

The code numbers: sizes, slopes, and heights

YES Electric • a plain-language course for new plumbing apprentices

Draft 1 (October 2026). Code numbers follow the International Residential Code and International Plumbing Code as enforced in Alabama. The local inspector has the last word. Prices and hours are rough Birmingham-area numbers.

Every trade has numbers you have to know by heart. In plumbing, those numbers are the pipe sizes, the slopes, the distances, and the heights that the code sets. The numbers below follow the International Residential Code and International Plumbing Code, which Alabama and Birmingham enforce. The local inspector has the last word, and some cities add a few rules of their own. Where a city often goes stricter than the book, this chapter says so. Heights are measured from the finished floor unless the text says otherwise.

Read this chapter twice. The first time, just get the shape of it. The second time, start memorizing the numbers in the last section, because a journeyman will quiz you on them.

Why the numbers matter

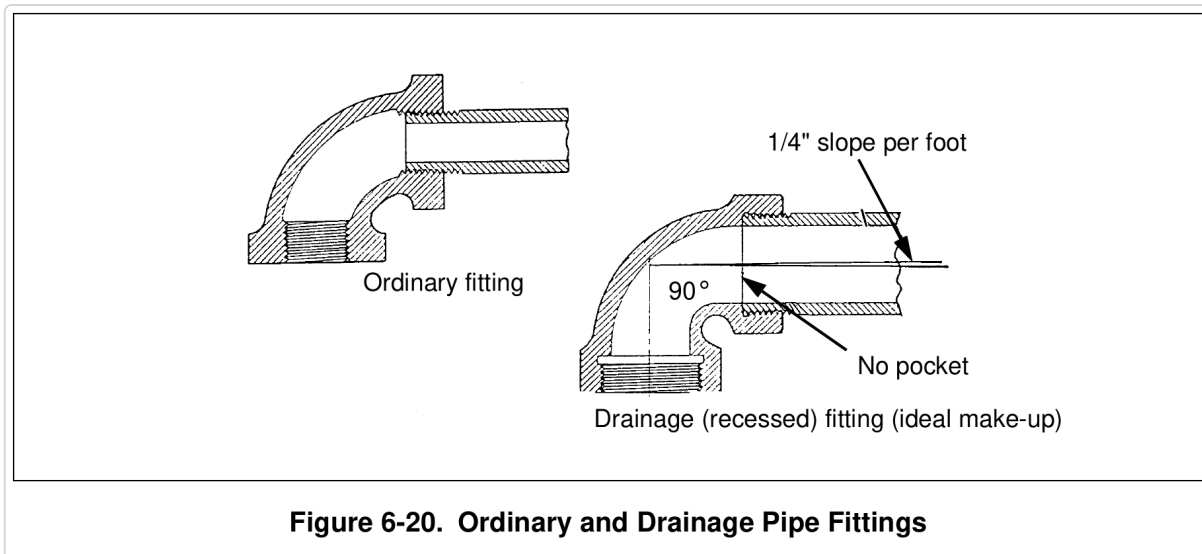
A drain pipe that is too flat holds water and clogs. A drain pipe that is too steep lets the water run away from the solids and leaves them behind. A trap arm that is too long siphons the trap dry and lets sewer gas into the house. A supply pipe that is too small starves the shower when someone flushes. None of this is guesswork. The code gives a number for each one, and the inspector checks it with a tape measure and a level.

Slope and angle rules that apply everywhere

These rules apply to every drain in the house, from the kitchen sink to the main line leaving the foundation.

Rule	Number
Minimum slope, drain pipe 2 1/2 inch and smaller	1/4 inch per foot (about 2 percent, 1.2 degrees)
Minimum slope, drain pipe 3 inch and larger	1/8 inch per foot (about 1 percent). Most plumbers still run 3 and 4 inch at 1/4 if they have the room.

