

Larry Daniels Training Center

Plumbing topics

Safety

(Practice working safe)

45 min

Reference: *Ultimate Guide Plumbing* page 5

Safety is not just personal protection; it's also about protecting the innocent people around you. In this video, the “plumber” had no personal safety equipment on. Water was flowing into the electrical lights below and into electrical panels. The ceilings below crashed down because of the large amounts of water saturating the drywall. This “plumber” not only didn’t practice safety for himself. He put everyone around him into unsafe conditions. Working safe is smart! There is no reason to take chances.

Example: always have a fire extinguisher ready when soldering inside of a building. Let the management team know that there is a chance something can go wrong and an alternative plan should be put together just in case.













Fire extinguisher

Pick the right one

FIRE CLASSIFICATIONS

**BEFORE
USING A FIRE
EXTINGUISHER
LOOK FOR ONE OF
THE FOLLOWING
SYMBOLS
THESE SYMBOLS
INDICATE WHAT
TYPES OF FIRES
AN EXTINGUISHER
IS MEANT TO
BE USED ON**

LETTER SYMBOL:	PICTURE SYMBOL:	FOR USE ON:
		ORDINARY COMBUSTIBLES SUCH AS TRASH, PAPER, WOOD AND TEXTILES
		FLAMMABLE LIQUIDS
		ELECTRICAL EQUIPMENT
		COMBUSTIBLE METAL
		COMBUSTIBLE COOKING MEDIA

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Ladder safety

LADDER SAFETY

DO'S

- 1 Do maintain 3 points of contact on the extension ladder
- 2 feet & 1 hand or
- 2 hands & 1 foot
- 2 Do place the extension ladder on level, solid ground
- 2 Do position the extension ladder at a safe 4:1 angle. For every 4 feet up, the feet of the ladder go out 1 foot from the wall
- 4 Do face the extension ladder when climbing or ascending
- 5 Do use a co-worker to hold the bottom of the extension ladder so it doesn't move
- 6 Do make sure all extension ladder locks are engaged
- 7 Do stay centered on the extension ladder

DON'TS

- 1 Don't use the wrong height or type of ladder for the job
- 2 Don't position the top of any ladder at such a low angle on the wall. This low angle can cause the ladders feet to slip, moving rapidly backward, while simultaneously causing the top of the ladder to come crashing down with who's on it to come crashing down, possibly resulting in severe injuries
- 3 Don't carry a heavy object or load that can cause you to fall
- 4 Don't use the top two steps of any ladder
- 5 Don't over reach or lean to the side



ALPHA

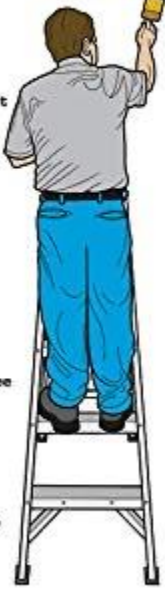
LADDER SAFETY

DO'S

- 1 Do maintain 3 points of contact on the step ladder:
- 2 feet & 1 hand or
- 2 hands & 1 foot
- 2 Do place the step ladder on level ground, solid and an unmoveable surface
- 3 Do face the step ladder when ascending or descending
- 4 Do stay centered on the step ladder
- 5 Do fully open the step ladder and lock supports in place
- 6 Do brace yourself with your free hand if possible
- 7 Do carry tools in a toolbelt or pouch not in your hands
- 8 Do use a step ladder with non-slip feet
- 9 Do use the right height of step ladder for the job
- 10 Do inspect the step ladder before using it

DONT'S

- 1 Don't overreach so you lose your balance and fall possibly causing severe injuries
- 2 Don't ever use the top two steps of the step ladder as it can collapse under you and lead to crippling injuries
- 3 Don't move or shift the step ladder while someone is on it
- 4 Don't place the step ladder on uneven ground, moveable objects, or a soft surface
- 5 Don't carry a heavy object or load that can cause you to lose your balance
- 6 Don't fold up and lean the step ladder against a wall or surface



ALPHA

Lifting

SAFE LIFTING TIPS

Bend your knees

Bend your knees, and not your waist. This helps keep your center of balance and lets your leg muscles do the lifting.



"Hug the load"

Try to hold the object you're lifting as close to your body as possible as you gradually straighten into a standing position.



Avoid twisting

Twisting can overload your spine and lead to serious injury. Make sure your feet, knees, and torso are pointed in the same direction when you are lifting.



Get help

Get help with heavy, awkward or long items.



