2021 IRC Essentials

Based on 2021 *International Residential Code*® (IRC®)

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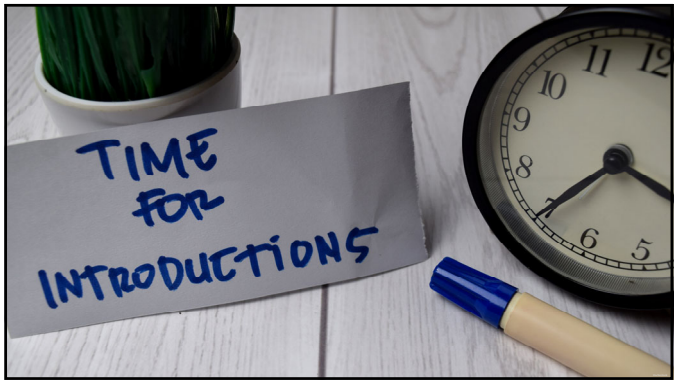

6

Introductions

What is your primary job function?

a. Inspector
b. Plans Reviewer
c. Building Official
d. Fire Official
e. Designer/Engineer
f. Contractor/Builder
g. Permit Technician

7

Introductions

Where in the World do you work?

8

Introductions

How many years have you worked in the construction industry?

a. 0-5
b. 6-10
c. 11-20
d. 21-30
e. 30+

9

GOAL & OBJECTIVES

Apply the critical concepts and provisions of the 2021 *International Residential Code*®

1) Explain fundamental provisions of 2021 IRC
2) Locate topics and applicable tables in the 2021 IRC
3) Define terms for correct code interpretation
4) Identify code provisions that relate to design, construction or inspection of residential buildings

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Tips for Success

- Slides contain some text and iconic images to help you learn
- Text and commentary is in the handout
- Follow along in the course handout
- Ask Questions, ask questions, ASK QUESTIONS!!!!

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COURSE OUTLINE

- Administration
- Site Development
- Structural
- Finishes & Weather Protection
- Health & Safety
- Building Utilities
- Energy Conservation
- Protection from Other Hazards
- Summary, Q&A and Debrief

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Code Administration

Chapter 1

14

Introduction to Building Codes

- Codes are minimum requirements to safeguard health, safety and welfare of the public and occupants or users of spaces or buildings

15

ICC Code Development Cycle

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International Residential Code

- Regulates 1- and 2- family dwellings and townhouses
- Combines all regulations into on document

Single-family dwelling

Townhouses

§R101

17

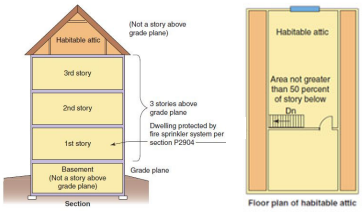
Dwellings and Townhouses

§R101.2

18

Habitable Attic

- Habitable attic above 3rd story not a story if
  - Sprinkler system
  - Area limited to 1/2 area of story below



§R326

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Dwellings

- Separate means of egress for each unit
  - One exterior door
  - Egress travel distance not regulated
- No size limit
- 2- family dwelling require fire-resistant separations

20

Townhouses

- Minimum of 3 townhouses
- No maximum number of townhouses
- Fire-resistant separations between townhouses
- Open on front and back

§R202

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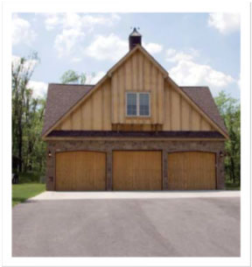
Accessory Buildings

- Use incidental and accessory to dwelling
- On same lot as dwelling
- Unlimited area
- ≤ 3 stories AGP



§R101.2 & R202

22

Existing Buildings

- Existing buildings permitted to continue without change
  - Maintained per code under which they were constructed
- IRC regulates additions, alterations and repairs to existing buildings
- Appx J offers compliance alternatives for construction on existing buildings
  - Categorized as repair, renovation, alteration or reconstruction

§R102.7

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IRC Adoption

ORDINANCE NO. 000-18
Residential Building Regulations

An ordinance of the city adopting the 2021 edition of the *International Residential Code*, regulating and governing the construction, alteration, movement, enlargement, replacement, repair, equipment, location, removal and demolition of detached one and two family dwellings and townhouses not more than three stories in height with separate means of egress and their accessory structures in the city providing for the issuance of permits and collection of fees therefore; repealing Ordinance No. 000-18 of the city and all other ordinances and parts of the ordinances in conflict therewith.

- Adopting by local ordinance includes
  - Edition and title of the IRC
  - Purpose and scope
  - Effective date for ordinance
  - Insertion of local information and criteria into code text

§R101.1 & T301.2

24

Local and State Laws

- Zoning ordinances may be more restrictive
- Other ordinances
  - Storm water management
  - Erosion control
  - Public/private sewers and wells
  - Energy conservation
  - Manufactured/modular housing
  - Accessibility
  - Licensed RDP circumstances

§R102.2

25

Appendices

- Developed same way as main code body
- Provides guidelines of recommended practices
- Assists in determination of alternative methods
- No legal status until recognized in adopted ordinance

§R102.5

26

Building Official Authority and Duties

- Authorized and directed to
  - Enforce provisions of code and make interpretations
  - Adopt policies and procedures
  - Approve modifications and alternatives

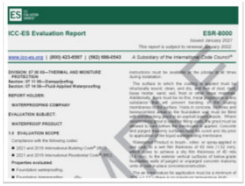
  Within intent and purpose of code
- Not authorized to
  - Waive code requirements
  - Require more than the code

§R104.1

27

Alternative Methods and Materials

- IRC does not exclude any material or method
- Building Official has an obligation to approve alternatives that meet IRC intent
  - Reports issued by ICC Evaluation Service (ICC-ES) are valuable resources
- Reason for disapproval in writing



§R104.11

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Permits

- Construction requires a permit before work begins
- Exempt work
  - 1-story tool and storage sheds, playhouses, and similar uses ≤ 200 ft²
  - Decks
    - ≤ 200 ft² and ≤ 30" above grade
    - Not attached to a dwelling **and** does not serve required exit door
  - Fences ≤ 7' height

§R105

29

Plan Review

- Verify that design is code compliant
- Submittal documents
  - Manufacturer's installation instructions
  - Braced wall designs
  - Flood hazard areas
  - Storm shelters

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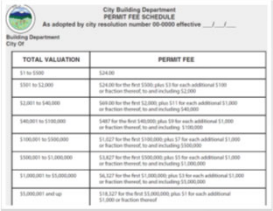
Fees

- Jurisdiction may charge fees to offset service costs
  - Administration
  - Plan review
  - Inspection
- Building Official develops equitable and consistent procedures for establishing fees



City Building Department
PERMIT FEE SCHEDULE
As adopted by city resolution number 00-0000 effective __/__/__

Building Department
City Of

TOTAL VALUATION	PERMIT FEE
$1 to $500	$24.00
$501 to $2,000	$24.00 for the first $500; plus $3 for each additional $100 or fraction thereof, to and including $2,000
$2,001 to $40,000	$69.00 for the first $2,000; plus $11 for each additional $1,000 or fraction thereof, to and including $40,000
$40,001 to $100,000	$487 for the first $40,000; plus $9 for each additional $1,000 or fraction thereof, to and including $100,000
$100,001 to $500,000	$1,027 for the first $100,000; plus $7 for each additional $1,000 or fraction thereof, to and including $500,000
$500,001 to $1,000,000	$3,827 for the first $500,000; plus $5 for each additional $1,000 or fraction thereof, to and including $1,000,000
$1,000,001 to $5,000,000	$6,327 for the first $1,000,000; plus $3 for each additional $1,000 or fraction thereof, to and including $5,000,000
$5,000,001 and up	$18,327 for the first $5,000,000; plus $1 for each additional $1,000 or fraction thereof

§R108

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Required Inspections

- Foundation
- Floodplain
- Plumbing, mechanical, gas and electrical systems
- Frame and masonry
- Fire-resistance-rated construction
- Final inspection

Inspection Record

Building Department
City Of

Permit No. _____

Name _____

Address _____

INSPECTOR SHALL SIGN ALL SPACES WHICH APPLY TO THIS JOB

Inspection Category	Date	Comment	Inspector
Foundation Inspection:			
Setbacks, Footings			
Under Slab Inspections:			
Plumbing			
Mechanical			
Electrical			
Utility Inspections:			
Electrical Service			
Gas Piping/Air Test			
Rough-In Inspections:			
Plumbing			
Mechanical (HVAC)			
Electrical			
Framing			

§R109

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Certificate of Occupancy

Certificate of Occupancy

Jurisdiction of _____

This structure or portion of structure as described below has been inspected for compliance with the International Residential Code (IRC) and is hereby issued a certi cate of occupancy

Description of applicable portion of structure _____

Address of the structure _____

Name of owner or owner's authorized agent _____

Address of owner or owner's authorized agent _____

Special conditions _____

Building O cial _____

Building permit number _____

Code edition 2021 IRC

Sprinkler system required ☐ yes ☐ no

Sprinkler system installed ☐ yes ☐ no

Location _____

§R110

33

Board of Appeals

- Public has due process to appeal a building official decision
- Basis for appeal
  - Code has been interpreted incorrectly
  - Code does not apply
  - Equivalent alternative was not accepted
- Board has no authority to waive code requirements


Department of Building Safety
Application for Appeal
Board of Appeals

Building Department
City Of

Project address _____

Use of structure _____

Description of work _____

Owner's name _____ Phone _____

Owner's address _____

In accordance with the provisions of Section R112 of the International Residential Code for One- and Two-Family Dwellings, I hereby appeal the Board of Appeals the determination made by the building official relative to the interpretation of the code or the refusal to grant the that I might construct the above structure or portion thereof as proposed and shown on the attached plans.

Appellant is advised to submit any documentation in support of the appeal. An application for appeal shall be based on a claim that the intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply, or an equally good or better form of construction is proposed. The board has no authority to waive requirements of the code. Appellant and any interested party may appear to present reasons for granting an appeal at the time of the scheduled meeting.

