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Code Check® Plumbing Fourth Edition

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For more information on the building, electrical, and mechanical codes, valuable resources, and why Benjamin Franklin is featured in the Code Check series, visit www.codecheck.com.

Code Check Plumbing 4th edition is an illustrated guide to common code questions in residential plumbing, heating, ventilation, and air conditioning systems. The book emphasizes the safety principles that are at the heart of the codes for these systems.

The primary code used in this book is the 2009 edition of the *International Residential Code for One- and Two-Family Dwellings*®, published by the International Code Council (ICC). It is the most widely used residential code in the United States. The other major code referenced in this book is the 2009 *Uniform Plumbing Code*®, published by the International Association of Plumbing & Mechanical Officials (IAPMO). For most topics, these codes are in agreement. Each of these codes references standards, many of which are maintained by the organizations in Table 2 (T2).

Additional codes for specialized items are listed in T1. The National Fire Protection Association (NFPA) publishes *NFPA 54—The National Fuel Gas Code*, which forms the basis of the fuel gas provisions in the IRC, UPC, and UMC.

The 2009 cycle of codes is likely to remain in effect in most areas for at least 3 or 4 years after the cover date. Energy codes vary greatly from one area to another, and may modify or overrule the code requirements shown in this book. Before beginning any project, check with your local building department to determine the codes that apply in your area.

Thanks to Hamid Naderi of ICC for his invaluable editorial input.

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TABLE 1 CODES & STANDARDS USED IN THIS BOOK		
Organization	Edition	Code
ICC	2009	International Residential Code
ICC	2009	ISPDC—International Private Sewage Disposal Code
IAPMO	2009	Uniform Plumbing Code
IAPMO	2009	Uniform Mechanical Code
NFPA	2009	NFPA 54 National Fuel Gas Code
NFPA	2011	NFPA 58 Liquefied Petroleum Gas Code

TABLE 2 ORGANIZATIONS	
Acronym	Name
ASSE	American Society of Sanitary Engineering
IAPMO	International Association of Plumbing & Mechanical Officials
ICC	International Code Council
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation

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HYPERLINKS & NAVIGATION IN THIS BOOK

Each figure reference and each table reference in the text of this book is a hyperlink to the page containing the figure or table. This feature is particularly handy when the text refers to a figure that is not on the same page you are viewing. Clicking on the figure number takes you to the figure, and clicking the “back to previous view” button at the top returns you to the text you were viewing.

~~Each IRC code reference is a live hyperlink. If you have web connectivity while viewing this book, clicking on the specific code citation will open a browser window with the complete text of the referenced code citation, including tables.~~

For further information on and tutorials on using this book, go to the demonstration file at www.codecheck.com/cc/ebooks/demonstration.

KEY TO USING CODE CHECK

Code Check Plumbing condenses large amounts of code information by using several “shorthand” conventions that are explained here. Each rule described in *Code Check* begins with a checkbox and ends with the code citations. When only one code is shown, the code citation is inside of brackets, and when two codes are shown, the second code is shown inside of braces, as in the following example from **p.20**:

All fixture traps req venting _____ [3101.2.1] {901.0}

This line is stating that all fixture traps require venting, and the rule is found in section 3101.2.1 of the IRC and section 901.0 of the UPC.

References to figures and tables are preceded by an **F** or a **T** as in the following example from **p.30**:

Changes in direction req appropriate fittings **F9–12, T9** [3005.1] {706.1}

This line is stating that changes of directions must use appropriate fittings, as illustrated in Figures 9–12 and in Table 9

A change from the previous code edition is shown by a code citation in a different color. The superscript after the code citation refers to the table on **p.57**, where more information about the change is found. The following example is from **p.14**:

COs for drains through backwater valve req label _____ [n/a] {710.1}²

This line says that when a cleanout would allow a snake to pass through a backwater valve, the UPC requires a label at the cleanout. This is explained further as code change No. 2 on page 121, where the exact wording of the label is stated.

A line ending in EXC means that an exception to the rule is contained in the line that follows, and that begins with a bullet rather than a checkbox. The following example is from **p.39**:

Ignition source 18 in. above garage floor EXC **F53** _____ [2801.6] {508.14}
 • Flammable vapor ignition-resistant (FVIR) WHs **F54** _____ [2408.2X] {508.14}

These lines are stating that water heaters in garages, as shown in Figure 53, must be elevated so the ignition source is at least 18 inches above the floor, unless the water heater is an FVIR type, as shown in Figure 54.

If a rule does not apply to a particular code, that will be indicated by “n/a” in the code citation column, as in this example from **p.39**:

WH also used for space heating must be L&L for both _____ [2448.2] {n/a}

This line is stating that a water heater used for space heating must be listed and labeled for both purposes. The rule is in section 2448.2 of the IRC and it does not apply when using the UPC.

Rules that are not explicitly stated in a model code are sometimes based on other local ordinances, as indicated in this example from **p.6**:

Building sewer depth per local ordinance _____ [2603.6.1] {local}

This line is saying that IRC section 2603.6.1 directs us to consult local ordinances for required sewer depth. The UPC does not have this rule, and the local building department should be consulted for its requirements.

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ABBREVIATIONS

AAV	=	air admittance valve	KS	=	kitchen sink
ABS	=	acrylonitrile-butadiene-styrene drain (black plastic pipe)	lav	=	lavatory sink
ACH	=	air changes per hour	L&L	=	listed & labeled
AHJ	=	Authority Having Jurisdiction	LP	=	liquefied petroleum (LP gas)
AMI	=	in accordance with manufacturer's instructions	LT	=	laundry tub
AWG	=	American Wire Gage	manu	=	manufacturer, manufacturer's
BO	=	building official	max	=	maximum
Btu	=	British thermal unit(s)	min	=	minimum
cfm	=	cubic feet per minute	MP	=	medium pressure
CO	=	cleanout	o.c.	=	on center
CPVC	=	chlorinated PVC pipe	PE	=	polyethylene tubing
CSST	=	corrugated stainless steel tubing (for gas)	PEX	=	crossed-link polyethylene tubing
cu.	=	cubic, as in cu. ft.	PP	=	polypropylene plastic tubing
Cu	=	copper	PRV	=	pressure relief valve
CW	=	clothes washer	psf	=	pounds per square foot
CW&V	=	combination waste & vent	psi	=	pounds per square inch
DFU	=	drainage fixture unit	psig	=	pounds per square inch gage
DW	=	dishwasher	PVC	=	polyvinyl chloride pipe
DWV	=	drain, waste & vent	req	=	require
EXC	=	exception to rule will follow in the next line	req'd	=	required
FLR	=	flood level rim	req's	=	requires
ft.	=	foot/feet	SDC	=	Seismic Design Category
FVIR	=	flammable-vapor ignition-resistant	sq.	=	square, as in sq. ft.
gal	=	gallon(s)	TPRV	=	temperature & pressure relief valve
GPF	=	gallons per flush	WC	=	water closet (toilet)
gpm	=	gallons per minute	WH	=	water heater
hr.	=	hour(s)	WSFU	=	water supply fixture unit
in.	=	inch(es)	Zi	=	zinc, galvanized

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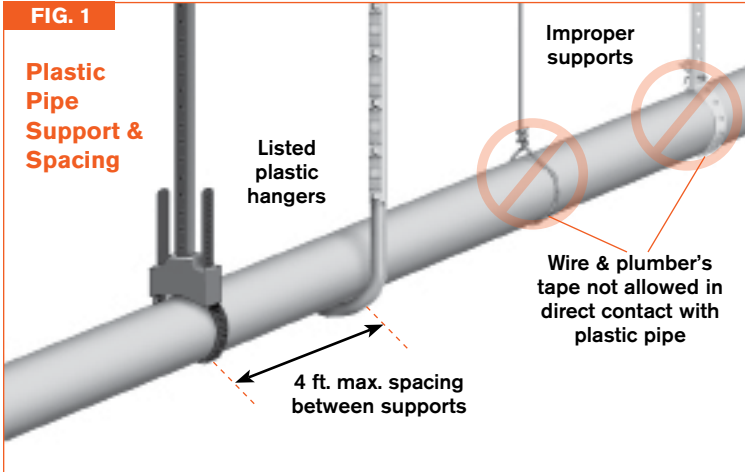
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GENERAL RULES FOR ALL PIPING**Materials****09 IRC 09 UPC**

- Materials must be 3rd party tested or certified _____ [2608.4] {301.1.1}
- All pipes & fittings marked by manu _____ [2608.1] {301.1.2}

Pipe Support**09 IRC 09 UPC**

- Hangers must prevent distortion & maintain alignment (no wires, no metal straps contacting plastic pipe) **F1** _____ [2605.1] {314.2&4}
- Insulate Zi hangers from contact with Cu pipes _____ [2605.1] {314.4}
- Max support intervals for water pipe **T3,4** _____ [2605.1] {314.1}

FIG. 1**TABLE 3 IRC MAX. SUPPORT SPACING OF WATER PIPE [T2605.1]**

Pipe Material	Horizontal	Vertical
ABS/PVC DWV	4 ft.	10 ft. ^A
Threaded steel	12 ft.	15 ft.
Cast-iron hubless	5 ft. (10 ft. OK for 10 ft. lengths of pipe)	15 ft.
Cu water tubing	6 ft. for $\leq 1\frac{1}{4}$ in. pipe 10 ft. for $\geq 1\frac{1}{2}$ in. pipe	10 ft.
CPVC	3 ft. for ≤ 1 in. pipe 4 ft. for $\geq 1\frac{1}{4}$ in. pipe	10 ft. ^A
PEX	32 in.	10 ft. ^A
PEX-AL-PEX	32 in.	4 ft. ^A

A. Provide mid-story guides for pipes ≤ 2 in.**TABLE 4 UPC MAX. SUPPORT SPACING OF WATER PIPE [T3-2]**

Pipe Material	Horizontal	Vertical
ABS/PVC DWV	4 ft.	Base & each floor ^A
Threaded steel	per AHJ	per AHJ
Cast-iron hubless	Within 18 in. of joints ^B (every other joint if 4 ft.)	Base & each floor 15 ft.
Cu water tubing	6 ft. for $\leq 1\frac{1}{2}$ in. pipe 10 ft. for ≥ 2 in. pipe	Each floor 10 ft.
CPVC	3 ft. for ≤ 1 in. pipe 4 ft. for $\geq 1\frac{1}{4}$ in. pipe	Base & each floor ^A
PEX	32 in.	Base & each floor ^A
PEX-AL-PEX	98 in. ^C	Base & each floor ^A

A. Provide mid-story guides.

B. Includes horizontal branch connections. Hangers not OK directly on couplings.

C. Manu may req closer support spacing.

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TRENCHES & PIPE PROTECTION

Pipes in soil must be supported for their entire length. Smooth, self-compacting backfill such as sand or pea gravel helps to eliminate sags that could cause water to be trapped and lead to blockage. Pipes must be protected from sharp rocks or other debris when backfill is placed. Piping encased in concrete requires protection. Pipes in walls and floors must be protected against damage from fasteners.

Piping in Concrete or Masonry

09 IRC 09 UPC

- Wrap embedded piping to prevent corrosion _____ [2603.3] {313.2}
- Provide for movement (expansion & contraction) _____ [2606.3] {313.2}
- Sleeve req'd to prevent structural load on pipes through foundation walls or under footings EXC _____ [2603.5] {313.10}
 - Not req'd for bored or drilled openings _____ [n/a] {313.10.1X}
- Seal spaces between pipes & sleeves _____ [2603.4] {313.10.3}
- Sleeve min 2 sizes larger than pipe through foundation _ [2603.5] {n/a}

Piping in Trenches

09 IRC 09 UPC

- Pipe supported on firm bed for entire length _____ [2604.1] {314.3}
- No rocks supporting or touching pipes _____ [2604.1] {315.4}
- No rocks or debris in first 12 in. of backfill over pipe _____ [2604.3] {315.4}
- Trenches not to undermine footings (within 45°) **F4** _____ [2604.4] {315.1}
- Water pipe min 12 in. cover below finished grade _____ [2603.6] {609.1}
- Water pipe min 6 in. (12 in. UPC) below frost line _____ [2603.6] {609.1}
- Building sewer depth per local ordinance _____ [2603.6.1] {local}

Piping in Common Trench

09 IRC 09 UPC

- Water & sewer OK in same trench if sewer materials approved for use within building **F5** _____ [2905.4.2] {609.2}
- Water & sewer min. 5 ft. apart if sewer materials not approved for use within building **F2** EXC _____ [2905.4.2] {609.2}
 - Water min 12 in. above & to side of sewer pipe **F3** _ [2904.4.2] {609.2}
- Water pipe crossing sewer min 12 in. above EXC ___ [2905.4.2] {609.2}
 - Water service sleeved 5 ft. each way from sewer ___ [2905.4.2X] {n/a}

FIG. 2

Separate Trenches

Required when sewer material is a type not approved within building.

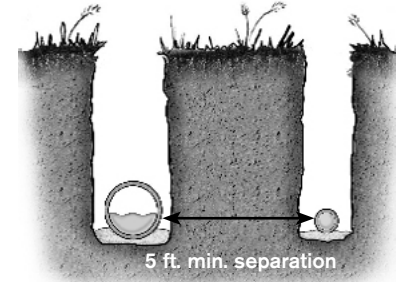


FIG. 3

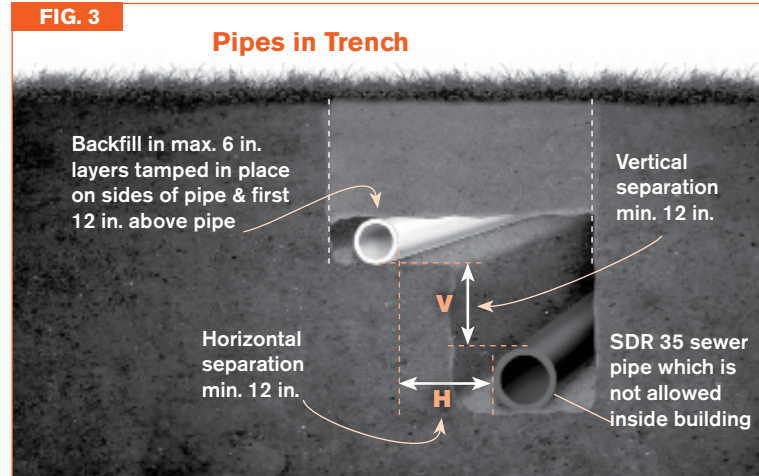
Pipes in Trench

Backfill in max. 6 in. layers tamped in place on sides of pipe & first 12 in. above pipe

Vertical separation min. 12 in.

Horizontal separation min. 12 in.

SDR 35 sewer pipe which is not allowed inside building



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FIG. 4

Pipes Near Footing

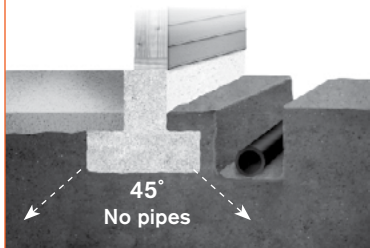
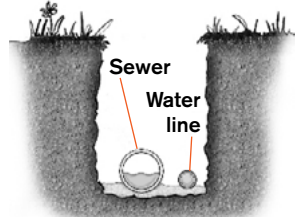


FIG. 5

Common Trench



Sewer material approved within building.

DRAINAGE

Drain and waste pipes must have adequate slope and size, based on the number of drainage fixture units (DFUs) each pipe must serve. Changes of direction in pipes must be done with fittings that will not cause an obstruction in flow. The change from vertical to horizontal requires the greatest sweep, as the liquid and solids in the vertical pipe have greater velocity than in the horizontal pipe.

General

- Materials per **T5** _____ [3002.1&2] {T7-1}
- Size per DFU loads **T6-8** _____ [3005.4] {703.1}
- Min slope 1/4 in./ft. EXC _____ [3005.3] {708.0}
- 1/8 in./ft. OK for 3 in. or larger pipe _____ [3005.3] {0}
 - 1/8 in./ft. OK for 4 in. pipe if structurally necessary per BO _[n/a] {708.0}
- Building drain & building drain branches max load based on slope per **T8** _____ [3005.4.2] {n/a}

09 IRC 09 UPC

General (cont.)

09 IRC 09 UPC

- Building drain & building drain branches max load based on slope per **T8** _____ [3005.4.2] {n/a}
- No reductions in direction of flow **F6,8** EXC [3002.3.1, 3005.1.7] {316.4.1}
- 3 in. x 4 in. WC bend OK **F7** _____ [3005.1.7] {316.4.2}
- No drilled or tapped connections (e.g., saddle fitting) _ [3003.2] {311.2}
- Different types of plastic not glued together EXC ____ [3003.2(5)] {316.1.6}
- ABS & PVC drain to sewer OK with listed transition solvent _[0] {316.1.6}

TABLE 5

DRAINAGE MATERIALS [T3002.1] [T7-1]

Material	Above Ground		Underground		Building Sewer	
	IRC	UPC	IRC	UPC	IRC	UPC
ABS schedule 40	✓	✓	✓	✓	✓	✓
PVC schedule 40	✓	✓	✓	✓	✓	✓
PVC 3¼ in. O.D.	✓	∅	✓	∅	✓	∅
Cu tubing K or L	✓	∅	✓	∅	✓	∅
Cu tubing M	✓	∅	✓	∅	∅	∅
Cu tubing DWV	✓	✓	✓	✓	∅	✓
Cast-iron hubless	✓	✓	✓	✓	✓	✓
Galvanized steel ^A	✓	✓	∅	∅	∅	∅
Vitrified clay	∅	∅	∅	∅	✓	✓
ABS/PVC SDR 35 ^B	∅	∅	∅	∅	✓	∅

A. Maintain at least 6 in. above soil.

B. The IRC also accepts other plastics < schedule 40.

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DRAIN SIZING

Drains must be sized to carry the maximum anticipated simultaneous load. Begin by drawing an isometric diagram of all the fixtures, and assign each the number of drainage fixture units from **T6**. Starting at the highest point of the system and working down to the building drain, size each pipe for the number of DFUs. Note that the IRC allows the use of bathroom and kitchen groups that take into account some fixtures not being used simultaneously. Though kitchen sink trap arms may be 1 1/2 in., the vertical drain must be at least a 2 in. diameter pipe.

TABLE 6 DFUs & TRAP SIZE [T3004.1 & T3201.7] {T7-3}

Fixture	DFUs		Min. Trap Size (in.)	
	IRC	UPC	IRC	UPC
Bar sink	1	1	1 1/2	1 1/2
Bathtub	2	2	1 1/2	1 1/2
Bidet (1 1/2 in. outlet)	1	1	1 1/4	1 1/4
Bidet	1	2	1 1/2	1 1/2
CW standpipe	2	3	2	2
DW (not on KS trap)	2	2	1 1/2	1 1/2
Floor drain	0	0	2	2
KS ^A	2	2	1 1/2	1 1/2
lavatory	1	1	1 1/4	1 1/4
LT	2	2	1 1/2	1 1/2
Single head shower stall	2	2	1 1/2	2
Additional shower heads	2	1	Note B	2
WC 1.6 GPF	3	3	n/a	n/a

(table continues on next page)

FIG. 6

Closet Bend Reductions

FIG. 7

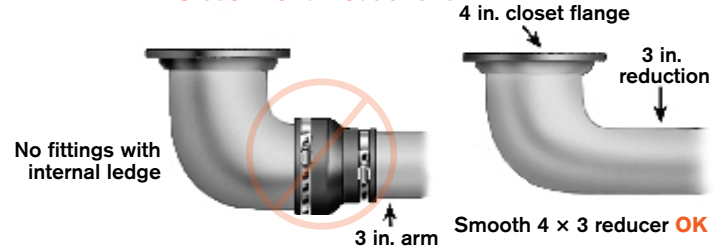


FIG. 8

Durham Fittings



Durham systems include sections of threaded galvanized steel piping that must be kept at least 6 in. above soil to prevent rust. Durham systems have a smooth interior waterway, whereas threaded water supply pipes have an internal ledge. Durham & cast-iron systems have the advantage of being quieter than plastics, & are often used for upper floors of a dwelling, with plastics on the 1st floor.

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TABLE 6 DFUs & TRAP SIZE (CONT.) [T3004.1 & T3201.7] {T7-3}				
Fixture	DFUs		Min. Trap Size (in.)	
	IRC	UPC	IRC	UPC
Full-bath group	5	5 ^C	n/a	n/a
Half-bath group	4	3 ^C	n/a	n/a
Multiple-bath groups (1 1/2)	7	n/a	n/a	n/a
Multiple-bath groups	Note D	n/a	n/a	n/a
Kitchen group	2	n/a	n/a	n/a
Laundry group	3	n/a	n/a	n/a

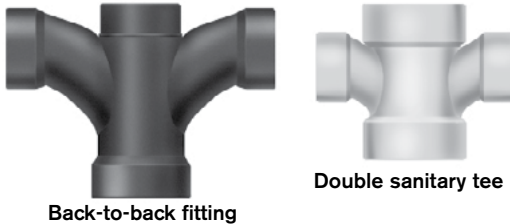
A. With or without DW or food waste grinder.
 B. The IRC bases the trap size on the flow rate. > 5.7 gpm & ≤ 12.3 gpm = 2 in., ≤ 25.8 gpm = 3 in.
 C. The UPC does not have bath groups in the main code text. They are included in appendix L, which reqs local adoption to be in effect.
 D. For each additional bath beyond 1 1/2 baths, add 1 DFU per half bath, 2 DFUs per full bath.

