

# Code Check<sup>®</sup> Ninth Edition

Based on the 2018 IRC, 2018 UMC & UPC, and the 2017 NEC

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**Code Check** is a field inspection guide to important code requirements and common code violations in the construction of 1- & 2-family dwellings & townhouses. The primary reference is the 2018 edition of the *International Residential Code<sup>®</sup> for One- and Two-Family Dwellings*, published by the International Code Council (the IRC).

Codes are adopted at different times in different places around the country. New editions come out every three years, and some states make extensive modifications to the model codes prior to adoption. Since the code used in a particular area could vary, we include references to the two most commonly used codes for the plumbing, mechanical, and electrical sections. Significant code changes are highlighted in the text and summarized on the inside back cover. Minor changes and those that only affected numbering, not substance, are not shown. To determine the codes in your area, contact your local building department and the ICC website at [codes.iccsafe.org](http://codes.iccsafe.org).

For updates to Code Check 9th edition, downloadable versions of this book with enhanced navigation tools, and other valuable news, articles, and information, visit [www.codecheck.com](http://www.codecheck.com).

MODEL CODES REFERENCED IN CODE CHECK		
Organization	Code	
ICC	2018 IRC	International Residential Code
IAPMO	2018 UPC	Uniform Plumbing Code
IAPMO	2018 UMC	Uniform Mechanical Code
NFPA	2017 NEC	National Electrical Code
The code changes on the inside back cover compare the most recent codes to the earlier editions. Most items do not change each year and this book can be used in areas using older codes.		

The IRC is a prescriptive guide to residential construction. It is intended primarily for conventional wood-frame construction within prescribed height limits and areas of wind and seismic design. When a project has aspects that exceed the prescriptive limits of the IRC, those aspects require an engineered design. Many houses will require design for certain specific portions, while the majority of the construction can be built prescriptively using the IRC. Some projects might be in wind, snow, or seismic areas that dictate that all of the *structural* aspects be built to the International Building Code (IBC), while the *nonstructural* aspects are built to the IRC.

The information in this document is believed to be accurate; however, it is provided for informational purposes only and is not intended as a substitute for the full text of the referenced codes. Publication by The Taunton Press, ICC, and the authors should not be considered by the user to be a substitute for the advice of a registered design professional. Contact the local building department to learn what codes apply in your area as well as any local amendments and procedures.

Code numbers in the IRC begin with a letter (R for building, P for plumbing, M for mechanical, G for gas & E for electrical). We omitted these letters to save space.

## KEY TO USING CODE CHECK

Each item with a checkbox refers to a **code rule**, with **code citations** at the right of the line. The building section has only one column of code citations, referencing the **2018 IRC**. Two columns of references are used in the plumbing, mechanical, and electrical sections. The citation in the left column is from the **2018 IRC**, and the one in the right column is from the **2018 UPC**, **2018 UMC**, or **2017 NEC**. Exceptions to a code are shown in the line following the letters EXC, as in this example from p. 19:

- Hot on left, cold on right when facing outlet EXC \_\_\_\_\_ 2722.2 417.5
- Single-handle tub or tub/shower controls per markings \_2722.2X 417.5

*The rule here is that fixtures must have hot water on the left, cold on right, as found in 2722.2 of the IRC and 417.5 of the UPC. The exception is for faucets with single handle controls that are marked hot and cold.*

Figures and tables are referenced in text lines by bolded colored fonts, as shown in the following example from p. 16:

- Max total length of trap arm per **T14, F28** \_\_\_\_\_ 3105.1 1002.2

*The bold letters direct to Table 14 and Figure 28.*

Significant changes are given a different color code citation, and an endnote that keys to the list on the inside back cover. Example from page 6:

- Staples into PT wood must be SS \_\_\_\_\_ 3173.1<sup>6</sup>

*The rule here is that staples used as fasteners in pressure-treated lumber must be stainless steel, and this is listed as change #6 on the inside back cover.*