_____
Signature of owner or appellant Date

Meeting date _____

Time _____

Location _____

§R112

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Site Development

Chapters 3 & 4

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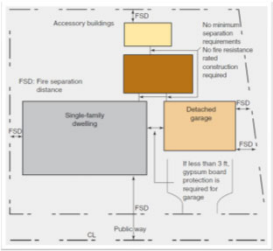
Location on Property

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



§R302.1

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2021 IRC Essentials 37

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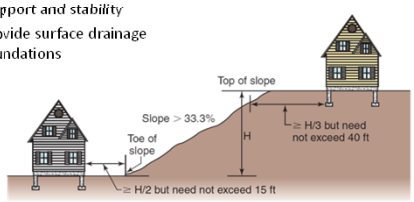
Site Preparation

- Two basic provisions
  - Soil characteristics related to foundation support and stability
  - Grading to provide surface drainage away from foundations



§R401 & R403

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General Requirements

- Exterior footings
  - Minimum of 12" below undisturbed ground level
  - Protected against frost
- All footings must bear on
  - Natural soil or
  - Compacted engineered fill

§R403

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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 mixtures	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

Tables R401.4.1 & R405.1

40

APPLICATION

What is your local soil load-bearing capacity (psf)?

a. 1500
b. 2000
c. 3000
d. Geotechnical report required

41

Engineered Fill

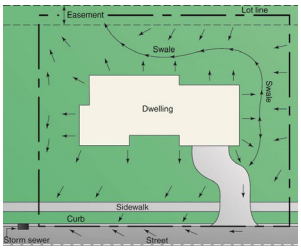
- Required for
  - Over-excavation to remove unsuitable soils
  - Additional material to raise footing elevation above existing undisturbed soil
- Must be
  - Designed by a registered design professional
  - Installed and tested as specified in design requirements

§R401.2

42

Storm Drainage

- Final grade
  - Minimum fall 6” within 10’ of foundation (5%)
  - Exception for local site conditions
    - Water can be directed to swales or drains
  - Concrete surfaces within 10’ of foundation need 2% slope



§R401.3

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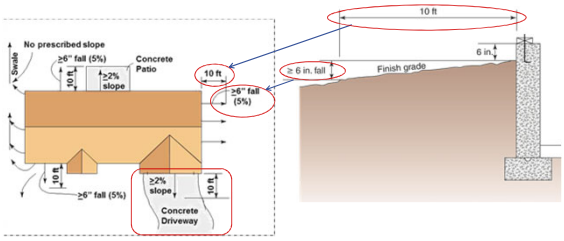
Storm Drainage



§R401.3

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Flood Hazard Areas

- State or local floodplain management ordinances often supersede IRC flood-resistance provisions
- Minimum standards
  - National Flood Insurance Program (NFIP) by Federal Emergency Management Agency (FEMA)

§R322

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Structural

Chapters 3, 4, 5, 6 & 8

46

EXAMPLE

Climatic & Geographic Design Criteria

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

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

Table R301.2

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EXAMPLE

Climatic & Geographic Design Criteria

- IRC adoption: jurisdiction completes table with applicable data – 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

48

EXAMPLE

Climatic & Geographic Design Criteria

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

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

Table R301.2

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Climatic & Geographic Design Criteria

Manual J Design Criteria						
Elevation	Altitude Correction Factor	Coincident Wet Bulb	Indoor Winter Design Relative Humidity	Indoor Winter Design Dry-Bulb Temp.	Outdoor Winter Design Dry-Bulb Temp.	Heating Temp. Difference
Latitude	Daily Range	Summer Design Grains	Wind Velocity Cooling	Indoor Summer Design Dry-Bulb Temp.	Outdoor Summer Design Dry-Bulb Temp.	Cooling Temp. Difference

Table R301.2

50

Prescriptive and Performance

- Prescriptive requirements
  - Specific set of rules to follow
- Performance requirements
  - Expectation that systems will function a certain way
  - For structural requirements, performance is achieved through engineering

§R301.1.2 &R301.1.3

51

Prescriptive and Performance

- Conventional construction
  - Engineered design can be used for structural elements that
    - Exceed code limits or
    - Not included in the code
- Wood framing alternative
  - *Wood Frame Construction Manual* published by AWC
    - Wind speeds up to 195 mph
    - IRC wind speeds <140 mph

Example: sizing wide flange steel beams

§R301.1.1

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Live Loads

Minimum Uniformly Distributed Loads

USE	LOAD (psf)
Attics without storage	10
Attics with limited storage	20
Habitable attics and attics served by fixed stairs	30
Sleeping areas	30
Areas other than sleeping areas and stairs	40
Balconies (exterior) and decks	40
Passenger vehicle garages	50

Table R301.5

53

Live Loads

Minimum Concentrated Loads

USE	LOAD (lbs)	NOTES
Guard in-fill components	50	Horizontally applied on area of 1 ft^2
Handrails	200	Applied in any direction
Guards	200	Applied downward and outward if not acting as a handrail
Stairs	300	300-lb concentrated load / 4 in^2
Passenger vehicle garages	2,000	Applied on 4.5" x 4.5" area for elevated garage floors

Table R301.5

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EXAMPLE

Dead Loads

- Average dead loads included in prescriptive tables
  - Footings
  - Floors
  - Walls
  - Roofs

DESCRIPTION	WEIGHT (PSF)
Roof dead load (framing, sheathing, asphalt shingles, insulation, drywall)	10
Exterior wall (2 × 4 framing, sheathing, siding, insulation, drywall)	11
Floor (joist, sheathing, carpeting, drywall)	10
Concrete wall, 8 in. thick	100
10 in. thick	125
12 in. thick	150
Solid CMU (density 125 pcf) wall, 8 in. thick	81
Hollow CMU (density 125 pcf) wall, 8 in. thick, grout at 48" o.c.	44

Table R301.4

55

EXAMPLE

Deflection

- Allowable deflection in structural framing members
  - Studs
  - Joists
  - Beams
  - Rafters

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters, slope > 3/12, no finished ceiling attached to rafters	L/180
Rafters, slope > 3/12, gypsum board ceiling attached to rafters	L/240
Gypsum board ceilings	L/240
Plaster ceilings	L/360
Floors	L/360
All other structural members	L/240
[Ref. Table R301.7]	

Table R301.7

L = span length

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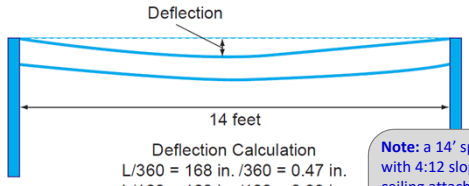
Floor Joist Deflection



Deflection Calculation
L/360 = 168 in. /360 = 0.47 in.
L/180 = 168 in. /180 = 0.93 in.

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

Table R301.7

57

Wind Loads

- IRC conventional framing limits wind speed to 140 mph
  - 130 in hurricane-prone areas
- If limits exceeded
  - AWC – *Wood Frame Construction Manual* (WFCM)
  - ICC 600 – *Standard for Residential Construction in High-Wind Regions*
  - AISI S230 – *Standard for Cold-formed Steel Framing- Prescriptive Method for One- & Two-Family Dwellings*
  - IBC – *International Building Code*
  - ASCE 7 – *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

§R301.2.1

58

Wind Exposure Category

- Exposure B
  - Wind protection with trees and buildings
- Exposure C
  - Open terrain with scattered obstructions
- Exposure D
  - Flat areas exposed to open water, ice or similar for ≥ 5,000 ft

Wind exposure B

Wind exposure C

§R301.2.1.4

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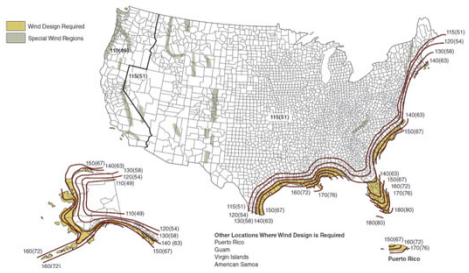
Wind Design Required

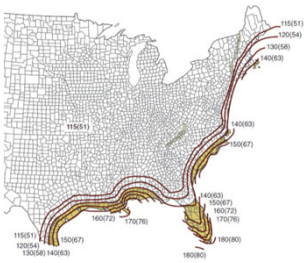


§R301.2.1

60

Hurricane-prone and Windborne Debris Regions

- Hurricane-prone regions
  - V_{ult} > 115 mph
- Windborne debris regions
  - $V_{ult} \geq$ 140 mph
  - $V_{ult} \geq$ 130 mph; $\leq$1 mile of the coast



§R301.2.1

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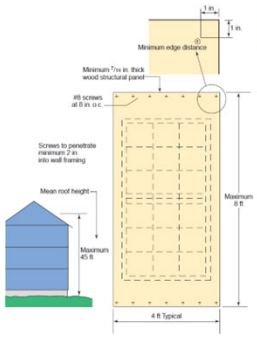
Protection of Openings

- Windborne debris regions
- Prescriptive provisions
  - WSP and screws
  - $V_{ult} \leq$ 180 mph



§R301.2.1.2

62

Snow Loads

- Must be considered where applicable
- IRC conventional framing tables are limited to $\leq$70 psf

§R301.2.3

63

Earthquakes

- IRC assigns Seismic Design Category (SDC) to building sites relative to anticipated intensity and frequency of earthquakes

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

§R301.2.2

64

Earthquakes

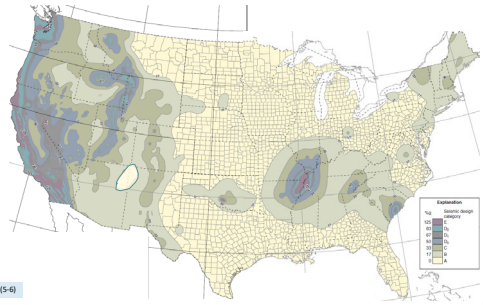
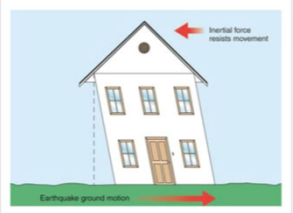


Fig R301.2.2.1(5-6)

65

Earthquakes

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



§R301.2.2.6

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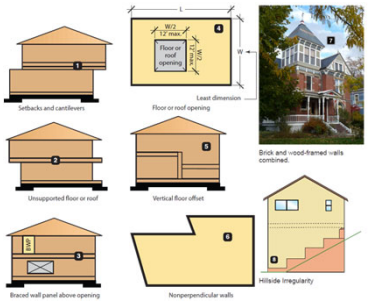
Earthquakes – Irregular Buildings



§R301.2.2.6

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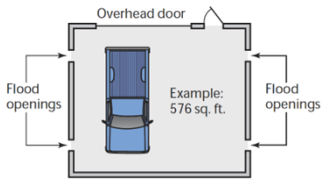
Flood Openings

EXAMPLE

Doors and windows do not satisfy flood opening requirements



Garage below required elevation used for parking and storage only

Flood opening requirements

- Two openings required on two sides of the building
- Total 576 sq. in. net area (1 sq. in. per sq. ft. of enclosed area)
- 576/4 = 144 sq. in. net area per opening (not less than 3" on any dimension)
- The bottom of each opening no more than 12 in. above grade

§R301.2.4 & R322

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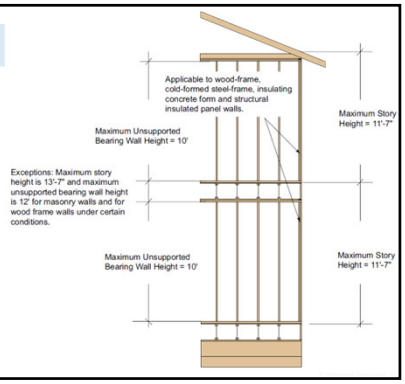
Story Height



§R301.3

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APPLICATION

Which type of foundation is common in your area?

a. Basement
b. Crawlspace
c. Slab-on-grade
d. Piles

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Foundation Materials

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

§R402

71

Concrete Minimum Compressive Strength

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH AT 28 DAYS (psi)		
	Weathering Potential		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500[a]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[a]
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000[b]	3,000[b]
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000[b,c]	3,500[b,c]

[Ref. Table R402.2]

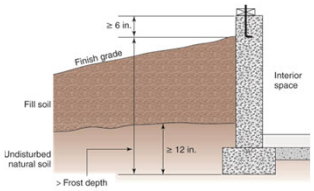
a. Concrete subject to freezing and thawing during construction shall be air entrained.
b. Concrete shall be air entrained.
c. See IRC for additional requirements.

