Instructor Information

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IRC Administration

Based on 2018 IRC Chapter One provisions

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Site Development

Table R302.1(1) Exterior Walls & Table R302.1(2) Exterior Walls-Dwellings with Fire Sprinklers

TABLE R302.1(1)
EXTERIOR WALLS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E119, UL 263 or Section 703.3 of the *International Building Code* with exposure from both sides	0 feet
	Not fire-resistance rated	0 hours	≥ 5 feet
Projections	Not allowed	NA	< 2 feet
	Fire-resistance rated	1 hour on the underside, or heavy timber, or fire-retardant-treated wood[a, b]	≥ 2 feet to < 5 feet
	Not fire-resistance rated	0 hours	≥ 5 feet
Openings in walls	Not allowed	NA	< 3 feet
	25% maximum of wall area	0 hours	3 feet
	Unlimited	0 hours	5 feet
Penetrations	All	Comply with Section R302.4	< 3 feet
		None required	3 feet

For SI: 1 foot = 304.8 mm.

NA = Not Applicable.

a. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave overhang if fireblocking is provided from the wall top plate to the underside of the roof sheathing.

b. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the rake overhang where gable vent openings are not installed.

TABLE R302.1(2)
EXTERIOR WALLS—DWELLINGS WITH FIRE SPRINKLERS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E119, UL 263 or Section 703.3 of the *International Building Code* with exposure from the outside	0 feet
	Not fire-resistance rated	0 hours	3 feet[a]
Projections	Not allowed	NA	< 2 feet
	Fire-resistance rated	1 hour on the underside, or heavy timber, or fire-retardant-treated wood[b, c]	2 feet[a]
	Not fire-resistance rated	0 hours	3 feet
Openings in walls	Not allowed	NA	< 3 feet
	Unlimited	0 hours	3 feet[a]
Penetrations	All	Comply with Section R302.4	< 3 feet
		None required	3 feet[a]

For SI: 1 foot = 304.8 mm.

NA = Not Applicable.

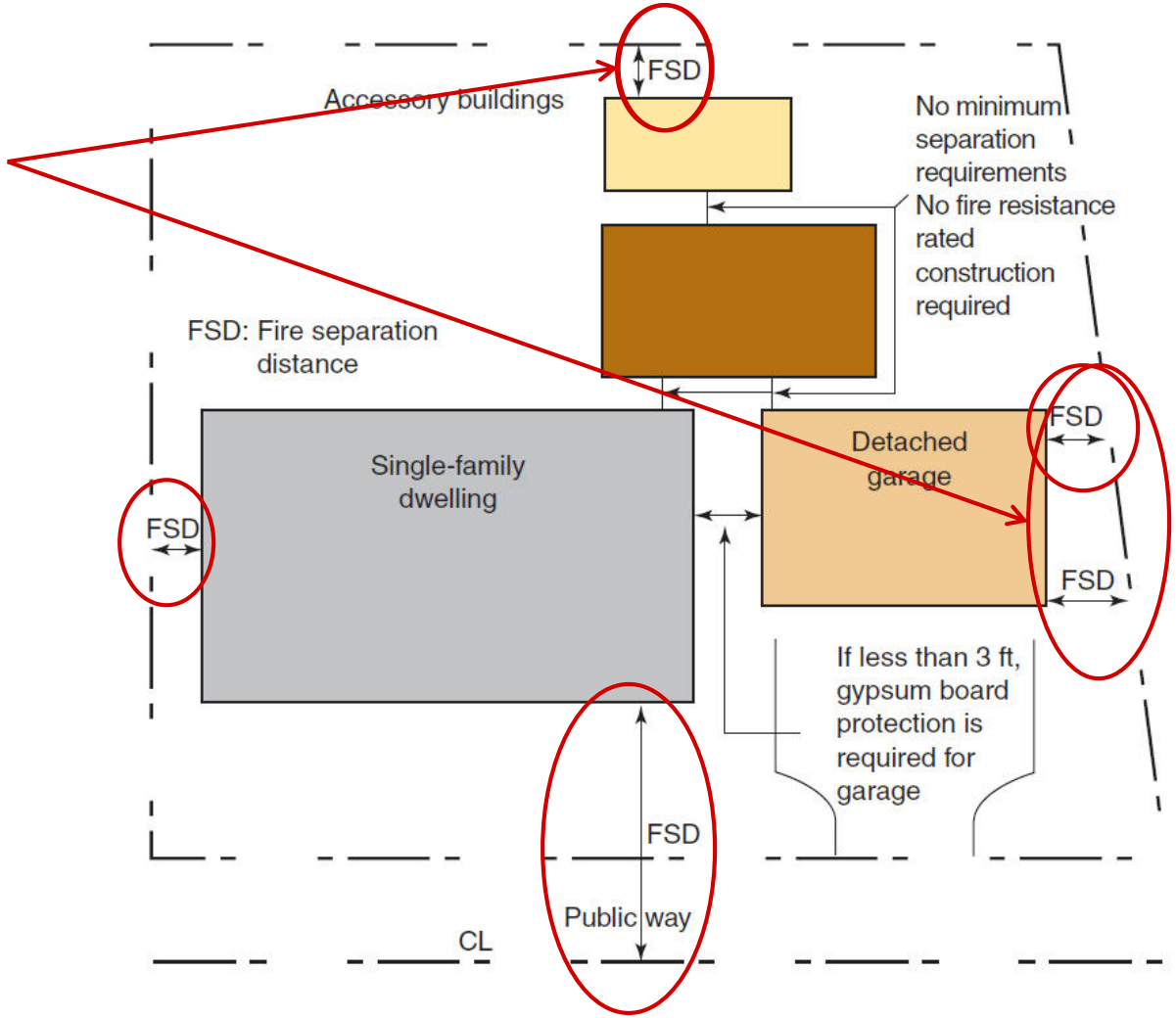
a. For residential subdivisions where all dwellings are equipped throughout with an automatic sprinkler system installed in accordance with Section P2904, the fire separation distance for exterior walls not fire-resistance rated and for fire-resistance-rated projections shall be permitted to be reduced to 0 feet, and unlimited unprotected openings and penetrations shall be permitted, where the adjoining lot provides an open setback yard that is 6 feet or more in width on the opposite side of the property line.

b. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave overhang if fireblocking is provided from the wall top plate to the underside of the roof sheathing.

c. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the rake overhang where gable vent openings are not installed.

Fire Separation Distance

- Measured perpendicular to the exterior wall
- Measured between the building and:
  - Lot lines
  - Centerline of a street or alley



R302.2 Townhouse Separation

Walls separating townhouse units allows an option of utilizing two 1-hour fire-resistance rated wall assemblies.

R302.13 Fire Protection of Floors

2. Floor assemblies located directly over a crawl space not intended for storage or for the installation of fuel-fired or electric-powered heating appliances.

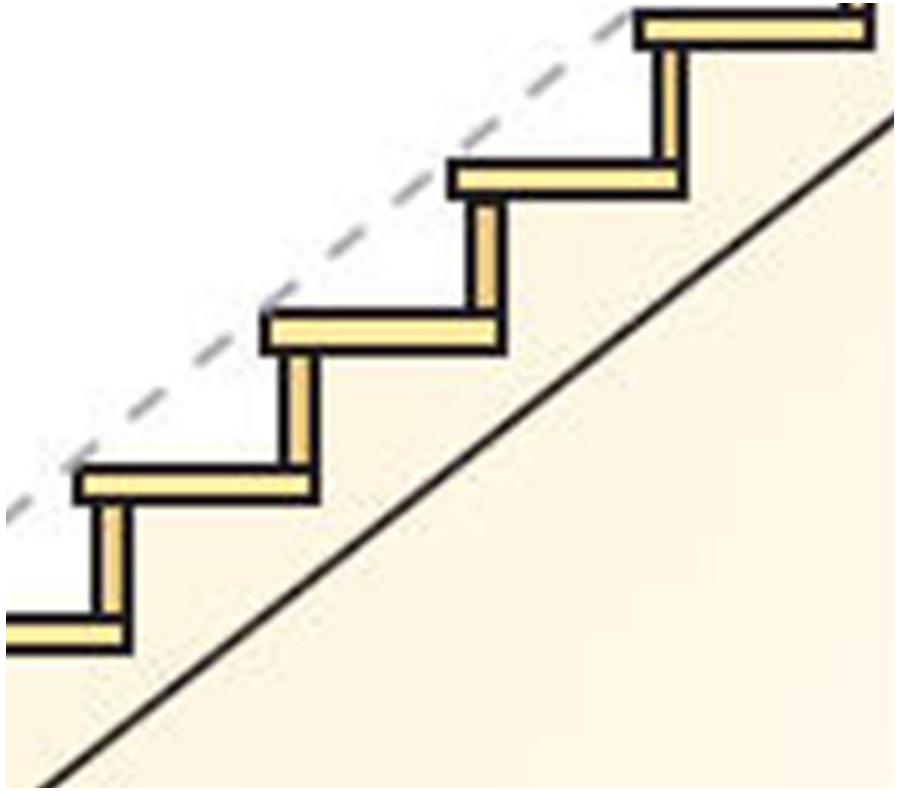
R302.13 Fire protection of floors. Floor assemblies that are not required elsewhere in this code to be fire-resistance rated, shall be provided with a $^{1}/_{2}$-inch (12.7 mm) gypsum wallboard membrane, $^{5}/_{8}$-inch (16 mm) wood structural panel membrane, or equivalent on the underside of the floor framing member. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

Exceptions:

1. Floor assemblies located directly over a space protected by an automatic sprinkler system in accordance with Section P2904, NFPA 13D, or other approved equivalent sprinkler system.
2. Floor assemblies located directly over a crawl space not intended for storage or for the installation of fuel-fired or electric-powered heating appliances.
3. Portions of floor assemblies shall be permitted to be unprotected where complying with the following:
   - 3.1. The aggregate area of the unprotected portions does not exceed 80 square feet (7.4 m^2) per story.
   - .2. Fireblocking in accordance with Section R302.11.1 is installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.

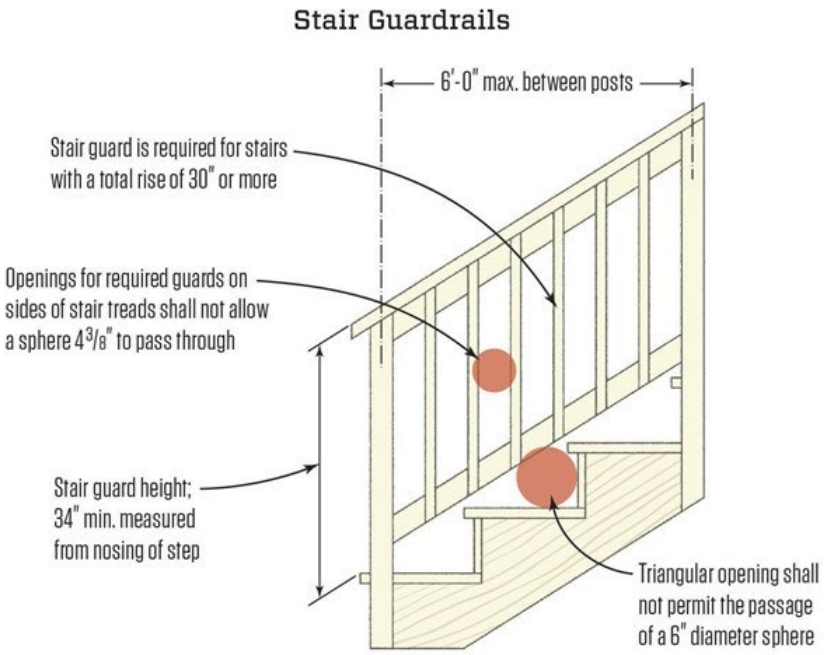
R311.7.3 Vertical Rise

The vertical limit for a flight of stairs between floor levels or landings is 150 inches maximum.



R312.1 Guards

- Height not less than 36”
- Not less than 34” above nose of tread on open side of stairs.
- When serving as a handrail must meet the 34” minimum to 38” maximum rule.
- Openings for a 4” sphere between rails on guards, 4 3/8” on open side of stairs.
- 6” sphere on Triangular section of stair.



R314 Smoke Alarms

No exception

R314.4 Interconnection. Where more than one smoke alarm is required to be installed within an individual dwelling unit in accordance with Section R314.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

R315 Carbon Monoxide Alarms

No exception on interconnection

Site Preparation

- Two basic provisions:
  - Soil characteristics as they relate to the support and stability of foundations
  - Grading to provide surface drainage away from foundations

General Requirements

- Exterior footings
  - Minimum of 12” below the undisturbed ground level
  - Protected against frost

- All footings must bear on:
  - Natural soil; or
  - Compacted engineered fill

Presumptive Load-bearing Values & Properties of Soils

Unified Soil Classification System Symbol	Soil Description	Load Bearing Pressure (psf)	Drainage Characteristics	Frost Heave Potential	Volume Change Potential Expansion
GW	Well-graded gravels, gravel sand mixtures, little or no fines	3000	Good	Low	Low
GP	Poorly graded gravels or gravel sand mixtures, little or no fines	3000	Good	Low	Low
SW	Well-graded sands, gravelly sands, little or no fines	2000	Good	Low	Low
SP	Poorly graded sands or gravelly sands, little or no fines	2000	Good	Low	Low
GM	Silty gravels, gravel-sand-silt mixtures	2000	Good	Medium	Low
SM	Silty sand, sand-silt mixtures	2000	Good	Medium	Low
GC	Clayey gravels, gravel-sand-clay mixtures	2000	Medium	Medium	Low
SC	Clayey sands, sand-clay mixture	2000	Medium	Medium	Low
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	1500	Medium	High	Low
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	1500	Medium	Medium	Medium to Low
CH	Inorganic clays of high plasticity, fat clays	1500	Poor	Medium	High
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	1500	Poor	High	High

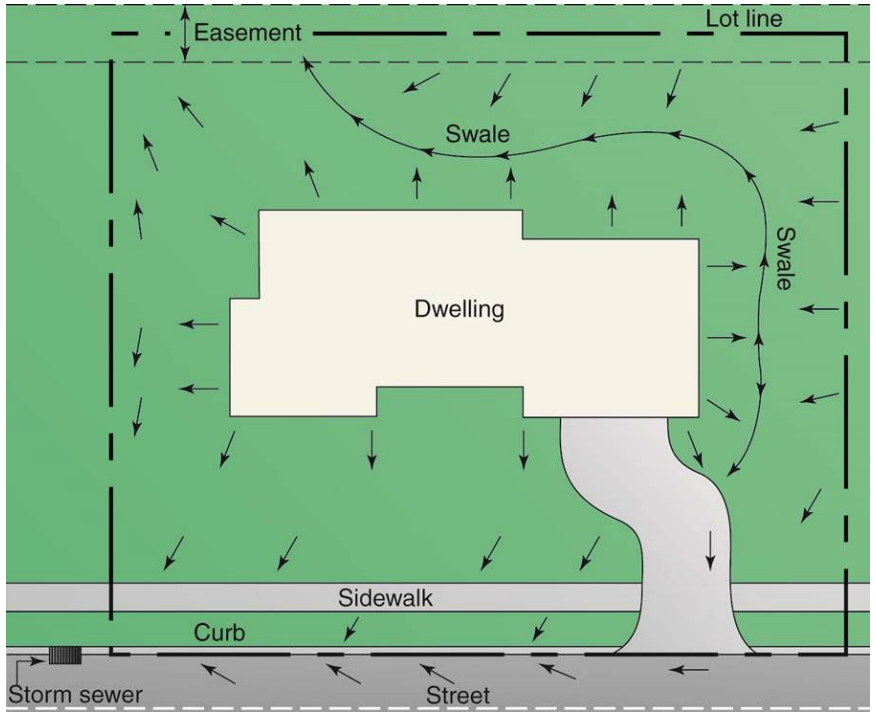
Fill

- Engineered fill is required for:
  - Over-excavation to remove unsuitable soils
  - Additional material to raise the elevation of the footings above the existing undisturbed soil

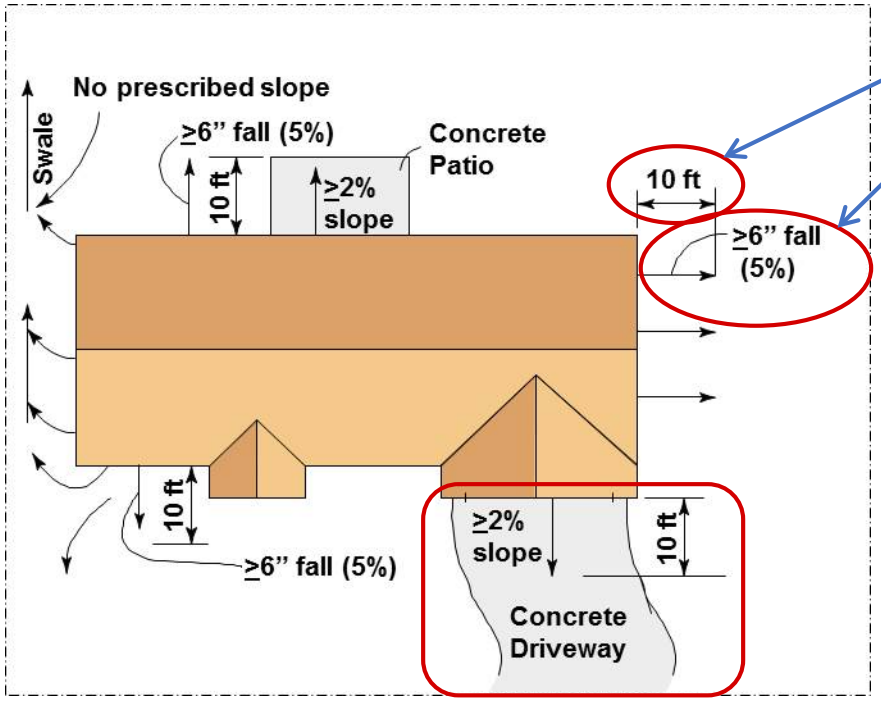
- Engineered fill must be:
  - Designed by a registered design professional
  - Installed as specified in design requirements
  - Tested as specified in design requirements

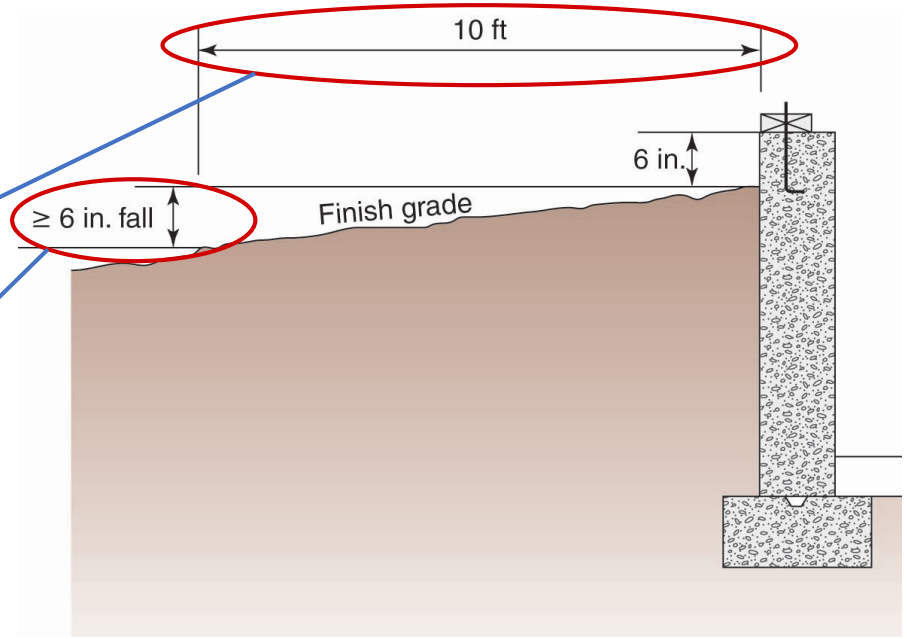
Storm Drainage

- Final grade
  - Minimum fall 6” within 10’ of foundation
  - Exception for local site conditions
    - Water can be directed to swales or drains
  - Concrete surfaces within 10’ of the foundation need 2% slope



Storm Drainage





R324.6.2.2 Solar Panels Near Emergency Escape and Rescue Openings

Rooftop mounted photovoltaic solar energy panels and modules are not permitted to be installed below emergency escape and rescue openings

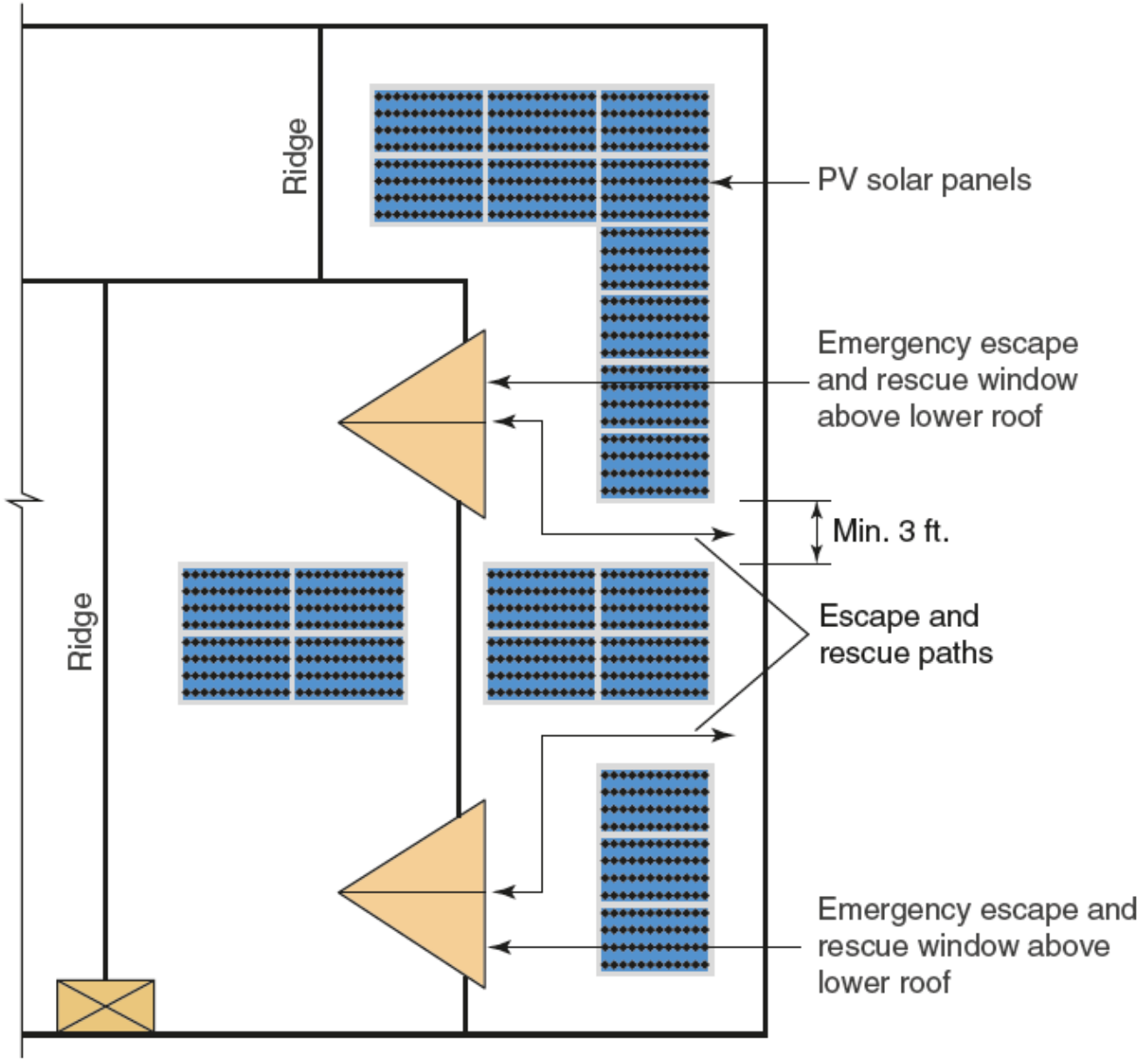


Table R301.2(1)
Climatic and Geographic Design Criteria

- IRC adoption: jurisdiction completes table with data applicable to the jurisdiction – for example:

Ground Snow Load	Wind Design				Seismic Design Category
	Speed (mph) V_{ult}	Topographic Effects	Special Wind Region	Wind-borne Debris Zone	
30 psf	115 mph	Yes or No	Yes or No	Identify or No	B

Table R301.2(1) (Continued)
Climatic and Geographic Design Criteria

- IRC adoption: jurisdiction completes table with data applicable to the jurisdiction – for example:

Subject to Damage from			Ice Barrier Underlayment Required
Weathering	Frost Line Depth	Termite	
Negligible or Moderate or Severe	42 in.	Yes or No	Yes or No

Table R301.2(1) (Continued)
Climatic and Geographic Design Criteria

Winter Design Temp	Flood Hazards	Air Freezing Index	Mean Annual Temp
2° F	Date NFIP, Etc.	1197	51° F

Prescriptive and Performance

- Prescriptive requirements
  - A specific set of rules to follow
- Performance requirements
  - Expectation that the system will function in a certain way
  - For structural requirements, performance is achieved through engineering

Prescriptive and Performance

- Conventional construction
  - Engineered design can be used for structural elements that:
    - Exceed the limits in the code; or
    - Are not included in the code
- Alternative to wood framing provisions
  - Wood Frame Construction Manual published by the American Wood Council
    - WFCM addresses wind speeds up to 150 mph
    - IRC wind speeds are less than 110 mph

For example, the sizing of wide flange steel beams

Live Loads

IRC Table R301.5

Minimum Uniformly Distributed Live Loads

USE	LIVE LOAD (psf)
Uninhabitable attics without storage	10
Uninhabitable attics with limited storage	20
Habitable attics and attics served with fixed stairs	30
Balconies (exterior) and decks	40
Fire escapes	40
Rooms other than sleeping rooms	40
Sleeping rooms	30

Live Loads (Continued)

IRC Table R301.5

Minimum Uniformly Distributed Live Loads

USE	LIVE LOAD (psf)	
Guardrails and handrails	200	Single concentrated load applied in any direction along the top.
Guardrail in-fill components	50	Horizontally applied normal load of 50 lb. on area of 1 sq. ft.
Passenger vehicle garages	50	2,000-lb concentrated load / 20-sq. in. area.
Stairs	40	300-lb concentrated load / 4 sq. in. of tread

Dead Loads

- Average dead loads are included in the prescriptive tables for:
  - Footings
  - Floors
  - Walls
  - Roofs

For example, spread footing sizes for conventional frame construction assume average weights for the construction materials being supported

Deflection

- Allowable deflection in structural framing members:
  - Studs
  - Joists
  - Beams
  - Rafters
- Table R301.7
  - L = span length
  - H = span height

Structural Member	Allowable Deflection
Rafters having slopes greater than 3:12 with no finished ceiling attached to rafters	*L*/180
Interior walls and partitions	*H*/180
Floors/ceilings with plaster or stucco finish	*L*/360
All other structural members	*L*/240
Exterior walls—wind loads with plaster or stucco finish	*H*/360
Exterior walls with other brittle finishes	*H*/240
Exterior walls with flexible finishes	*H*/120
Lintels supporting masonry veneer walls	*L*/600

Example 4-1 Floor Joist Deflection

- Floor joist span is 14’
- Allowable deflection from Table R301.7 is L/360

L = 14’ x 12” = 168”

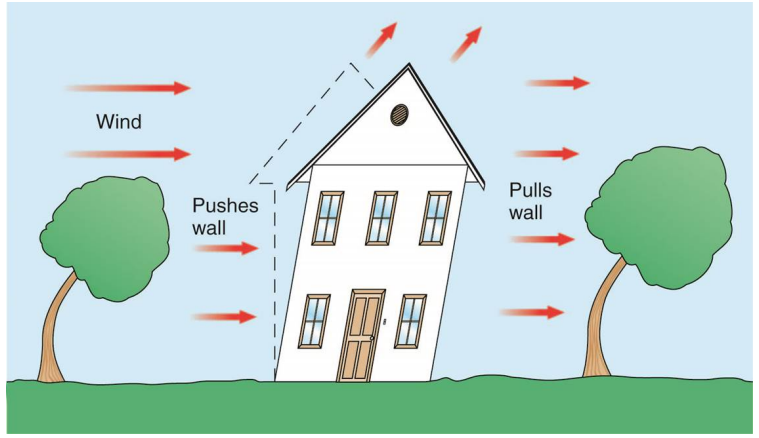
168 ÷ 360 = 0.47

Allowable deflection is 0.47”

Note: a 14’ span rafter with 4:12 slope and no ceiling attached has an allowable deflection of L/180, which is twice the deflection allowed for floor joists

Wind Loads

- Wind forces acting on buildings
  - IRC conventional framing limits wind speed to 140 mph V_{ult} (130 in hurricane prone areas)
  - AWC – *Wood Framing Construction Manual* (WFCM)
  - ICC 600 – *Standard for Residential Construction in High-Wind Regions*
  - ICC – *International Building Code*
  - ASCE 7 – *Minimum Design Loads for Buildings and Other Structures*



Wind Exposure Category

- Exposure B
  - Some wind protection with trees and buildings
  - Default
- Exposure C
  - Open terrain with scattered obstructions
- Exposure D
  - Flat, unobstructed areas exposed to open water, smooth mud flats, salt flats and unbroken ice for ≥ 5,000 ft

Wind exposure B

Wind exposure C

Hurricane-prone regions

- **Hurricane-prone regions.** Areas vulnerable to hurricanes, defined as the U.S. Atlantic Ocean and Gulf of Mexico coasts where the ultimate design wind speed, Vult, is greater than 115 miles per hour , and Hawaii, Puerto Rico, Guam, Virgin Islands and America Samoa.
- **Windborne debris region.** Areas within hurricane-prone regions located in accordance with one of the following:
  - 1. Within 1 mile of the coastal mean high water line where the ultimate design wind speed, Vult, is 130 mph or greater.
  - 2. In areas where the ultimate design wind speed, Vult, is 140 mph or greater; or Hawaii.

Snow Loads

- Snow loads must be considered where applicable
- IRC and WFCM conventional framing tables are limited to snow load <70 psf

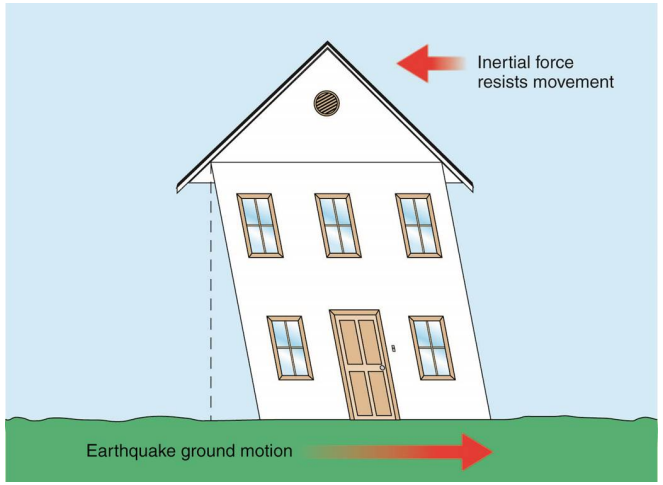
Earthquakes

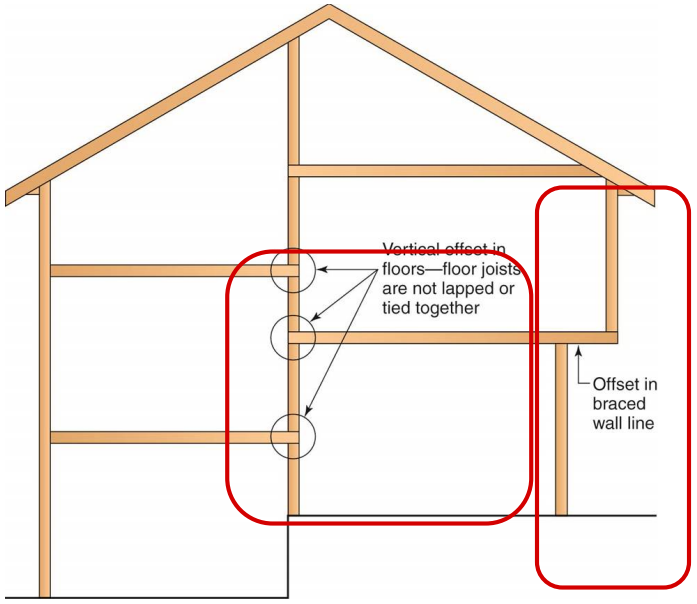
- The IRC assigns a Seismic Design Category to building sites relative to the anticipated intensity and frequency of earthquakes
- Prescriptive provisions of the IRC are adequate for SDC A and B

Seismic Design Category	1- and 2-Family Dwellings	Townhouses
A & B	No seismic requirements	No seismic requirements
C	No seismic requirements	Seismic Requirements Apply
D_0, D_1, D_2	Seismic Requirements Apply	
E	Engineered Design Required	

Earthquakes

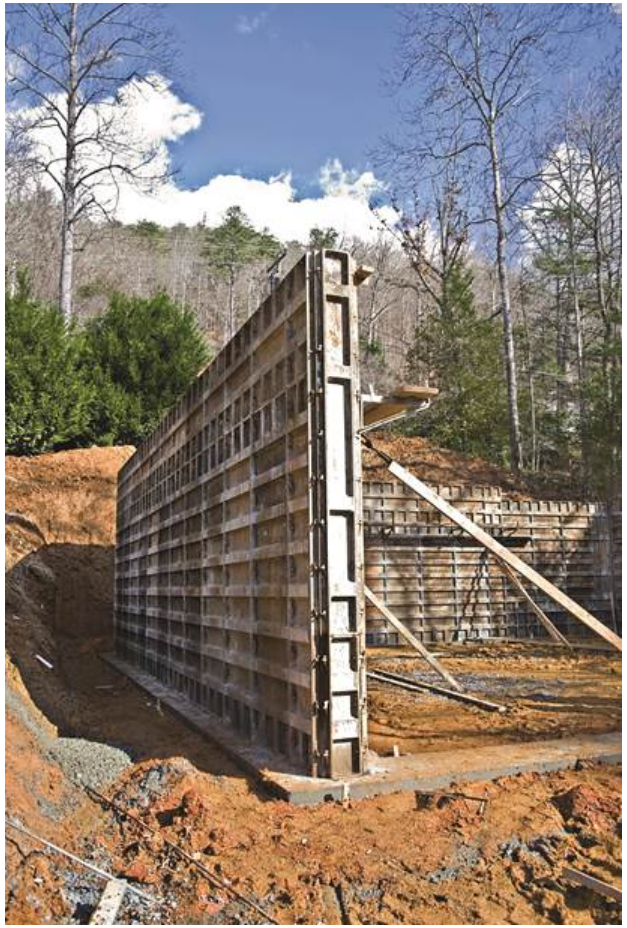
- Regularly shaped buildings
  - Uniform distribution of forces
  - More predictable response characteristics
- Irregularly shaped buildings
  - Force concentrations
  - Generally less effective in resisting earthquake load effects



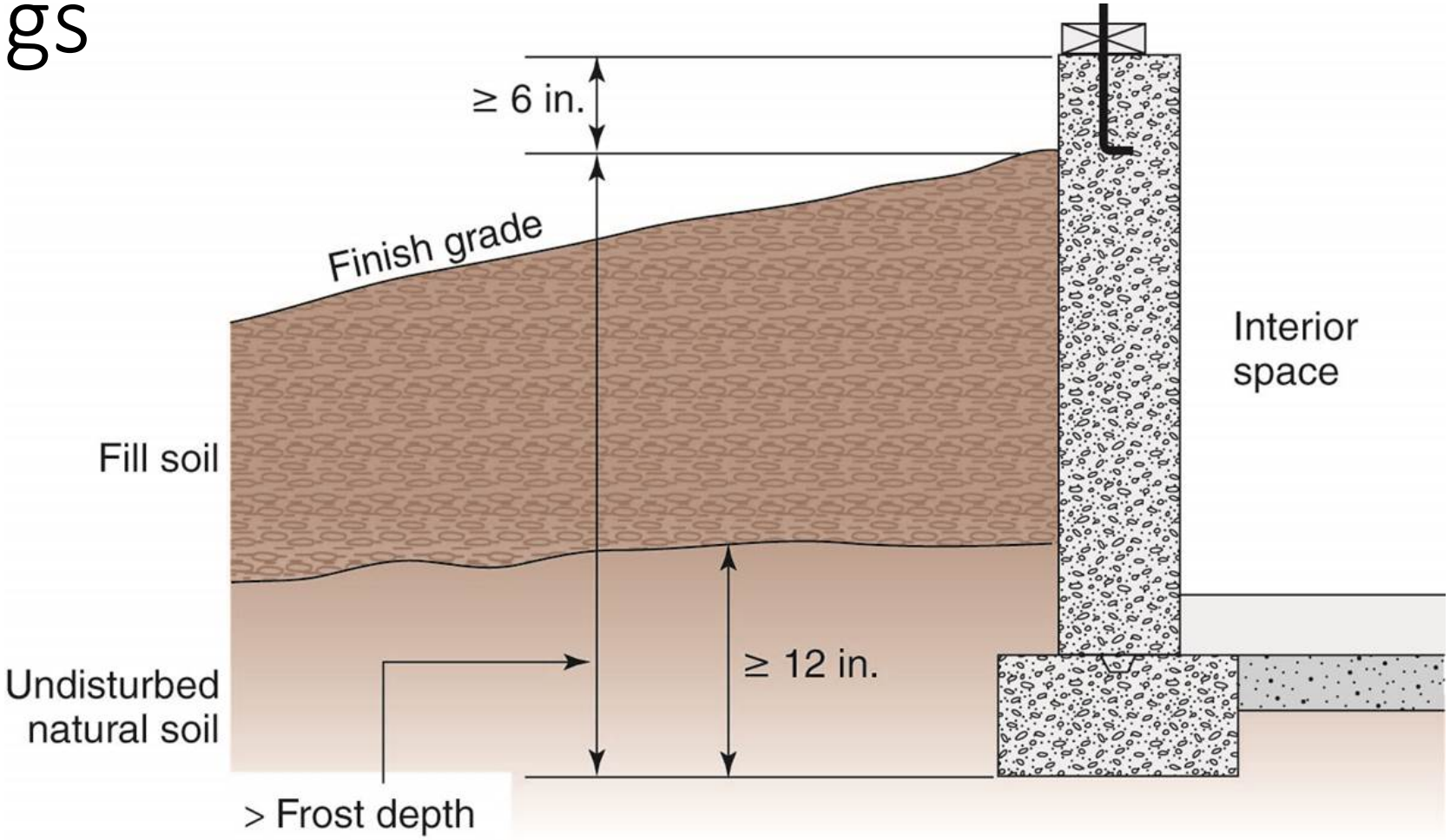


Foundation Materials

- Concrete
  - Removable forms
  - Stay-in-place insulating concrete forms (ICF)
- Precast concrete
- Masonry
- Wood
- Engineered or alternative designs



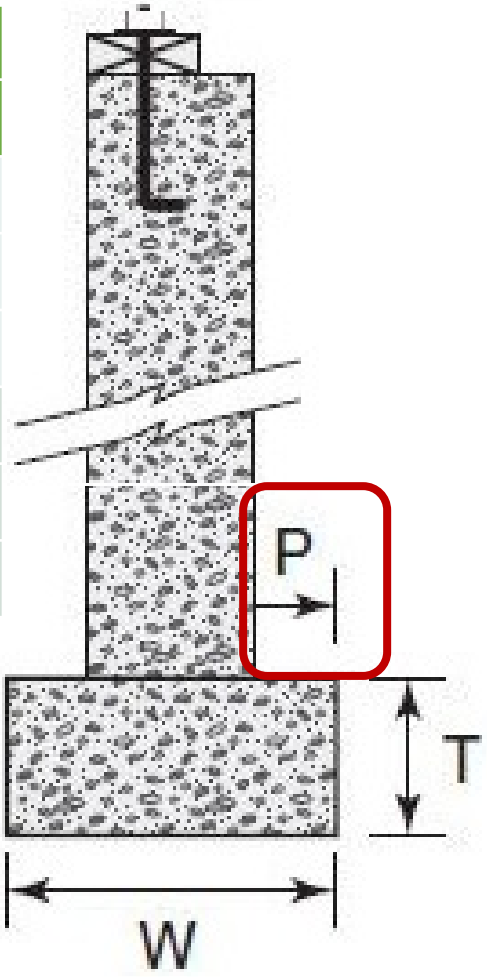
Footings


≥ 6 in.
Finish grade
Fill soil
Undisturbed
natural soil
≥ 12 in.
> Frost depth
Interior
space

Size of Concrete Footings

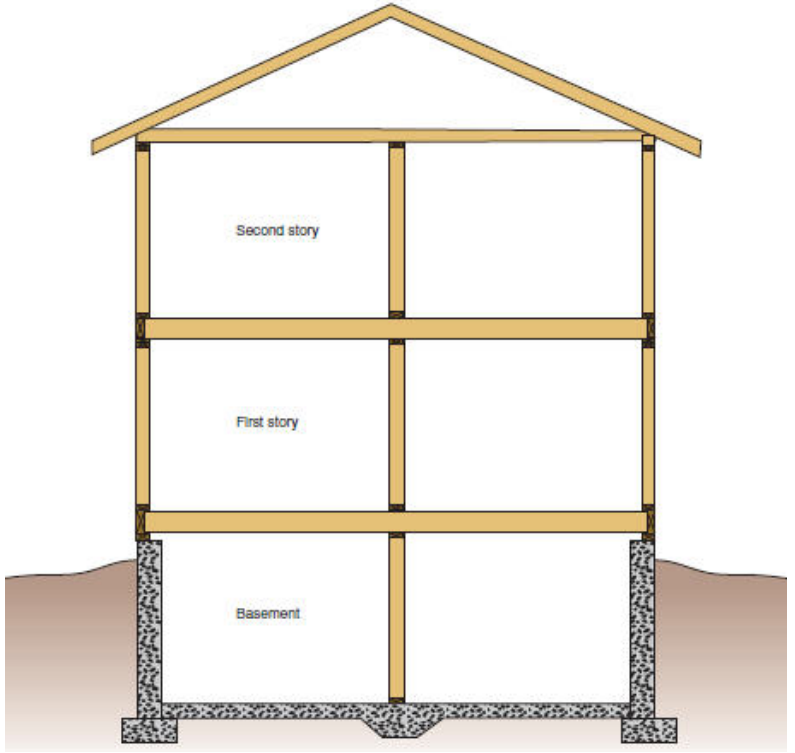
Conventional Light-Frame Construction				
Snow load	Type of foundation	Load bearing value of soil		
30 psf		1,500	2,000	2,500
1-story	Slab-on-grade	12 x 6	12 x 6	12 x 6
	With crawl space	13 x 6	12 x 6	12 x 6
	Plus basement	19 x 6	14 x 6	12 x 6
2-story	Slab-on-grade	12 x 6	12 x 6	12 x 6
	With crawl space	17 x 6	13 x 6	12 x 6
	Plus basement	23 x 6	17 x 6	14 x 6

Projection “P” ≥ 2 in. and ≤ T
Thickness “T” ≥ 6 in.
Width “W” per table



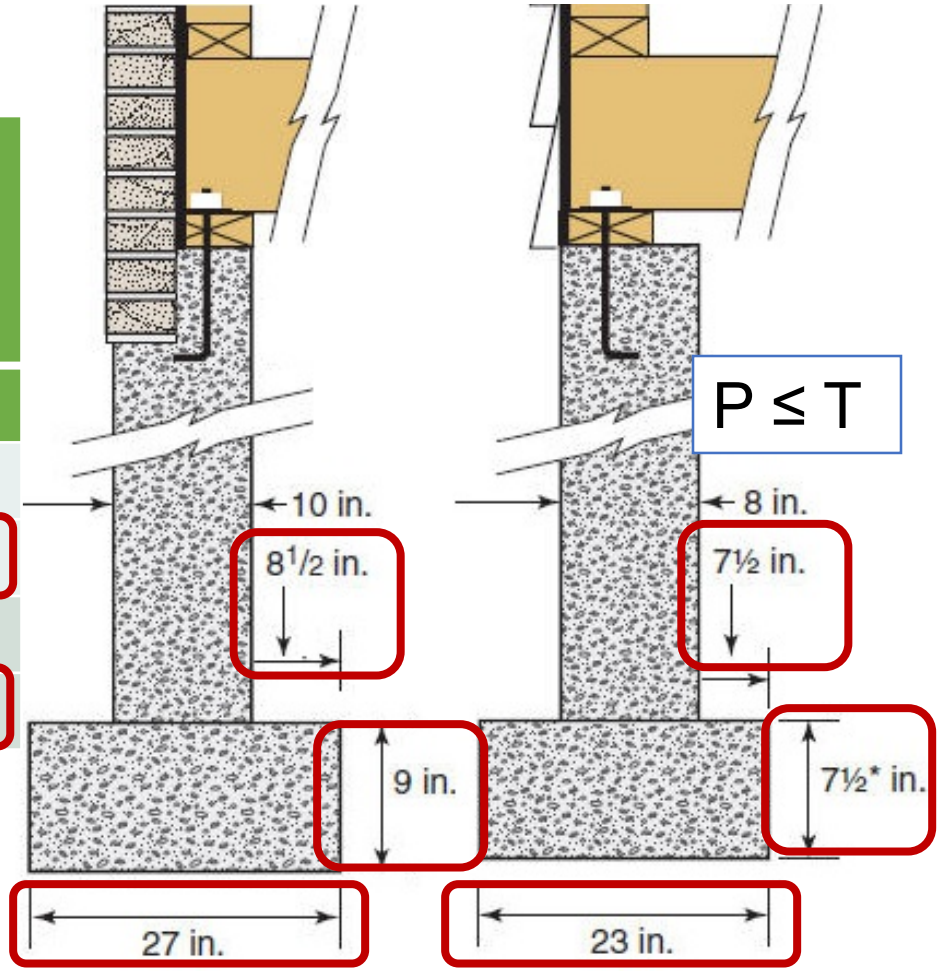
Example 5-1
Footing Size

- Determine minimum width (W), projection (P) and thickness (T) of a continuous spread footing
- Given:
  - 2-story dwelling with basement
  - 1500 psf assumed soil bearing capacity
  - 30 psf snow load
  - Conventional construction:
    a) Light-frame construction with siding
    b) Light-frame construction with brick veneer



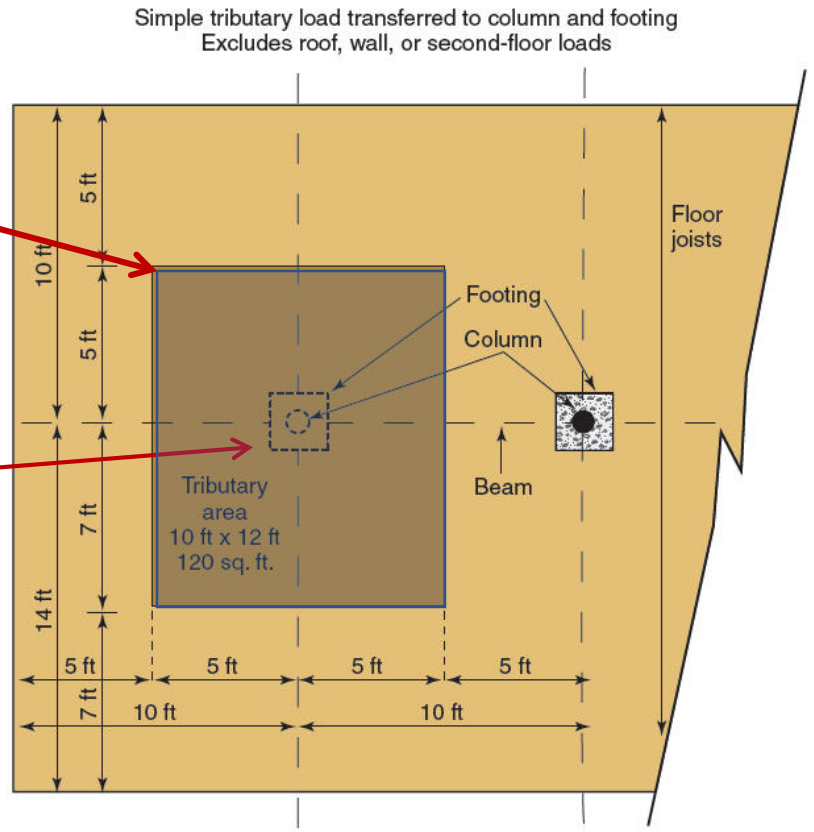
Example 5-1
Footing Size

Snow load	Type of foundation	Load bearing value of soil
30 psf		1,500
Conventional Light-Frame Construction		
2-story	Plus basement	23 x 6
With Brick Veneer		
2-story	Plus basement	27 x 9



Example 5-2
Isolated Footing Size

- Given:
  - Column supports tributary floor area of 120 ft^2 at 50 psf
  - 1,500 psf assumed soil-bearing capacity
- Determine minimum footing size