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WRONG



RIGHT



BEND KNEES
AND SQUAT

USE LEG MUSCLES,
NOT YOUR BACK

"HUG" ITEMS CLOSE
TO YOUR BODY

Tools

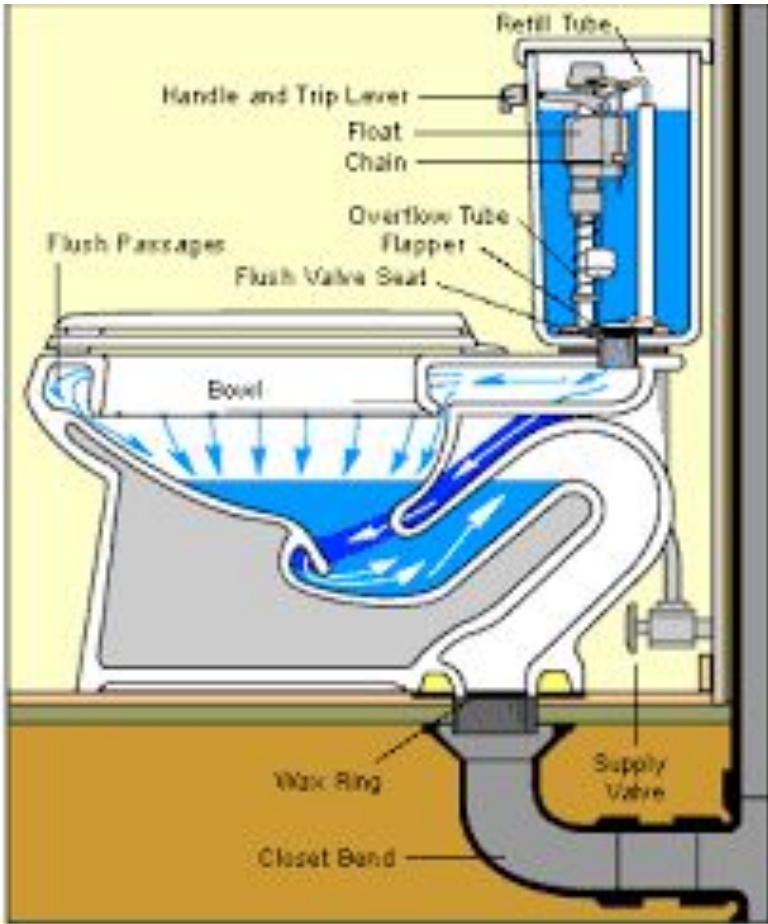
60 min

Reference: *Ultimate Guide Plumbing* pages 259 through 261





Toilets

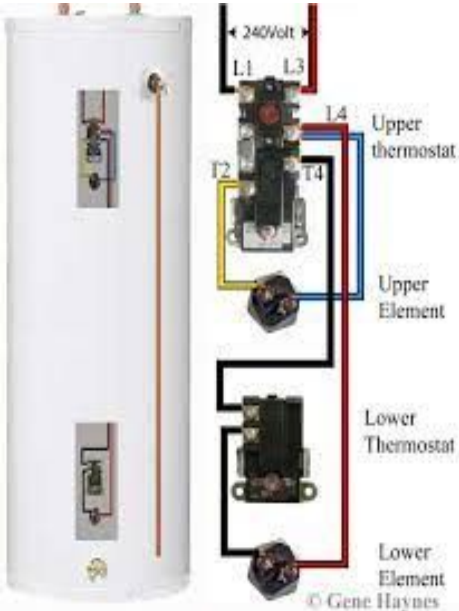


Water heaters

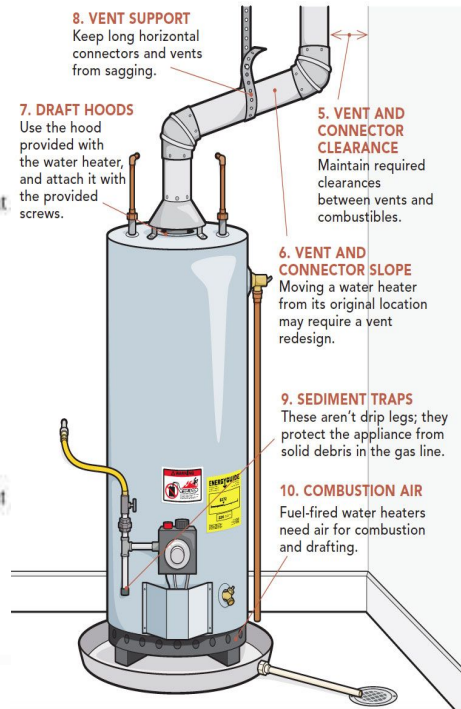
Reference: *Ultimate Guide Plumbing* pages 211 through 224

25 min

Electric WH 240 volt



Standard vent gas WH



Direct vent WH



Power direct vent WH



Gas water heaters

Reference: *Ultimate Guide Plumbing* pages 211 through 224

105 min

Gas heaters come in several different types depending on exhaust venting. **Standard vents** must run vertical and out the top of the structure. Single wall pipe can be used from the heater to the ceiling. Once the exhaust pipe passes through the room its located in, double wall venting “Type B vent” must be used to continue exhaust through the roof. Double wall vent pipe locks together and require an inch of clearance from combustibles. **Direct vent** water heaters vent horizontal. Direct vent heaters include a concentric vent system. The inner pipe is the exhaust. This exhaust pipe must be sealed with heat caulk provided in the exhaust kit. **Power direct vent** water heaters can be vented horizontal or vertical. This type of heater operates higher efficiency, which produces condensation, and must be vented in schedule 40 pressure pipe only. **Single pipe power direct vent** units pull combustion air from inside the structure needing more adequate combustion air. **Two pipe Power Vent** water heaters provide their own combustion air from outside and separate exhaust vent. This heater must also be piped in schedule 40 PVC pressure pipe with pressure fittings. All gas water heaters work on 5 inches of water column of gas pressure. Use a manometer to check for adequate gas pressure. When working with gas, always check for leaks, even on the surrounding pipes. Do Not Use Dish Soap. Two accurate ways to check for leaks are leak detection solution and a combustible gas leak detector. ** manometer

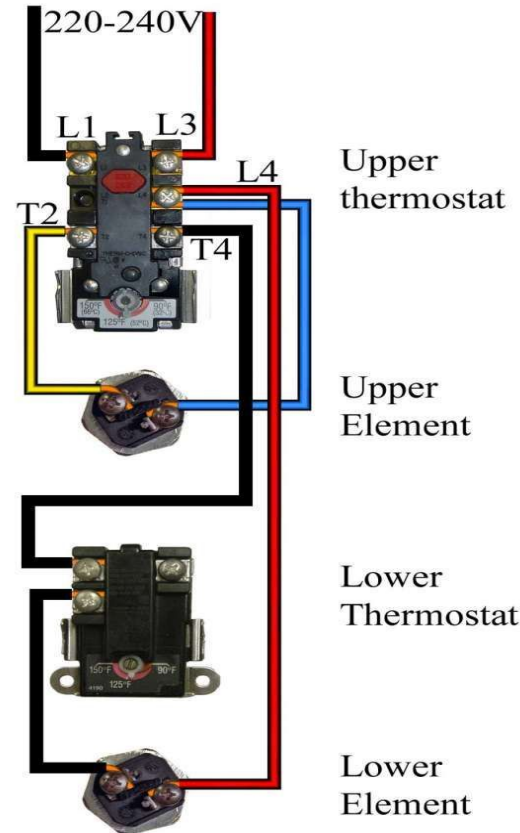


Electric water heater controls

Reference: *Ultimate Guide Plumbing* pages 211 through 224 65 min

Wire diagram 240 volt water heater 3500 watt / 4500 watt / 5500 watt units. High limit emergency cut off switch disconnecting power at 180 degrees.