Table R402.2

72

Footings

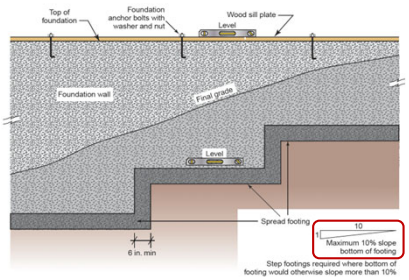
- Must bear on undisturbed ground
- Must extend below frost depth
- Exterior footings 12” below undisturbed ground level
- Detrimental materials removed prior to placing concrete



§R403

73

Stepped Footings



§R403.1.5

74

Concrete Footing Size

Conventional Light-Frame Construction				
Ground Snow Load = 30 psf	Type of Foundation	Soil Bearing (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	16 x 6	12 x 6	12 x 6
2-story	Slab-on-grade	13 x 6	12 x 6	12 x 6
	With crawl space	16 x 6	12 x 6	12 x 6
	Plus basement	19 x 6	14 x 6	12 x 6

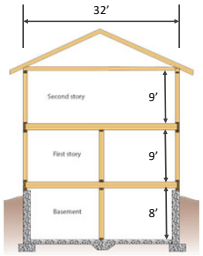


Table R403.1(1)

75

Concrete Footing Size

- Projection - P ≥ 2" and ≤ T
- Thickness - T ≥ 6"
- Width - W per table

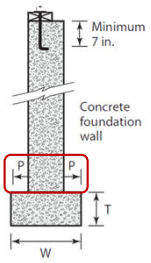
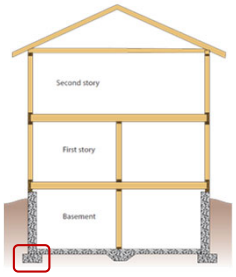


Table R403.1(1)

76

Footing Size

- Determine minimum W, P, and T of continuous spread footing
- Given
  - 2-story dwelling with basement
  - 1500 psf assumed soil-bearing capacity
  - 30 psf snow load
  - Conventional light-frame construction
    1. With siding
    2. With brick veneer



§R403

77

Footing Size

EXAMPLE

Ground Snow Load	Foundation	Load bearing value of soil
30 psf	Light Frame w/ Siding	1,500 psf
2-story	Plus basement	19 x 6

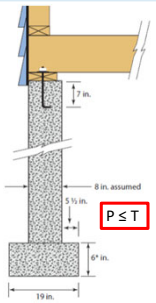


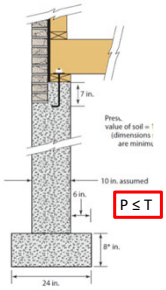
Table R403.1(1)

78

EXAMPLE

Footing Size

Ground Snow Load	Foundation	Load bearing value of soil
30 psf	Light Frame w/ Brick	1,500 psf
2-story	Plus basement	24 x 8



$P \leq T$

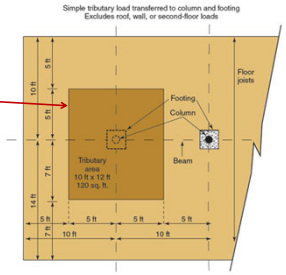
Table R403.1(1)

79

EXAMPLE

Isolated Footing Size

- Given
  - Column supports tributary floor area of 120 ft² at 50 psf
  - 1,500 psf assumed soil-bearing capacity
- Determine minimum footing size



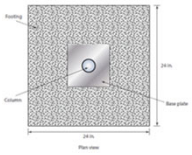
§R403.1.3.6

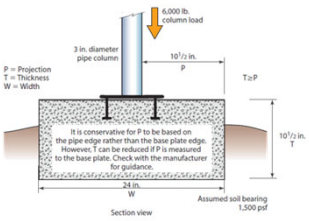
80

EXAMPLE

Isolated Footing Size

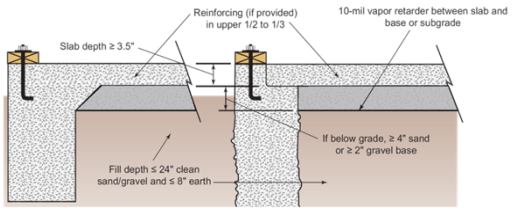
- Soil load-bearing capacity
  - 1500 psf
- Tributary column load
  - 120 ft² x 50 lbs = 6,000 lbs
- 6,000 lbs ÷ 1,500 psf = 4 ft²





81

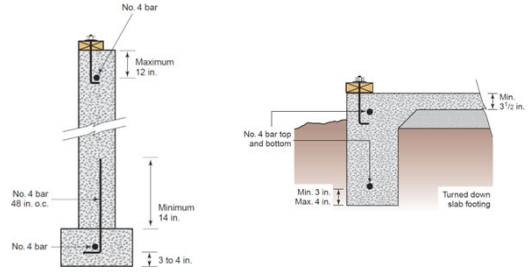
Concrete Slabs



§R506

82

Foundation Anchorage – SDC D_0, D_1, D_2

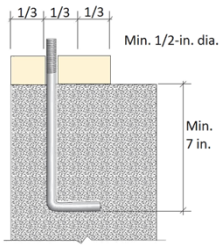


§R403.1.3 and R403.1.3.3

83

Foundation Anchorage

- Anchor Bolts

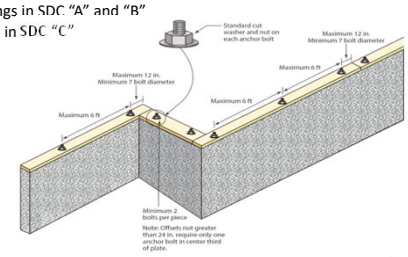


§R403.1.6

84

Foundation Anchorage

- Wood sill plate to foundation
  - All buildings in SDC "A" and "B"
  - Dwellings in SDC "C"

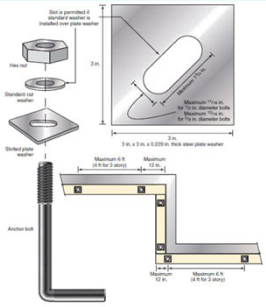


§R403.1.6

85

Foundation Anchorage

- Wood sill plate for seismic
  - Dwellings and townhouses in SDC D_U, D_1 and D_2
  - Townhouses in SDC C
  - 3" x 3" x ¼" plate washers
  - 4' o.c. for 3-story buildings

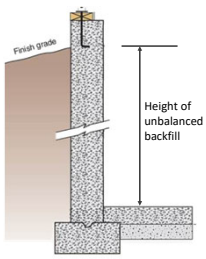


§R403.1.6.1

86

Concrete Foundation Walls

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



§R404.1

87

Concrete Foundation Walls

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

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

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

§R404.1

88

Horizontal Reinforcing

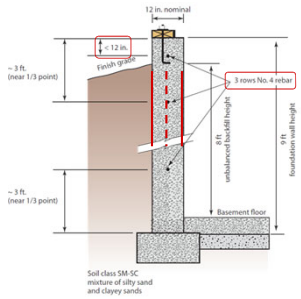


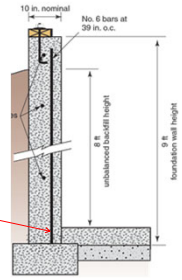
Table R404.1.2(1)

89

Vertical Reinforcing

EXAMPLE

Wall Ht.	Unbalanced Backfill Ht.	Soil class		
		SC, ML-CL and inorganic CL		
		8"	10"	12"
9'	6'	6 @ 39	NR	NR
	7'	6 @ 38	5 @ 37	NR
	8'	6 @ 29	6 @ 39	4 @ 48



Soil class = CL inorganic sandy clay

Table R404.1.2(8)

90

EXAMPLE

Vertical Reinforcing Cover

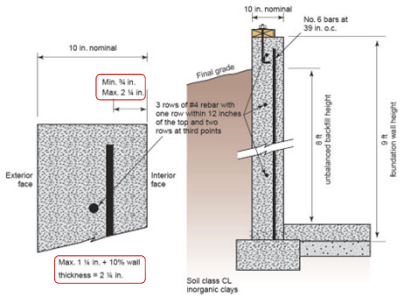


Table R404.1.2(8)

91

EXAMPLE

Plain Masonry Wall

- All buildings SDC A and B
- Dwellings SDC C

Minimum Nominal Wall Thickness (in.)		
Wall Ht.	Unbalanced Backfill Ht.	Soil class
		GW, GP, SW and SP
8′	6′	10″
	7′	12″
	8′	10″ fully grouted

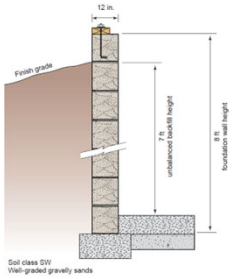


Table R404.1.1(1)

92

EXAMPLE

Reinforced Masonry Wall

Wall Ht.	Unbalanced Backfill Ht.	Soil class
		GM, GC, SM, SM-SC & ML
		45 psf per ft below grade
8′-8″	6′	5 @ 48
	7′	6 @ 48
	8′-8″	6 @ 32

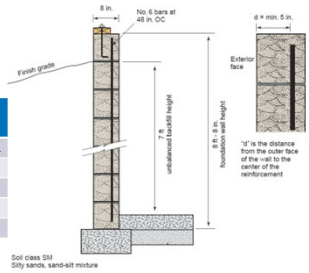
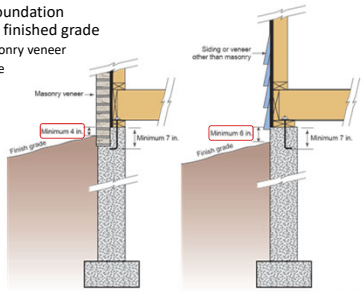


Table R404.1.1(2)

93

Height Above Finished Grade

- Concrete and masonry foundation walls must extend above finished grade
  - Minimum of 4" with masonry veneer
  - Minimum of 6" elsewhere

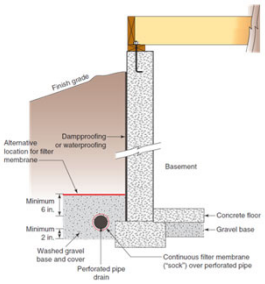


§R404.1.6

94

Moisture Protection

- Drainage by perforated pipe or other drain system
  - At or below basement/crawl space floor
  - Exception for areas with well-drained soils
- Dampproofing materials applied to foundation exterior
- Waterproofing
  - High-water table
  - Other severe soil-water conditions
  - Impervious materials

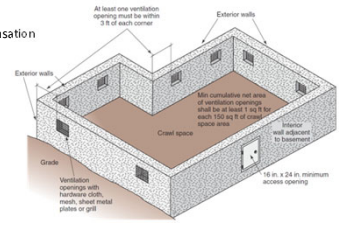


§R405, R406 & R506

95

Underfloor Space

- Ventilation required
  - Circulate air and dissipate condensation
- Method of ventilation
  - Foundation openings
  - Mechanical exhaust ventilation
  - Connection to conditioned air supply of dwelling
  - Dehumidification
- Access to underfloor spaces
  - 18" x 24" through floor
  - 16" x 24" through perimeter wall



§R408

96

APPLICATION

What is the maximum anchor bolt spacing in a sill plate?

a) 2 ft
b) 4 ft
c) 6 ft
d) 8 ft

97

Framing

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

§R502, R503, R602, R604, R802 & R803

98

Engineered Wood Products

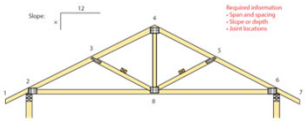
- Metal-plate-connected wood trusses
- I-joists
- Glued-laminated timber
- Structural composite lumber (SCL)
  - Laminated veneer lumber (LVL)
  - Parallel strand lumber (PSL)
  - Laminated strand lumber (LSL)

§R502, R602 &R802

99

Wood Trusses

- Design submitted to building official for approval
- Includes
  - Design loads
  - Slope or depth
  - Span and spacing
  - Required bearing widths
  - Lumber size, species and grade
  - Connection requirements
  - Required permanent bracing locations