Rule	Number
Maximum slope	Code sets none. Trade rule is to stay under 1/2 inch per foot, because water outruns solids and leaves them behind. Anything steeper than 45 degrees is treated as a vertical pipe and can use vertical rules.
Trap arm fall	The whole trap arm may drop no more than one pipe diameter from the trap to the vent. A 1 1/2 inch arm can fall 1 1/2 inches total. More than that and the trap siphons.
Trap arm maximum length (trap to vent)	1 1/4 inch pipe: 5 feet. 1 1/2 inch: 6 feet. 2 inch: 8 feet. 3 inch: 12 feet. 4 inch: 16 feet.
Vent takeoff	A dry vent leaves the drain and rises vertically at least 6 inches above the flood rim of the highest fixture it serves before it can go horizontal.
Vent above roof	Code minimum 6 inches above the roof surface. Many cities require 12 inches, and 12 is what most plumbers do.
Vent near openings	At least 10 feet horizontally from any window, door, or air intake, or at least 3 feet above it.
Vent above a usable roof deck	7 feet.
Fitting angles	1/4 bend is 90 degrees. 1/8 bend is 45. 1/16 bend is 22 1/2. 1/6 bend is 60. "Long sweep" means a 90 with a longer radius for drainage.
Which fitting where	Horizontal drain turning down into a vertical: sanitary tee is fine. Vertical turning to horizontal: long sweep 90, or a wye with a 1/8 bend. Horizontal joining horizontal: wye plus 1/8 bend, or a combo. A san tee lying on its back is never allowed for drainage. Vents can use any of them.
Cleanouts	At the base of every stack. Every 100 feet on a horizontal run. At every change of direction over 45 degrees. One where the building drain meets the sewer, inside or within 10 feet outside. Cleanout is the same size as the pipe up to 4 inches. Needs 18 inches of clearance in front for 3 inch and up, 12 inches for smaller.
Slope for vents	Dry vents pitch slightly back toward the drain so condensation runs out. No puddles in a vent.



Section through a recessed drainage elbow showing the 1/4 inch per foot slope built into the fitting so the horizontal pipe falls toward the stack with no pocket at the joint. It is a fitting drawing, not a level on a pipe, but it states the slope number directly.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 6-20 Ordinary and Drainage Pipe Fittings by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

The slope rule is the one you will use most. A quarter inch per foot means that over a 10 foot run, the far end of the pipe sits 2 1/2 inches lower than the near end. A torpedo level with a slope bubble shows this directly: when the bubble sits between the slope lines, the pipe is at 1/4 per foot.

