved method.

Fuel-Gas Vent Terminations

It is a common mistake to apply chimney termination-height requirements to fuel vents, which cause vents to extend above roofs much higher than needed, in most cases. For example, vent pipes terminating above roof pitches up to 6/12 need to be only 1 foot high.

Gas vents that are 12 inches (305 mm) or less in size and located at least 8 feet from a vertical wall or similar structure should terminate above the roof in accordance with the table that follows.

Gas Vent Terminations	
Roof Pitch	**Minimum Height in Feet (& in Meters)**
flat to 6/12	1 (0.30)
6/12 to 7/12	1¼ (0.38)
over 7/12 to 8/12	1½ (0.46)
over 8/12 to 9/12	2 (0.61)
over 9/12 to 10/12	2½ (0.76)
over 10/12 to 11/12	3¼ (0.99)
over 11/12 to 12/12	4 (1.22)
over 12/12 to 14/12	5 (1.52)
over 14/12 to 16/12	6 (1.83)
over 16/12 to 18/12	7 (2.13)
over 18/12 to 20/12	7½ (2.27)
over 20/12 to 21/12	8 (2.244)

The table requirements indicate that a greater vent height above the roof is needed as the roof pitch approaches being a vertical surface. The greater the roof pitch, the greater the effect of the wind hitting the roof's surface.

Gas vents that are greater than 12 inches (305 mm) in size, or which are located less than 8 feet from a vertical wall or similar structure, should terminate at least 2 feet (610 mm) above the highest point where they pass through the roof, and not less than 2 feet above any portion of a dwelling within 10 feet horizontally. There are other requirements for direct-vent fireplaces, appliances with integral vents, and appliances using mechanical draft fans.




Automatic Dampers

An automatic flue damper is an energy-saving device that closes off or restricts an appliance flue when the appliance is not operating and is in its “off” cycle. It traps residual heat in the heat exchanger after the burners shut off, and prevents the escape of conditioned air up the vent pipe.

An automatic vent damper should be labeled and of a listed type. The installation of an automatic damper must be in strict accordance with the manufacturer’s installation instructions. A malfunctioning or improperly installed damper could cause malfunction and a discharge of combustion byproducts into the dwelling's interior.

A manual damper should be used only with a solid fuel-burning appliance, and not with a gas-fired appliance. The user of a solid fuel-burning appliance would be aware of a closed or malfunctioning manual damper because of the smoke. The user of a gas-fired appliance may not know of a partially closed or malfunctioning manual damper, and a hazardous condition would develop.


QUIZ on SECTION 14

1. A _____ damper should be used only with a solid fuel-burning appliance, and not with a gas-fired appliance.

- 4-inch diameter
- flow-reducing
- manual
- automatic

2. The cross-connection of two oil storage tanks is permitted if the total aggregate capacity does not exceed ____ gallons.

- 2,000
- 660
- 1,220

3. A sediment trap should be installed _____ of the equipment's shut-off valve and as close to the inlet of the equipment/appliance as possible.

- downstream
- upstream
- in lieu

4. Where two or more vent connectors enter a common gas vent, chimney flue, or single-wall metal pipe, the _____ connector should enter at the highest level consistent with the available head room or clearance to combustible material.

- double-walled
- larger
- greatest
- smaller

5. Gas vent pipes terminating above roof pitches up to 6/12 need to be _____ high.

- at least 10 feet
- at least 3 feet
- 1 foot

Answer Key is on next page.

Answer Key to Quiz on Section 14

1. A manual damper should be used only with a solid fuel-burning appliance, and not with a gas-fired appliance.

2. The cross-connection of two oil storage tanks is permitted if the total aggregate capacity does not exceed 660 gallons.

3. A sediment trap should be installed downstream of the equipment's shut-off valve and as close to the inlet of the equipment/appliance as possible.

4. Where two or more vent connectors enter a common gas vent, chimney flue, or single-wall metal pipe, the smaller connector should enter at the highest level consistent with the available head room or clearance to combustible material.