## MODEL CODE ORGANIZATIONS

**ICC** = The International Code Council

**IAPMO** = International Association of Plumbing and Mechanical Officials

**NFPA** = National Fire Protection Association

## ABBREVIATIONS

- A** = amp(s) (ex: a 15A breaker)
- ABS** = black plastic DWV pipe
- ACCA** = AC Contractors of America
- ACH** = air changes per hour
- AFCI** = arc-fault circuit interrupter
- AFF** = above finished floor
- AHJ** = authority having jurisdiction
- AMI** = in accordance with manufacturer's instructions
- ANSI** = American National Standards Institute
- ASCE** = American Society of Civil Engineers
- ASTM** = ASTM International (Standards)
- AWG** = American Wire Gauge
- B (vent)** = gas vent, usually double-wall
- BO** = building official
- Btu** = British thermal unit
- BWL** = braced wall line
- BWP** = braced wall panel
- CATV** = cable television
- cfm** = cubic feet per minute
- CMU** = concrete masonry unit
- CO** = carbon monoxide
- CO** = cleanout (plumbing)
- CPVC** = chlorinated polyvinyl chloride plastic pipe
- CSST** = corrugated stainless-steel gas tubing
- cu.** = cubic (ex: 24 cu. ft.)
- Cu** = copper
- DASMA** = Doors & Access Systems Manufacturers Association
- DFU** = drainage fixture unit(s)
- DW** = dishwasher
- DWV** = drain, waste & vent
- e.g.** = for example (exempli gratia)
- EGC** = equipment grounding conductor
- EMT** = electrical metallic tubing
- ex:** = example
- FAU** = forced-air unit (central furnace)
- FLR** = flood level rim
- FMC** = flexible metal conduit
- FSD** = fire separation distance
- ft.** (after number) = foot, feet (ex: 5 ft.)
- FVIR** = flammable-vapor ignition-resistant
- galv** = galvanized
- GB** = gypsum board
- GEC** = grounding electrode conductor
- GFCI** = ground-fault circuit interrupter
- gpm** = gallons per minute
- ICF** = insulating concrete forms
- IMC** = intermediate metal conduit
- in.** (after number) = inch(es) (ex: 24 in.)
- kw** = kilowatt
- L&L** = listed & labeled
- lav** = lavatory (bathroom sink)
- lb.** = pound
- LFMC** = liquidtight flexible metal conduit
- LFNC** = liquidtight flexible nonmetallic conduit
- LL** = line separating lots or lot from street
- max** = maximum
- MFR** = manufacturer
- min** = minimum
- n/a** = not applicable
- NM** = nonmetallic sheathed cable
- O.C.** = on center
- p.** = page
- PEX** = cross-linked polyethylene plastic pipe (water pipe)
- psf** = pounds per square foot
- psi** = pounds per square inch
- psig** = pounds per square inch gauge
- PT** = preservative-treated (wood)
- PVC** = polyvinyl chloride plastic water pipe or electrical conduit
- recep** = receptacle outlet (electrical)
- req, req'd, req's** = require, required, requires
- RMC** = rigid metal conduit
- SDC** = Seismic Design Category
- SDC D** = SDC D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub>
- SE** = service entrance
- SFD** = single family dwelling
- SMACNA** = Sheet Metal & Air Conditioning Contractors National Association
- sq.** = square (ex: 24 sq. in.)
- SS** = stainless steel
- UL** = Underwriter's Laboratories, Inc.
- W** = conductors rated for wet location
- w/** = with
- w/o** = without
- WC** = water closet (toilet)
- WH** = water heater
- WRB** = water-resistive barrier
- WSFU** = water supply fixture unit(s)
- WSP** = wood structural panel

**WALL FRAMING**

**Stud Framing** **18 IRC**

- Size & spacing per tables **T4** EXC. \_\_\_\_\_ 602.3.1
  - Alternate exterior load bearing studs to 12 ft. \_\_\_\_\_ **602.3.1X3 & T602.3(6)<sup>5</sup>**
- Studs req full bearing on min 2 in. plate at least equal to stud width. \_\_\_\_\_ 602.3.4
- Corners req 3 studs min EXC. \_\_\_\_\_ F602.3(2)
  - 2 studs OK w/ cleats for attaching interior surfaces \_\_\_\_\_ F602.3(2)
- Notching 25% max in bearing wall, 40% non bearing **F10** \_\_\_\_\_ 602.6#1
- Bored holes 40% max in bearing, 60% non bearing **F10** EXC. \_\_\_\_\_ 602.6#2
  - Notching/boring exceeding above OK w/ approved stud shoes AMI 602.6X
- Holes min <sup>5</sup>/<sub>8</sub> in. from face of stud & not same area as notch **F10** \_\_\_\_\_ 602.6#2

**Top Plates & Headers**

- Bearing wall intersections & corners must overlap \_\_\_\_\_ 602.3.2
- End joints must offset 24 in. min (see **T7** for nailing) \_\_\_\_\_ 602.3.2
- Joints need not be over studs \_\_\_\_\_ 602.3.2
- If notches/holes > 50% plate width, min 16 gauge 1<sup>1</sup>/<sub>2</sub> in. strap
  - min 8 10d nails each side of notch/hole **F10** EXC. \_\_\_\_\_ 602.6.1
  - Not req'd when WSP sheathing covers notch \_\_\_\_\_ 602.6.1X
- Single member headers allowed w/ spans per T602.7.1 **F11** \_\_\_\_\_ 602.7.1
- Jack studs or approved framing anchors req'd end of header \_\_\_\_\_ 602.7.5