TABLE 7 MAX. DFUs ON BRANCHES & STACKS [T3005.4.1] {T7-5}				
Pipe Size (in.)	IRC DFUs		UPC DFUs	
	Horizontal	Vertical	Horizontal	Vertical
1 1/4 ^{A,B}	1	1	1	1
1 1/2 ^B	3	4	1	2 ^C
2 ^B	6	10	8	16
2 1/2 ^B	12	20	14	32
3	20	48	35 ^D	48
4	160	240	216	256

A. 1 1/4 in. pipe is limited to a single fixture drain or trap arm.
 B. Drains < 3 in. may not receive discharge from WCs.
 C. No sinks, urinals, or DW > 1 DFU.
 D. Max. 3 WCs on any horizontal branch or drain.

FIG. 9

Drains Entering at Same Level



Back-to-back fitting

Double sanitary tee

A back-to-back fixture fitting should be used for fixtures or trap arms entering at the same level. The IRC also allows a double sanitary tee to be used for this purpose, while the UPC allows it only for branch drains entering at the same level & into a barrel that is a minimum of 2 pipe sizes larger than the inlets.

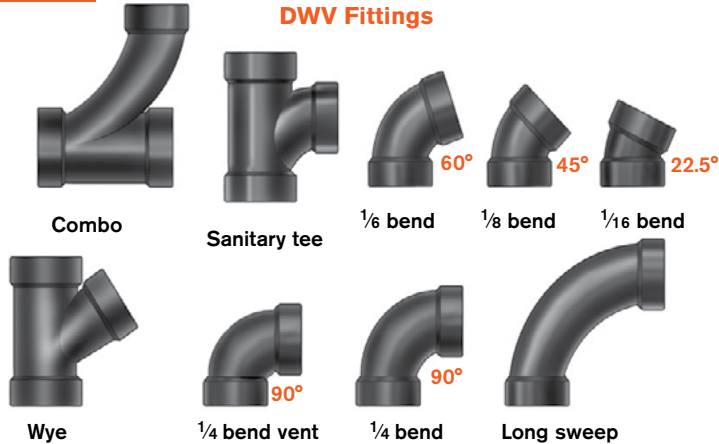
TABLE 8 IRC DFUs ON BUILDING DRAIN & BRANCHES [T3005.4.2]			
Pipe size (in.)	Slope (in./ft.)		
	1/8	1/4	1/2
1 1/2 ^A	n/a	Note A	Note A
2 ^B	n/a	21	27
2 1/2 ^B	n/a	24	31
3	36	42	50
4	180	216	250

A. 1 1/2 in. horizontal branches to building drains limited to 1 pumped fixture (included food waste grinder) or 2 non-pumped fixtures.
 B. Drains < 3 in. may not receive discharge from WCs.

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FITTINGS & CONNECTIONS**Fittings & Connections**

- Changes in direction req appropriate fittings **F9-12, T9** [3005.1] {706.1}
- Use double sanitary tees or equivalent for 2 fixture inlets at same level **F9** _____ [3005.1.1] {706.2}
- Double sanitary tee barrel min 2 sizes larger than inlets **F9** __[n/a] {706.2}
- No horizontal-horizontal fittings within 10 pipe diameters downstream of stack base or horizontal offset _____ [3005.5] {n/a}

09 IRC 09 UPC**FIG. 10****DWV Fittings****TABLE 9 FITTINGS FOR CHANGE OF DIRECTION [T3005.1] {706}**

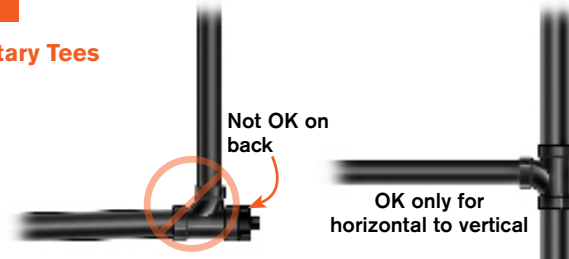
Fitting	Horizontal to Vertical	Vertical to Horizontal	Horizontal to Horizontal
1/16 bend	✓	✓	✓
1/8 bend	✓	✓	✓
1/6 bend	✓	✓	IRC ✓ • UPC Ø
1/4 bend	✓	IRCA • UPC Ø	IRCA • UPC Ø
Short sweep (cast iron)	✓	✓ ^B	✓ ^A
Long sweep	✓	✓	✓
Sanitary tee	✓ ^{C,D}	Ø	Ø
Wye	✓	✓	✓
Combo wye & 1/8 bend	✓	✓	✓

A. IRC max. 2 in. diameter.

B. IRC fixture drain max 2 in. diameter, fitting min. 3 in. diameter.

C. Double sanitary tees not to receive discharge from pumped waste or from WCs unless min. 18 in. between WC & fitting.

D. Double sanitary tees in UPC must have barrel 2 pipe sizes larger than inlets.

FIG. 11**Sanitary Tees**

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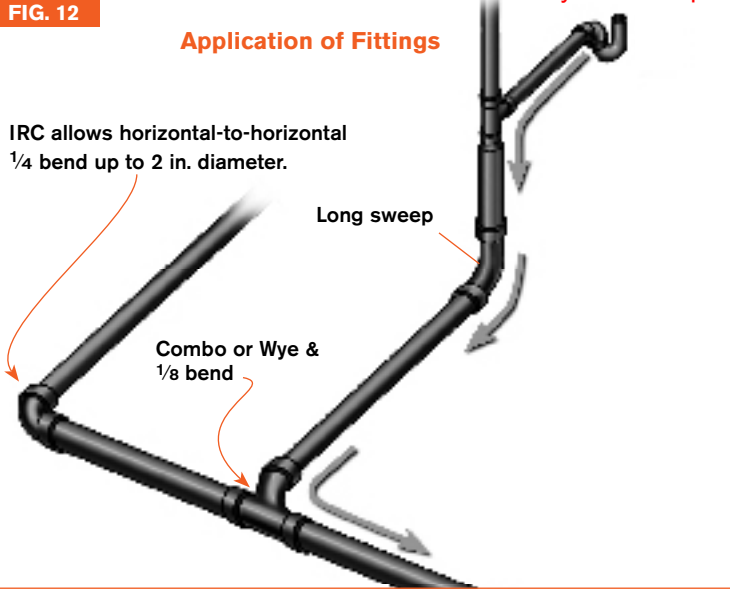
FIG. 12

Application of Fittings

IRC allows horizontal-to-horizontal
1/4 bend up to 2 in. diameter.

Long sweep

Combo or Wye &
1/8 bend



CLEANOUTS

Cleanouts are necessary for clearing drain obstructions and for inspecting the building sewer with a sewer camera. While each code allows cleanouts to be in crawl spaces, a preferred method is to extend them to an area that is more readily accessible. The UPC requires that underfloor cleanouts be no farther than 20 ft. from the access opening, with a 30 in. wide, 18 in. high path from the access to the cleanout. When those conditions cannot be met, the cleanout must be extended to the exterior. The IRC allows drain cleaning through a removable fixture trap or by removing the toilet.

IRC Cleanout (CO) Requirements

09 IRC

- COs liquid & gas tight; plugs brass or plastic _____ [3005.2.1]
- Size same as drain pipes up to 4 in. diameter EXC _____ [3005.2.9]
 - Traps as CO OK 1 size smaller than drain (e.g., kitchen) _____ [3005.2.9X1]
 - CO in stacks OK 1 size smaller than stack _____ [3005.2.9X1]
- Removable trap OK as CO _____ [3005.2.10]
- COs req'd not > 100 ft. apart in each horizontal drain line _____ [3005.2.2]
- COs for underground drains req extensions above grade **F17** _____ [3005.2.3]
- Req'd in horizontal drains, building drains & building sewer for each change of direction > 45° **F14** EXC _____ [3005.2.4]
 - Only 1 cleanout req'd per 40 ft. of run **F14** _____ [3005.2.4]
- Req'd at base of all stacks _____ [3005.2.6]'
- Junction of building drain & building sewer req's CO brought to finished grade or lowest floor level EXC _____ [3005.2.7]
 - CO can be on 3 in. soil stack within 10 ft. _____ [3005.2.7]
- 2-way CO at junction of building drain & building sewer can be req'd CO for both _____ [3005.2.7]
- Install COs to allow cleaning in direction of flow _____ [3005.2.8]
- Pipes < 3 in. req 12 in. clearance; 3 in. req's 18 in. _____ [3005.2.5]
- CO openings not OK for new fixtures without new CO **F15** _____ [3005.2.11]

UPC Cleanout Requirements

09 UPC

- COs liquid & gas tight _____ {707.3}
- Plugs brass or plastic with raised head or countersunk slot _____ {707.1}
- Size: 2 in. pipe = 1 1/2 in.; 2 1/2 or 3 in. pipe = 2 1/2 in.; 4 in. pipe = 3 1/2 in. {707.10}
- Req'd at upper terminal of all horizontal runs **F14** EXC _____ {707.4}
 - Horizontal runs < 5 ft. (unless serving sinks or urinals) _____ {707.4X1}
 - Horizontal pipes 72° from vertical (1/5 bend) _____ {707.4X2}
 - Pipes above lowest floor of building _____ [707.4X3]
 - No upper terminal CO req'd if 2-way CO at junction of building drain & building sewer **F13** _____ {707.4X4}

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UPC Cleanout Requirements (cont.)

- Req'd for runs with aggregate change of direction > 135° **F14** _____ {707.4}
- Trap arm bends < 90° do not req CO _____ {707.14}
- Takeoff above flow line unless wye branch or end of line **F30** _____ {707.5}
- Pipes 2 in. req 12 in. clearance; > 2 in. req's 18 in. clearance _____ {707.10}
- Underfloor CO must extend above finished floor or outside building if > 20 ft. from access door or if < 18 in. vertical clearance or if passageway to CO < 30 in. wide _____ {707.9}

09 UPC

FIG. 13

UPC Cleanouts Horizontal Distances

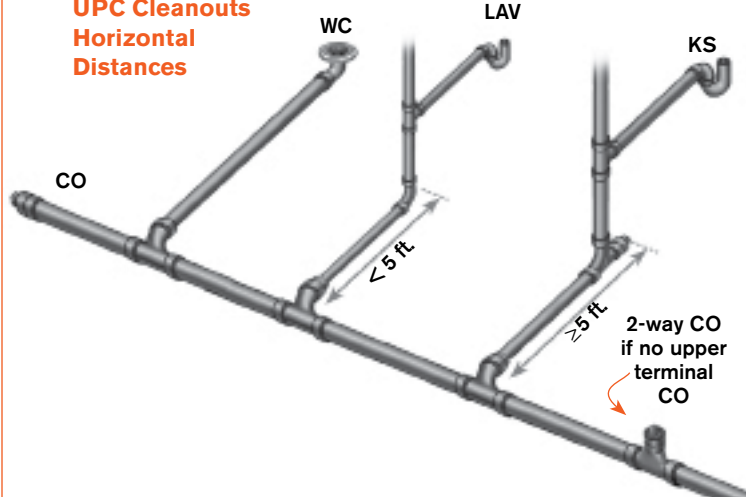
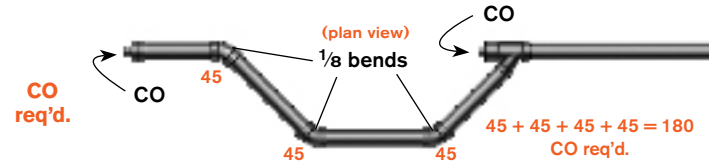


FIG. 14

Cleanout Bends & Clearances



UPC req's. a CO for an aggregate total bend > 135°.

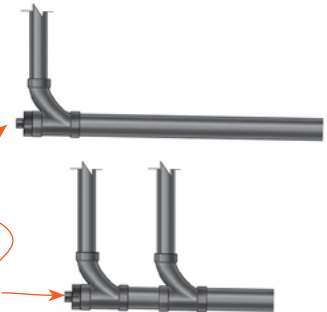
IRC req's a CO for every change of direction > 45° except only 1 is req'd each 40 ft.

FIG. 15

Adding Drain at Cleanout

CO openings not to be used for installation of new fixtures.

If additional drain is added here, new CO is req'd.



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WASTE STACKS & VENTS

A waste stack provides a convenient way of discharging clustered fixtures on different floor levels. Toilets and urinals may not discharge into the waste stack. The stack must be undiminished in size to its vent, & offsets are not allowed unless at least 6 in. above the highest fixture draining to the stack. The principle of a waste stack is that water will travel on the walls of the pipe, leaving the center with air to function as a vent. The UPC does not allow waste stacks and vents in single-family residential structures; there is a potential for suds in the lower fixture, or for air pressures from a falling slug of water to create pressure across the lower trap seal. The IRC addresses this by limiting the DFUs discharging into one branch interval.

General

09 IRC 09 UPC

- Waste stack must be vertical with no offsets _____ [3109.2] {Ø}
- No WCs or urinals allowed on waste stack _____ [3109.2] {Ø}
- Stack vent above waste stack may have offsets _____ [3109.3] {Ø}
- Stack vent offsets min 6 in. above FLR off highest fixture [3109.3] {Ø}
- Waste & vent stack same size for entire length **F16** _ [3109.3&4] {Ø}
- Size waste stack per total DFUs discharging into it **T10** [3109.4] {Ø}

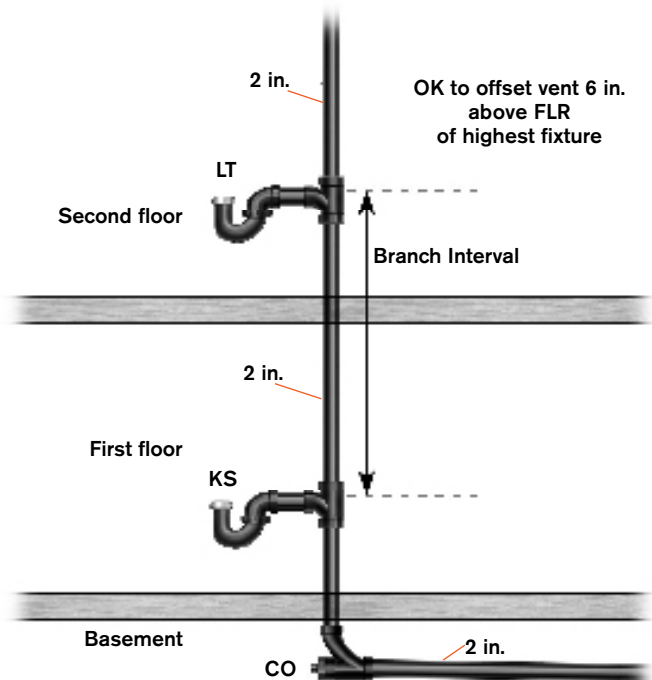
TABLE 10

IRC WASTE STACK VENT SIZE [T3109.4]

Stack Size (in.)	Total Discharge into 1 Branch Interval (DFUs)	Total Discharge for Stack (DFUs)
1½	1	2
2	2	4
2½	No limit	8
3	No limit	24
4	No limit	50

FIG. 16

IRC Waste Stack & Vent



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FIXTURES BELOW MANHOLE COVER OR SEWER

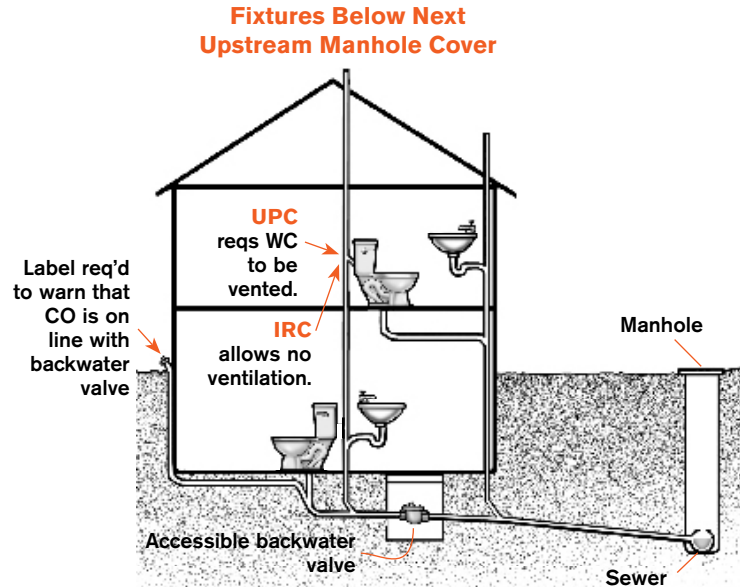
Fixtures above the sewer will drain by gravity. If the fixtures or their drains are also below the manhole cover, sewage could back up to the fixtures when the sewer is blocked. Backup can be prevented by installing backwater valves on the drain lines below the manhole cover. Backwater valves must remain accessible for maintenance. Cleanouts that could lead to a backwater valve should be labeled to avoid damage to the backwater valve.

Backwater Valves F17

09 IRC 09 UPC

- | | |
|--|----------------------|
| <input type="checkbox"/> Fixtures below next upstream manhole req backwater valve (measured from FLR in IRC, from floor level in UPC) ___ [3008.1] | {710.1} |
| <input type="checkbox"/> Fixtures above elevation of manhole cover not allowed to discharge through backwater valve _____ [3008.1] | {710.1} |
| <input type="checkbox"/> Backwater valves req'd to be accessible for service ___ [3008.5] | {710.6} |
| <input type="checkbox"/> COs for drains through backwater valve req label _____ [n/a] | {710.1} ² |

FIG. 17

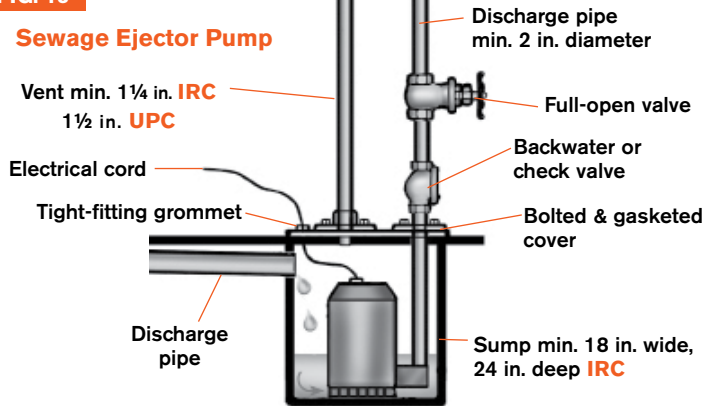


*Fixtures above the sewer, but below the flood weir of the next upstream manhole are req'd to be protected by an accessible backwater valve (a type of check valve), as shown here. The valve protects the building from sewer contamination in the event of a street main backup. The **UPC** also reqs a backwater valve for fixtures below the manhole cover of a private sewer system.*

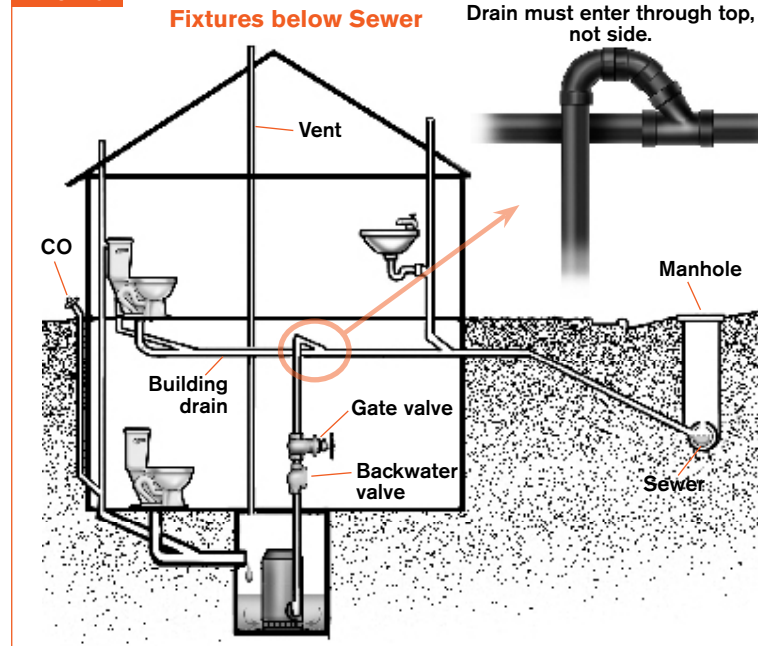
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Fixtures Below Sewer**09 IRC 09 UPC**

- Fixtures to drain by gravity where practical _____ [3007.1] {709.0}
- Sump discharge must be lifted above gravity drain _____ [3007.1] {710.2}
- Connect to wye in top of horizontal gravity drain **F19** _____ [3007.3.5]^P {710.4}
- Backwater valve req'd on ejector discharge pipe **F18,19** [3007.2] {710.3.2}
- Gate valve req'd on discharge side of check valve **F18,19** [3007.2] {710.3.2}
- Ball valves OK for ejectors not serving WCs _____ [n/a] {710.4}
- Valve bodies cast iron or brass (no plastic ball valves) _____ [n/a] {710.4}
- Sumps req's water & gas tight removable cover **F18** _____ [3007.3.2] {710.10}
- Min pump capacity 21 gpm {20 gpm in UPC} _____ [3007.6]⁴ {710.3.1}
- Min 2 in. discharge piping **T11** EXC _____ [T3007.6]⁴ {710.3.2}
 - Grinder pumps min 1 ¼ in. discharge _____ [3007.6] {710.12}
- Gravity drains receiving discharge from ejector sized at 1.5 DFU for each gpm of pump (2 DFU in UPC) **F19** _____ [T3004.1] {710.5}

FIG. 18**Sewage Ejector Pump****TABLE 11****MINIMUM EJECTOR PUMP CAPACITY [T3007.6]**

Discharge Pipe Diameter	Pump Capacity
2 in.	21 gpm
2½ in.	30 gpm
3 in.	46 gpm

FIG. 19

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ON-SITE SEWAGE DISPOSAL SYSTEMS

In addition to codes enforced by building departments, on-site sewage disposal systems may be regulated by the local department of environmental health services. Septic tanks and leach fields must be sized and situated so they do not have an adverse impact on local water supply systems. The minimum areas shown in **T12B** are a general planning guide, and local regulations must be followed. The area will vary based on the results of soil percolation test data and the type of construction. The IRC does not directly deal with on-site systems, and the ICC has a separate code for these, the IPSDC. The UPC has an appendix chapter K for such systems.