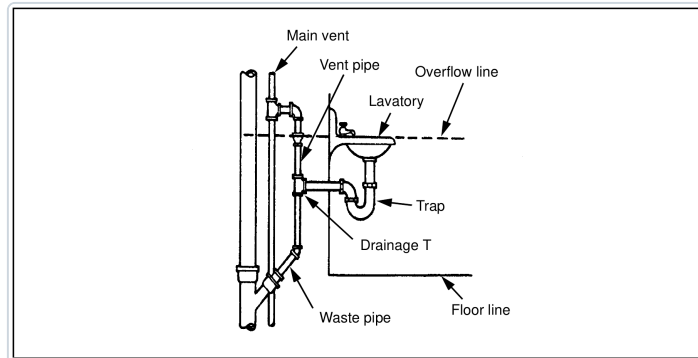


Figure 9-8. Single-Fixture Vent

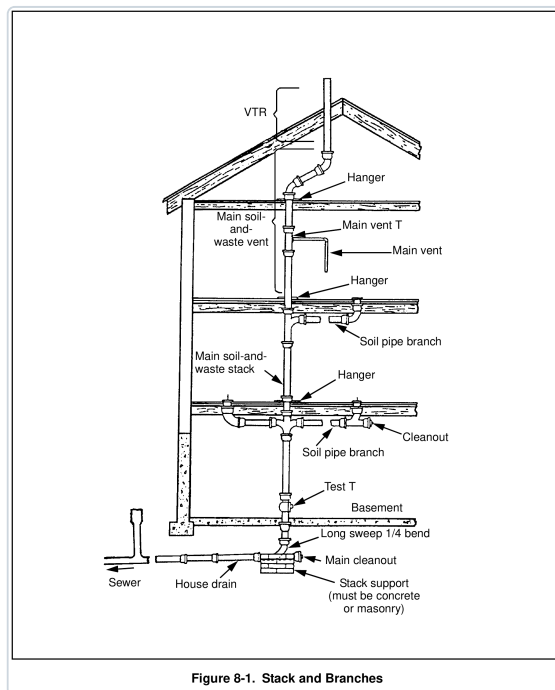
Table 9-1. Determining the Pipe Size From the Fixture to the Vent

Maximum Distance From the Fixture Trap to the Vent	Size of the Fixture Drain (in Inches)
2' 6"	1 1/4
3' 6"	1 1/2
5'	2
6'	3
10'	4

Single-fixture vent: the trap arm runs from the lavatory P-trap to a drainage tee, the vent rises from the tee above the fixture overflow line before it turns to join the main vent. The table below gives maximum trap-arm length by drain size. The 6 inch rise above the flood rim is not dimensioned; the instructor adds it.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 9-8 Single-Fixture Vent and Table 9-1 by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

The trap arm rule is the one beginners break most often. The trap arm is the horizontal pipe from the trap to the vent. If it is too long, the water rushing through it pulls the water out of the trap behind it, like sucking on a straw. Keep it inside the table and you never have that problem.



Whole DWV stack from house drain to vent through roof (VTR), with the stack passing through the roof deck and the terminal sticking up above it. No height is dimensioned; the instructor marks 6 inch minimum (12 inch common) above the roof and the window clearance.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 8-1 Stack and Branches by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

Supply sizing

Supply pipe is small because the water is pushed. The sizes below are what gets run in nearly every house.

Item	Normal size and material
Water service from meter to house	3/4 inch minimum. 1 inch if the run is long or the house has 3 or more baths. PE (black poly) or type K copper, 12 inches of cover minimum and below frost. In Alabama 18 inches is typical. Tracer wire on plastic.
Main trunk through the house	3/4 inch hot and 3/4 inch cold. PEX is standard. Type L copper in a copper house.
Branch to a bathroom group	3/4 inch to the room, 1/2 inch to each fixture.
Branch to one fixture	1/2 inch PEX or copper.
Water heater in and out	3/4 inch.
Hose bibs	3/4 inch preferred, 1/2 inch allowed.
Static pressure	80 psi is the maximum. Above that a PRV is required. Set the PRV at 50 to 60.

Item	Normal size and material
Minimum pressure at a fixture	About 20 psi at a tank toilet, 8 psi at most other fixtures.
Expansion tank	Required whenever a PRV or check valve closes the system. Sized by heater gallons. A 2 gallon tank covers a 40 or 50 gallon heater.
Water velocity	Keep under 8 feet per second cold and 5 hot in copper to prevent erosion and noise. In practice that is why the trunk is 3/4 and not 1/2.
Hot water temperature	Heater set at 120. Tub and shower valves must be pressure-balance or thermostatic and limited to 120 at the spout.

The pattern is simple. Three-quarter inch runs the length of the house. Half inch branches off to each fixture. The water heater gets 3/4 in and 3/4 out. If you remember those three facts you can size the supply in most houses without opening a book.