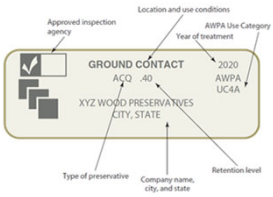


§R502.11 & R802.10

100

Wood Treatment

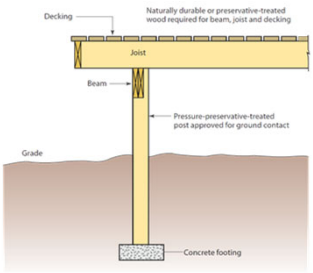
- Wood in locations subject to decay requires
  - Preservative-treated wood
  - Naturally durable wood
    - Redwood
    - Cedar
    - Black locust
    - Black walnut



§R317

101

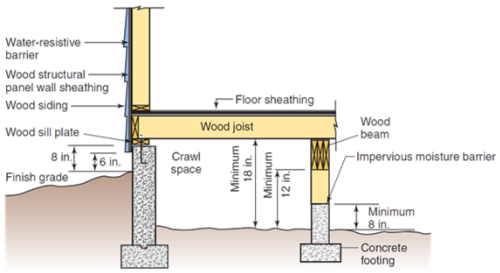
Protection Against Decay



§R317

102

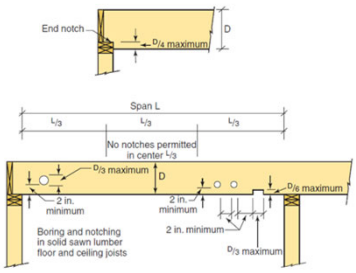
Protection Against Decay



§R317

103

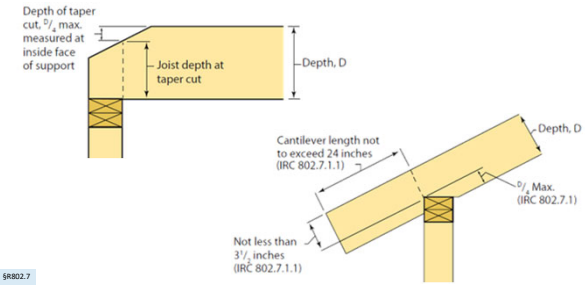
Boring and Notching



§R502.8

104

Boring and Notching

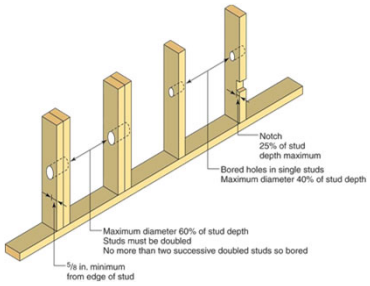


§R802.7

105

Boring and Notching

- Bearing walls



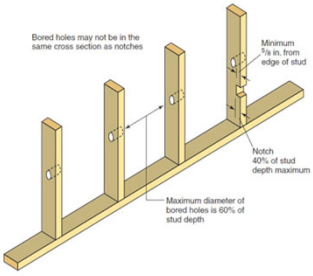
§R602.6

106

Boring and Notching

- Nonbearing Walls

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



§R602.6

107

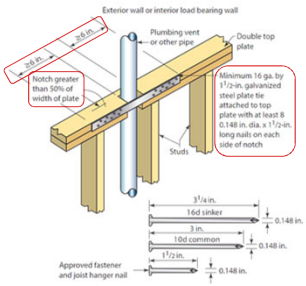
Boring and Notching

SAWN LUMBER FLOOR JOISTS, CEILING JOISTS AND RAFTERS		APPROXIMATE NOTCH AND HOLE LIMITATIONS IN INCHES		
Nominal Size	Actual Depth 'D' in Inches	D/3	D/4	D/6
2 x 4	3½	$1^1/_8$	$^7/_8$	½
2 x 6	5½	$1^3/_4$	$1^3/_8$	$^7/_8$
2 x 8	7¼	$2^3/_8$	$1^3/_4$	$1^1/_8$
2 x 10	9¼	3	$2^1/_4$	1½
2 x 12	11¼	3¾	$2^3/_4$	$1^7/_8$
Wood Studs		60%	40%	25%
2 x 4	3½	$2^1/_8$	$1^3/_8$	$^7/_8$
2 x 6	5½	$3^1/_4$	$2^1/_8$	$1^3/_8$

108

Boring and Notching

- Bearing wall top plate
  - Not a nailer plate for pipe protection
  - Maintains top plate load path

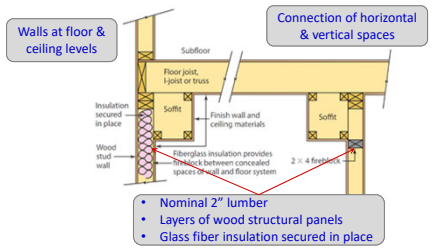


§R602.6.1

109

Fireblocking

- Stop fire spread in wood frame construction concealed spaces

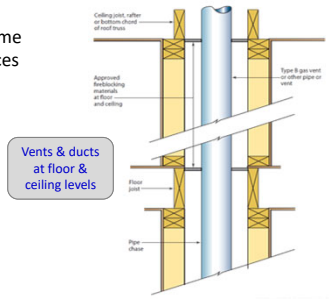


§R302.11

110

Fireblocking

- Stop fire spread in wood frame construction concealed spaces



§R302.11

111

Draftstopping

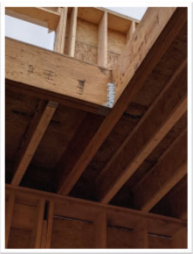
- Divide concealed floor assembly spaces into areas of ≤1000 ft^2
- Materials
  - 1/2" gypsum board
  - 3/8" wood structural panels
  - Other approved materials

§R302.12

112

Wood Floor Framing

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



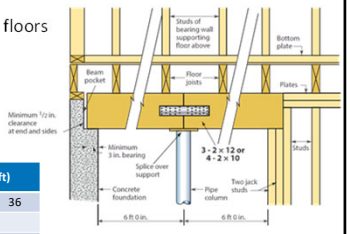
§R502

113

EXAMPLE

Beam Size and Bearing

- Interior beam supporting 2 floors
- #2 hem-fir lumber
- Building width = 24'
- Beam span = 6'



Girder supporting	Size	Building width (ft)		
		12	24	36
Two floors		Span (ft-in.)		
	3-2x12	8-8	6-5	5-4
	4-2x10	8-6	6-4	5-3

Table R602.7(2)

114

EXAMPLE

Beam Size and Bearing

2 simple span beams

Continuous multi-span beam

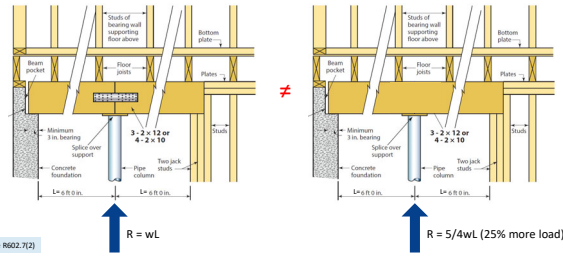


Table R602.7(2)

115

EXAMPLE

Joist Size and Spacing

- #2 Douglas fir-larch
- Live load = 40 psf
- Dead load = 10 psf

Joist Spacing	Joist Size	Span
12" o.c.	2 x 8	14' – 2"
16" o.c.	2 x 10	15' – 7"
24" o.c.	2 x 12	14' – 9"

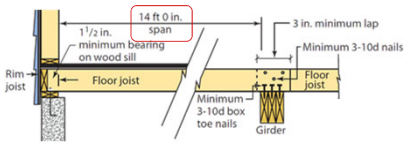


Table R502.3.1(2)

116

Fastener Schedule – Floor Framing

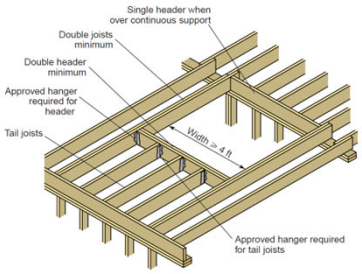
DESCRIPTION	NUMBER AND SIZE OF NAILS	SPACING, LOCATION AND METHOD
Joist to sill, top plate or girder	3 - 10d box (3" x 0.128") or 3 - 3" x 0.131" nails	Toe nail
Rim joist, band joist or blocking to sill or top plate	10d box (3" x 0.128") or 3" x 0.131" nails	6" o.c. toe nail
Band or rim joist to joist	4 - 10d box (3" x 0.128") or 4 - 3" x 0.131" nails	End nail
Built-up girders and beams, 2-inch lumber layers	10d box (3" x 0.128") or 3" x 0.131" nails	24" o.c. face nail at top and bottom staggered on opposite sides
	and 3 - 10d box (3" x 0.128") or 3 - 3" x 0.131" nails	Face nail at ends and at each splice

Table R602.3(1)

117

Framing at Openings

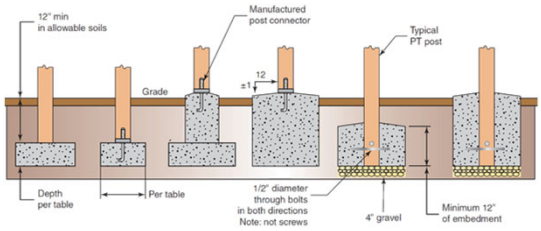
- Header span ≥ 4 ft
  - Double headers
  - Double trimmers
- Single trimmer
  - Only if header ≤ 3 ft trimmer bearing



§R502.10

118

Deck Footings



Note: Posts must be centered on or in footing.

Fig R507.3

119

Deck Footings

EXAMPLE

- Determine minimum round concrete footing size for corner and interior posts of a 20' x 12' deck
  - LL = 40 psf and exceeds snow load
  - Presumed soil bearing pressure = 2,000 psf

LIVE OR GROUND SNOW LOAD (psf)	TRIBUTARY AREA (ft²)	SOIL BEARING CAPACITY (psf)					
		1,500			2,000		
		Diameter of a Round	Side of a Square Footing	Thickness	Diameter of a Round Footing	Side of a Square Footing	Thickness
40 Live Load	40	16	14	6	14	12	6
	60	19	17	6	17	15	6
	80	22	20	7	19	17	6
	100	25	22	8	21	19	6
	120	27	24	9	23	21	7

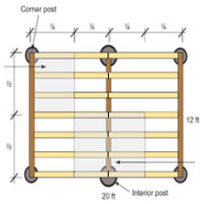
Table R507.3.1

120

EXAMPLE

Deck Footings

- Tributary area – Corner post
  - Length is ¼ of total length = 20′ × ¼ = 5′
  - Width is ½ of total width = 12′ × ½ = 6′
  - Area = 5′ × 6′ = 30 ft²

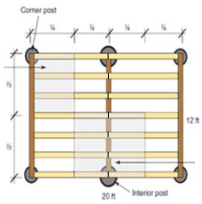


121

EXAMPLE

Deck Footings

- Tributary area – Interior post
  - Length is ½ of total length = 20′ × ½ = 10′
  - Width is ½ of total width = 12′ × ½ = 6′
  - Area = 10′ × 6′ = 60 ft²



122

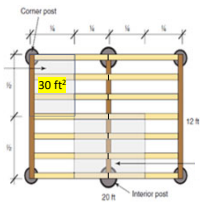
EXAMPLE

Deck Footings

- Footing size – Corner post (30 ft²)
  - Min. 14″ diameter (12″ interpolated)
  - Min. 6″ thick

TRIBUTARY AREA (ft²)	SOIL BEARING CAPACITY (psf) 2,000		
	Diameter of a Round Footing	Side of a Square Footing	Thickness
40	14	12	6
60	17	15	6
80	19	17	6
100	21	19	6
120	23	21	7