**Cripple Walls**

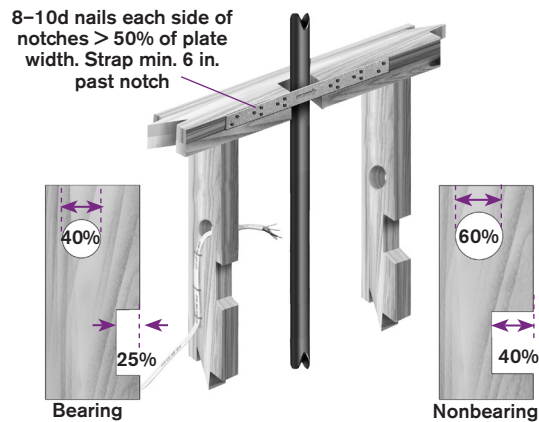
- Cripple wall < 14 in. continuously sheathed or solidly blocked \_\_\_\_\_ 602.9
- Studs ≥ studs above them, walls > 4 ft. sized as additional story \_\_\_\_\_ 602.9

TABLE 4	STUD SIZE AND SPACING T602.3(5)			
Bearing walls to 10 ft. laterally unsupported height <sup>A</sup>				
Load Supported	Stud size & maximum o.c. spacing (in.)			
	2x4	3x4	2x5	2x6
Roof + ceiling or habitable attic	24	24	24	24
1 floor	24	24	24	24
1 floor & roof+ceiling or habitable attic	16	24	24	24
2 floors & roof+ceiling or habitable attic	-	16	-	16
Nonbearing walls				
Stud size	2x3	2x4	2x5	2x6
Max laterally unsupported height <sup>A</sup>	10	14	16	20

A. Lateral support refers to walls or roof/ceiling assemblies.

**FIG. 10**

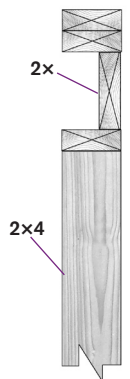
**Notching & Boring Studs**



60% hole OK on bearing walls if the studs are doubled & the holes do not pass through more than 2 successive studs. Stud shoes may be used with AHJ approval.

**FIG. 11**

**Single Member Header**



**WALL BRACING FOR WOOD FRAME BUILDINGS**

**Wood Structural Panel Sheathing** **18 IRC**

- Panels req grade stamp from approved agency \_\_\_\_\_ 602.1.8
- Fasten direct to framing members in accordance w/ **T7** \_\_\_\_\_ 602.3
- Staples into PT wood must be SS \_\_\_\_\_ **317.3.1<sup>6</sup>**

**Locations**

- BWL is straight line in plan view \_\_\_\_\_ 602.10.1
- Exterior walls max offset from braced wall line 4 ft. \_\_\_\_\_ 602.10.1.2

**Methods**

- All buildings req engineered design or prescriptive bracing per IRC \_\_\_\_\_ 602.10
- Bracing methods include intermittent, continuous sheathing (CS), or mixed methods \_\_\_\_\_ 602.10.4
- CS method req's WSP all sheathable surfaces one face of BWL \_\_\_\_\_ 602.10.4.2
- Simplified bracing method allowed for SFD in SDC A, B, or C \_\_\_\_\_ 602.12
- Simplified bracing method allowed for Townhouse in SDC A or B \_\_\_\_\_ 602.12
- Let-in bracing not allowed in SDC D \_\_\_\_\_ T602.10.3(3)

## PIPING INSTALLATION & PROTECTION

- General**
- Max support intervals **T11** \_\_\_\_\_ **18 IRC** 2605.1#5 **18 UPC** 313.3
  - Min 16 gauge steel shield plate if < 1 1/4 in. from edge of framing (UPC: 18 gauge, ≤1 in. & 1 1/2 in. past hole) **F26** \_\_\_\_\_ 2603.2.1 312.9
  - Extend plate 2 in. above sole plate & below top plates 2603.2.1 n/a
  - Where necessary, protect from freezing outside building thermal envelope (crawl spaces, attics, outdoors, etc.) \_\_\_\_\_ 2603.5 312.6
  - Pipes & fittings must bear manufacturer identification & any markings req'd by applicable standards, exc field-cut pipe nipples \_ 2609.1 301.2.1
  - Thrust blocks for 4 in. drain >45° horizontal change \_ **2605.1#4<sup>26</sup>** n/a

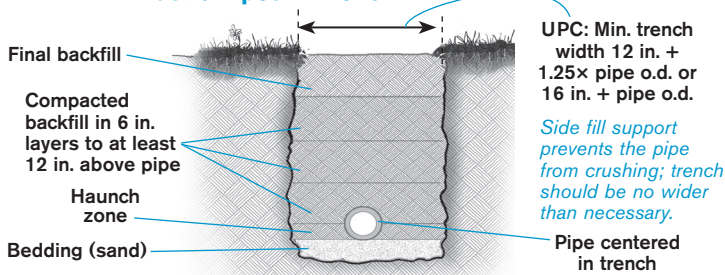
**TABLE 11 MAX. SUPPORT INTERVALS IRC T2605.1 UPC T313.3**