Septic Tanks**09 IPSDC 09 UPC**

- Tank in flood hazard area anchored in place _____ [303.2] {K1.0D}
- Min capacity per **T12A** _____ [802.7.1] {K2.0}
- Tank min 5 ft. from building _____ [802.8] {n/a}

TABLE 12A SEPTIC TANK CAPACITY [T802.7.1] {T K-2}

Bedrooms	Min. Tank Size IPSDC	Min. Tank Size UPC	Max UPC DFUs
1-2	750	750	15
3	1,000	1,000	20
4	1,200	1,200	25
5	1,425	1,500	33
6	1,650	1,500	33

TABLE 12B MIN. ABSORPTION AREA [T603.1]

Percolation Class	Percolation Rate ^A	Seepage Trenches ^B	Seepage Beds ^B
1	0 to < 10	165	205
2	10 to < 30	250	315
3	30 to < 45	300	375
4	45 to 60	330	415

A. Minutes req'd for water to fall 1 in.

B. Sq. ft. per bedroom.

TRAPS & TAILPIECES

Traps prevent sewer gases, vermin, and other contaminants from entering the dwelling. The trap seal must be a sufficient depth (2 in.) to maintain a seal and not so deep (4 in. max) as to become blocked with sludge or create a siphoning effect. Trap arms (fixture drains) must be vented, otherwise the negative pressure created by water moving down the pipe will cause air to be sucked through the trap seal. The maintenance of proper trap seals is the underlying principle behind the code rules for drainage, traps, and venting.

Traps**09 IRC 09 UPC**

- Each fixture reqs separate trap EXC _____ [3201.6] {1001.1}
- Fixtures with integral traps (WCs) _____ [3201.6X1] {1001.1}
 - 2 or 3 lavs, LTs, or sinks of same type OK on
 - 1 center trap in same room _____ [3201.6X2] {1001.2}
 - Laundry trap may drain to CW standpipe _____ [3201.6X3] {n/a}
 - Fixtures sharing trap max 30 in. apart horizontal _____ [3201.6X2] {1001.2}
 - Trap seal min 2 in. min, max 4 in. **F20** _____ [3201.2] {1005.0}
 - Set traps level & protect from freezing _____ [3201.3] {1005.0}
 - No S traps, bell traps, drum traps, traps with moving parts, or traps with interior partitions EXC **F21** _____ [3201.5] {1004.0}
 - Lav traps with plastic or stainless partitions _____ [3201.5] {1004.0}
 - Size per **T6** _____ [3201.7] {1003.3}
 - Trap size ≥ fixture outlet size _____ [3201.7] {1003.3}
 - No double traps (in series) _____ [3201.6] {1004.0}

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FIG. 20

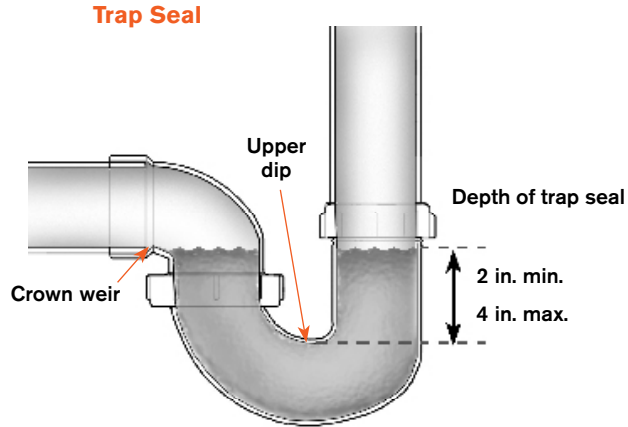
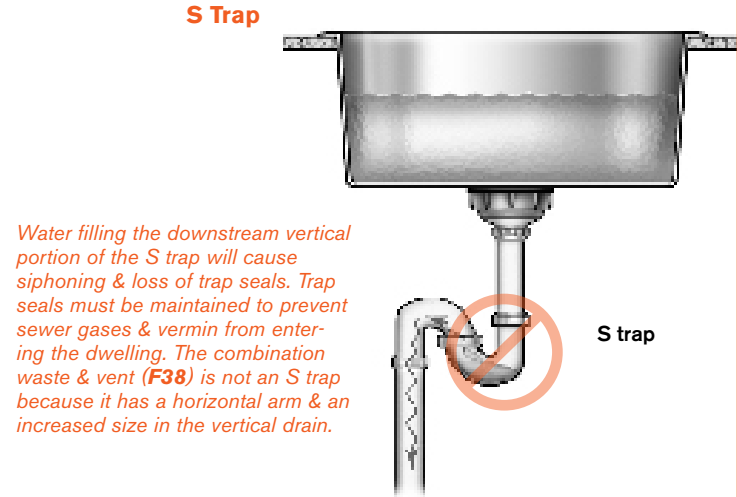


FIG. 21



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Fixture Tailpieces

09 IRC 09 UPC

- Fixture tailpiece max 24 in. vertical distance EXC **F22** [3201.6] {1001.4}
 - CW standpipes 18–42 in. {18–30 in. UPC} **F62** [2706.2] {804.1}
- IRC: Max 30 in. horizontal distance **F22** [3201.6] {Ø}
- UPC: Max 24 in. total developed length **F22** [n/a] {1001.4}
- Directional fittings req'd for continuous wastes from disposer or DW (i.e., wyes, combos, or tees with baffles) **F22,23** [2707.1] {404.4}

FIG. 22

Tailpiece Lengths

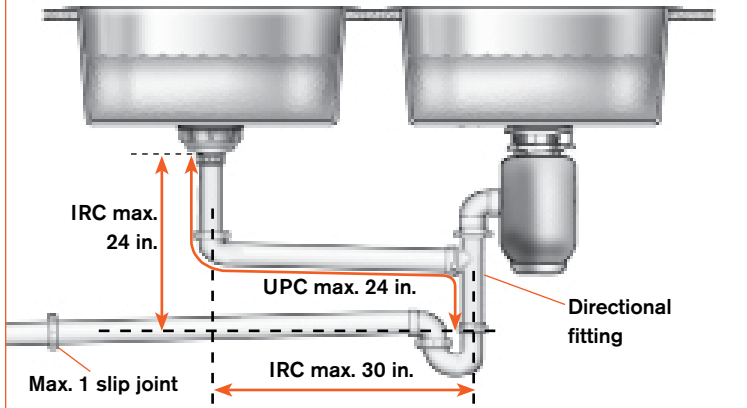


FIG. 23

Directional Fittings

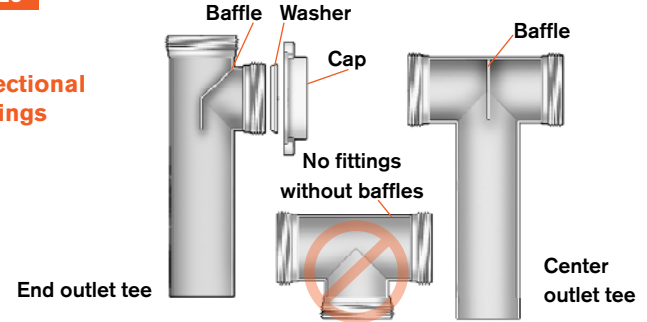
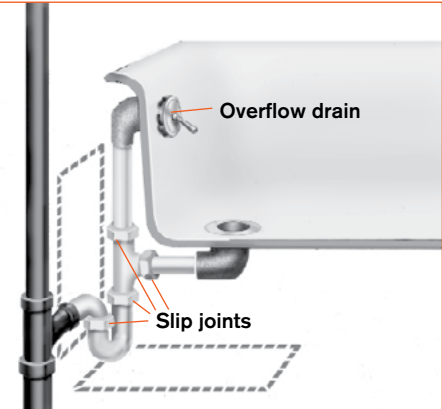


FIG. 24

Slip Joints & Access

An access opening at least 12 in. × 12 in. is req'd for repair or replacement of concealed slip joints. The opening can be in a ceiling or a wall.



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Trap Arms

09 IRC 09 UPC

- Trap same size as trap arm _____ [3201.7] {1003.3}
- Arm length min 2× trap arm diameter **F27** _____ [3105.3] {1002.2}
- Arm length & slope per table EXC **T13** _____ [3105.1] {1002.2}
 - Trap arm length from WC unlimited (6 ft. in UPC) ____ [3105.1X] {T10-1}
- Arms < 3 in. diameter (all in UPC) min slope ¼ in./ft. ____ [T3105.1] {T10-1}
- Total fall of trap arm max 1 pipe diameter **F25** _____ [3105.2] {n/a}
- Only 1 trap permitted on trap arm EXC _____ [3201.6] {1001.1}
 - 2 trap arms allowed to join through double-wye fitting to common vent **F34** _____ [3107.1&2] {Ø}
- Tubing traps req trap adapter **F26** _____ [n/a] {1003.2}
- Max 1 slip joint allowed on outlet side of trap **F22** _____ [n/a] {1003.2}
- CO req'd if direction change > 90° in < 3 in. arm _____ [n/a] {1002.3}
- Slip joints req'd to be accessible **F24** _____ [3201.1] {404.2}

TABLE 13 TRAP ARM DISTANCE TO VENT [T3105.1] [T10-1]

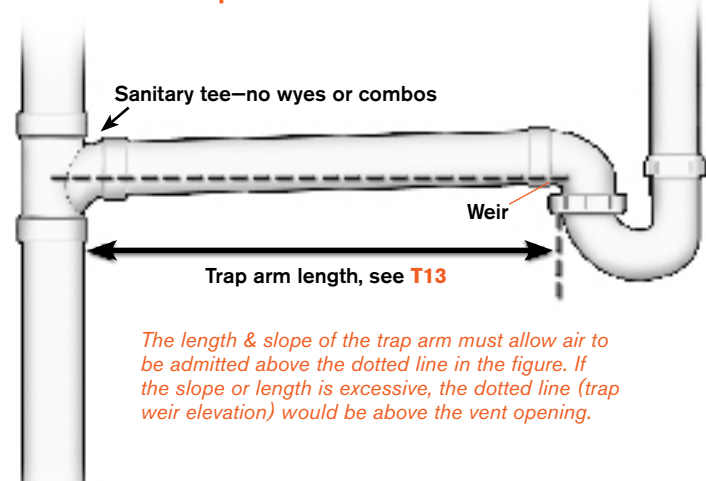
Trap Arm Diameter	Min.	IRC Max.	UPC Max.
1 ¼ in.	2 ½ in.	5 ft.	2 ft. 6 in.
1 ½ in.	3 in.	6 ft.	3 ft. 6 in.
2 in.	4 in.	8 ft.	5 ft.
3 in. ^A	6 in.	12 ft.	6 ft.
4 in. or larger ^A	8 in.	16 ft.	10 ft. ^B

A. In the IRC, these arms can have 1/8 in./ft. slope. In the UPC, all arms must slope ¼ in./ft.

B. The maximum length from a WC to the vent is 6 ft. in the UPC & unlimited in the IRC.

FIG. 25

Trap Arm Distances

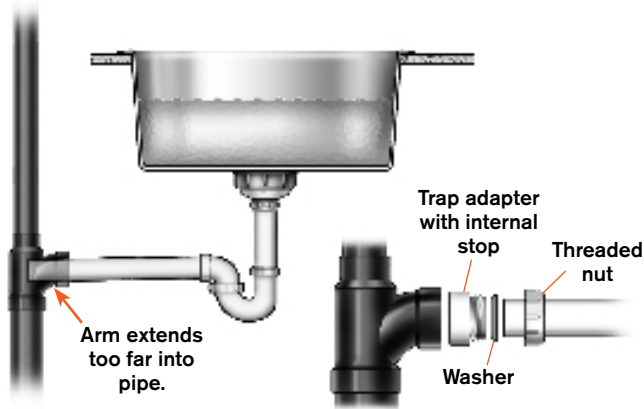


The length & slope of the trap arm must allow air to be admitted above the dotted line in the figure. If the slope or length is excessive, the dotted line (trap weir elevation) would be above the vent opening.

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FIG. 26

Trap Adapter for Tubing Traps



VENTS

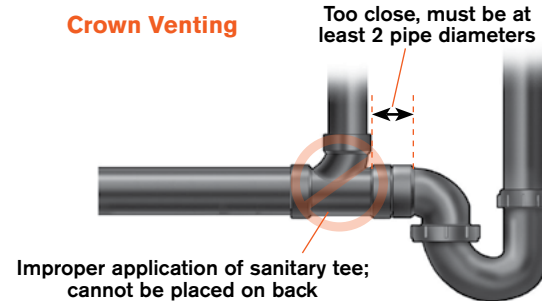
Vents prevent atmospheric pressure differences across traps and are essential to maintaining the trap seal. Without vents, the water in the seal could be sucked out, leaving the occupants unprotected from contaminants downstream of the trap. The IRC and UPC have very different approaches to venting.

General

- | | | | |
|--|------------|---------------|---------------|
| <input type="checkbox"/> All fixture traps req venting _____ | [3101.2.1] | 09 IRC | 09 UPC |
| <input type="checkbox"/> Vent system not to be used for any other purposes ____ | [3101.3] | | {n/a} |
| <input type="checkbox"/> No flat dry vents (take off above horizontal centerline) F30 | [3104.3] | | {905.2} |
| <input type="checkbox"/> Slope vents to drain to soil or waste piping _____ | [3104.2] | | {905.1} |
| <input type="checkbox"/> Change direction with appropriate fittings F29 | [3104.2] | | {903.3} |
| <input type="checkbox"/> No vent opening below trap weir except WCs F25 | [3105.2] | | {905.5} |
| <input type="checkbox"/> No crown vents: min 2 pipe diameters from trap F27 | [3105.3] | | {1002.2} |
| <input type="checkbox"/> Horizontal dry vents min 6 in. above FLR F28 | [3104.4] | | {905.3} |
| <input type="checkbox"/> Horizontal branch vents min 6 in. above FLR F28 | [3104.5] | | {905.3} |
| <input type="checkbox"/> Piping < 6 in. above FLR req's drainage type fittings _____ | [n/a] | | {905.3} |

FIG. 27

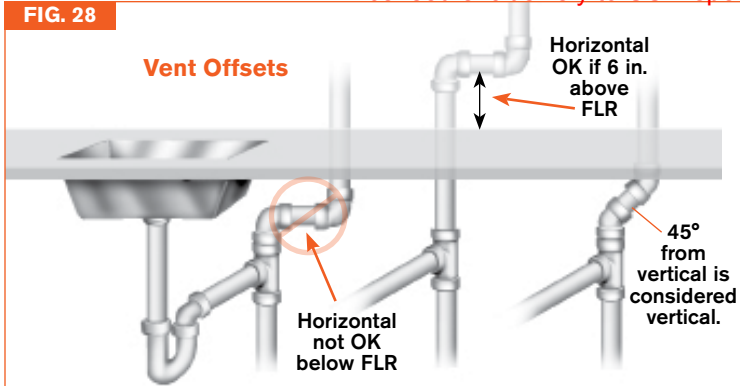
Crown Venting



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FIG. 28

Vent Offsets



Do not combine vents until 6 in. above highest FLR.

FIG. 30

Vent Takeoff above Center Line



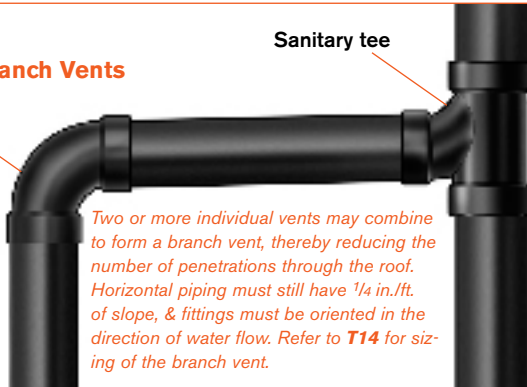
Vent takeoffs must be at least 45° from horizontal. A direct horizontal takeoff could be blocked by effluent in the pipe, which would make the vent ineffective.

FIG. 29

Branch Vents

Sanitary tee

¼ bend



*Two or more individual vents may combine to form a branch vent, thereby reducing the number of penetrations through the roof. Horizontal piping must still have ¼ in./ft. of slope, & fittings must be oriented in the direction of water flow. Refer to **T14** for sizing of the branch vent.*

TABLE 14

UPC VENT SIZE AND LENGTH {T7-5}

Pipe size (in.)	1 ¼	1 ½	2	2 ½	3	4
Max. DFUs	1	8	24	48	84	256
Max. length (ft.) ^A	45	60	120	180	212	300

A. Max. horizontal length is 1/3 of total length. If pipes are increased 1 size, the length limitations of this table do not apply.

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Size	09 IRC	09 UPC
<input type="checkbox"/> Min size 1¼ in. _____ [3113.1]		{904.1}
<input type="checkbox"/> Vents min ½ size of drain served _____ [3113.1]		{904.1}
<input type="checkbox"/> Size per no. of DFUs served & length of vent T14 _____ [n/a]		{904.1}
<input type="checkbox"/> Increase 1 pipe size if developed vent length > 40 ft. ___ [3113.1]		{n/a}
<input type="checkbox"/> Increase 1 pipe size if > 1/3 of vent is horizontal _____ [n/a]		{904.2X}
<input type="checkbox"/> Waste stack vent same size as waste stack F16 _____ [3109.3]		{n/a}
<input type="checkbox"/> Total area of vents ≥ to size of building sewer T15 _____ [n/a]		{904.1}
<input type="checkbox"/> Vents for fixtures discharging through pumps, ejectors, or backwater valves do not meet area requirement _____ [n/a]		{904.1}

Vertical Wet Venting	09 IRC	09 UPC
<input type="checkbox"/> All wet vented fixtures to be on same story _____ [3108.4]		{908.1}
<input type="checkbox"/> Size wet vent per DFUs of upper drains T16 _____ [3108.3]		{n/a}
<input type="checkbox"/> WCs at same elevation & below other drains _____ [3108.4]		{n/a}
<input type="checkbox"/> Each fixture drain connect independently to wet vent ___ [3108.4]		{n/a}
<input type="checkbox"/> Limited to trap arms of 1-DFU & 2-DFU fixtures _____ [n/a]		{908.1}
<input type="checkbox"/> Max 4 fixtures _____ [n/a]		{908.1}
<input type="checkbox"/> 6 ft. max developed length of wet vent F32 _____ [n/a]		{908.1}
<input type="checkbox"/> Wet vent min 1 pipe size larger than req'd waste & min 2 in. _ [n/a]		{908.2}

TABLE 15				UPC VENT AREA FILL-IN TABLE {904.1}	
Vent Size (in.)	Area (sq. in.)	No. of Vents	Net Vent Area		
1¼	1.23			Example:	
1½	1.77			4 in. building drain = 12.57 sq. in.	
2	3.14			One 1¼ in. vent = 1.23 sq. in.	
3	7.07			Three 2 in. vents = 9.42 sq. in.	
4	12.57			1.23 + 9.42 = 10.65 sq. in.	
TOTAL				Thus more venting would be req'd.	

Common Vent	09 IRC	09 UPC
<input type="checkbox"/> OK only for fixtures on same floor level F31,33 _____ [3107.1]		{905.6}
<input type="checkbox"/> Max 2 fixtures to vertical common vent _____ [3107.1]		{905.6}
<input type="checkbox"/> UPC must connect at approved double fitting F9 _____ [n/a]		{905.6}
<input type="checkbox"/> Connect fixtures to vertical vent at same level F33 EXC _____ [3107.2]		{905.6}
• Vent connection downstream OK in IRC F34 _____ [3107.2]		{Ø}
<input type="checkbox"/> Size common vent per DFUs of upper drain T16 _____ [3107.3]		{n/a}
<input type="checkbox"/> Upper fixture cannot be WC _____ [3107.3]		{908.1}

FIG. 31

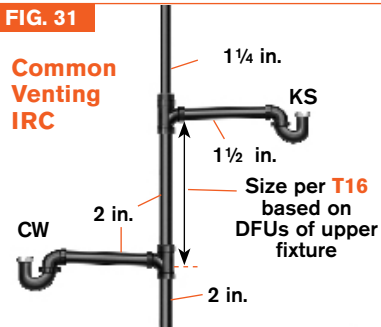


FIG. 32

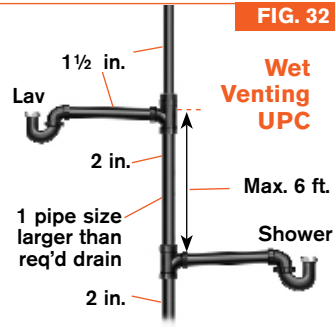


FIG. 33

Common Venting UPC



UPC common vented fixtures must enter through back-to-back sanitary tee that has a barrel size 2 sizes larger than inlets—see **F9**.