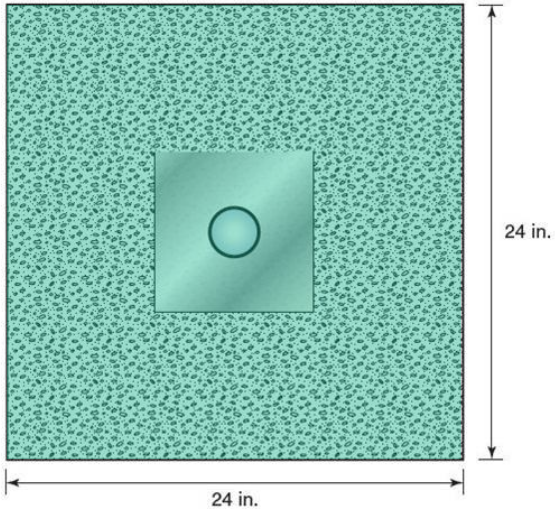


Example 5-2
Isolated Footing Size

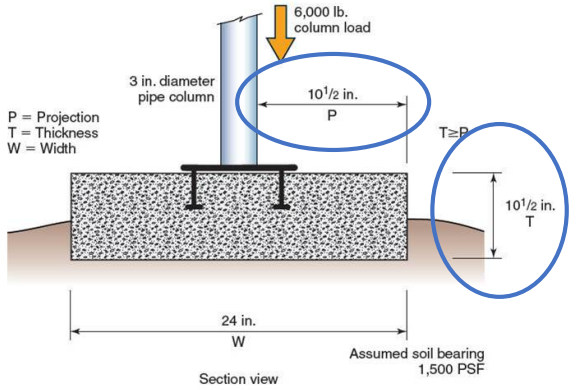
- Soil load-bearing capacity
  - 1500 psf
- Tributary column load
  - 120 ft^2 x 50 lbs. = 6,000 lbs.

$$6{,}000 \text{ lbs.} \div 1{,}500 \text{ psf} = 4 \text{ ft}^2$$

- Thickness (T) Min. 6”
- Projection (P) cannot exceed footing thickness



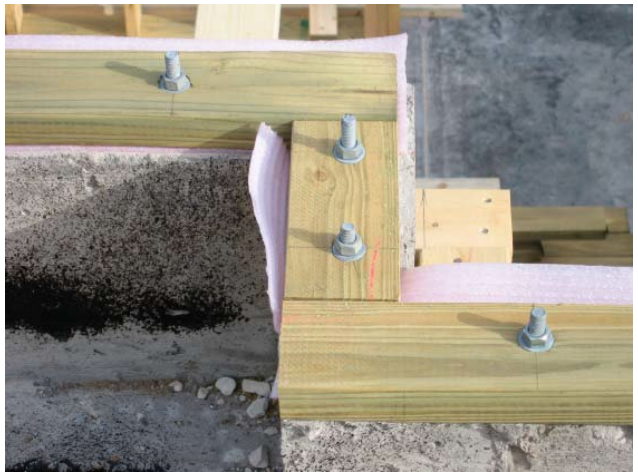
Plan view

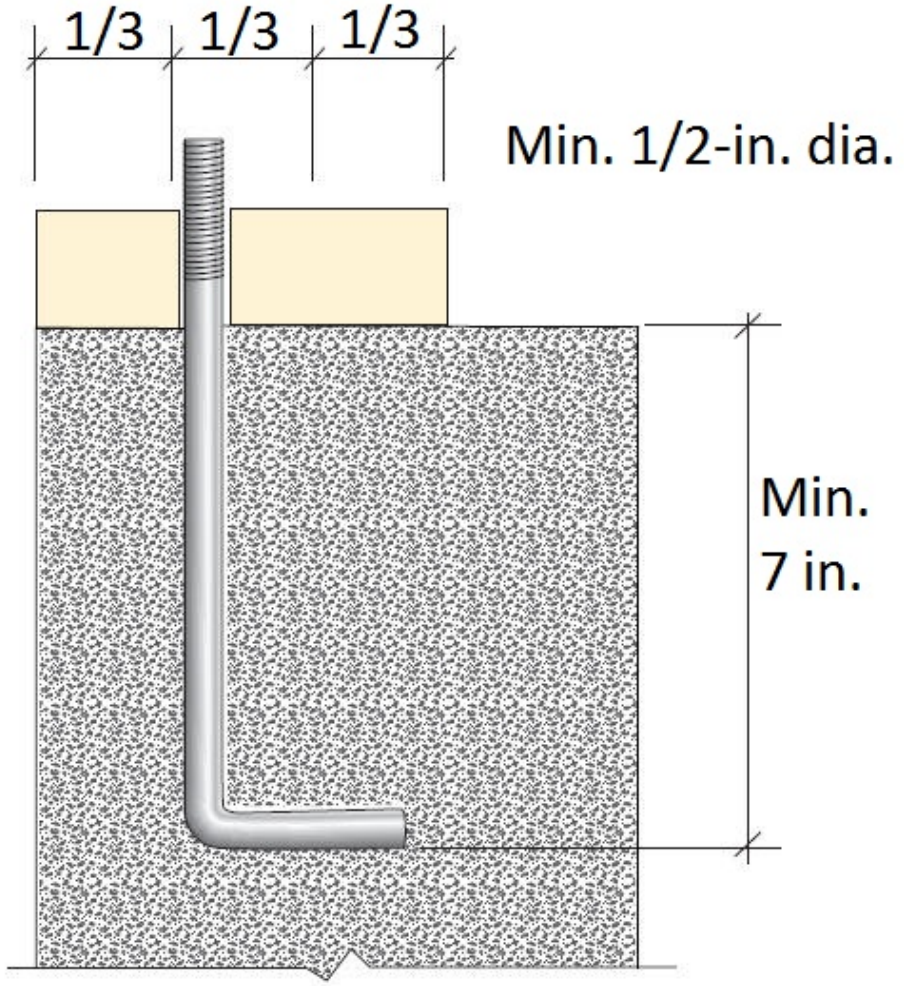


Section view

Foundation Anchorage

- Anchor bolts
  - ½-inch diameter
  - 7-inch embedment
  - Middle 1/3 of plate



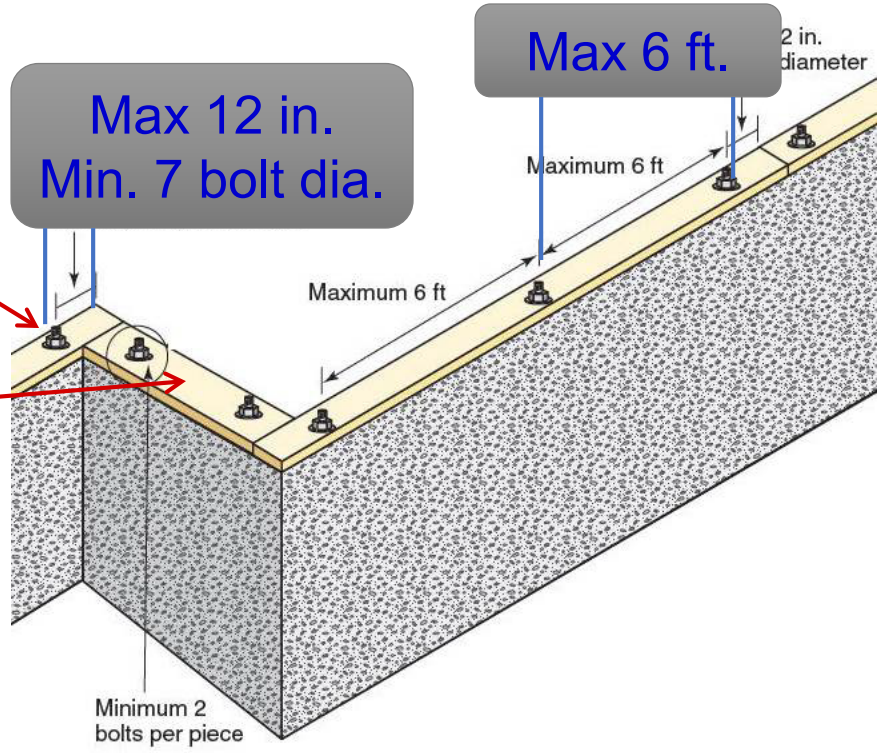


Foundation Anchorage

- Wood sill plate anchorage to foundation for
  - Dwellings and townhouses in SDC “A” and “B”
  - Dwellings in SDC “C”

Standard washer and nut on each bolt

Note: Offsets ≤ 24” require only one anchor bolt in center third of plate

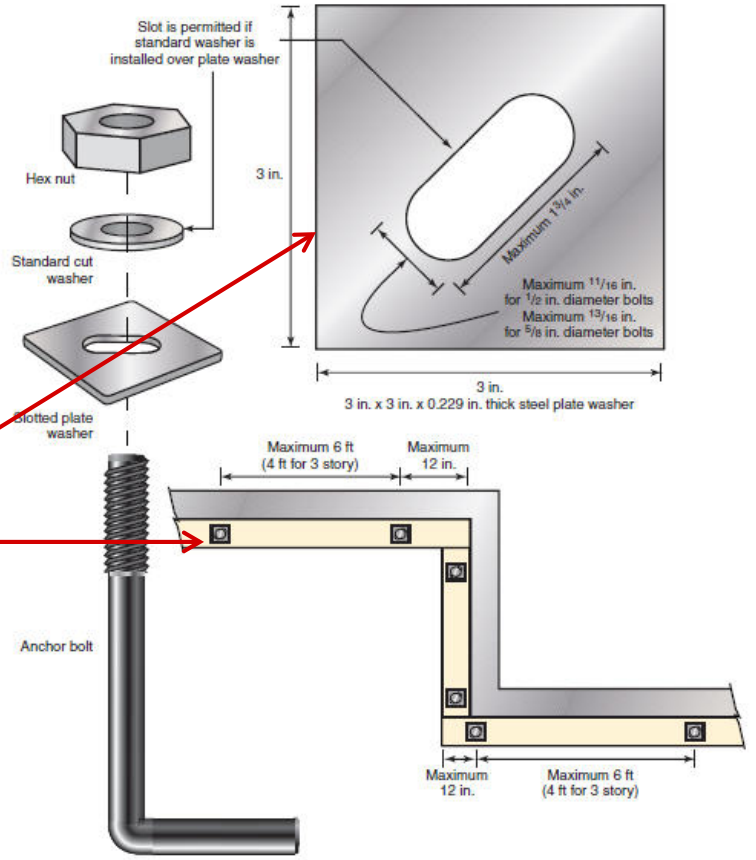


Foundation Anchorage

- Wood sill plate anchorage Seismic
  - Dwellings and townhouses in SDC D_0, D_1 and D_2
  - Townhouses in SDC C

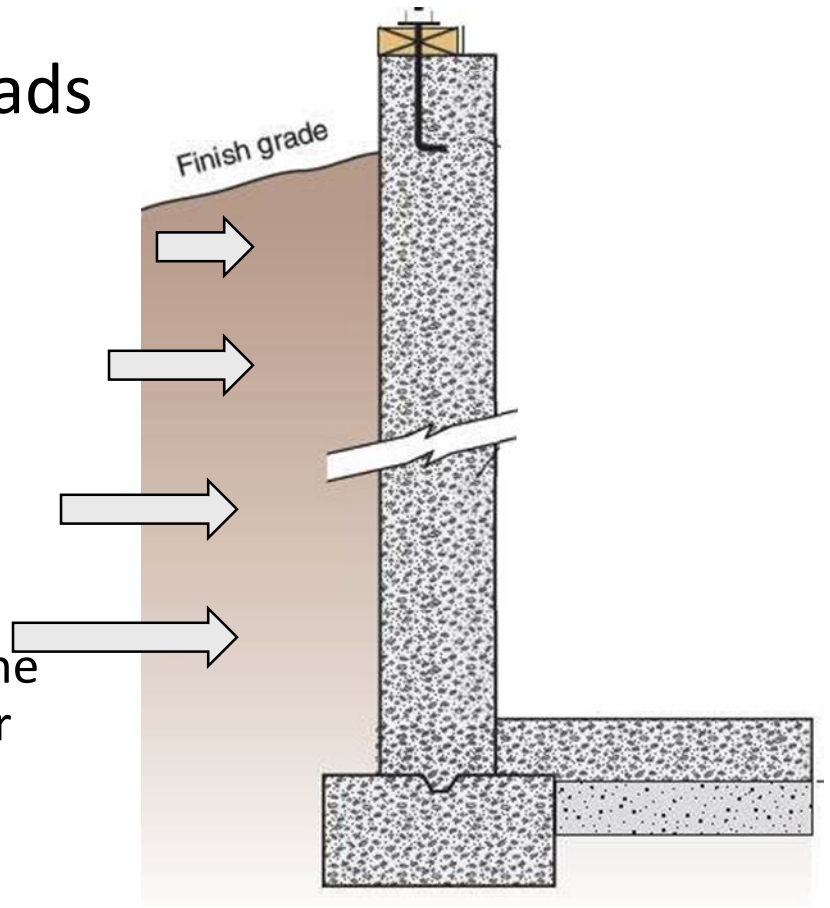
3” x 3” plate washers approximately ¼” thick

Bolt spacing ≤ 4’ for anchorage of 3-story buildings



Concrete Foundation Walls

- Foundation walls must be constructed to resist lateral loads
- Thickness and vertical reinforcement determined by:
  - Soil type
  - Height of foundation
  - Height of unbalanced backfill
    - Difference in height between the exterior finish ground level and the top of the interior basement floor



Concrete Foundation Walls

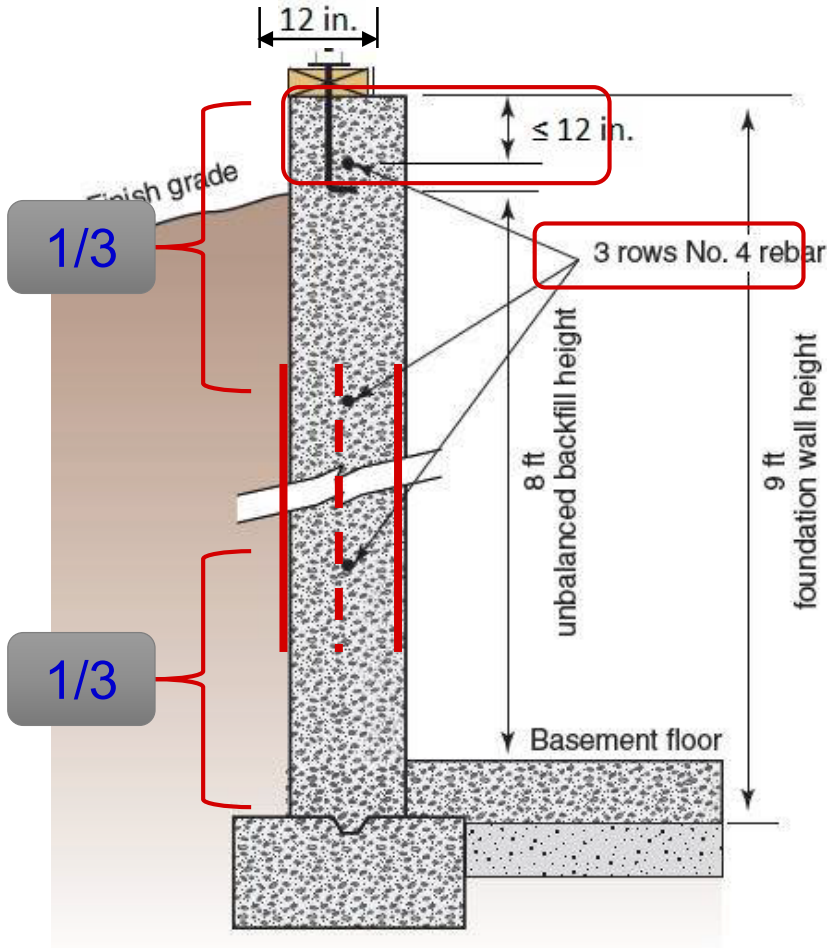
- Horizontal reinforcing required for basement walls
  - Table R404.1.2(1)

Maximum Unsupported Height of Basement Wall	Location of Horizontal Reinforcement
≤8 feet	One No. 4 bar within 12” of the top of the wall and one No. 4 bar near mid-height of the wall story
>8 feet	One No. 4 bar within 12” of the top of the wall and one No. 4 bar near third points the wall story

- Vertical reinforcing required
  - Tables R404.1.2(2) through R404.1.2(9)

Horizontal Reinforcing in Concrete Basement Wall

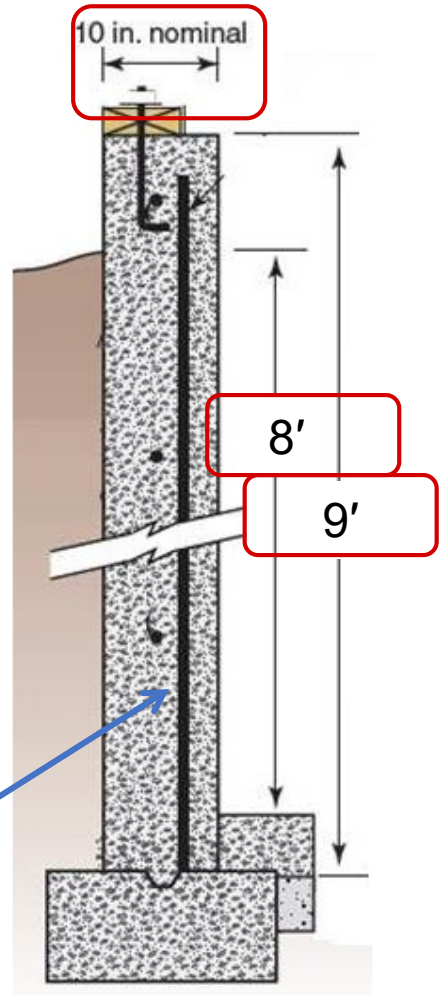
- Table R404.1.2(1)
  - 3 horizontal No. 4 bars
  - One bar within 12” of top
  - Other bars at third points
  - Bars located in center of wall



Vertical Reinforcing in Concrete Basement Wall

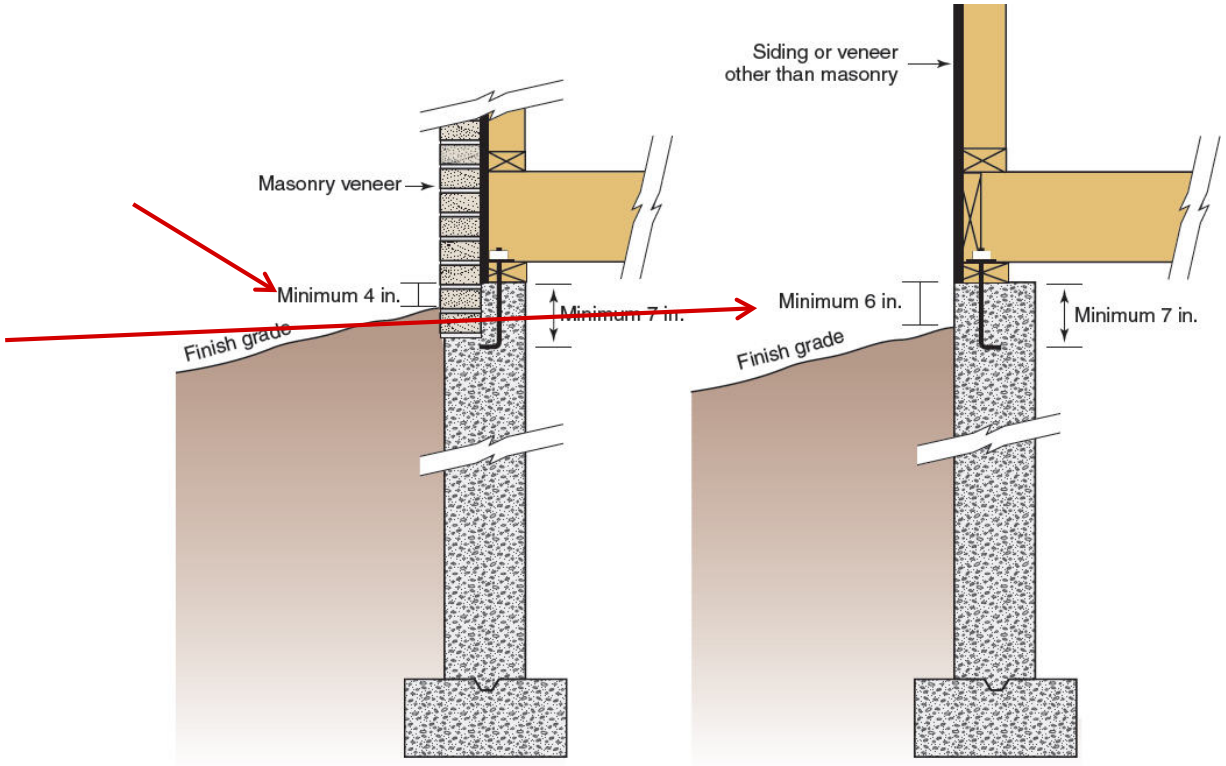
- Soil class = CL inorganic sandy clay
- 10″ nominal thickness
- Wall height = 9′
- Unbalanced backfill height = 8′
- Table R404.1.2(8) Vertical Reinforcement
  - No. 6 bars at 39 inches on center

Wall Hgt.	Unbal. backfill	Soil class			
		SC, ML-CL and inorganic CL			
		6″	8″	10″	12″
	6	6 @ 36	6 @ 39	NR	NR
9	7	6 @ 33	6 @ 38	5 @ 37	NR
	8	6 @ 24	6 @ 29	6 @ 39	4 @ 48



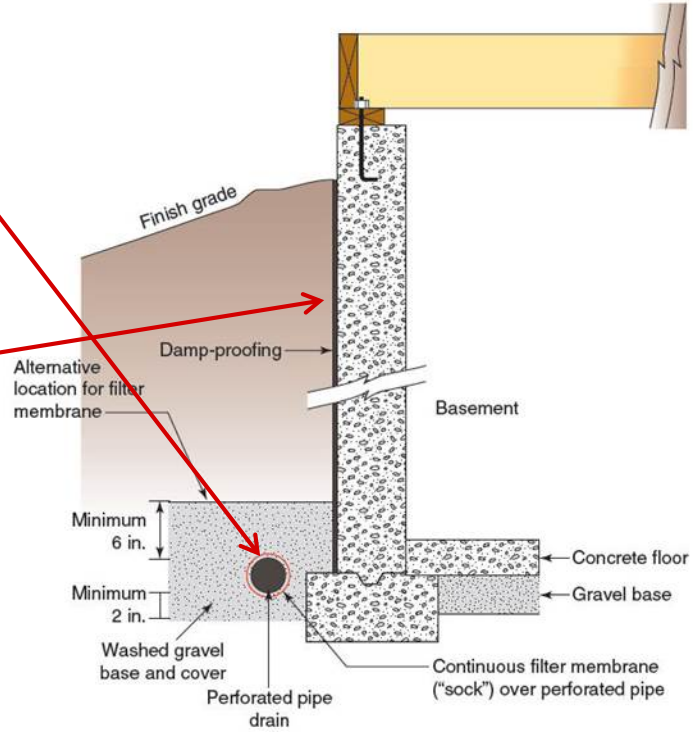
Height Above Finished Grade

- Concrete and masonry foundation walls must extend above the finished grade adjacent to the foundation
  - Minimum of 4” with masonry veneer
  - Minimum of 6” elsewhere



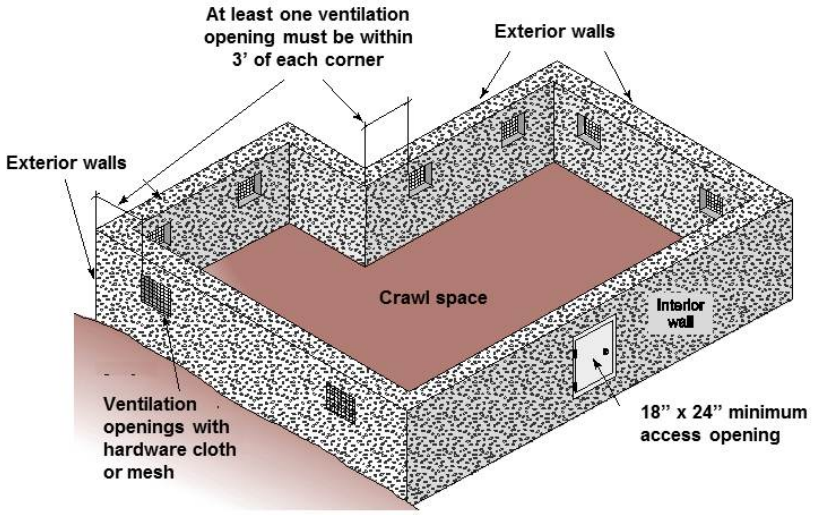
Moisture Protection

- Drainage by perforated pipe or other approved drain system
  - Installed at or below the level of the basement or crawl space floor
  - Exception for areas with well-drained soils
- Dampproofing materials applied to the exterior of the foundation
- Waterproofing in areas with a high water table or other known severe soil-water conditions
  - Flexible sealants or other impervious material



Underfloor Space

- Ventilation of crawl space required
  - Circulate air
  - Dissipate condensation
- Method of ventilation
  - Foundation openings
  - Mechanical exhaust ventilation
  - Connection to the conditioned air supply of the dwelling
- Access to underfloor spaces
  - 18” x 24” through floor
  - 16” x 24” through perimeter wall



Framing

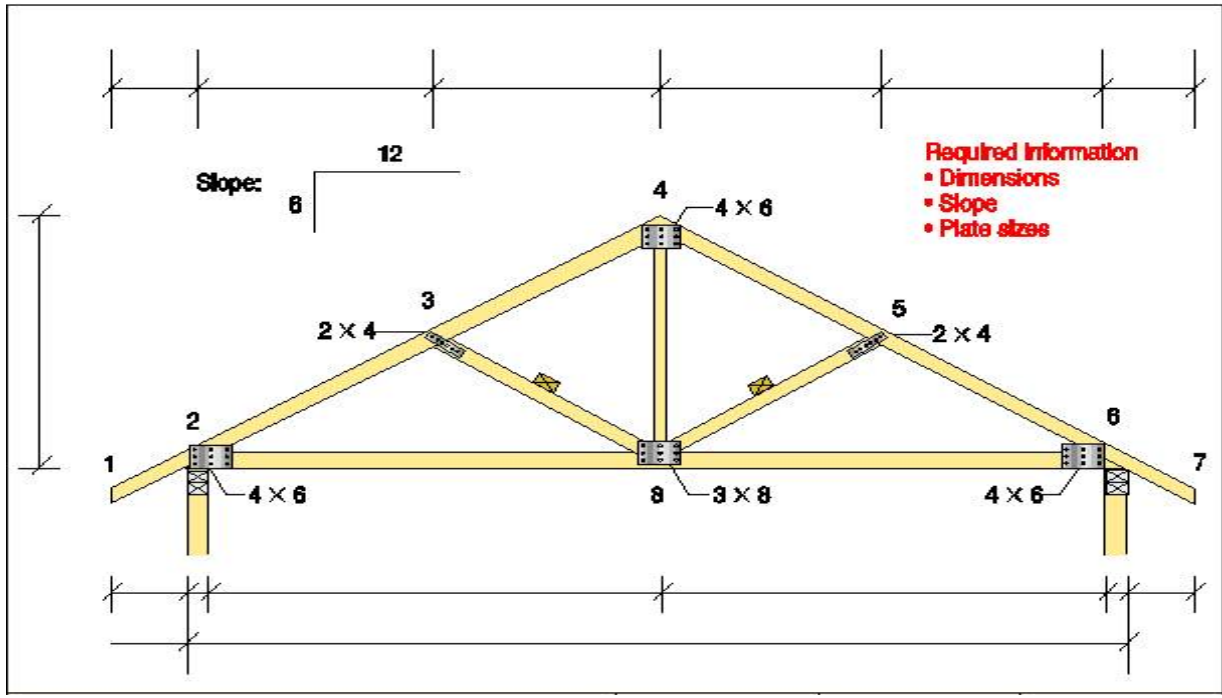
- Light-frame construction
  - Wood or cold-formed steel
- Grade mark on wood products
  - Wood structural panels
  - Load-bearing dimension lumber

Engineered Wood Products

- Plate-connected open web trusses
- I-joists
- Glued-laminated lumber
- Laminated veneer lumber (LVL)
- Other structural composite lumber (SCL)

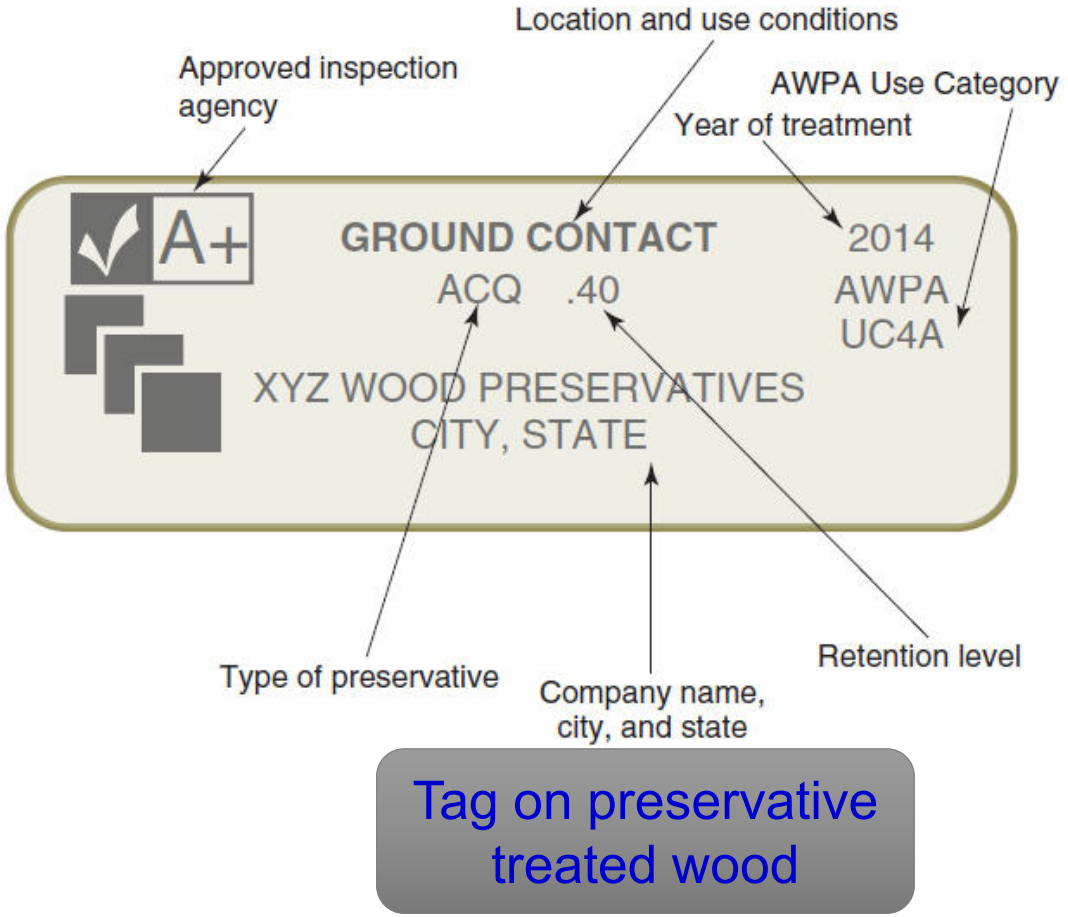
Wood Trusses

- Design submitted to building official for approval
- Include:
  - Design loads
  - Slope or depth, span and spacing
  - Required bearing widths
  - Lumber size, species and grade
  - Connection requirements
  - Required permanent bracing location
  - Other information

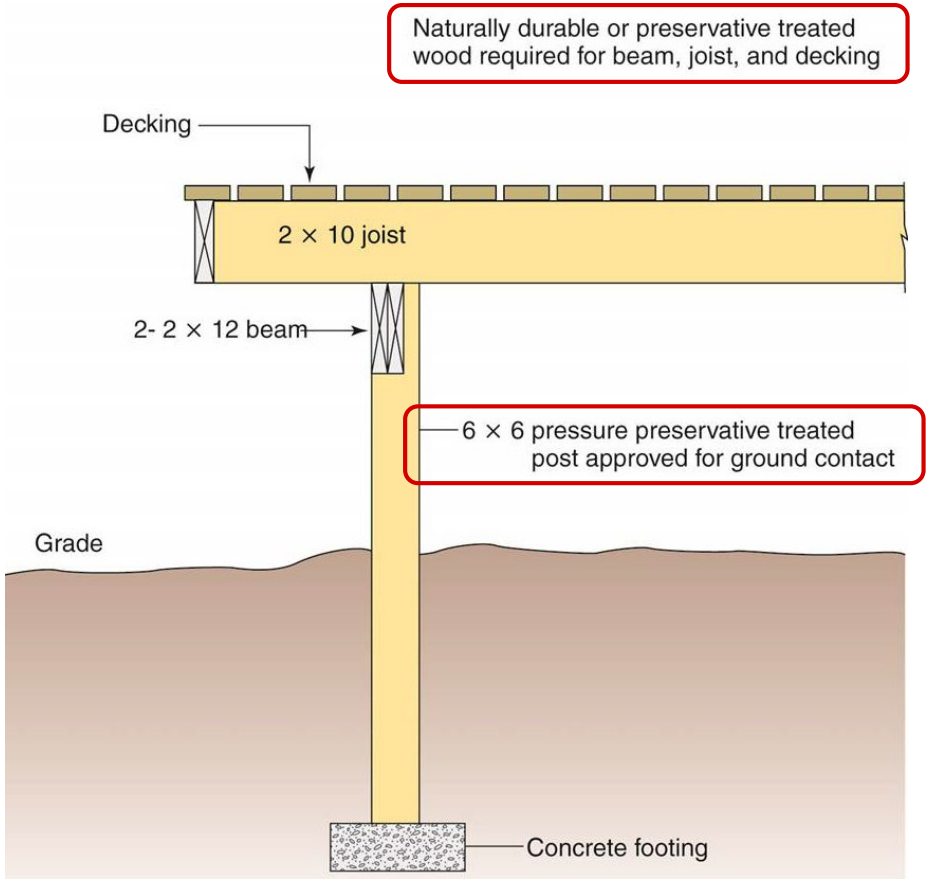


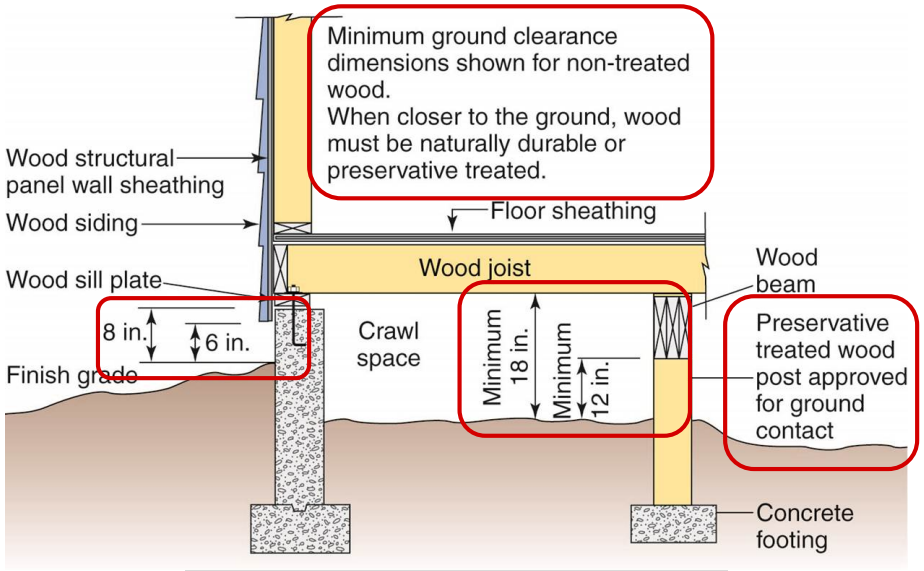
Wood Treatment

- Wood in locations subject to decay requires:
  - Wood treated with preservative or
  - Naturally durable wood
    - Redwood
    - Cedar
    - Black locust
    - Black walnut



Protection Against Decay

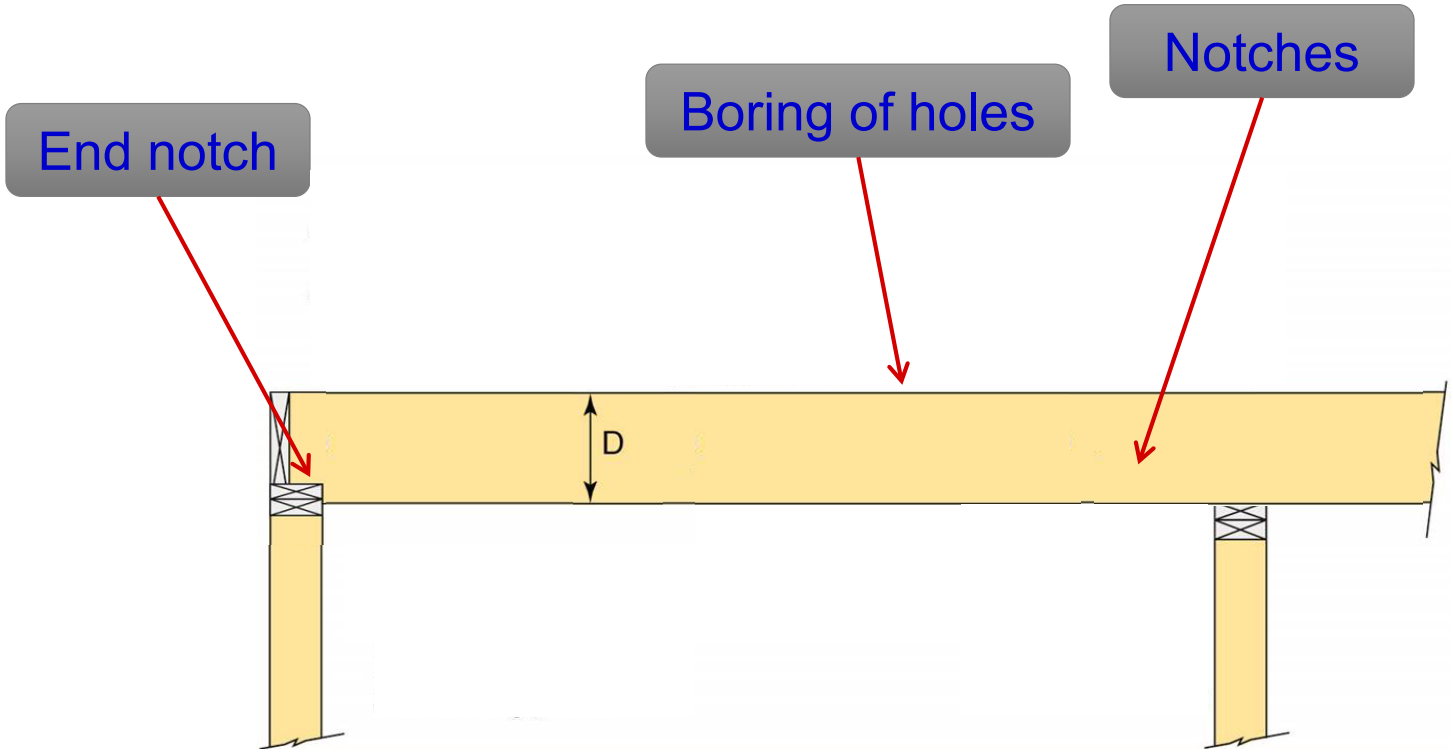




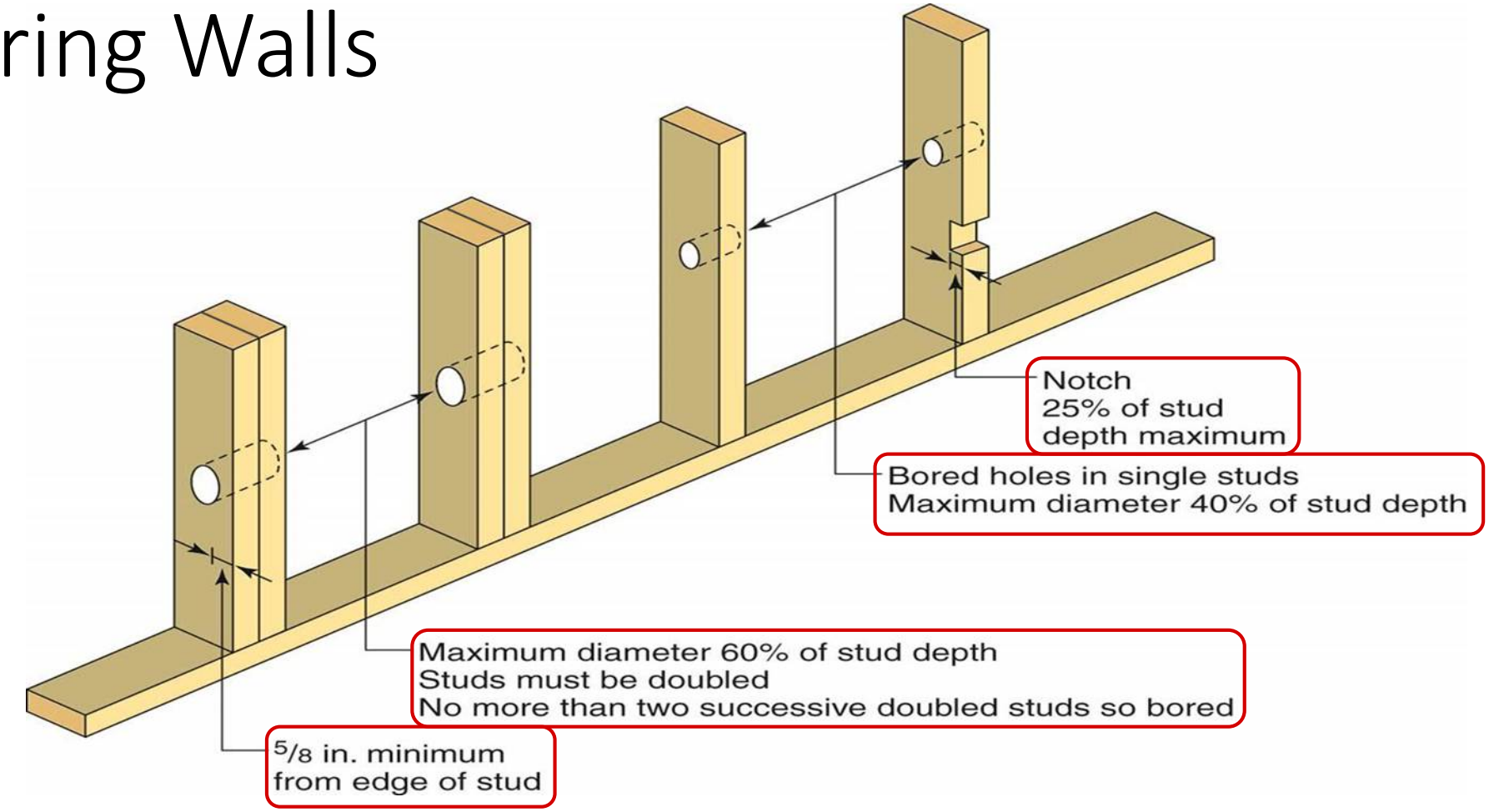
Clearance above grade

Boring and Notching
Floor and Ceiling Joists

- Boring holes and notching of solid sawn beams, floor joists and ceiling joists

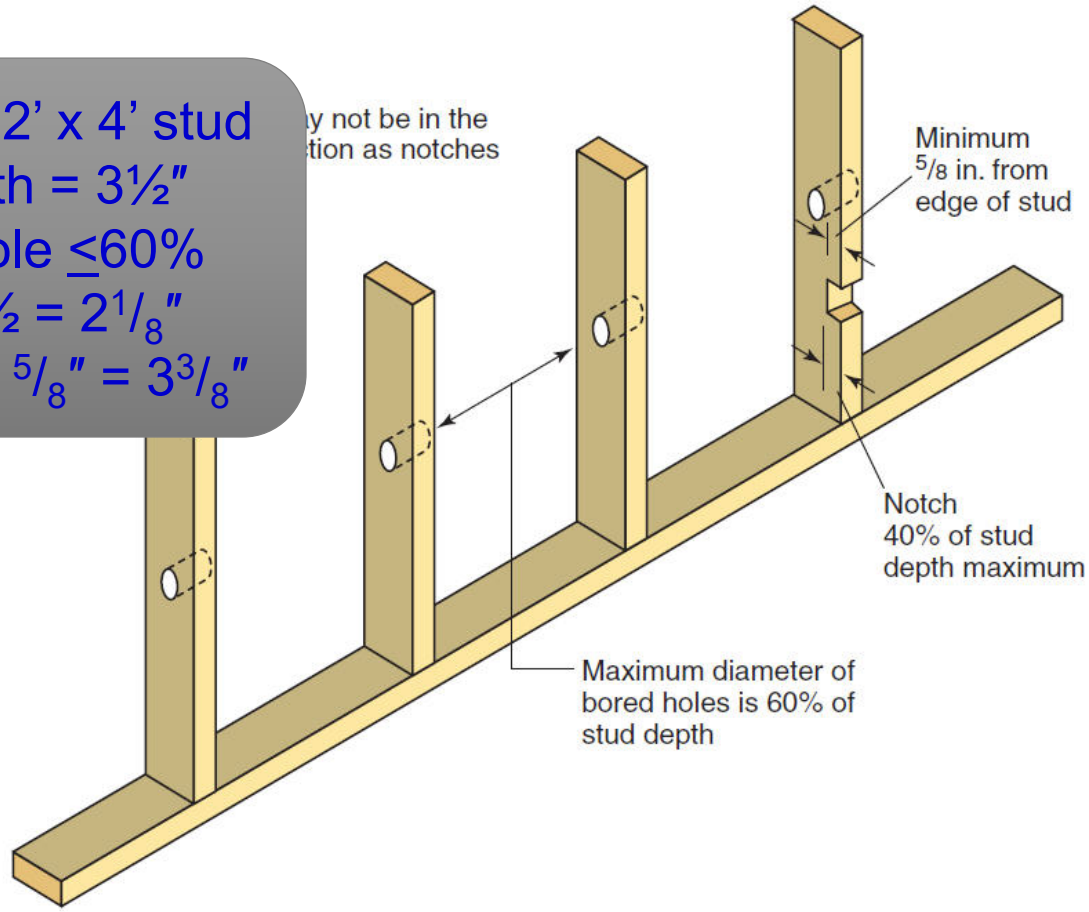


Boring and Notching Bearing Walls

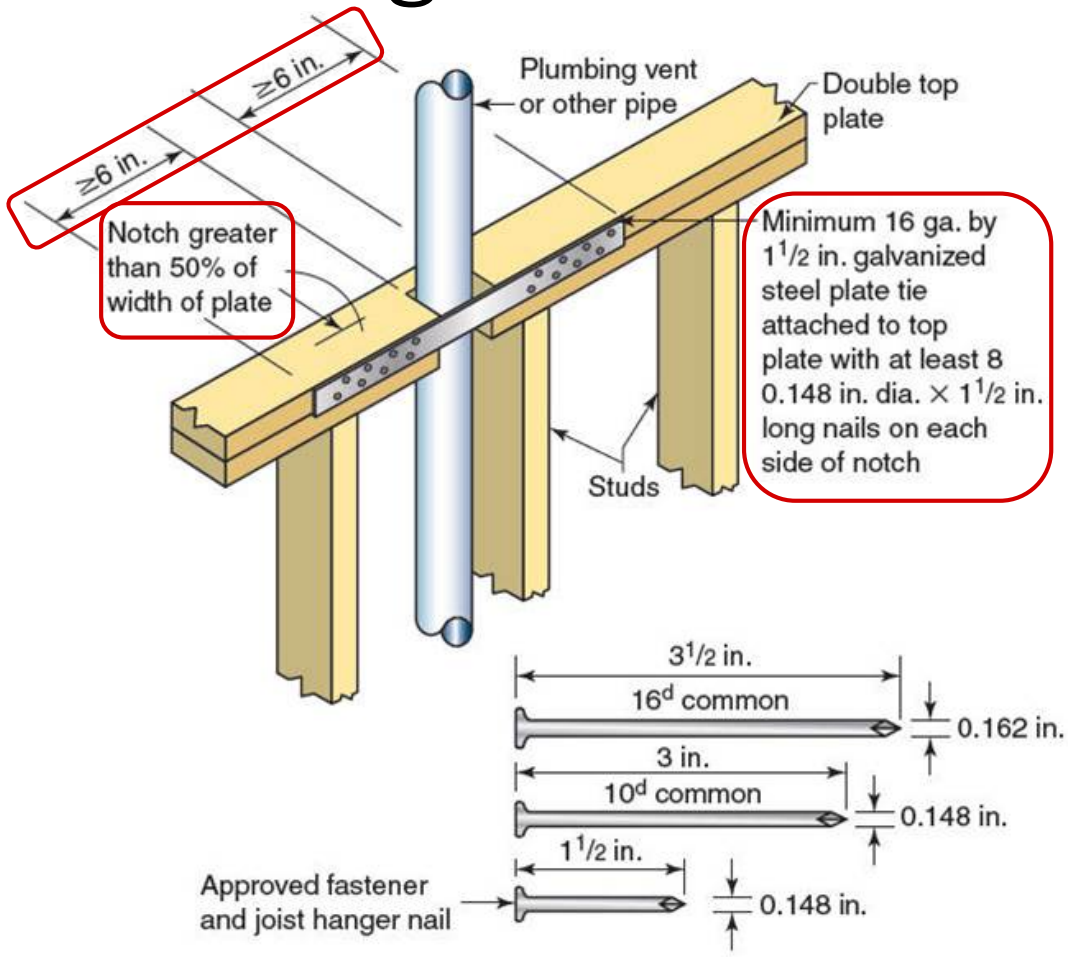


Boring and Notching Nonbearing Walls

Hole size in 2’ x 4’ stud
Stud depth = 3½″
Largest hole ≤60%
60% x 3½ = $2^1/_8$″
$^5/_8$″ + $2^1/_8$″ + $^5/_8$″ = $3^3/_8$″