Pipe or Tube	Horizontal	Vertical
CPVC	3 ft. for ≤ 1 in. diameter, 4 ft. if ≥ 1 1/4 in.	IRC: 10 ft. & midstory guides for ≤ 2 in. UPC: Base & each floor + midstory guides
PEX	32 in. if ≤ 1 in. diameter, 4 ft. if ≥ 1 1/4 in.	
ABS & PVC <sup>A</sup>	4 ft.	
Cast iron w/ no-hub fittings <sup>B</sup>	IRC: 5 ft. (10 ft. for 10 ft. pipes) UPC: If > 4 ft.—every joint, <sup>C</sup> ≤ 4 ft. lengths—every other joint. <sup>C</sup>	IRC: 15 ft. UPC: Base & each floor & max. 15 ft.
Cu Tubing	IRC: ≤ 1 1/4 in.—6 ft., ≥ 1 1/2 in.—10 ft. UPC: ≤ 1 1/2 in.—6 ft., ≥ 2 in.—10 ft.	IRC: 10 ft. UPC: Each floor & max. 10 ft.

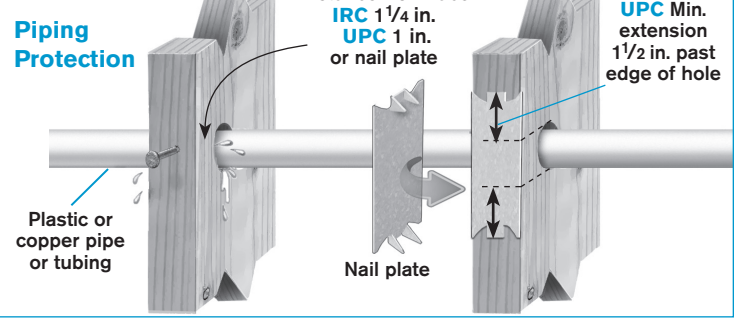
A. UPC: Provide for expansion every 30 ft.  
B. UPC: Brace at max. 40 ft. intervals to prevent horizontal movement.  
C. Support adjacent to joint within 18 in.; do not place hanger directly on coupling

- Utility Trenches** **18 IRC** **18 UPC**
- Backfill layered & tamped in place—no backhoe or grader until 12 in. of tamped earth above pipe **F25** \_\_\_\_\_ 2604.3 314.4
  - Trench width per MFR (ASTM D2321) (UPC: see **F25**) \_ 2609.2 **314.4.1<sup>27</sup>**
  - Water service min 12 in. cover \_\_\_\_\_ 2603.5 609.1
  - Water service min 6 in. (UPC: 12 in.) below frost line \_\_\_\_\_ 2603.5 609.1
  - Water pipe & sewer OK in same trench unless sewer material is clay or other material not approved inside house \_\_\_\_\_ 2906.4.1 609.2
  - Sewer depth per local BO & utility \_\_\_\_\_ 2603.5.1 718.0
  - Utility or other trench may not undermine footing \_\_\_\_\_ 2604.4 314.1
  - Pipes through foundation req sleeve or bored hole \_\_\_\_\_ 2603.4 312.10

**FIG. 25 Plastic Pipes in Trench**



**FIG. 26**



- Piping under or Encased in Concrete Slabs** **18 IRC** **18 UPC**
- Pipes through concrete wrapped or sheathed \_\_\_\_\_ 2603.3 312.2
  - Cu water tubing underground beneath building min Type L \_ n/a 604.3

### Underground Gas Pipes

- Conduit or listed system req'd if gas is below building \_ 2415.14 1210.1.6
- Min cover below grade 12 in. EXC \_\_\_\_\_ 2415.12 1210.1.1
  - 18 in. cover if external damage likely at 12 in. \_\_\_\_\_ n/a 1210.1.1
- Plastic only OK underground outside building \_\_\_\_\_ 2415.17.1 1210.1.7
- Corrosion-resistant tracer wire min 18 AWG (UPC 14 AWG) buried with plastic pipe & brought above ground at riser \_\_\_\_\_ 2415.17.3 1210.1.7.2
- Factory-applied & electrically insulated coating req'd for metal pipe; field wrapping OK AMI for threads & fittings \_\_\_\_\_ 2415.11.2(2) 1210.1.3(2)

## ROUGH INSPECTION: TESTING

- Required Pre-Concealment Piping Tests** **18 IRC** **18 UPC**
- Test all piping before cover or concealment \_\_\_\_\_ 2503.2 105.1
  - DWV min 5 ft. (UPC: 10 ft.) water head for 15 min. OR 2503.5.1 712.2
    - Air test 5 psig (10 in. mercury) for 15 min. \_\_\_\_\_ 2503.5.1 712.3
  - Water pipe test 15 minutes w/ potable water at ≥ working pressure; nonplastic OK to test w/ air ≥ 50 psig air EXC \_\_\_\_\_ 2503.7 609.4
    - Air OK for PEX if AMI for tubing & fittings \_\_\_\_\_ **2503.7X<sup>28</sup>** **609.4X<sup>28</sup>**
  - Gas test min 10 min. @ 1 1/2x working pressure & min 3 psig (UPC: 15 min. @ 10 psig) \_\_\_\_\_ 2417.4.1&2 1213.3