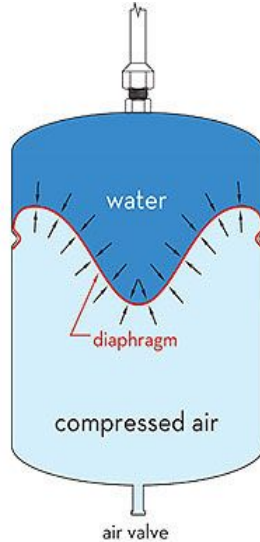
Operation on cold water temp start up: Upper element comes on first. When the upper thermostat is satisfied, it directs power to the lower element until the lower thermostat is satisfied. When hot water is drawn, the cold water enters the tank through a dip tube that sends cold water to the bottom of the tank. Cooling the lower thermostat makes the element will come back on. As the cold water reaches the upper thermostat, it will redirect power to the upper element. When the upper thermostat is satisfied, it directs power to the lower element until satisfied and repeating the process. Tools needed voltmeter with amp probe, thermometer, screw driver, element wrench, and needle nose pliers. ** voltmeter



Water heater thermal expansion tanks / T&P relief valve Reference: *Ultimate Guide Plumbing* pages 211 through 224 25 min

Thermal expansion tank controls the increased pressure generated within the normal operating temperature of a water heater in a closed loop situation. Thermal expansion tanks are pre charged at 55 PSI, if you need to add air pressure to match the building pressure do not exceeding 80 PSI. Max tested factory pressure is 150 PSI. Tanks can be installed upright or hanging down. Do not install the tank sideways. This will cause uneven wear on the bladder in the tank.

T&P relief valve set point 150 psi and 210 degrees. Never plug the end of the relief valve and always make accommodations for the drain pipe.



Drainage and vent system

Reference: *Ultimate Guide Plumbing* pages 275 through 295

90 min

- **Drainage system and vent system**

Common drainage piping materials are copper, clay tile, cast iron, PVC , and ABS.

Drain lines are designed to have $\frac{1}{4}$ inch per foot of pitch allowing solids to flow with the water.

Vent lines also have pitch upwards, vents maintain equal air flow in the system eliminating positive and negative pressures protecting the water in the traps.

- **Preventative maintenance:**

- Locate the building sewer connecting to the public sewer system.

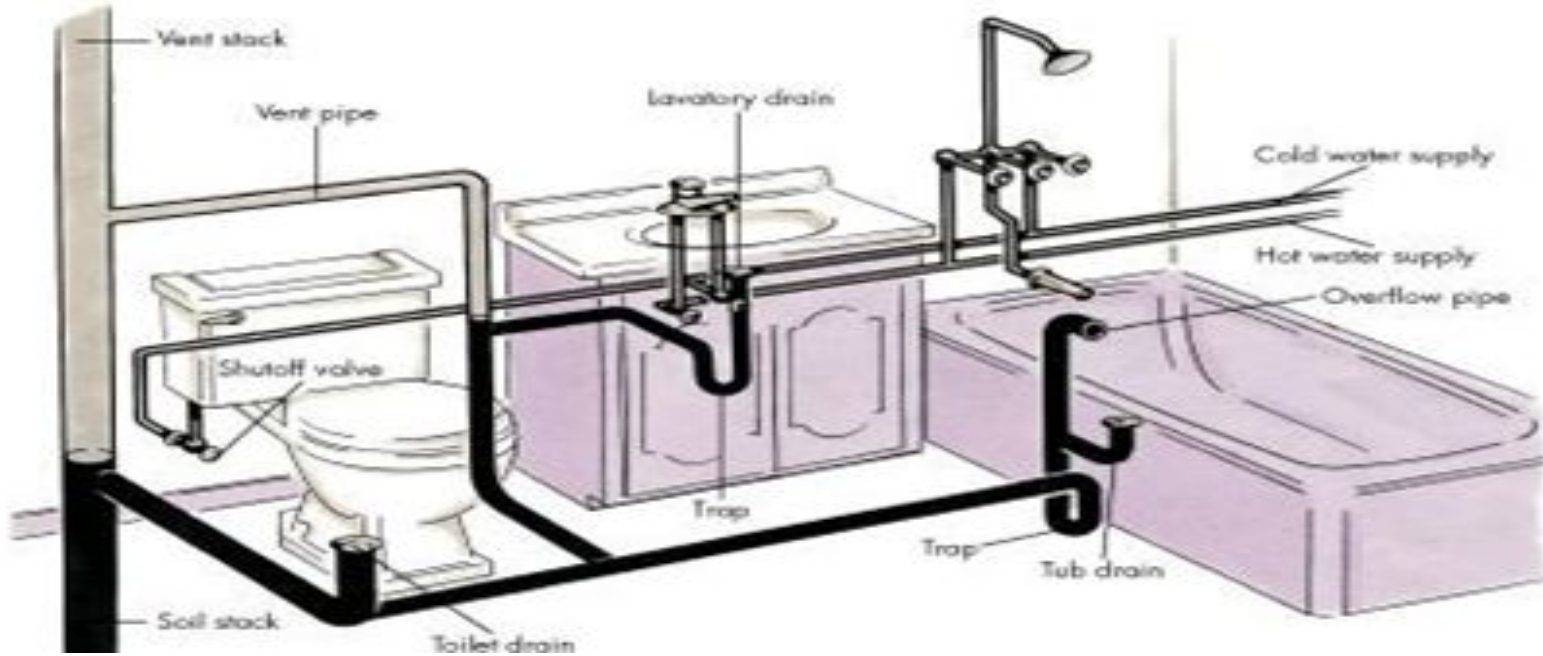
****Sewer municipalities provide sewer mapping that can help locate the public sewer connections.**

- Clean out ports are a very important for providing maintenance and emergency services to the drainage system.
- Expose clean outs and limit blocking these areas. Make sure they are sealed to keep out rocks, sticks, and animals.
- Map drain lines and cleanouts.
- Some Properties have manholes which are not always public sewer.

****Never enter a manhole without proper equipment. Oxygen monitor, tripod hoist, and air induction fan are required. Vent pipes can become blocked creating slow drains. This is normally seen when a toilet just swirls and when the water does go down it siphons the water from the trap in the toilet.**