Boring and Notching
Top Plate of Bearing Wall

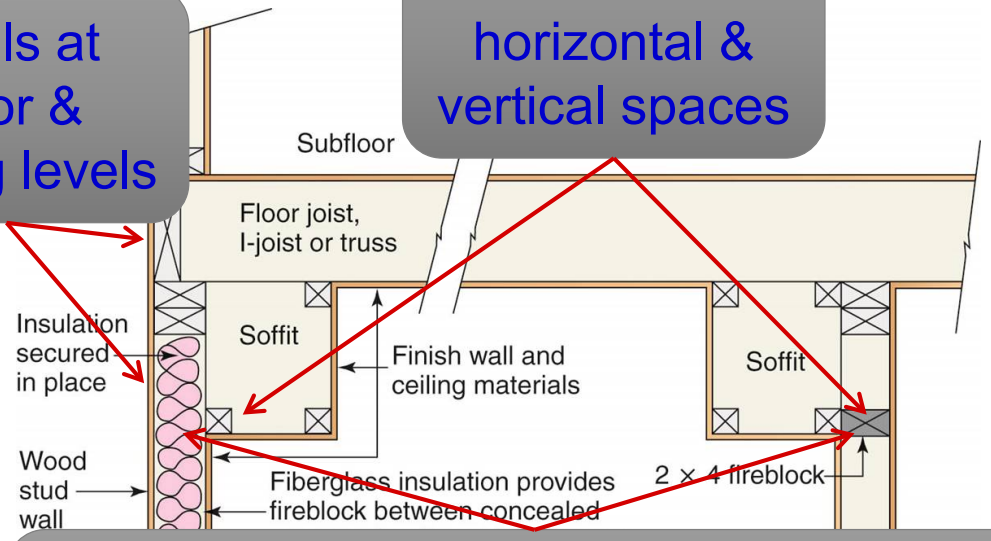


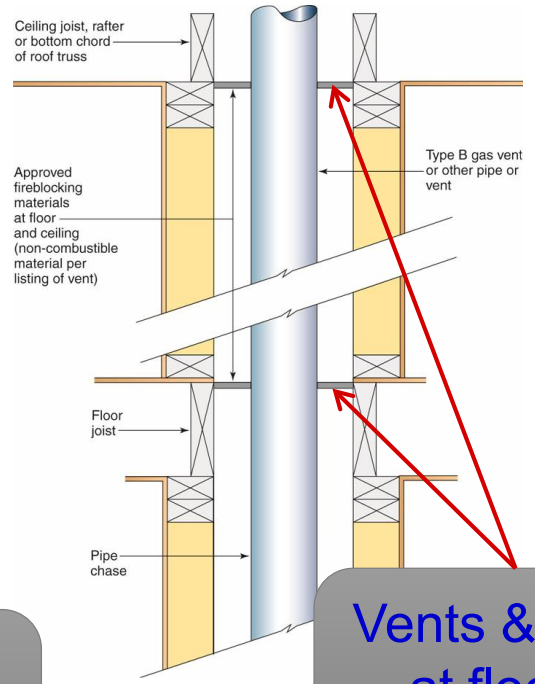
Fireblocking

- Designed to stop the spread of fire in concealed spaces of wood frame construction

Walls at floor & ceiling levels

Connection of horizontal & vertical spaces





Vents & ducts at floor & ceiling levels

- Nominal 2” lumber
- Layers of structural wood panels
- Glass fiber insulation secured in place

Draftstopping

- Divide concealed floor assembly spaces into areas of <1000 ft^2

- Materials:
  - 1/2” gypsum board
  - 3/8” wood structural panels
  - Other approved materials

Wood Floor Framing

- Prescriptive tables for:
  - Beams and girders
    - No. 2 grade Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir
    - Various support conditions
  - Floor joists
    - Specific grade and species of lumber
    - Live load 30 or 40 psf
    - Dead load 10 or 20 psf

Example 6-1
Beam Size and Bearing Support

- Determine the minimum size and bearing support requirements for an interior beam supporting 2 floors
- #2 hem-fir lumber
- Building width = 28’
- Beam span = 6’

Girder supporting	Size	Building width		
		20	28	36
		Span	Span	Span
Two floors	3-2x10	6-2	5-2	4-10
	3-2x12	7-2	6-1	5-7
	4-2x8	6-1	5-0	4-8
	4-2x10	7-2	6-0	5-6

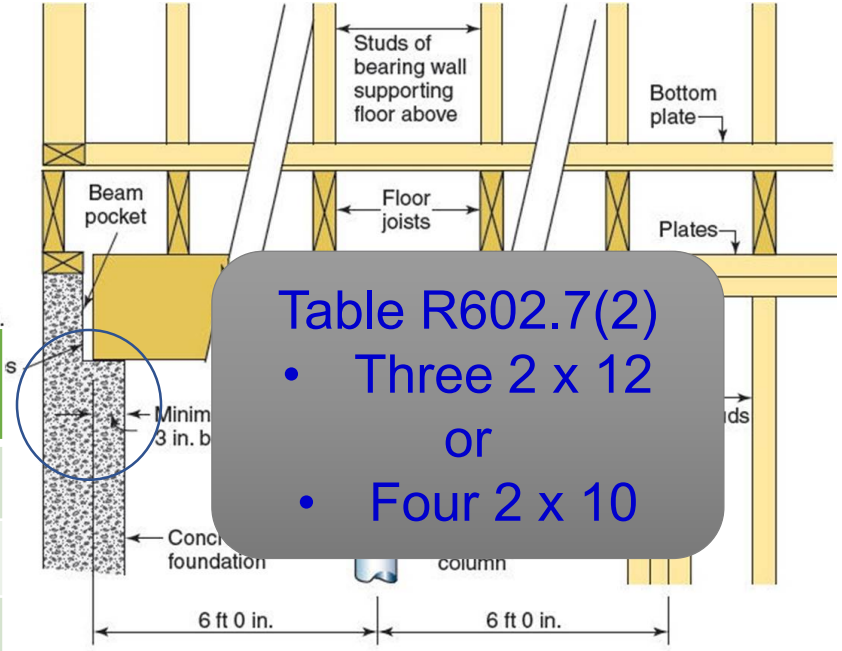


Table R602.7(2)
- Three 2 x 12

or
- Four 2 x 10

Sub-note c Interpolation allowed

Example 6-2
Joist Size and Spacing

- Living area = 40 psf LL
- #2 Douglas fir-larch
- Dead load = 10 psf
- Span = 14’

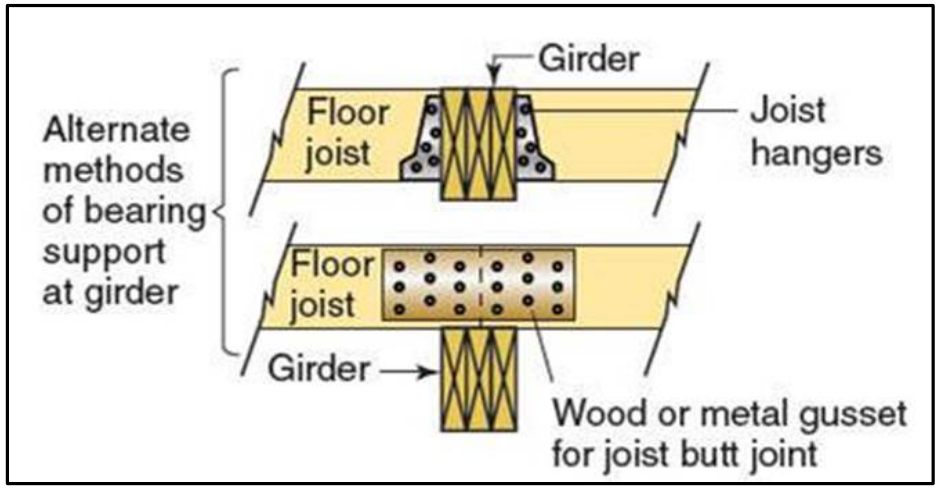
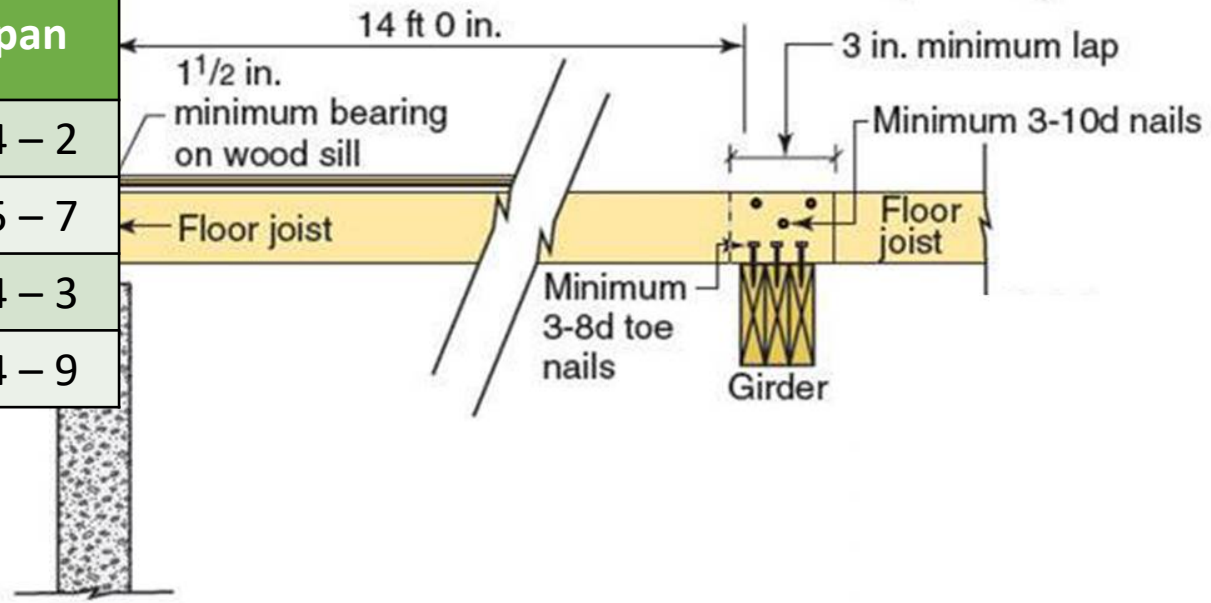


Table R502.3.1(2)

Joist Spacing	Joist Size	Span
12” O.C.	2 x 8	14 – 2
16” O.C.	2 x 10	15 – 7
19.2” O.C.	2 x 10	14 – 3
24” O.C.	2 x 12	14 – 9



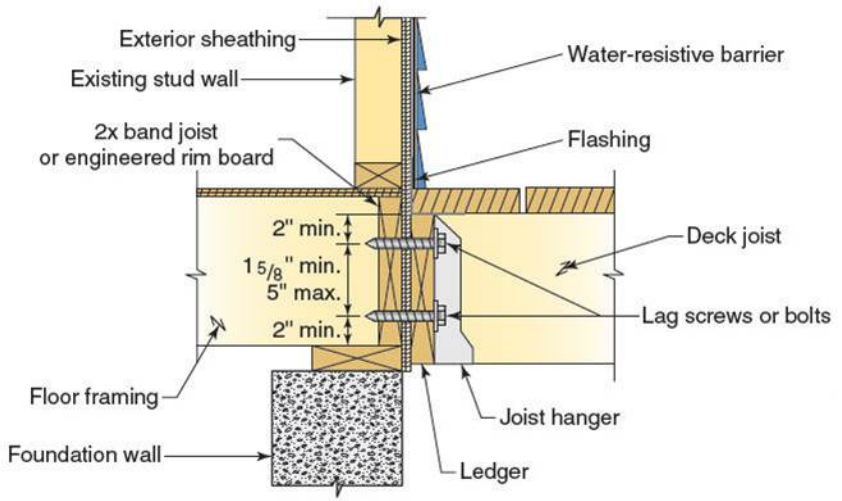
Fastener Schedule for Floor Framing

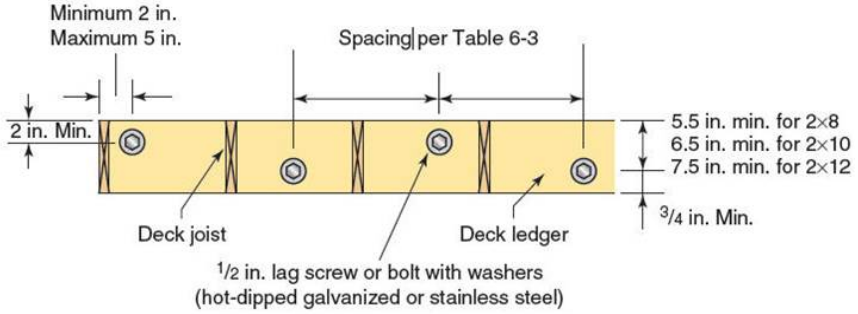
- IRC Table R602.3(1)
  Fastener Schedule for Structural Members
- Common nails

Description	Nails	Spacing
Rim joist to plate, toe nail	8d	6” O.C.
Joist to sill or girder, toe nail	3 - 8d	–
Joists lapped at bearing support, face nail	3 - 10d	IRC Section R502.6.1
Built-up girders and beams	10d	24” O.C. at top and bottom and staggered. Three nails at ends and at each splice.

Deck Attachment

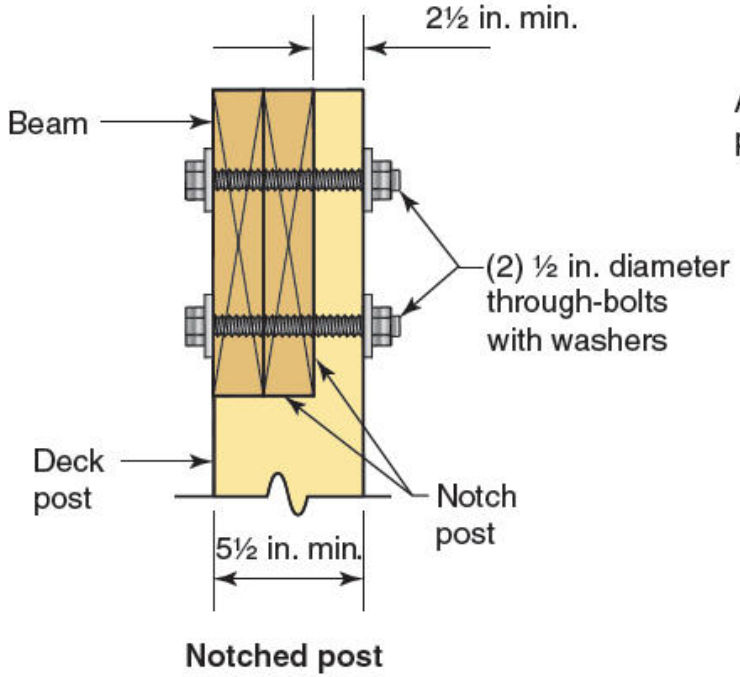
- Deck ledger connection to:
  - 2” band joist; or
  - 1 x 9½ Douglas Fir LVL rim board
- Fasteners
  - ≥½” diameter lag screws or bolts with washers
  - Hot-dipped galvanized or stainless steel
  - Lag screws full-depth through rim joist
  - Fasteners staggered along length of ledger

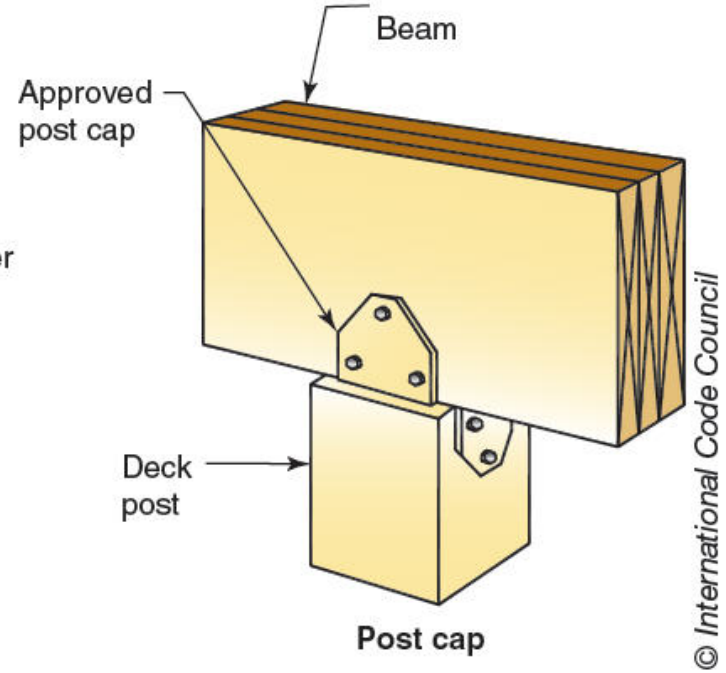




Deck Joists and Beams

- Prescriptive methods for joists and beams in deck construction.
  - Spans & bearing requirements





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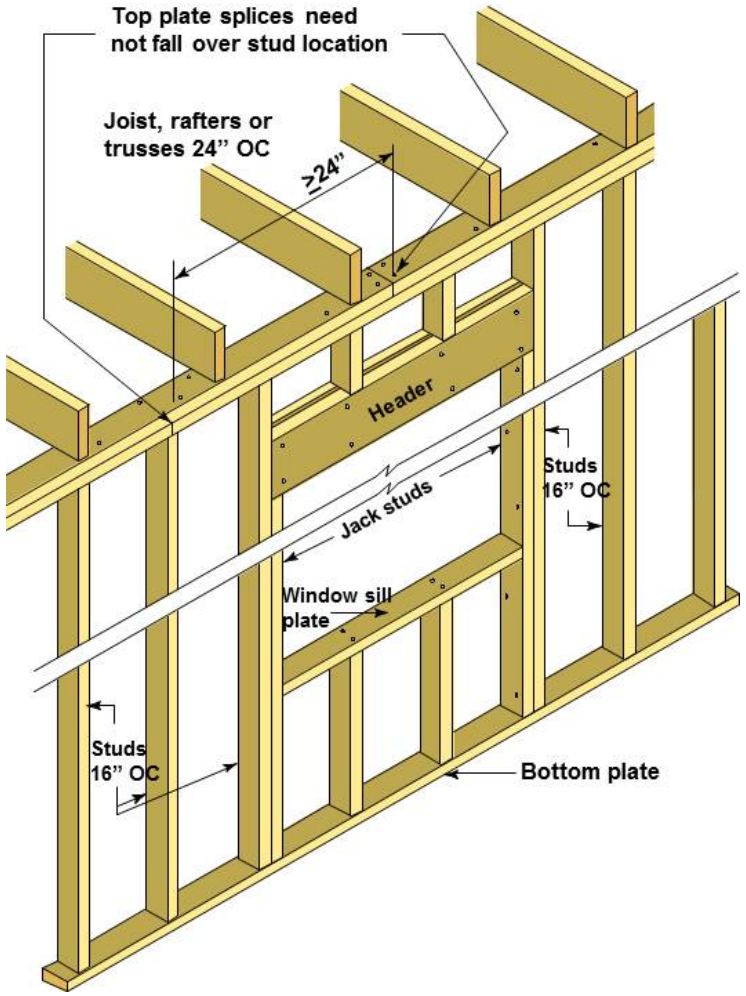
Wall Framing

- Size and spacing of studs is related to:
  - Number of floors being supported
  - With or without the additional load of the roof-ceiling assembly



Example 6-3
Stud Size and Spacing

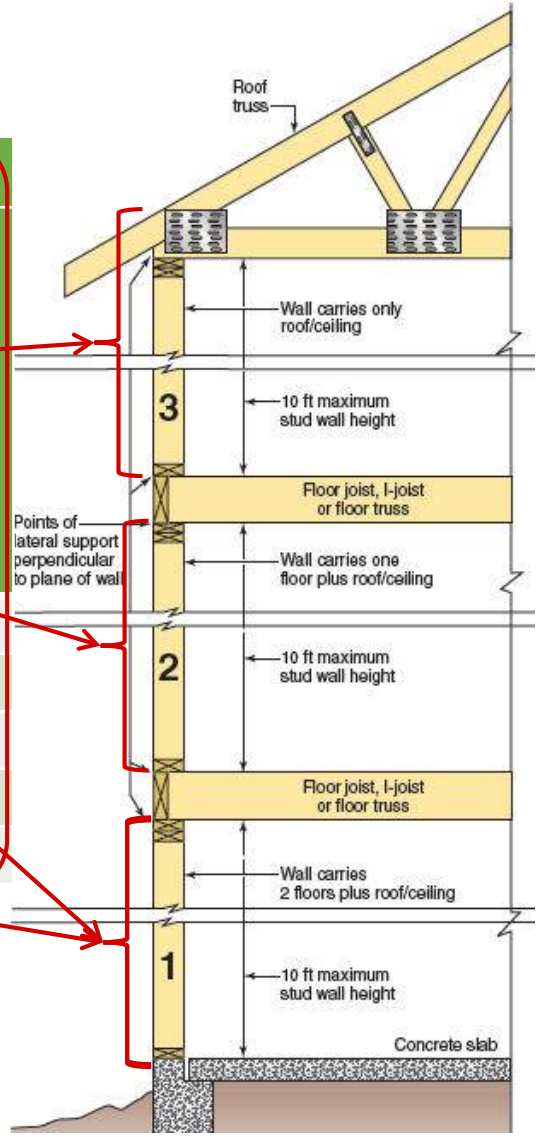
- Determine the minimum size, maximum height and maximum spacing of standard studs in an exterior bearing wall
- Given:
  - 3 stories of wood framing (walk-out basement plus 2 stories)
  - Standard- or stud-grade lumber

Example 6-3
Stud Size and Spacing

Stud height in bearing walls is generally limited to 10’

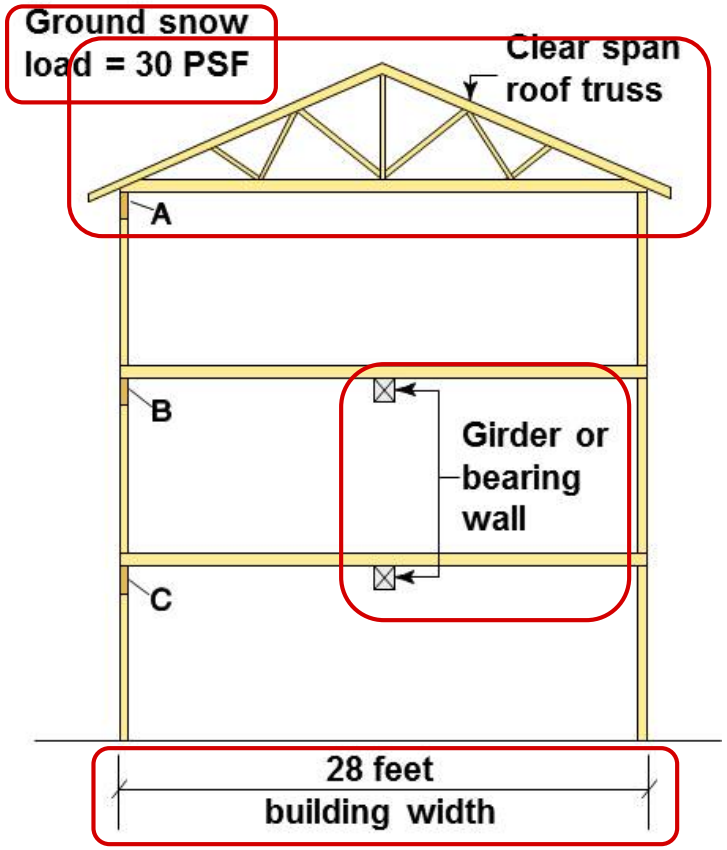
- Table R602.3(5)
- Size, Height and Spacing of Wood Studs

Stud Size (inches)	Bearing Walls					Nonbearing Walls	
	Laterally Unsupported Stud Height (feet)	Maximum Spacing When Supporting a Roof/Ceiling Assembly or a Habitable Attic Assembly Only	Maximum Spacing When Supporting One Floor, Plus a Roof/Ceiling Assembly or a Habitable Attic Assembly	Maximum Spacing When Supporting Two Floors, Plus a Roof/Ceiling Assembly or a Habitable Attic Assembly	Maximum Spacing When Supporting One Floor Only	Laterally Unsupported Stud Height	Maximum Spacing
2 x 3	--	--	--	--	--	10’	16”
2 x 4	10 ft	24”	16”	--	24”	14’	24”
3 x 4	10 ft	24”	24”	16”	24”	14’	24”
2 x 5	10 ft	24”	24”	--	24”	16’	24”
2 x 6	10 ft	24”	24”	16”	24”	20’	24”



Example 6-4
Header Size in Exterior Walls

- Given:
  - Ground snow load = 30 psf
  - Clear span roof truss
  - Center bearing floor framing
  - Building width = 28’
  - Header span = 7’
  - #2 Douglas fir-larch



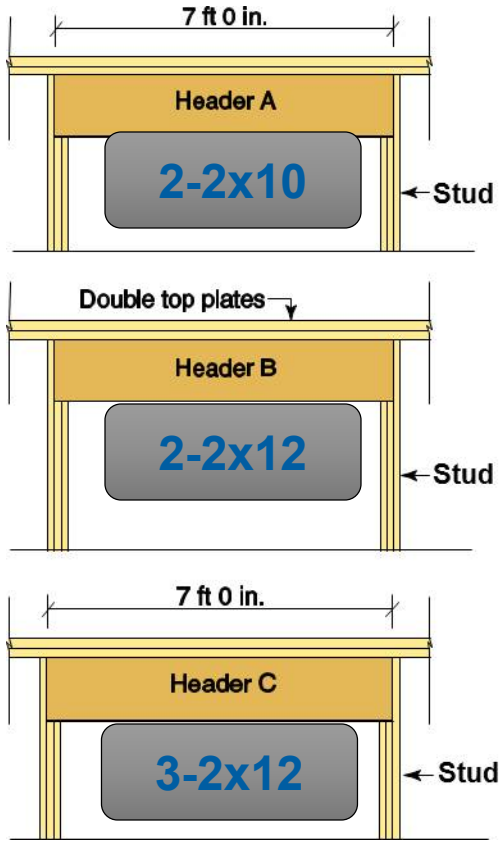
Example 6-4
Header Size in Exterior Walls

Sub-note c Interpolation allowed

Table R602.7.1

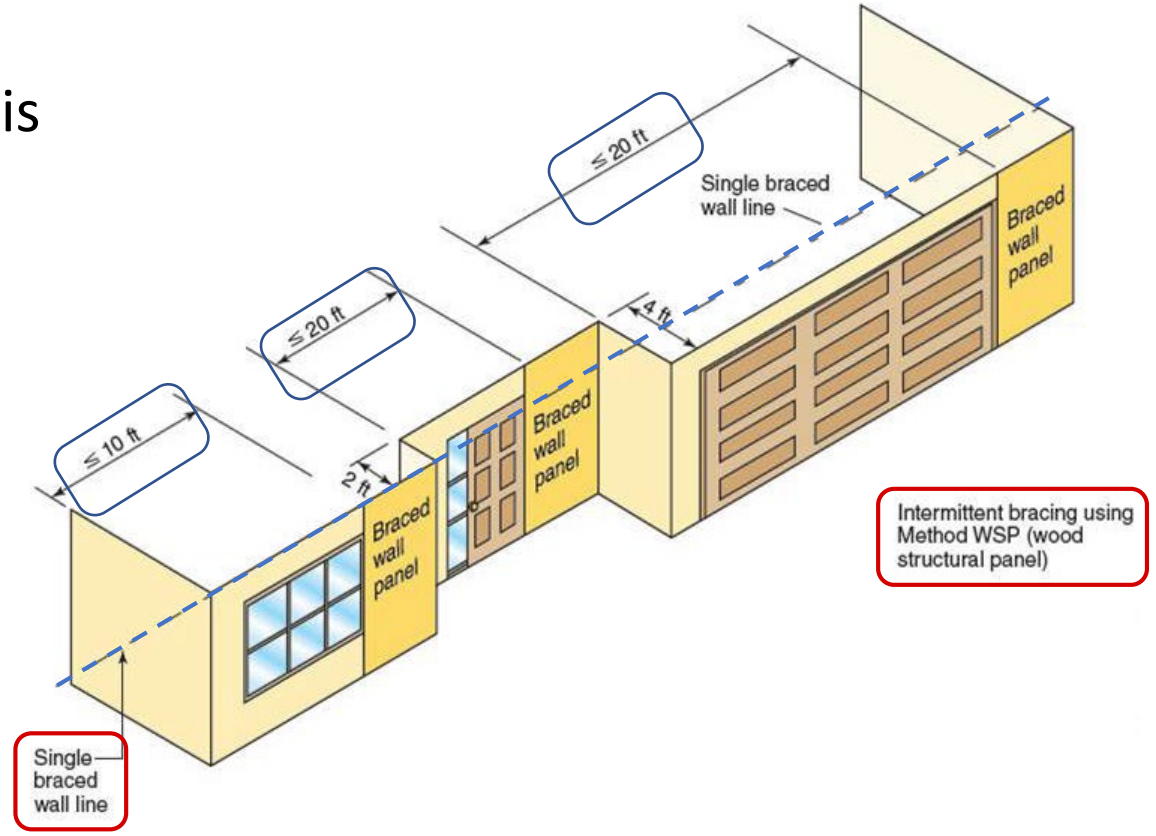
Interpolation allowed. Table is for 20 ft., 24 ft. and 36’

Ground snow load = 30 psf Building width = 28 feet			
Supporting	**Size**	**Span**	**Jack studs**
Roof & Ceiling	2-2x10	6-1	2
	2-2x12	7-2	2
Roof, ceiling, one center-bearing floor	2-2x12	6-1	2
	3-2x12	7-2	2
Roof, ceiling, two center-bearing floors	3-2x12	6-3	2
	4-2x12	7-2	2



Wall Bracing

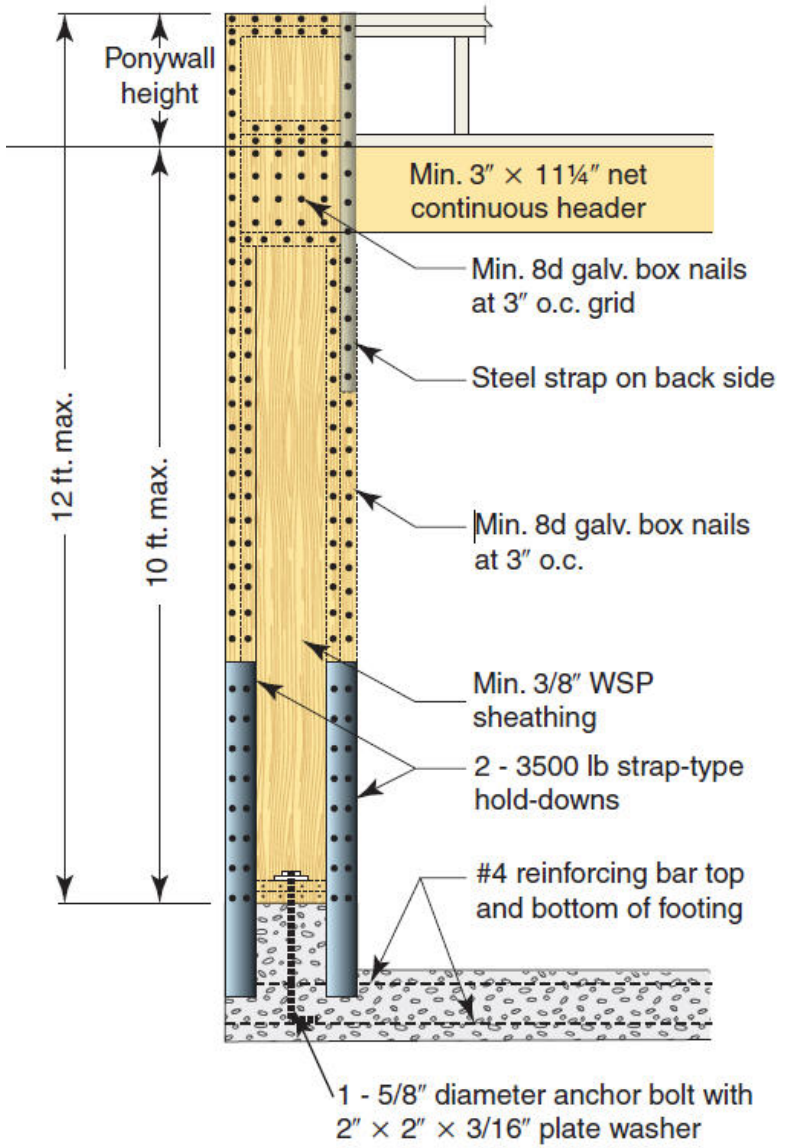
- Wall bracing provides resistance to racking from lateral loads, primarily wind and seismic forces
- Amount and location of bracing is determined by several factors:
  - Number of stories
  - Seismic design category
  - Design wind speed
  - Method of bracing



Method PFH
Braced Wall Panels

Portal Frame with Hold-Downs

- Minimum hold-down capacity 3500 lbs.
- Double sill plate
- 5/8-inch anchor bolt



Ceiling Joists

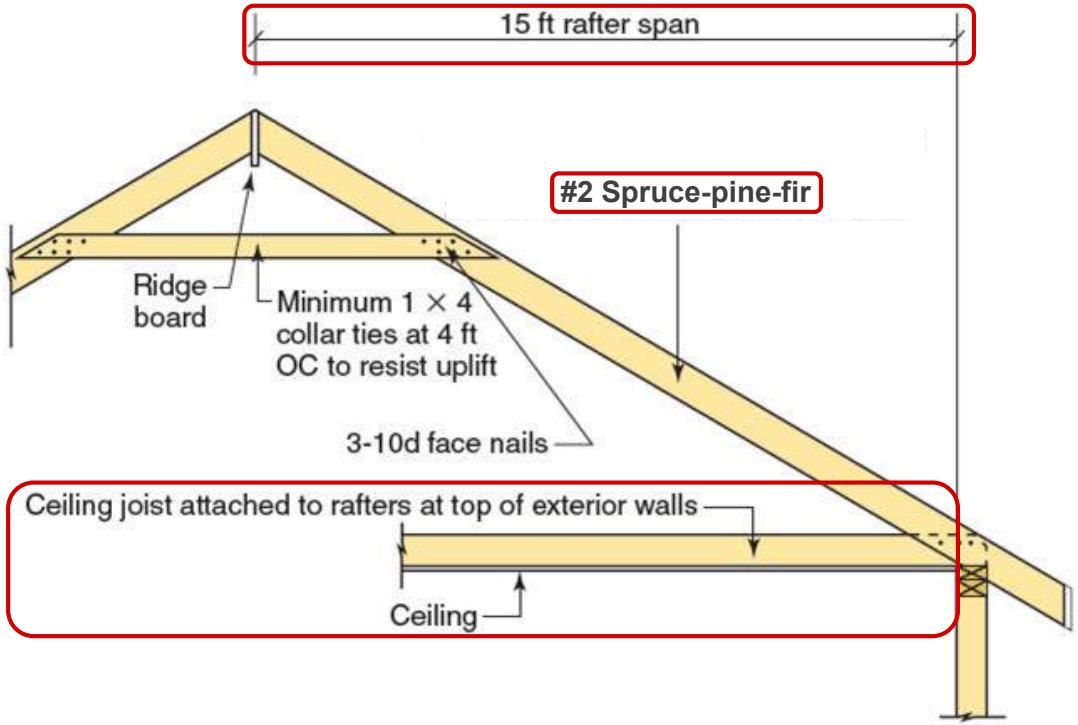
- Ceiling joists
  - Support ceiling materials
  - Serve as rafter ties to resist the outward thrust of the rafters at the top of the wall
  - Require adequate connection to the rafter and top of wall
- Ceiling joist spans for:
  - Attics without storage
  - Attics with limited storage
    - Attics with fixed stair access require joists sized as floor joists

Rafters

- Rafter spans based on:
  - Snow load of the geographic area;
  - Roof live load of 20 psf where snow load <30 psf;
  - Whether ceiling material is attached to the bottom of the rafter
- Connection to ceiling joists
  - Rafters are connected to the ceiling joists at the top plate; or
  - 2 x 4 rafter ties are required to resist the outward thrust forces of the rafters on the wall

Example 6-6
Rafter Size and Spacing

- Given:
  - #2 Spruce-pine-fir lumber
  - Span = 15’
  - Ground snow load = 30 psf
  - Dead load = 10 psf
  - Ceiling not attached to rafters

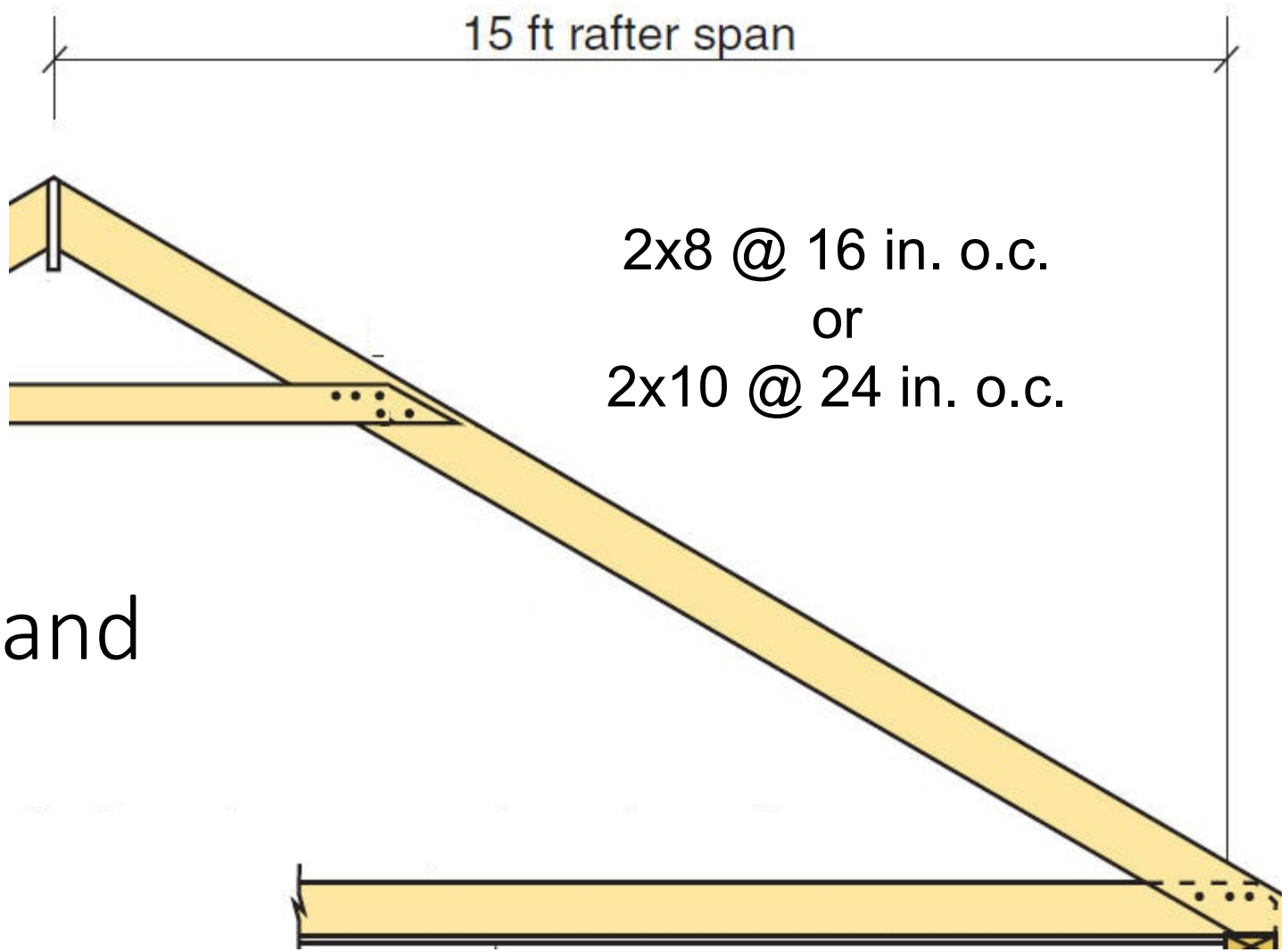


Example 6-6
Rafter Size and Spacing

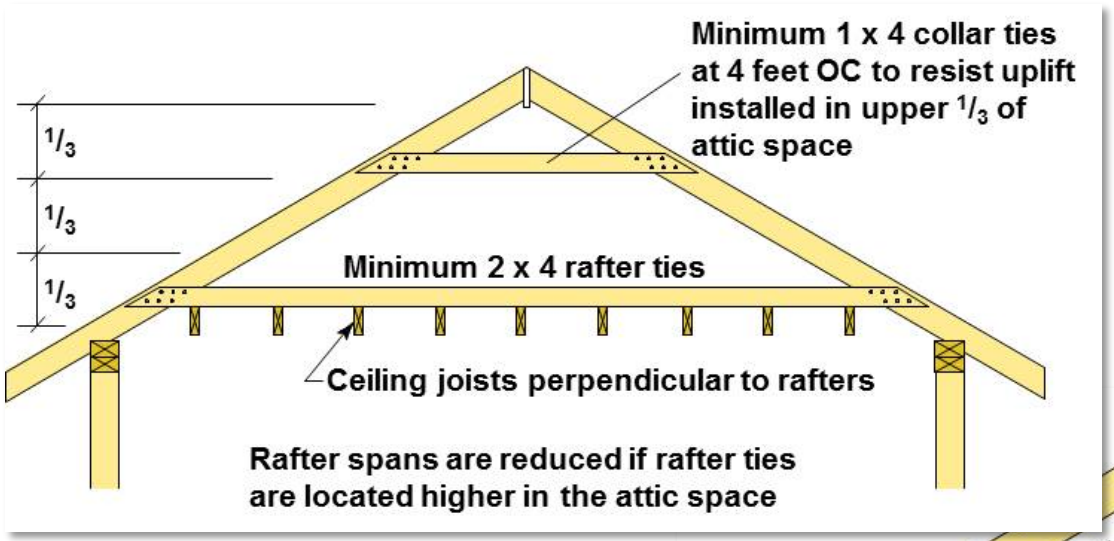
Table 802.4.1(3) - Rafter Spans

Rafter Spacing (inches)	**Species and Grade**	**Dead Load = 10 psf**		
		2 x 6	2 x 8	2 x 10
		Maximum rafter spans		
		ft - in	ft - in	ft - in
16	Douglas fir-larch #2	12-1	15-4	18-9
	Southern Pine #2	11-2	14-2	16-10
	Spruce-pine-fir #2	11-11	15-1	18-5
24	Douglas fir-larch #2	9-9	12-4	15-1
	Southern Pine #2	10-2	13-2	15-9
	Spruce-pine-fir #2	9-9	12-4	15-1

Example 6-6
Rafter Size and Spacing



Rafter Tie Alternatives



- Rafter ties

- Ridge beam

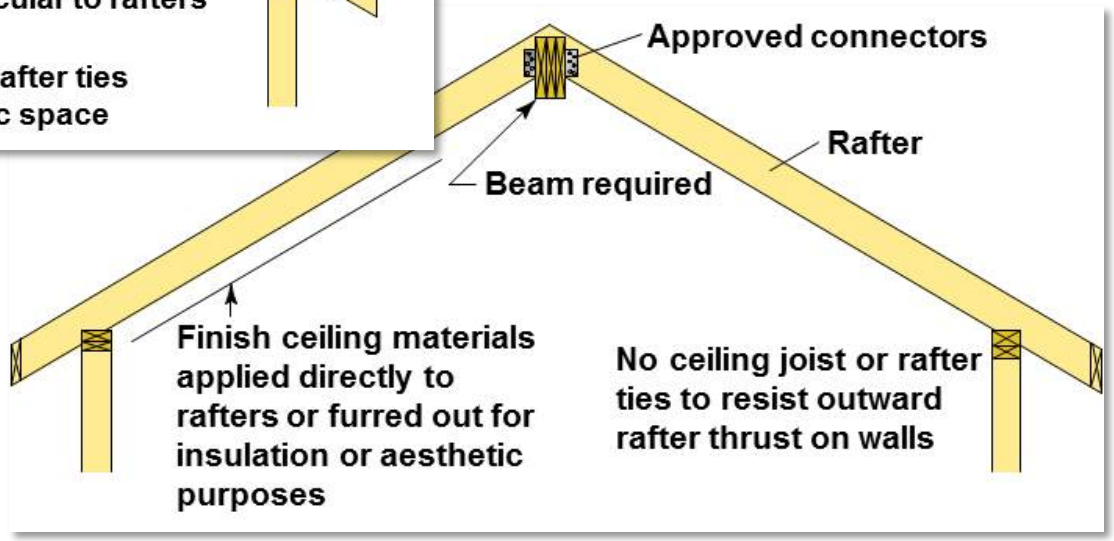


Table R602.3(1)
Fastener Schedule for Roof Framing

Description	Nails	Spacing
Rafter or roof truss to plate, toe nail	3-16d box or 3-10d common	2 toe nails on one side and 1 toe nail on opposite side
Roof rafters to ridge, valley or hip rafters	4-16d toe nail 3-16d face nail	–
Ceiling joists to plate, toe nail	3-8d common	–
Collar tie to rafter, face nail	3-10d common	–
Rafter/ceiling joist heel joint connection	Table R802.5.1(9)	–

Roof Uplift Connections

- Table provides uplift values based on:
  - Building width
  - Wind speed
  - Exposure category
  - Roof pitch
- For ≤200 lbs. uplift, toe-nail connection is OK
- For >200 lbs. uplift, a connector is required

Example
Roof Uplift Connection

- Determine uplift forces
- Given:
  - Wind speed = 115 mph
  - Wind exposure B
  - Trusses 24 in. o.c.
  - Building width = 36 ft
  - Roof slope = 5:12

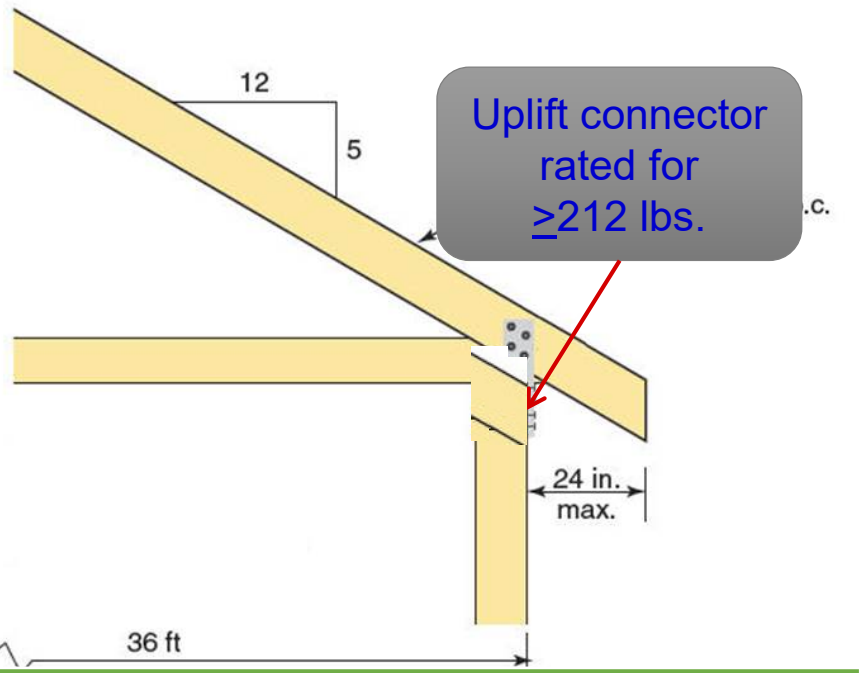


Table R802.11 – Rafter or Truss Uplift Connection Forces from Wind

115 MPH wind speed, Exposure B

Rafter or Truss Spacing	Roof Span (feet)	Roof Pitch	
		< 5:12	≥ 5:12
24” OC	28	198	176
	32	218	194
	36	240	212