**TABLE 12 BRANCH DRAIN & VENT SIZE IRC T3005.4.1 UPC T703.2**

Pipe size		1 1/4 in.	1 1/2 in.	2 in.	2 1/2 in.	3 in.	4 in.
IRC DFUs	Vertical	1	4	10	20	48	240
	Horizontal	1	3	6	12	20	160
	Wet Vents	Ø	1	4	6	12	32
UPC DFUs	Vertical	1	2	16	n/a	48	256
	Horizontal	1	1	8	n/a	35 <sup>A</sup>	216 <sup>B</sup>
UPC Vents <sup>C</sup>	Max DFUs	1	8	24	n/a	84	256
	Max Feet <sup>D</sup>	45	60	120	n/a	212	300

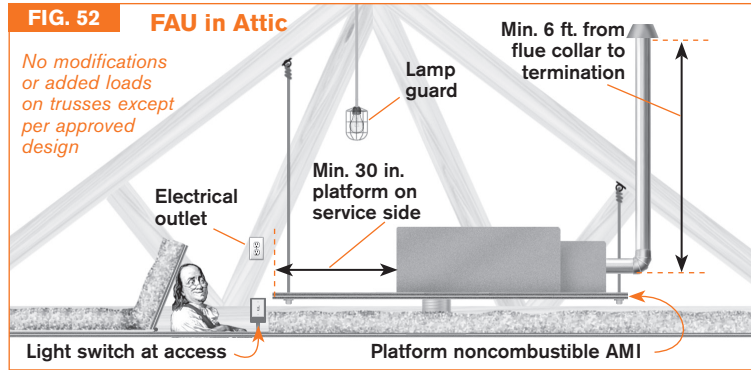
A. UPC: Horizontal drain pipe min. 4 in. if receiving > 3 water closets  
B. Based on 1/4 in./ft. slope. For 1/2 in./ft. slope, multiply by 0.8.  
C. IRC vents min 1 1/4 in. & min half the req'd drain diameter. IRC vents > 40 ft. req 1 pipe size increase.  
D. UPC vents increase 1 pipe size if horizontal length > 1/3 the overall length.

**APPLIANCES & EQUIPMENT**

General	18 IRC	18 UMC
<input type="checkbox"/> Equipment must be L&L or approved as equivalent by AHJ 1302.1		301.2
<input type="checkbox"/> Install listed equipment AMI _____ 1307.1 & 1401.1 & 2408.1		303.1
<input type="checkbox"/> Attach installation instructions to appliance ___ 1307.1 & 2408.1		303.1
<input type="checkbox"/> Install above design flood elevation _____ 1401.5		305.2
<input type="checkbox"/> Air filter(s) req'd for heating & cooling air systems ___ 1307.1		311.2
<input type="checkbox"/> Habitable rooms req heating facilities (cannot be portable space heaters) capable of maintaining 68°F 3 ft. above floor @ 2 ft. distance from exterior walls _____ 303.1.0		local
<b>Electrical</b>		
<input type="checkbox"/> Electrical disconnect within sight or per electrical code ___ T4101.5		301.4 <sup>38</sup>
<input type="checkbox"/> Recep req'd within 25 ft. of appliance _____ 1305.1.2.1		301.4
<input type="checkbox"/> Light near attic or crawl space appliances <b>F52</b> 1305.1.2.1&1.3.3		304.4.4
<input type="checkbox"/> Light switch located at passageway entry opening ___ 1305.1.2.1		304.4.4
<input type="checkbox"/> Exposed lamps req lamp guard <b>F52</b> _____ 1305.1.2.1&1.3.3		p .28
<input type="checkbox"/> Recep near attic or crawl space appliances <b>F52</b> 1305.1.2.1&1.3.3		304.4.4
<input type="checkbox"/> Recep not on appliance circuit _____ 3901.12		p .28