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TABLE 16 IRC COMMON VENT SIZES [T3107.3]	
Pipe Size (in.)	Max. Discharge from Upper Fixture Drain (Fixture Units)
1½	1
2	4
2½ to 3	6

Vent Termination

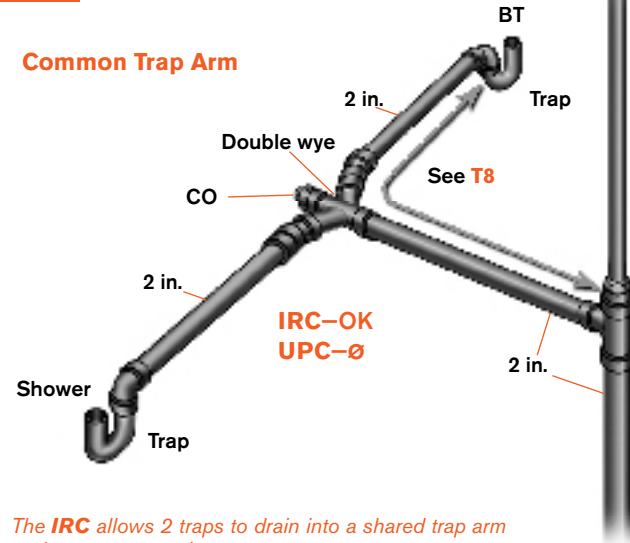
- At least 1 vent must extend outdoors (all vents UPC) ___ [3102.1] {906.1}
- Req'd IRC exterior vent must be dry vent _____ [3102.2] {n/a}
- Req'd IRC exterior vent not an island fixture vent **F36** ___ [3102.2] {n/a}
- Req'd IRC exterior vent min ½ size of building drain ___ [3102.3] {n/a}
- Vents through roof min 6 in. above roof _____ [3103.1] {906.1&3}
- Min 12 in. horiz. from adjacent vertical surfaces _____ [n/a] {906.1}
- Min 7 ft. above roof used as deck _____ [3103.1] {906.3}
- Min 7 ft. above roof if within 10 ft. horizontal of roof deck ___ [n/a] {906.3}
- Min 2 ft. (3 ft. UPC) above openings within 10 ft. EXC _ [3103.5] {906.2}
- OK if 4 ft. below building openings _____ [3103.5] {Ø}
- Min 3 ft. distance from PL _____ [n/a] {906.2}
- Provide flashing for roof penetrations _____ [3103.3] {906.5}
- Vent pipes secured in approved manner when anchoring flagpoles, aerials, or similar items (OK only when roof used for other than weather protection in UPC) _____ [3103.4] {906.3}

Snow or Frost Closure

- Applies when min design temperature < 0°F _____ [3103.2] {906.7}
- Min 3 in. diameter (2 in. UPC) termination _____ [3103.2] {906.7}
- Transition to larger diameter min 1 ft. below roof _____ [3103.2] {906.7}
- 6 in. above snow line (UPC 10 in. above roof or per AHJ) [3103.1] {906.7}

09 IRC 09 UPC

FIG. 34

Common Trap Arm

The IRC allows 2 traps to drain into a shared trap arm to the vent connection.

The UPC specifically prohibits this practice and all traps must enter the vent through individual trap arms.

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SPECIAL VENTING SYSTEMS

The IRC offers a number of options for island sinks, including air admittance valves, combination waste and vent, and the loop vents shown in **F35** & **F36**. The UPC allows only the method shown in **F35** unless specific approval is obtained from the AHJ.

Island Sinks

- | | 09 IRC | 09 UPC |
|--|--------|---------|
| <input type="checkbox"/> Island venting limited to sinks (disposer OK) & lavs _____ [3112.1] | | {909.0} |
| <input type="checkbox"/> Island vented with drainage pattern fittings only F35,36 [3112.3] | | {909.0} |
| <input type="checkbox"/> Island vent above fixture drain outlet F36 (UPC: as high as possible F35) before returning downward _____ [3112.2] | | {909.0} |
| <input type="checkbox"/> Lowest part of island vent shall connect full size to vertical drain or top half of a horizontal drain F36 _____ [3112.3] | | {Ø} |
| <input type="checkbox"/> COs req'd in island vents & drains F35,36 _____ [3112.3] | | {909.0} |
| <input type="checkbox"/> Connect island vent downstream of fixture drain F36 _____ [n/a] | | {909.0} |
| <input type="checkbox"/> Foot vent req'd through wye branch off below-floor vent F35 [n/a] | | {909.0} |
| <input type="checkbox"/> CO req'd in vertical section of foot vent F35 _____ [n/a] | | {909.0} |
| <input type="checkbox"/> No upstream fixtures on drain serving island _____ [n/a] | | {909.0} |

FIG. 35

UPC Kitchen Island Sink

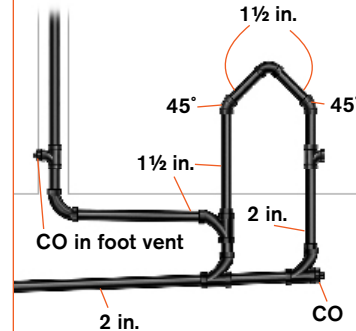
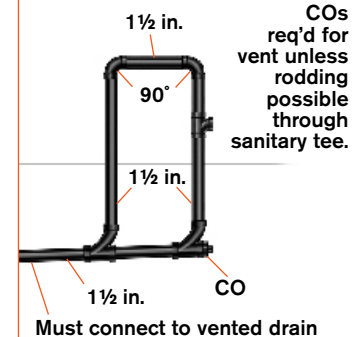


FIG. 36

IRC Kitchen Island Sink



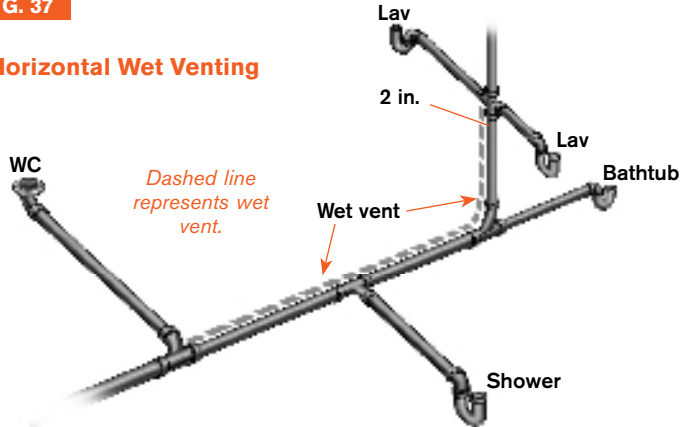
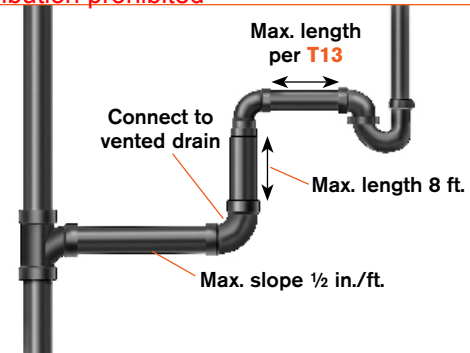
Combination Waste & Vent (CW&V)

- | | 09 IRC | 09 UPC |
|---|--------|---------|
| <input type="checkbox"/> UPC CW&V reqs specific approval from AHJ _____ [n/a] | | {910.2} |
| <input type="checkbox"/> Only sinks (no disposers), lavs & floor drains _____ [3111.1] | | {Ø} |
| <input type="checkbox"/> 1 vertical pipe (max 8 ft. length) allowed between fixture drain & horizontal CW&V pipe _____ [3111.2] | | {Ø} |
| <input type="checkbox"/> Max slope of CW&V piping 1/2 in./ft., min slope 1/4 in./ft. [3111.2.1] | | {n/a} |
| <input type="checkbox"/> CW&V must connect to vented horizontal drain or have vent connected to CW&V pipe F38 _____ [3111.2.2] | | {n/a} |
| <input type="checkbox"/> Vent connected to CW&V pipe must rise 6 in. min above fixture FLR before horizontal offsets _____ [3111.2.2] | | {n/a} |

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Horizontal Wet Venting**09 IRC 09 UPC**

- Horizontal wet venting OK for any combination of fixtures within 1 or 2 bathroom groups on same floor **F37** ____ [3108.1] {908.2.1}
- Fixtures within bathroom groups only ones allowed on horizontal wet vent ____ [3108.1] {908.2.1}
- Other vented fixtures OK downstream of wet vent ____ [3108.1] {908.2.1}
- UPC WC must be downstream of other drain connections __[n/a] {908.2.1}
- Dry vent connection to wet vent must be individual or common vent connected to non-WC fixture EXC__ [3108.2.1] {908.2.2}
 - OK for horizontal WC drain to be wet vent ____ [3108.2.1]⁵ {Ø}
- Max trap arm length from trap weir to wet vent **T13** ____ [3108.5] {908.2.1}

FIG. 37**Horizontal Wet Venting****FIG. 38****IRC: Combination Waste & Vent****TABLE 17****MAX. DFUs FOR WET VENTS & CW&V**
[T3108.3 & 3111.3] & {908.2 & 908.4.3}

Pipe Size (in.)	Wet Vents		CWV [IRC]	
	IRC	UPC	To Branch	To Building Drain
1½	1	Ø	Ø	Ø
2	4	4	3	4
2½	6	8 ^A	6	26
3	12	8 ^B	12	31
4	32	8 ^B	20	50

A. For horizontal wet vents, max load is 4 DFUs on 2½ in. pipe.
 B. More than 8 possible for horizontal wet vents.

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AIR ADMITTANCE VALVES

Air admittance valves (AAVs) operate by gravity, as shown in **F39** & **F40**, and have no metal or rubber parts that could corrode or deform. In the IRC they can be used for individual fixtures or for branches. The UPC does not explicitly approve AAVs, although some jurisdictions might accept them under the provisions for Alternate Materials and Methods in 301.2. If the UPC is the code in your area, be sure to check with the local building department before installing AAVs.

General

- Install after DWV leak test _____ [3114.2]
- OK at individual, branch, circuit & stack vents **F39** _____ [3114.3]
- Individual & branch type AAV to vent only fixtures on same floor level & that connect to a horizontal branch drain _____ [3114.3]⁶
- Individual fixture AAV min 4 in. above fixture drain **F39** _____ [3114.4]
- Stack-type AAV min 6 in. above FLR of highest fixture _____ [3114.4]
- AAV within same max distance as conventional vent **T13** _____ [3114.4]
- AAVs terminating in attic min 6 in. above insulation _____ [3114.4]
- AAVs must be accessible _____ [3114.5]
- Space containing AAV must be ventilated _____ [3114.5]
- Min 1 vent to outdoors _____ [3114.7]
- Not OK for sumps or tanks without an engineered design _____ [3114.8]⁷

09 IRC

FIG. 39

Air Admittance Valve

AAVs must remain accessible. When AAVs are placed in attics, they must be at least 6 in. above insulation.

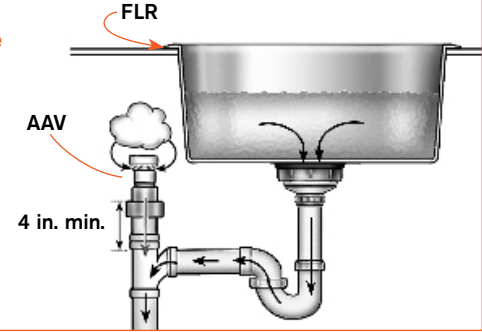
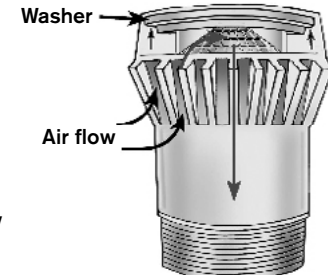
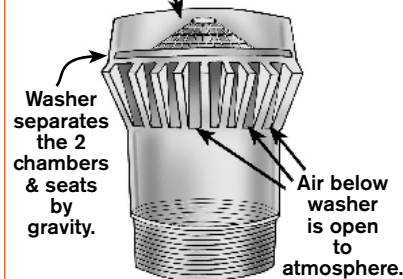


FIG. 40

Air Admittance Valve Operation

Air above washer is open to atmosphere



Negative pressure in pipe lifts washer & allows air intake.

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WATER SUPPLY & DISTRIBUTION

Water supply piping must provide an adequate flow of clean potable water and be free of any cross-connections that would introduce contaminants. Piping systems must be protected against damage and movement. Modern plumbing systems often use plastic pipe and tubing, and in some systems the branch piping originates from a central manifold, rather than a traditional series system with a main line and branches.

General**09 IRC 09 UPC**

- Use only approved materials **T18** _____ [2905.4&5] {604.1}
- Proper installation & support req'd **T3,4** _____ [2605.1] {314.0}
- Min water service ¾ in. _____ [2903.7] {610.8}
- Pressure tank & pump req'd if supplied pressure < 40psi (15psi in UPC) _____ [2903.3] {608.1}
- Regulator req'd if pressure > 80psi **F46** _____ [2903.3.1] {608.2}
- Mechanical water hammer arrestors (not air chambers) req'd near quick-close valves (DW or CW) _____ [2903.5] {609.10}
- Arrestors to conform to ASSE 1010 _____ [2903.5] {609.10}
- No pipes previously used for other than potable water _____ [2608.5] {604.7}

PEX Tubing**09 IRC 09 UPC**

- Bend radius AMI **T19** _____ [manu] {manu}
- Not allowed in 1st 18 in. of WH connections _____ [manu] {604.11.2}
- ¾ in. tubing limited to 60 ft. developed length _____ [2903.8.2] {manu}
- WH fed from end of cold water manifold req's manifold 1 size larger than WH feed _____ [2903.8.2] {manu}

TABLE 18 WATER PIPE MATERIALS [T2905.4&5] {T6-4}

Material	IRC		UPC	
	Service	Distribution	Service	Distribution
ABS	✓	∅	∅	∅
Brass pipe	✓	✓	✓	✓
CPVC	✓	✓	✓	✓
Cu tubing	✓	✓	✓	✓
Ductile iron	✓	∅	✓	✓
Galvanized steel	✓	✓	✓	✓
PE	✓	∅	✓	∅
PE-AL-PE	✓	✓	✓	✓
PEX	✓	✓	✓	✓
PEX-AL-PEX	✓	✓	✓	✓
PEX-AL-HDPE	✓	✓	∅	∅
PP	✓	✓	∅	∅
PVC	✓	∅	✓	∅
Stainless steel	✓	✓	✓	✓

TABLE 19 RECOMMENDED MIN. BEND RADIUS FOR PEX

Tube Size (in. nominal)	Tube outer diameter (in.)	Bend Radius (in.) ^A
¾	1/2	4
1/2	5/8	5
¾	7/8	7
1	1 1/8	9

A. As recommended by the Plastic Pipe & Fitting Association.

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Joists & Connections

- | | | |
|--|---------------|---------------|
| <input type="checkbox"/> Cu to galvanized steel req's brass or dielectric fitting _ [2905.17.1] | 09 IRC | 09 UPC |
| <input type="checkbox"/> Cu joints in or under concrete slab on grade within building req brazed wrought-Cu fittings _____ [n/a] | | {316.2.1} |
| <input type="checkbox"/> Slip joints only at exposed fixture supply _____ [n/a] | | {609.3.2} |
| <input type="checkbox"/> Unions req'd (within 12 in. in UPC) in WH hookups _____ [n/a] | | {606.2.3} |
| <input type="checkbox"/> Unions req'd 12 in. of softeners, filters, regulators, etc. _____ [n/a] | | {609.5} |
| | | {609.5} |

Prohibited Joints

- | | | |
|---|---------------|---------------|
| <input type="checkbox"/> Joints between different types of plastic req adapter _ [2905.17.2] | 09 IRC | 09 UPC |
| <input type="checkbox"/> Female threaded PVC fittings only OK with plastic male fittings ____ [n/a] | | {316.2.3} |
| | | {606.2.2} |

Required Valves

- | | | |
|--|---------------|---------------|
| <input type="checkbox"/> Accessible main valves req'd near entrance _____ [2903.9.1] | 09 IRC | 09 UPC |
| <input type="checkbox"/> Main & WH valve must be full-open type F41,42 _ [2903.9.1&2] | | {605.2} |
| <input type="checkbox"/> Throttling valves not OK for main & WH F43 _____ [2903.9.1&2] | | {605.2} |
| <input type="checkbox"/> Main valve must be on discharge side of water meter _____ [local] | | {605.2} |
| <input type="checkbox"/> Main valve must have bleed orifice or separate drain _ [2903.9.1] | | {n/a} |
| <input type="checkbox"/> Valves req'd on fixture supply except tub & shower ____ [2903.9.3] | | {605.5} |
| <input type="checkbox"/> Valves only at distribution manifold OK if labeled ____ [2903.8.5] | | {605.5} |
| <input type="checkbox"/> Hose bibbs subject to freezing req valve with drain (stop-and-waste-type) EXC _____ [2903.10] | | {313.6} |
| • Frostproof hose bibbs with stem through insulation _ [2903.10X] | | {313.6} |
| <input type="checkbox"/> Valves req'd on cold water supply at each WH _____ [2903.9.2] | | {605.2} |
| <input type="checkbox"/> All shutoffs req access _____ [2903.9.3] | | {605.6} |

FIG. 41

Gate Valve



FIG. 42

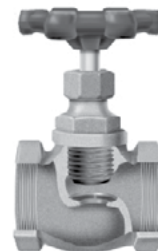
Ball Valve



Full-open valves

FIG. 43

Globe Valve



Shutoff valve

CROSS-CONNECTION CONTROL

Backflow preventers protect water systems from backup and contamination. Vacuum breakers prevent contaminants from entering through systems such as lawn sprinklers. A physical separation in the form of an air gap prevents contamination at waste receptors, such as sinks.

Protection of Potable Water

- | | | |
|---|---------------|---------------|
| <input type="checkbox"/> Prevent contamination of potable water supply _____ [2902.1] | 09 IRC | 09 UPC |
| <input type="checkbox"/> Connections for private to public water supply prohibited [2902.1] | | {602.1} |
| <input type="checkbox"/> Reduced pressure principle backflow preventers OK for: | | {602.4} |
| • Boilers with conditioning chemicals _____ [2902.5.1] | | {T6-2} |
| • Fire-sprinkler systems with additives _____ [2902.5.4.1] | | {T6-2} |
| • Lawn irrigation systems with chemical injectors ____ [2902.5.3] | | {T6-2} |
| • Solar heating piping with additives _____ [2902.5.5] | | {T6-2} |

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Protection of Potable Water (cont.)

09 IRC 09 UPC

- Atmospheric vacuum breakers OK for:
 - Hose connections (not needed for tank drain valves) [2902.4.3] {603.4.7}
 - Swimming pool inlets without an air gap [2902.1] {603.4.5}
 - Irrigation system, 6 in. above highest head **F63** [2902.5.3] {T6-2}
- Integral air gaps in fixtures to recognized standards OK for:
 - Reverse osmosis drinking water treatment units [2908.2] {603.4.13}
 - DWs [2717.1] {n/a}
 - Pullout spouts & sprayers with integral backflow AMI [2902.4.2] {603.3.7}
 - Pull-out or separate shower spray wands [2902.4.2] {603.3.7}
 - Flush tank fill valves [2902.4.1] {603.4.2}
- Fixture outlet receptor air gaps:
 - Min 2x diameter of outlet & per table **F44, T20** [2902.3.1] {603.2.1}

Opening Diameter & Typical Fixtures (in.)	MIN. REQUIRED AIR GAPS [T2902.3.1] & [T6-3]		Affected by Side Walls ^A (in.)	
	Not Affected by Side Walls (in.)		IRC	UPC
≤ 1/2 (lav)	1	1	1 1/2	1 1/2
≤ 3/4 (LT)	1 1/2	1 1/2	2 1/2	2 1/4
≤ 1 (BT)	2	2	3	3
> 1 (pool)	2x diameter	3x diameter	2x diameter	3x diameter

A. Affected by side walls = any time the distance from the spout to the wall is < 3x the diameter of the effective opening, or < 4x the diameter for 2 intersecting walls.