Attic Ventilation and Access

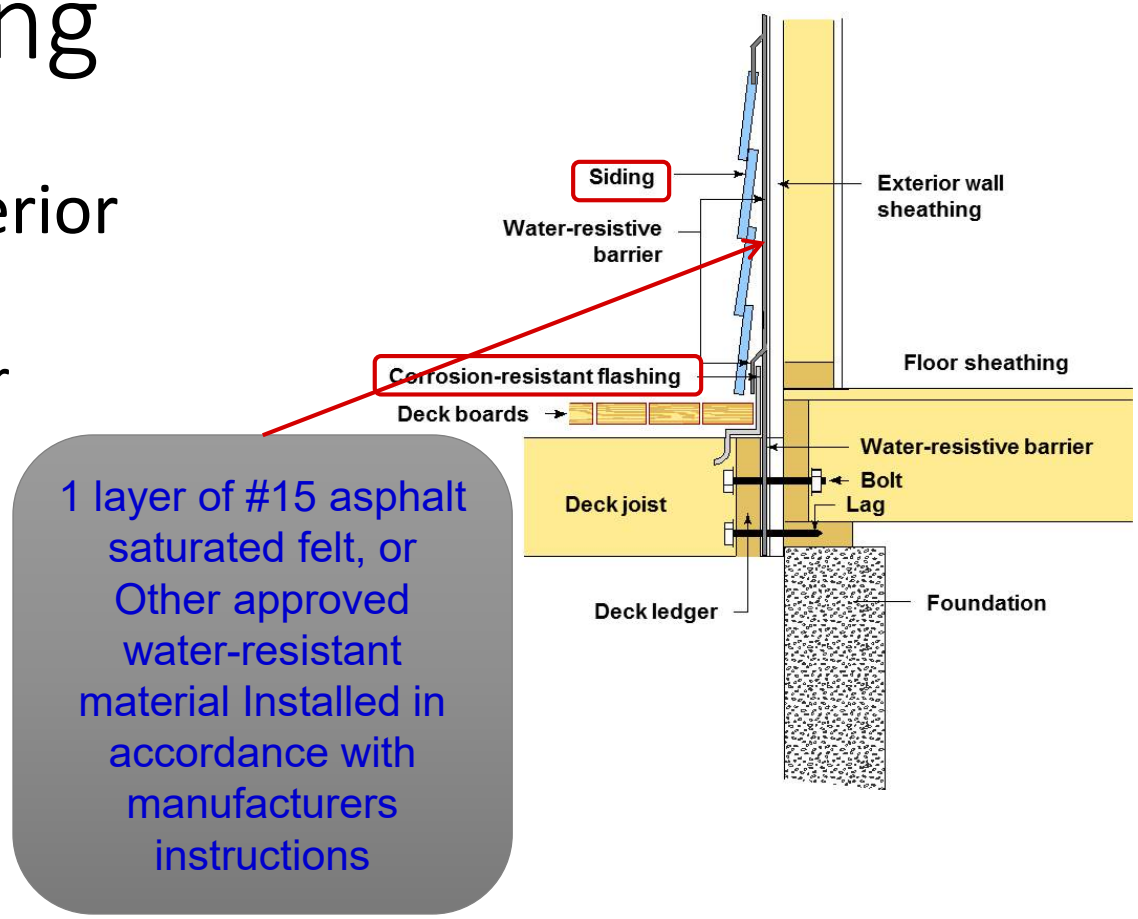
- Total net free ventilating area must be 1/150 of attic area
  - Reduced to 1/300 when 40% to 50% of ventilating area in upper portion of space
    - Class I or II vapor retarder in Zones 6, 7 and 8.
    - Not more than 40% or less than 50% provided via ventilators located within 3 feet of the ridge.
  - Unvented attics may be permitted with certain conditions
- Access to attics required when:
  - Attic area >30 ft^2, and
  - Attic height >30”
- Access
  - Minimum 22” x 30”
  - 30” headroom above the opening
  - Located in a hallway or other readily accessible location

Interior Finishes

- Minimum installation requirements for:
  - Gypsum board (drywall)
  - Plaster
  - Ceramic tile
  - Wood paneling
- Inspection is not required except when part of a fire-resistance-rated assembly

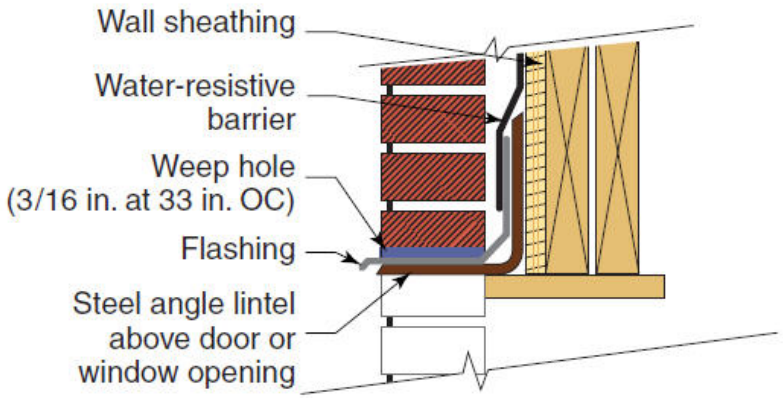
Exterior Wall Covering

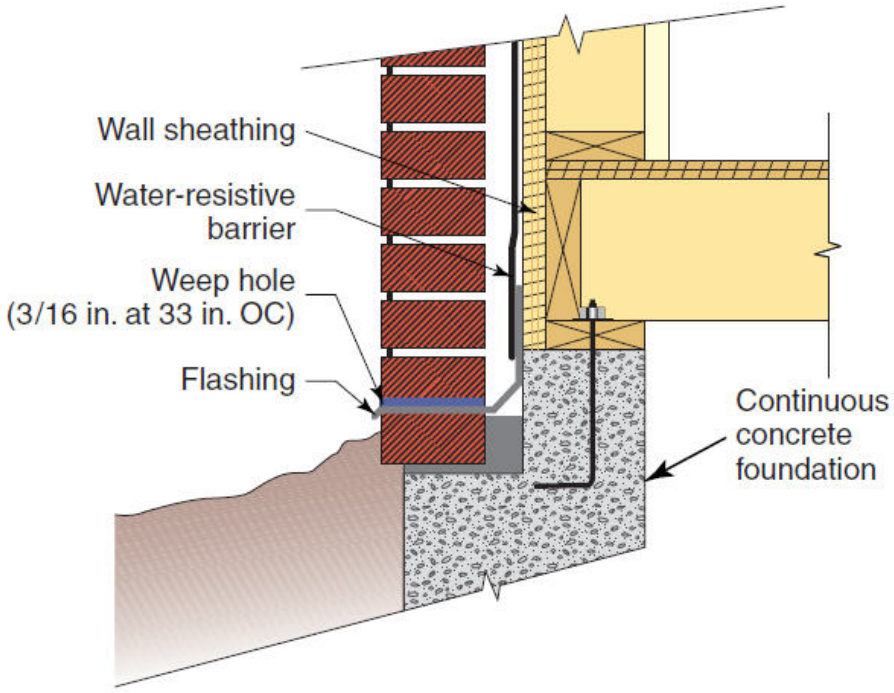
- 3 components of a weather-resistant exterior wall assembly:
  - Water-resistive barrier required over sheathing of all exterior walls, except for detached accessory buildings
  - Flashing
  - Siding or veneer



Masonry and Stone Veneer

- SDC A, B or C
  - < 3 stories
  - < 30 feet above noncombustible foundations
  - Additional 8 feet for gable end walls
  - < 5 inches thick
  - Weight < 50 psf weight
- SDC D_0, D_1, or D_2
  - Reduced height, weight and thickness limitations





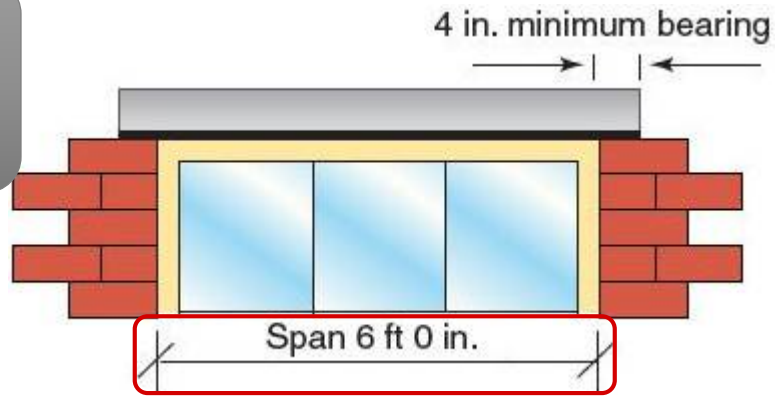
Example 7-1
Size of a Steel Lintel

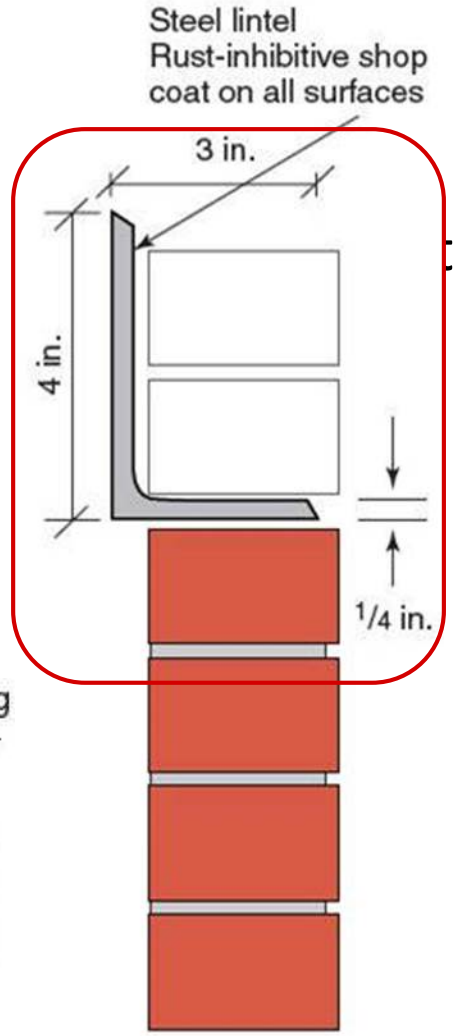
- Determine the minimum size of a steel lintel supporting ma th 1 story above

Table R703.8.3.1
Allowable Spans for Lintels Supporting Masonry Veneer

Long side of steel angle must be in the vertical position

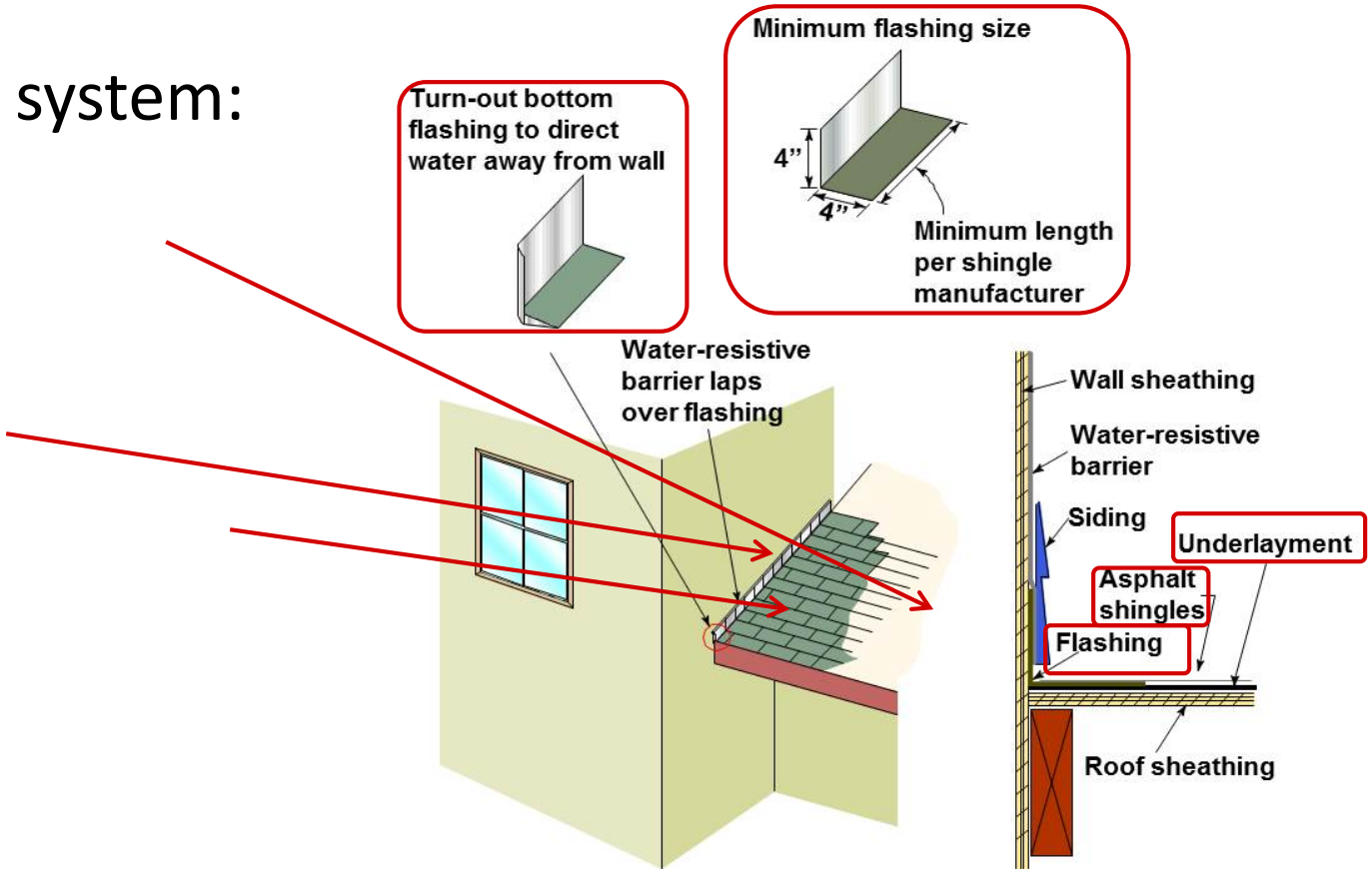
Stories above = 1
Span = 6'0"
Steel angle = 4" x 3" x ¼"



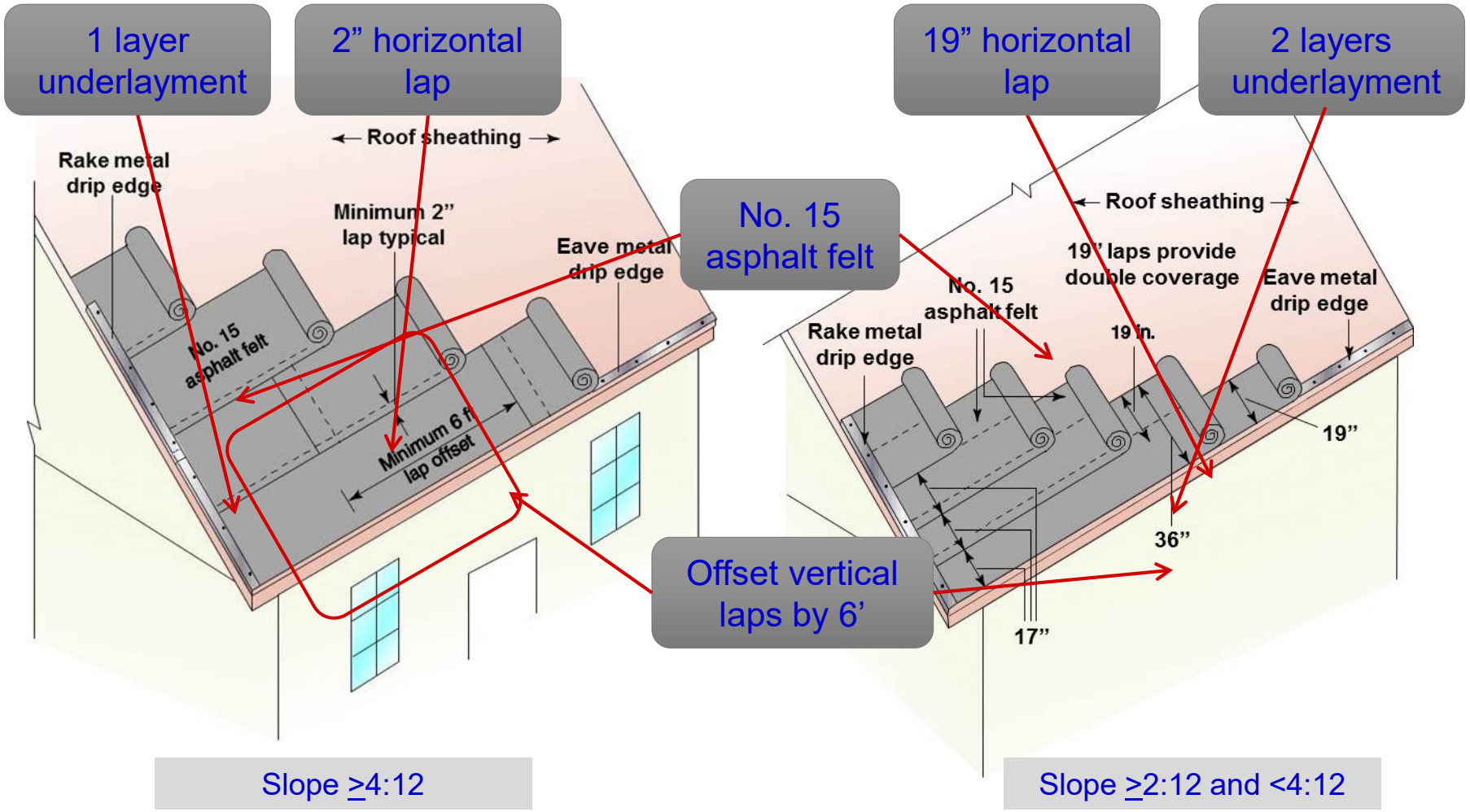


Roof Covering

- Weather protection system:
  - Underlayment
  - Ice barriers
  - Flashing
  - Roofing material



Underlayment for Asphalt Shingles

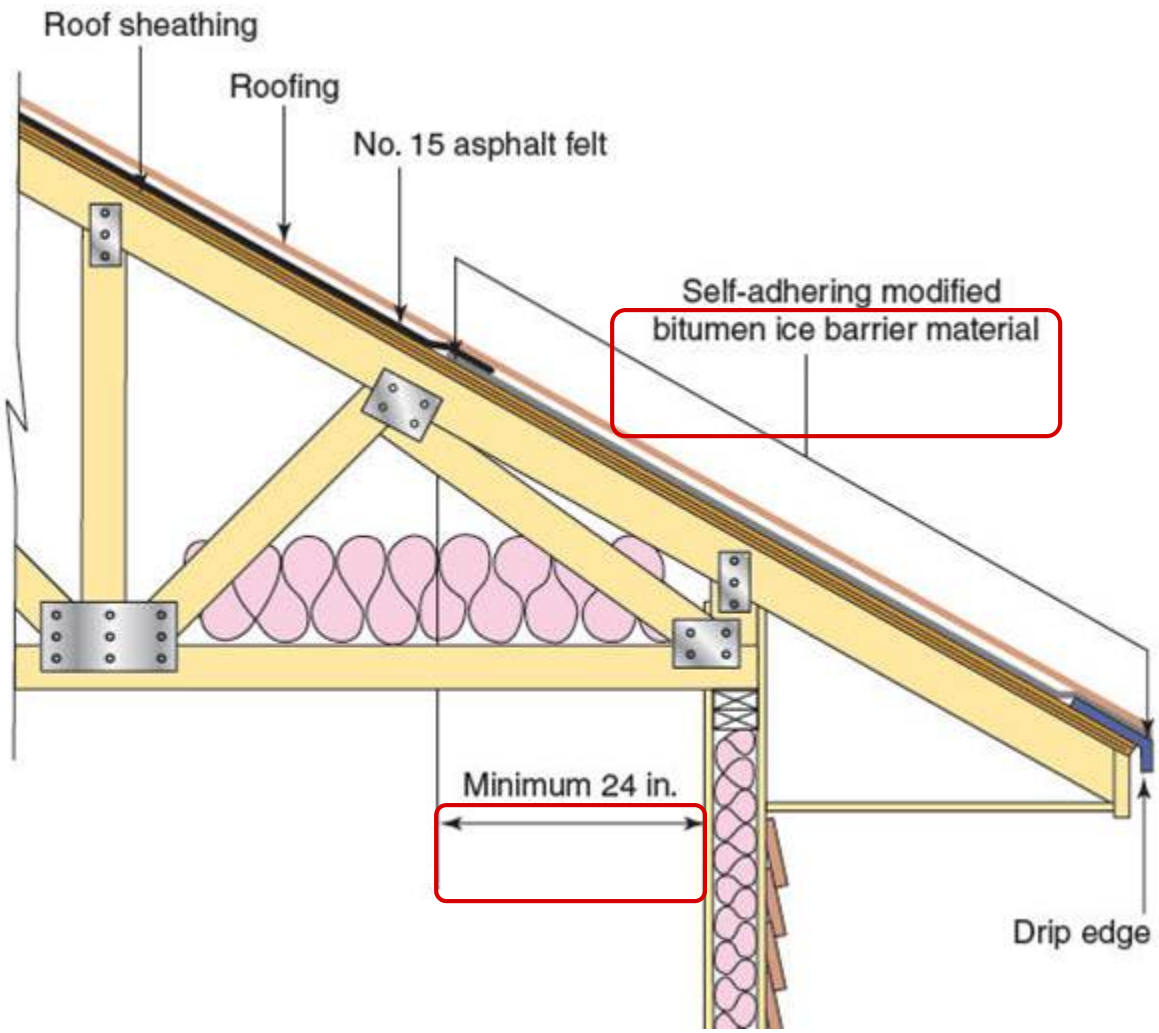


Slope ≥4:12

Slope ≥2:12 and <4:12

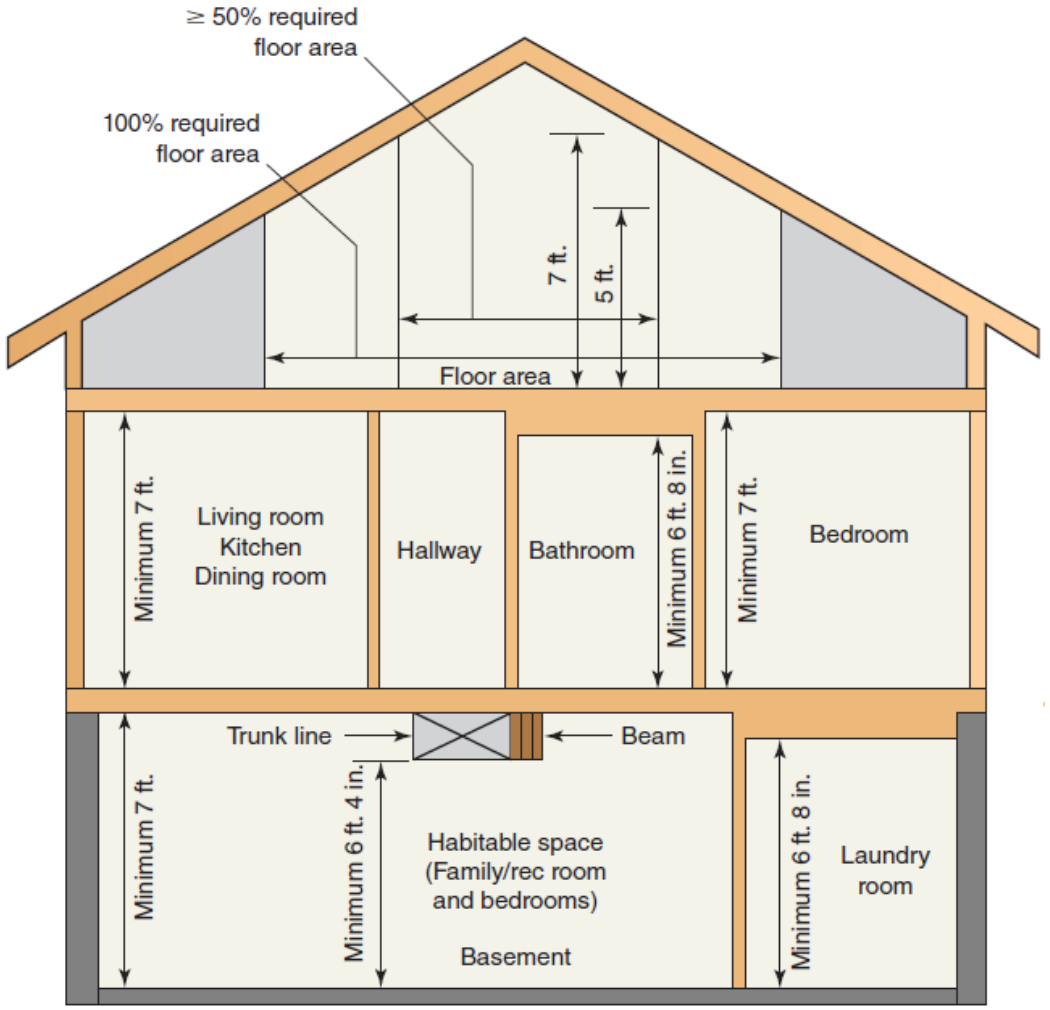
Ice Barriers

- Ice barrier is required in areas with a history of water damage to structures from ice dams at roof eaves



Ceiling Height

- Generally 7 ft. 0 in.
- 6 ft. 8 in.:
  - Bathrooms
  - Toilet rooms
  - Laundry rooms
  - Basements w/o habital space or hallways
- 6 ft. 4 in. basements:
  - Beams
  - Girders
  - Ducts
  - Other obstructions



Ceiling height

Means of Egress

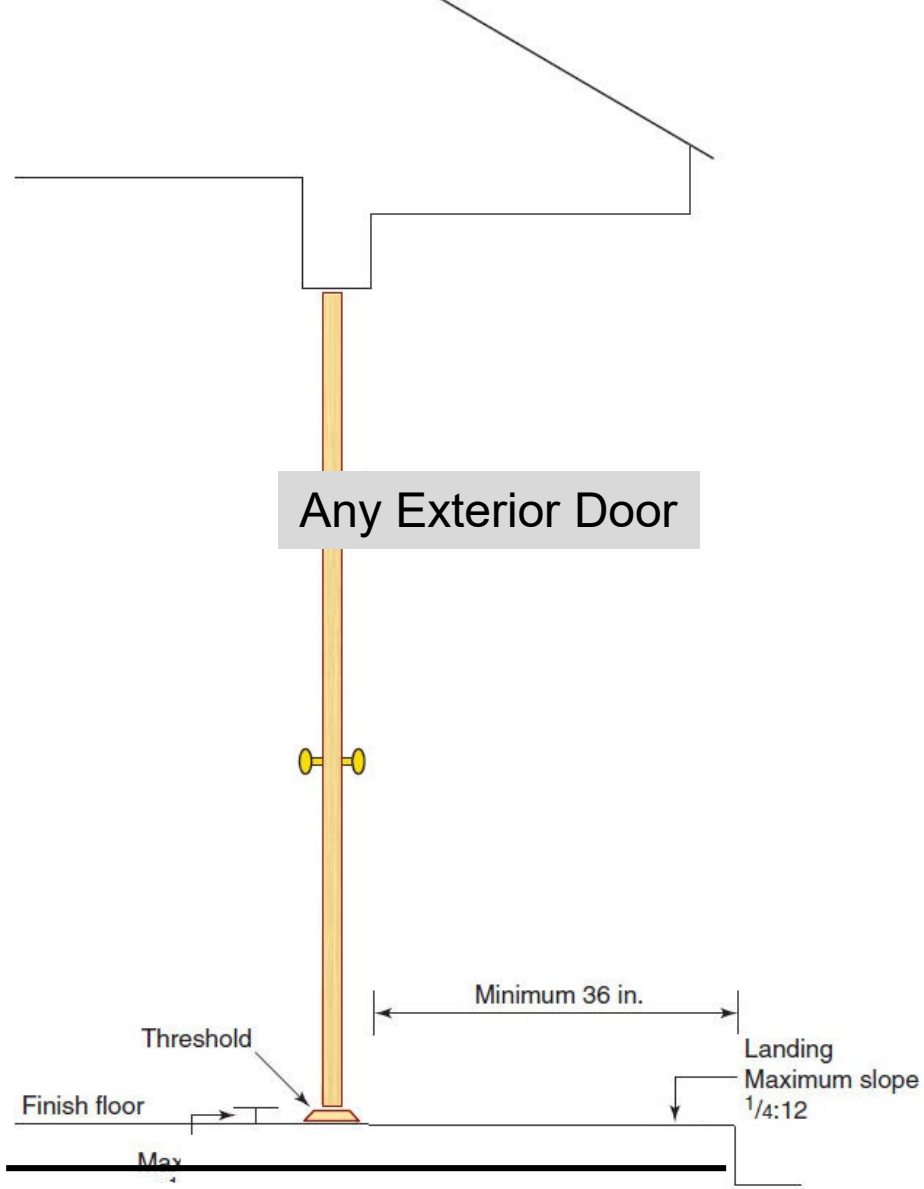
- “Means of egress” describes the path of travel from any location in the dwelling to the exterior
  - Stairways
  - Ramps
  - Hallways
  - Doors
    - One 3 - 0 × 6 - 8 side-swinging egress door to exterior
    - No size or type requirements for other doors
    - No limits on travel distance

Means of Egress

- Designed to provide a safe path to exterior
  - Does not pass through a garage
  - ½” gypsum board on enclosures under stairs
  - Egress components securely anchored to the structure
  - Required egress door can be opened without a key or special knowledge
  - Access to grade at required egress door

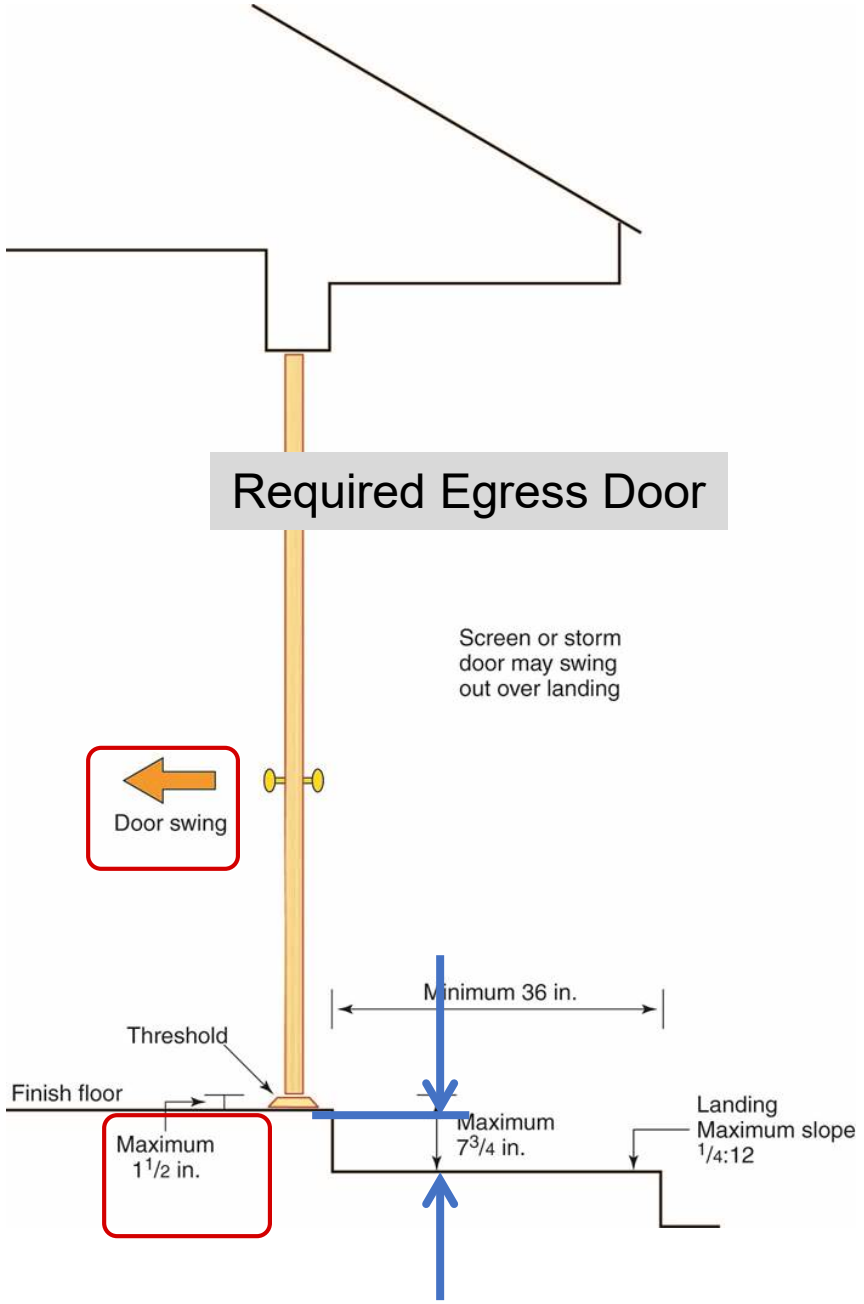
Landings at Exterior Doors

- Landing or floor on each side of exterior door
  - At least as wide as the door
  - ≥ 36 in. in the direction of travel
- Max. landing slope = ¼ / 12
- No elevation requirements in Section R311.3
- Exception for balconies



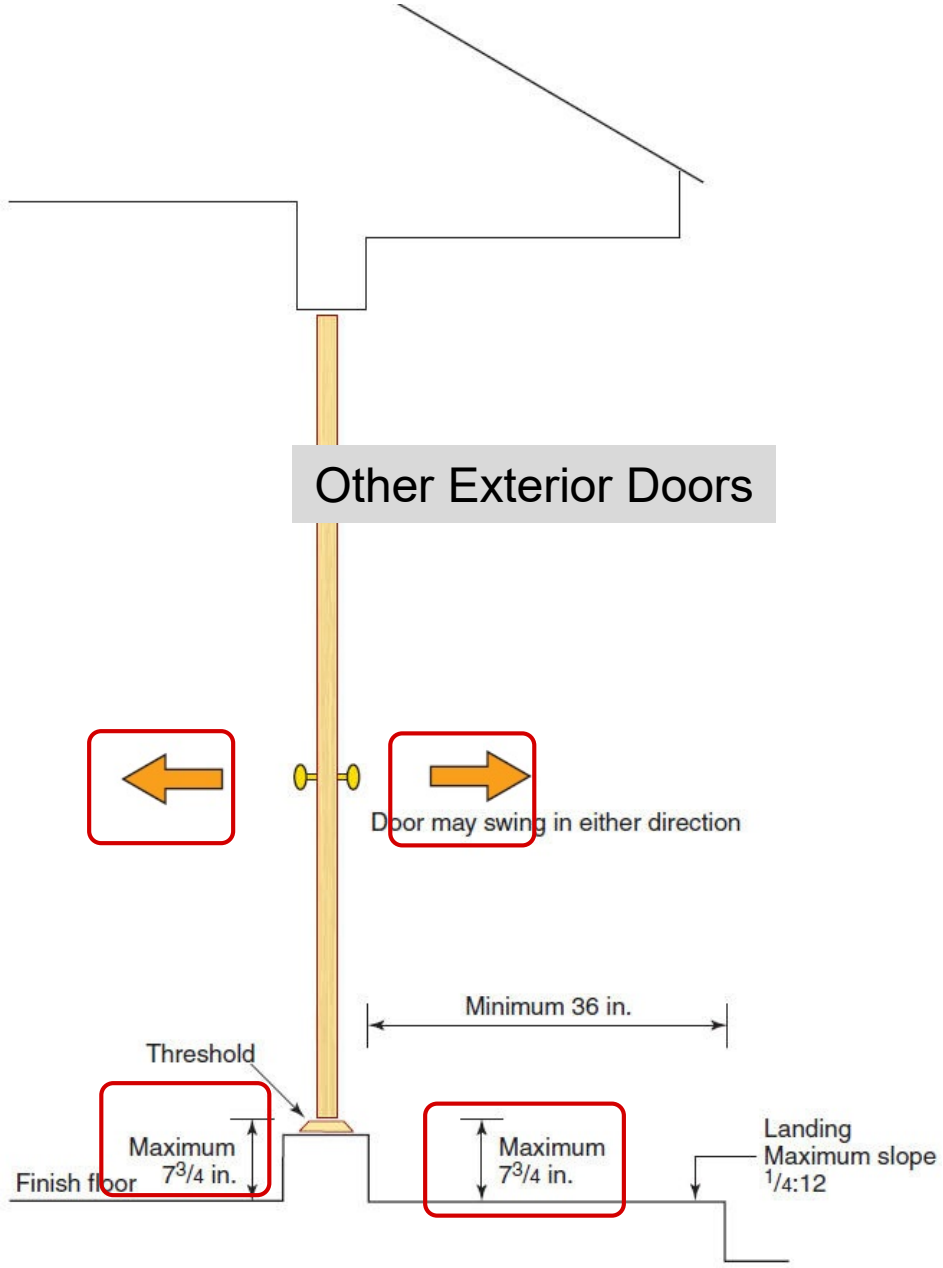
Landings at Exterior Doors

- Required egress door
- Landings or finished floors ≤ 1½ in. below top of threshold
- Exception
  - Door swings in
  - Exterior landing can be a maximum of 7¾ inches below top of the threshold
- Access to grade



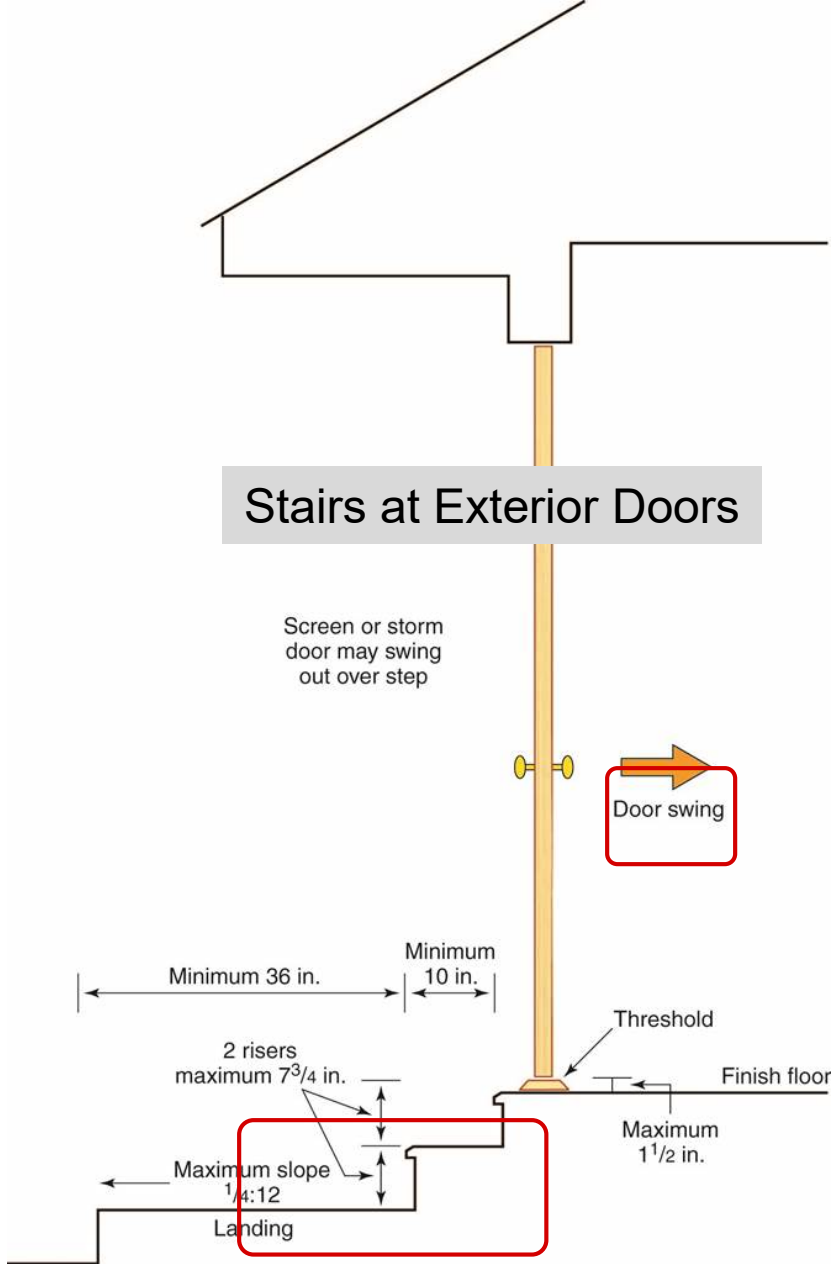
Landings at Exterior Doors

- Other than required egress door
- Landing on either side:
  - ≤ 7¾ in. below top of the threshold
- Door swings either direction



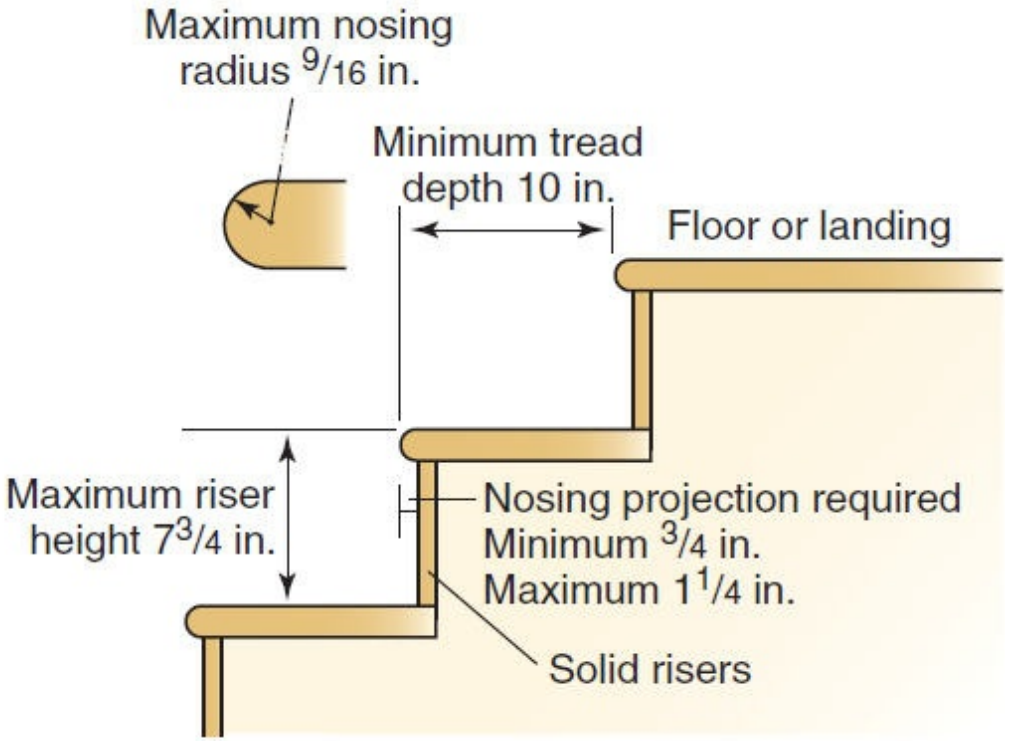
Stairs at Exterior Doors

- Door other than required egress door
- Exception
  - Stairs allowed on exterior side
    - Door cannot swing out over stairs
    - Stairs can have a maximum of 2 risers



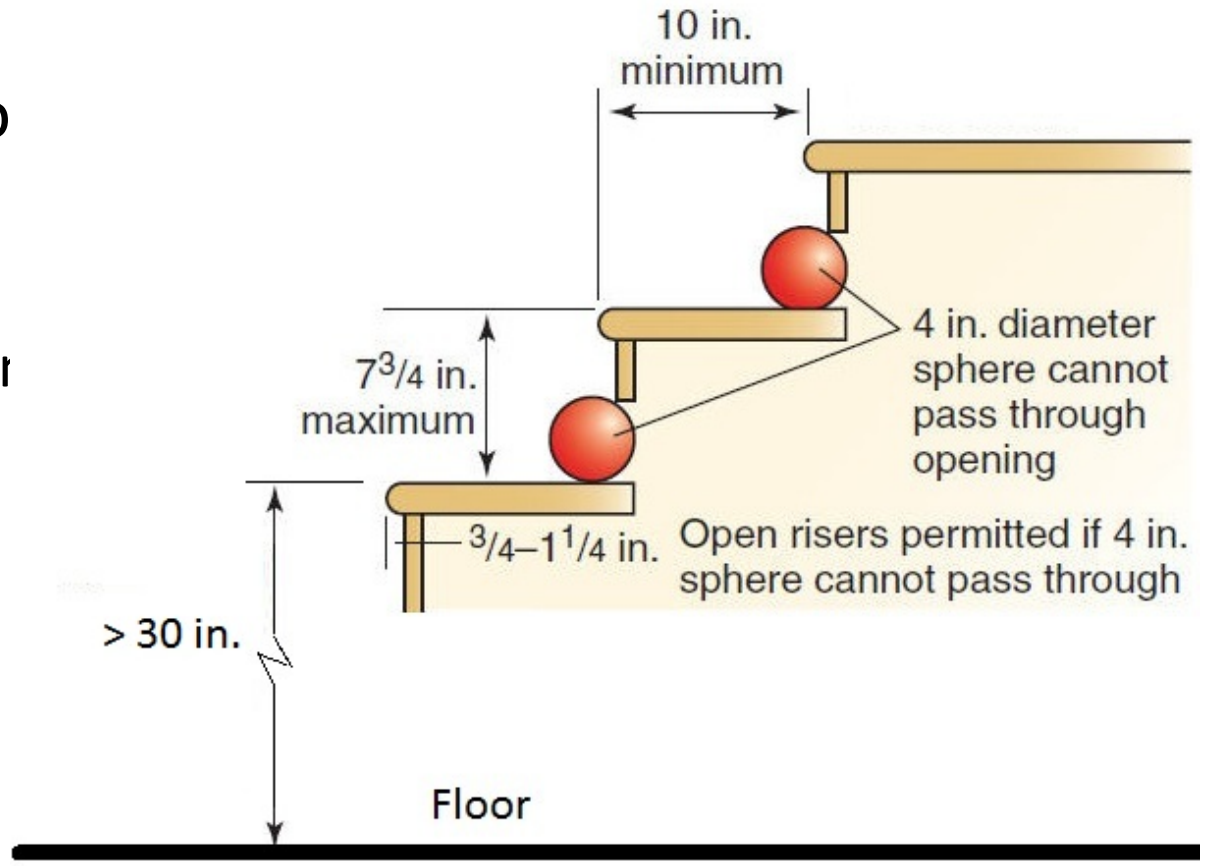
Stair treads and risers

- Riser ≤ 7¾ in.
- Tread ≥ 10 in.
- Variance ≤ ⅜ in.
- Nosing projection ¾ - 1¼ in.
  - Expanded language requires a nosing ≤ 9/16” or bevel ½” or less.
  - Variance ≤ ⅜ in.