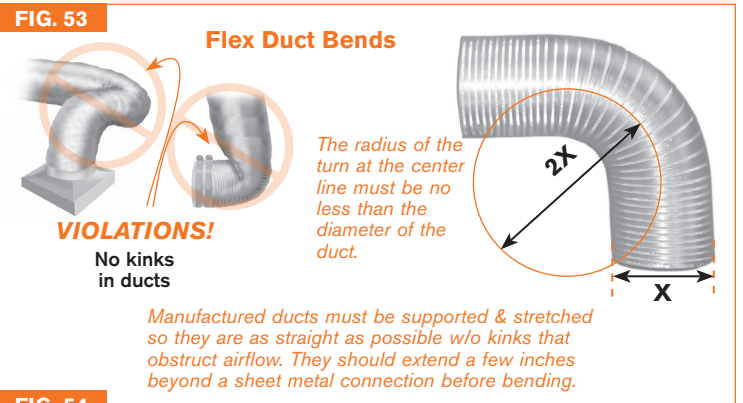
**APPLIANCE LOCATIONS**

Access & Clearances	18 IRC	18 UMC
<input type="checkbox"/> Gas-fired not OK in bedroom, bath, or their closets EXC 2406.2		904.1
• Direct-vent type _____ 2406.2(1)		904.1(2)
• Closet w/ exterior C.A. & gasketed self-close door ___ 2406.2(5)		904.1(1)
<input type="checkbox"/> Min 30 in. x 30 in. work area service side of appliance ___ 1305.1		304.1
<input type="checkbox"/> Locate so as to allow access for appliance service _____ 1305.1		304.1
<input type="checkbox"/> Min 24 in. wide opening to allow appliance removal ___ 1305.1.1		n/a
<input type="checkbox"/> Install w/ clearances to combustibles AMI _____ 1306.1		303.1
<b>Underfloor &amp; Attic</b>		
<input type="checkbox"/> Support slab/platform min 3 in. above ground 1305.1.3.1 & 2408.4		904.3.1.1
<input type="checkbox"/> Suspended equipment min 6 in. above ground _1305.1.3.1 & 2408.4		904.3.1.2
<input type="checkbox"/> Passageway min 22 in. wide x 30 in. high _____ 1305.1.2&3		304.4
<input type="checkbox"/> Passageway max distance 20 ft. if < 6 ft. high _____ 1305.1.2&3		304.4.1
<input type="checkbox"/> Attic req's solid floor min. 24 in. wide to equipment _____ 1305.1.2		304.4.2
<input type="checkbox"/> Min 30 in. x 30 in. platform at service side EXC ___ 1305.1.2&3		304.4.3
• Not req'd if equipment can be serviced from opening (UMC: max setback from attic opening 12 in.) _____ 1305.1.2X1		304.4.3X
<b>Garage</b>		
<input type="checkbox"/> Protect appliance from impact _____ 1307.3.1 & 2408.3X		305.1.1
<input type="checkbox"/> Ignition source min 18 in. above floor EXC _____ 1307.3 & 2408.2		305.1
• Listed FVIR _____ 1307.3 & 2408.2X		305.1
• Separate enclosed area w/ outside access & C.A. _____ 2408.2.1		305.1.2
<input type="checkbox"/> Ducts & penetrations min 26 gauge steel ___ 302.5.2, 1601.4.9		local
<input type="checkbox"/> No duct openings into attached garage _____ 302.5.2, 1601.4.9		local