Drainage and vent system

Reference: *Ultimate Guide Plumbing* pages 275 through 295



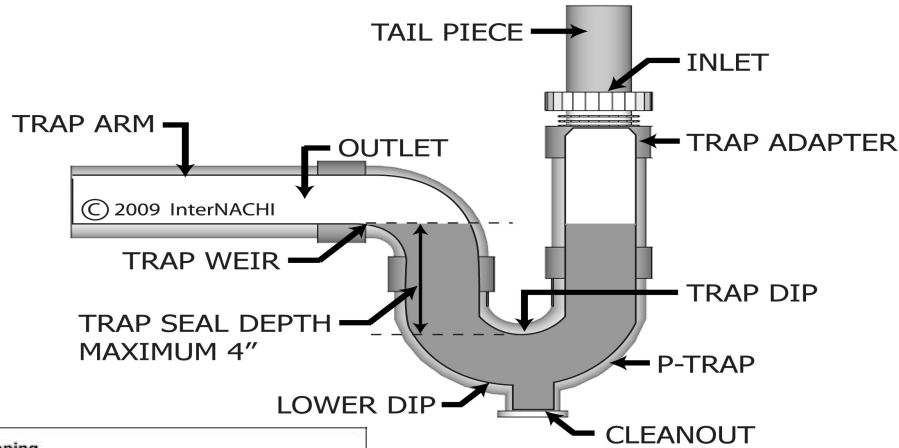
Types of drain traps

Reference: *Ultimate Guide Plumbing* pages 275 through 295

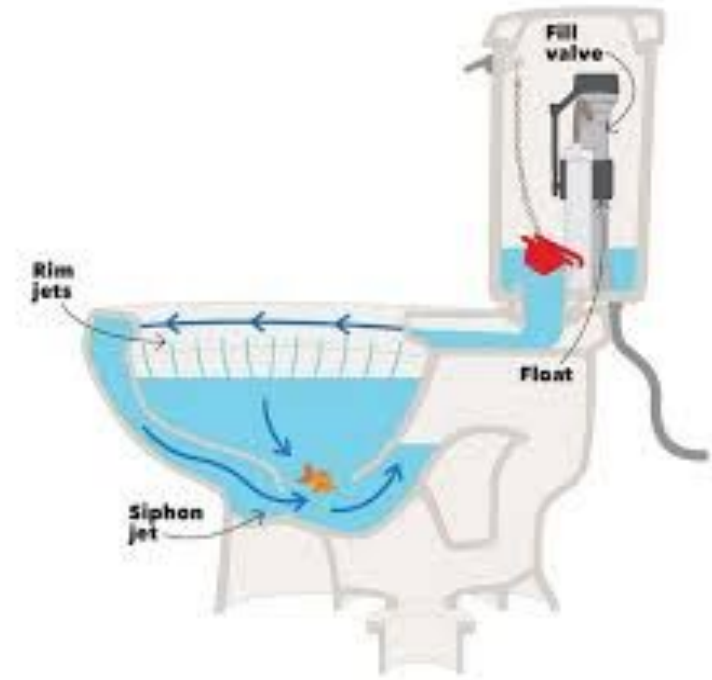
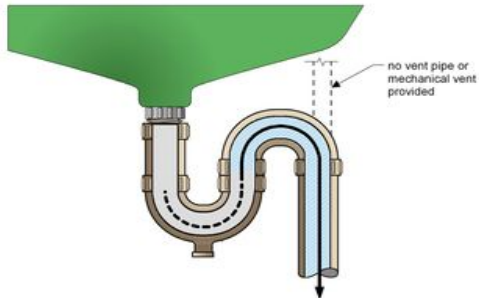
20 min

TRAP

(2 / 120)



S-traps can lead to siphoning



Drainage and vent system

- **Drainage system and vent system**

Common drainage piping materials are copper, clay tile, cast iron, PVC and ABS.

Copper



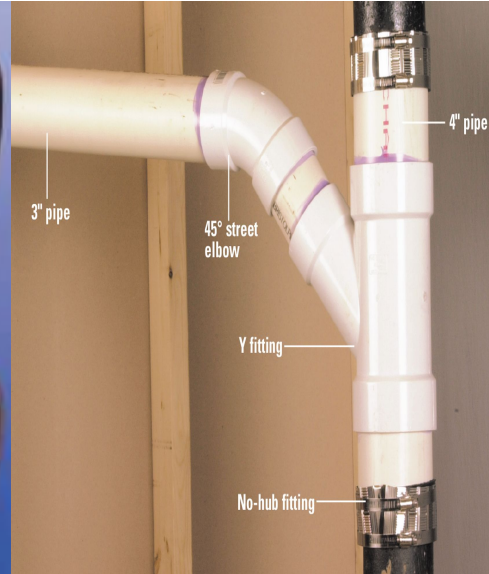
Cast Iron



Clay Tile



PVC



ABS



Broken sewer lines above ground

Reference: sub category

Cast iron pipes will begin to deteriorate with age, creating cracks in the old pipes. Some of these pipes are in walls, between concrete slabs, under sub floors and under the building. These repairs can be very costly, difficult to access and create a mess.



CIPP repaired



Broken sewer lines underground

Reference: sub category

Cast iron and clay tile pipes underground can create costly excavations, disruption of utilities and messy reconstruction.



Water supply: materials and connections

Reference: *Ultimate Guide Plumbing* pages 11 through 29 / 38 through 45

25 min

Most common types of water supply piping:

Copper



Galvanized
(20 / 120)



Pex



PVC

*cold water only



CPVC



Copper grades L, M, K, DWV - Blue, Red, Green, and Yellow

Thickness range from DWV (the thinnest) and gaining thickness in M, L, and K.

Copper connections: Above ground-solder,propress and compression. Underground-propress, compression and flared.

Galvanized pipe can be used above and below ground. Connections are threaded or compression fittings. Compression fittings can only be used on cold water.

Pex piping is used on hot and cold, above or below ground. Connections can be done with expansion or crimped mechanical fittings. **varmints chew through pex pipe easily*

PVC pressure pipe, schedule 40 and 80, check the label to ensure the pipe is rated for water pressure. PVC is connected by glue joints with pressure fittings and compression. **No PVC can to be used on hot water.*

CPVC pipe can be used on hot and cold water, above ground. Connections are glue joints with special cpvc glue. **CPVC pipe is very brittle.*

DEMO: Propress / Compression Ford couplings / PEX / and glue fittings pressure vs. dwv / gas piping propress

Water systems / Valves

Reference: Ultimate Guide Plumbing pages 30 through 37

15 min

Water systems consist of:

- Water mains from the public water system to the meter. (some properties own the water lines before the water meter)
- Water main supply from the water meter to the building.
- Water distribution system inside the property.

Water supply control devices:

- Meter shut off valve (takes several types of water keys to operate the valve) **4 meter keys
- Main water shut off controls the water supply usually found inside the property or in a water valve box outside the property.
- Automated electric ball valves, easy operation can be done remotely off site.
- Isolation valves are found throughout the distribution piping system, allowing to isolate sections of pipes.
- Fixture valve shut offs are designed to shut water off to individual fixtures.
- Pressure reduction valves control the pressure in the distribution system.
- Backflow preventer valves protect from cross contamination. Backflow preventers always have two shut off valves.

Types of valves: These valves should be located and mapped. Exercise these valves as an important part of any PM program. Most valves have packing nuts that will need to be tightened after valve is exercised.