FIG. 44

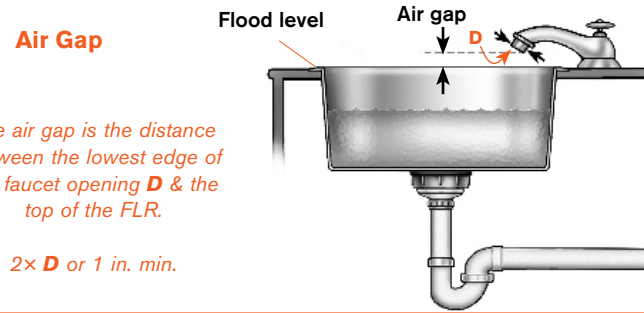
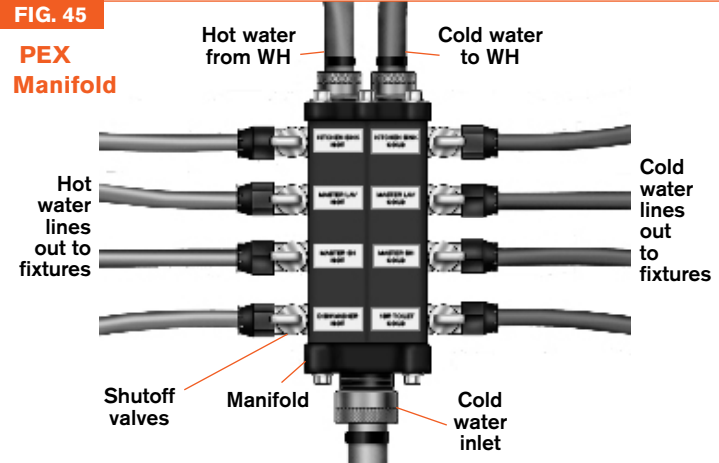


FIG. 45

PEX Manifold



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WATER SUPPLY SIZING

Modern plastic supply systems typically use a method of parallel distribution from a central manifold, such as **F45**. Traditional water supply systems are installed with a large main supply & a series of progressively smaller pipes toward the final fixture outlet. That method is still used in the UPC. The IRC no longer acknowledges that method & instead simply requires that the system be designed to provide the required capacities of **T21**. In addition to these major code changes, many jurisdictions now have ordinances that mandate water efficiency and conservation.

IRC Water Supply Design**09 IRC**

- Design system to provide capacity of **T21** under peak demand _____ [2903.1]*
- Max consumption limited to rates in **T25** _____ [2903.2]
- Mains, branches & risers sized according to supply demand, available pressure, friction loss of water meter & developed length of pipe including equivalent length of fittings **F45** _____ [2903.7]*

TABLE 21 MIN. CAPACITIES AT FIXTURE SUPPLY OUTLETS [T2903.1]		
Fixture Outlet	Flow Rate (gpm)	Flow Pressure (psi)
Bathtub	4	20
Bidet	2	20
DW	2.75	8
LT	4	8
Lav	2	8
Shower (pressure-balancing or thermostatic mixing)	3	20
Shower (temperature controlled)	3	20
Hose bibb	5	8
KS	2.5	8
WC (tank type)	3	20
WC (flushometer)	1.6	20
WC (one piece)	6	20

TABLE 22**WATER SUPPLY FIXTURE UNITS FILL-IN TABLE**
[T2903.6] & [T6-4]

Fixture	IRC			UPC	No.	Extension
	Hot	Cold	Comb.	Comb.		
BT	1	1	1.4	4		
CW	1	1	1.4	4		
DW	1.4	–	1.4	1.5		
Hose bibb	–	2.5	2.5	2.5		
KS	1	1	1.4	1.5		
Lav	0.5	0.5	0.7	1		
LT	1	1	1.4	1.5		
Shower (per head)	1	1	1.4	2.0		
WC	–	2.2	2.2	2.5		
Laundry group ^A	1.8	1.8	2.5	–		
Kitchen group ^B	1.9	1	2.5	–		
Half-bath group ^C	0.5	2.5	2.6	–		
Full-bath group ^D	1.5	2.7	3.6	–		
Total Demand						

A. Laundry group = CW & LT.
 B. Kitchen group = DW & sink with or without garbage grinder.
 C. Half-bath group = WC & lav.
 D. Full-bath group = WC & lav & bathtub (with or without shower) or shower stall.

TABLE 23**MANIFOLD SIZING [T2903.8.1]**

Inlet Pipe Size (in.)	Max. GPM Plastic ^A	Max. GPM Metal ^B
¾	17	11
1	29	20
1¼	46	31
1½	66	44

A. Based on velocity limitation of 12 ft./second.
 B. Based on velocity limitation of 8 ft./second.

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TABLE 24		CONVERTING WSFUs to GPM [T2903.6(1)]	
Load (WSFUs)	Demand (gpm)	Load (WSFUs)	Demand (gpm)
1	3.0	14	17.0
2	5.0	15	17.5
3	6.5	16	18.0
4	8.0	17	18.4
5	9.4	18	18.8
6	10.7	19	19.2
7	11.8	20	19.6
8	12.8	25	21.5
9	13.7	30	23.3
10	14.6	35	24.9
11	15.4	40	26.3
12	16.0	45	27.7
13	16.5	50	29.1

TABLE 25		MAXIMUM FLOW RATES FOR PLUMBING FIXTURES [T2903.2]	
Plumbing Fixture or Fixture Fitting	Max. Flow Rate		
Lav faucet	2.2 gpm at 60 psi		
Showerhead ^{A,B}	2.5 gpm at 80 psi		
Sink faucet	2.2 gpm at 60 psi		
WC	1.6 gal per flush		

A. Handheld shower sprays are also considered showerheads

B. Individual states have different policies on whether the max. flow rate applies to each individual head in a multiple showerhead assembly or to the overall assembly. Check with your local jurisdiction.

TABLE 26		UPC WATER SIZING TABLE (T6-6)					
Meter	Supply	Units Allowed per Lengths of Pipe					
30–45 psi		40 ft.	60 ft.	80 ft.	100 ft.	150 ft.	200 ft.
¾ in.	½ in. ^A	6	5	4	3	2	1
¾ in.	¾ in.	16	16	14	12	9	6
¾ in.	1 in.	29	25	23	21	17	15
1 in.	1 in.	36	31	27	25	20	17
1 in.	1¼ in.	54	47	42	38	32	28
46–60 psi		40 ft.	60 ft.	80 ft.	100 ft.	150 ft.	200 ft.
¾ in.	½ in. ^A	7	7	6	5	4	3
¾ in.	¾ in.	20	20	19	17	14	11
¾ in.	1 in.	39	39	36	33	28	23
1 in.	1 in.	39	39	39	36	30	25
1 in.	1¼ in.	78	78	76	67	52	44
> 60 psi		40 ft.	60 ft.	80 ft.	100 ft.	150 ft.	200 ft.
¾ in.	½ in. ^A	7	7	7	6	5	4
¾ in.	¾ in.	20	20	20	20	17	13
¾ in.	1 in.	39	39	39	39	35	30
1 in.	1 in.	39	39	39	39	38	32
1 in.	1¼ in.	78	78	78	78	74	62

A. Min. building supply is ¾ in.

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TABLE 27 UPC WATER SIZING WORKSHEET^A {610.8}

1. Determine fixture unit demand (total from T22)	
2. Min. daily static pressure at meter or source	
3. Subtract ½ lb. pressure per ft. of rise	
4. Deduct pressure losses for filters, regulators, etc.	
5. Find pressure range group in T26	
6. Find column for developed length to most remote fixture	
7. Find row meeting fixture unit demand (total from T26)	
8. Find req'd meter & pipe size in left column of T26	
A. The same procedure can be used for branches.	

PRESSURE REGULATORS

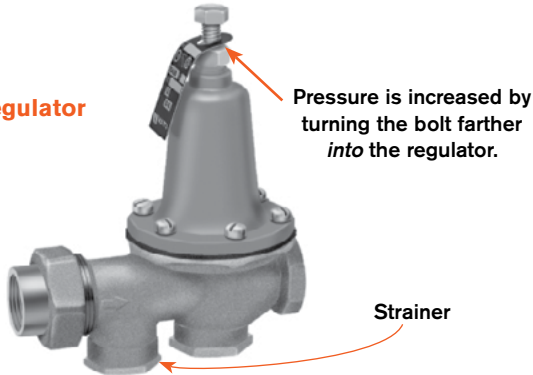
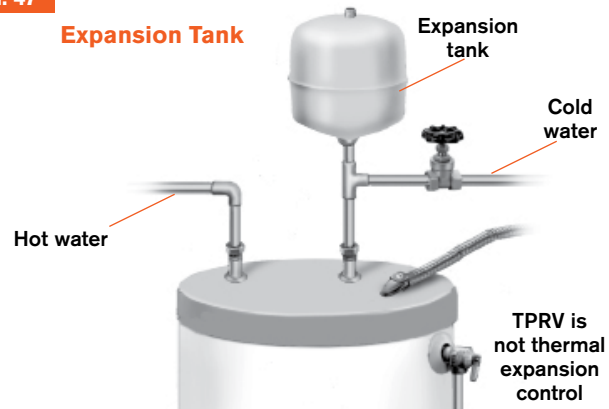
Excessive pressure increases the risk of leaks and scalding. When supply pressure exceeds 80 psi, a regulator is required. A screen in the regulator can prevent it from clogging with sediment. Regulators without an integral bypass feature create a closed system downstream from the regulator. As the water heater recovers heat, pressure rises. To prevent excessive pressure, expansion tanks are then required & are usually placed in the cold water line just above the water heater.

General

- | | 09 IRC | 09 UPC |
|--|---------------|---------------|
| <input type="checkbox"/> Req'd when water pressure at building > 80psi _____ [2903.3.1] | | {608.2} |
| <input type="checkbox"/> Strainer req'd ahead of regulator F46 _____ [n/a] | | {608.2} |
| <input type="checkbox"/> Regulator & strainer accessible without removing piping __[manu] | | {608.2} |
| <input type="checkbox"/> Regulated pressure computed at 80% of setting _____ [n/a] ¹⁰ | | {608.2} |
| <input type="checkbox"/> Expansion tank req'd for closed systems F47 _____ [2903.4.1] | | {608.3} |
| <input type="checkbox"/> Expansion tank req'd for systems with supply check valves [2903.4.2] | | {608.3} |

FIG. 46**Pressure Regulator**

Strainer must remain accessible.

**FIG. 47**

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GAS PIPING

Gas pipe sizes depend upon the appliance demand, gas pressure, Btus per cubic foot of gas, and length of run. Corrugated stainless steel tubing systems (CSST) can be run at medium pressure (approximately 2 psig) to a central manifold where the pressure is then reduced to the operating pressure used by the appliances, typically not more than 0.5 psig. This method allows smaller main runs and uses less tubing than a system operating at utilization pressure.

General**09 IRC 09 UPC**

- Nonsteel pipe req's yellow label marked "gas" in black letters at 5 ft. intervals EXC _____ [2412.5] {n/a}
 - When located in same room as appliance served _____ [2412.5] {n/a}
- Meters identified to indicate which premises served _____ [2412.7] {1209.6.5}
- LPG storage per NFPA 58 (see **p.152**) _____ [2412.2] {1213.0}
- No piping in circulating air duct, chimney or gas vent, ventilating duct, or elevator shaft _____ [2415.1] {1211.2.5}
- No concealed piping in solid partition except in chase _____ [2415.2] {1211.3.3}

Joints & Fittings**09 IRC 09 UPC**

- Joints threaded, flanged, brazed, or welded _____ [2414.10.1] {1209.5.8.1}
- Clear fittings of burrs, brush, blow out chips & scales _____ [2414.7] {1209.5.5}
- No unions, tubing fittings, bushings, right-left couplings, or compression couplings in concealed locations _____ [2415.3] {1211.3.2}

Materials**09 IRC 09 UPC**

- Steel or black pipe min schedule 40 _____ [2414.4.2] {1209.5.2.2}
- Cu tubing type K or L _____ [2414.5.2] {1209.5.3.2}
- No Cu or brass if > 0.3 grains H₂S per 100 cu. ft. gas [2414.5.2] {1209.5.3.2}
- No pipe repair – pipe with defects must be replaced _____ [2414.7] {1209.5.5}
- CSST listed per ANSI LC 1/CSA 6.26 _____ [2414.5.3] {1209.5.3.4}

TABLE 28 TYPICAL GAS APPLIANCE DEMAND [T2413.2] [T12-1]

Appliance	Typical kBtu/hr.	Actual kBtu/hr.	Typical cu.ft./hr. ^A	Actual cu.ft./hr.
FAU or hydronic boiler	100		91	
Space & water heating units	120		109	
Instantaneous WH 2 gpm	143		130	
Instantaneous WH 4 gpm	285		259	
Storage tank WH 30–40 gal.	35		32	
Storage tank WH 50 gal.	50		45	
Built-in oven	25		22	
Built-in cooktop	40		36	
Freestanding range	65		59	
Barbecue	40		36	
Clothes dryer	35		32	
Direct-vent fireplace	40		36	
Gas log	80		73	
Total cu. ft./hr. max. gas demand				

A. Based on 1100 Btu/cu. ft.—consult local gas provider for actual values.

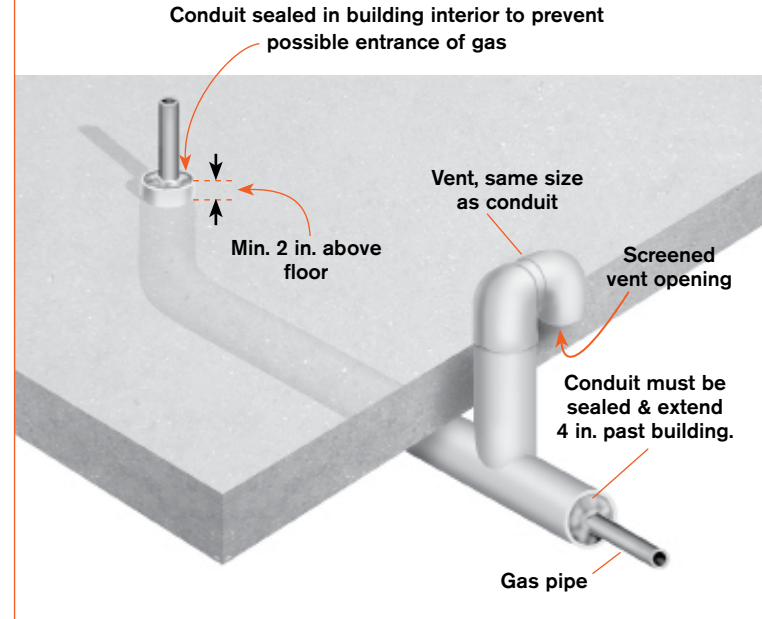
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Underground**09 IRC 09 UPC**

- Protect piping subject to corrosion from soil or moisture [2415.9] {1211.1.3}
- Zi coatings not sufficient protection underground [2415.9] {1211.1.3}
- Coatings & wrappings factory-applied EXC [2415.9.2] {1211.1.3}
 - Nipples & fittings where field coating OK if AMI [2415.9.2X] {1211.1.3}
- Min cover depth 12 in. (UPC 18 in. EXC) [2415.10] {1211.1.2A}
 - UPC OK at 12 in. if external damage not likely [1211.1.2A]
- Pipe trenches to have firm continuous bearing [2415.11] {1211.1.2B}
- No pipe penetrating foundation walls below grade [2415.4]¹¹ {n/a}
- UPC allows below ground penetration if sleeved [Ø] {1211.1.5}
- Plastic OK only underground & outdoors EXC [2415.15.1] {1211.1.7}
 - Anodeless risers & wall head adapters [2415.15.1X] {1211.1.7X}
 - Regulator vent connections on exterior [2414.6.3] {n/a}
- Provide yellow insulated tracer wire min 18 AWG (14 AWG in UPC) along plastic pipe & terminating above ground [2415.15.3] {1211.1.7C}

Gas Piping in or below Slab**09 IRC 09 UPC**

- Piping may not penetrate foundation below grade [2415.4]¹¹ {n/a}
- Piping in slab req's protected channel or conduit [2415.6]¹² {n/a}
- Conduit under slab req's protective conduit **F48** [2415.12]¹² {1211.1.6}
- Conduit with both ends terminating in building should not have ends sealed & both must be accessible [2415.6.2&2415.12.2]¹³ {n/a}
- Conduit with one end on exterior & one on interior: **F48**
 - Seal pipe to conduit in interior [2415.6.1&2415.12.1] {1211.1.6}
 - Exterior pipe min 4 in. outside building [2415.6.1&2415.12.1] {1211.1.6}
 - Conduit vented above grade [2415.6.1&2415.12.1] {1211.1.6}
 - Conduit to prevent water & insect entry [2415.6.1&2415.12.1] {1211.1.6}

FIG. 48**Gas Pipe under Slab**

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Protection & Installation

09 IRC 09 UPC

- Outdoor piping min 3½ in. above ground or roof surface [2415.7] {n/a}
- Shield plates 4 in. past edge of framing members for other than black or Zi steel pipe < 1½ in. from face of framing **F50** _____ [2415.5] {manu}

Piping Support

09 IRC 09 UPC

- Max support intervals for gas pipe **T29** _____ [2424.1] {1211.2.6B}
- Hangers to dampen excessive vibration _____ [2418.2] {1211.2.6A}
- Hangers must allow for expansion & contraction of pipe [2418.2] {1211.2.6C}

TABLE 29 GAS PIPING & TUBING SUPPORT [T2424.1] (T12-3)			
Steel Pipe Nominal Size (in.)	Max. Support Spacing (ft.)	Smooth-Wall Tubing Nominal Size (in.)	Max. Support Spacing (ft.)
½	6	½	4
¾ or 1	8	5/8 or ¾	6
≥ 1¼ (horizontal)	10	7/8 or 1 (horizontal)	8
≥ 1¼ (vertical)	Every floor level	7/8 or 1 (vertical)	Every floor level

Electrical

09 IRC 09 UPC

- Electrical bond req'd for above-ground gas piping _____ [2411.1] {1211.15.1}
- EGC (**p.188**) supplying equipment OK as bond EXC _____ [2411.1] {1211.15.1}
 - CSST req's 6AWG bond to service at building entry [2411.1.1] {1211.15.2}
- Gas piping not OK as grounding electrode in earth _____ [2410.1] {1211.15.3}

Drips & Sediment Traps

09 IRC 09 UPC

- Slope piping ¼ in./15 ft. for other than dry gas _____ [2419.1] {n/a}
- Nondry gas: Accessible drips at meter & as needed _____ [2419.2] {1211.8.1}
- Sediment traps req'd as close as practical to appliance inlets **F49** EXC _____ [2419.4] {1212.7}
 - Ranges, dryers, gas lights, fireplaces & outdoor grills _____ [2419.4] {1212.7}

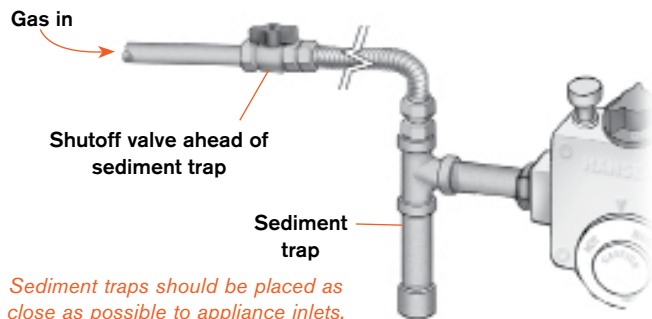
Valves, Shutoffs & Appliance Connections

09 IRC 09 UPC

- All valves accessible & protected from damage _____ [2420.1.3] {1212.5}
- Valve within 6 ft. of appliance & in same room EXC _____ [2420.5.1] {1212.5}
 - Valve can be at manifold within 50 ft. of appliance _____ [2420.5.3]¹⁴ {Ø}
- Valve upstream from union at appliance _____ [2420.5.1] {1212.5}
- Multiple buildings req shutoff for each building _____ [2420.3] {1211.11.2}
- Valve ahead of each MP regulator **F51** _____ [2420.4] {1211.11.1}
- Cap any unused outlets _____ [2415.13] {1211.9.2A}
- Connector can be rigid pipe, CSST AML, ≤ 6 ft., or L&L connectors entirely in same room as appliance _____ [2422.1] {1212.1}
 - (Note: flexible connectors may be req'd in seismically active areas.)
- Connector max 6 ft. length EXC _____ [2422.1.2.1]¹⁵ {n/a}
 - Developed length of rigid pipe OK > 6 ft. if sized as pipe (not as connector) & if valve within 6 ft. of appliance _____ [2422.1.2.1X] {n/a}

FIG. 49

Sediment Trap



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CORRUGATED STAINLESS STEEL TUBING (CSST)

The standard for CSST is ANSI/IAS LC 1-2005, which includes a requirement that workers be certified before installing it. The manufacturers offer training & certification courses. Concerns over damage to CSST from indirect lightning strikes have caused some jurisdictions to restrict its use, and have led to the bonding requirements on **p.35**.

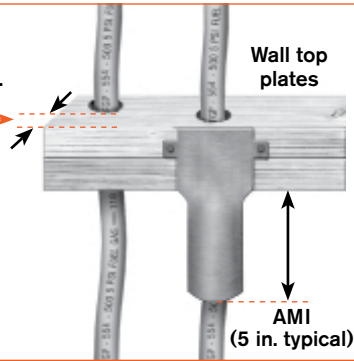
FIG. 50

CSST Strike Plates

Not req. when $> 1\frac{1}{2}$ in.
from surface

The codes req strike-plate protection for piping & tubing other than black pipe or galvanized.

CSST manu recommendations are typically more restrictive, and proprietary plates are used.