**DUCTS**

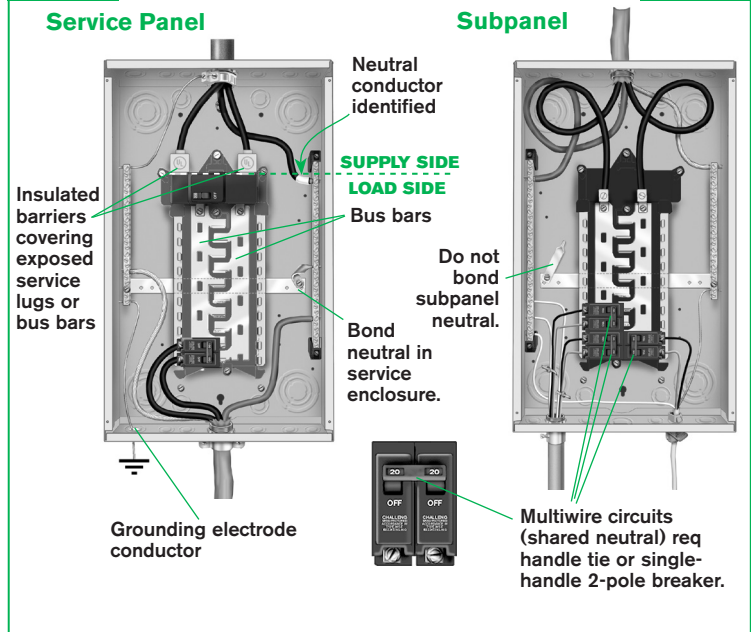
General	18 IRC	18 UMC
<input type="checkbox"/> Size per ACCA Manual D or other approved method ___ 1601.1		601.2 <sup>39</sup>
<input type="checkbox"/> Factory-made ducts L&L per UL 181 & installed AMI ___ 1601.1.1		603.4
<input type="checkbox"/> Duct penetrations between floors req fireblocking 302.11&1601.4.5		local
<b>Return Air</b>		
<input type="checkbox"/> Must be from space ≥ 25% of area served or from space w/ openings to spaces ≥ 25% of area served EXC ___ 2442.3(4)		311.3
• (UMC: OK in hallway w/ ≥ 3 doors to rooms served by unit) _ n/a		311.3X
<input type="checkbox"/> Not from area of objectionable odors or vapors (closet, bathroom, kitchen, garage, mechanical room, or attic) ___ 1602.2 & 2442.3		311.3
<input type="checkbox"/> Min 10 ft. from draft hood or vent outlet _____ 1602.2 & 2442.3		311.3
<input type="checkbox"/> No return air from one dwelling unit to another _ 1602.2 & 2442.5		311.4
<b>Installation</b>		
<input type="checkbox"/> Ground clearance min 4 in. _____ 1601.4.8		603.3&4
<input type="checkbox"/> 18 in. vertical clearance where needed under duct to prevent cutting off access to crawl space _____ n/a		603.2
<input type="checkbox"/> Min 2 in. encasement for metal ducts under/in concrete 1601.1.2		603.12
<input type="checkbox"/> Underground ducts req slope to accessible drainage point (UMC: 1/4 in./ft. to the main riser) _____ 1601.1.2 <sup>40</sup>		603.12
<input type="checkbox"/> Support metal ducts per SMACNA standards _____ 1601.4.4		603.3
<input type="checkbox"/> Flex duct support AMI or per SMACNA standards <b>F53,54</b> 1601.4.4		603.8
<input type="checkbox"/> Flex support interval max 4 ft. horizontal 6 ft. vertical <b>F54</b> ___ n/a		603.5 <sup>41</sup>
<input type="checkbox"/> Stud cavities OK as return (not supply) if no condensation & max 125°F & not from one floor to another EXC _____ 1601.1.1		602.2&5
• Not allowed by energy code _____ 1103.3.5		local
<input type="checkbox"/> Duct joints sealed airtight per SMACNA standards & w/ mastics & pressure-sensitive tapes L&L to UL 181B _____ 1601.4.1		603.10
<input type="checkbox"/> Duct leakage test req'd (IRC: max differential 0.1 in w.g.) (UMC: SMACNA HVAC Air Duct Leakage Test) <sup>42</sup> _____ 1103.3.3		603.10.1
<b>Insulation in Unconditioned space (1-in. fiberglass ≈ R-3)</b>		
<input type="checkbox"/> Ducts < 3 in. diameter R-6 min in attics, R-4.2 elsewhere ___ 1103.3.1		n/a
<input type="checkbox"/> R-8 min in attics, R-6 elsewhere EXC _____ 1103.3.1		local
• Ducts completely inside building thermal envelope _ 1103.3.1X		604.1X2



**PANELBOARDS (LOAD CENTERS)**

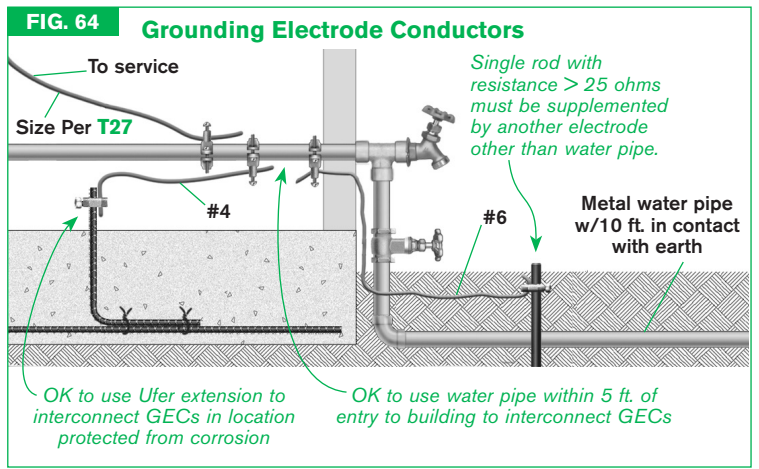
- General**
- Working space 30 in. wide x 3 ft. deep min **F61** 3405.2 110.26A1&2
  - Working space to floor & min 6 ft. 6 in. height **F61** 3405.2 110.26A3
  - No grounding of neutral after service EXC **F63** 3607.2 250.24A5
    - Existing separate structure w/ no parallel metal path 3607.3.2 250.32BX
  - Subpanel neutral isolated from enclosure **F63** 3908.6 408.40
  - Only 1 wire per breaker terminal unless L&L for 2 3406.10 110.14A
  - Each neutral req's individual terminal 3706.4 408.41
  - Overcurrent protection req'd per **T29** 3705.5 240.4
  - Torque all terminals per labeling 3406.12<sup>49</sup> 110.14D<sup>49</sup>
  - Breaker brand and models L&L for panel 3403.3 110.3B
  - Backfed breakers mechanically secured in place 3706.5 408.36D
  - Use of each circuit identified by purpose w/ sufficient detail to be distinguished from all other circuits 3706.2 408.4A
  - Circuit description not dependent on temporary conditions, e.g., room color or occupant's name 3706.2 408.4A
  - Multiwire circuits req handle tie or single handle **F63** 3701.5.1 210.4B
  - Open knockouts & missing cover twist-outs closed 3404.6 110.12A
  - Max height of center of breaker handle 6 ft. 7 in. 3705.7#6 240.24A
  - No panels in clothes closet or bathroom 3705.7#3&4 240.24D&E
  - Not to be located over steps of a stairway 3705.7#5 240.24F
  - 1/4 in. air space req'd behind surface-mounted metal panel in damp or wet location 3907.2 312.2