Table R507.3.1



123

EXAMPLE

Deck Footings

- Footing size – Interior post (60 ft²)
  - Min. 17" diameter
  - Min. 6" thick

TRIBUTARY AREA (ft²)	SOIL BEARING CAPACITY (psf) 2,000		
	Diameter of a Round Footing	Side of a Square Footing	Thickness
40	14	12	6
60	17	15	6
80	19	17	6
100	21	19	6
120	23	21	7

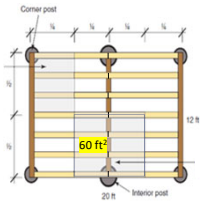


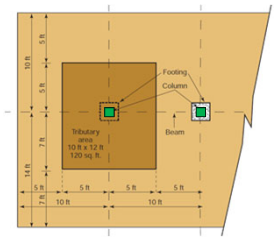
Table R507.3.1

124

EXAMPLE

Post Size

- Given
  - Southern pine No. 2
  - 50 psf ground snow load
  - 10 ft tall posts
  - Tributary area = 120 ft²
- Determine post size



125

EXAMPLE

Post Size

LOAD (psf)	SPECIES	SIZE	TRIBUTARY AREA (ft²) 40	60	80	100	120
			Maximum Deck Post Height*				
50 Ground Snow Load	Southern pine	4 x 4	12-2	9-10	8-5	7-5	6-7
		4 x 6	14-0	12-6	10-9	9-6	8-7
		6 x 6	14-0	14-0	14-0	14-0	14-0
		8 x 8	14-0	14-0	14-0	14-0	14-0
		4 x 4	11-8	9-0	6-10	3-7	NP

Solution: 6x6 No. 2 Southern Pine

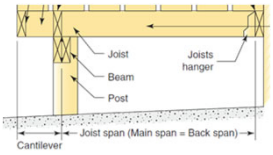
Table R507.4

126

EXAMPLE

Beam and Joist Sizes

- Ground Snow Load = 50 psf
- Beam: 2-ply Southern Pine 2x10
- Joist: Southern Pine with 14' span
  - Assumes ¼ cantilever = 3.5'
- Determine allowable beam span and joist size



§R507.5

127

EXAMPLE

Beam Size

LOAD (psf)	SPECIES	SIZE	EFFECTIVE DECK JOIST SPAN LENGTH (feet)						
			6	8	10	12	14	16	18
			Maximum Beam Span						
50 Ground Snow Load	Southern pine	2-2x10	10-1	8-9	7-10	7-1	6-7	6-2	5-10
		2-2x12	11-11	10-3	9-2	8-5	7-9	7-3	6-10
		3-2x10	12-8	10-11	9-9	8-11	8-3	7-9	7-3
		3-2x12	14-11	12-11	11-6	10-6	9-9	9-1	8-7
	Douglas fir-larch, Hem-fir, Spruce-pine-fir, Redwood, Western cedars, Ponderosa pine, Red pine	2-2x10	9-5	8-2	7-3	6-8	6-2	5-9	5-5
		2-2x12	10-11	9-5	8-5	7-8	7-2	6-8	6-3
		3-2x10	11-9	10-2	9-1	8-4	7-8	7-2	6-9
		3-2x12	13-8	11-10	10-7	9-8	8-11	8-4	7-10

Solution: Two No. 2 Southern Pine 2x10s span 6'-7"

§R507.5

128

EXAMPLE

Joist Size

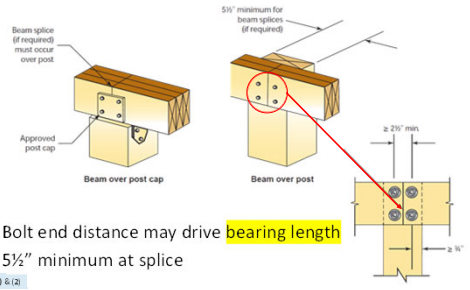
LOAD (psf)	SPECIES	SIZE	ALLOWABLE JOIST SPAN			MAXIMUM CANTILEVER			
			Joist Spacing (inches)			Joist Back Span (feet)			
			12	16	24	8	10	12	14
50 Ground Snow Load	Southern pine	2x8	12-1	11-0	9-5	2-0	2-5	2-3	NP
		2x10	15-5	13-9	11-3	2-0	2-6	3-0	3-1
		2x12	18-0	16-2	13-2	2-0	2-6	3-0	3-6
	Douglas fir, Hem-fir, Spruce-pine-fir, Redwood, Western cedars, Ponderosa pine, Red pine	2x8	10-10	9-10	8-6	2-0	1-11	NP	NP
		2x10	13-10	12-7	10-5	2-0	2-6	2-9	NP
		2x12	16-10	14-9	12-1	2-0	2-6	3-0	3-5

Solution: No. 2 Southern Pine 2x12 at 16" o.c.

§R507.6

129

Deck Beams and Posts – Bearing at Splice



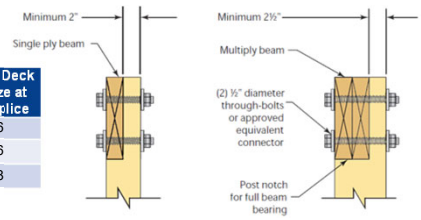
- Bolt end distance may drive bearing length
- 5½" minimum at splice

Fig R507.5.1(1) & (2)

130

Deck Beams and Posts – Bearing at Splice

Beam Plies	Notched Deck Post Size at Beam Splice
1	4 x 6
2	6 x 6
3	6 x 8



- Bearing width prescriptively set
- Minimum post size at beam splice based on bearing length and width

Fig R507.5.1(1) & (2)

131

Deck Ledger Attachment

- Positive anchorage
- No toenails or nails in withdrawal

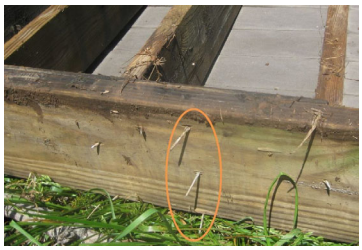


Photo courtesy of Frank Woeste

§R507.8

132

Deck Ledger Attachment

- Shall not
  - Support concentrated loads from beams or girders
  - Be supported on stone or masonry veneer

§R507.9.1.1

133

Deck Ledger Attachment

Courtesy of *Journal of Light Construction*

§R507.9.1.1

134

Deck Ledger Attachment – Gravity Loads

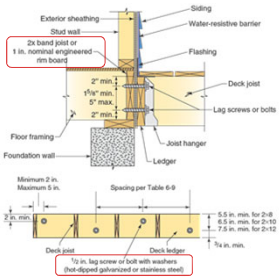
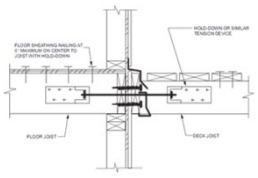


Table R507.9

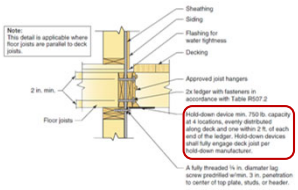
135

Deck Ledger Attachment – Lateral Loads

Option 1 – Two @ 1500 lbs



Option 2 – Four @ 750 lbs



§R507.9.2

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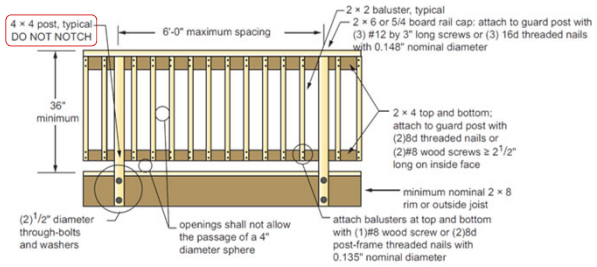
Deck Guards

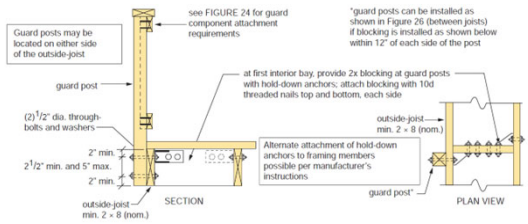


§R507.10.2

137

Deck Guards

EXAMPLE



§R507.10.1.1

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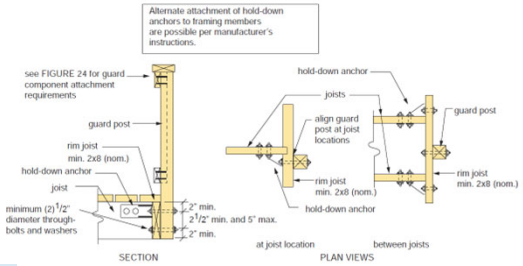
EXAMPLE

Deck Guards



§R507.10.1.1

139

Deck Guards

- When mounted on top of decking
  - Connect to framing or blocking

Courtesy *Journal of Light Construction* / Mike Guertin

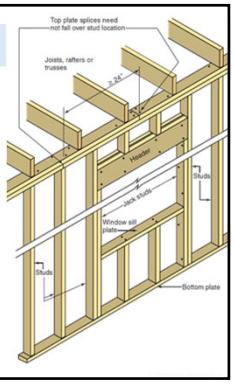
Courtesy *Frank Woeste*

§R507.10.1.2

140

Wood Wall Framing

- Size and spacing of studs is related to
  - Number of floors supported
  - Roof-ceiling assembly
  - Wind speed



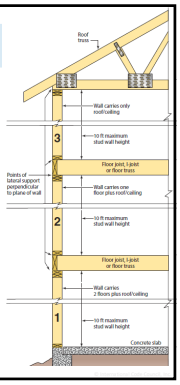
§R602

141

EXAMPLE

Stud Size and Spacing

- Determine stud size, height and spacing in an exterior bearing wall
- Given
  - 3 stories of wood framing
  - Standard- or stud-grade lumber



§R602

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EXAMPLE

Stud Size and Spacing

Stud Size (inches)	Bearing Walls					Nonbearing Walls	
	Laterally Unsupported Stud Height					Laterally Unsupported Stud Height	Maximum Spacing
2 x 4	10′	24″	16″	--	24″	14′	24″
2 x 6	10′	24″	24″	16″	24″	20′	24″

Story	Minimum stud size	Maximum spacing
3	2 × 4	24 in.
2	2 × 4	16 in.
	2 × 6	24 in.
1	2 × 6	16 in.