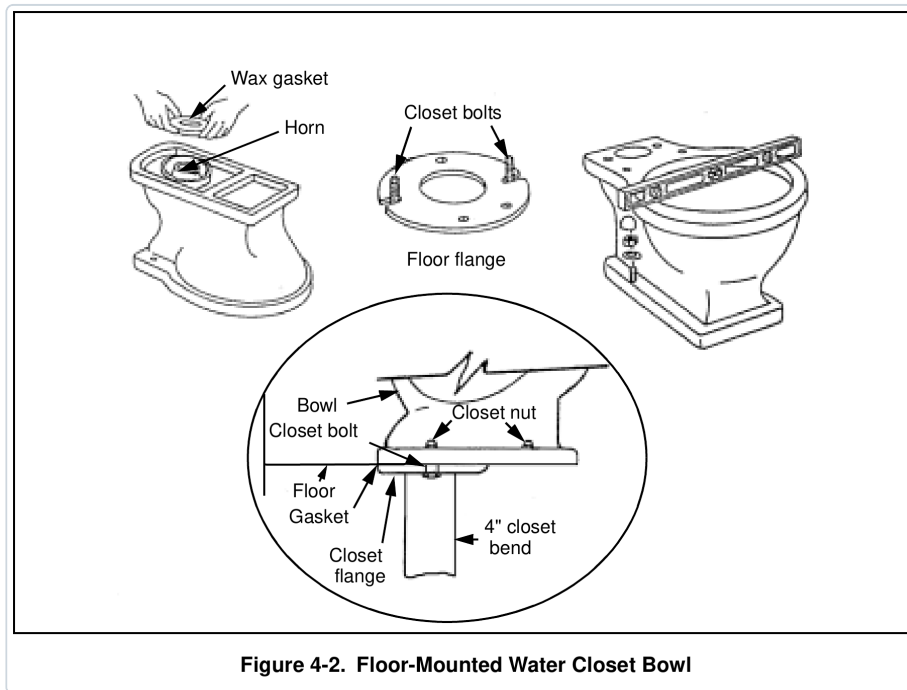
Fixture by fixture

Each fixture has its own set of numbers: how big its drain is, how big its trap is, where the supply stubs land, and how far it has to sit from the walls.

Toilet

The toilet is the fixture that drives the whole bathroom layout. Set it first, then fit everything else around it.

Item	Number
Drain	3 inch minimum, 4 inch allowed. PVC schedule 40.
Trap	Built into the bowl. No separate trap.
Flange	3 or 4 inch PVC closet flange, top sits on the finished floor, screwed down.
Rough-in	12 inches from the finished wall to the center of the flange. 10 and 14 inch toilets exist for old houses.
Side clearance	15 inches from flange center to any wall, vanity, or tub. 30 inches total width.
Front clearance	21 inches clear in front of the bowl.
Supply stub	1/2 inch, about 6 inches up and 6 inches to the left of flange center when you face the wall. Stop valve with 3/8 compression outlet, braided supply tube.
Vent	1 1/2 inch minimum. Toilet trap arm on 3 inch pipe can be 12 feet to the vent.
How many on a 3 inch line	Up to 2 toilets on a 3 inch horizontal branch. A 3 inch stack can carry up to 6. Most new houses run 4 inch for the building drain to avoid the question.