**FIG. 62** Service Panel **FIG. 63** Subpanel



**GROUNDING & BONDING**

- Grounding Electrode System (GES) F64**
- Use metal underground water pipe if ≥ 10 ft. in earth 3608.1.1 250.52A1
  - Water pipe cannot be only grounding electrode 3608.1.1.2 250.53D2
  - Bond around water meters, regulators, etc. 3608.1.1.2 250.53D1
  - "Ufer" = 20 ft. min #4 rebar or min 4 AWG Cu wire in concrete footing, foundation, or pier in contact w/ earth EXC 3608.1.2 250.52A3
    - Ufer not req'd in existing buildings where steel not accessible w/o removal of concrete 3608.1X 250.50X
  - Rod driven min 8 ft. deep & flush to ground level 3608.1.4.1 250.53G
  - If resistance > 25 ohms, 2<sup>nd</sup> rod req'd ≥ 6 ft. from 1<sup>st</sup> 3608.4 250.53A2&3
  - Each structure w/ > 1 branch circuit req's GES 3607.3 250.32A
  - Connections to water pipe > 5 ft. inside building not OK as interconnection of GECs 3608.1.1.1 250.68C1



- Clamps**
- Ground rod clamps L&L for direct burial 3611.1 250.70
  - Clamps accessible unless buried or encased 3611.2 250.68A
- Grounding Electrode Conductor (GEC)**
- GEC must connect to incoming service neutral 3607.2 250.24A
  - 8 AWG req's protection in raceway or cable armor 3610.2 250.64B
  - 6 AWG following building contour OK w/o protection 3610.2 250.64B
  - Size GEC to **T27** EXC T3603.4 T250.66
    - 6 AWG largest req'd size if dead-ends at rod T3603.4 250.66A
    - 4 AWG largest req'd size if dead-ends at Ufer T3603.4 250.66B

TABLE 27 GROUNDING ELECTRODE CONDUCTOR & EQUIPMENT GROUNDING CONDUCTOR SIZES				TABLE 28	
GEC IRC T3603.4 & NEC T250.66				EGC IRC T3908.12 & NEC T250.122	
Cu Service Wire AWG Size	Al Service Wire AWG Size	Max. Service Rating	Size of Cu GEC	Breaker Rating	AWG Size of Cu EGC <sup>A</sup>
≤ 2	1/0	125	8	15	14
1 or 1/0	2/0 or 3/0	150/175	6	20	12
2/0 or 3/0	4/0 or 250 kcmil	200/225	4	30-60	10
> 3/0 to 350 kcmil	> 250 kcmil to 500 kcmil	250/300	2	70-100	8
				110-200	6
> 350 kcmil to 600 kcmil	> 500 kcmil to 900 kcmil	400	1/0	300	4
				400	3

A. Al EGCs 1 size larger than Cu.

- Bonding**
- Bond all available electrodes (water piping, rod, Ufer) 3608.1 250.50
  - Bond metal raceways enclosing GEC 3610.3 250.64E
  - Bond service raceway fittings w/ bonding jumpers if knockouts remain or reducing washers used 3609.4 250.92B
  - Use bonding locknuts if no remaining concentrics 3609.4 250.92B
  - Bond all metal piping systems capable of becoming energized (hot, cold & gas) at an accessible location 3609.6&7 250.104A&B
  - EGC of equipment may be used to bond gas 3609.7 250.104B
- Intersystem Bonding**
- Provide accessible external L&L terminal bar w/ min 3 terminals to bond phone & CATV, min 6 AWG **F45** 3609.3 250.94
  - Bar shall not interfere w/ opening service enclosure 3609.3 250.94

- Equipment Bonding & Grounding**
- Wire EGCs sized per **T28** 3908.12 250.122
  - EGC must provide effective ground-fault current path 3908.4 250.4A5
  - Earth is not an effective ground-fault current path 3908.5 250.4A5
  - RMC, IMC, EMT, AC cable armor, electrically continuous raceways & surface metal raceways OK as EGC 3908.8 250.118
  - Remove paint from contact surfaces of grounding equipment unless using threaded fittings listed for grounding 3908.17 250.12