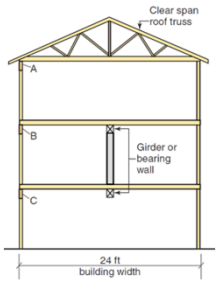
Table R602.3(5)

143

EXAMPLE

Exterior Wall Headers

- Given
  - #2 Douglas fir-larch
  - Clear span roof truss
  - Center bearing floor framing
  - Building width = 24′
  - Header span = 7′
  - Ground snow load = 30 psf
  - Wind = 115 mph Exp C



§R602.7

144

EXAMPLE

Exterior Wall Headers

Ground snow load = 30 psf Building width = 24 feet			
Supporting	Size	Span	Jack studs
Roof, ceiling, two center-bearing floors	3-2x10	5-11	2
	3-2x12	7-0	2

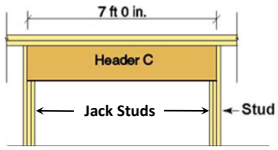


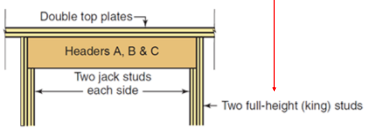
Table R602.7(1)

145

EXAMPLE

Exterior Wall Headers

MAXIMUM HEADER SPAN (FEET)	ULTIMATE DESIGN WIND SPEED AND EXPOSURE CATEGORY	
	≤ 115 MPH, EXPOSURE B	< 140 MPH, EXPOSURE B OR < 130 MPH, EXPOSURE C
4	1	1
6	1	2
8	1	2

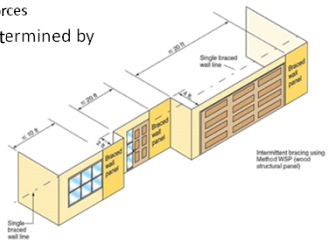


§R602.7.5

146

Wall Bracing

- Provides resistance to lateral racking
  - Primarily wind and seismic forces
- Bracing amount/location determined by
  - Number of stories
  - Seismic design category
  - Design wind speed
  - Bracing method

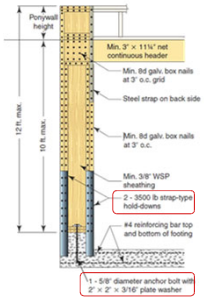


§R602.10

147

Method PFH Braced Wall Panels

- Portal Frame with Hold-Downs



§R602.10

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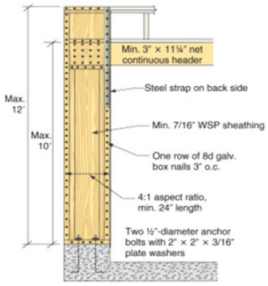
Method PFG Braced Wall Panels

Portal Frame with anchor bolts at Garage doors

- SDC A, B and C



§R602.10

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APPLICATION

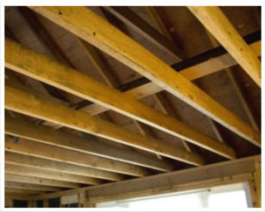
What percentage of the roofs you see are trusses vs rafters?

a. 100% trusses
b. 90% trusses : 10% rafters
c. 75% trusses : 25% rafters
d. 50% trusses : 50% rafters
e. 10% trusses : 90% rafters

150

Ceiling Joists

- Ceiling joists
  - Support ceiling materials
  - Serve as rafter ties to resist outward thrust of rafters at top of bearing walls
  - Require adequate connection to rafters and top of wall

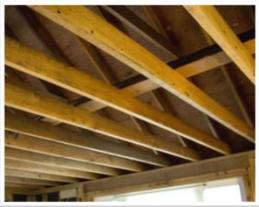


§R802.5

151

Ceiling Joists

- Ceiling joist span tables for
  - Attics without storage
  - Attics with limited storage
    - Attics with fixed stair access require joists sized as floor joists

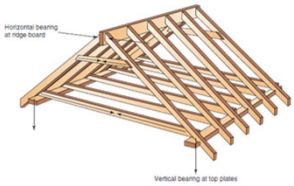


§R802.5

152

Rafters

- Rafter spans based on
  - Snow load of geographic area
  - Roof live load of 20 psf where snow load <30 psf
  - Whether ceiling material is attached to bottom of rafter

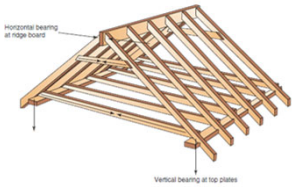


§R802.4 & R802.5

153

Rafters

- Connection to ceiling joists
  - Rafters are connected to ceiling joists at top plate or
  - 2x4 rafter ties are required to resist outward thrust on walls



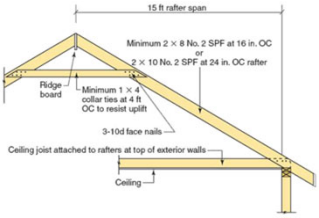
§R802.4 & R802.5

154

EXAMPLE

Rafter Size and Spacing

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



§R802.4

155

EXAMPLE

Rafter Size and Spacing

Rafter Spacing (inches)	Species and Grade	GSL = 30 psf; DL = 10 psf		
		2 x 6	2 x 8	2 x 10
		Maximum Rafter Spans		
		ft - in	ft - in	ft - in
16	Spruce-pine-fir #2	11-11	15-1	18-5
24	Spruce-pine-fir #2	9-9	12-4	15-1

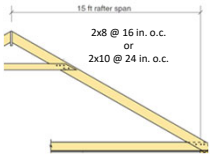
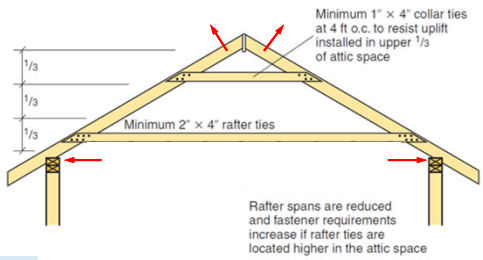


Table R802.4.1(3)

156

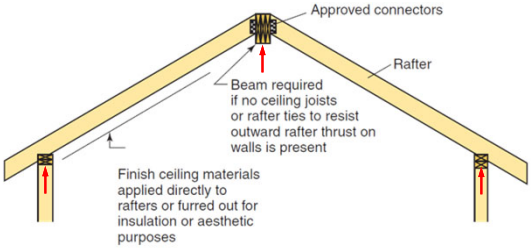
Rafter Ties and Collar Ties



§R802.4.6 & R802.5.2.2

157

Ridge Beams



§R802.3

158

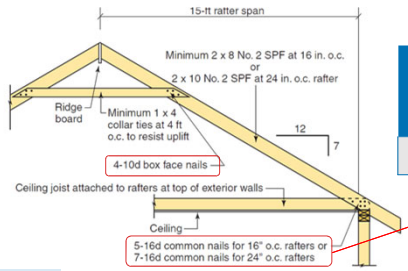
Fastener Schedule for Roof Framing

	Description	Nails	Location
Uplift →	Rafter or roof truss to plate	4-10d box	Toenails: 2 on one side and 1 on opposite side
	Roof rafters to 2x ridge beam	3-10d box	End nail
Uplift →	Ceiling joists to plate	3-10d box	Toenail
Uplift →	Collar tie to rafter	4-10d box	Face nail
Thrust →	Rafter/ceiling joist heel joint connection	Table R802.5.2(1)	Face nail

Table R602.3(1)

159

Fastener Schedule for Roof Framing



RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf) 30		
		Roof span (feet)		
		12	24	36
		Required number of 16d common nails per heel joint splice		
7:12	12	3	3	4
	16	3	4	5
	24	3	5	8

Table R802.5.2(1)

Table R602.3(1)

160

Roof Uplift Connections

- ≤200 lbs
  - Toenail connection
- >200 lbs
  - Connector required

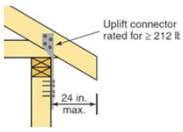


TABLE 6-17 Rafter or Truss Uplift Connection Forces from Wind (pounds per connection)

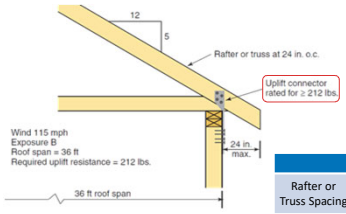
RAFTER OR TRUSS SPACING	ROOF SPAN (feet)	EXPOSURE B Ultimate Design Wind Speed (mph) 115 Roof Pitch < 5:12	≥ 5:12
16 in. o.c.	28	132	117
	32	145	129
	36	160	141
24 in. o.c.	28	198	176
	32	218	194
	36	240	212

§R802.11

161

Roof Uplift Connection

EXAMPLE



Uplift Load, lbs			
Rafter or Truss Spacing	Roof Span	Roof Pitch < 5:12	≥ 5:12
24" o.c.	28'	198	176
	32'	218	194
	36'	240	212

Table R802.11

162

Roof Sheathing

Span Rating	Minimum Nominal Panel Thickness (in.)	Maximum Span (in.)		Load (psf)	
		With Edge Support	Without Edge Support	Total Load	Live Load
Sheathing		Roof			
16/0	3/8	16	16	40	30
20/0	3/8	20	20	40	30
24/0	3/8	24	20	40	30
24/16	7/16	24	24	50	40

Excerpted from Table R503.2.1.1(1)

§R803

163

Roof Sheathing – Fastener Schedule

WSP Nominal Thickness (in.)	Nail	Edge (in.)	Field (in.)
3/8 – 1/2	8d common or RSRS-01 nail	6[f]	6[f]
19/32 – 3/4	8d common or RSRS-01 nail	6[f]	6[f]
7/8 – 1-1/4	10d common	6	12

f. For WSP roof sheathing attached to gable end roof framing and to intermediate supports within 48" of roof edges and ridges, nails shall be spaced at 4" o.c. where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 110 mph in Exposure C.

§R803.2.3 & Table 602.3(1)

164

Tighter Roof Sheathing Fastener Schedule

- Wind speed
  - >130 mph Exp B
  - >110 mph Exp C
- Framing w/i 48" of roof edge/ridge/eave
  - Including gable end roof framing
- Nails at 4" o.c.
  - Edge & field

If an overhang exists, the edge distance shall be measured from the outside edge of the overhang

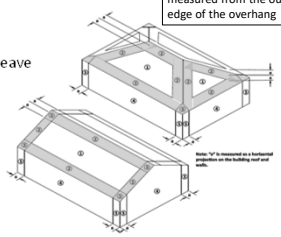
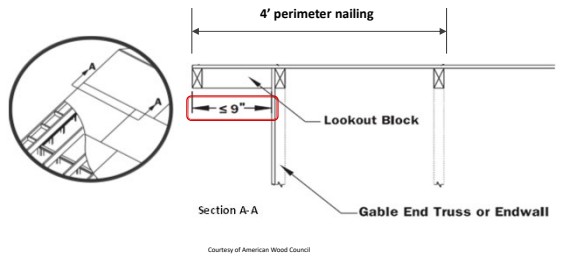


Table R602.3(1) Footnote f

165

Roof Sheathing – Gable Endwall Limits

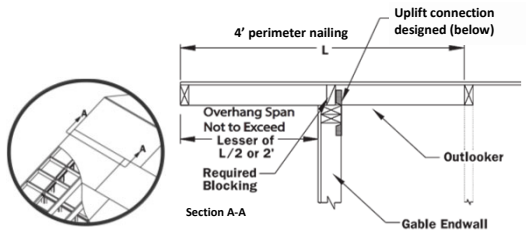


Courtesy of American Wood Council

§R803.2.3

166

Roof Sheathing – Gable Endwall Limits



Wind Speed (Exp B)	110	115	120	130	140
Uplift Load (plf)	238	260	283	333	386

Courtesy of American Wood Council – 2018 WFCM Table 2.2C with MRH=33'

§R803.2.3

167

Attic Ventilation and Access

- Total net free ventilating area = 1/150 of attic area
  - Reduced to 1/300 with certain conditions
  - Unvented attics under certain conditions
- Access required when
  - Attic area >30 ft^2, and
  - Attic height >30"
- Access opening
  - Minimum 22" x 30" and
  - 30" headroom above the opening
  - Located in hallway or other accessible location

§R806 & R807

168

APPLICATION

WSP roof sheathing requires nailing to gable end roof framing and intermediate supports at 4" o.c. under which of the following conditions?

a) Within 4 feet of roof edges and ridges
b) Wind speed > 130 mph Exposure B
c) Wind speed > 110 mph Exposure C
d) All of the above

169

Finishes and Weather Protection

Chapters 7 & 9

170

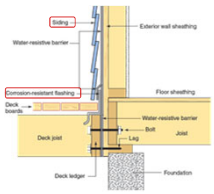
Interior Finishes

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

171

Exterior Wall Covering

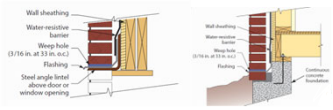
- Weather-resistant exterior wall assembly
  - Water-resistive barrier required over sheathing of all exterior walls
  - Flashing
  - Siding or veneer



172

Masonry and Stone Veneer

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



173

APPLICATION

Steel Lintel Size

- Determine minimum size of a steel lintel supporting masonry veneer
  - Stories above = 1
  - Span = 6'0"

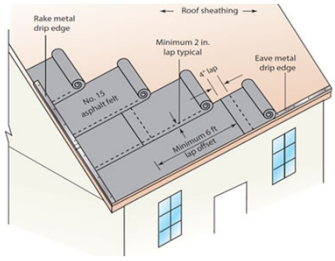
SIZE OF STEEL ANGLE (in.)	NO STORY ABOVE	ONE STORY ABOVE
3 × 3 × ¼	6'-0"	4'-0"
4 × 3 × ¼	8'-0"	6'-0"
5 × 3½ × 5/16	10'-0"	8'-0"
6 × 3½ × 5/16	14'-0"	9'-6"
2 – 6 × 3½ × 5/16	20'-0"	12'-0"

[Ref. Table R703.8.3.1]

Note: Long leg of the angle shall be placed in a vertical position.