5. Gas vent pipes terminating above roof pitches up to 6/12 need to be 1 foot high.

SECTION 15: INSPECTION CHECKLIST

Plumbing systems in the home cover not just the water supply, waste and vents, but many other areas. Normally, any evaluation of the plumbing also includes other supply piping, such as gas and oil lines.

The following inspection guidelines are excerpted from InterNACHI's *Residential Standards of Practice,* reiterated here for the inspector's review:

2.6. Plumbing

I. The inspector shall:

A. inspect and determine if the water supply is public or private;
B. verify the presence of and identify the location of the main water shut-off valve;
C. inspect the water heating equipment, including venting, connections, energy-source supply system, and seismic bracing, and verify the presence or absence of temperature-pressure relief valves and/or Watts 210 valves;
D. flush toilets;
E. water-test a representative number of sinks, tubs and showers for functional drainage;
F. inspect the interior water supply, including all fixtures and faucets;
G. inspect the drain, waste and vent systems, including all fixtures;
H. describe any visible fuel-storage systems;
I. inspect the drainage sump pumps, and test pumps with accessible floats;
J. inspect and describe the water supply, drain, waste and main fuel shut-off valves, as well as the location of the water main and main fuel shut-off valves;
K. inspect and report as in need of repair deficiencies in the water supply by viewing the functional flow in two fixtures operated simultaneously;
L. inspect and report as in need of repair deficiencies in installation and identification of hot and cold faucets;
M. inspect and report as in need of repair mechanical drain stops that are missing or do not operate if installed in sinks, lavatories and tubs; and
N. inspect and report as in need of repair commodes that have cracks in the ceramic material, are improperly mounted on the floor, leak, or have tank components which do not operate.

Most computerized reporting systems include a field that identifies the location of the main water shut-off valve. Some inspectors also physically tag it as a future aid to the home buyer. Caution must be exercised with old shut-off valves, as they can easily leak when they have not been operated in some time. Evaluation of the supply should also include the materials of the supply and waste piping.

It should be determined whether the water supply is from a private well or a public supply. Often, an inspector will recommend water testing of private water sources to determine the safety of the supply.

The water heating system must be identified and described, and its visible condition reported on. Special care should be taken to evaluate the TPR valve and discharge line. It is not required to operate the TPR valve, but it needs to be present and should have a proper discharge line and termination. Many regions also require that the tank be strapped due to potential seismic issues.

All toilets should be fully evaluated, and the inspection report should reflect any deficiencies in water supply, waste service, connection to the floor, and obvious defects, such as cracked lids. It is common to find rotted sub-flooring adjacent to the toilet due to leakage around the mounting flange.

The most common procedure used when evaluating plumbing fixtures is to stopper the sinks, run the faucets (noting their operation), then unplug the sink and inspect the waste and its connections for signs of leakage. Damp stains in the bottom of cabinetry are a reliable sign of previous or ongoing problems that should be reported on. Fixtures that are slow to drain should also be reported, as these can be signs of blockage or poor ventilation in the system.

Inspectors should report on the functional flow of water through the fixtures. The most common method is to run two or more faucets or fixtures at the same time. Significant drops in flow at an individual faucet during this test can be a sign of either poor supply pressure or partially clogged piping, which would require further evaluation. Some inspectors use a pressure and flow meter, but this is not required.

Fuel supply lines and storage devices should also be inspected and described, such as gas lines and their shut-offs, oil tanks and their locations (if known), and any propane or LPG tanks.

Any sump pumps, if accessible, should be evaluated and operated during the plumbing inspection, with any deficiencies noted.

II. The inspector is not required to:

A. light or ignite pilot flames;
B. determine the size, temperature, age, life expectancy or adequacy of the water heater;
C. inspect interiors of flues or chimneys, combustion-air systems, water-softening or filtering systems, well pumps or tanks, safety or shut-off valves, floor drains, lawn sprinkler systems or fire sprinkler systems;
D. determine the exact flow rate, volume, pressure, temperature or adequacy of the water supply;
E. determine the water quality, potability or reliability of the water supply or source;