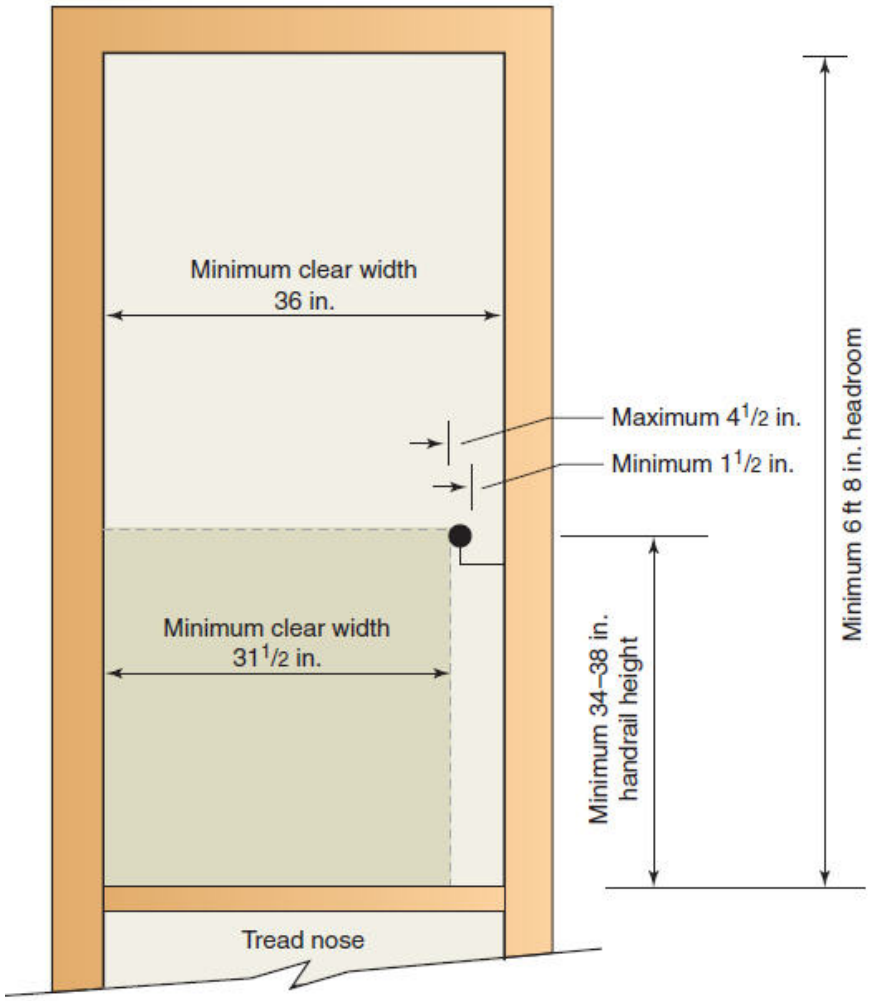
Stair treads and risers

- Treads > 30 in. above floo grade
  - Solid risers, or
  - 4-in. diameter sphere cann through



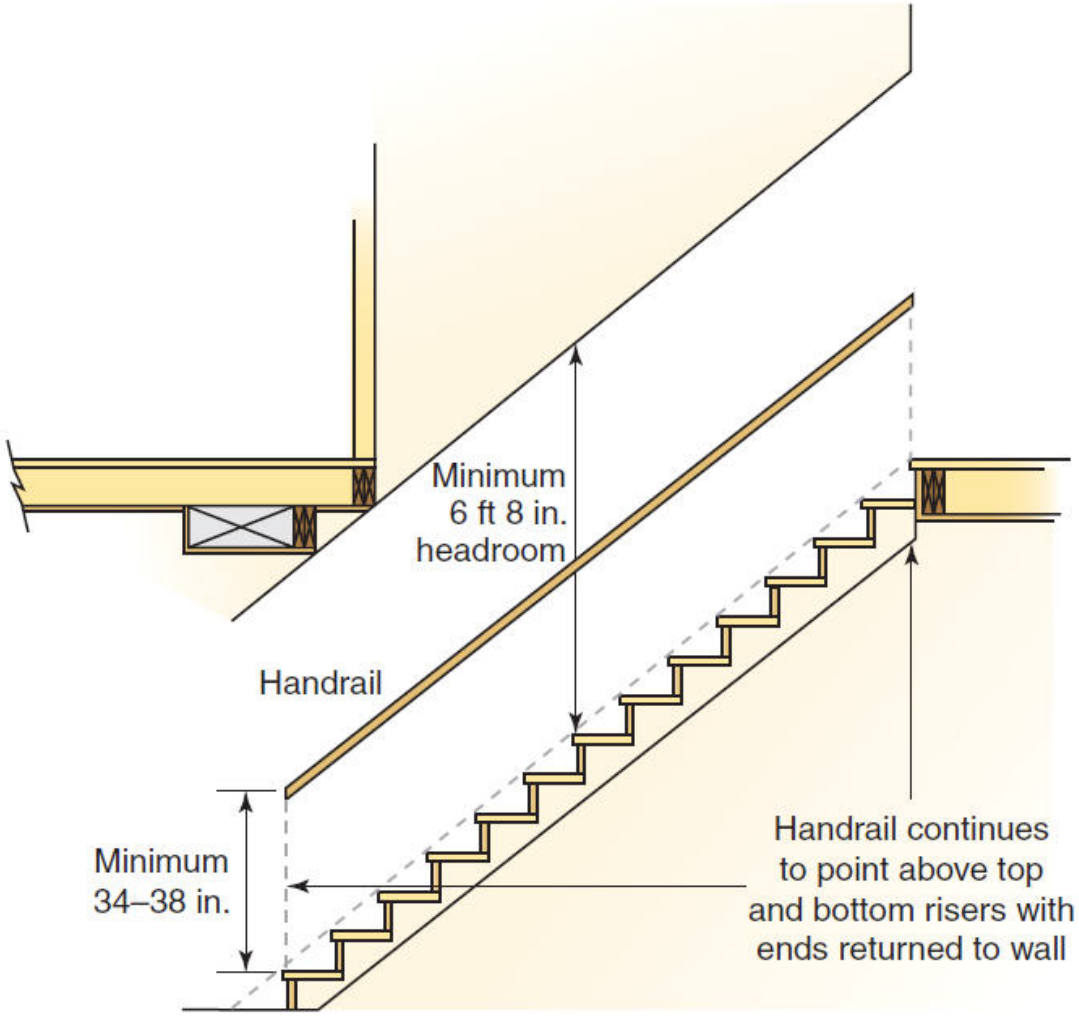
Stairway Width

- Minimum clear width of 36”
  - Required above the handrail; and
  - Below the required headroom height
  - ≤ 4½” handrail projection either side



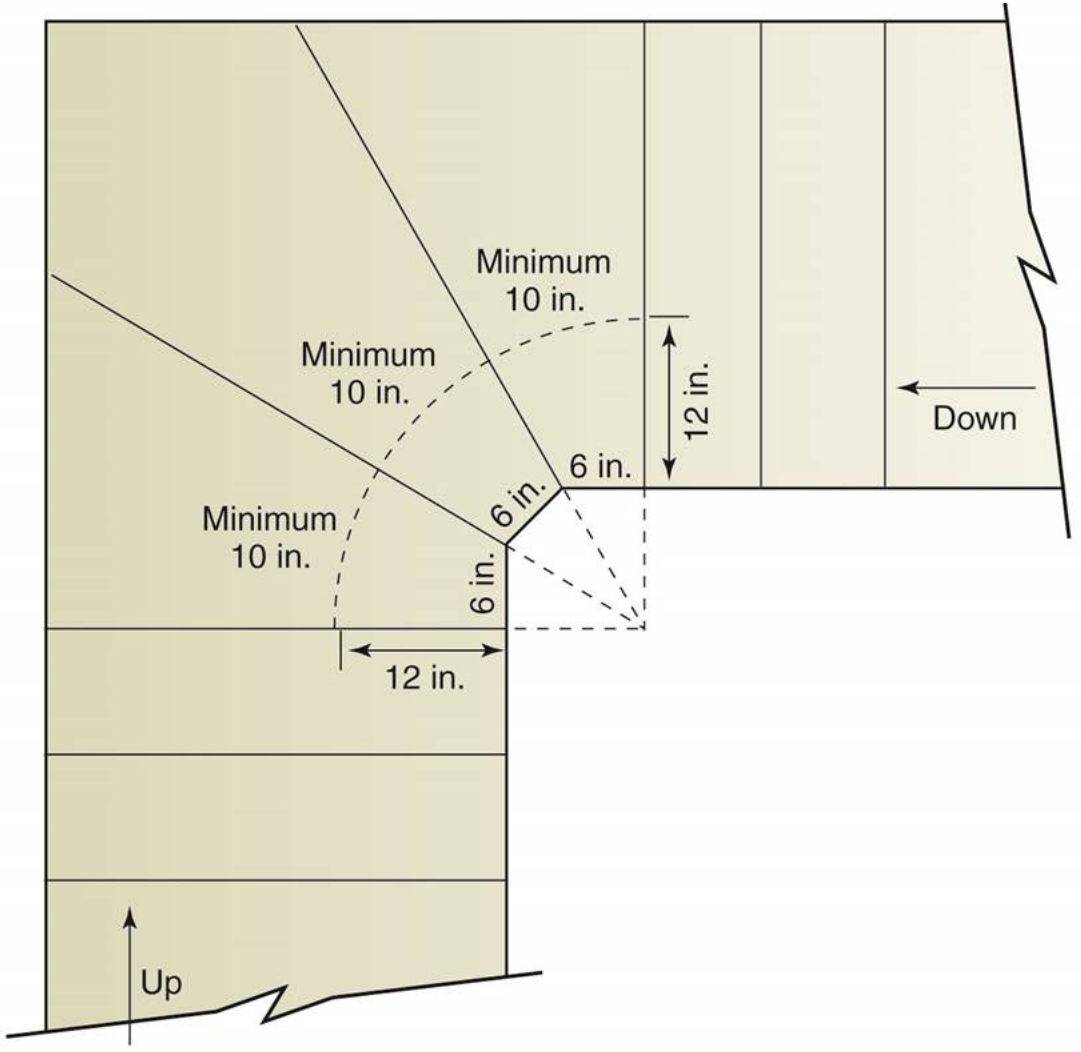
Stairway Headroom

- Minimum headroom
  - 6 ft. 8 in.
  - Above plane of tread nosings



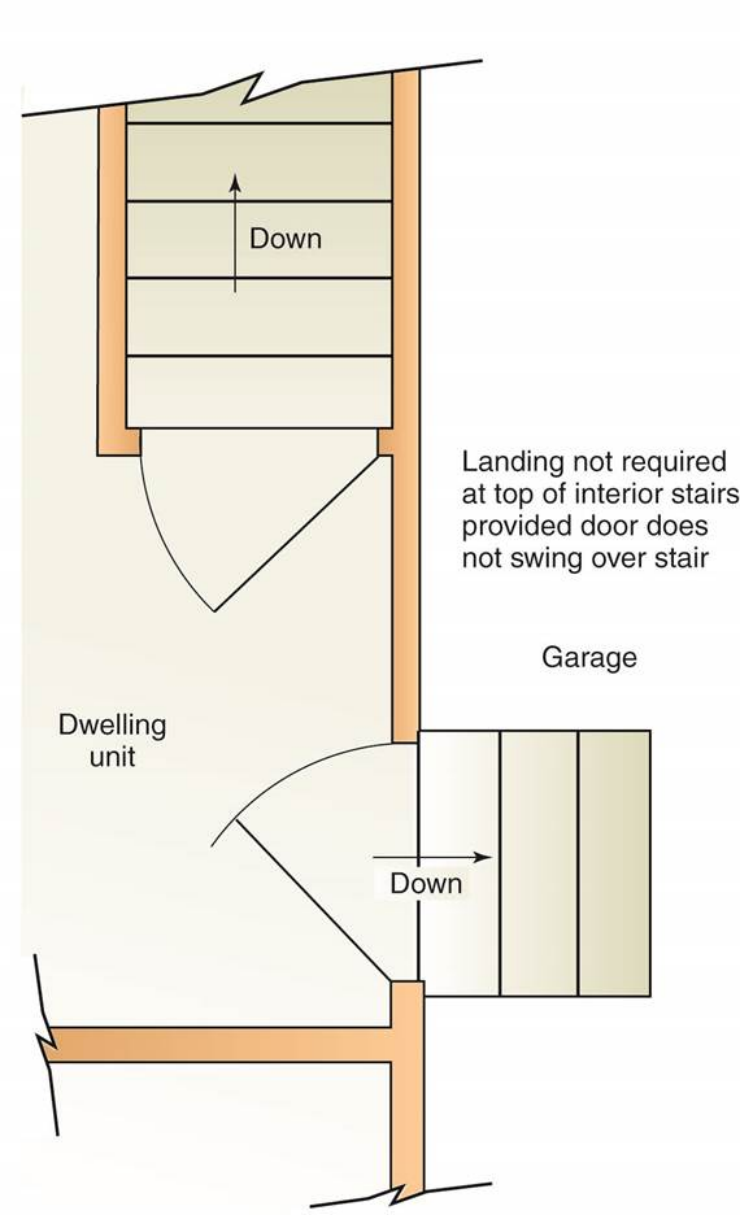
Winder Stairs

- Nonparallel edges
- Tread depth of 6” at the narrow end
- Tread depth of 10” measured at walk line



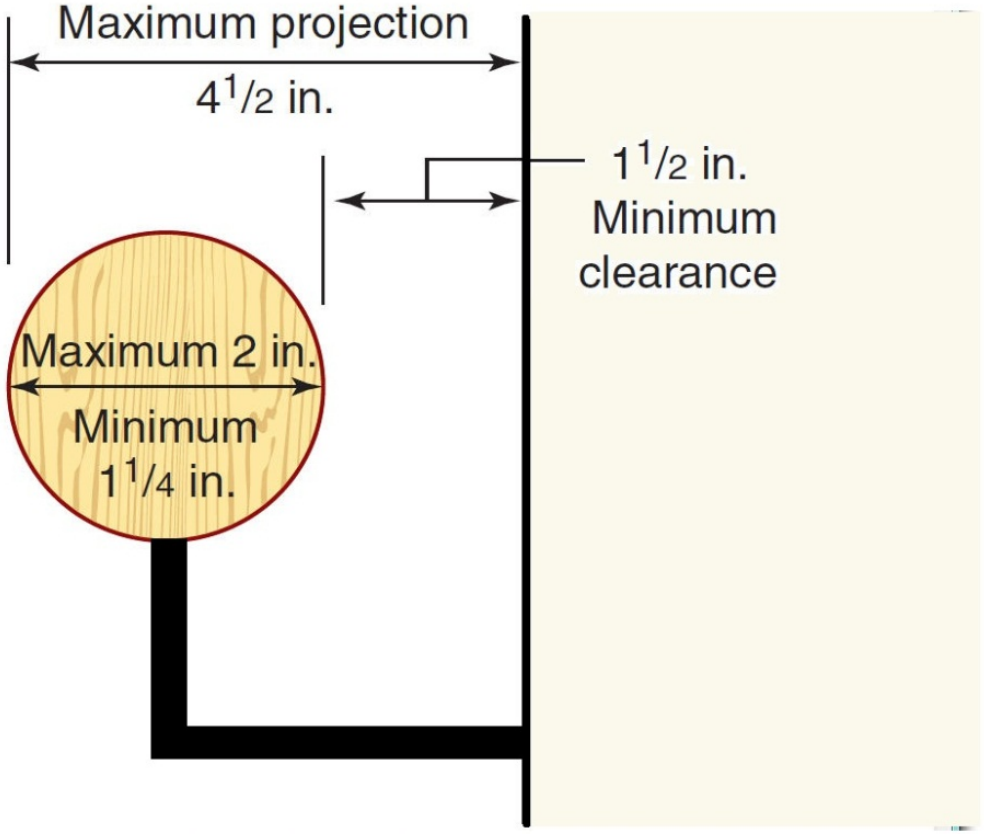
Landings

- Required at top and bottom of stairs
- Width of stairway
- Minimum 36” in direction of travel
- Maximum 151” vertically between landings
- Exception allows a door at the top of an interior flight of stairs, provided the door does not swing over the step



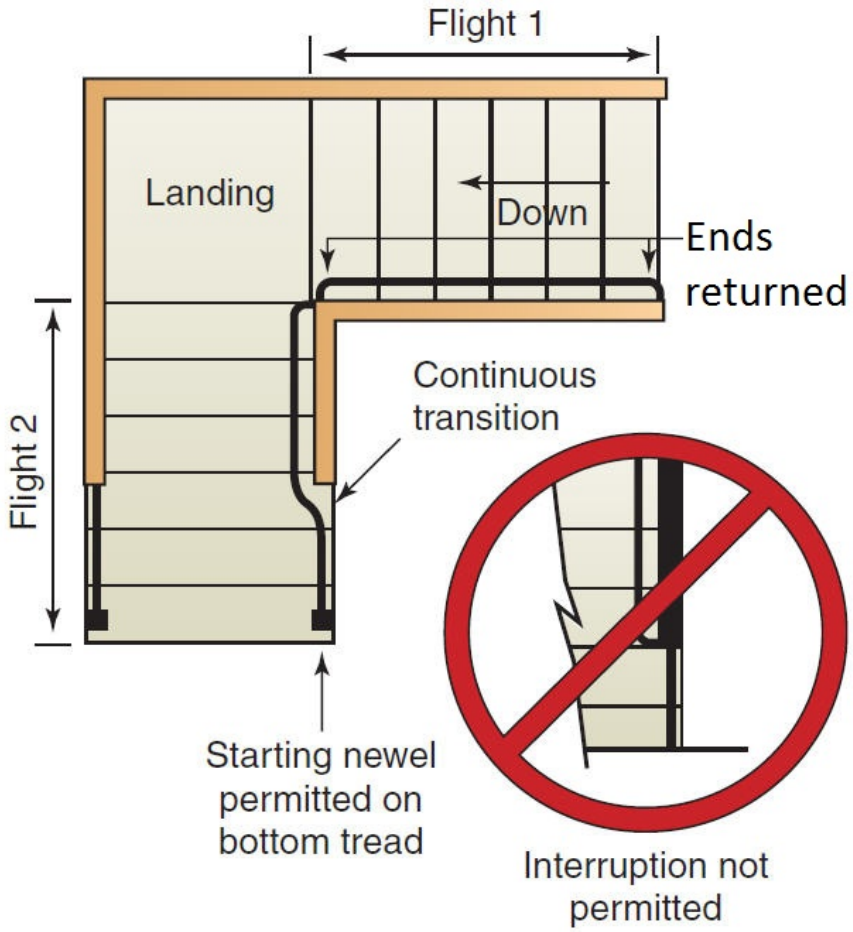
Handrail

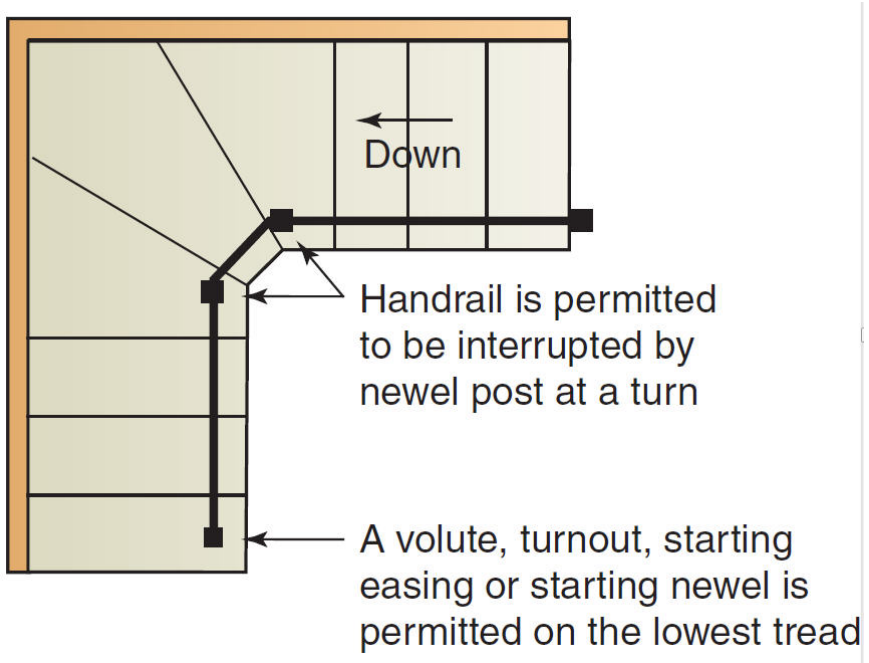
- Max. 4½-inch projection from wall
- Min. 1 ½-inch clearance to wal
- Graspable shape



Circular handrail

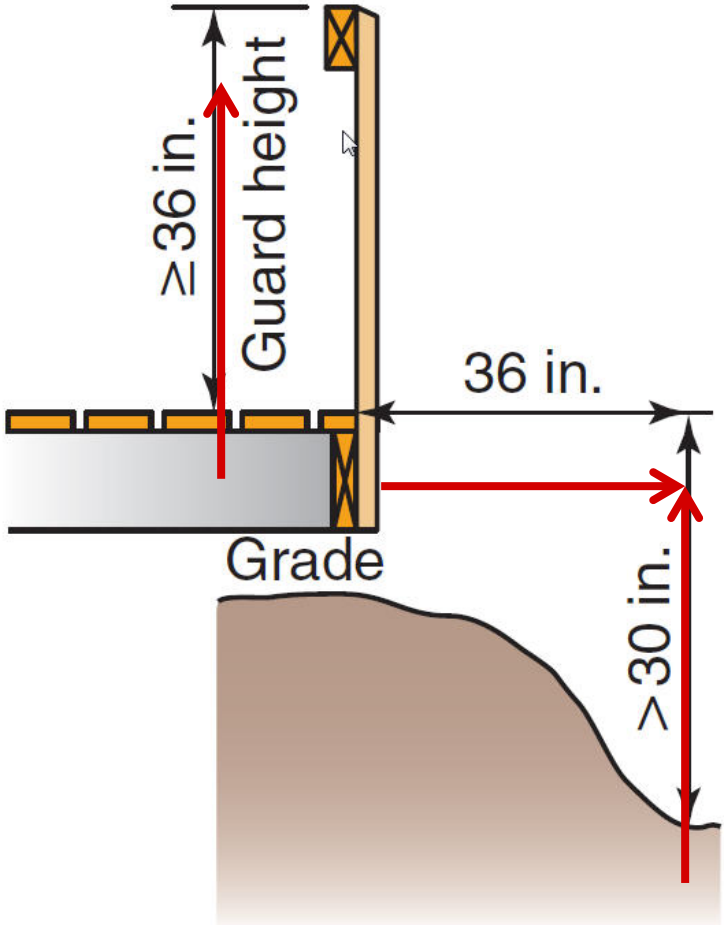
Handrail continuity





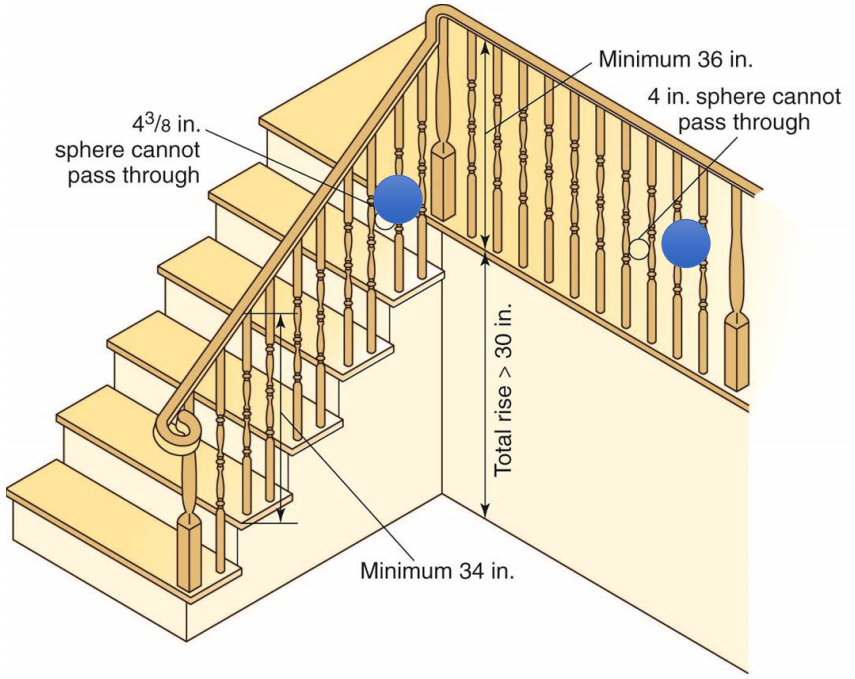
Guards

- A walking surface >30 inches above any point within 36 inches horizontally
- Min. guard height 36 in.
  - 34 in. at stairs



Guards

- Openings shall not allow a 4-in. sphere to pass through
  - 4 ⅜ in. along stairs
- Top rail to resist a single concentrated load of 200 lbs. applied in any direction
- Infill components to resist 50-lb. horizontal load applied to an area of 1 ft^2

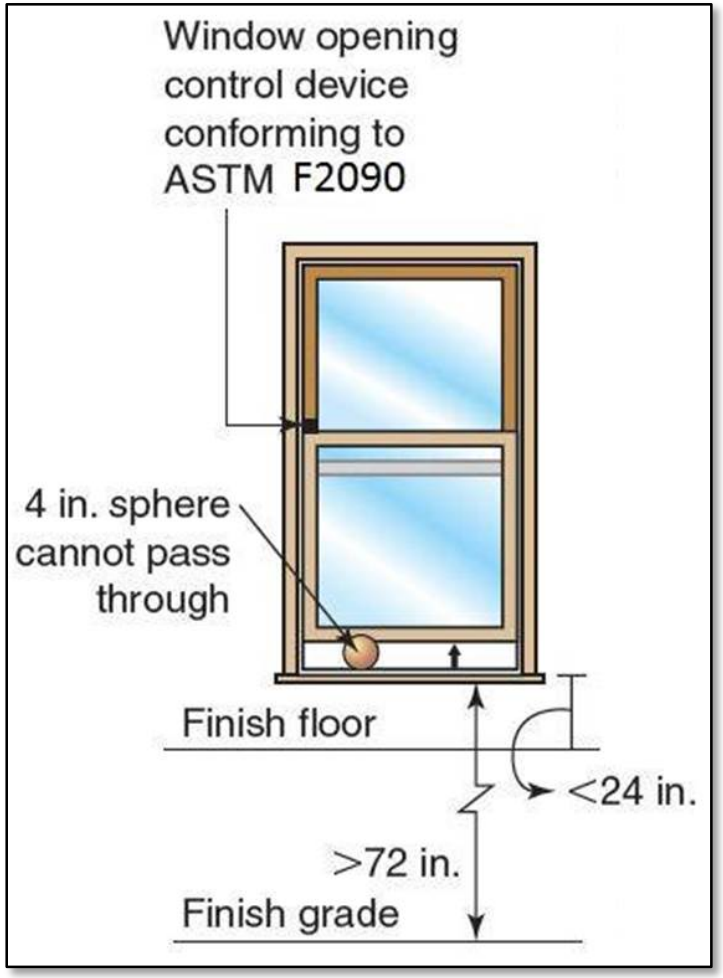


R311.7.1 and R311.7.8 Handrail Projection

The handrail projection limitation provides for adequate clearance behind the handrail when it passes a projection of a floor, landing or tread return.

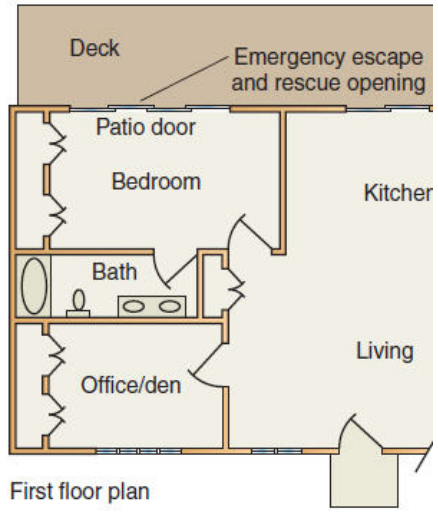
Windowsill Height

- Window openings >72” above grade must have a sill height of >24”
- Alternatives to 24” sill height
  - Window opening control device
  - Window fall prevention device
  - Fixed glazing

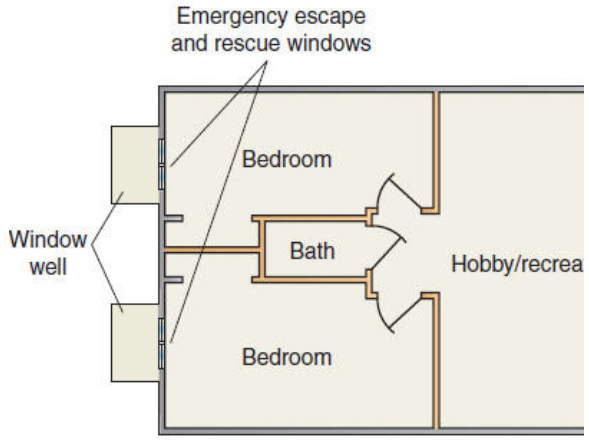


Emergency Escape and Rescue Openings

- Basements
- Habitable attics
- Sleeping rooms
  - Exceptions:
    - Storm shelters
    - Basements ≤ 200 sq. ft. used only to house mechanical equipment



First floor plan



Basement floor plan

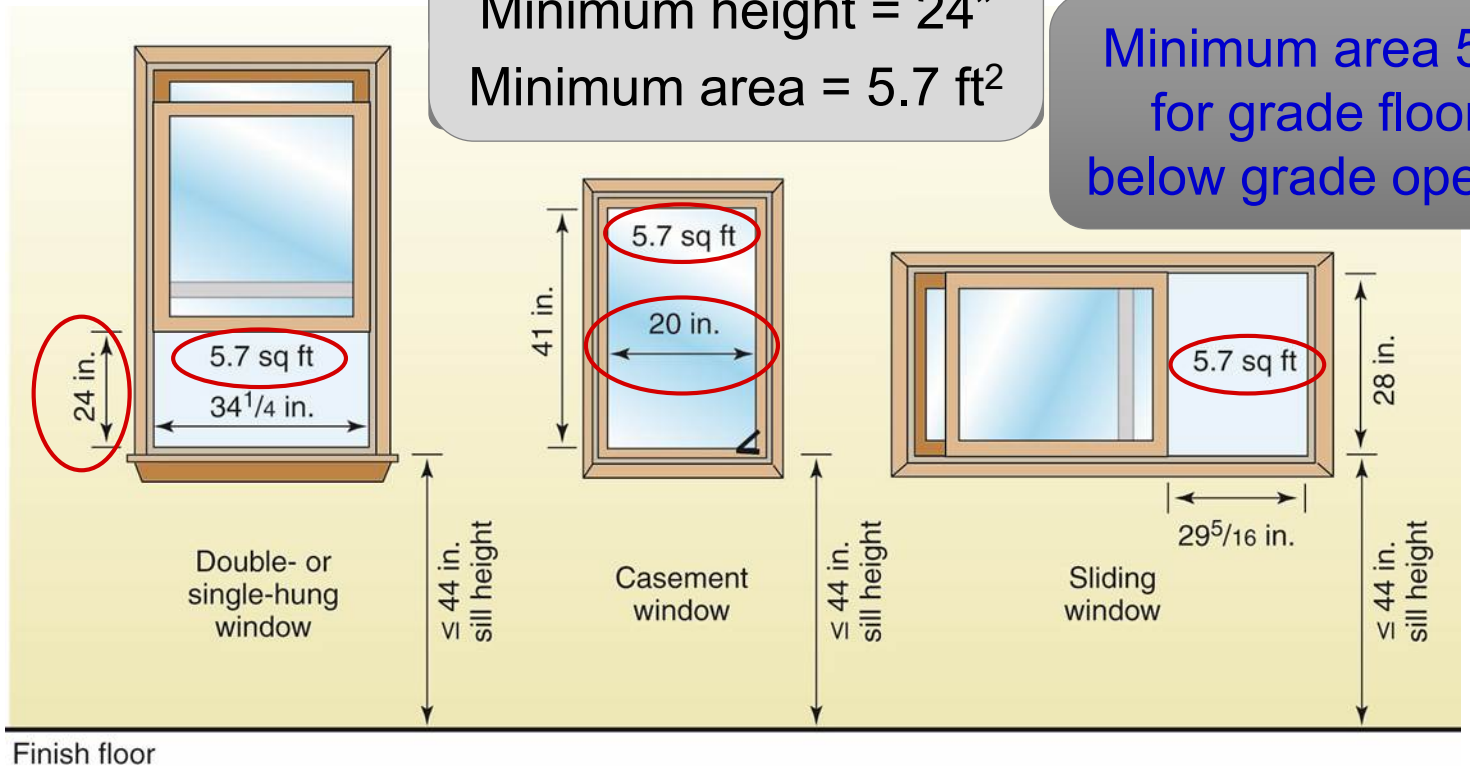
Emergency Escape and Rescue Openings

Minimum width = 20”

Minimum height = 24”

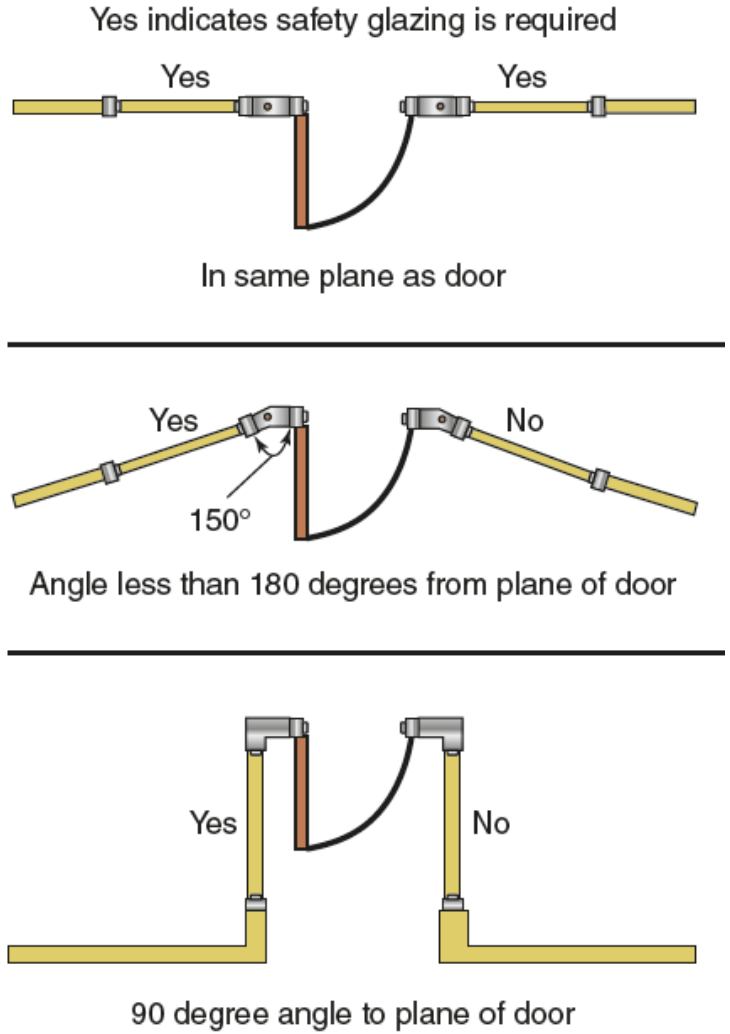
Minimum area = 5.7 ft^2

Minimum area 5.0 ft^2 for grade floor or below grade openings



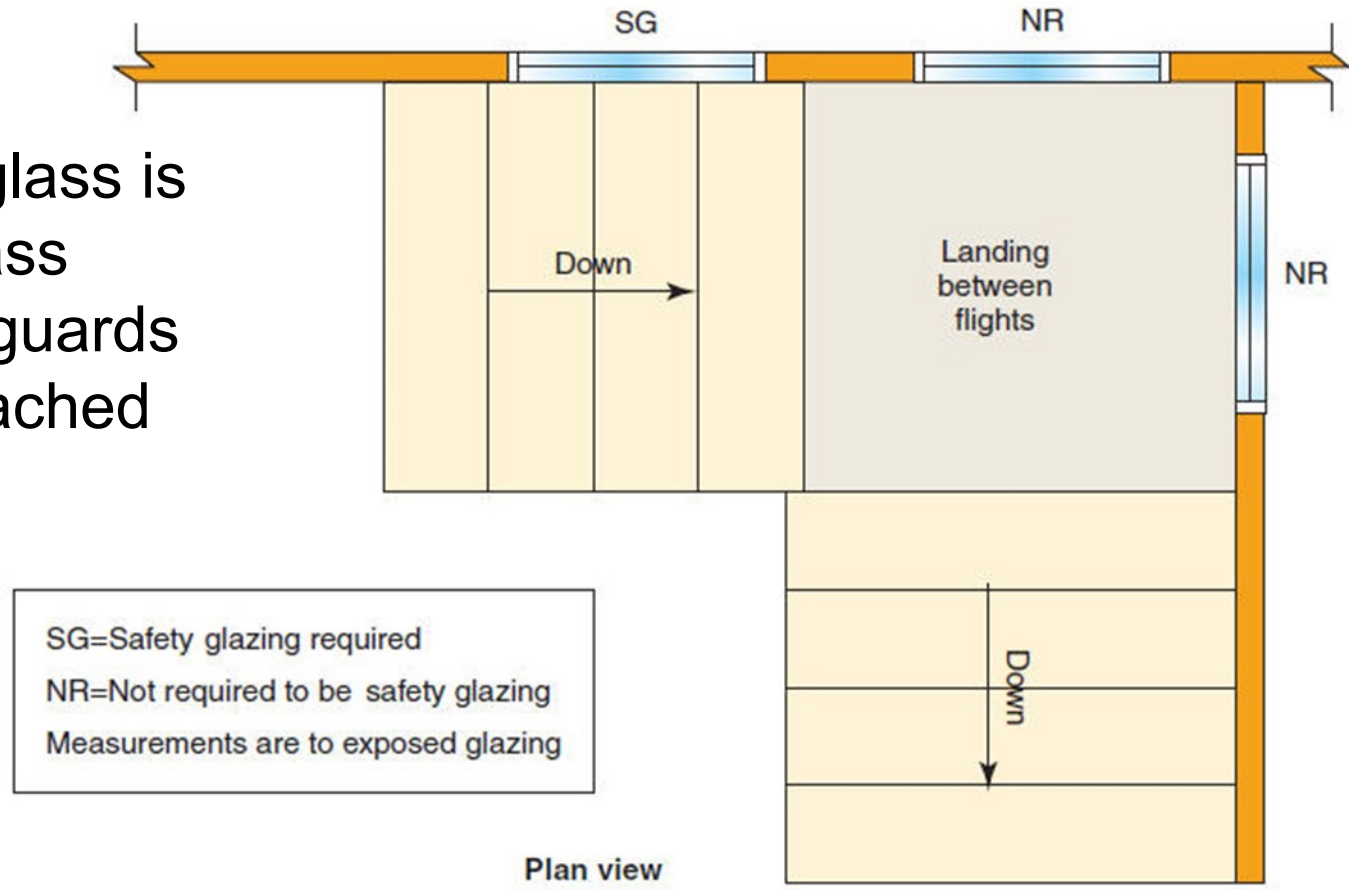
R308.4.2 Glazing Adjacent to Doors

Glazing within 24 inches of the hinge side of an in-swinging door now requires safety glazing where the glazing is at an angle less than 180 degrees from the plane of the door.



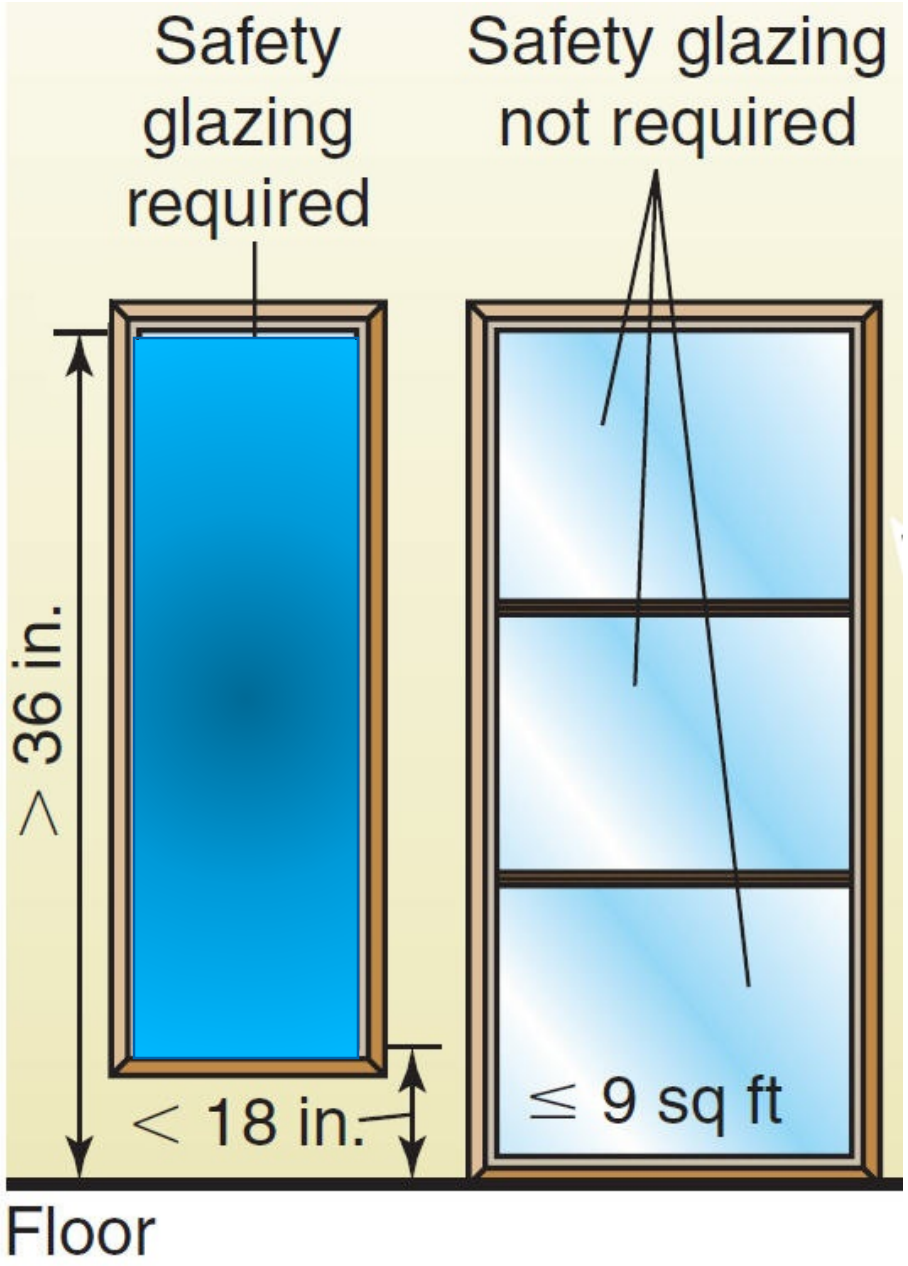
R308.4.4 Glazing in Guards and Railings

Unless laminated glass is used, structural glass baluster panels in guards now require an attached top rail or handrail.

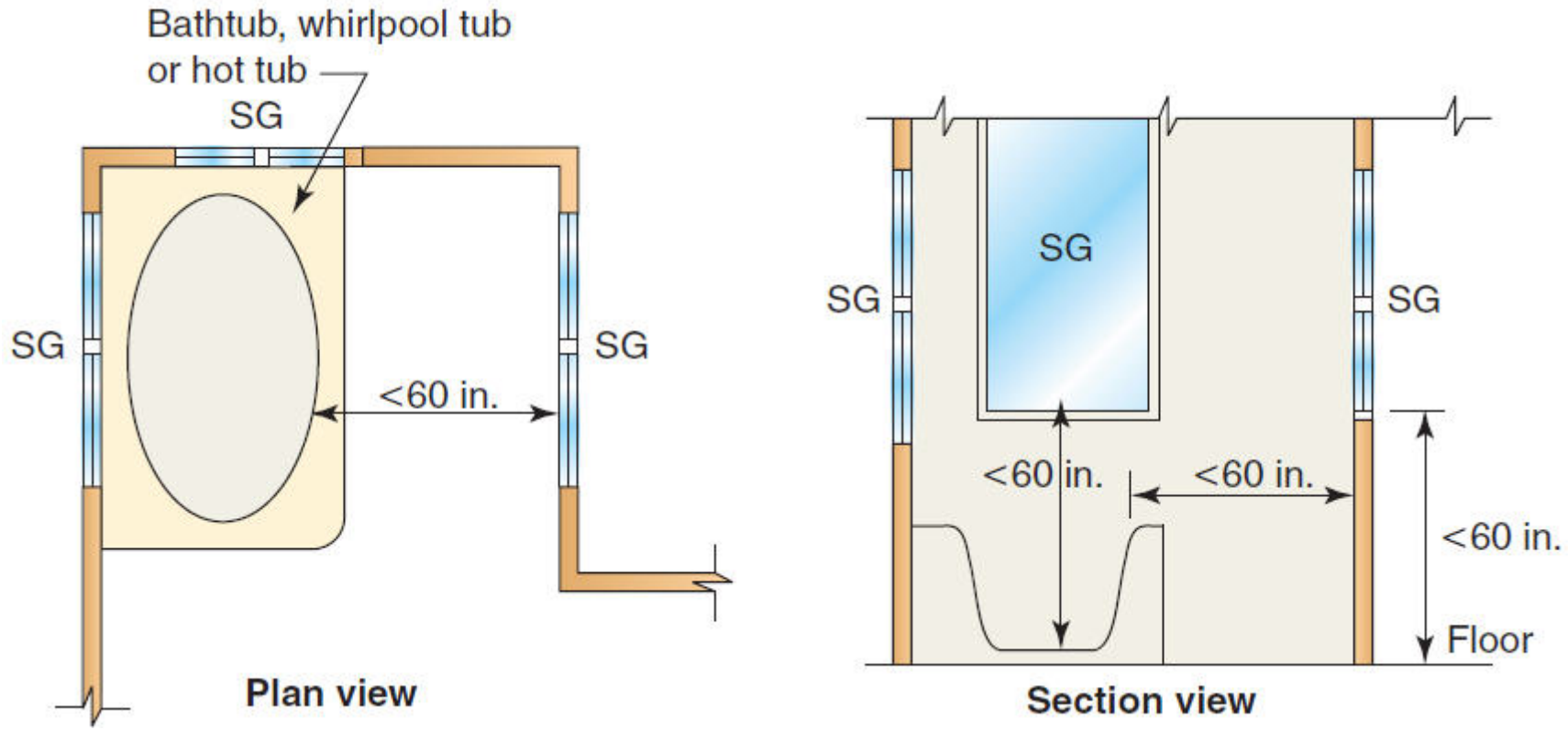


Safety Glazing – Windows

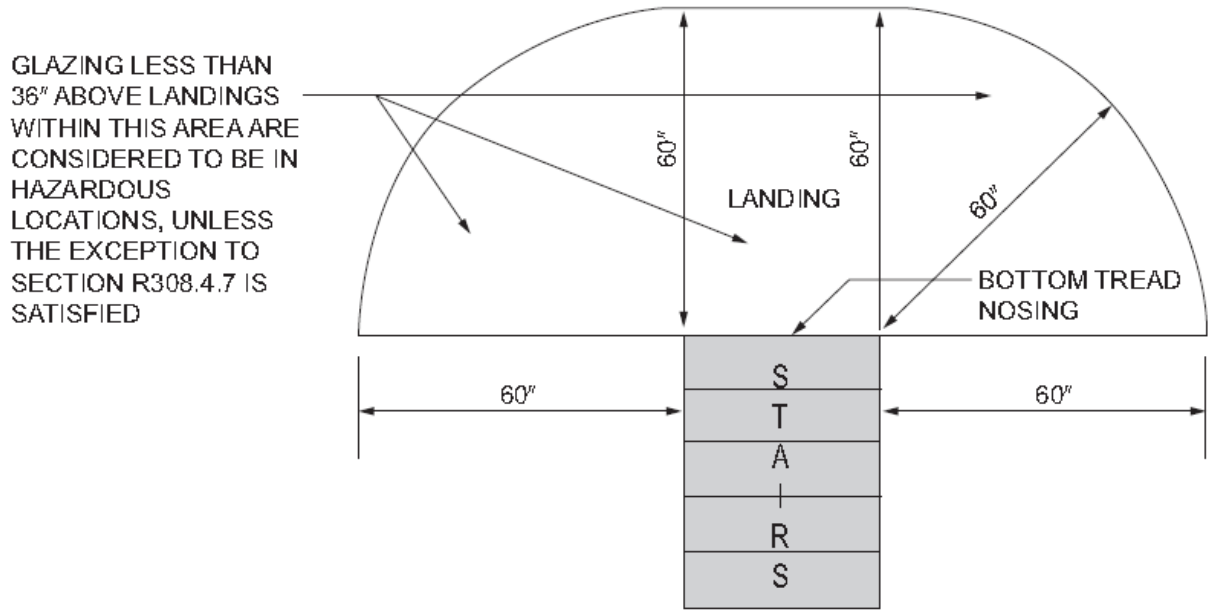
- Exposed area of an individual pane > 9 sq. ft.
- Bottom edge of glazing < 18 in. above floor
- Top edge of glazing > 36 in. above floor
  - Exception:
    - Horizontal rail installed 34 to 38 in. above walking surface



Safety Glazing – Wet Surfaces



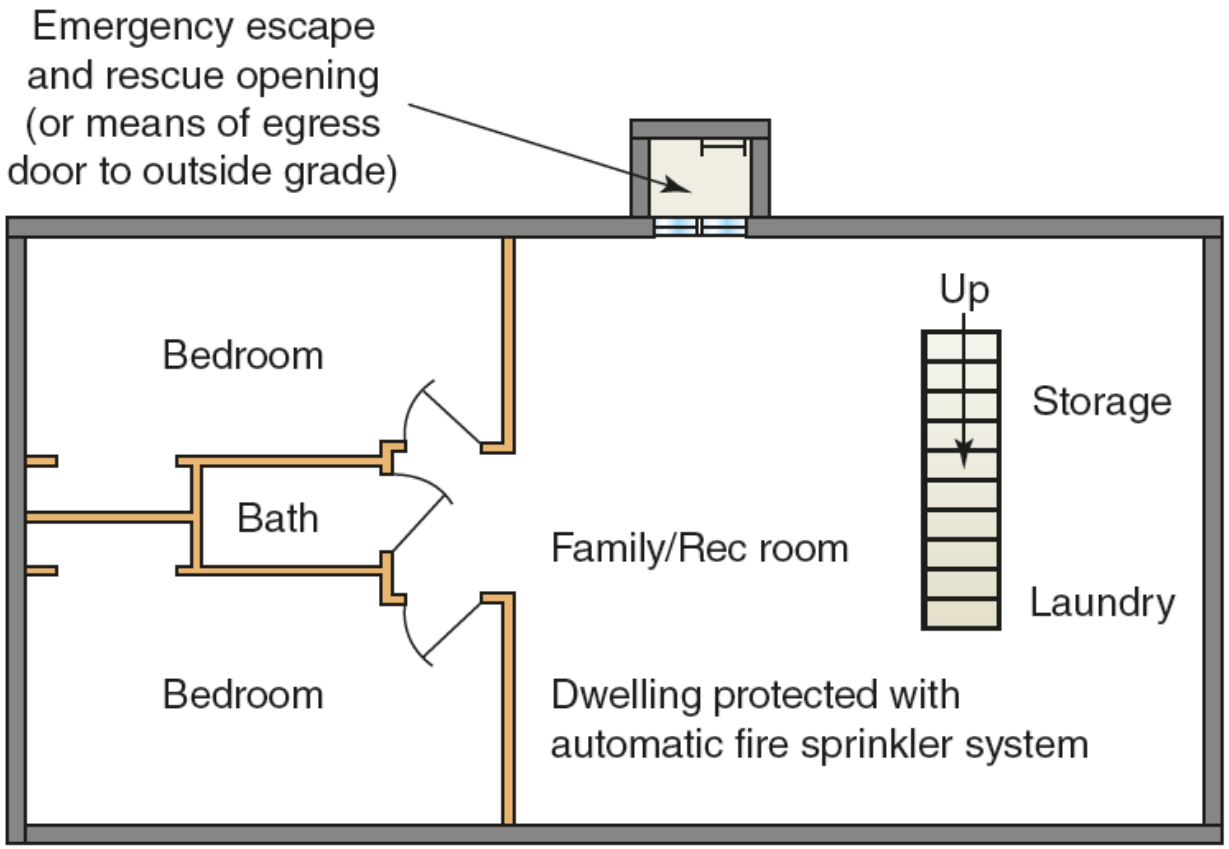
R308.4.7 Glazing Adjacent to the Bottom Stair Landing



For SI: 1 inch = 25.4 mm.