Ball valves



Globe or gate valves



Fixture shut off valves



Main water supply valves



Automated electric ball valve



Pressure regulator set up procedure

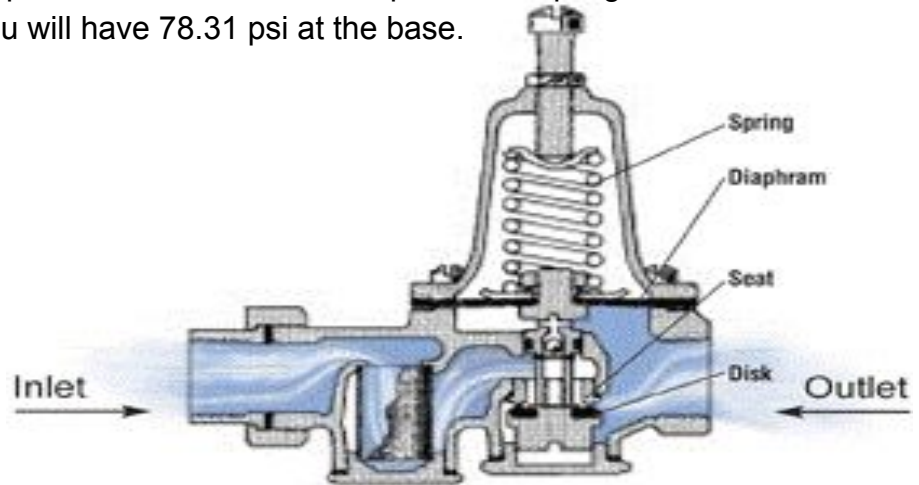
Reference: *Ultimate Guide Plumbing* page 37 20 min

1. Test the water pressure in a static position, this means no water flow.
2. Set the water pressure at approx. 60 psi.
3. Run water in 25% of the fixtures and watch the pressure drop-assuring it doesn't drop more than 10 psi.
4. If water pressure drops more than 10 psi, adjust the water pressure up, not exceeding 80 psi at the lowest portion of the building.
5. Set the air in the expansion tank on the water heater to the same adjusted water pressure setting .

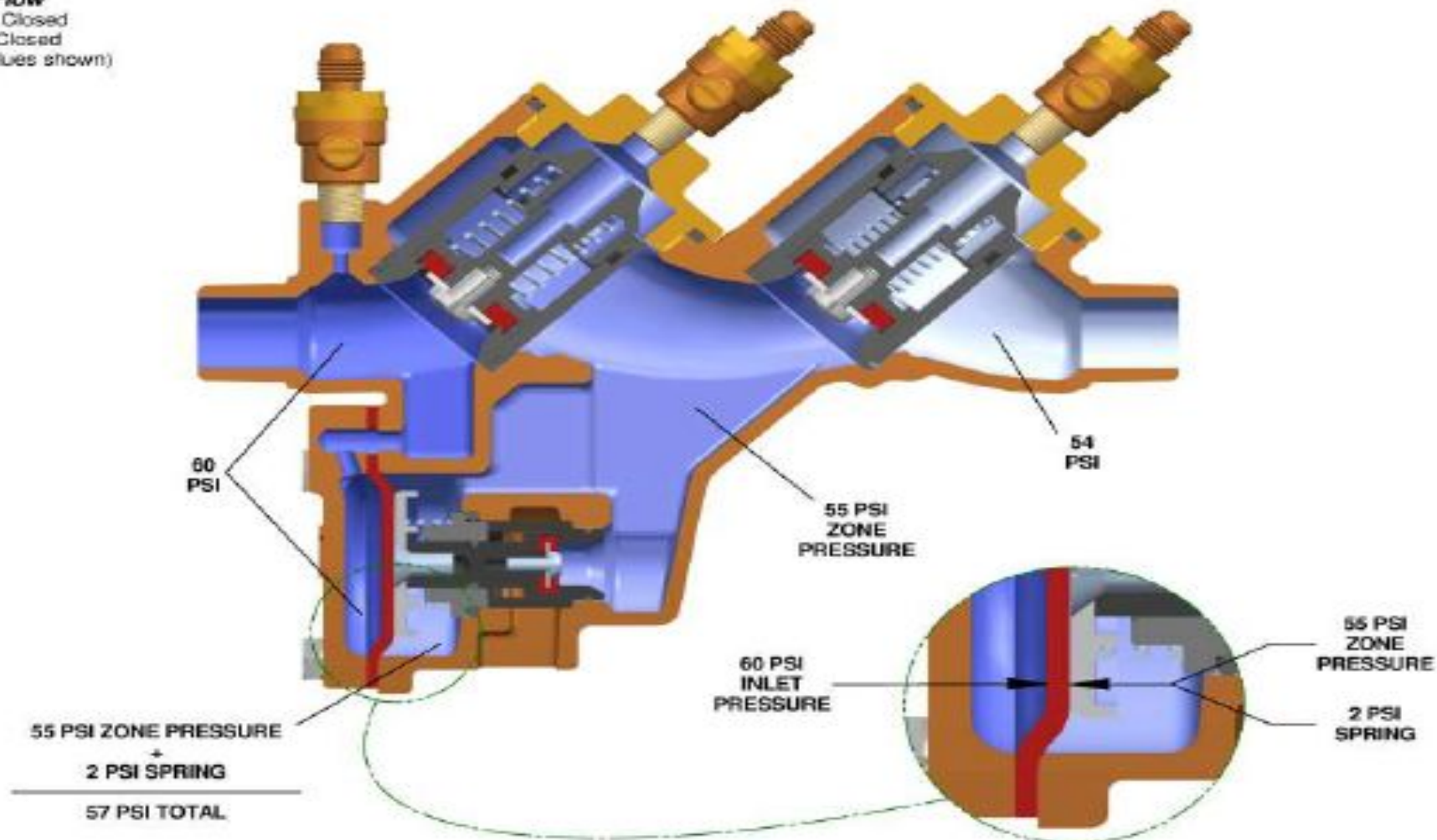
Note: Water has weight and will affect the readings at the lowest and highest points in static pressure.

This calculation is .03609 psi every inch in elevation. Example: 100 feet in elevation equals 43.31 psi greater at the base. Which means if you need 35 psi at 100 feet of elevation you will have 78.31 psi at the base.