F. open sealed plumbing access panels;
G. inspect clothes washing machines or their connections;
H. operate any main, branch or fixture valve;
I. test shower pans, tub and shower surrounds, or enclosures for leakage;
J. determine the system's compliance with local or state conservation or energy standards, or evaluate the proper design or sizing of any water, waste or venting components, fixtures or piping;
K. determine the effectiveness of anti-siphon, back-flow prevention or drain-stop devices;
L. determine whether there are sufficient cleanouts for effective cleaning of drains;
M. evaluate gas, liquid propane or oil storage tanks;
N. inspect any underground or concealed fuel supply systems;
O. inspect any private sewage waste disposal system or component thereof;
P. inspect water treatment systems or water filters;
Q. inspect water storage tanks, pressure pumps or bladder tanks;
R. evaluate the wait time to obtain hot water at fixtures, or perform testing of any kind to water heater elements;
S. evaluate or determine the adequacy of combustion air;
T. test, operate, open or close safety controls, manual stop valves and/or temperature or pressure-relief valves;
U. examine ancillary systems or components, such as, but not limited to, those relating to solar water heating or hot water circulation; or
V. determine the existence or condition of polybutylene plumbing.

As in the case of heating boilers, the inspector is not required to ignite pilot lights, and should never start any system that has been shut down. There are many tales of inspectors who, in an effort to be helpful, have activated a plumbing system, only to have a major flood on their hands!

While the age and size of a water heater can often be determined from the data plate, it is usually a mistake to guess how well it will meet the future loads placed on it and, especially, how long it is likely to last. There are too many variables that come into play, such as usage, maintenance and water quality.

Many inspectors have fallen into the trap of, in effect, warranting a system, only for that system to fail soon after or be shown to be inadequate for new needs.

The inspector can comment and report only on what s/he can see. The inspector is not required to remove any normally fixed access panels. Many plumbing components are hidden in this way and are, therefore, not available for inspection. Bath and shower drains are examples of components that simply cannot be visibly inspected. The internal parts of other components, such as the bladder in a pressure tank, are inaccessible and, generally, cannot be evaluated for their condition.

Evaluation of septic and other sewage systems is, likewise, beyond the capabilities of most inspectors and, in many states, is a separately licensed profession.

Inspection of sprinkler systems and irrigation equipment is not required by these *Standards.*

Finally, water filtration, water softening or other treatment systems and equipment should be evaluated and serviced by the original installers and manufacturers' agents.

Checklist for Bathroom Fixtures:

- Fully open cold water faucet at lavatory.
- Fully open cold water faucet at bathtub. Note any pressure or flow changes.
- Close faucets.
- Fully open hot water faucet at lavatory.
- Fully open hot water faucet at bathtub. Note any pressure or flow changes. Note water temperature.
- Confirm that, when facing the fixtures' handles, the left side controls the hot water.
- Close drainage stoppers.
- Check the traps, waste piping, and water supply valves and pipes.
- Engage the showerhead. Note pressure and flow.
- Flush the toilet.
- Note pressure and flow at showerhead.
- Close faucets, leaving a few inches of water in the lavatory and bathtub.
- Flush toilet and open the drain stoppers of the lavatory and bathtub at the same time. Note drainage and listen for gurgling.
- Observe drainage. Note slow or clogged drains.
- Don't leave the water running unattended. Some inspectors will run water in two bathrooms simultaneously.

QUIZ on SECTION 15

1. When inspecting toilets, inspectors should check:

- attachments
- cracks in the bowl
- waste connections
- water supply
- all of these

2. T/F: Inspectors should flush all toilets.

- True
- False

3. T/F: All visible wastes, drains and vents should be inspected.

- True
- False

4. Reporting on the inspection of the water heater should include the _____.

- age of the unit
- presence of a TPR valve
- size of the unit
- identification of any sludge buildup

5. T/F: It is not necessary to report on leaky faucets.

- True
- False

6. T/F: Inspectors should determine whether the water supply is public or private.

- True
- False

(continued)

7. T/F: Inspectors should identify main water and fuel shut-off valves.

- True
- False

8. Functional water flow should be evaluated by _____.

- running two faucets simultaneously
- using a pressure and flow meter
- the local utility company only