CSST—Typical manufacturer recommendations:

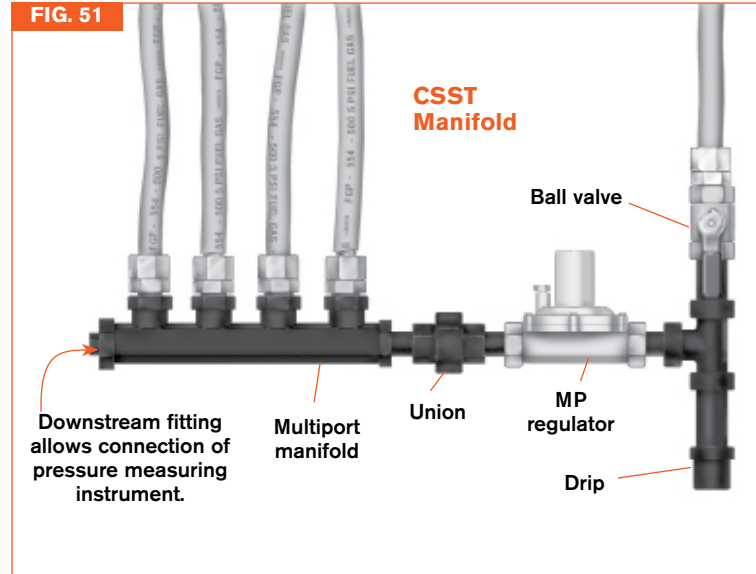
- Support per manu tables
- Size per manu tables
- Bending radius per manu tables
- No direct burial—routing through conduit OK
- Striker plates per manu **F50**
- Avoid kinking, twisting, or contact with sharp objects
- Protect where passing through sheet metal
- Regulators in vented area or with vent limiters

Medium Pressure (MP) Regulators **F51**

09 IRC 09 UPC

- MP regulators must be accessible _____ [2421.2] {1209.7.3}
- MP regulators req tee between shutoff & regulator _____ [2421.2] {manu}
- Capped tee fitting req'd downstream _____ [2421.2] {manu}
- Vented regulators must be vented to outdoors EXC _____ [2421.3] {1209.7.5B}
 - If equipped with approved vent-limiting device _____ [2421.3X] {1209.7.5B}
- Vent piping must run independently to outdoors _____ [2421.3.1] {n/a}

FIG. 51



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GAS PIPE SIZE

Gas piping systems in series (**F52**) can be sized by either the longest length or the branch length method. Systems with MP regulators are sized by the hybrid pressure method.

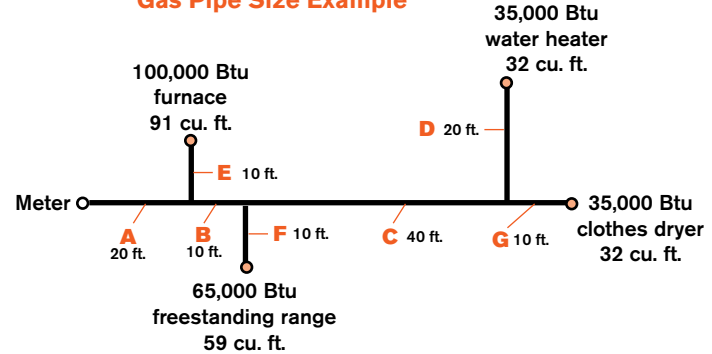
General**09 IRC 09 UPC**

- Size per max demand based on appliance ratings _____ [2413.2] {1209.4.1}
- Assume all appliances operating simultaneously _____ [2413.2] {1209.4.2}
- Size AMI or per tables **T30–32** _____ [2413.3] {1209.4.3}¹⁶

TABLE 30 PROCEDURES FOR SIZING GAS PIPE [2413.3] {1217.1}

1. Determine Btu/cu. ft. from local gas provider
2. Determine cu. ft./hr. demand for each appliance
3. Sketch layout with piping lengths to each appliance (**F52**)
4. Determine total cu. ft./hr. demand on each pipe section
5. Determine length to most remote appliance
- 6A. (Longest length method) use row of **T32** for that length for all appliances.
- 6B. (Branch length method) use same row for all sections in series with most remote appliance. For other branches, use actual length of each branch.

The **Longest Length** method is more conservative & compensates for pressure losses throughout the system. The **Branch Length** method has less leeway & consideration should be given to the lengths of pipe fittings. The codes accept both methods. Systems with MP regulators use the “hybrid pressure” method, where the pipe sizes before the regulator are determined separately, each by the longest length method.

FIG. 52**Gas Pipe Size Example****TABLE 31****GAS PIPE SIZE EXAMPLE**

Pipe Section	Total cu. ft./hr. ^A	Longest Length	Longest-Length Method	Actual Lengths	Branch-Length Method
A	214	90 ft.	1 ¼ in.	90 ft.	1 ¼ in.
B	129	90 ft.	1 in.	90 ft.	1 in.
C	64	90 ft.	¾ in.	90 ft.	¾ in.
D	32	90 ft.	½ in.	90 ft.	½ in.
E	91	90 ft.	¾ in.	30 ft.	½ in.
F	59	90 ft.	¾ in.	40 ft.	½ in.
G	32	90 ft.	½ in.	80 ft.	½ in.

A. Based on 1,100 Btu/cu. ft.—Contact local provider for actual values.

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TABLE 32 Pipe Length (ft.)	CUBIC FEET CAPACITY OF SCHEDULE 40 METALLIC GAS PIPE ^A [T2413.4(1)] [T12-8]									
	Nominal Pipe Size									
	½	¾	1	1¼	1½	2	2½	3	4	
	Demand Capacity (in cu.ft./hr)									
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	
40	81	170	320	657	985	1,900	3,020	5,350	10,900	
50	72	151	284	583	873	1,680	2,680	4,740	9,660	
60	65	137	257	528	791	1,520	2,430	4,290	8,760	
70	60	126	237	486	728	1,400	2,230	3,950	8,050	
80	56	117	220	452	677	1,300	2,080	3,670	7,490	
90	52	110	207	424	635	1,220	1,950	3,450	7,030	
100	50	104	195	400	600	1,160	1,840	3,260	6,640	
125	44	92	173	355	532	1,020	1,630	2,890	5,890	
150	40	83	157	322	482	928	1,480	2,610	5,330	
175	37	77	144	296	443	854	1,360	2,410	4,910	
200	34	71	134	275	412	794	1,270	2,240	4,560	
250	30	63	119	244	366	704	1,120	1,980	4,050	
300	27	57	108	221	331	638	1,020	1,800	3,670	
350	25	53	99	203	305	587	935	1,650	3,370	
400	23	49	92	189	283	546	870	1,540	3,140	
450	22	46	86	177	266	512	816	1,440	2,940	
500	21	43	82	168	251	484	771	1,360	2,780	

A. Based on inlet pressure < 2 psi, pressure drop 0.5 in. water column, specific gravity 0.60.

GAS PIPE SIZE EXAMPLE FILL-IN					
Pipe Section	Total cu. ft./hr. ^A	Longest Length	Longest-Length Method	Actual Lengths	Branch-Length Method
A					
B					
C					
D					
E					
F					
G					

A. Btu/cu. ft. (from gas supplier).

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WATER HEATERS

Water heaters should be maintained at as low a temperature as comfortably practical to reduce the risk of scalding. An undersize water heater is more likely to be turned to a dangerously high setting. Aside from the water heater thermostat control, other means of protection against scalding are recommended. These include tempering valves at the water heater or at individual fixtures. Temperatures at the point of use in excess of 120°F are considered a hazard.

Tankless water heaters are becoming more popular, including hybrid systems that contain a small storage tank and circulating line. Water heaters that are part of a boiler system are discussed in *Code Check Complete Mechanical 4th edition* on p.16.

General**09 IRC 09 UPC**

- Size to meet demand **T33** _____ [2801.1] {501.0}
- Replacement WHs req permits _____ [105.1] {503.0}
- Valve req'd on cold water supply at or near WH _____ [2903.9.2] {605.2}
- Valve must be full open type **F41,42** _____ [2903.9.2] {605.2}
- WH also used for space heating must be L&L for both _ [2448.2] {n/a}
- Systems also used for space heating req master mixing valve to temper domestic water to ≤140°F _____ [2802.2] {n/a}
- Unions req'd within 12 in. to allow removal **F47** _____ [n/a] {609.5}
- Electric WH req's in-sight or lockable disconnect **F59** _ [T4101.5] {506.1}

For information on combustion air and venting of gas-fired water heaters, see *Code Check Mechanical 4th edition (electronic edition)* or *Code Check Complete 2nd edition (print)* or *Code Check PLumbing & Mechanical 4th edition (print)*.

TABLE 33 WATER HEATER MIN. CAPACITY^A {T5-1}

No. of Bathrooms	No. of Bedrooms	1st hr. Rating ^B
1 to 1½	1	42
	2 to 3	54
2 to 2½	2	54
	3 to 4	67
	5	80
3 to 3½	3	67
	4 to 6	80

A. Based upon the 1st-hr. rating found on the "Energy Guide" label. This number is approximately equal to storage size plus hourly recovery rate.

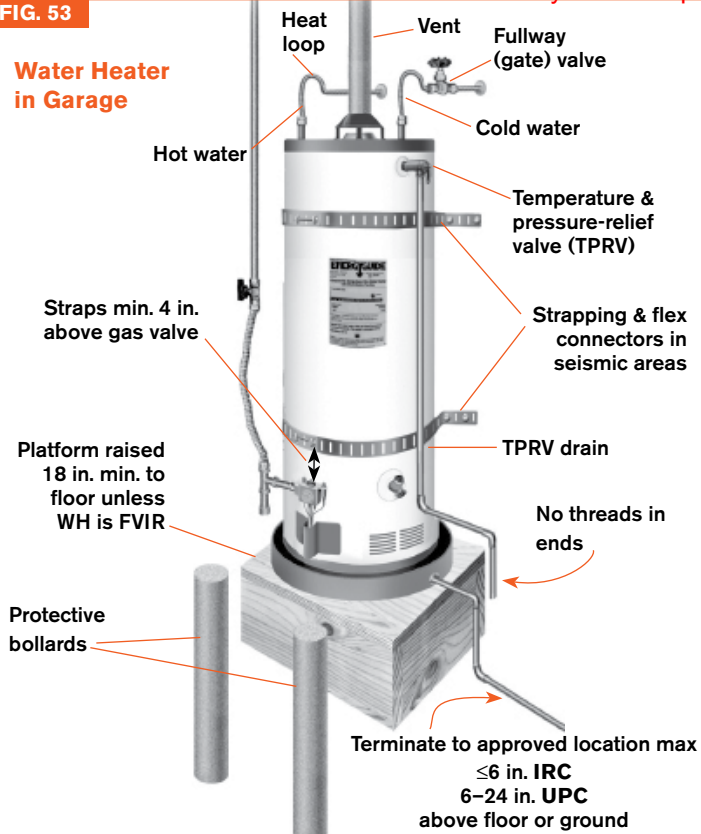
B. This table can also be used to size tankless WHs.

Special Locations**09 IRC 09 UPC**

- Fuel-fired WH prohibited in storage closets _____ [2005.2] {n/a}
- Not in bedrooms, bathrooms, or their closets EXC _____ [2005.2] {505.1}
 - Direct-vent WH OK without enclosure _____ [2005.2 & 2406.2] {505.1}
 - WH OK in dedicated enclosure with solid, weatherstripped, self-close door & all combustion air from exterior _____ [2005.2] {505.1}
- Ignition source 18 in. above garage floor EXC **F53** _____ [2801.6] {508.14}
 - Flammable vapor ignition-resistant (FVIR) WHs **F54** _ [2408.2X] {508.14}
 - WH in separate enclosed space accessible from outside the garage & no combustion air from garage _____ [2406.2] {508.14}
- Min 18 in. above floor in area where flammables stored (basements) unless FVIR **F53,54** _____ [2801.6] {508.13}
- SDC C seismic bracing req'd (IRC - townhouses) **F53** _ [2801.7] {508.2}
- SDC D & E seismic bracing req'd (all) **F53** _ [1307.2 & 2801.7] {508.2}
- Barrier or elevation req'd in garage or carport **F53** _ [1307.3.1] {508.14}
- Min. 3 in. concrete pedestal if supported on ground_ [1305.1.4.1] {508.3}

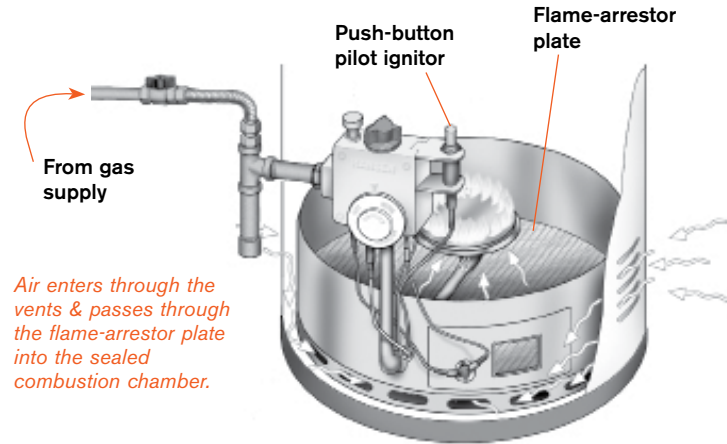
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FIG. 53

Water Heater in Garage**Access & Working Space****09 IRC****09 UPC**

- Clearances to combustibles AMI _____ [2408.5] {505.3.1}
- Remain accessible for service, inspection & removal ____ [2801.3] {505.3.1}
- Appliance must fit through attic door _____ [2005.1,1305.1.3] {509.4.1}
- Attic hatch/door min 22 in. wide x 30 in. high_ [2005.1,1305.1.3] {509.4.1}
- Attic min 24 in. passageway, solid floor to WH [2005.1,1305.1.3] {509.4.3}
- Max 20 ft. from attic access if ceiling < 6ft_ [2005.1,1305.1.3] {509.4.2}
- Min 30 x 30 in. level working platform req'd EXC_ [1305.1.3] {509.4.4}
 - Platform not req'd if can be serviced from opening [1305.1.3X1] {Ø}
- Attic req's light & receptacle near WH _____ [2005.1,1305.1.3.1] {509.4.5}
- Light switch req'd at entrance to attic [2005.1,1305.1.3.1 & 3903.4] {509.4.5}

FIG. 54

FVIR Water Heater

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Tankless Water Heaters

09 IRC 09 UPC

- Type III vent typically req'd AMI **F55** _____ [2427.3.1] {510.1.2}
- PRV AMI _____ [2005.1] {505.6}
- Size gas line to max Btu rating **F52** _____ [2413.2] {1209.4.1}

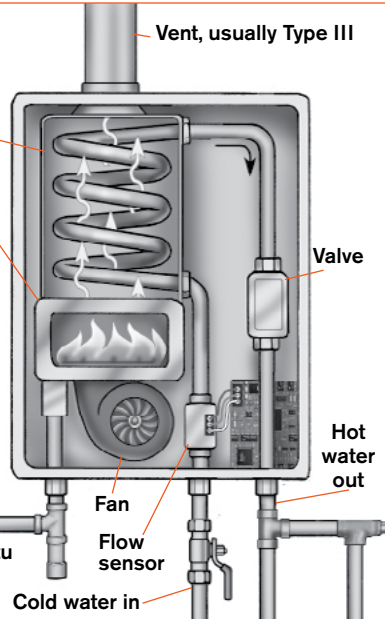
FIG. 55

Tankless Water Heater

Heat exchanger

Burner

1. Hot water tap is turned on.
2. Water enters the heater.
3. The water-flow sensor detects the entry of water into the unit, switching on computer.
4. The computer ignites the burner.
5. Water circulates through the heat exchanger.
6. The heat exchanger heats water.
7. When the tap is shut off, the unit shuts down.



Temperature & Pressure Relief Valves

09 IRC 09 UPC

- All WHs req pressure relief device **F56,58** _____ [2803.1] {505.4}
- All WHs req temperature limiting device **F56, F57** _____ [2803.1] {505.5}
- Devices may be combination TPRV (mandatory for storage-tank WHs in UPC) **F56** _____ [2803.5] {608.3}
- Temperature probe top 6 in. of tank (AMI in UPC) **F53, 59** [2803.4] {505.6}
- Settings not > 150psi OR 210°F _____ [2803.3&4] {608.4}
- Watts 210 also req's PRV **F57,58** _____ [2803.1] {505.6}

TPRV Drain Piping

09 IRC 09 UPC

- No shutoff valves before or downstream of TPRV _____ [2803.6] {505.6}
- Piping may not be shared with condensate drain or relief valves of other systems _____ [2803.6.1] {608.4}
- Drain must end outside building or at other approved location (IRC allows floor, pan, exterior, or indirect waste) _____ [2803.6.1] {608.5}
- TPRV may discharge into pan (not allowed in UPC) _ [2803.6.1]"' {Ø508.5}
- End ≤6 in. (6–24 in. UPC) from ground or receptor _ [2803.6.1] {608.5}
- Drain size at least same as outlet of valve _____ [2803.6.1] {608.5}
- Must drain by gravity; cannot run uphill or be trapped [2803.6.1] {608.5}
- No kinks or restrictions in pipe _____ [2803.6.1] {608.5}
- End of pipe visible & no threads on end **F53,59** _____ [2803.6.1] {608.5}
- Material can be any allowed for water distribution (only Zi steel, CPVC, hard-drawn Cu, or listed TPRV drain in UPC) **F53,59** _____ [2803.6.1] {608.5}
- Protect from freezing (terminate through air gap to indirect receptor located in a heated space) _____ [2803.6.1] {608.5}
- May not drain to crawl space _____ [2803.6.1] {608.5}

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FIG. 56

Temperature & Pressure-Relief Valve



When the WH is in a basement or below grade, it may not be possible to arrange for a gravity drain of the TPRV valve. A Watts 210 valve (F57) might be an allowable option. The temperature-sensing bulb of the valve goes in the upper portion of the tank & the gas piping runs through the valve. The Watts 210 shuts off the gas if the temperature is excessive. In addition, a separate water pressure-relief valve (F58) must be installed in the piping & must drain by gravity to an approved location. Check with the local AHJ to see if this method is accepted in your area.

FIG. 57

Watts 210
Gas Shutoff
Valve

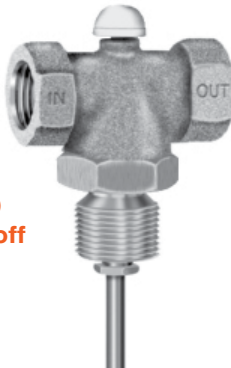


FIG. 58

Pressure-
Relief Valve



Required Pans & Drain

09 IRC 09 UPC

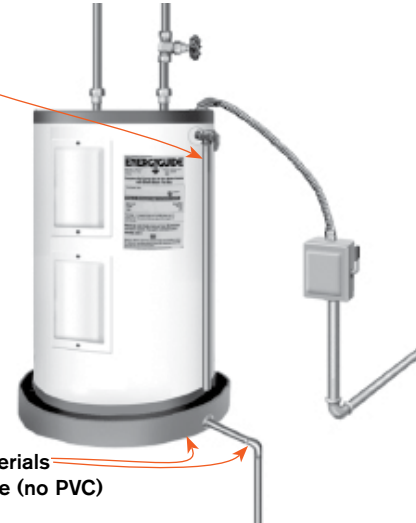
- Watertight corrosion-resistant pan req'd for WHs in attics or where leakage could cause damage **F53,59** _____ [2801.5]¹⁸ {508.4}
- Pan 24-gage Zi or listed corrosion-resistant material _____ [2801.5] {508.4}
- Pan drain size min 3/4 in. **F53,59** _____ [2801.5.1] {508.4}
- Pan drain req'd to end in indirect waste or outdoors 6 to 24 in. above grade (to any approved location in UPC) [2801.5.2] {508.4}
- Pan min 1 1/2 in. deep **F53,59** _____ [2801.5.1] {n/a}

FIG. 59

TPRV Discharge Pipes

TPRV discharge pipe:

- No threads on end
- Not trapped
- No smaller than relief valve outlet
- No valves or fittings
- Discharge to readily observable location
- Max. 6 in. above receptor in IRC
- Not to drain to pan in UPC



Pan & TPR drain only with materials approved for interior water pipe (no PVC)

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FIXTURES

Fixtures include faucets, showers, sinks, toilets, hose bibbs & similar equipment. They must be arranged so as to prevent cross-connections between the supply and waste. Fixtures must be constructed to recognized standards to maintain a sanitary condition. Fixtures such as toilets and showers must also conform to local water conservation regulations.