** 4 pressure gauges



Static, No Flow
Both Checks Closed
Relief Valve Closed
(Minimum values shown)



Backflow Preventers DC - RPZ valves

Reference: *Ultimate Guide Plumbing* pages 275 through 295

15 min

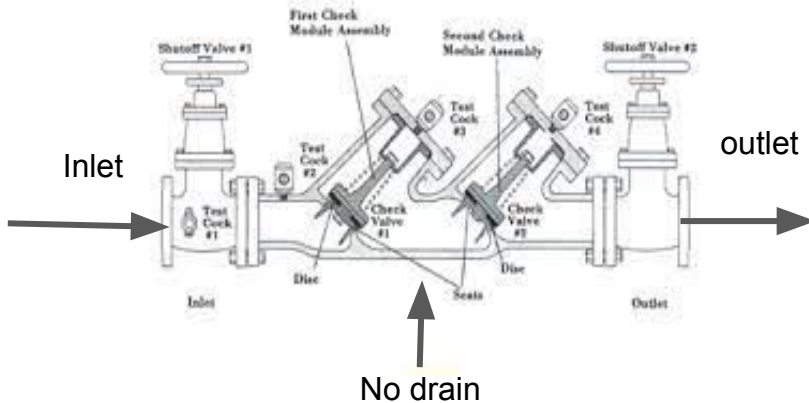
Designed to protect the public water system from contaminated non potable water created by cross-connections.

All backflow preventers have their own serial number and are supposed to be tested annually by a certified tester.

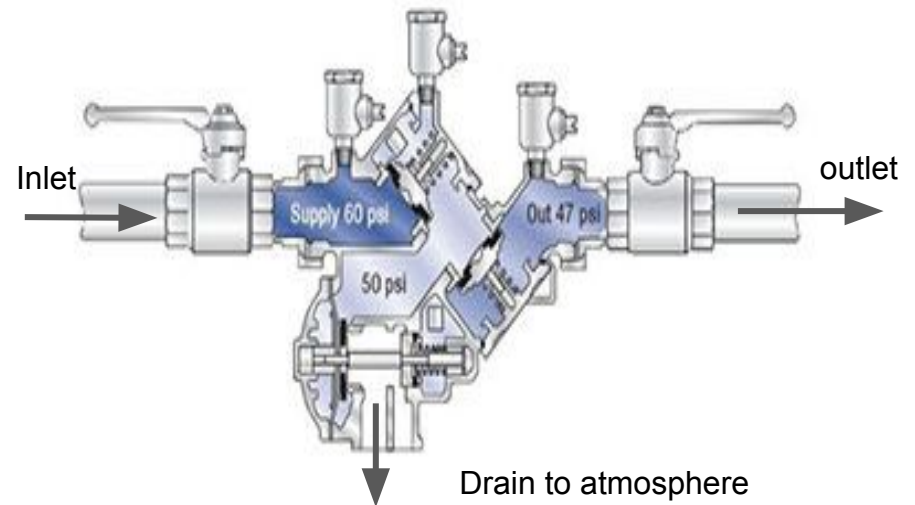
Cross-connection example: water main break and a hose in a mop sink with contaminated water syphoning back into the potable piping system.

Two common back flow units are a DC (double check) and an RPZ (reduced pressure zone). RPZ units must be installed above ground and have a drain. **Demo parts repair**

DC



RPZ





HOW IT WORKS

GAS VALVE



GAS
IGNITES

HEAT
RISES



PILOT LIGHT

Natural Gas

Reference: *Ultimate Guide Plumbing* pages 20 through 24

45 min

- Types of materials / valves
- Sizing systems : Pipe sizing chart
- Pressures
- Installation / connections
- Testing for leaks
- Venting
- Safety

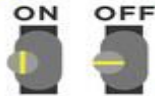


Capacity of Schedule 40 Metallic Pipe in Cubic Feet of Natural Gas Per Hour (based on .60 specific gravity, 0.30" w.c. pressure drop)															
Pipe Size (Inches)	Length of Pipe in Straight Feet														
	10	20	30	40	50	60	70	80	90	100	125	150	175	200	
1/2	131	90	72	62	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
3/4	275	188	151	129	114	104	95	89	83	79	70	63	58	N/A	
1	514	353	284	243	215	195	179	167	157	148	131	119	109	102	
1 1/4	1,090	726	583	499	442	400	368	343	322	304	269	244	224	209	
1 1/2	1,580	1,090	873	747	662	600	552	514	482	455	403	366	336	313	
2	3,050	2,090	1,680	1,440	1,280	1,160	1,060	989	928	877	777	704	648	602	
2 1/2	4,860	3,340	2,680	2,290	2,030	1,840	1,690	1,580	1,480	1,400	1,240	1,120	1,030	960	
3	8,580	5,900	4,740	4,050	3,590	3,260	3,000	2,790	2,610	2,470	2,190	1,980	1,820	1,700	
4	17,500	12,000	9,660	8,270	7,330	6,640	6,110	5,680	5,330	5,040	4,460	4,050	3,720	3,490	



NATURAL GAS KEEPS YOU WARM, BUT IT CAN ALSO CAUSE HARM.

KNOW HOW
TO SHUT OFF
THE GAS



IMMEDIATELY GO
OUTSIDE AND CALL 911
IF THERE IS A LEAK



HAVE NATURAL
GAS DETECTORS
ON EVERY FLOOR



Ready 

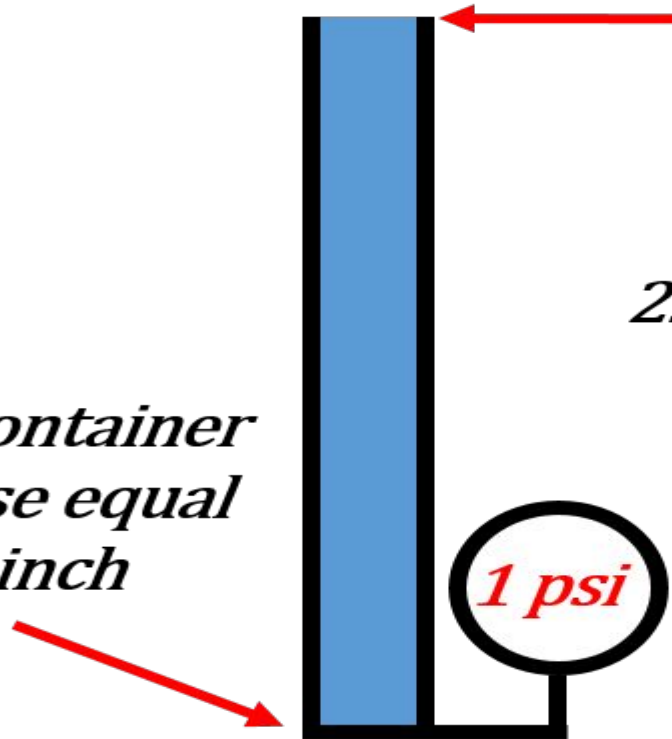
Inches Water column

*2.31 feet
or
27.72" w.c*

where.....

$$\begin{aligned} &2.31 \text{ feet} \times 12"/\text{ft} \\ &= 27.72" \text{ w.c.} \end{aligned}$$

*Area of container
at the base equal
1 square inch*



BTU meaning

WHAT IS A BRITISH THERMAL UNIT (BTU)?