9. When evaluating the water heater, the inspector should report on its _____.

- age
- fuel type
- total capacity
- life expectancy

10. Mechanical drain stoppers should be reported as _____ if missing or if not working properly.

- in need of repair
- a significant defect
- a structural failure

11. T/F: The plumbing inspection report should include the types of supply piping inspected.

- True
- False

12. T/F: Inspectors are required to operate all plumbing and fuel shut-off valves.

- True
- False

13. T/F: Sump pumps are not included as part of a home inspection.

- True
- False

(continued)

14. T/F: The inspector must determine the potability of the water supply.

- True
- False

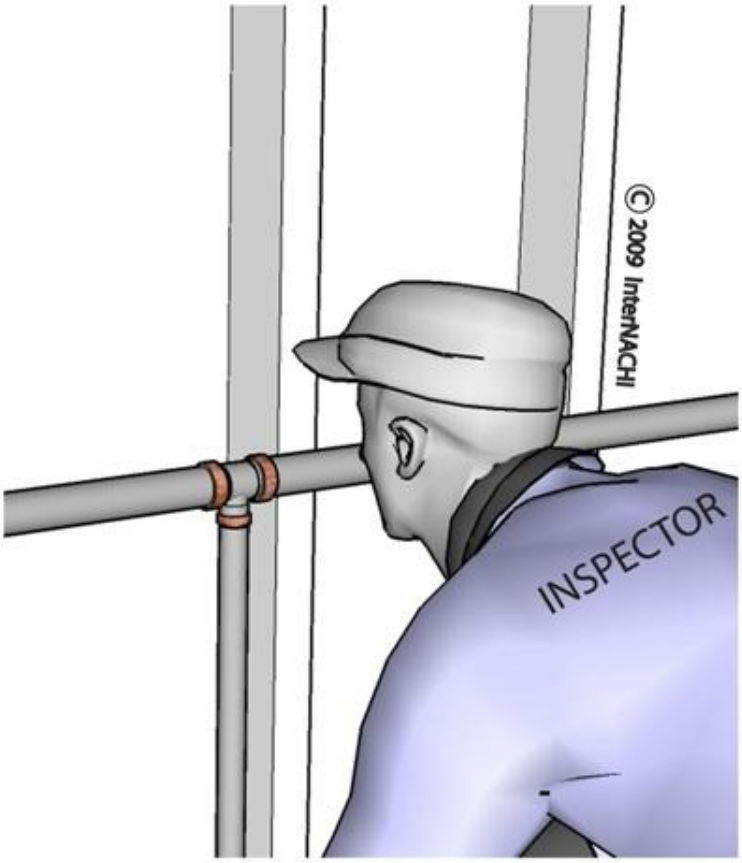
15. T/F: The inspector must guarantee that shower pans and bath wastes are free of leaks.

- True
- False

16. T/F: Evaluating water softeners and purifiers is part of a home inspection.

- True
- False

Answer Key is on next page.



Answer Key to Quiz on Section 15

1. When inspecting toilets, inspectors should check all of these.

2. T/F: Inspectors should flush all toilets.
   Answer: True

3. T/F: All visible wastes, drains and vents should be inspected.
   Answer: True

4. Reporting on the inspection of the water heater should include the presence of a TPR valve.

5. T/F: It is not necessary to report on leaky faucets.
   Answer: False

6. T/F: Inspectors should determine whether the water supply is public or private.
   Answer: True

7. T/F: Inspectors should identify main water and fuel shut-off valves.
   Answer: True

8. Functional water flow should be evaluated by running two faucets simultaneously.

9. When evaluating the water heater, the inspector should report on its fuel type.

10. Mechanical drain stoppers should be reported as in need of repair if missing or if not working properly.

11. T/F: The plumbing inspection report should include the types of supply piping inspected.
    Answer: True

12. T/F: Inspectors are required to operate all plumbing and fuel shut-off valves.
    Answer: False

13. T/F: Sump pumps are not included as part of a home inspection.
    Answer: False

14. T/F: The inspector must determine the potability of the water supply.
    Answer: False

15. T/F: The inspector must guarantee that shower pans and bath wastes are free of leaks.
    Answer: False

16. T/F: Evaluating water softeners and purifiers is part of a home inspection.
    Answer: False

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