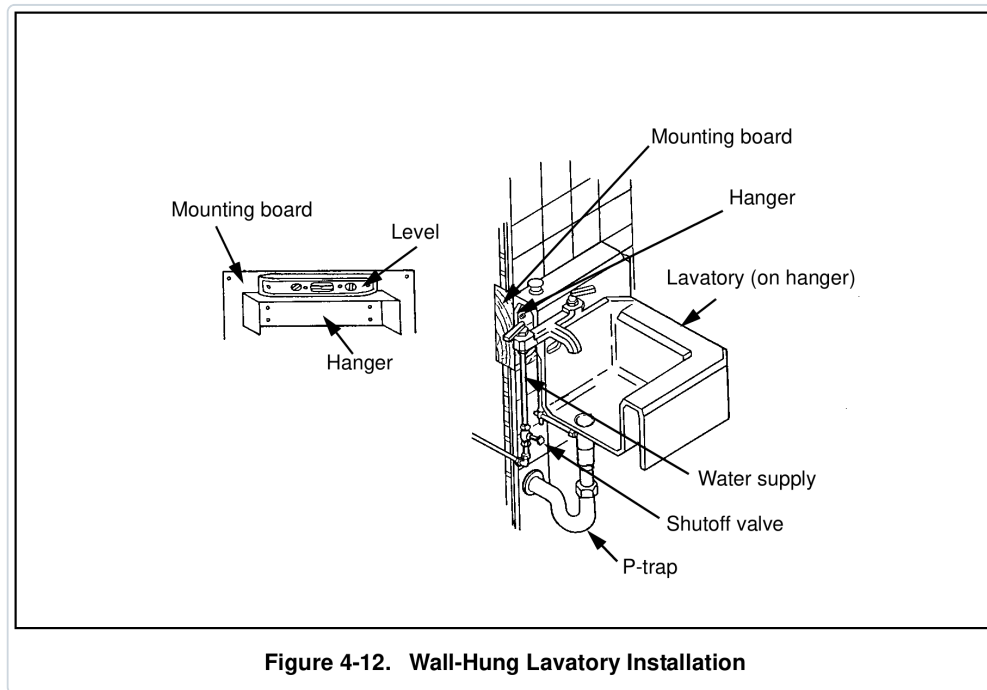
Toilet rough-in parts: wax gasket, horn, closet flange with closet bolts, and a section through the flange onto the 4 inch closet bend. No dimensions are drawn; the instructor annotates 12 inches from wall to flange center, 15 inches each side, and 21 inches in front.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-2 Floor-Mounted Water Closet Bowl by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

The 12 inch rough-in is measured from the finished wall, not the stud. If the wall is getting 1/2 inch drywall, you measure 12 1/2 inches from the stud face. Forget that and the tank will not fit against the wall.

Bathroom sink (lavatory)

Item	Number
Drain	1 1/4 inch minimum, 1 1/2 inch is what gets run. Stub out of the wall at about 18 to 19 inches.
Trap	1 1/4 inch P-trap, 1 1/2 is also common. Chrome or PVC.
Supply stubs	1/2 inch hot and cold at about 20 to 22 inches, spaced 8 inches apart, 4 inches each side of the drain centerline. Hot on left.
Stops	Quarter-turn angle stops, 1/2 inch inlet, 3/8 compression outlet.
Vent	1 1/4 inch minimum. Trap arm up to 5 feet on 1 1/4 pipe, 6 feet on 1 1/2.
Counter height	32 to 36 inches. Stubs land inside the cabinet either way.



Wall-hung lavatory rough-in showing the mounting board in the studs, the two supply stubs with shutoff valves, and the drain stub with P-trap. Clean diagram with no numbers; the instructor adds the supply height (about 20 to 22 inches, 8 inches apart) and drain height (about 18 to 19 inches).

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-12 Wall-Hung Lavatory Installation by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