FIGURE R308.4.7
HAZARDOUS GLAZING LOCATIONS AT BOTTOM STAIR LANDINGS

R310.1 Emergency Escape and Rescue Opening Required



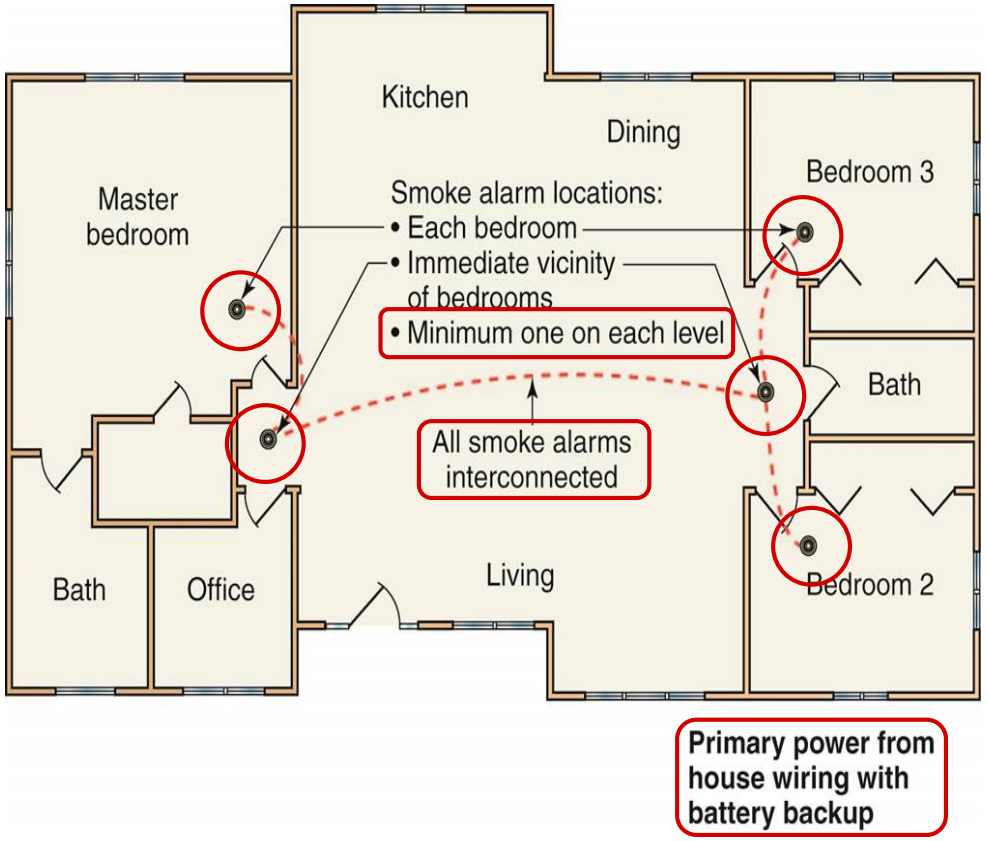
Basement floor plan

R310.3 Emergency Escape and Rescue Doors

Emergency escape and rescue windows require area wells and based on depth ladders or steps when over 44 inches deep.

Smoke Alarms

- In each sleeping room
- Outside each sleeping area
- On each story
- Building wiring system to provide primary power
- Battery backup
- Interconnection – No exception in 2018 IRC
- Wireless interconnection is acceptable



Smoke Alarms in Existing Dwellings

- Retrofit smoke alarms when a permit is required:
  - Interior alterations or repairs
  - Additions
- Battery-operated smoke alarms
- Exception – provisions do not apply for:
  - Minor work that does not require a permit
  - Exterior work such as roofing or siding
  - Replacing doors or windows
  - Addition of a deck or porch

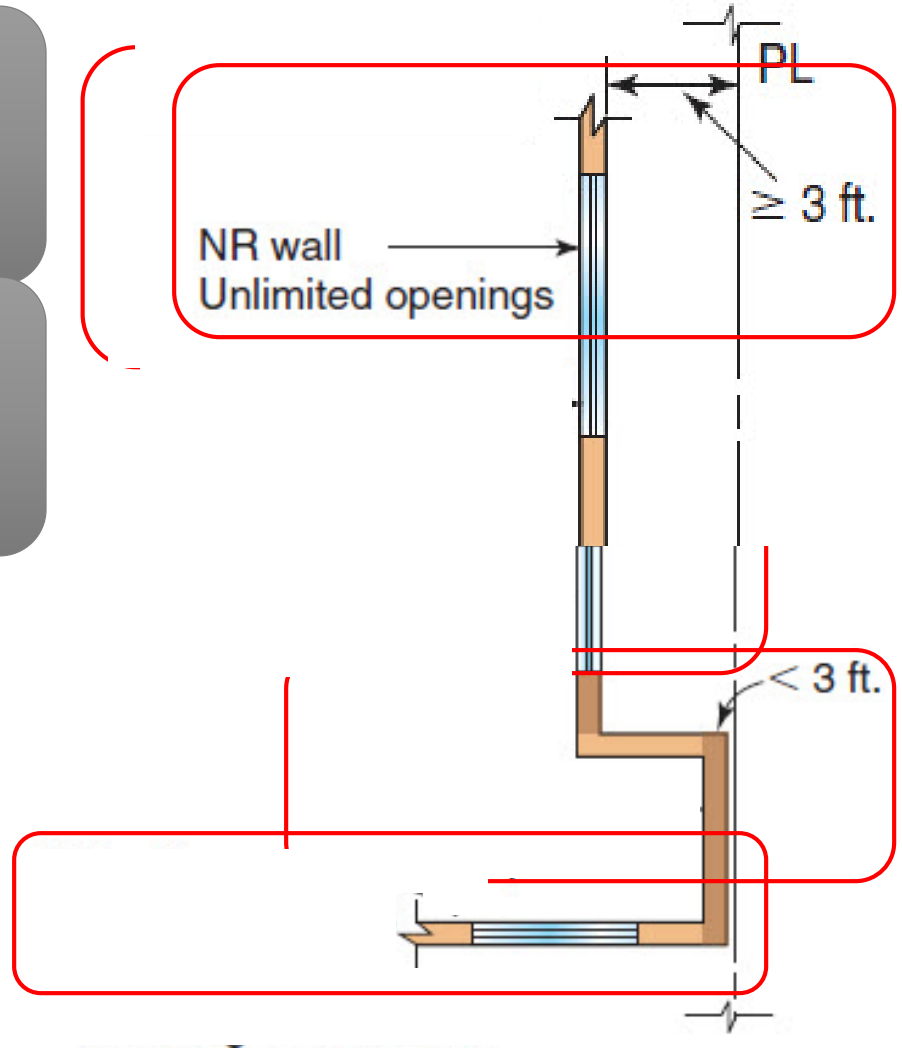
Residential Fire Sprinkler Systems

- Required in:
  - New dwellings
  - New townhouses
- Design criteria:
  - IRC Section P2904
  - NFPA 13D
  - Both designs applicable to 1- and 2-family dwellings and townhouses

Exterior Walls

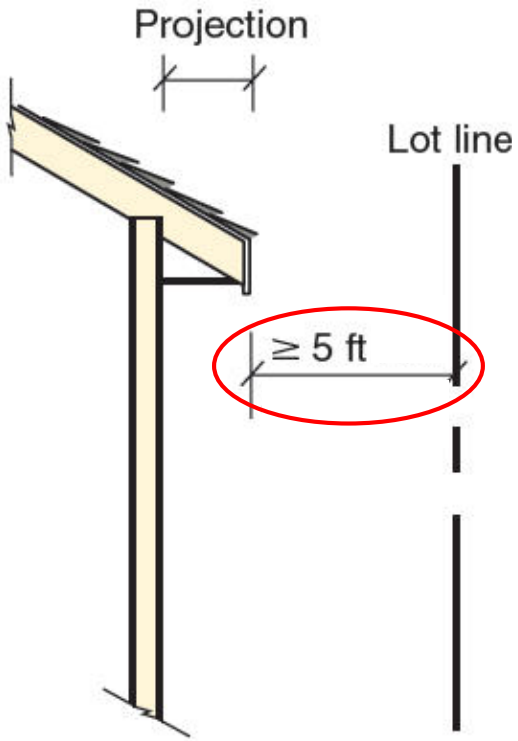
Dwelling **without** fire sprinklers

Dwelling **with** fire sprinklers



Eave Projections

Dwelling **without** fire sprinklers

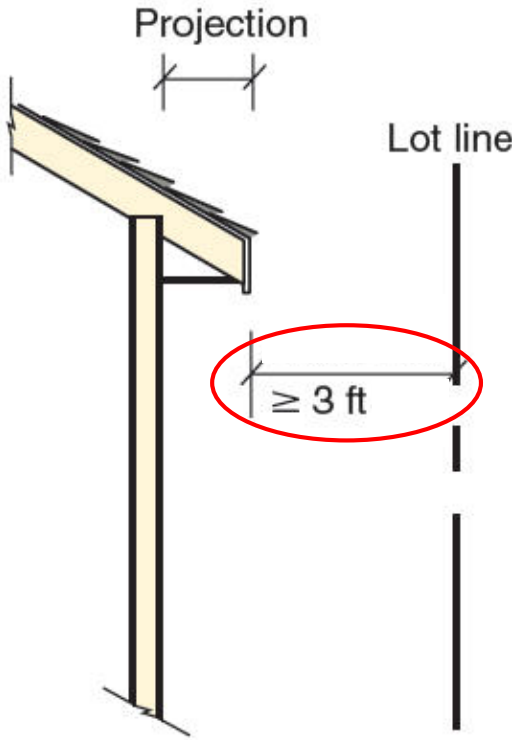


No protection required

1-HR protection

Eave Projections

Dwelling **with** fire sprinklers

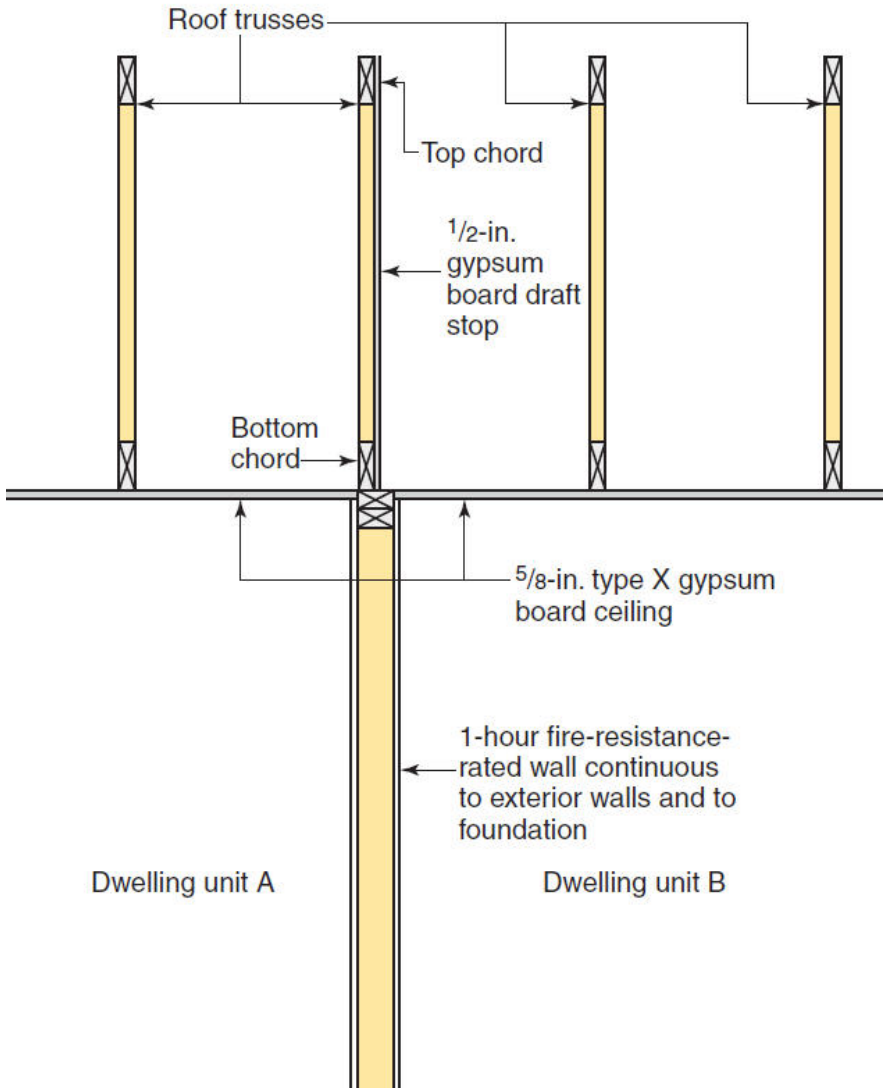


No protection required

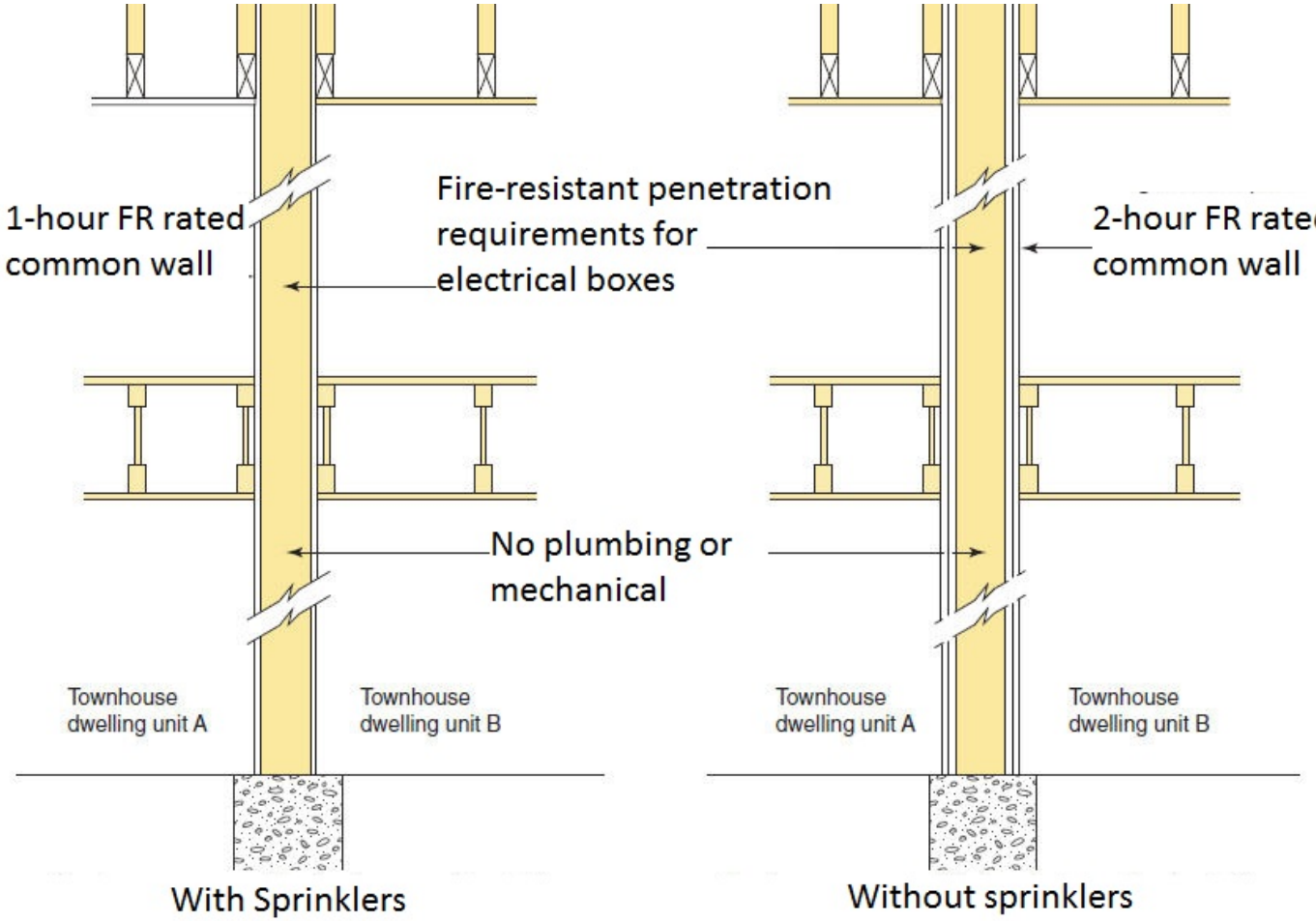
1-HR protection

Two-Family Dwelling Separation

- 1-hour separation
  - Continuous foundation to roof
- Exception
  - ⅝-inch gypsum board ceiling
  - ½-inch gypsum board on bearing walls
  - Draft stop in attic

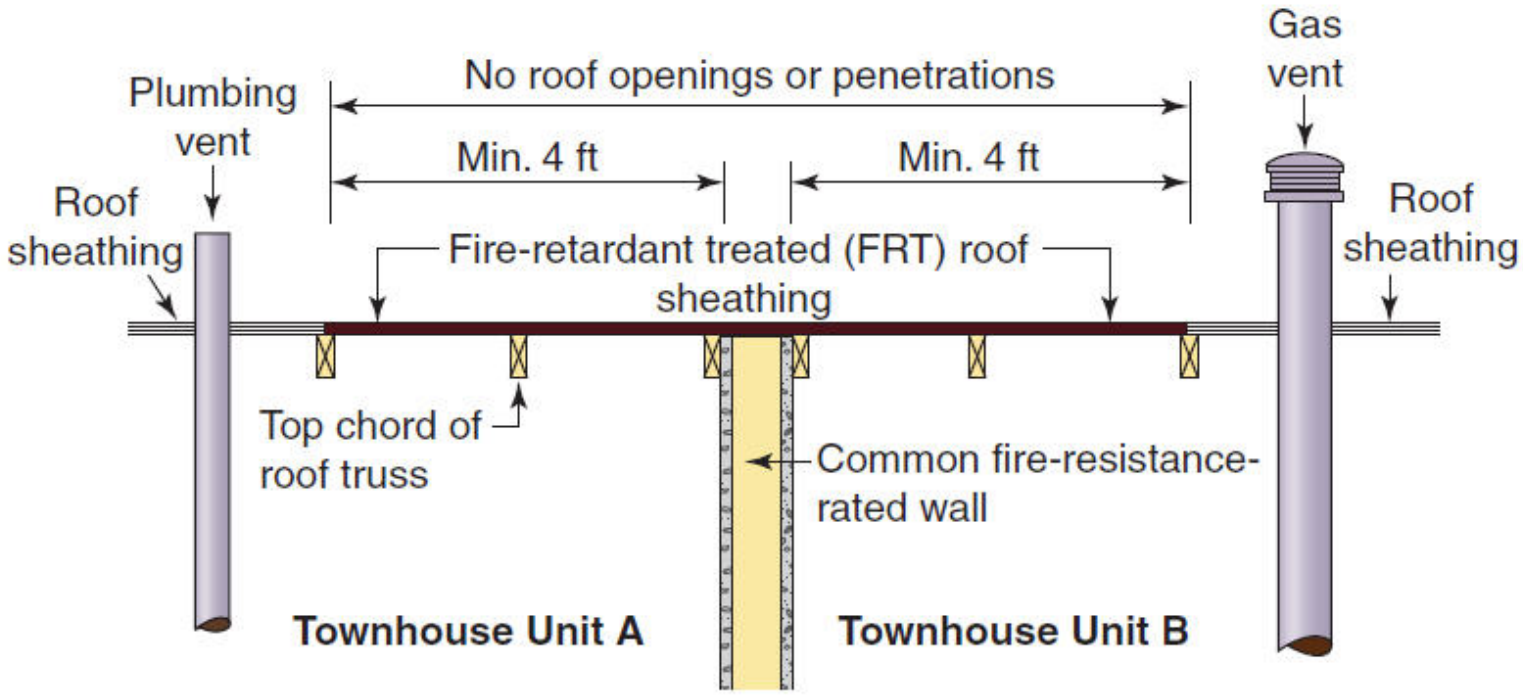


Townhouse Separation



Use of two 1-hour fire resistance wall assemblies is allowed.

Parapet Exception

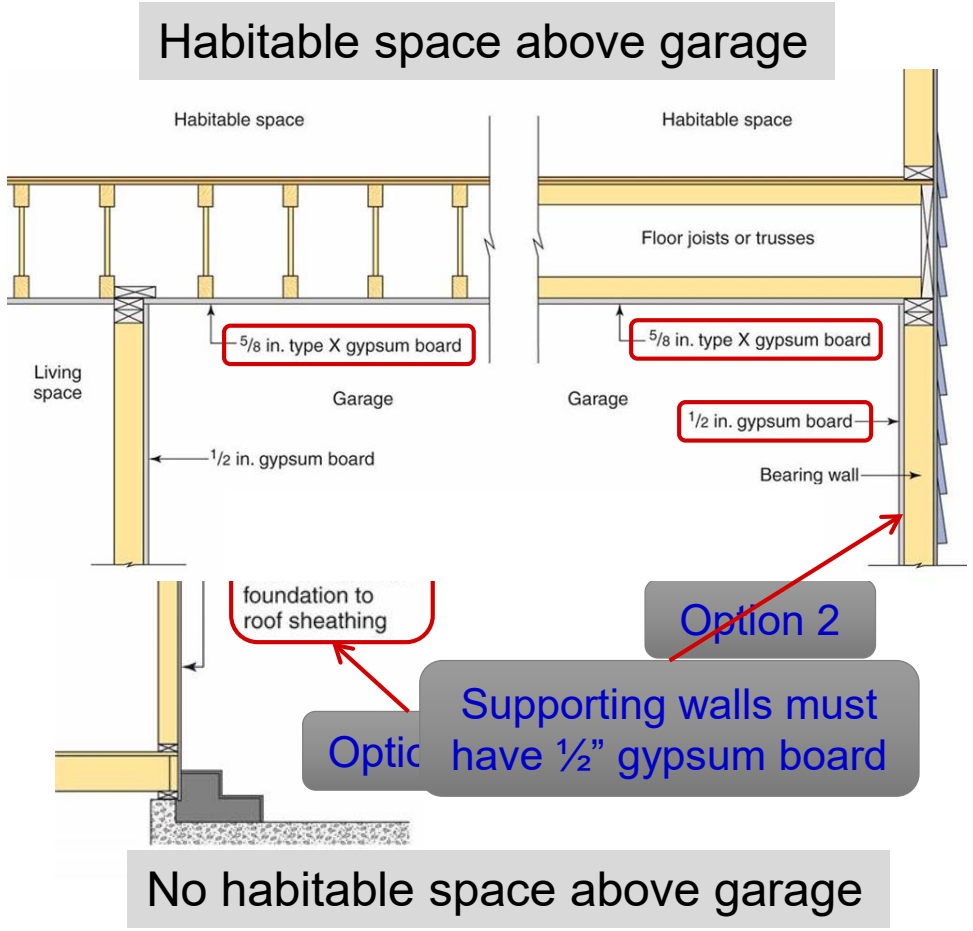


Alternatives to FRT sheathing:

- Non-combustible sheathing
- 5/8-in. type X gypsum board below sheathing

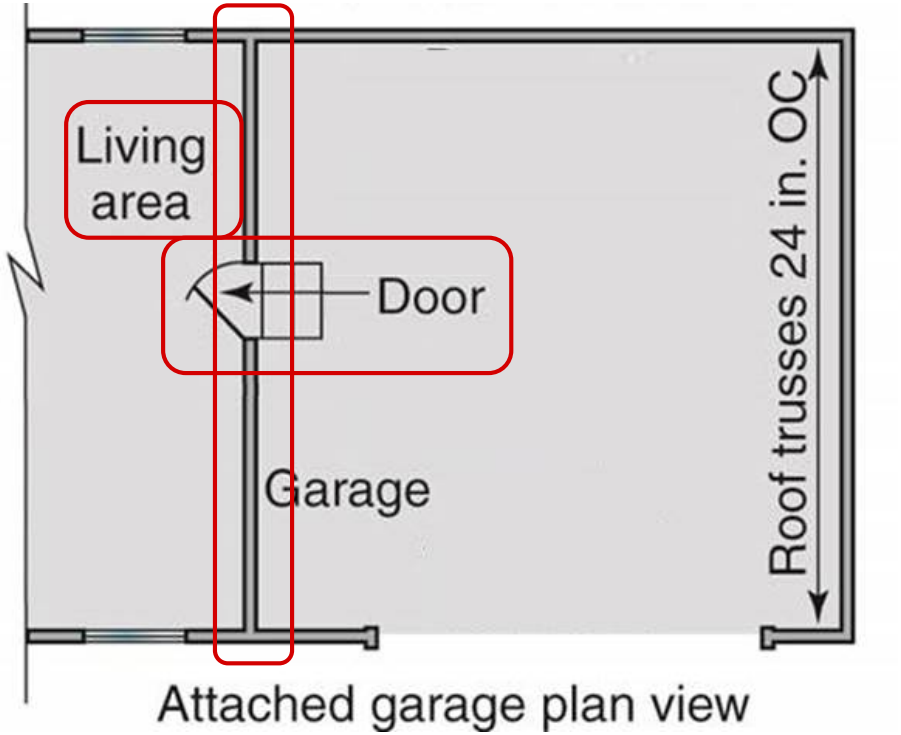
Dwelling Separation from Garage

- Not a fire-resistance-rated assembly
- ½” gypsum board on the garage side provides limited resistance to the spread of fire
- ⅝” Type X gypsum board on ceiling when habitable space above



Dwelling Separation from Garage

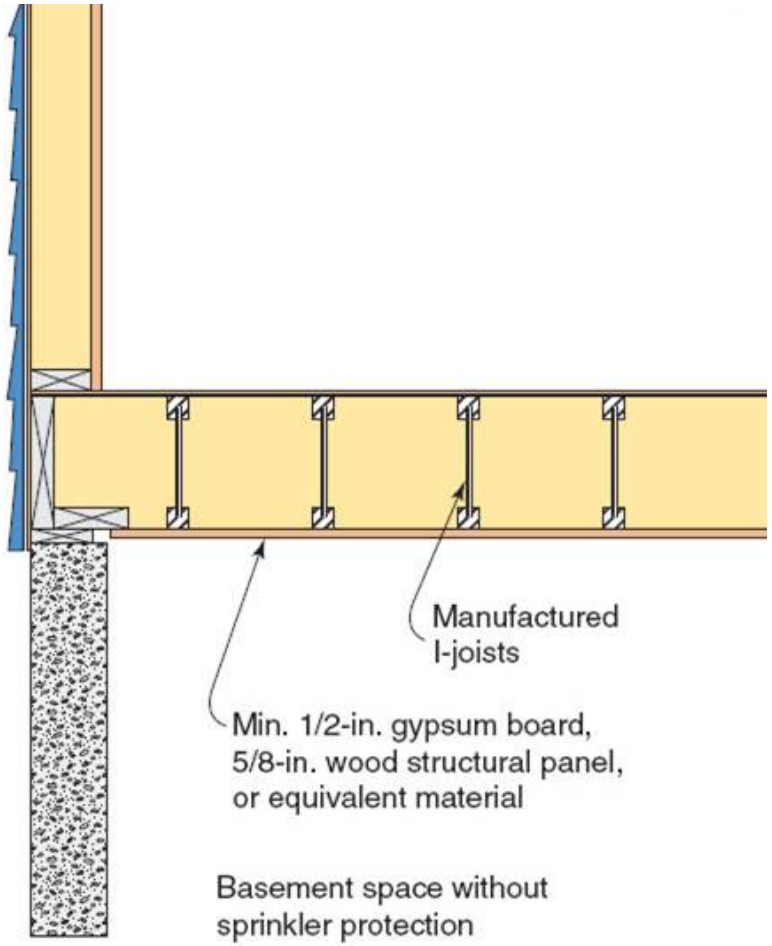
- Penetrations not rated
- No openings from garage into a sleeping room
- Self-closing door
  - 1⅜”-thick solid-core wood
  - 1 ⅜”-thick solid-core steel
  - 1 ⅜”-thick honeycomb-core steel
  - 20-minute fire-resistance-rated



Attached garage plan view

Fire Protection of Floors

- Underside of floor assembly
  - ½” gypsum board
  - ⅝” wood structural panel
  - equivalent material
- Exceptions
  - ≥ 2 ×10 dimension or SCL
  - Sprinklers below
  - ≤ 80 ft^2 area
  - Crawl space with no storage or fuel-fired appliances

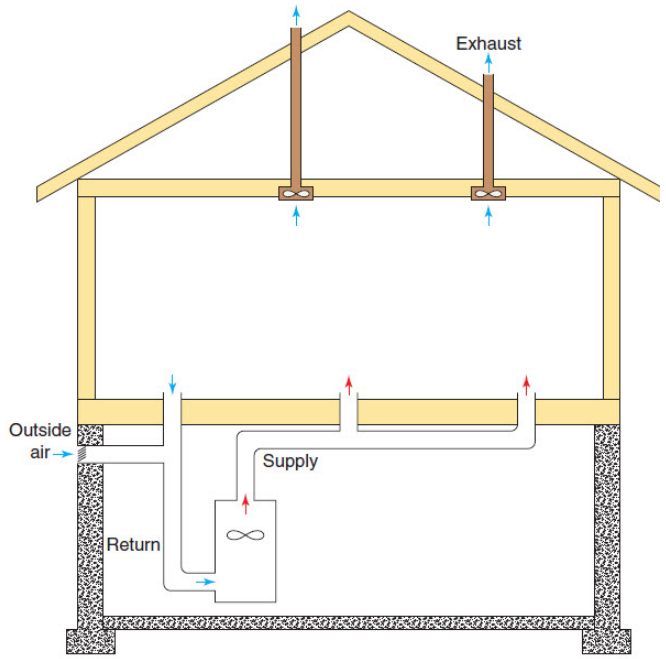


Light and Ventilation

- Habitable rooms:
  - Glazing ≥ 8% or lighting ≥ 6 footcandles
  - Openings ≥ 4% or mechanical ventilation
- Bathrooms:
  - Glazing ≥ 3 ft^2 or electric lighting
  - Openings ≥ 1.5 ft^2 or mechanical exhaust

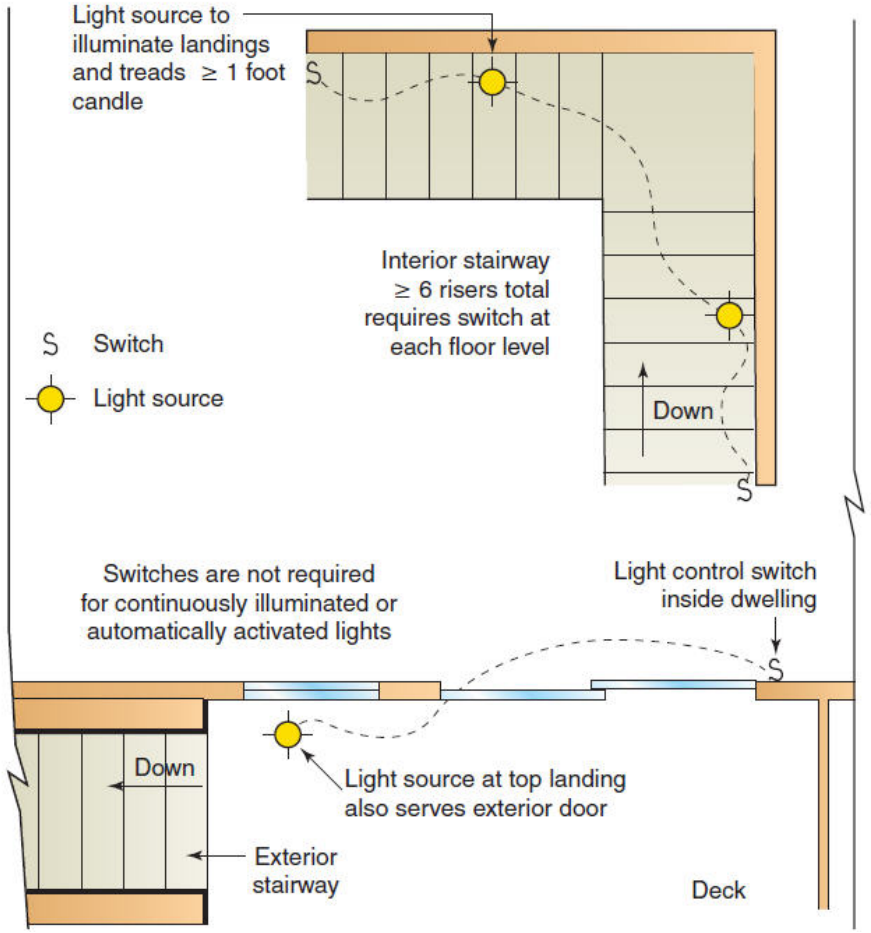
Whole-house Mechanical Ventilation System

- Required if
  - Blower door test performed and
  - Air infiltration rate ≤ 5 ACH
- Prescriptive air flow rate based on
  - Area of dwelling
  - Number of bedrooms
  - Continuous or intermittent operation



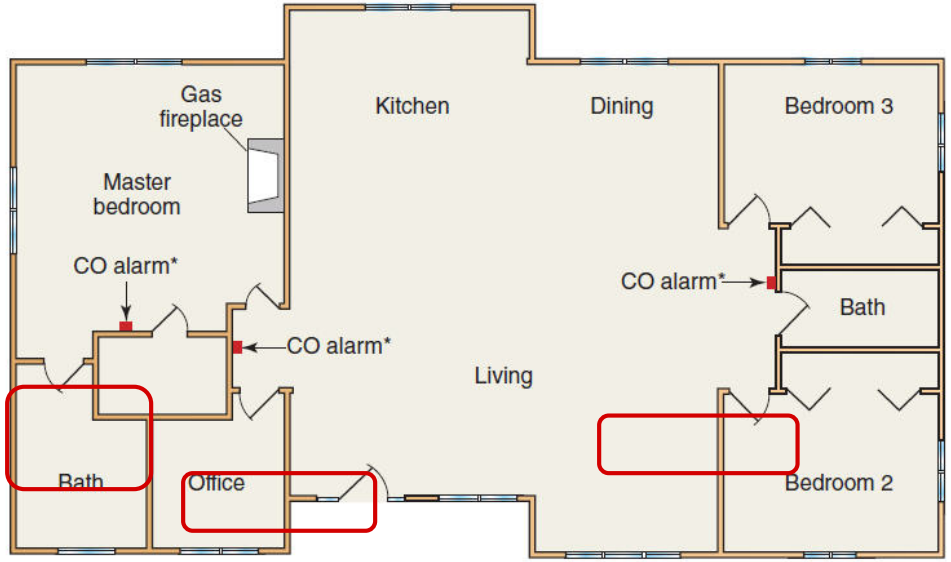
Stairway Illumination

- Interior stairways
  - Treads and landings ≥1 foot-candle
  - Wall switch at each floor level ≥ 6 risers.
- Exterior stairways
  - Light source at top landing
  - Bottom landing providing access to a basement



Carbon Monoxide (CO) Alarms

- Required if
  - Fuel-fired appliance or
  - Attached garage communicating with dwelling unit
- Locations
  - Outside of each separate sleeping area adjacent bedrooms
  - Within bedroom with fuel-burning appliance located within bedroom or attached bathroom
- Power
  - House wiring with battery backup
  - Interconnection – No exception in 2018 IRC
  - Wireless interconnection is acceptable



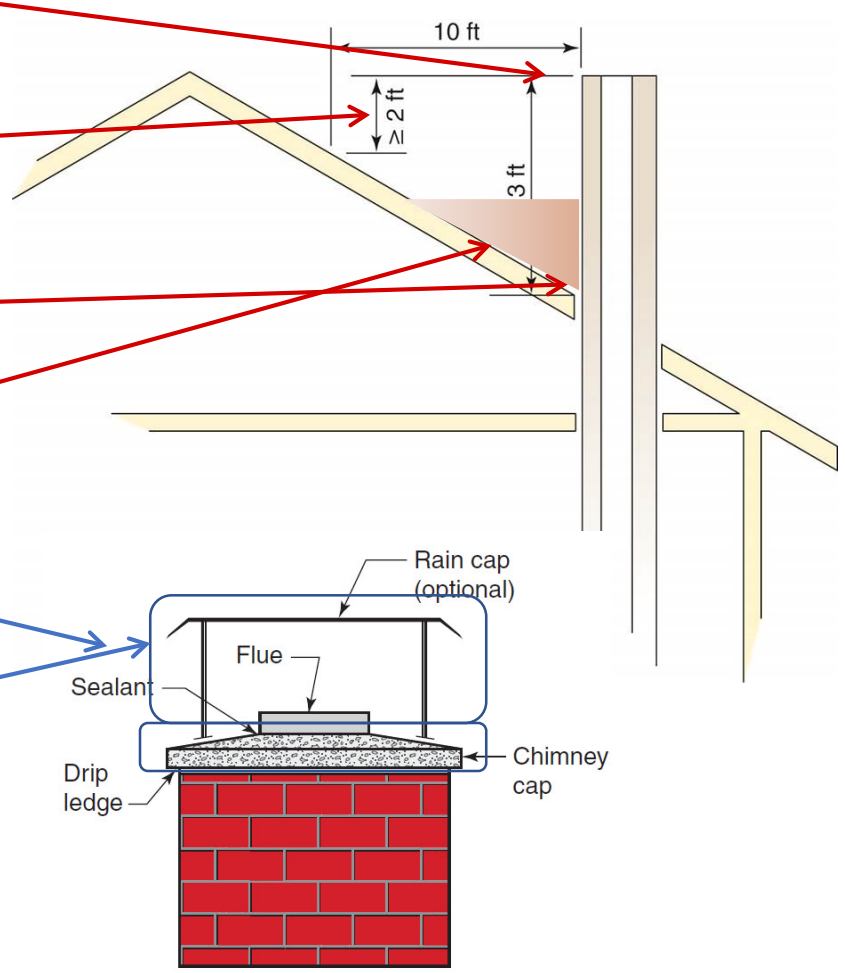
Chimneys and Fireplaces

- Masonry fireplaces
- Masonry chimneys
- Factory-built fireplaces
- Factory-built chimneys
- Exterior Air Supply

Per manufacturer's instructions

Masonry Chimney Termination

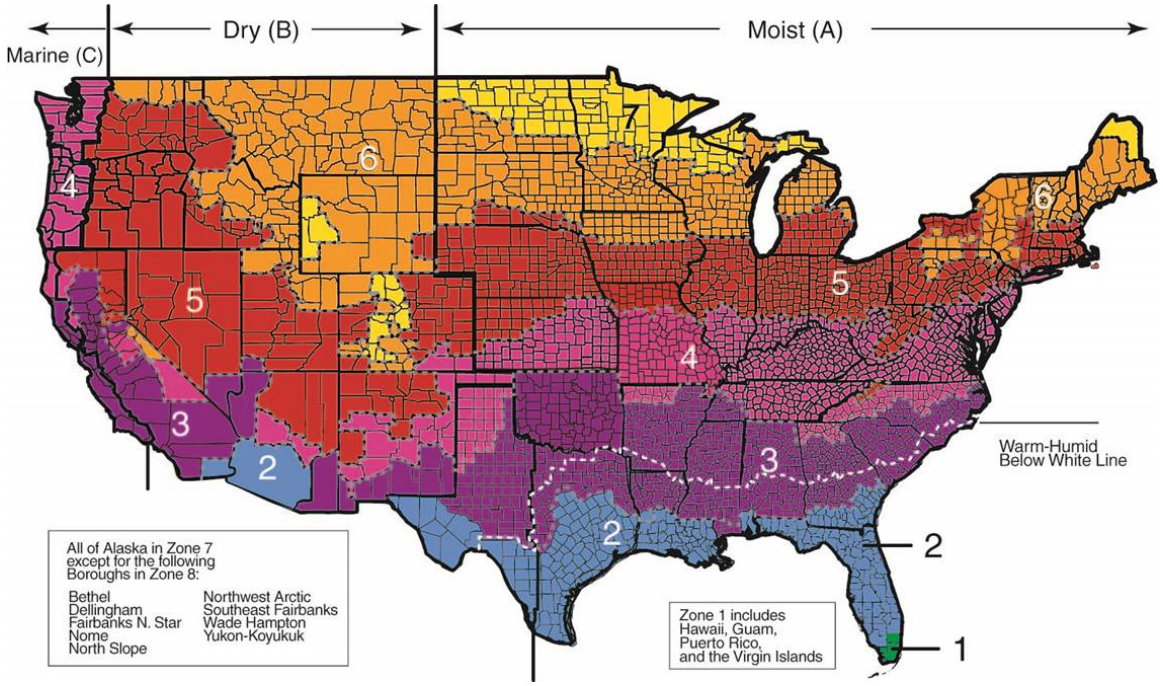
- 3 feet above roof penetration
- 2 feet higher than any portion of a building within 10 feet
- Flashing to weatherproof the chimney penetration at the roof
- Crickets required for chimneys ≥30” wide
- Chimney cap required
- Rain cap optional

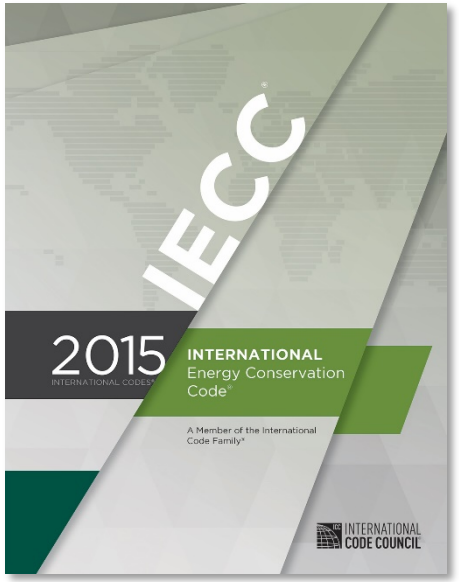


Energy Conservation

Energy Efficiency

- IRC Chapter 11 is extracted from the applicable provisions of the 2015 IECC





Compliance Paths

Projects shall comply with one of the following:

1. Sections N1101.14 through N1104.
2. Section N1105 and the provisions of Sections N1101.14 through N1104 labeled “Mandatory.”
3. An energy rating index (ERI) approach in Section N1106.