General

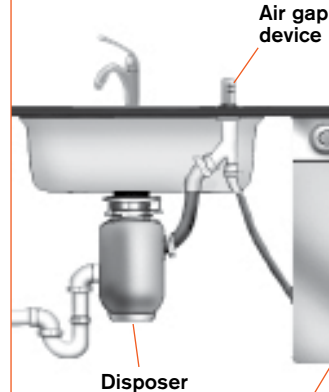
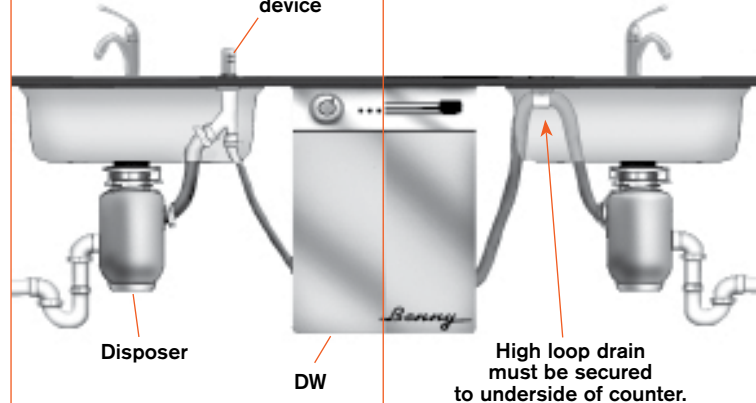
- | | 09 IRC | 09 UPC |
|--|---------------|---------------|
| <input type="checkbox"/> Fixtures req'd to be smooth, impervious & free from concealed fouling areas F63 _____ [2701.1] | | {401.1} |
| <input type="checkbox"/> Watertight seal req'd between fixtures & walls or floors (caulk base of WC) _____ [2705.1] | | {407.2} |
| <input type="checkbox"/> Separate accessible shutoff req'd at each fixture EXC _____ [2903.9.3] | | {605.5} |
| • Tubs & showers _____ [2903.9.3] | | {605.5} |
| <input type="checkbox"/> Shutoffs can be at manifolds or at fixture _____ [2903.8.5] | | {605.5} |
| <input type="checkbox"/> Shutoffs at manifolds must be labeled F45 _____ [2903.8.5] | | {605.5} |
| <input type="checkbox"/> Hot on left, cold on right when facing outlet _____ [2722.2] | | {415.0} |
| <input type="checkbox"/> Drain strainers req'd except WCs & urinals _____ [2702.1] | | {404.1} |
| <input type="checkbox"/> Tailpiece min 1 1/4 in. for lavs & bidets _____ [2703.1] | | {404.3} |
| <input type="checkbox"/> Tailpiece min 1 1/2 in. for other fixtures _____ [2703.1] | | {404.3} |
| <input type="checkbox"/> Floor drains req removable strainers _____ [2719.1] | | {411.1} |
| <input type="checkbox"/> Floor drains not OK under or restricted by appliances _ [2719.1] ¹⁹ | | {n/a} |

Kitchens

- | | 09 IRC | 09 UPC |
|--|---------------|---------------|
| <input type="checkbox"/> Sink min outlet 1 1/2 in diameter _____ [2714.1] | | {T7-3} |
| <input type="checkbox"/> OK for sink, DW & disposer on same 1 1/2 in. trap _____ [2717.3] | | {T7-3} |
| <input type="checkbox"/> 2 in. drain req'd for sink downstream of trap _____ [n/a] | | {T7-3} |
| <input type="checkbox"/> DW supply req's air gap or integral backflow device ____ [2717.1] | | {301.1.1} |
| <input type="checkbox"/> May discharge directly to a trap, trapped fixture, branch wye tailpiece on kitchen sink, or directly to disposer _____ [2717.2&3] | | {Ø} |
| <input type="checkbox"/> Secure drain hose to underside of counter F61 _____ [2717.2&3] | | {n/a} |

Kitchens (cont.)

- | | 09 IRC | 09 UPC |
|---|---------------|---------------|
| <input type="checkbox"/> Air gap fitting above sink flood level req'd for DW drain F60 _____ [n/a] | | {807.4} |
| <input type="checkbox"/> No connection to discharge side of disposer F60 _____ [n/a] | | {404.4} |
| <input type="checkbox"/> Reverse osmosis systems to recognized standards ____ [2908.1] | | {603.4.13} |
| <input type="checkbox"/> Reverse osmosis systems req air gap _____ [2908.2] | | {603.4.13} |
| <input type="checkbox"/> No saddle fittings or tapping/drilling of drain line ____ [3003.2] | | {311.2} |

FIG. 60**Dishwasher Drain-UPC****FIG. 61****Dishwasher Drain-IRC**

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Laundry

09 IRC 09 UPC

- Standpipe 18–42 in. (18–30 in. UPC) above trap **F62** [2706.2] {804.1}
- Must drain through air break (no pressurized waste)____ [2718.1] {805.0}
- No trap below floor _____ [n/a] {804.1}
- Trap 6–18 in. above floor **F62** _____ [n/a] {804.1}
- CW may drain directly into LT _____ [2706.3X2] {T7-3}
- LT may drain into washer standpipe within 30 in. if standpipe min 30 in. above trap weir & above FLR of LT _____ [2706.2.1]²⁰ {Ø}

FIG. 62

Laundry Standpipe

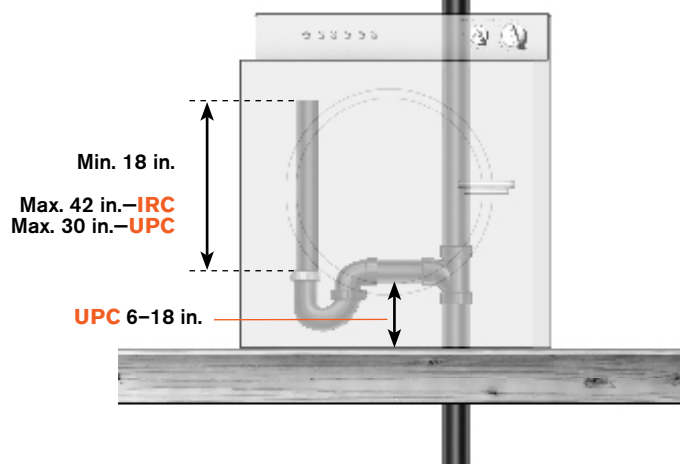
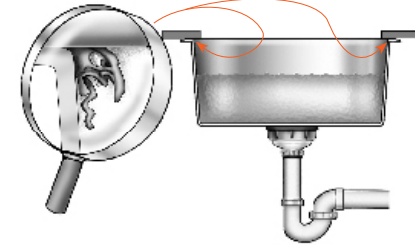


FIG. 63

Concealed Fouling Areas



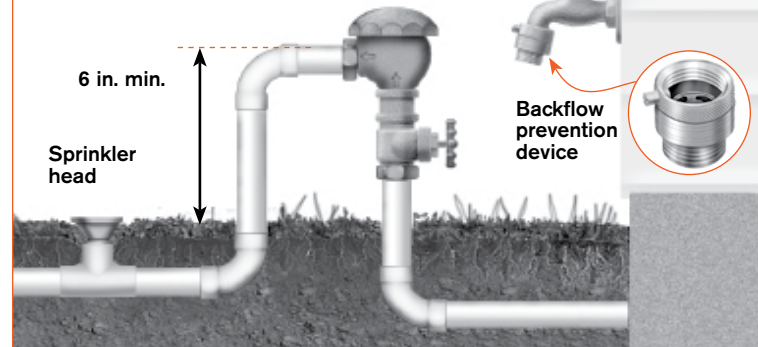
Outdoors & Irrigation Systems **F64**

09 IRC 09 UPC

- Hose bibbs req backflow preventer or vacuum breaker [2902.4.3] {603.4.7}
- Irrigation vacuum breakers above highest head _____ [2902.5.3] {T6-2}

FIG. 64

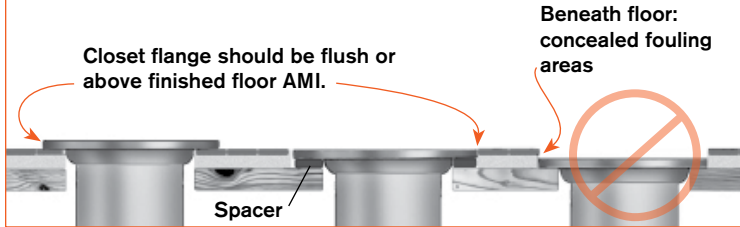
Vacuum Breakers



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FIG. 65

Toilet Flanges



Toilets & Bidets

- Floor flanges req'd for floor outlets **F65** _____ [2705.1] {408.3}
- Secure floor flange with corrosion-resistant fasteners __ [2705.1] {408.3}
- WC or bidet req's min 15 in. clearance from center to side walls or outer rim of adjacent fixtures or partitions or vanity **F66** __ [2705.1]²¹ {407.5}
- Min 21 in. (24 in. UPC) front clearance **F66** _____ [2705.1] {407.5}
- No offset or reducing floor flanges _____ [3002.3.1] {408.3}
- Max developed distance from closet ring to vent 6 ft. UPC (no length limit in IRC) _____ [3105.1X] {T10-1}
- Ballcock critical level \geq 1 in. above overflow pipe _____ [2712.4] {603.4.2}

09 IRC 09 UPC

Tubs

- Slip joints accessible, min 12 in. \times 12 in. door **F24** ____ [2704.1] {404.2}
- Over-rim bath spout-min air gap 2 in. from FLR ____ [T2902.3.1] {T6-3}
- Overflow min 1½ in. diameter _____ [2713.1] {404.3}
- Approved stopper req'd _____ [2713.1] {n/a}
- Tub or whirlpool max water temperature 120°F _____ [2713.3] {414.5}

09 IRC 09 UPC

FIG. 66

Fixture Layout

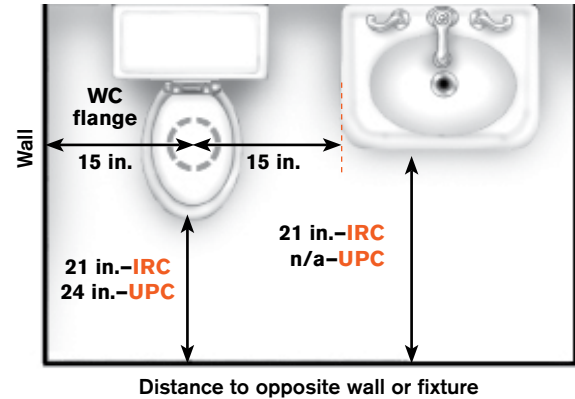
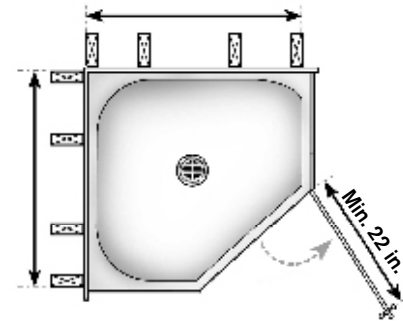


FIG. 67

Shower Pan

Outside dimensions:

- IAPMO listed—39½ in.
- Not IAPMO listed—37½ in.



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Showers

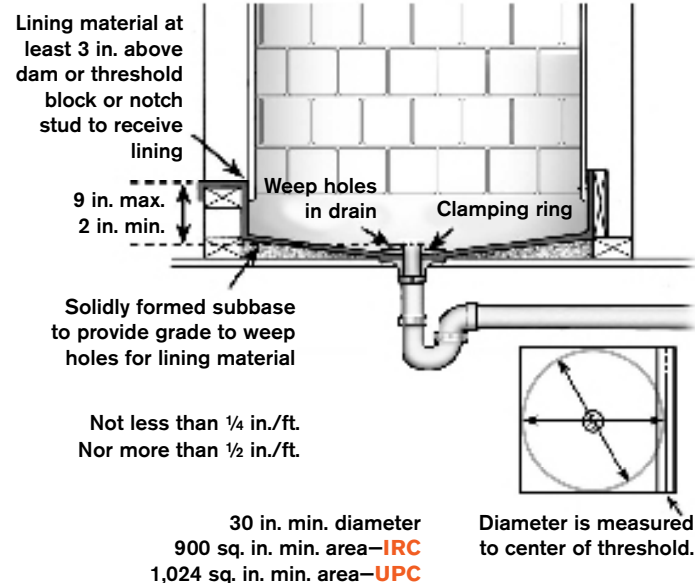
- | | 09 IRC | 09 UPC |
|---|--------|--------|
| <input type="checkbox"/> Min area 900 sq. in. (1024 sq. in. UPC) & min diameter 30 in. measured from finished wall F67 _____ [2708.1] (411.7) | | |
| <input type="checkbox"/> Min shower area to be maintained to 70 in. above drain _____ [2708.1] (411.7) | | |
| <input type="checkbox"/> Showerheads, valves, grab bars & soap dishes allowed to protrude into req'd min. space _____ [2708.1] (411.7) | | |
| <input type="checkbox"/> Shower walls nonabsorbent to min 72 in. above drain _____ [307.2] (IS-4.6) | | |
| <input type="checkbox"/> Finished threshold height min 1 in. below rest of shower receptor & 2–9 in. above top of drain F68 _____ [2709.1] (411.6) | | |
| <input type="checkbox"/> Door must open outward F67 _____ [2708.1] (411.6) | | |
| <input type="checkbox"/> Door min 22 in. wide F67 _____ [2708.1.1] (411.6) | | |
| <input type="checkbox"/> Finished floor slope ¼ in. to ½ in./ft. _____ [2709.1] (411.6) | | |
| <input type="checkbox"/> Secure shower valve, head/riser to permanent structure [2708.2] (411.11) | | |
| <input type="checkbox"/> Showerhead not discharging directly at door _____ [n/a] (411.10) | | |
| <input type="checkbox"/> Listed anti-scald/pressure balance valve req'd 120°F max [2708.3] (418.0) | | |

Shower Pan & Liner

- | | 09 IRC | 09 UPC |
|--|--------|--------|
| <input type="checkbox"/> Min rough pan 900 sq. in. (1024 sq. in. UPC) _____ [2708.1] (411.7) | | |
| <input type="checkbox"/> Must conform to approved standards _____ [2709.2] (411.8) | | |
| <input type="checkbox"/> Slope underlayment ¼ in./ft. F68 _____ [2709.3] (411.8) | | |
| • Liner min 3 in. above dam F68 _____ [2709.2] (411.8) | | |
| <input type="checkbox"/> Pan liner plastic or 3 layers hot mop type 15 felt _____ [2709.2] (411.8) | | |
| <input type="checkbox"/> Special attention to hot mop corner installation; extend 4 in. all directions from corner _____ [2709.2.3] (411.8) | | |
| <input type="checkbox"/> PVC & CPE sheet lining AMI _____ [2709.2.1&2] (411.8) | | |
| <input type="checkbox"/> Weep holes at drain req'd & must remain clear F68 _____ [2709.4] (411.8) | | |
| <input type="checkbox"/> No fasteners < 1 in. above finished threshold _____ [2709.3] (411.8) | | |
| <input type="checkbox"/> Roll over top of rough threshold (no penetrations through top) & fasten to outside edge F68 _____ [2709.3] (411.8) | | |

FIG. 68

Site-Built Shower Pan



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INSPECTIONS**General****09 IRC 09 UPC**

- Nothing concealed until inspected & approved _____ [2503.2] {103.5.1}
- Testing to be conducted in presence of AHJ _____ [2503.1] {105.5.3.1}

Water Supply**09 IRC 09 UPC**

- Test all piping before cover or concealment _____ [2503.2] {103.5.1.1}
- Water pipe test at working pressure 15 minutes EXC _____ [2503.7] {609.4}
 - 50 psi air for other than plastic pipe _____ [2503.7] {609.4}
- Water for testing must be from potable water source _____ [2503.7] {609.4}
- Reduced-pressure-principle backflow devices tested at installation & annually _____ [2503.8.2] {603.3.3}
- Test gauges req'd to have increments of: _____ [2503.9] {319.1-3}
 - 0.1 psi up to 10 psi test pressure
 - 1 psi up to 100 psi test pressure
 - 2 psi up if over 100 psi test pressure

DWV Systems**09 IRC 09 UPC**

- Rough-in plumbing, one of the following:
 - Water test—10 ft. head for 15 minutes OR _____ [2503.5.1] {712.2}
 - Air test—5 psi (10 in. mercury column) 15 minutes _____ [2503.5.1] {712.3}
- Building sewer 10 ft. head 15 minutes (or air test UPC) [2503.4] {723.0}
- UPC no air testing for plastic pipe _____ [n/a] {712.1}
- Finished plumbing: fill each drain, inspect traps EXC _____ [2503.5.2] {712.1}
 - BO may req gas test with smoke 15 minutes @ 1 in. water column or peppermint test 2 ounces in 10 quarts water _____ [2503.5.2] {n/a}

Gas**09 IRC 09 UPC**

- Leave all joints exposed until tested _____ [2417.3] {1214.2.1}
- Test pressure min 1½ × working pressure, min 3 psig _____ [2417.4.1] {1214.3.2}
- Test time min 10 minutes _____ [2417.4.2] {1214.3.3}

Gas (cont.)**09 IRC 09 UPC**

- Test medium air, nitrogen, or CO₂ (not oxygen) _____ [2417.2] {1214.1.7}
- Test gauge scale not > 5× test pressure _____ [2417.4.1] {1214.3.1}
- Cap outlets before pressure test _____ [2417.3.4] {1214.2.5}
- Inspect for open fittings or valves before turning on gas [2417.6.2] {1214.5.2}
- Check for leakage immediately after turning on gas _____ [2417.6.3] {1214.5.3}
- Soapy water or gas detector OK for locating leaks _____ [2417.5.1] {1214.4.2}
- Matches not OK for locating leaks _____ [2417.5.1] {1214.4.2}
- Purge appliances before placing in operation _____ [2417.7.4] {1214.6.4}

*Note: Air must be safely displaced from the fuel lines before they are placed in use. An addendum to several fuel gas codes specifies the purging procedures to be used. Further information is available at: <http://www.nfpa.org/Assets/files/AboutTheCodes/54/TIA54-09-3.pdf>
Fireblocking: Purpose & Materials.*

STRUCTURAL**Pipe Protection in Framing F69****09 IRC 09 UPC**

- Steel-plate protection for pipes other than galvanized & cast iron in notches or holes < 1½ in. (1 in. UPC) of face of framing _____ [2603.2.1] {313.9}
- Protection min 2 in. above sole plates & below top plates [2603.2.1] {n/a}
- Protection min 1½ in. beyond outside of pipe _____ [n/a] {313.9*}
- Protective plates min 16 gage (18 gage UPC) _____ [2603.2.1] {{313.9}}

Structural Modifications: General**09 IRC 09 UPC**

- No structural member weakened or impaired _____ [2603.1] {313.2}
- Drilling & notching per **T34, 35** _____ [2603.2] {313.2}

Fireblocking**09 IRC**

- Purpose is to cut off concealed draft openings _____ [302.11]
- At openings around vents, ducts, pipes & cables at ceilings & floors (see *Code Check Complete Building 3rd edition p.9* _____ [302.11]
- Caulking does not have to be fire-rated _____ [302.11]

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FIG. 69

Piping Protection

Protect pipe when $< 1\frac{1}{2}$ in. (1 in. UPC) from face of framing.

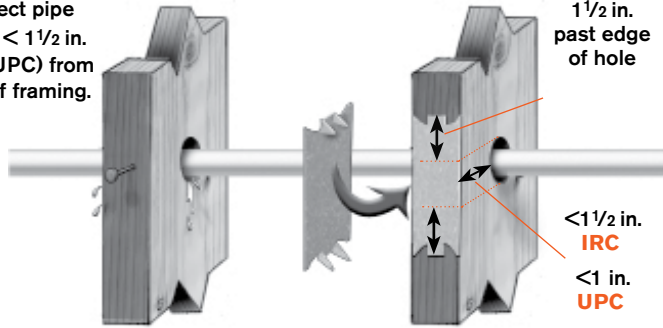
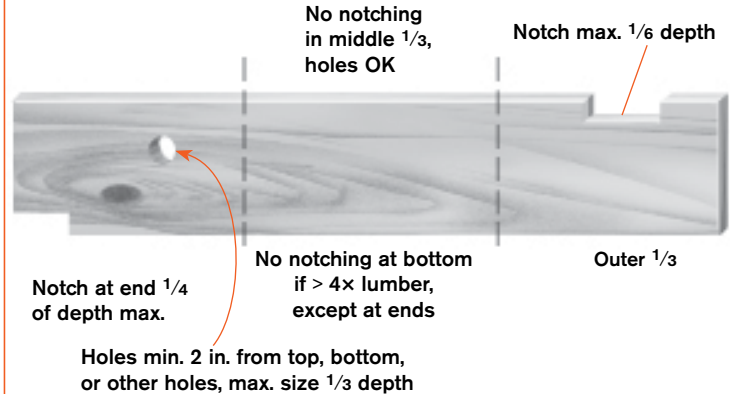


FIG. 70

Notching & Boring Joists & Girders



Notches in Joists, Girders & Rafters

09 IRC

- Notches in sawn lumber max $\frac{1}{8}$ depth of member **F70, T34** _____ [502.8.1]
- Max length of notches in sawn lumber $\frac{1}{3}$ depth of member **F70** _____ [502.8.1]
- Notches in sawn lumber not in middle $\frac{1}{3}$ **F70** _____ [502.8.1]
- End notches max $\frac{1}{4}$ depth of member **F70** _____ [502.8.1]
- No notches in tension side of members ≥ 4 in. except at ends _____ [502.8.1]
- Holes 2 in. min to top or bottom or notch or other hole **F70** _____ [502.8.1]
- Engineered product (TJI®'s) notches, holes, or cuts AMI only _____ [502.8.2]
- No field modification of trusses, e.g., notching, cutting _____ [802.10.4]
- No alteration or loading of trusses without written concurrence of design professional _____ [802.10.4 & 2405.2]

TABLE 34

NOTCHING & BORING JOISTS [502.8.1]

Nominal ^A Dimension Joist or Girder	Max. Diameter Bored Hole	Max. Notch Length	Max. Notch Depth Outer 1/3	Max. Depth End Notch
6	1 $\frac{1}{2}$ in.	1 $\frac{3}{4}$ in.	$\frac{7}{8}$ in.	1 $\frac{3}{8}$ in.
8	2 $\frac{3}{8}$ in.	2 $\frac{3}{8}$ in.	1 $\frac{3}{16}$ in.	1 $\frac{7}{8}$ in.
10	3 $\frac{1}{16}$ in.	3 $\frac{1}{16}$ in.	1 $\frac{1}{2}$ in.	2 $\frac{3}{8}$ in.
12	3 $\frac{3}{4}$ in.	3 $\frac{3}{4}$ in.	1 $\frac{7}{8}$ in.	2 $\frac{7}{8}$ in.