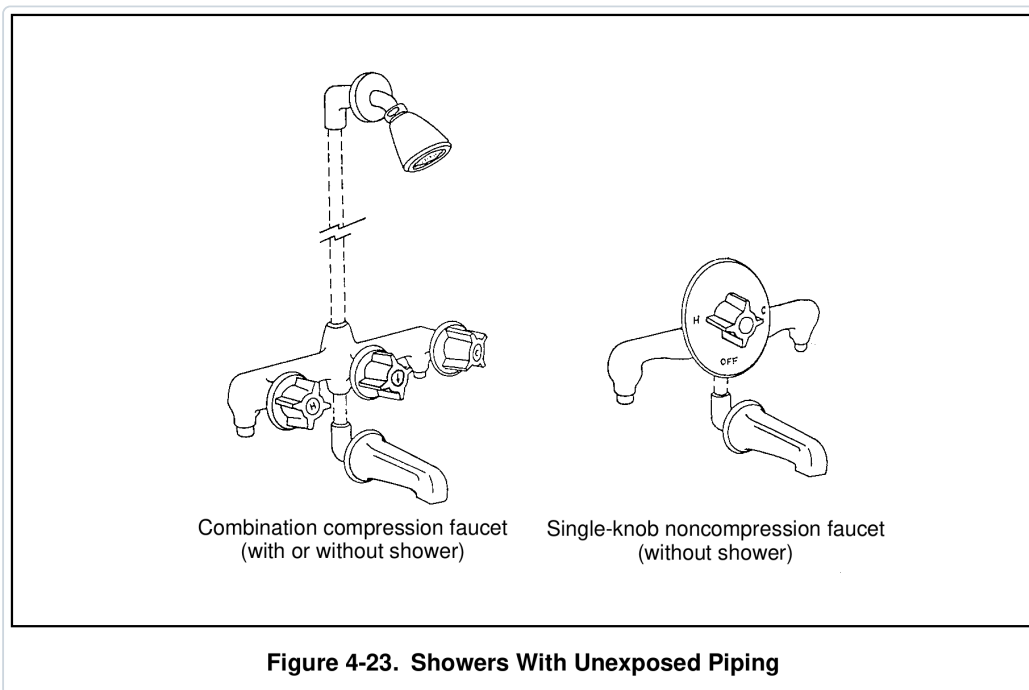
Kitchen sink

Item	Number
Drain	1 1/2 inch minimum by code. 2 inch is standard practice because of grease and the disposal. Stub out at about 18 inches, roughly centered under the sink.
Trap	1 1/2 inch P-trap.
Supply stubs	1/2 inch hot and cold at about 20 to 22 inches, 8 inches apart.
Stops	Angle stops. The hot side often gets a dual-outlet stop to feed the dishwasher.
Dishwasher	1/2 inch supply to a 3/8 compression connection. Drain hose loops up high under the counter or goes through an air gap at the sink deck.
Ice maker	1/4 inch line from a 1/2 inch stop in a recessed box behind the fridge.
Vent	1 1/2 inch. Trap arm up to 6 feet on 1 1/2, 8 feet on 2 inch. An island sink gets a loop vent or an air admittance valve where the city allows one.

Bathtub

Item	Number
Drain	1 1/2 inch.
Trap	1 1/2 inch P-trap set below the floor at the drain end.

Item	Number
Waste and overflow	1 1/2 inch assembly, PVC or brass, connects drain and overflow to the trap.
Supply to valve	1/2 inch hot and cold.
Valve height	About 28 inches for a tub-only valve. 48 inches if it is a tub and shower combination.
Tub spout	4 inches above the tub rim, which usually lands at about 20 inches off the floor. 1/2 inch drop-ear elbow screwed to a block.
Shower head	72 to 80 inches. 78 is the common number. 1/2 inch drop-ear elbow.
Access	Panel or open framing at the valve end so the trap and overflow can be reached.



Tub and shower valve body in the wall with the spout below and the shower arm and head above. No heights are given; the instructor adds valve 28 inches (tub) or 48 inches (shower), spout about 20 inches, head about 78 inches.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-23 Showers With Unexposed Piping by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

Shower

Item	Number
Drain	2 inch.
Trap	2 inch P-trap below the pan.
Supply to valve	1/2 inch hot and cold.
Valve	Pressure-balance or thermostatic, limited to 120 degrees. 48 inches is typical.

Item	Number
Shower head	78 inches typical, 72 minimum.
Floor size	900 square inches minimum with a 30 inch circle fitting inside. 30 by 30 is the smallest legal shower, 36 by 36 is comfortable.
Walls	Waterproof finish to 72 inches above the drain.
Vent	1 1/2 inch. Trap arm up to 8 feet on 2 inch pipe.

Washing machine

Item	Number
Drain	2 inch standpipe.
Trap	2 inch, set 6 to 18 inches above the floor.
Standpipe height	18 to 42 inches above the trap.
Supply	1/2 inch hot and cold to a recessed washer box with quarter-turn valves. Box bottom at about 42 inches.
Vent	1 1/2 inch.