Prescriptive and mandatory provisions

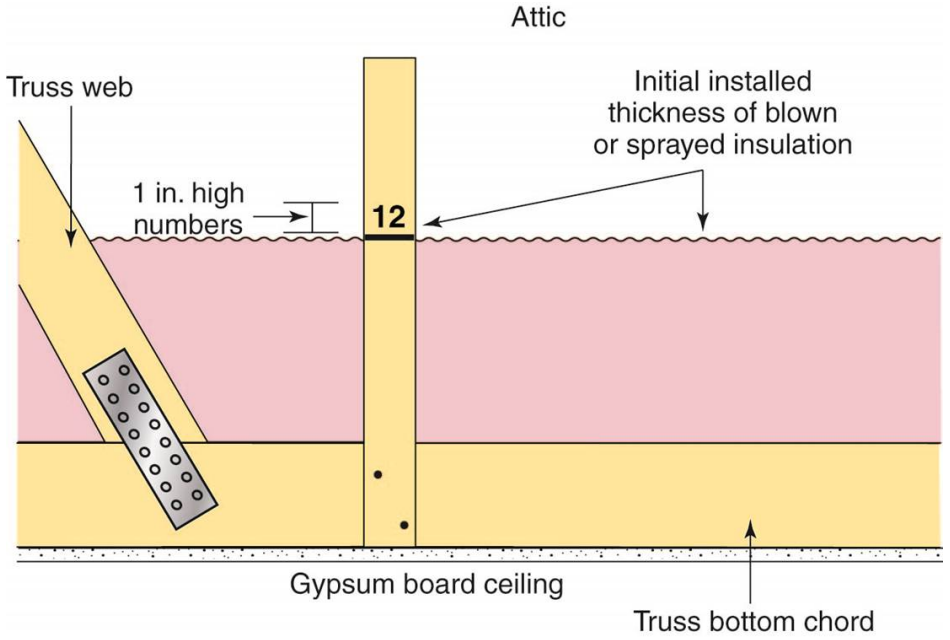
Performance and mandatory provisions

Building Insulation

- Pieces of insulation >12” in width must have:
  - Visible R-value mark; or
  - Installer certification
    - Insulation type
    - Manufacturer
    - R-value

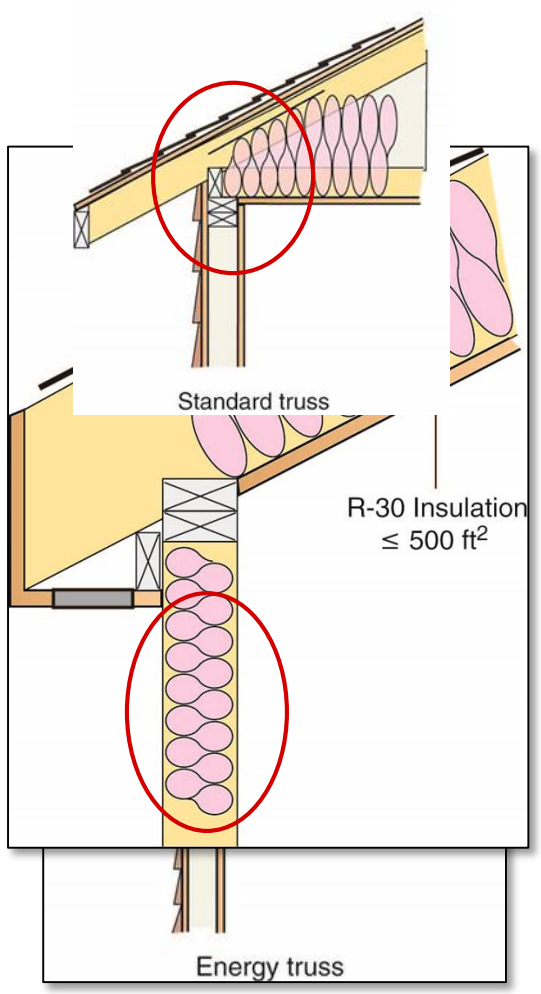
Blown-in or Sprayed Insulation

- Attic markers each 300 sq. ft.
- Certificate indicating:
  - Initial installed thickness
  - Settled thickness
  - Settled R-value
  - Installed density
  - Coverage area
  - Number of bags installed



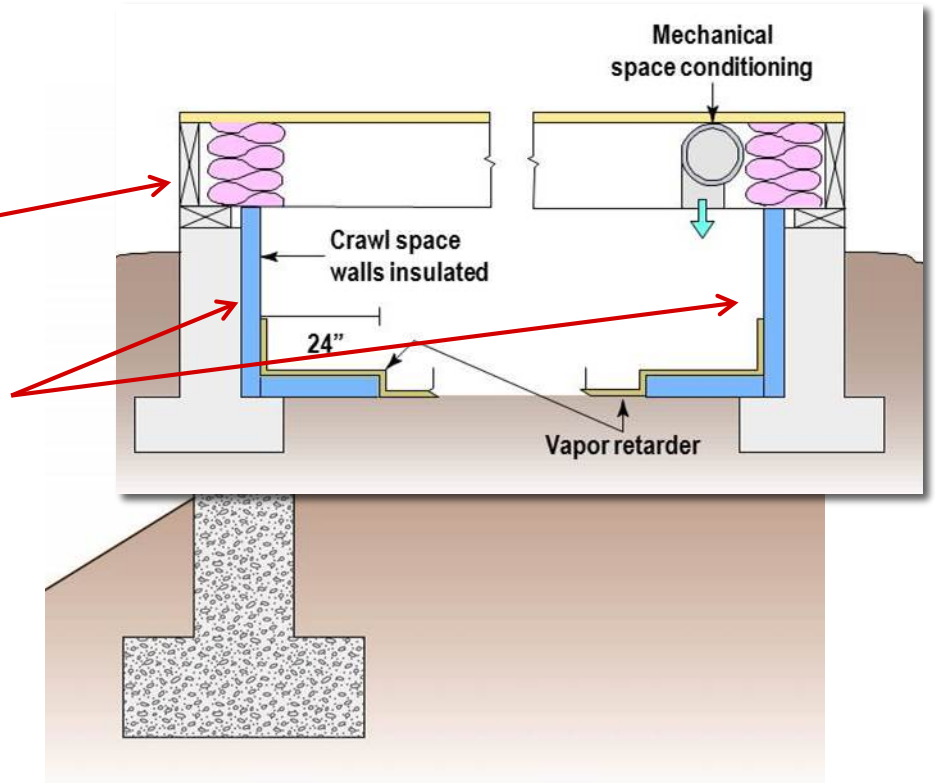
Insulation Requirements

- Minimum R-values for insulation is based on climate zone
- Exceptions:
  - Energy truss or raised-heel roof truss
  - Reduced R-values in rafter or joist space
  - Cold-formed steel framing requires higher insulation R-values and continuous insulation sheathing to provide a thermal break



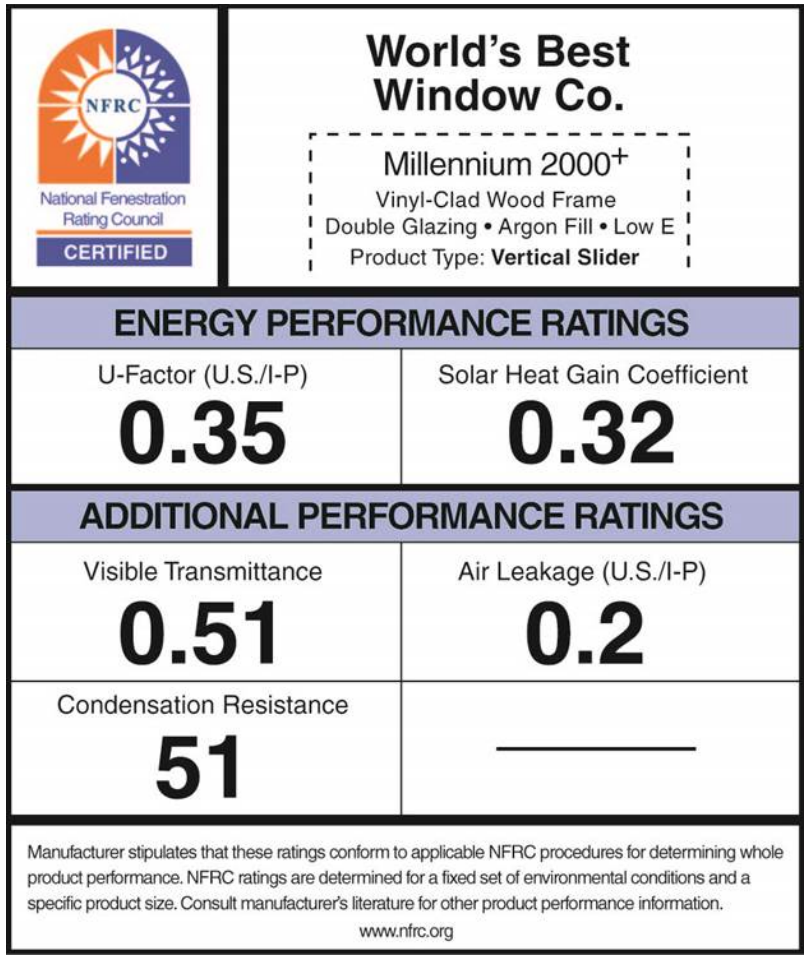
Insulation Requirements

- Slab on grade
- Crawl spaces
  - Insulation of the floor above the crawl space; or
  - Insulation of the exterior walls
    - When the crawl space is not ventilated to the outside
    - Vapor retarder on exposed earth of unventilated crawl spaces



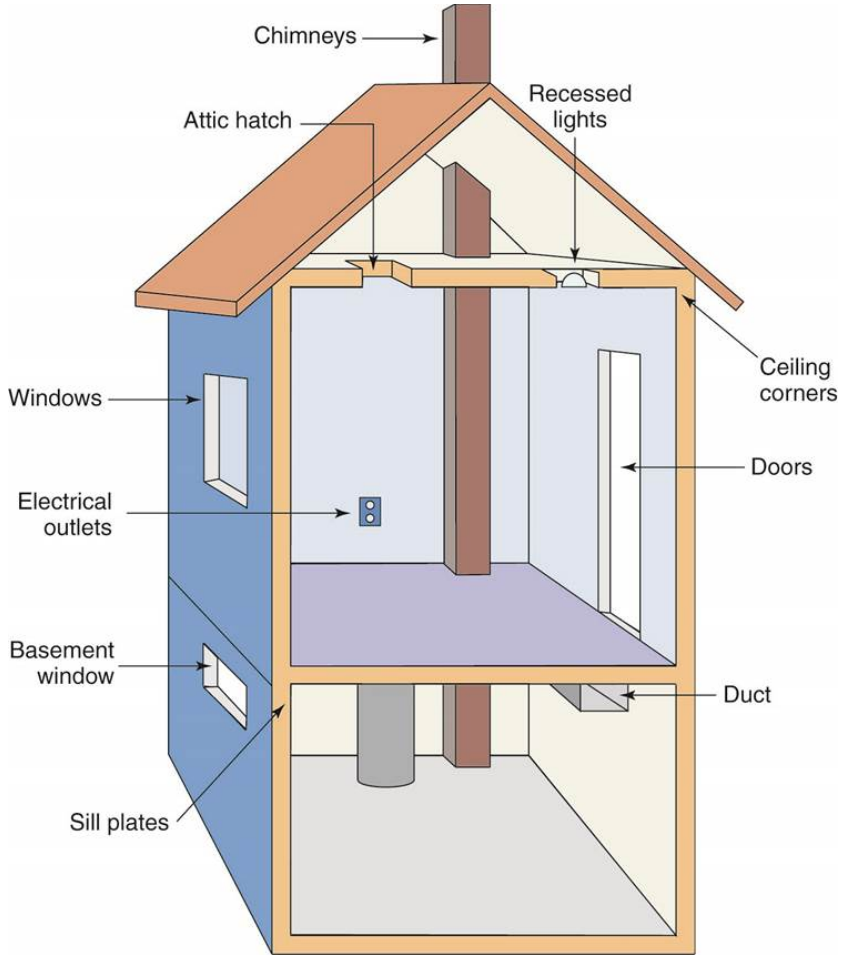
Windows and Doors

- Fenestration includes:
  - Skylights
  - Roof windows
  - Vertical windows
  - Opaque doors
  - Glazed doors
  - Glass block
- U-factor
- Solar Heat Gain Coefficient (SHGC)



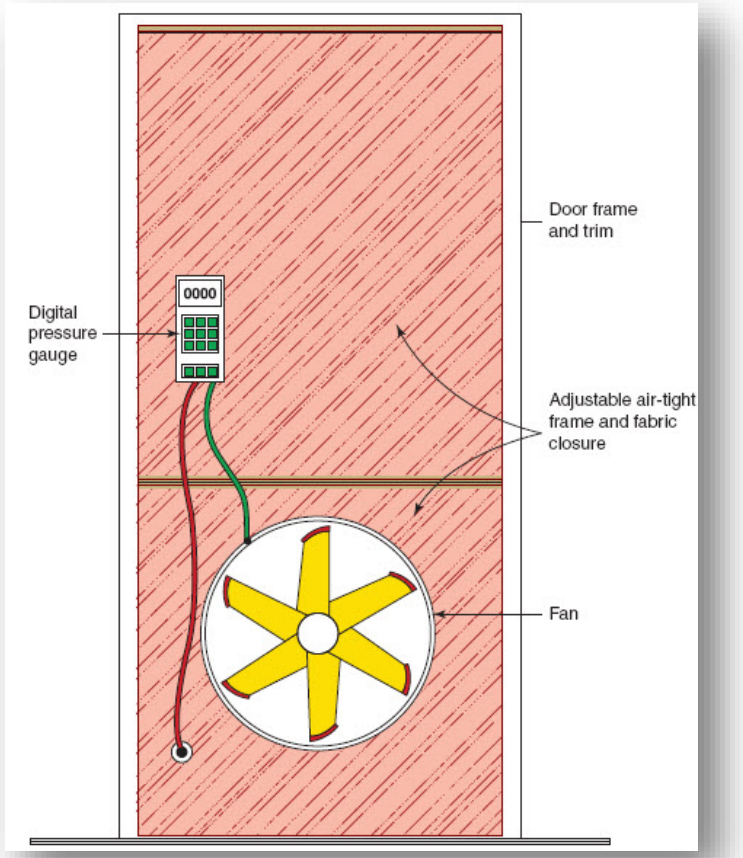
Sealing Against Air Leakage (Mandatory)

- Windows and doors
- Sill plate, rim joist, top plate
- Garage separation
- Tubs/showers
- Attic access opening
- Rim joists
- Recessed lighting
- Electrical boxes



Testing of Building Thermal Envelope (Mandatory)

- Blower door test required
- Allowable air-leakage rate:
  - Climate Zones 1 – 2: ≤ 5 ACH
  - Climate Zones 3 – 8: ≤ 3 ACH
- Test results on permanent certificate



Duct Insulation and Sealing

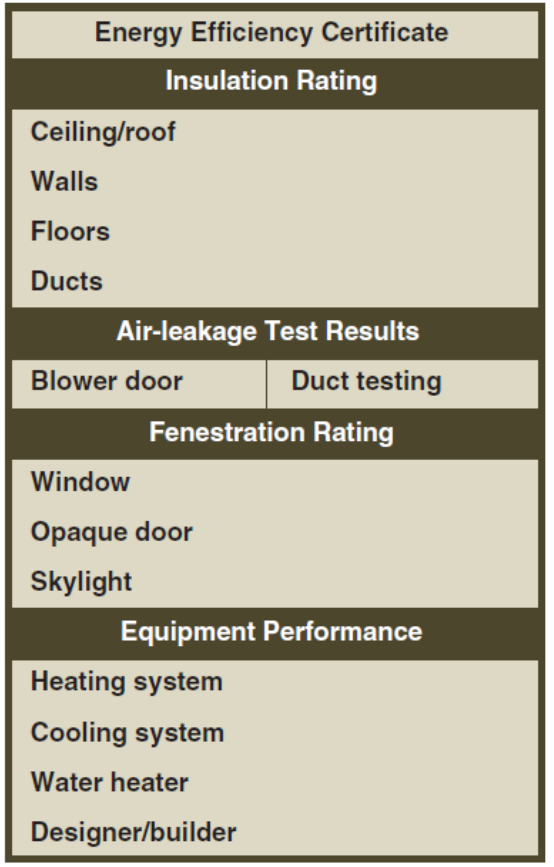
- Supply and return ducts in attics >R-8
- Supply and return ducts in other locations >R-6
- No insulation required for ducts within conditioned spaces
- Sealing of all ducts is required
- Air leakage test except when entire system is installed within the thermal envelope
- Building cavities cannot be used as ducts or plenums

Hot Water Pipe Insulation (Prescriptive)

- Hot water pipe insulation ≥ *R*-3 for:
  - ≥ ¾” diameter pipe
  - Water Heater to distribution manifold
  - Outside conditioned space
  - Under slab or underground
  - Piping in recirculation systems other than demand systems

Energy Certificate (Mandatory)

- Completed by:
  - Builder; or
  - Registered design professional
- Listing of
  - Insulation
  - Fenestration
  - Type and efficiency of equipment
  - Results of air testing
- Permanent certificate posted near furnace or approved indoor location



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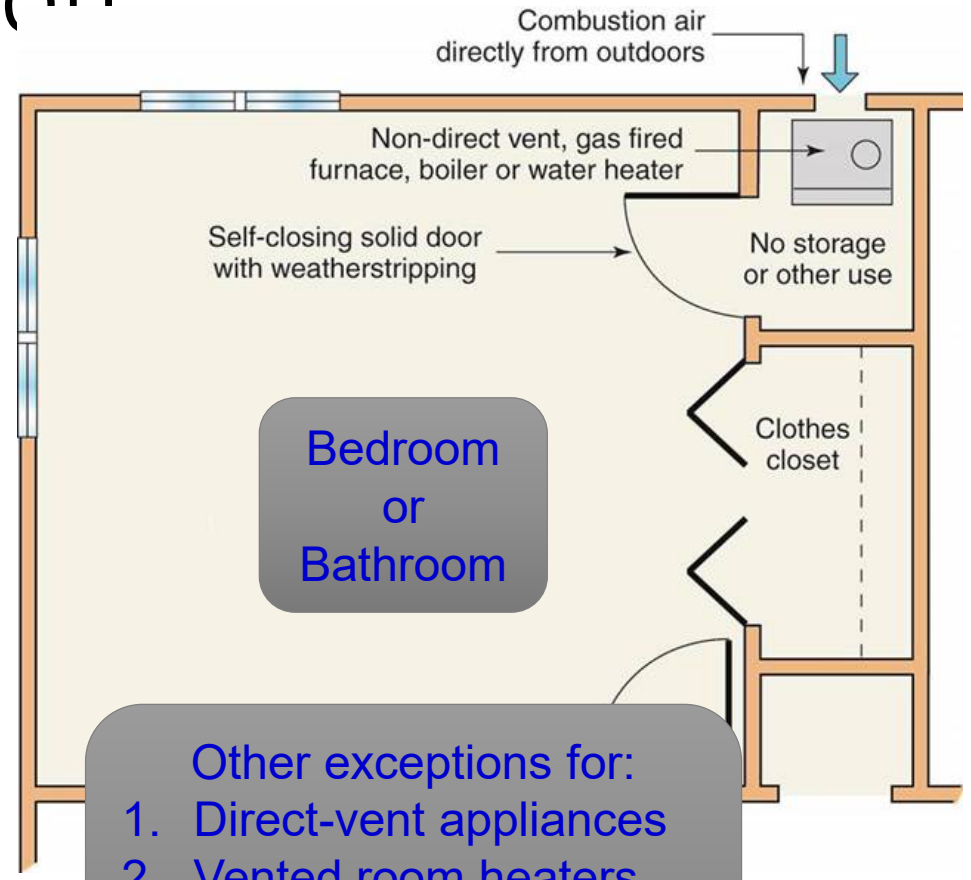
Permanent energy certificate

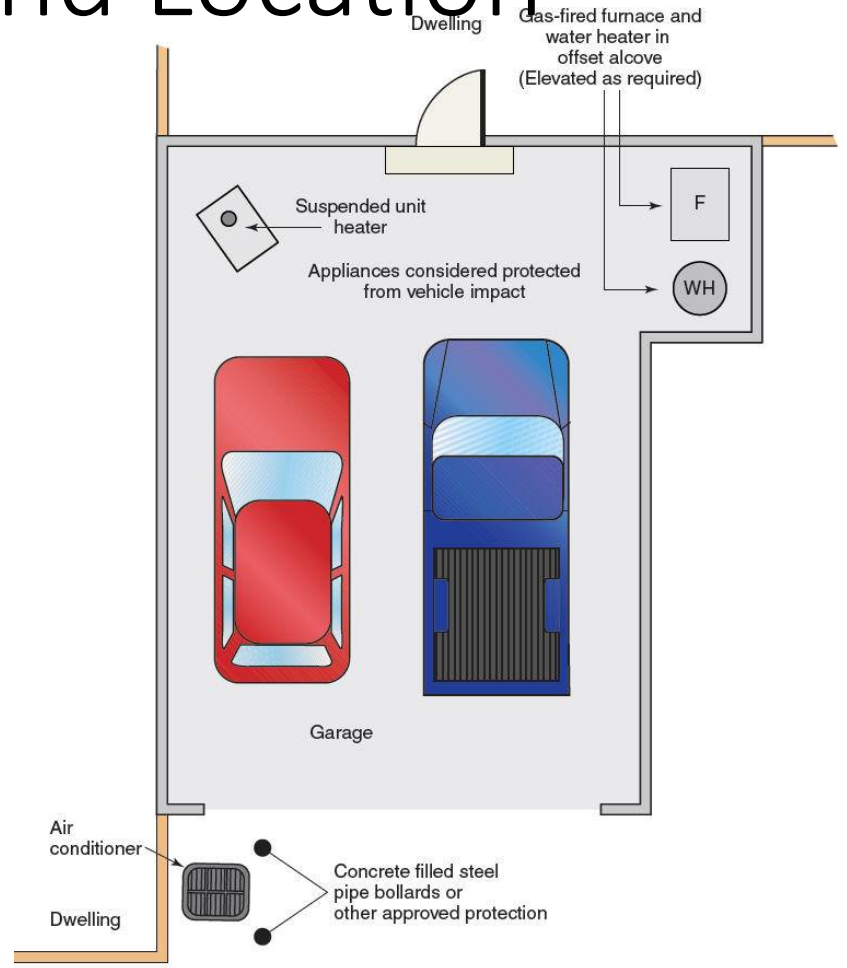
Appliances Installation and Location

- Gas-fired appliances
- Installation and clearances per the appliance listing
- Prohibited locations
  - Sleeping room
  - Bathroom
  - Toilet rooms
  - Storage closets
  - Space that opens only into such rooms or spaces



Appliances Installation and Location

- In garages, the ignition source ≥18” above the floor
  - Unless the appliance is listed as flammable-vapor-ignition resistant
- In all locations, protected from impact by vehicles

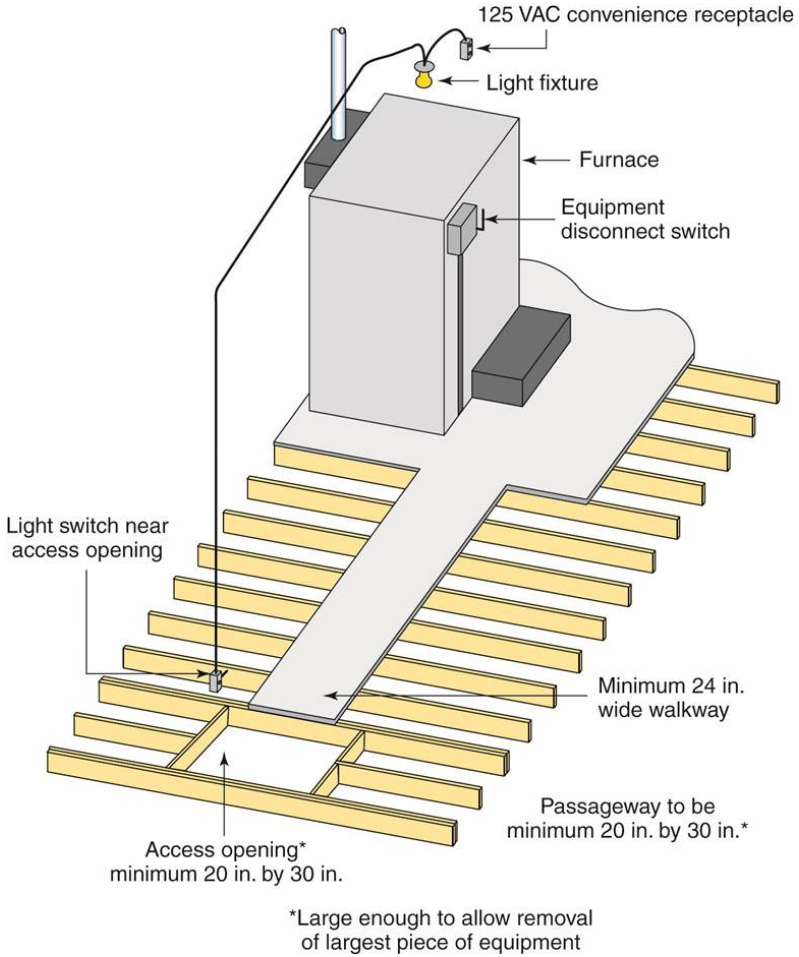


Access to Appliances

- Minimum 30” x 30” working space in front of the controls
- Access doors and passageways
  - Minimum 24” wide
  - Large enough to remove the largest appliance
- Clearance
  - Furnace compartments to be >12” inches wider than the appliance
  - Minimum 3” clearance at the sides and back

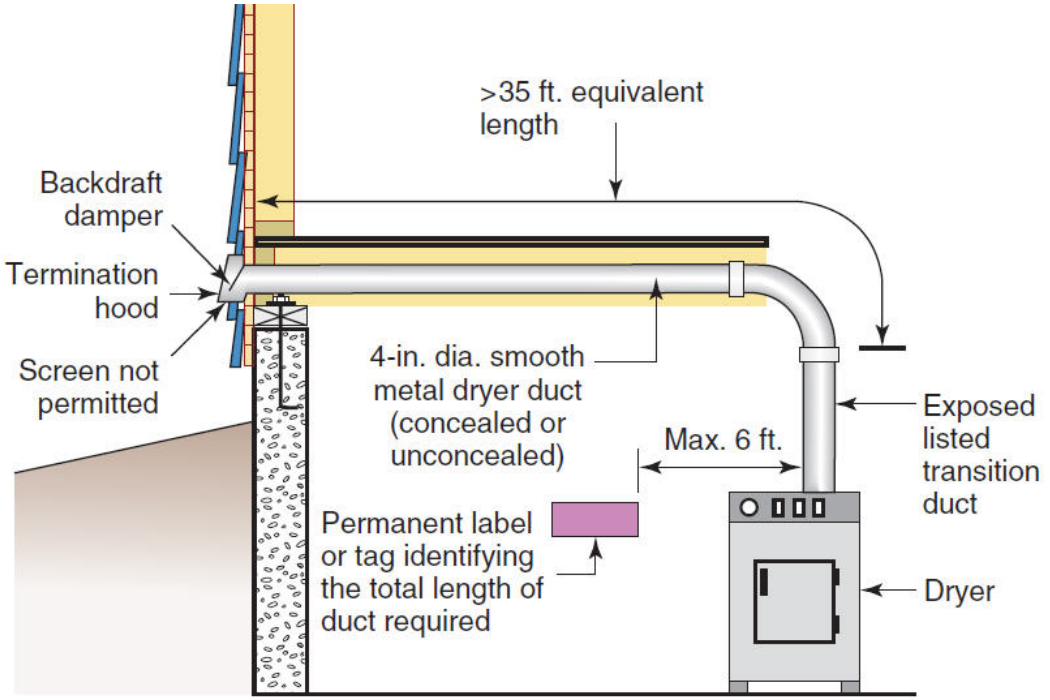
Access
Appliances in Attics

- Finish access opening ≥ 20 x 30
  - (R807.1 Rough 22 x 30)
- Passageway
  - ≥ 22 x 30 h
  - ≥ 24-in. wide flooring
  - ≤ 20-ft. length
  - Exception
    - ≤ 6-ft. high x 50 ft. long



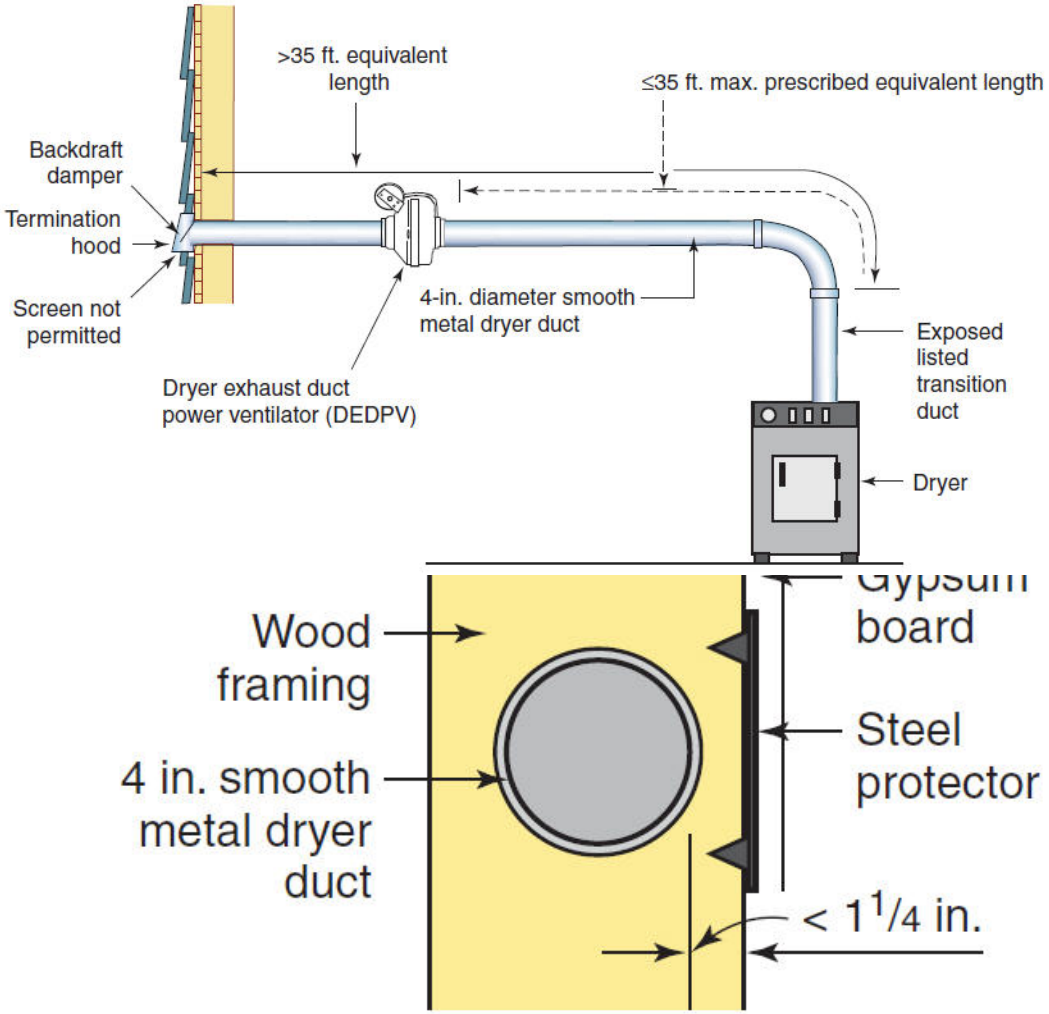
Clothes Dryer Exhaust Systems

- Termination
  - Backdraft damper
  - No screen
  - ≥ 3 ft. from openings
- Length
  - Deductions for fittings
  - Label when > 35 ft.
  - Label ≤ 6 ft. from dryer
- Listed transition duct



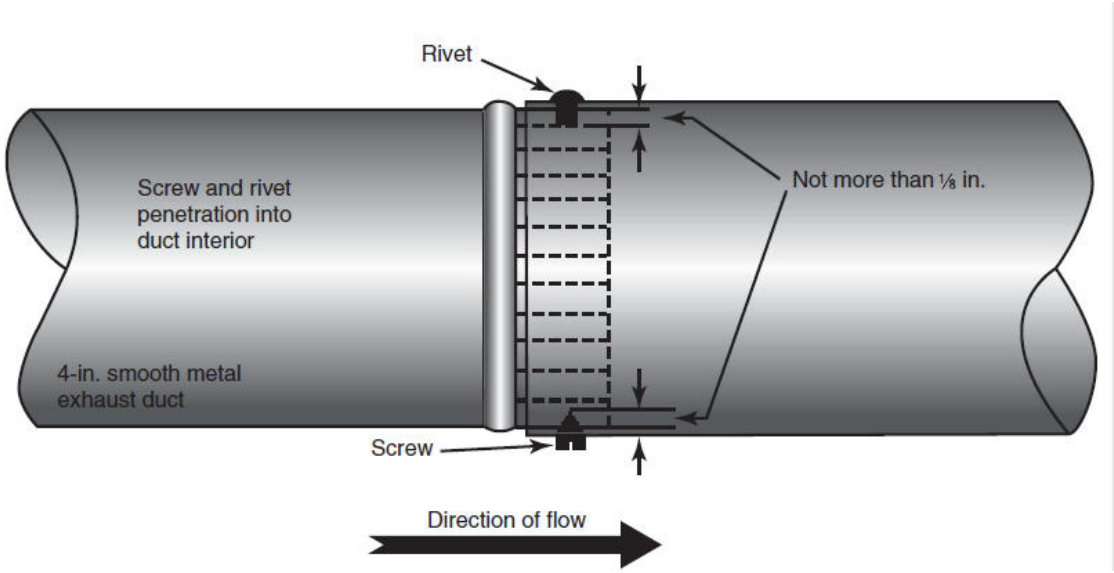
Clothes Dryer Exhaust Systems

- Dryer Exhaust Duct Power Ventilator (DEDPV)
  - Per manufacturer
- Protection of concealed dryer duct
  - < 1¼ inches
  - ≥ 2 in. above sole plates, below top plates



Dryer Exhaust Duct

- 4-in. smooth metal duct
  - Min. No. 28 gage
- Insert in direction of flow
- Max. ⅛-in. screw penetration
- Installed without deformation



Whole-house Mechanical Ventilation system

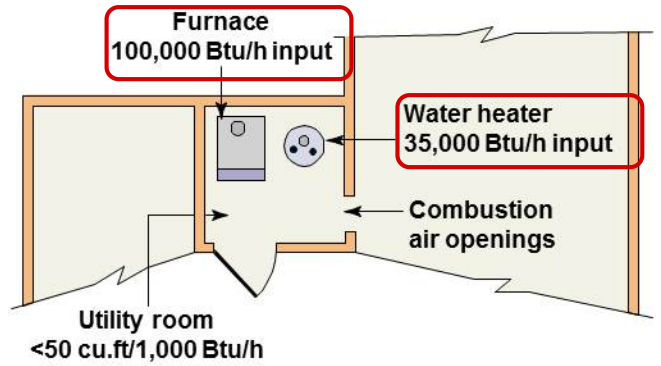
- Prescriptive airflow rate based on:
  - Floor area of dwelling unit
  - Number of bedrooms
  - Continuous or intermittent
- System design
  - One or more supply or exhaust fans, or a combination
  - Outdoor air ducts connected to the return permitted to supply ventilation.

Floor Area	**Bedrooms**	
	2 – 3	4 – 5
	CFM Airflow	
< 1500	45	60
1501 – 3000	60	75
3001 – 4500	75	90

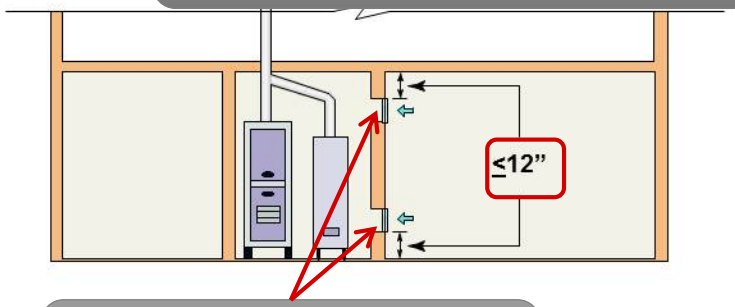
Combustion Air from Inside the Building

- Combustion air can draw from an adjacent room if:
  - Volume of adjacent space is >50 ft^3 per 1000 Btu/h
  - At least 2 openings provide air from the adjacent room
  - Free area of openings based on:
    - Btu/h input rating of all appliances
    - 1 in^2 per 1000 Btu/h
    - Minimum 100 in^2 per opening

Furnace = 100,000 Btu/h
Water heater = 35,000 Btu/h
Combined input = 135,000 Btu/h



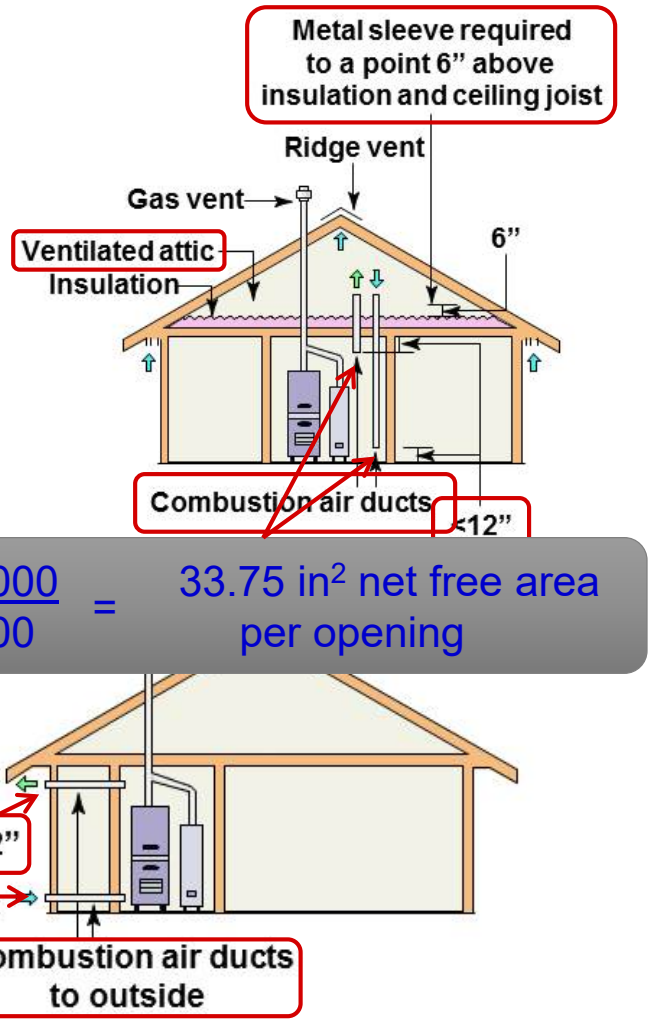
$\frac{135,000}{1,000}$ = 135 in^2 net free area per opening



Each opening must be ≥135 in^2 of free area

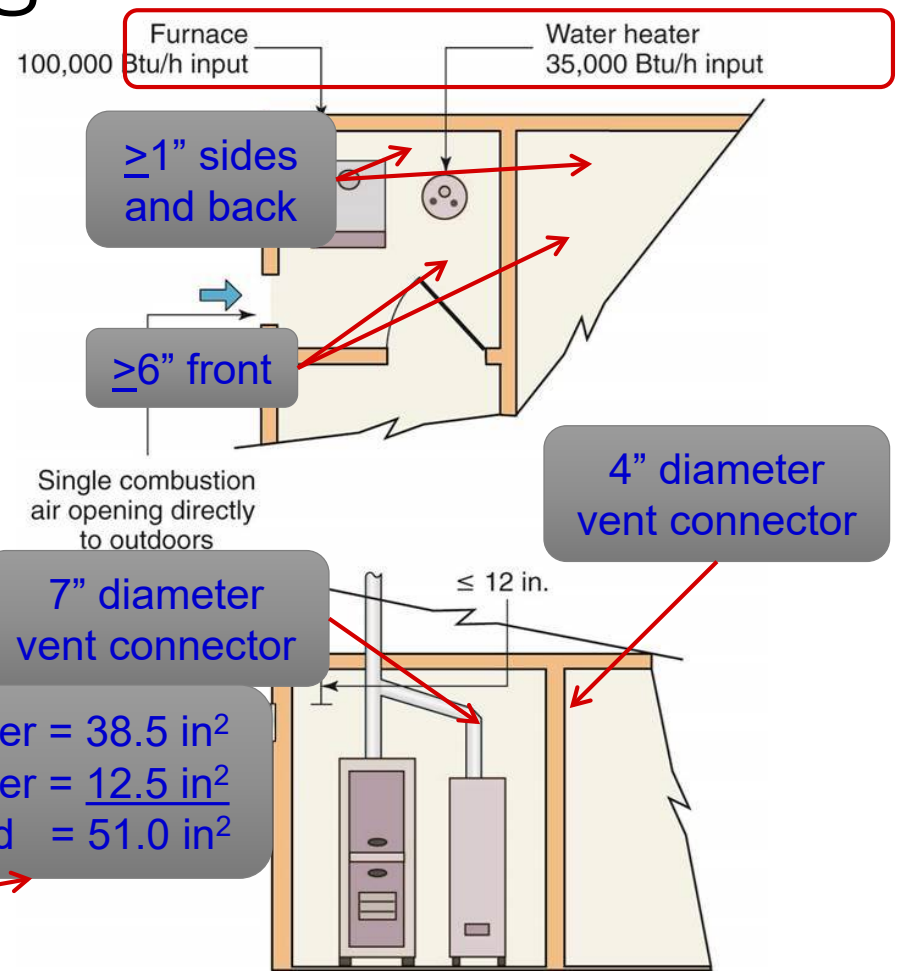
Combustion Air from *Two Outdoor* Openings

- Direct opening or vertical duct
  - Free area of ≥1 in^2 per 4000 Btu/h of total input rating
- Direct opening or horizontal ducts
  - Free area of ≥1 in^2 per 2000 Btu/h of total input rating



Combustion Air from *Single Outdoor* Opening

- Free area of the opening ≥1 in² per 3000 Btu/h
- Free area must equal the sum of the areas of all vent connectors in the space
- Minimum clearances required around the appliances for free circulation of air



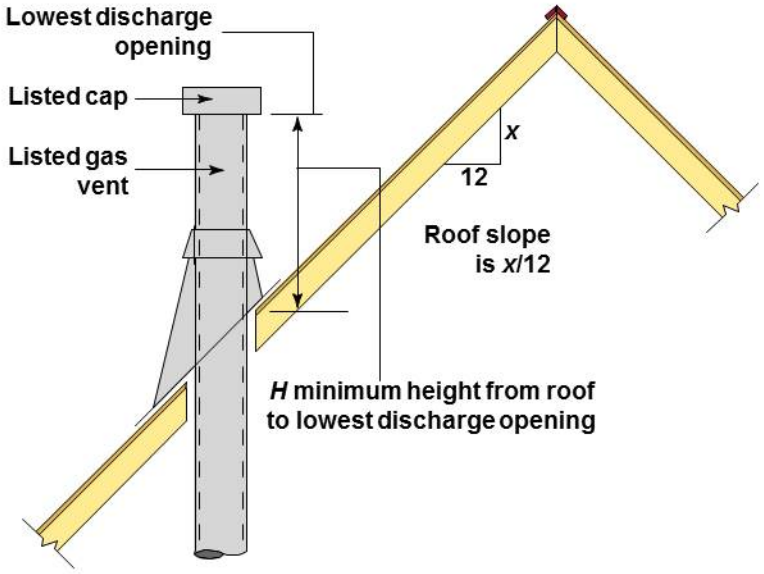
$\frac{135{,}000}{3{,}000}$ = 45 in² net free area per opening

7" diameter = 38.5 in²
4" diameter = 12.5 in²
Combined = 51.0 in²

Larger of the two = 51 in²

Gas Vent Roof Termination

- Termination height for gas vents with a cross section <12” and at least 8’ from a vertical wall is based on the roof slope



Roof Slope	Minimum Height from Roof to Lowest Discharge Opening (feet)
≤6/12	1.0
>6/12 to ≤7/12	1.25
>7/12 to ≤8/12	1.5
>8/12 to ≤9/12	2.0
>9/12 to ≤10/12	2.5
>10/12 to ≤11/12	3.25
>11/12 to ≤12/12	4.0
>12/12 to ≤14/12	5.0
>14/12 to ≤16/12	6.0
>16/12 to ≤18/12	7.0
>18/12 to ≤20/12	7.5
>20/12 to ≤21/12	8.0

Gas Pipe Materials

- Schedule 40 steel
- Approved seamless metallic tubing
  - Gas used cannot be corrosive to the material
- Corrugated stainless steel tubing (CSST)
- Exterior underground locations only:
  - Approved plastic pipe, tubing and fittings

Prohibited Locations for Gas Piping

- Piping cannot be installed:
  - Within an air duct
  - Within a clothes chute
  - Within a chimney
  - Within a gas vent
  - Through any other townhouse unit
  - Entering a building below grade

Gas Piping Protection

- Concealed piping installed through holes or notches in studs, joists, rafters must be:
  - >1½” from the nearest edge of the member or
  - Protected by No. 16 Gage nail shield plates
  - Except Schedule 40 black or galvanized steel gas piping
- CSST gas tubing requires protection in accordance with the code and the manufacturer’s installation instructions

Other Gas Piping Installation Requirements

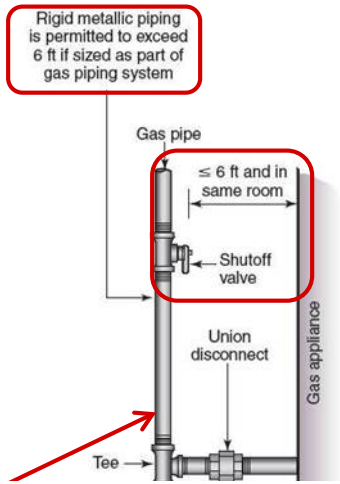
- Above-ground gas piping outdoors
  - ≥ 3½” above ground and above roof surface
  - Protection from corrosion for ferrous metal
    - Painting
    - Galvanizing
- Underground gas piping
  - Steel pipe wrapped with approved material for corrosion protection
  - Galvanizing is not approved protection from corrosion
  - Buried ≥ 12” deep

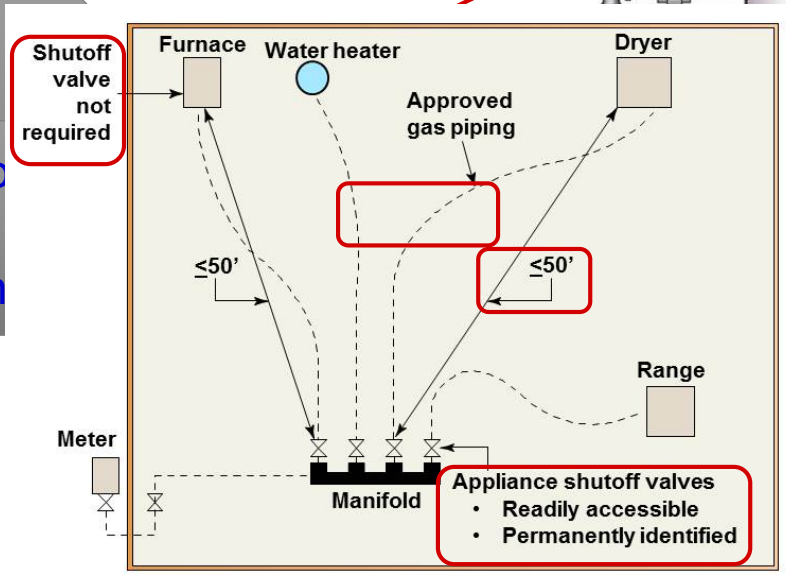
Gas Appliance Connections

- Appliance connector materials
- Appliance connector installation
  - Can pass through the appliance
- C
- S
  - ≤6’, or
  - <50’ when connected to manifold

- Rigid metallic piping
- CSST
- Listed and labeled
- Listed and labeled
  appliance connecto

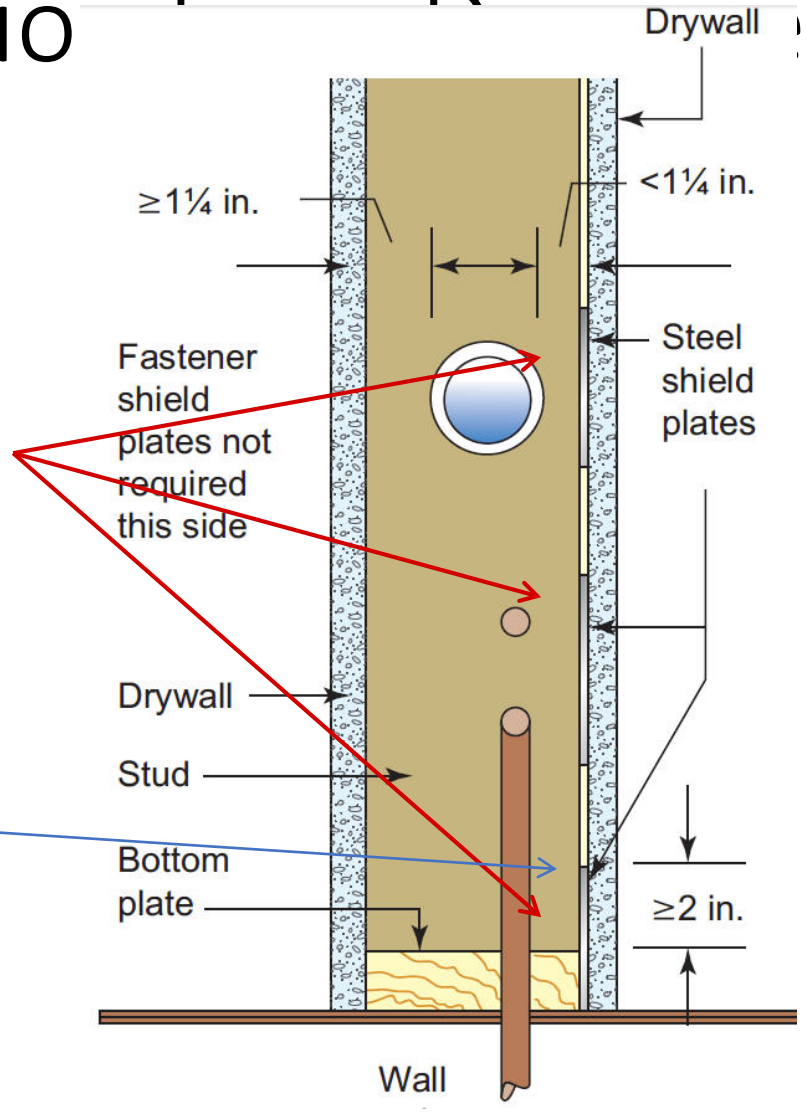
Cannot pass thro
walls, floors,
partitions, ceilin





Plumbing Piping Protectio

- Concealed piping installed through studs, joists or rafters
- < 1¼ in. from nearest edge
  - Shield plates ≥ 0.0575” thick steel (No. 16 Gage)
    - Covers area where the pipe passes through
    - Extends ≥ 2” above sole plates and below top plates
- Exception for cast iron and galvanized steel pipe



Protection from Freezing

- Underground water service pipe
  - Buried ≥12” deep
  - Buried ≥ 6” below the frost line
- Building sewer pipe
  - Depth determined by the Jurisdiction
  - Stipulated in the adopting ordinance

Plumbing Piping Support

- Support
  - Maintains alignment and slope
  - Prevents sagging
  - Allows for expansion and contraction
- Underground
  - Continuous support
  - Suitable bedding materials – 6” lifts tamped in place
  - Not supported on rocks or blocks
  - Backfill free of debris, rocks, concrete, and frozen material
  - Protection of footings

Aboveground Plumbing Piping Support

Piping Material	Maximum Horizontal Spacing (ft)	Maximum Vertical Spacing (ft)
ABS pipe	4	10
Cast-iron pipe, <10’ lengths	5	15
Cast-iron pipe, 10’ lengths	10	15
Copper or copper alloy pipe	12	10
PEX pipe	2.67	10
PVC pipe	4	10

Water Service

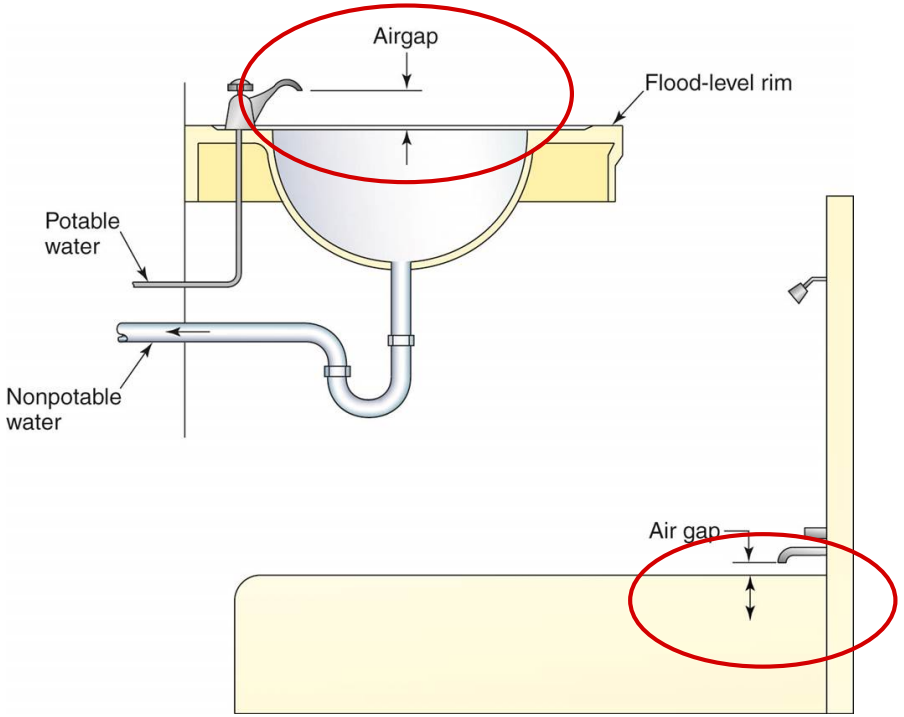
- When pipe for building sewer is listed for underground use within a building:
  - Water service pipe is permitted in the same trench with a building sewer (e.g. cast-iron or schedule 40 PVC DWV)
- For building sewer pipe not approved for underground use within a building:
  - Water service must be separated from sewer pipe:
    - ≥ 5’ of horizontal separation, or
    - Installed on a ledge ≥ 12” inches above and to one side of the highest point of the building sewer

Water Supply System Design Criteria

- Water service at the building entrance
  - 40–80 psi
  - ≥ ¾” pipe size
- Distribution system pipe size based on
  - Fixture unit values
  - Developed length of piping
  - Water pressure
- Flow rates and consumption are limited for plumbing fixtures to conserve water
- Valves
  - Main shut-off valve
  - At each fixture other than showers and tubs