A BTU is the amount of energy required to raise the temperature of 1 lb of water, at sea level by 1° F

For process cooling, BTUs are used to measure the amount of energy needed to remove 1° F

(16 ounces = 1 lbs)



Natural Gas Sizing Chart Iron Pipe

Natural Gas Pipe Sizing Chart

Length of Pipe In Feet	Size of Pipe in Inches								
	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
10	108	230	387	793	1237	2259	3640	6434	
20	75	160	280	569	877	1610	2613	5236	9521
30	61	129	224	471	719	1335	2165	4107	7859
40	52	110	196	401	635	1143	1867	3258	6795
50	46	98	177	364	560	1041	1680	2936	6142
60	42	89	159	336	513	957	1559	2684	5647
70	38	82	149	317	476	896	1447	2492	5250
80	36	76	140	239	443	840	1353	2315	4900
90	33	71	133	275	420	793	1288	2203	4667
100	32	68	126	266	411	775	1246	2128	4518
125	28	60	117	243	369	700	1143	1904	4065
150	25	54	105	215	327	625	1008	1689	3645
175	23	50	93	196	303	583	993	1554	3370
200	22	47	84	182	280	541	877	1437	3160
300	17	37	70	145	224	439	686	1139	2539

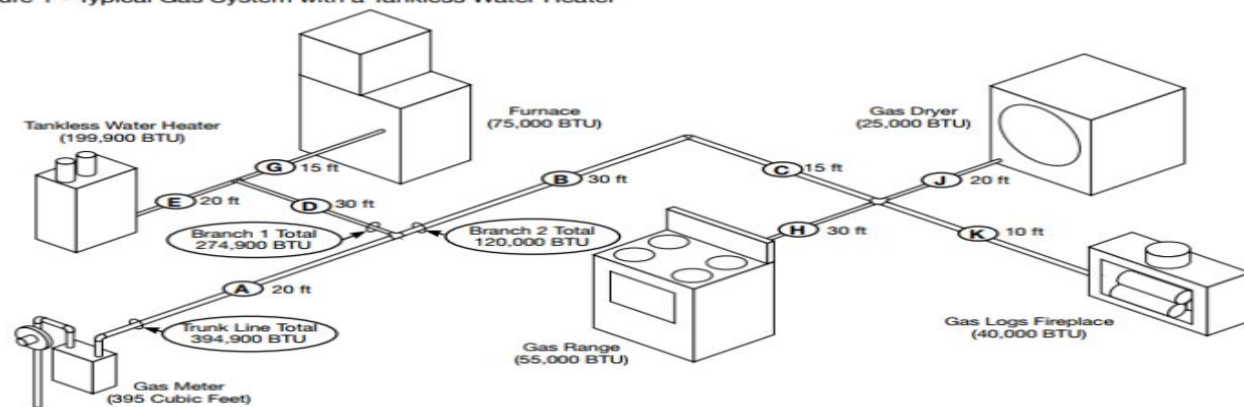
Natural Gas flow is given in thousands of BTU/hr. - One cubic foot of LP gas = 1000 BTU

Nominal pressure at the burner for Natural Gas is 3.5" of water column. (Typical machine supply 5"-7")

Pipe length must include additional length for all fittings. Add approximately 5 feet of pipe per fitting

Natural Gas Example: A machine with a burner that requires 440,000 BTU would need a 1 -1/4" pipe for a 20' long run.

Figure 1 - Typical Gas System with a Tankless Water Heater



Ultimately, no, a carbon monoxide detector cannot detect a natural gas leak. Carbon monoxide (CO) is a toxic gas created when fuel is burned in the presence of low levels of oxygen. Carbon monoxide is very different from methane and cannot be detected with the same sensor. Carbon monoxide might appear during a gas leak, but a carbon monoxide detector is not normally capable of detecting natural gas.

Carbon Monoxide or Natural Gas?

Carbon monoxide is difficult to detect by the human nose but is known to cause rapid loss of consciousness. Similarly, **natural gas** is normally odorless but gas companies add **mercaptan** to make it smell like sulfur or rotten eggs. What's more, natural gas leaks can usually be identified by a hissing sound or visible damage to a gas line. That being said, not having a complete gas detection system could cause disastrous results. Along with the high flammability of natural gas, carbon monoxide can be fatal under certain conditions. Without proper warning, you could be at risk for sudden fire, explosion or toxic gas. To protect your environment, install a reliable gas detection system to detect dangerous levels of carbon monoxide and methane.

Pro Tip: Does your gas alarm configured to detect carbon monoxide? Install a **high-performance sensor** in your detection system to combat the poisonous health effects of carbon monoxide.

Types of Natural Gas Detectors

Monitoring unsafe levels of methane in natural gas is crucial to combat natural gas poisoning and combustion. GDS Corp offers a number of gas detection solutions to monitor your gas lines.

- **GASMAX CX Gas Monitor** – Single or dual channel gas monitor certified for hazardous areas where gas readings need to be transmitted in real-time.
- **GASMAX II Gas Monitor** – Single or dual channel gas monitor of any combination of one toxic and one combustible (bridge-type) sensor.
- **GDS-50 Gas Sensor** – DC-powered infrared gas sensor of any toxic or combustible gas in Class I Div 1 hazardous areas.
- **GDS-IR Gas Sensor** – Infrared gas sensor used to detect carbon dioxide or explosive levels of methane or propane in harsh environments.