Water heater

Item	Number
Water connections	3/4 inch hot and cold. Flex connectors or hard pipe. Dielectric unions where copper meets steel.
Shutoff	Full-port ball valve on the cold inlet.
T&P relief	3/4 inch outlet. Discharge line 3/4 inch, same material as supply, runs downhill, ends 6 inches or less above the floor or outside, no threads on the end, no valve, no reduction.
Expansion tank	On the cold side within a few feet of the tank.
Pan	Required when the heater is where a leak would damage the house. 1 1/2 inch deep minimum, 3/4 inch drain to outside or a floor drain.
Gas	1/2 or 3/4 inch black iron or CSST, drip leg, shutoff within 6 feet. 1/2 inch is fine for a 40,000 BTU tank heater on a short run. Tankless at 150,000 to 199,000 BTU needs 3/4 and sometimes 1 inch.
Electric	240 volt, 30 amp, 10 gauge wire for a standard 4,500 watt tank.
Clearance	Per the label. Gas heaters need combustion air and a flue with proper rise. 18 inches off the floor in a garage.

Hose bibs

Item	Number
Supply	3/4 or 1/2 inch, mounted to a block with a drop-ear or a sillcock flange.
Type	Frost-free sillcock, long stem so the valve seat is inside the warm wall. Pitched slightly down to drain.
Backflow	Vacuum breaker required on every hose bib. Frost-free units have it built in.

Vent sizing

Vents let air into the drain system so water can fall freely and traps stay full. The sizing rules are short.

Rule	Number
Smallest vent allowed	1 1/4 inch.
Vent for any drain	At least half the diameter of the drain it serves. A 3 inch toilet drain can be vented with 1 1/2 inch.
Through the roof	At least one vent through the roof. Common practice is to make it 3 inch so it cannot frost shut and so the system has enough air. Smaller vents in the attic tie into it.
Air admittance valve	Where allowed, sits at least 4 inches above the trap arm, in a ventilated accessible space, and the house still needs a real roof vent somewhere.
Roof flashing	Neoprene boot or lead flashing, slid under the shingles above the pipe.

Fixture units and pipe capacity

The code counts drain load in drainage fixture units, written DFU. Each fixture is worth a certain number of units. A plumber adds up the units on a pipe and checks the pipe is big enough to carry them.

Fixture	DFU
Bathroom sink	1
Kitchen sink with disposal and dishwasher	2
Tub or shower	2
Toilet (1.6 gallon)	3
Washer standpipe	2
Whole bathroom group	5

Pipe	Carries
1 1/2 inch horizontal branch	3 DFU (one sink and one tub, no toilet)
2 inch horizontal branch	6 DFU
3 inch horizontal branch	20 DFU and 2 toilets max
3 inch building drain at 1/4 per foot	42 DFU
4 inch building drain at 1/4 per foot	216 DFU, which is any house

A whole bathroom is 5 units. Two bathrooms, a kitchen, and a washer add up to 14 units, which fits on a 3 inch building drain with room to spare. Most plumbers run 4 inch anyway, because the pipe costs a little more and never comes up short.

Hanging, drilling, and protecting pipe

Pipe has to be held up at set distances or it sags, and a sagging drain holds water. Pipe that passes through framing has to be protected from the drywall screws and nails that come later.

Material	Horizontal support	Vertical support
PVC and ABS	Every 4 feet	Every 10 feet, plus a guide at each floor
PEX	Every 32 inches	Every 10 feet, plus mid-story guide
Copper, 1 1/4 and smaller	Every 6 feet	Every 10 feet
Copper, 1 1/2 and larger	Every 10 feet	Every 10 feet
CPVC	Every 3 feet	Every 10 feet
Cast iron	Every 5 feet, or at every joint	Every 15 feet
Black iron gas, 1/2 inch	Every 6 feet	Every floor
Black iron gas, 3/4 and larger	Every 8 feet	Every floor



Horizontal drain in a parking-garage ceiling hung on threaded rod and clevis-style hangers at regular spacing, with a vertical drop tied in. Cast-iron (SML) pipe in Germany rather than PVC, but the hanger spacing idea reads the same.

Photo: File:Ver- und Entsorgungsleitungen Gebaeude.jpg by Erkaha, CC BY-SA 4.0.