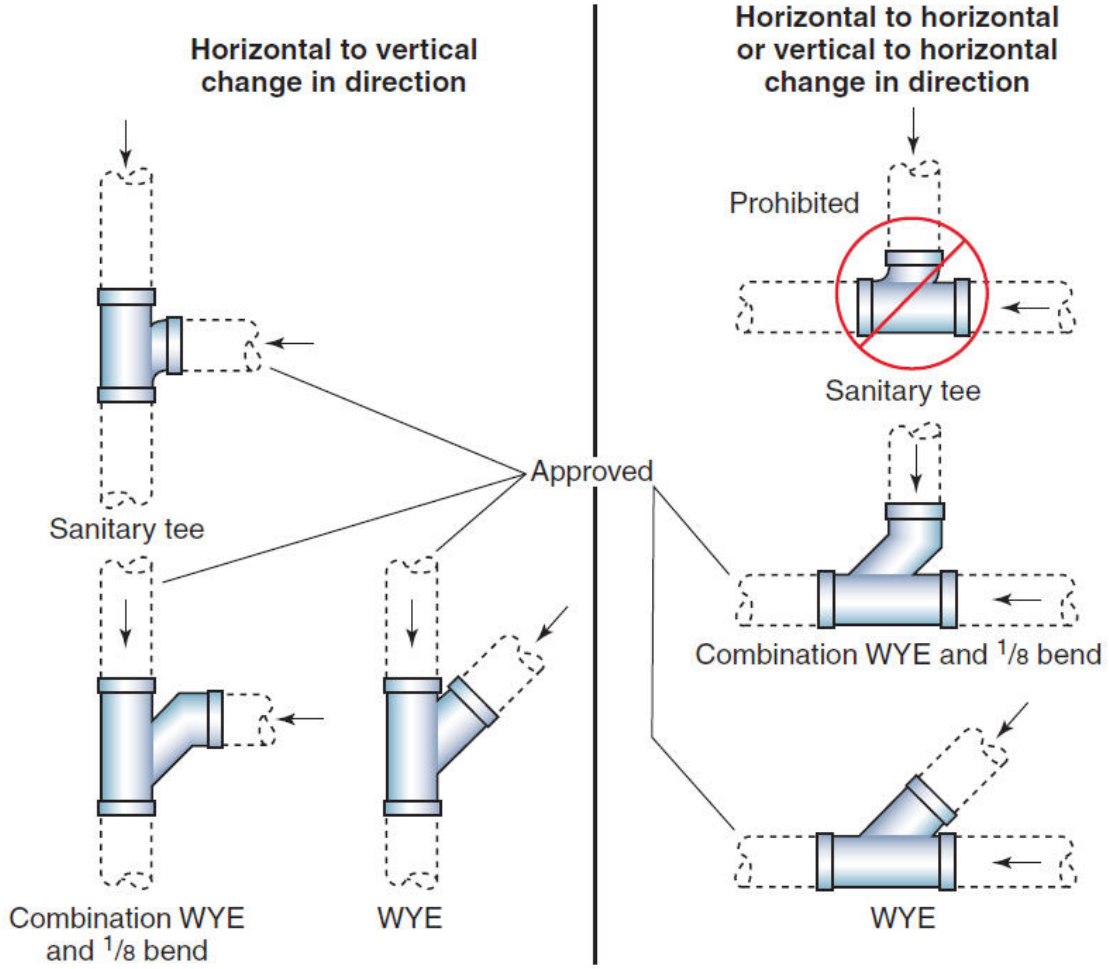
Water Supply Protection

- Backflow prevention devices suitable for the application
  - Hose connections
  - Boilers
  - Heat exchangers
  - Lawn irrigation systems
- Air gap required at
  - Sinks
  - Lavatories
  - Bathtubs



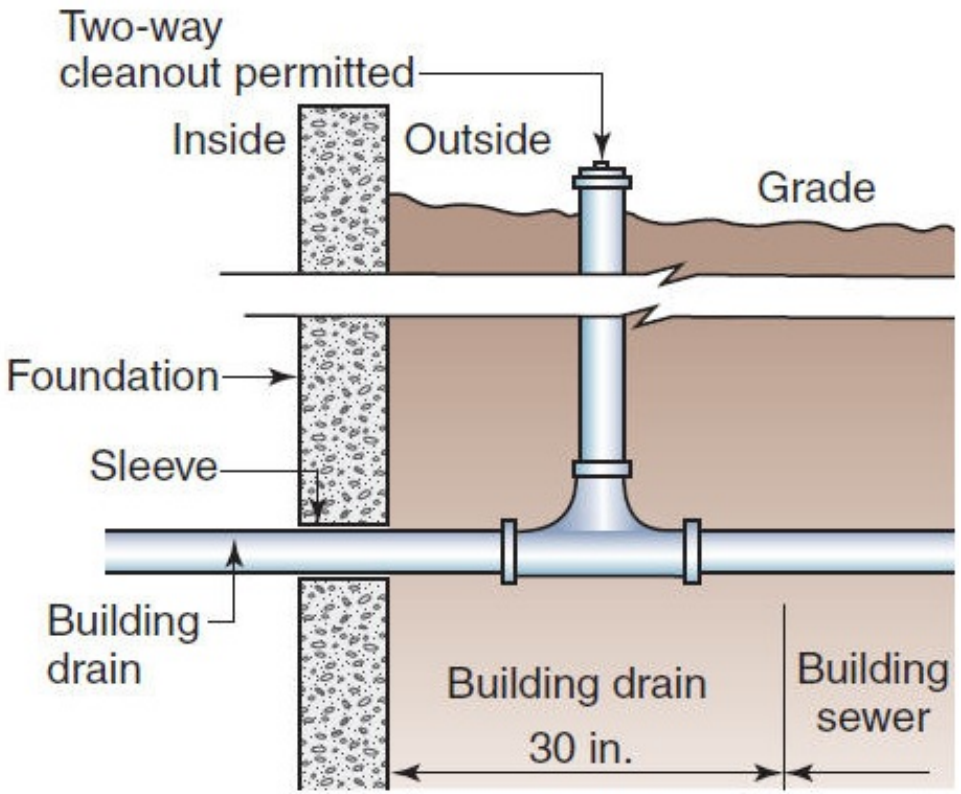
Sanitary Drainage

- Approved fittings for change in direction



Cleanouts

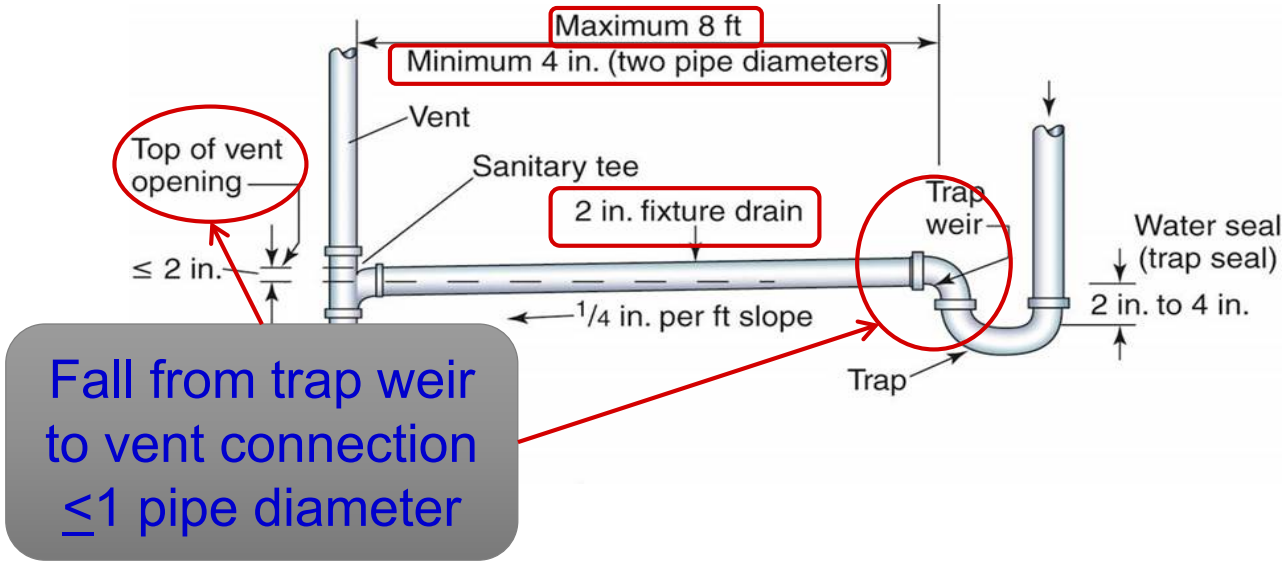
- Cleanouts required where:
  - Horizontal drain lines change direction >45°
  - Within 10 ft. of building drain / building sewer connection
- Where more than one change of direction occurs, only one cleanout is required in each 40’
- A readily removable fixture, such as a water closet or a fixture trap of a sink, may serve as a cleanout



Cleanout required near building drain/sewer connection

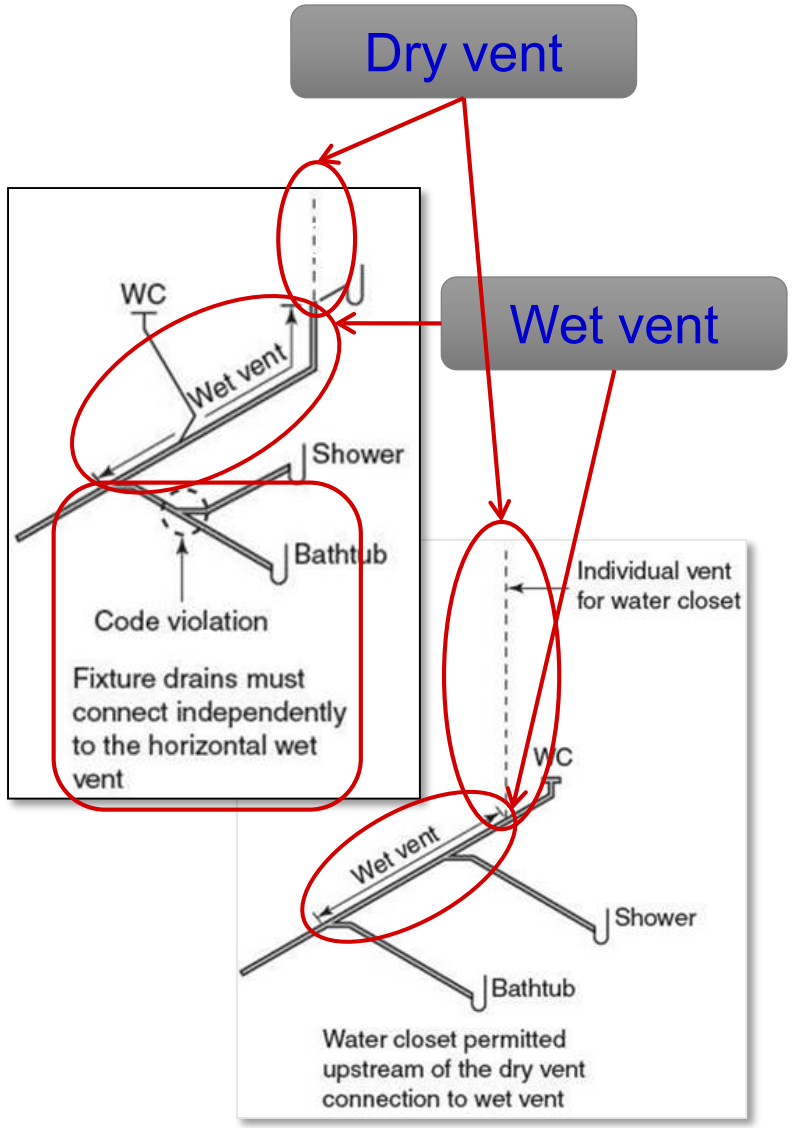
Fixture Vents

- The distance from the trap to the vent is limited
  - Self-siphoning fixtures such as water closets are not limited
- Vent connection is not permitted to be below the trap weir



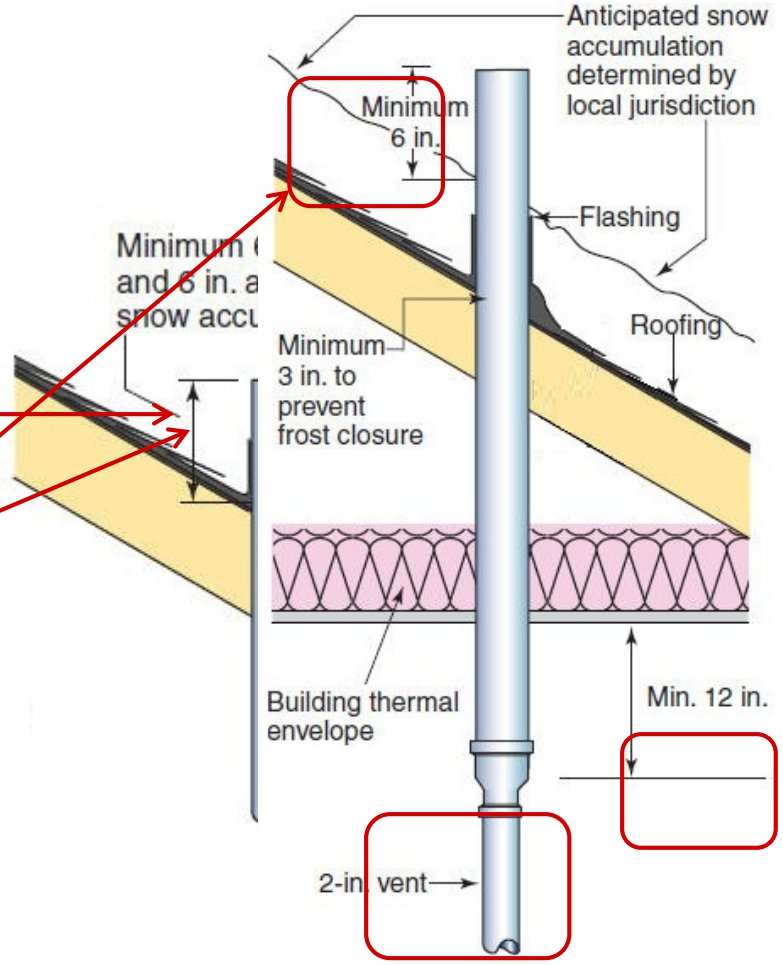
Vent Pipe

- Horizontal wet venting is permitted for fixtures of one or two bathroom groups located on the same floor
- Diameter of vent piping
  - At least ½ of the required diameter of the drain served
  - >1¼”
  - For vents >40’, increase of one pipe size



Vent Termination

- Open vents
  - ≥ 6 in. above roof
  - ≥ 6 in. above anticipated snow accumulation
- Frost closure
  - 97.5% outside design temperature ≤ 0°F
  - Increase to 3 in. at point ≥ 12 in. inside building envelope



Vent termination through roof in cold climates (97.5% outside design temperature ≤0°F)

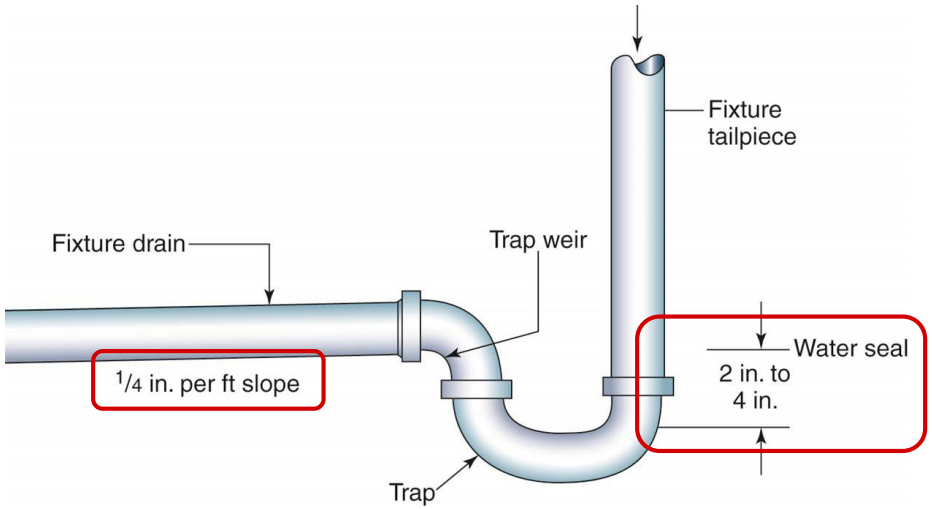
Protection Against Scalding

- Temperature control devices are required on the water outlets of bathing fixtures and bidets to prevent scalding

Fixture	Maximum Temperature	Approved Device	Standard
Shower or Tub/Shower Combination	120°F	Pressure-balance control valve	ASSE 1016 / ASME A112.1016/CSA B125.1
		Thermostatic-mixing control valve or Combination pressure-balance/thermostatic-mixing control valve	
Bathtub or Whirlpool	120°F	Water-temperature-limiting device	ASSE 1070 or CSA B125.3
Bidet	110°F		

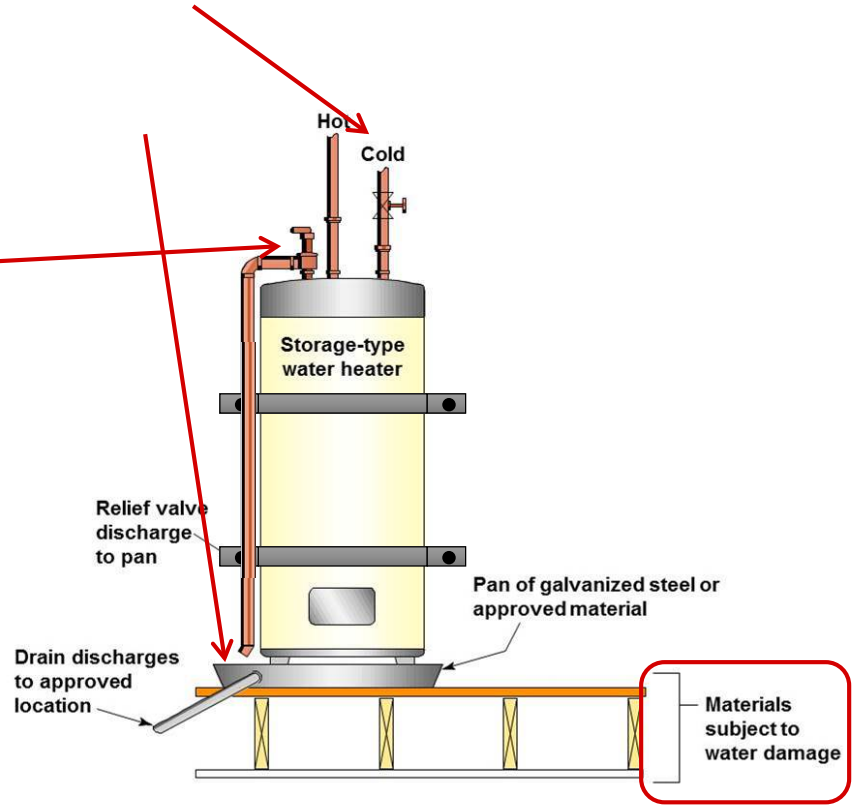
Fixture Traps

- Traps provide a water seal with a depth of 2” to 4” to prevent sewer gases from entering the building
- Floor drains require a trap-primer or deep-seal design to prevent the loss of their water seal by evaporation



Water Heaters

- Connection to the water supply
- Drain pan if damage will occur
- Temperature & pressure relief valve
- Ignition sources elevated
  - ≥18” above garage floor
- Anchorage to walls
  - SDCs D_0, D_1, and D_2
  - Townhouses in SDC C

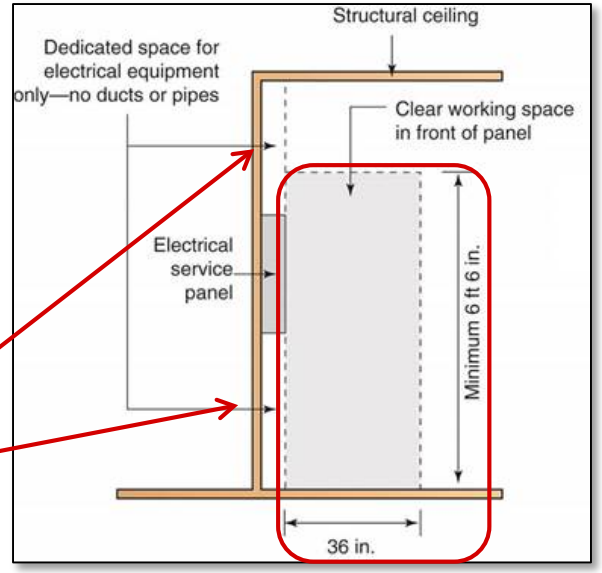


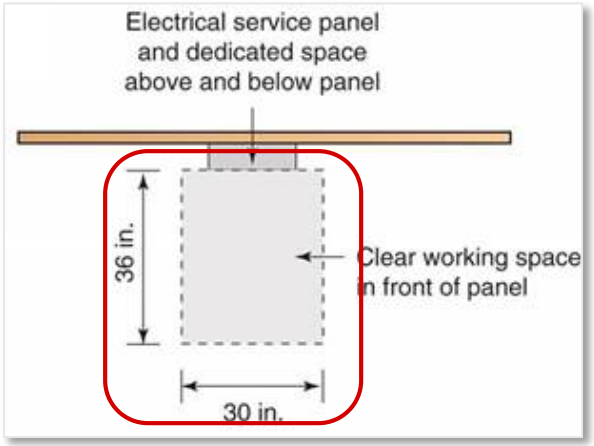
Electrical Services

- IRC covers:
  - 120/240-volt
  - Single-phase systems
  - <400 amperes
- Main service disconnect
- Service distributes electricity to the premises wiring system
- Only one service is permitted for 1- and 2-family dwellings

Equipment Location

- Readily accessible service disconnect
- Working space
- Light source nearby
- Spaces above and below the panel are dedicated to the electrical installation
- Not in clothes closets or bathrooms
  - Electrical panels
  - Service disconnects
  - Circuit breakers



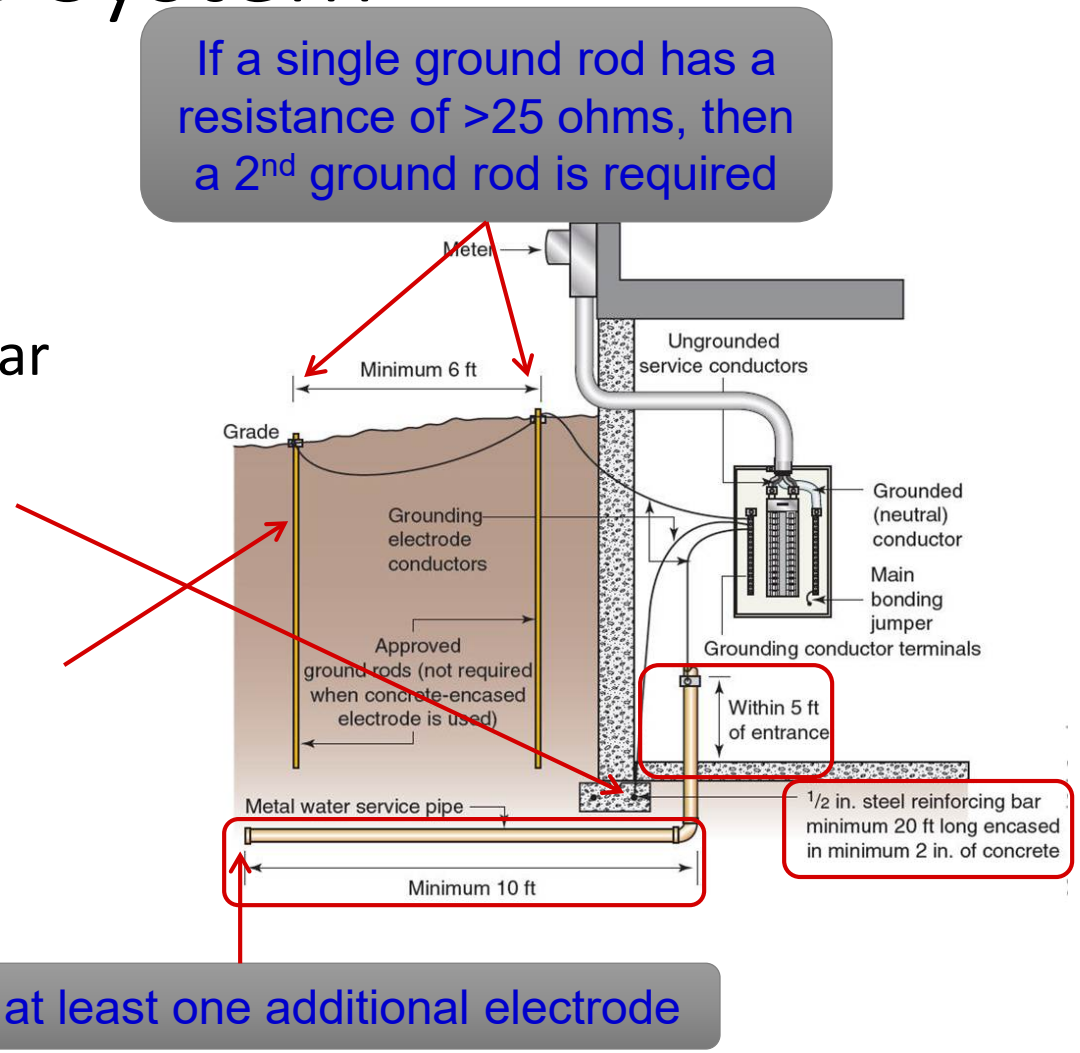


Electrical Service Size and Rating

- Service rating
  - Minimum 100 amp for single-family dwellings
  - Minimum 60 amperes for other installations
- Ampacity of ungrounded service conductors and service rating must at least match the load served in the structure

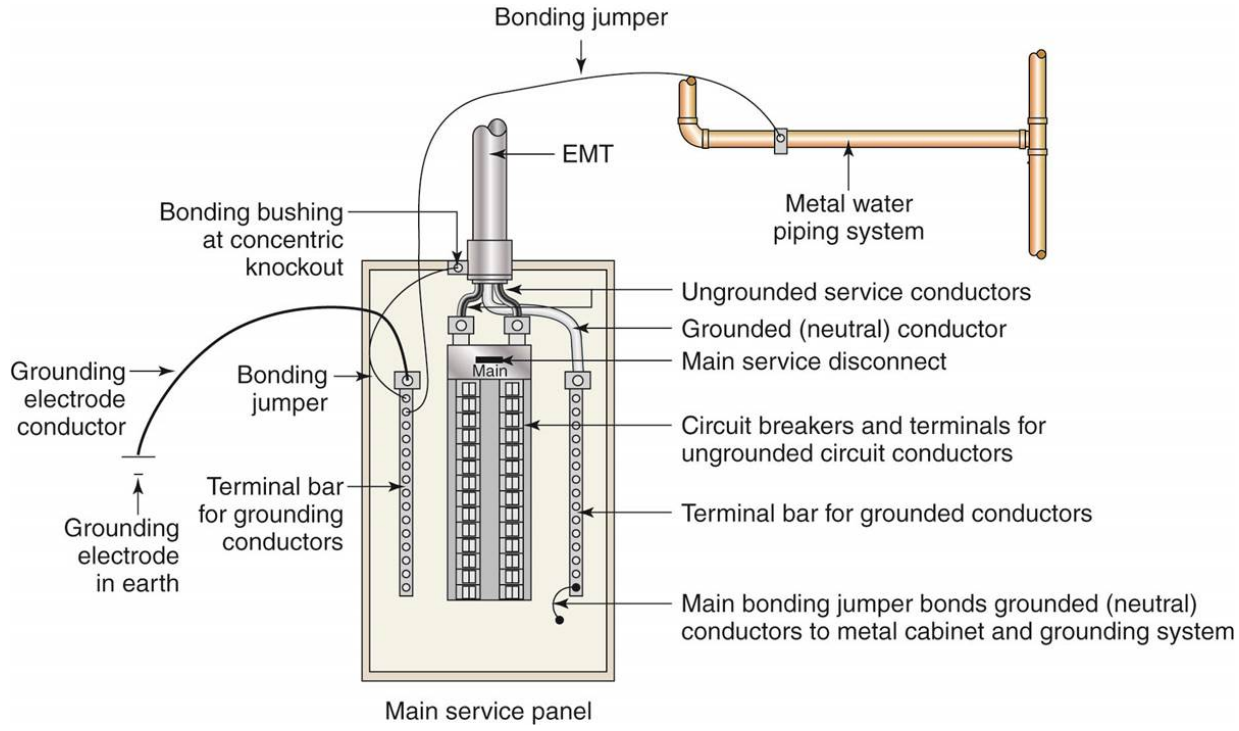
Grounding Electrode System

- Grounding options
  - Underground metal water pipe
  - Concrete-encased reinforcing bar (Ufer ground)
  - Approved ground rods



Bonding

- Main bonding jumper at service equipment
  - Connection of the grounding system to the grounded (neutral) conductors occurs at main service disconnect
- Metal water piping must be bonded to the ground system



Conductor Sizing

- Ampacity tables are provided for all wire sizes based on the material and insulation type
- When sizing wires, several variables must be considered:
  - Temperature rating of the conductor insulation
  - Derating for bundled conductors
  - Temperature rating of the terminal

Conductors	Circuit Rating		
	15 amp	20 amp	30 amp
Min. size (AWG) circuit conductors (copper)	14	12	10
Overcurrent-protection device: max. amp rating	15	20	30
Duplex or multiple outlet receptacle rating (amps)	15 max.	15 or 20	30
Single receptacle outlet minimum rating (amps)	15	20	30
Max. load (amps)	15	20	30

Overcurrent Protection Required

- Circuit breaker or fuse is required to protect all ungrounded branch circuit and feeder conductors
- Overcurrent protective device ratings cannot exceed the allowable ampacity of the conductor

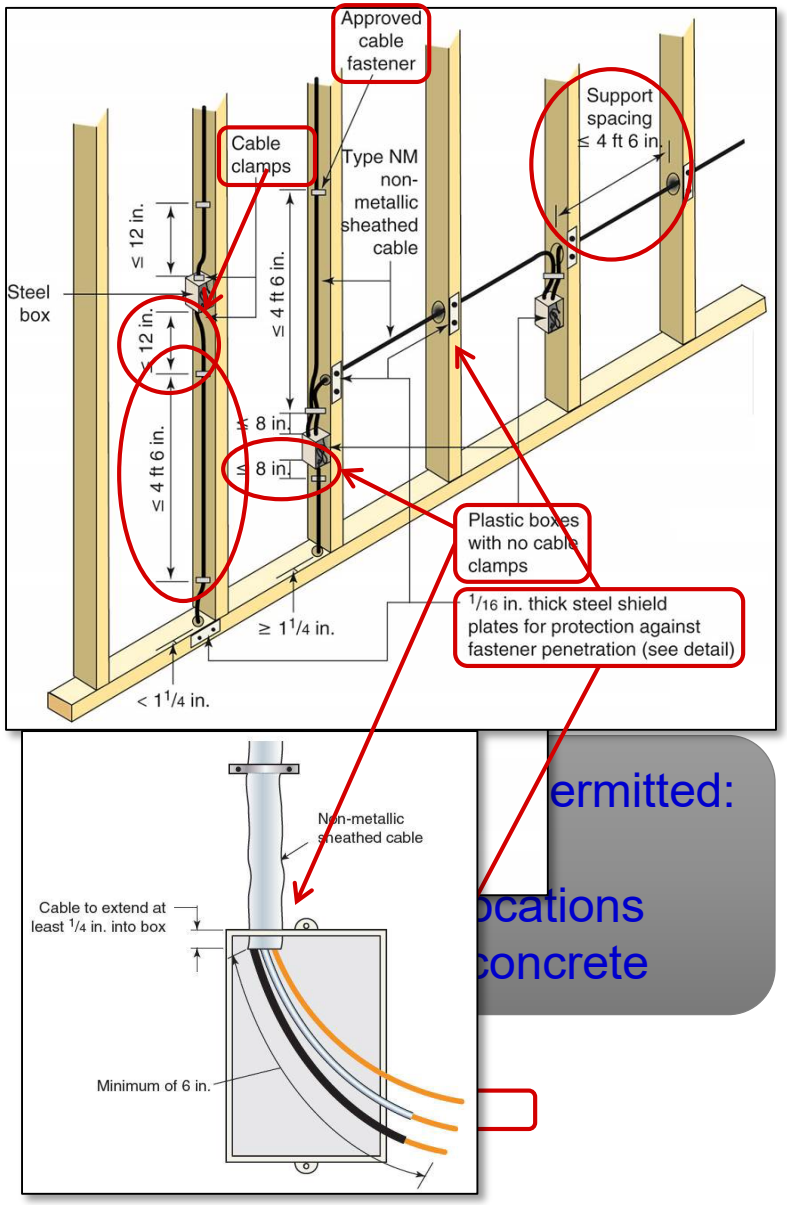
Copper		Aluminum or Copper-Clad Aluminum	
Size (AWG)	Maximum overcurrent protection device rating		Maximum overcurrent protection device rating
14			
12			
10			

Overcurrent devices located:

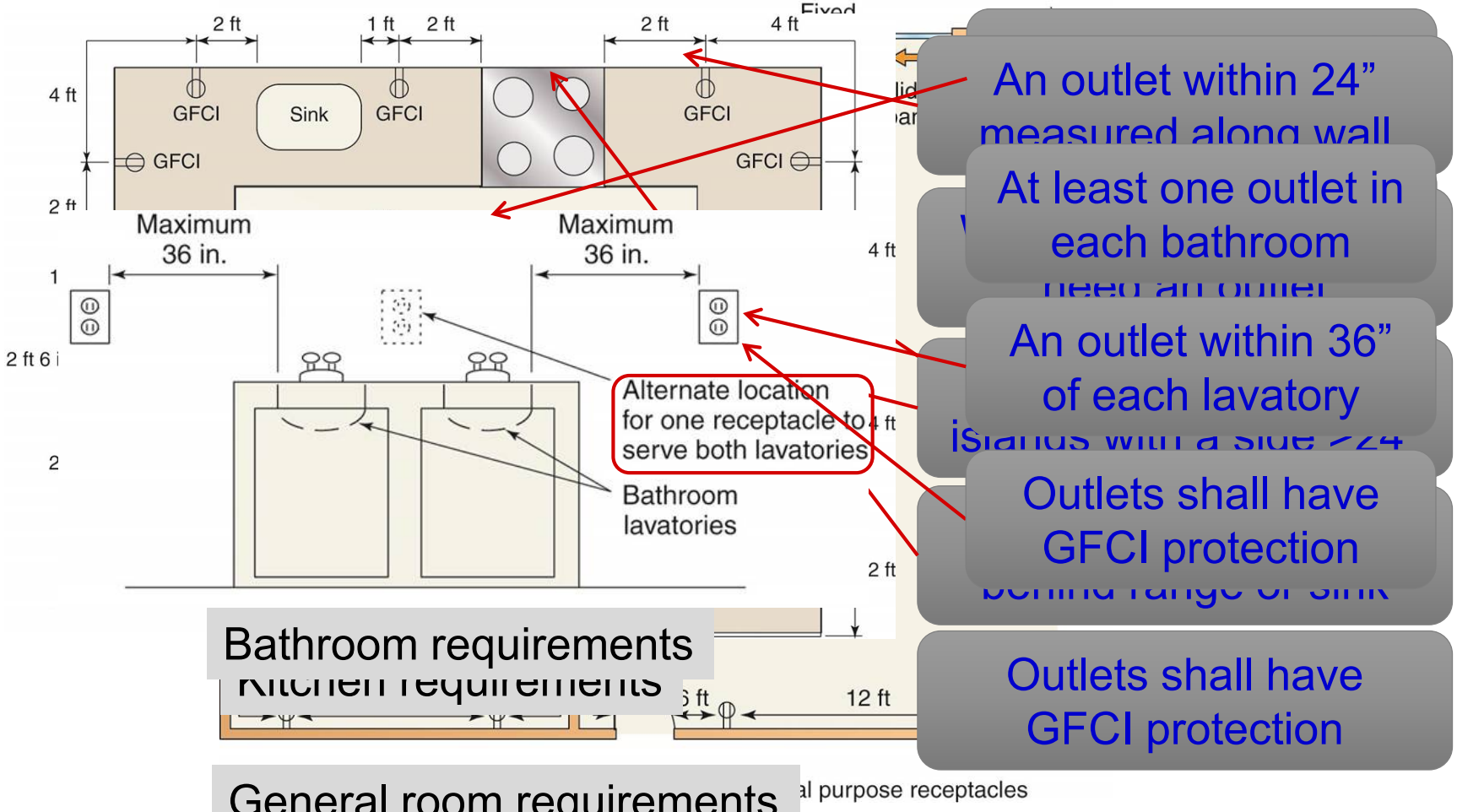
1. Where the branch circuit conductors receive their supply
2. At the service panel (typically)
3. So they are readily accessible
4. Where not subject to damage
5. Not in clothes closets or bathrooms
6. Not located above a step

Wiring Methods

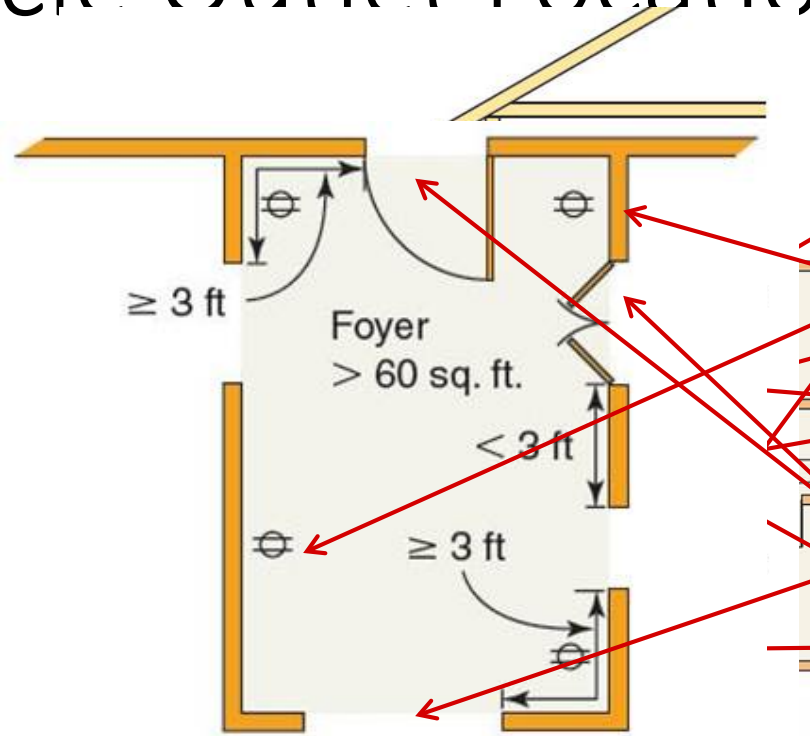
- Cable and conductors must be approved for the location
- Typically, above-ground wiring is Type NM non-metallic cable
- Protection from physical damage
- Fasteners
  - Approved fasteners
  - Spacing
- Cable support



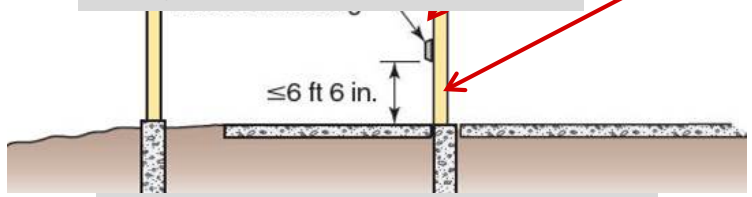
Receptacle Outlet Locations



Receptacle Outlet Locations



Foyer requirements



Outdoor requirements

1 outlet at the front, and
1 outlet at the back of

Foyers >60 sq.ft. require an outlet on each wall ≥3' wide

porches which are

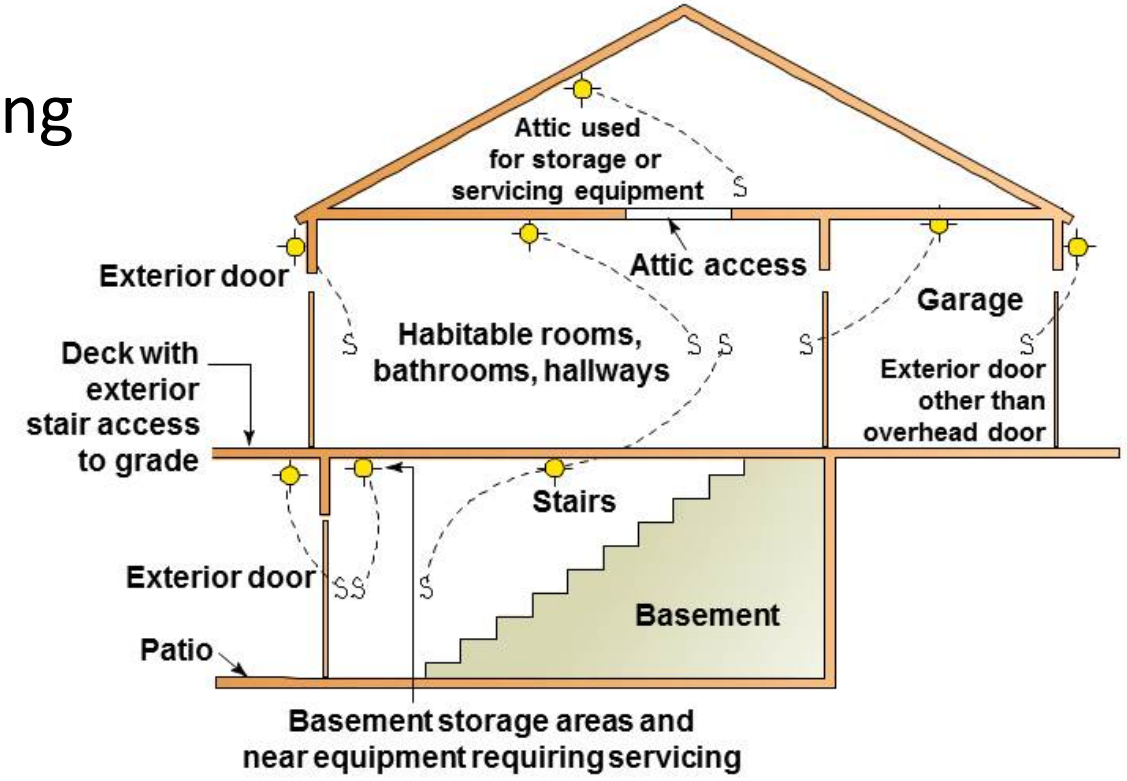
Measured between:

- Doorways
- Floor-to-ceiling windows
- Similar openings

Outlets shall have GFCI protection

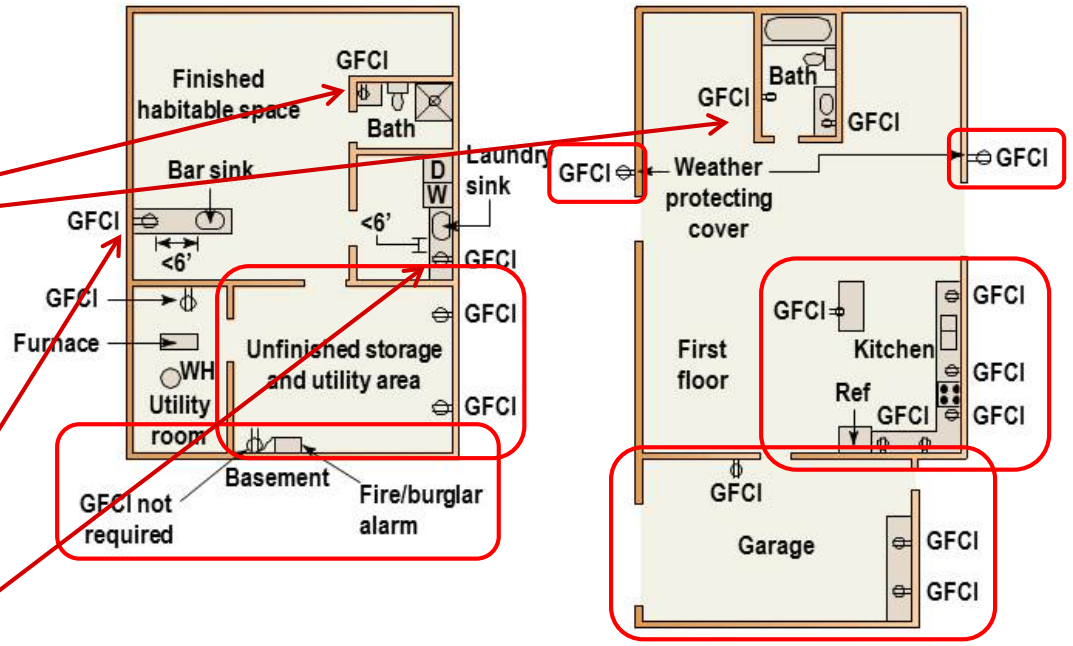
Lighting Outlets

- Wall switch–controlled lighting outlet
  - Habitable rooms
  - Bathrooms
  - Hallways
  - Storage areas
  - Garages
  - Stairways
  - Outside each exterior door



Ground-fault Circuit-Interrupter Protection (GFCI)

- GFCI protection required:
  - Bathroom
  - Kitchen counter
  - Unfinished basement
    - Except fire/burglar alarm system
  - Garage
  - <6’ from sink
  - Exterior



Arc-fault Circuit Interrupter Protection (AFCI)

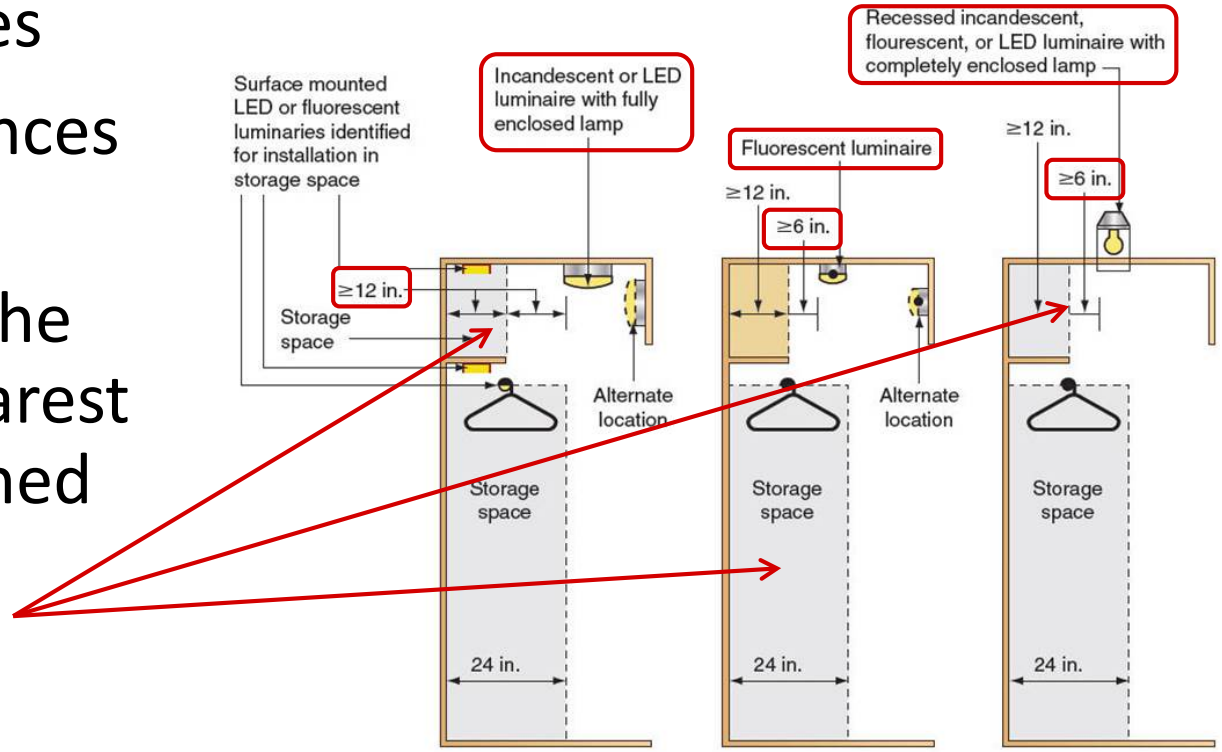
- AFCI devices
  - Detect unwanted arcing in the wiring of the branch circuit
  - Open the circuit before excessive heat buildup can cause a fire
- AFCI devices are installed in the service panel or subpanel
- AFCI protection required for:
  - Living areas
  - Hallways
  - Closets

Receptacles

- Wet locations
  - Enclosure that is weatherproof
  - when a cord is plugged in
  - Receptacles prohibited within or
  - directly over a bathtub or shower space
- Tamper-resistant receptacle required in locations accessible to children
  - Not required when:
    - >5½’ above the floor
    - Part of a luminaire or appliance
    - In a dedicated space for an appliance

Luminaires in Clothes Closets

- Type of luminaires
- Minimum clearances
- Clearances are measured from the fixture to the nearest point of the defined storage space



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