Choosing the Best Gas Leak Detectors

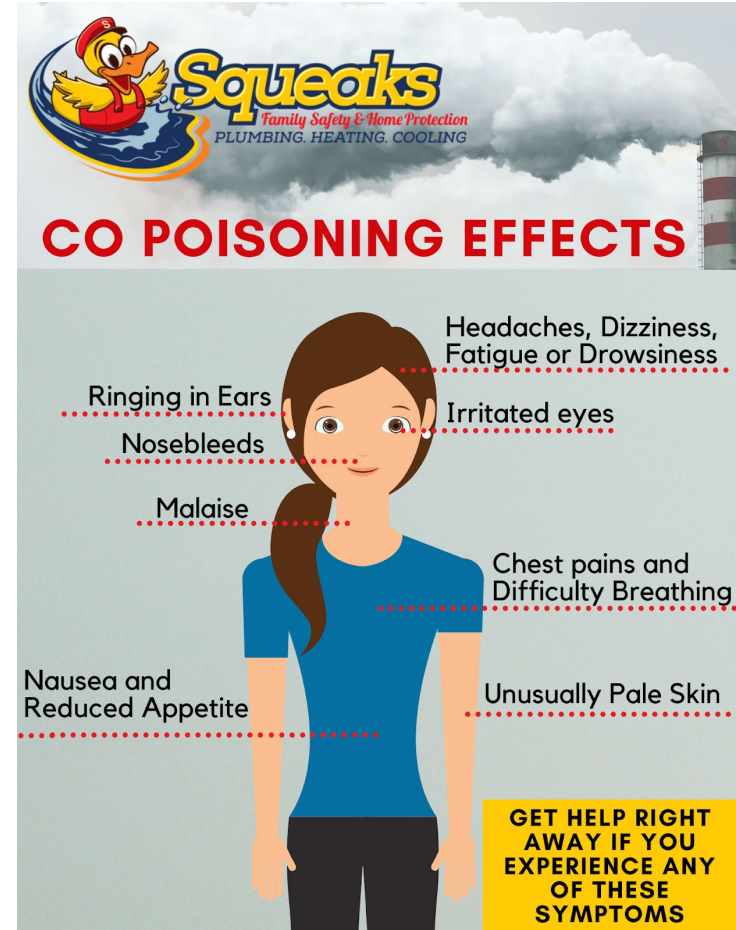
Whether you're protecting against natural gas leaks or the presence of carbon monoxide in your manufacturing or industrial process, finding the right gas monitor is important. In addition to carbon monoxide alarms and smoke detectors, a complete detection system can be customized for you. Be sure to protect your health and working environments from the many dangers of natural gas.

Do you need an accurate and trusted detection system? **Connect with our professional technicians** to help you choose the best gas leak detector.

Natural Gas

Although generally safe to use in the home, when natural gas does not burn up completely because of faulty installation or lack of ventilation, it emits a byproduct of [carbon monoxide](#). The more carbon monoxide present in the air, the less oxygen you can inhale, potentially killing you. At least 430 people in the United States die of unintentional carbon monoxide poisoning every year. And 50,000 people visit the ER for accidental carbon monoxide poisoning annually [source: [CDC](#)]. Unvented space heaters are the most common source of carbon monoxide poisoning [source: [Johns Hopkins Medicine](#)]. But fumes are also produced by furnaces, stoves, kerosene heaters and vehicles "warmed up" in garages.

If you have a gas stove, there are about 5 to 15 parts per million of natural gas in the air inside your home. More than 30 parts per million crosses into dangerous levels of natural gas and indicates a faulty stove [source: [EPA](#)]. How do you know if the methane levels in your house are safe? You can buy a natural gas detector or a carbon monoxide detector that will sound an alarm if gas levels exceed a safety threshold.



Natural Gas



IF YOU SUSPECT A GAS LEAK

1

Cease use of all electrical devices, even your cell phone.

Usage of electrical devices can ignite the gas if you're near the source of the leak. Without knowing for sure where the leak is located, wait to call 911 until you're outdoors.

2

Immediately evacuate all people and pets inside the house!

Natural gas and carbon monoxide are highly flammable and could ignite without warning. Make sure your family remains safe by immediately evacuating them. Don't stop to grab any "important" belongings.

3

Leave doors open and dial 911 or the local fire department.

Don't close the doors as you're leaving. Let the gas seep outside to minimize the risk of a fire. Immediately call 911 or your local fire department for help.

WARNING

If you suspect a gas leak in your home, DO NOT attempt the following:

- Calling 911 or the local fire department from inside your home
- Seeking out the source of the gas leak
- Repairing the source of the gas leak
- Turning appliances on or off
- Closing the doors as you leave
- Not reporting the situation to emergency authorities

Contact Squeaks Family Safety & Home Protection for more information or gas line services.



Toilets

Reference: Ultimate Guide Plumbing pages 63 through 83

60 min

Kitchen sinks

Reference: Ultimate Guide Plumbing pages 153 through 159

15 min

Lavatory sinks

Reference: Ultimate Guide Plumbing pages 151 through 153

15 min

Bathtubs / showers

Reference: Ultimate Guide Plumbing pages 198 through 206

15 min

Drain cleaning Procedures (lavatory and tubs)

Reference: *Ultimate Guide Plumbing* pages 179 through 184

20 min

Lavatory sink and bathtub drains require drain machines with $\frac{1}{4}$ inch cable and 25 feet long. Tubs can be run through the overflow. You must removed the overflow pop up stopper assembly. Lavatory drains can be unblocked by removing the trap and inserting the cable machine directly into the drain line. Check below the fixture after opening the drain to assure the cable didn't break through the pipe, allowing the water to drain out and appearing the drain line is unblocked.



Drain cleaning procedures (kitchen and 3 inch drains)

Reference: *Ultimate Guide Plumbing* pages 179 through 184

20 min

Kitchen sink and drain lines up to 3 inch in diameter, require drain machines with $\frac{3}{8}$ inch cable 75 feet long. Kitchen drains can be unblocked by removing the trap and inserting the cable machine directly into the drain line. Check below the fixture after opening the drain to assure the cable didn't break through the pipe allowing the water to drain out and appearing the drain line is unblocked. Secondary main lines up to 3 inch should be accessed through a clean out ports. The best way to clean these drains is to run water while running the cable machine, this process allows the water to help remove build up.



Unblock sewer and camera inspection (Main sewer lines 4 inch and larger) (3 / 180)

Reference: *Ultimate Guide Plumbing* pages 179 through 184

20 min

Sewer drain lines 4 inch and larger in diameter, require drain machines with $\frac{5}{8}$ to 1 $\frac{1}{2}$ inch diameter cables and 100 to 200 feet long. 4 inch drains can be accessed through a clean out ports. Evaluate the piping system to find where water is holding to determine the location of the blockage, then unblock with the sewer machine. Use sewer camera to make sure the blockage was completely removed.

Milwaukee MK $\frac{3}{4}$ " cable



insight vision inspection camera



Electric eel 1.5" cable



Sewer camera inspection

(Camera inspection)



Drain cleaning

(Hydro Jetting)

Used for PM programs, removing build up in pipes.

Reference: sub category

20 min



Removing scale and build up off the pipe, new drain cleaning tools.



CIPP Robotic Cutter

(4 / 240)



CIPP Cured In Place Pipe Repair

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