Framing rule	Number
Hole in a bearing stud	No more than 40 percent of the stud width, so 1 3/8 inch in a 2x4. 60 percent in a non-bearing stud.
Hole edge to stud face	5/8 inch minimum.
Nail plate	Required when pipe is within 1 1/4 inch of the face of the stud or plate. 1/16 inch steel.
Hole in a joist	No more than 1/3 the joist depth, 2 inches from top and bottom edges. 3 inch hole in a 2x10 is the max.
Notch in a joist	No more than 1/6 the depth, never in the middle third of the span. This is why 3 inch toilet drains usually run parallel to joists or under them.
Top plate	A 3 or 4 inch stack cuts most of a double top plate. A metal strap or stud shoe spans the cut.

The nail plate rule protects your work from the next trade. A drywall screw is 1 1/4 inches long. If the pipe is closer than that to the stud face, a screw can reach it. The steel plate stops the screw.

Tests the inspector wants to see

Nothing gets covered with drywall until it has been tested and inspected. Here is what each test looks like.

System	Test
Drain, waste, vent	Water: fill to the top of the roof vent, or at least 10 feet of head above the highest joint, hold 15 minutes. Or air: 5 psi, hold 15 minutes with no drop.

System	Test
Water supply	Water at working pressure or 100 psi for 15 minutes, or air at 50 psi for 15 minutes.
Gas	1 1/2 times working pressure but not less than 3 psi, 10 minutes minimum. Most Birmingham-area inspectors want to see 15 to 20 psi held 15 to 30 minutes.
Shower pan	Plug the drain and fill the pan to the curb for 24 hours before tile.
Final	Every fixture runs hot and cold, every drain holds water in the trap, T&P discharge visible, dishwasher high loop or air gap, hose bib vacuum breakers, water heater pan drain.

The numbers an apprentice gets quizzed on

Learn these cold. A journeyman will ask them on the truck.

Question	Answer
Drain slope	1/4 inch per foot
Trap arm, 1 1/2 inch	6 feet
Trap arm, 2 inch	8 feet
Fall across a trap arm	One pipe diameter
Vent rise before going flat	6 inches above the flood rim
Vent above roof	6 inches by code, 12 in practice
Toilet rough-in	12 inches to center
Toilet side clearance	15 inches each side
Toilet front clearance	21 inches
Toilet drain	3 inch
Shower drain	2 inch
Tub and kitchen drain	1 1/2 inch
Lavatory drain	1 1/4 inch
Trunk line	3/4 inch
Branch line	1/2 inch
Maximum pressure	80 psi, PRV set at 50 to 60
Hot water at the tap	120 degrees

Check yourself

1. A 2 inch drain runs 12 feet horizontally. How much lower is the far end than the near end at code minimum slope?
2. How far can a 1 1/2 inch trap arm run before it has to hit a vent?
3. Where is the 12 inch toilet rough-in measured from?
4. How high above the flood rim does a vent have to rise before it can turn horizontal?
5. Name the three places a cleanout is always required.
6. What size pipe runs the length of the house for supply, and what size branches to each fixture?
7. At what pressure does the code require a pressure reducing valve?
8. How often does horizontal PVC drain pipe need a hanger? How often does PEX?

Image credits

Photos are used under the licenses listed. Drawings without a credit line were made for this course.

Figure	Source	Author	License
f06	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 6-20 Ordinary and Drainage Pipe Fittings	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f05	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 9-8 Single-Fixture Vent and Table 9-1	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f08	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 8-1 Stack and Branches	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f01	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-2 Floor-Mounted Water Closet Bowl	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f02	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-12 Wall-Hung Lavatory Installation	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f03	FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 4-23 Showers With Unexposed Piping	US Army (Headquarters, Department of the Army)	Public domain (US federal government work)
f09	File:Ver- und Entsorgungsleitungen Gebaeude.jpg	Erkaha	CC BY-SA 4.0