A. Table numbers based on actual dimensions: typically 5 $\frac{1}{2}$, 7 $\frac{1}{4}$, 9 $\frac{1}{4}$ & 11 $\frac{1}{4}$.

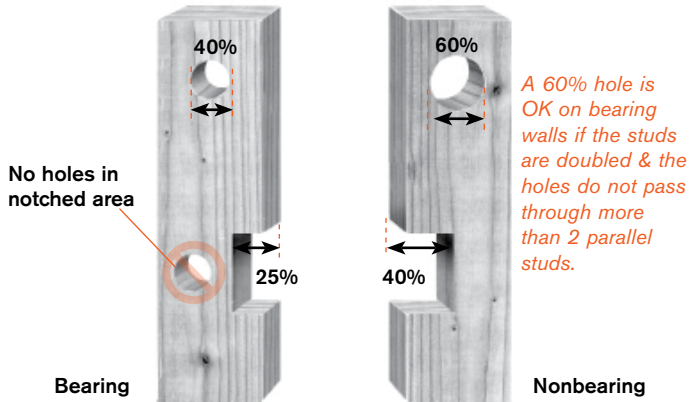
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Stud Notching & Boring**09 IRC**

- Notching 25% max in bearing wall, 40% nonbearing **F71, T35** _____ [602.6]
- Bored holes min $\frac{5}{8}$ in. from face of stud _____ [602.6]
- Boring 40% max in bearing wall, 60% nonbearing EXC **F71, T35** _____ [602.6]
 - 2 successive doubled bearing studs 60% OK **F71** _____ [602.6]
- Holes not in same stud section as cuts or notches _____ [602.6]
- If top plate > 50% removed for pipes, attach galvanized 16-gage metal tie $1\frac{1}{2}$ in. wide with min 8-10d nails each side of notch EXC _____ [602.6.1]
 - If entire side of wall with notch covered with wood sheathing ____ [602.6.1X]

TABLE 35		STUD NOTCHING & BORING [602.3(5)]			
Bearing Walls:		2x4	3x4	2x6	
Max. notch depth		$\frac{7}{8}$ in.	$\frac{7}{8}$ in.	$1\frac{3}{8}$ in.	
Max. diameter bored hole		$1\frac{3}{8}$ in.	$1\frac{3}{8}$ in.	$2\frac{3}{16}$ in.	
Max. diameter bored hole doubled studs		2 in.	2 in.	$3\frac{1}{4}$ in.	
Nonbearing Walls:		2x3	2x4	3x4	2x6
Max. notch depth		1 in.	$1\frac{3}{8}$ in.	$1\frac{3}{8}$ in.	$2\frac{3}{16}$ in.
Max. diameter bored hole		$1\frac{1}{2}$ in.	2 in.	2 in.	$3\frac{1}{4}$ in.

FIG. 71

Notching & Boring Studs

In 1752, Benjamin Franklin brought the first bathtub to America. After designing a more comfortable model, he took it with him on his travels to Europe.

GLOSSARY**A**

AAV (air admittance valve): One-way valve designed to admit air into the plumbing system during periods of relative negative pressure in the vent system to protect traps from siphonage and to remain sealed under zero or positive pressure. **F39,40**

ABS (acrylonitrile-butadiene-styrene): A plastic pipe that is usually black and used for DWV. It can also be used for building water supply and for vent piping of high-efficiency condensing appliances.

Accessible: Capable of being exposed without damage to the building or component structure or finishes, and that may require removal of access doors or fasteners requiring tools.

AHJ (Authority Having Jurisdiction): An organization responsible for enforcing the code, typically the building department and its authorized representatives.

Airbreak: A physical separation in which a discharge pipe from a fixture, appliance, or device drains indirectly into a receptor and enters below the flood level rim of a receptor, such as a clothes washer standpipe.

Air chamber: A pressure surge-absorbing device operating through the compressibility of air. Expansion tanks have air chambers. Mechanical water hammer arresters have replaced air chambers in piping systems.

Air gap (for drainage systems): Unobstructed vertical distance through free atmosphere between the outlet of a waste pipe and the flood level rim of the receptacle into which the waste pipe is discharging.

F44

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

Antisiphon valves: Valves or devices that prevent siphoning, typically by an opening to the atmosphere.

Approved: Accepted by the AHJ. UL and other testing laboratories do not approve materials; they test products and determine their conformity to published standards. Only the AHJ can approve them.

B

Backflow: A flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source other than its intended source.

Backflow connection: Any arrangement whereby backflow can occur.

Backflow preventer: A device or means to prevent backflow into the potable water system. These include air gaps, vacuum breakers, pressure vacuum breaker backflow prevention assemblies, and reduced pressure principle backflow prevention assemblies.

Backpressure: A potential backflow condition, created by pressure in the potential backflow source higher than the pressure in the water main.

Backsiphonage: Backflow caused by a loss of supply pressure.

Backwater valve: A device that prevents the backflow of sewage.

F17-19

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Ball cock: A valve in a toilet tank to control the supply of water into the tank.

Bathroom: In ASHRAE, a bathroom is a room containing a tub, shower, spa, or other source of moisture. A half bath contains only a water closet and lavatory & is not considered a bathroom. In the NEC, a bathroom is a room containing a basin and another plumbing fixture.

Bathroom group: A group of fixtures including a water closet, one or two lavatories, and bathtub, combination bath/shower, or a shower. The group can also include a urinal or bidet and an emergency floor drain.

Bonding jumper: A conductor installed to electrically connect metal gas piping to the grounding electrode system.

Branch: Any part of the drains except a main, riser, or stack.

Branch interval: A vertical measurement of distance, at least 8 ft., between connections of horizontal branches to a drainage stack, measured down from the highest horizontal branch connection. **F16**

Branch vent: A vent connecting two or more individual vents with a vent stack or stack vent. **F29**

Btu (British thermal unit): The quantity of heat necessary to raise the temperature of 1 lb. of water 1°F.

Building drain: The lowest piping of a drainage system that conveys discharge of soil, waste, and drainage pipes in the building to the building sewer beginning 30 in. (24 in. in UPC) outside the building wall.

Building sewer: Horizontal piping from a drainage system extending from the building drain to the public or private sewer or private sewage disposal system.

C

Check valve: A device used to prevent the flow of liquids in a direction not intended in the design of the system. Check valves are not backflow preventers. They are often used in solar systems.

CO (cleanout): An opening for cleaning the drainage system. See **p.75**.

Common vent: A pipe venting two trap arms on the same branch, either back-to-back or one above another. **F31, 33**

Concealed: Not exposed to view without removal of building surfaces or finishes.

Contamination: Impairment of potable water quality that creates a health hazard.

Continuous waste: A drain from 2 or more adjacent fixtures connecting the compartments of a set of fixtures to a trap or connecting other permitted fixtures to a common trap. An example is a double kitchen sink with each side connecting together and then to the trap. **F22, 23**

CPVC (chlorinated polyvinyl chloride): Plastic pipe designed for hot and cold water. Water distribution pipe is typically cream-colored, and orange CPVC is used for automatic fire sprinkler piping.

Cross-connection: A backflow connection or other arrangement whereby a potable water system may be contaminated.

Crown weir (trap weir): Highest point of the inside portion of the bottom surface of the horizontal waterway at the exit of a trap. Water flows into the trap arm once it rises above the crown weir. **F20**

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CW&V (combination waste drain & vent system): A system employing horizontal and/or vertical pipes functioning as vents and drains for sinks and floors by providing for free movement of air above the water line in the horizontal pipe. CW&Vs are not self-scouring and their use is restricted. **F38**

DWV (drain, waste, and vent): The system of piping and fittings that carries drainage, waste, and sewer gases and that equalizes atmospheric pressure at traps to protect the occupants from the contaminated gases in the system.

D

Developed length: The distance measured along the centerline of a pipe.

(DFU) Drainage fixture unit: A value used to calculate a fixture's load on the drainage system. **T6**

Directional fittings: Drainage fittings designed to join two pipes and direct their flow, such as wyes, combos, or tees with baffles. **F22, 23**

Discharge pipe: A pipe that conveys the discharge from a fixture or plumbing appliance.

Draft hood: A nonadjustable device integral to an appliance or made part of the appliance connector. It provides for the escape of flue gases from the appliance in the event of insufficient draft, backdraft, or stoppage. A draft diverter (typical on water heaters) prevents backdraft from entering the appliance and neutralizes the stack effect on the operation of the appliance.

Drain: A pipe carrying soil and water-borne waste.

Drainage system: Includes all the piping within public or private premises, which conveys sewage to a legal point of disposal.

E

Effective opening: The cross-sectional area of a water outlet, expressed in terms of the diameter of an equivalent circle. In the case of a faucet, measured at the smallest orifice or in the supply piping.

F

Fireblock: Building materials installed to resist the free passage of flame to other areas through small concealed spaces of the building.

Firestop: Until the early 1990s, this term was used for what today is called fireblocking. A penetration firestop assembly is a group of materials installed to resist free passage of flame through an assembly, typically around a duct, vent, or chimney passing through a rated ceiling, floor, or wall.

Fixture branch drain: A drain serving two or more fixtures that discharges to another drain or to a stack.

Fixture branch supply: A water supply pipe between the fixture supply pipe & the water distributing pipe.

Fixture drain: A drain from a fixture trap to a junction with any other drain; also called a trap arm. **F25**

Fixture unit: A unit of measure for the drain (DFU) or water supply (WSFU) load from different fixtures.

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FLR (flood level rim): The level at which water overflows from a fixture or the surface to which it is fastened. **F28**

G

Gas connector: Tubing or piping that connects the gas supply piping to the appliance.

Grade: The slope or fall of a line of pipe in reference to a horizontal plane. In drainage, it is usually expressed as the fall in vertical units compared to horizontal units or a fraction of an inch per foot length of pipe, such as ¼ in. per ft.

H

Hangers: See “Supports.”

Horizontal: Any pipe or vent that is less than 45° from horizontal.

Horizontal branch drain: A drainage pipe that extends from a stack or drain and that serves two or more fixtures.

Hot water: Water at a temperature of 110°F (120°F in the UPC).

I

In sight: See “Within sight”.

Indirect-fired water heater: A water heater with a storage tank with a heat exchanger used to transfer heat from an external source to heat potable water. The storage tank could derive its heat source from an external source, such as solar or a boiler, or an internal source.

Indirect waste pipe: A waste discharge into the drainage system through an airbreak into a trap, fixture, or receptor, such as a clothes washer standpipe. **F62**

Individual vent: A pipe that vents a fixture trap. **F25**

J

Joint: Connection between two pipes:

Brazed joint: Any joint obtained by joining metal parts with alloys that melt at temperatures above 840°F (449°C), but lower than the melting temperature of the parts to be joined.

Expansion joint: A loop, return bend, or return offset that accommodates pipe expansion and contraction.

Flexible joint: A joint that allows movement of one pipe without deflecting the other pipe.

Mechanical joint: A joint that uses compression to seal the joint.

Slip joint: A joint that incorporates a washer or special packing material to create a seal. **F22, 24**

Soldered joint: A joint obtained by joining of metal parts with metallic mixtures or alloys that melt at a temperature less than 800°F (427°C) & above 300°F (149°C).

Welded joint or seam: Any joint or seam obtained by the joining of metal parts in the plastic molten state.

L

Label: A marking applied on a product that identifies the manufacturer, the function or designation of the product, and the agency that has evaluated a sample of that product.

Labeled: Equipment, materials, or products affixed with a label or other identifying mark to attest that the product complies with identified standards or has been found suitable for a specific purpose. *See "Listed"*.

Liquefied petroleum (LP) gas: LP or propane gas is composed primarily of propane, propylene, butanes, or butylenes or mixtures thereof that are gaseous under normal atmospheric conditions but capable of being liquefied under moderate pressure at normal temperatures. LP gas is typically stored in tanks on site. Unlike natural gas (CH₄), LP gas (C₃H₈) is heavier than air.

Liquid waste: A discharge from any fixture or appliance that does not receive fecal matter.

Listed: Equipment or materials on a list published by an approved organization that is concerned with product evaluation and that maintains periodic inspection of production of listed equipment or materials. The listing will state that the product meets specified standards or has been found suitable for a specific purpose.

Low-pressure hot-water heating boiler: A boiler furnishing hot water at pressures not exceeding 160psi or temperatures not exceeding 250°F.

Luminaire: A complete lighting fixture including the lamp(s), mounting assembly, and cover.

M

Main: A principal artery of any system of continuous piping to which branches may be connected.

MP regulator: A line pressure regulator that reduces gas pressure from a medium pressure to a range at which appliances can use it (typically 0.5 psig). These are often found in CSST systems with a central manifold.

N

Nationally Recognized Testing Laboratory (NRTL): A testing facility recognized by OSHA as qualified to provide testing and certification of products and services. Examples of NRTLs are CSA, NDF, and UL.

Natural gas: Gas, usually odorized methane, supplied to the site by a gas utility company and metered at the site. Natural gas is lighter than air.

O

Offset: A combination of elbows or bends in a line of piping that brings a section of the pipe out of line, but into a line parallel with the other section. **F28**

P

PEX tubing: Water-supply tubing made of cross-linked polyethylene, typically found in parallel distribution systems. *See p.27*. PEX-AL-PEX has a thin layer of aluminum sandwiched between layers of PEX. The aluminum serves as an oxygen barrier and helps overcome the bending memory of the PEX.

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Plumbing system: The water-supply system, drainage system, storm drains, sewers, connected fixtures, supports, appurtenances, and appliances.

Potable water: Water fit for human consumption.

Pressure-balancing valve: A mixing valve that senses incoming hot and cold water pressures and compensates for fluctuations in either to stabilize outlet temperature. They can be built into shower and tub mixers or added as separate devices ahead of other individual fixtures.

Pressure-relief valve (PRV): A device designed to protect against high pressure and to function as a relief mechanism.

Public sewer: A sewer controlled by a public authority.

Public water main: Water supply pipe controlled by public authority.

R

Readily accessible: Access that does not require removing a panel or door. For electrical equipment, this also means not having to resort to use of a ladder.

Reduced-pressure principle backflow preventer (RPPBP): An RPPBP consists of two independently acting check valves, internally pressure-forced to the normally open position. These checks are separated by an intermediate chamber that is equipped with a means of automatic relief. Should there be a reversal of flow, the downstream liquid will drain instead of placing back pressure on the supply liquid. RPPBPs have a means of field testing.

Relief vent: A vent providing air circulation between vent and drainage systems.

Rim: An unobstructed open edge of a fixture. **F28**

Riser: A water or gas supply pipe that extends one or more stories.

Rough-in: Part of the plumbing system that is installed in a structure before fixture installation.

S

Sewage: Liquid waste that contains chemicals or animal or vegetable matter.

Sewage ejector: A device for lifting sewage at high velocity with air or water. **F18,19**

Sewage pump: A device, other than an ejector, for lifting sewage from a sump.

Shielded coupling: An approved elastomeric sealing gasket with an approved outer shield and a tightening mechanism (i.e., no hub coupling).

Slope: Fall or pitch along a line of pipe.

Soil pipe: A pipe that conveys waste including fecal matter.

Stack: A vertical drain line that extends one or more stories. **F16**

Stack vent: A vent that extends from a stack.

Stack venting: A method of venting fixtures through the soil or waste stack. **F16**

Static pressure: The pressure existing in a system without any flow.

Sump: A tank or pit that receives waste and is discharged by mechanical means. **F19**

Supports: Devices used to support or secure pipes, fixtures, or equipment. **F1**

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T

Tailpiece: Pipe or tubing connecting the outlet of a plumbing fixture to a trap. **F22**

Temperature & pressure-relief valve (TPRV): A device designed to protect against high pressure or temperature and to function as a relief for either. **F56**

Top dip (of trap): See “Upper dip”.

Trap: A fitting or device that employs a liquid seal to prevent the escape of sewer gas from the plumbing system. **F20**

Trap arm: A horizontal pipe between a trap and the connection to the drain and vent system—also called a fixture drain. **F25**

Trap seal: Vertical distance between the crown weir and the upper dip of the trap. **F20**

Tubular brass: Traps, waste bends, and tailpieces with slip-joint connections.

U

Upper dip: Highest point in the internal cross section of the trap at the lowest part of the bend. By contrast, the bottom dip is the lowest point in the internal cross section.

V

Vent (plumbing): A pipe or device for introduction of air into the plumbing system to equalize pressure, allow drainage, and prevent siphoning of trap seals.

Vent stack: A vertical vent pipe that provides air circulation for the drainage system.

Vertical: Any pipe or vent that is 45° or more from horizontal.

W

Waste: Liquid-borne waste free of fecal matter.

Waste pipe: A pipe that conveys only waste.

Water main: A water supply controlled by a public entity or utility.

Water pipe: A pipe that conveys water to fixtures and outlets.

Water supply system: Pipes, valves, fittings & supports that supply water to and throughout a residence & its accessories, such as sprinkler piping.

Weir: See “Crown weir”. **F20**

Wet vent: A vent that also serves as drain. **F32,37**

Whirlpool bathtub (hydromassage tub): A bathtub fixture equipped & fitted with a pump and circulating piping & that is drained after each use. A spa is not a whirlpool tub.

Within sight: Within 50 ft. & with an unobstructed line of sight.

WSFU (water supply fixture unit): A measure of the estimated normal demand on the water supply by various types of plumbing fixtures. **T22**

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TABLE 36

SIGNIFICANT CODE CHANGES – 2009 IRC, UPC & UMC; 2011 NFPA 31 & NFPA 58

No.	Page	Code No.	Description
1	11	IRC 3005.2.6	The 2006 IRC allowed cleanouts outside within 3 ft. of the building wall as an alternative.
2	14	UPC 710.1	Drain cleanouts through backwater valves require permanent labeling: "backwater valve downstream."
3	15	IRC 3007.3.5	Though this rule was implied by other rules, the 2006 IRC did not specifically require connection through a wye at the top of the gravity drain.
4	15	IRC 3007.6	The 2006 IRC specified the velocity, not the gpm, of the pump. T11 is new in the 2009 IRC.
5	25	IRC 3108.2.1	A water closet is now permitted to be located upstream of the dry vent connection to the horizontal wet vent.
6	26	IRC 3114.3	Branch or stack type AAVs can only vent fixtures on the same floor level & which connect to horizontal drains.
7	26	IRC 3114.8	AAVs may not vent sumps or tanks without an engineered design.
8	30	IRC T2903.1	The min. dynamic flow pressure at bathtubs, showers, and WCs was increased in 2009.
9	30	IRC 2903.7	The IRC WSFU method previously used was similar to the UPC method, and is now located in Appendix P, which typically requires local adoption to be enforceable. The new method is based on conversion of WSFUs to GPM flow rates. IRC Appendix P provides examples.
10	32	IRC 2903.7	The 2006 IRC applied an 80% multiplier to the minimum daily supply pressure used as the basis of pipe size calculations. The rule is now in Appendix P in the 2009 IRC.

11	34	IRC 2415.4	The 2009 IRC does not allow any gas pipe to penetrate a foundation below grade, including sleeved underground penetrations to basements.
12	34	IRC 2415.6 & 2415.12	The 2009 IRC distinguishes between gas piping inside a concrete slab and piping below the slab.
13	34	IRC 2415.6.2 & 2415.12.2	In the 2006 IRC a conduit beneath or encased in a slab with both ends terminating indoors would have both ends sealed. In 2009 neither is sealed.
14	35	IRC 2420.5.3	Appliance shutoff valves no longer have to be in the same room and within 6 ft. of the appliance if they are clearly labeled and located at a manifold within 50 ft. and serving no other purpose.
15	35	IRC 2422.1.2.1	In the 2006 IRC the length was 3 ft. except for dryers and ranges & rigid pipe.
16	37	UPC 1209.4.3	The 2006 UPC & UMC restricted the "branch length" method to 250 cu. ft./hr. and did not acknowledge the "longest length" method.
17	41	IRC 2803.6.1	The IRC now explicitly allows the TPR discharge piping to drain to the water heater pan.
18	42	IRC 2801.5	Pans other than 24 gage galvanized or CSA LC3 listed must be an approved type.
19	43	IRC 2719.1	Appliances may not restrict access to floor drains or be located over floor drains.
20	44	IRC 2706.2.1	A standpipe receiving continuous waste of a laundry tray must be above the laundry tray FLR.
21	45	IRC 2705.1	Toilets and bidets now require 15 in. clearance from their centerline to adjacent vanity or partition.