174

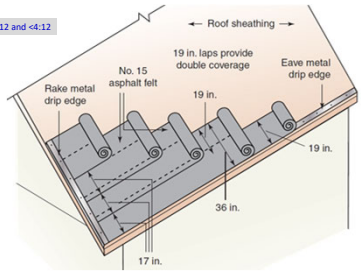
Underlayment for Asphalt Shingles



175

Underlayment for Asphalt Shingles

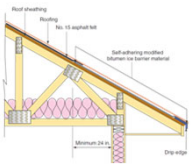
Slope >2:12 and <4:12



176

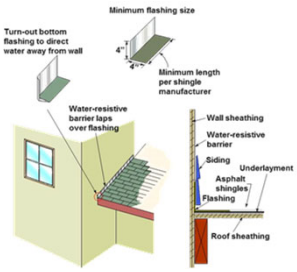
Ice Barriers

- Required where water damage due to ice dams at roof eaves occurs



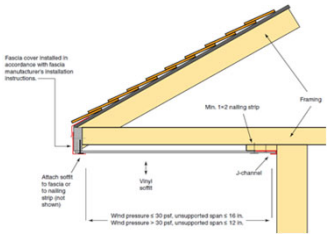
177

Flashing



178

Soffits



179

Health and Safety

Chapters 3 & 10

180

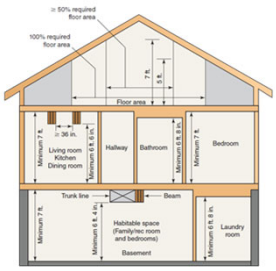
Ceiling Height

7′-0″	6′-8″	6′-6″	6′-4″

Generally, this is the height used.	• Bathrooms
	• Laundry rooms
	• Basements w/o habitable space
		Beams ≥36″ apart	• Basements with habitable space
			  • Beams
			  • Girders
			  • Ducts
			  • Other obstructions

181

Ceiling Height



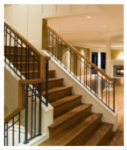
§R305

182

182

Means of Egress

- Describes travel path from any location in a dwelling to exterior
  - Stairways, Ramps, Hallways
  - Doors
    - One side-swinging egress door to exterior
    - Minimum 32″ x 78″ clear opening
    - No size or type requirements for other doors
    - No limits on travel distance



§R311

One Required.

183

Means of Egress

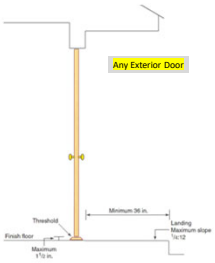
- Provide safe path to exterior
  - Does not pass through garage
  - ½" gypsum board on enclosures under stairs
  - Egress components securely anchored to structure
  - Required egress door can be opened without key or special knowledge
  - Access to grade at required egress door

§R311

184

Landings at Exterior Doors

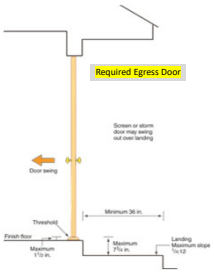
- Landing or floor on each side of exterior door
  - At least as wide as door
  - Landings or finished floors ≤ 1½" below threshold
  - ≥ 36" in travel direction
    - Exception for balconies
  - Max. landing slope = ¼:12



185

Landings at Exterior Doors

- Landings or finished floors ≤ 1½" below top of threshold
  - Exception
    - Door swings in
    - Exterior landing can be max 7¾" below top of threshold
- Access to grade

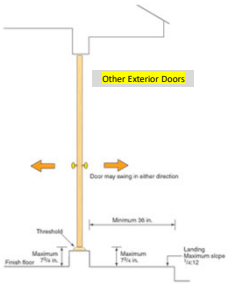


§R311.3.1

186

Landings at Exterior Doors

- Other than required egress
- Landing on either side
  - ≤ 7¾" below top of threshold
- Door swings either direction

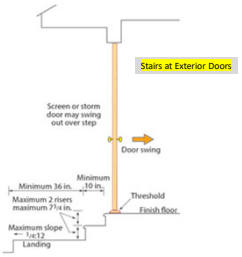


§R311.3.2

187

Stairs at Exterior Doors

- Door other than required egress
- Exception
  - Stairs allowed on exterior side
    - Door cannot swing over stairs
    - Stairs can have 2 risers max

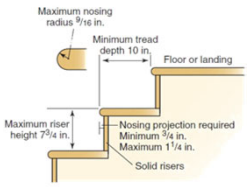


§R311.3.2

188

Stair Treads and Risers

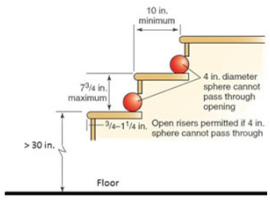
- Riser ≤ 7¾"
- Tread ≥ 10"
- Variance ≤ ⅜"
- Nosing projection ¾" - 1¼"



189

Stair Treads and Risers

- Treads > 30” above floor or grade
  - Solid risers, or
  - 4” diameter sphere limit

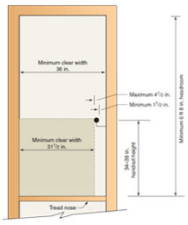


§R311.7.5

190

Stairway Width

- 36” min clear width
  - Required above handrail
  - Below required headroom height
  - 4½” max handrail projection either side

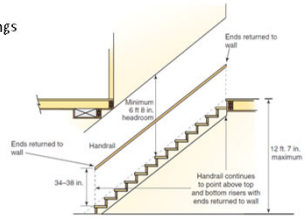


§R311.7.1

191

Stairway Headroom

- Minimum headroom
  - 6’-8”
  - Above plane of tread nosings

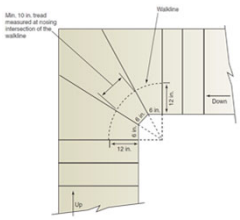


§R311.7.2

192

Winder Stairs

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

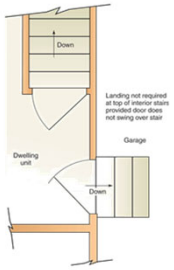


§R311.7.5.2.1

193

Stair Landings

- Required at top and bottom of stairs
- Width of stairway
- Minimum 36” in travel direction
- Maximum 12’-7” vertically between landings
- Exception at top of interior stairs

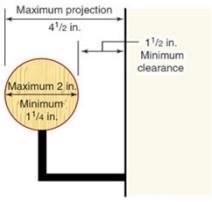


§R311.7.6

194

Handrail

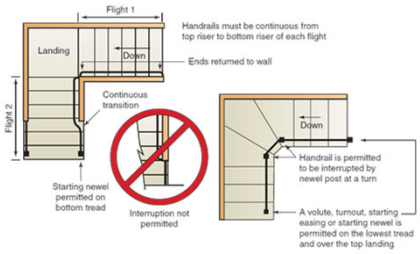
- Max 4½” projection from wall
- Min 1 ½” wall clearance
- Graspable shape



§R311.7.8

195

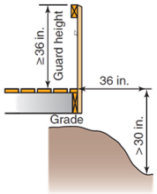
Handrail Continuity



196

Guards

- Walking surface >30” above any point within 36” horizontally
- Min. guard height 36”
  - 34” at stairs

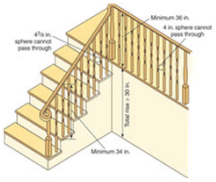


§R312.1

197

Guards

- Openings <4” sphere
  - <4⅜” along stairs
- Top rail to resist point load of 200 lbs in any direction
- Infill components to resist 50-lb horizontal load applied to an area of 1 ft^2

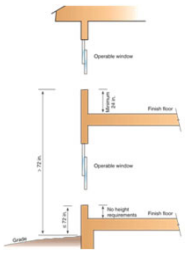


§R312.1

198

Window-sill Height

- Window openings >72” above grade must have a sill height of >24”



§R312.2

199

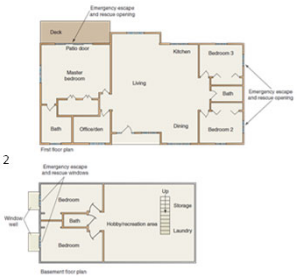
Window-sill Height Alternatives

§R312.2

200

Emergency Escape and Rescue Openings

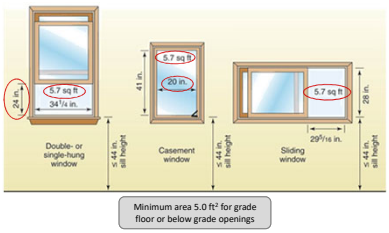
- Basements
- Habitable attics
- Sleeping rooms
  - Exceptions
    - Storm shelters
    - Basements ≤ 200 ft² used only to house mechanical equipment with 2 ways out



§R310.1

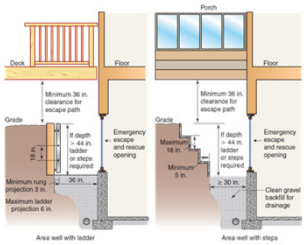
201

Emergency Escape and Rescue Openings



202

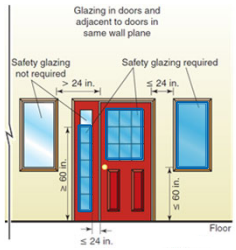
Area Wells

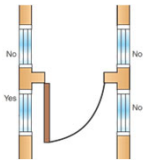


§R310.4

203

Safety Glazing – Adjacent Doors



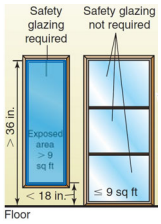


§R308.4.2

204

Safety Glazing - Windows

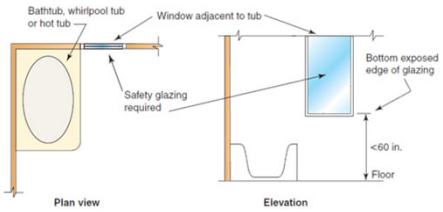
- Exposed area of an individual pane > 9 ft^2
- Bottom edge of glazing < 18" above floor
- Top edge of glazing > 36" above floor
  - Exception
    - Horizontal rail installed 34" to 38" above walking surface



§R308.4.3

205

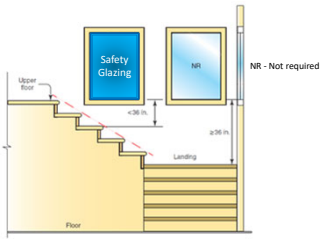
Safety Glazing – Wet Surfaces



§R308.4.5

206

Safety Glazing – Adjacent Stairs

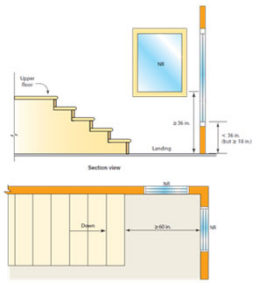


§R308.4.6

Hazardous Locations

207

Safety Glazing – Adjacent Landing

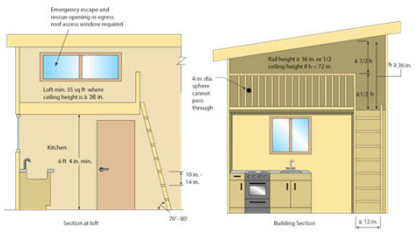


§R308.4.7

208

Tiny Houses

≤ 400 sf

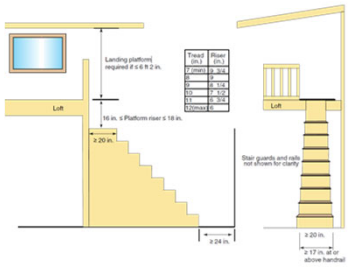


Appendix Q

IRC Appendix Q

209

Tiny Houses

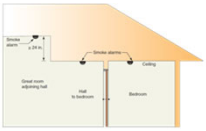


Appendix Q

210

Smoke Alarms

- Building wiring system provides primary power
- Battery backup



§R314

211

Smoke Alarms – Existing Dwellings

- Retrofit smoke alarms when permit required
  - Interior alterations/repairs and Additions
- Battery-operated smoke alarms
- Interconnection – wireless
- Exceptions
  - Minor work not requiring a permit
  - Exterior work, Addition of a deck or porch
  - Replacing doors or windows

§R314.2.2

212

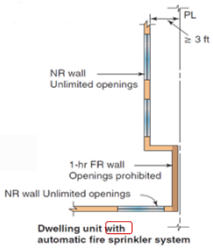
Residential Fire Sprinkler Systems

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

§R313

213

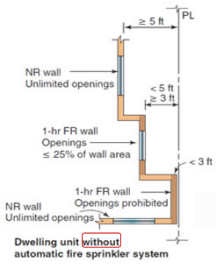
Exterior Walls



§R302.1

214

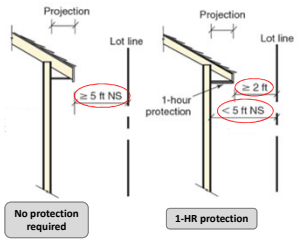
Exterior Walls



§R302.1

215

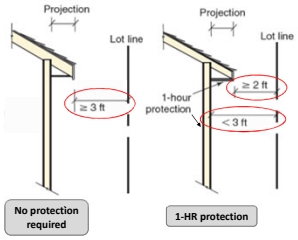
Eave Projections – w/o Sprinklers



§R302.1

216

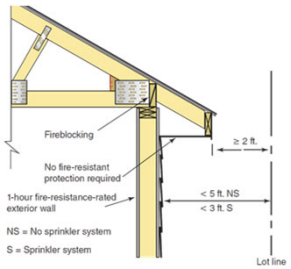
Eave Projections – w/ Sprinklers



§R302.1

217

Eave Projections



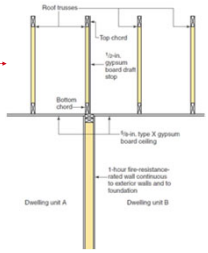
§R302.1

A fire-resistance rating is not required for roof eave projections when fireblocking is installed.

218

Two-Family Dwelling Separation

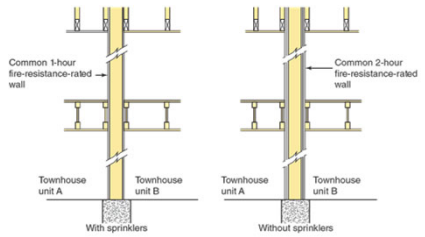
- 1-hour separation
  - Continuous from foundation to roof
- Alternate
  - ⅝" Type X gypsum board ceiling
  - ½" gypsum board on bearing walls
  - Draft stop in attic



§R302.3

219

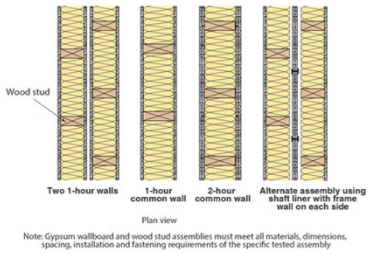
Townhouse Separation



§R302.2

220

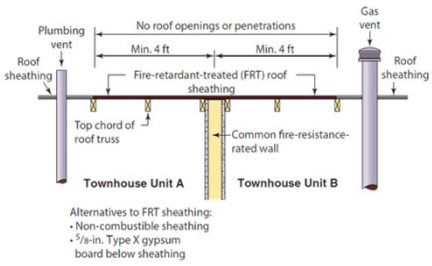
Townhouse Separation



§R302.2

221

Parapet Exception



§R302.2.4

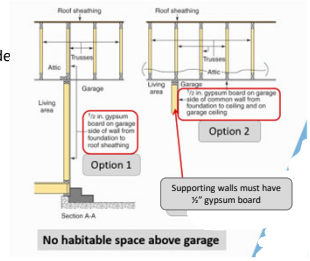
222

2021 IRC Essentials 223

223

Dwelling Separation from Garage

- Not a fire-resistance-rated assembly
- ½" gypsum board on garage side provides limited fire resistance

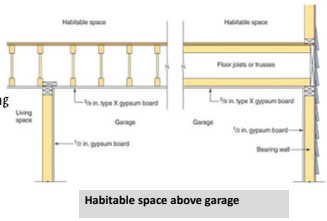


§R302.6

224

Dwelling Separation from Garage

- Not a fire-resistance-rated assembly
- ½" gypsum board on garage side provides limited fire resistance
- ⅝" Type X gypsum board on ceiling when habitable space above

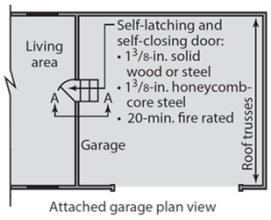


§R302.6

225

Dwelling Separation from Garage

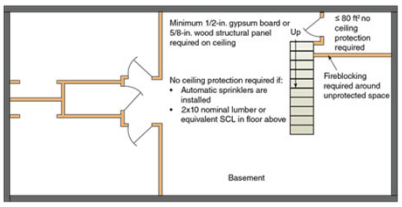
- Penetrations not rated
- No openings from garage into a sleeping room
- "Automatic closing" permitted in lieu of self- closing



§R302.6

226

Fire Protection of Floors



§R302.13

227

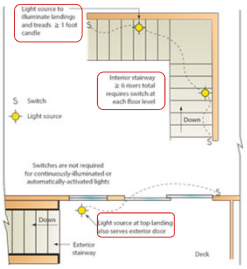
Light and Ventilation

- Habitable rooms
  - Glazing ≥ 8% or lighting ≥ 6 footcandles
  - Openings ≥ 4% or mechanical ventilation
- Bathrooms
  - Glazing ≥ 3 ft² or electric lighting
  - Openings ≥ 1.5 ft² or mechanical exhaust

§R303.1

228

Stairway Illumination

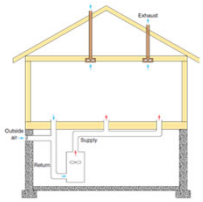


§R303.7
&R303.8
egress path

229

Whole-house Mechanical Ventilation

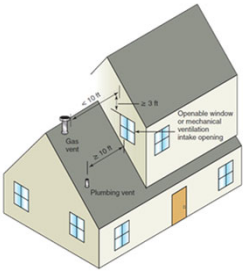
- Required if
  - Blower door test shows air infiltration rate
    - ≤ 5 ACH or
    - 0.28 cfm/ft^2
- Separate system not required
  - Supply and exhaust fans can achieve ventilation



§R303.4

230

Opening and Intake Locations

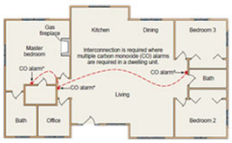


§R303.5

231

Carbon Monoxide (CO) Alarms

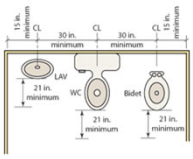
- Required if
  - Fuel-fired appliance or
  - Attached garage communicating with dwelling unit
- Locations
  - Outside of each separate sleeping area adjacent bedrooms
  - Bedrooms with fuel-burning appliance located in or near bedroom
- Power
  - House wiring with battery backup

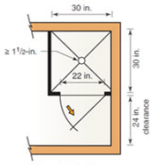


§R315

232

Sanitation



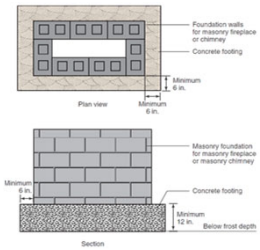


General rule minimum shower dimensions

§R307.1

233

Chimneys and Fireplaces



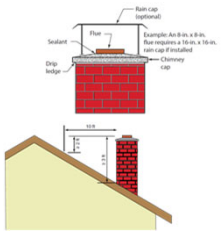
§R1001.2
&R1003.2

Both factory-built and masonry fireplaces require an adequate exterior air supply.

234

Masonry Chimney Termination

- Flashing to weatherproof the chimney penetration at the roof
- Crickets required for chimneys ≥30" wide
- Chimney cap required
- Rain cap optional



§R1003.9
&R1003.20

235

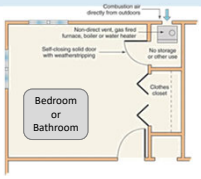
Building Utilities

Chapters 12-43

236

Appliances – Installation and Location

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



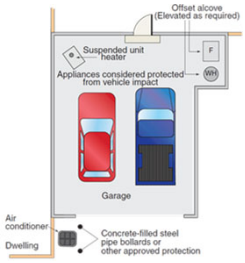
Exceptions
1. Direct-vent appliances
2. Vented room heaters
3. Vented wall furnaces
4. Vented gas fireplaces

§G2406.2

237

Appliances – Installation and Location

- Private garages
  - Appliances and equipment
  - Ignition source ≥18" above floor
  - Unless appliance listed as flammable-vapor-ignition resistant
  - Protected from vehicle impact



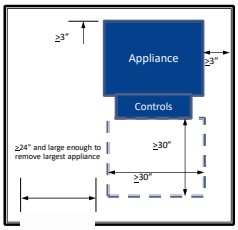
§G2408.3
&M1307.3.1

Vapors from gasoline and other flammable liquids

238

Appliances – Access

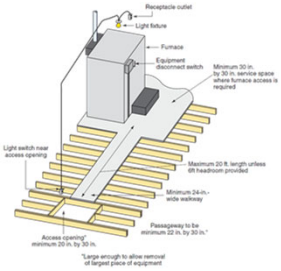
- Minimum 30" x 30" working space in front of controls
- Access doors and passageways
  - Minimum 24" wide
  - Large enough to remove largest appliance
- Clearance
  - Furnace compartments >12" wider than appliance
  - Minimum 3" sides & back



§M1305.1

239

Attic Appliances – Access

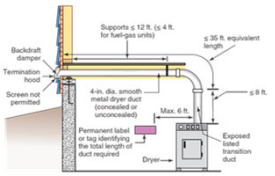


§M1305.1
&E3901.12

240

Clothes Dryer Exhaust Systems

- Exhaust Duct Termination
  - Not connected to vent connector, vent or chimney
- Length
  - Deductions for fittings
  - Label when > 35'
  - Per Manufacturer Installation Instructions

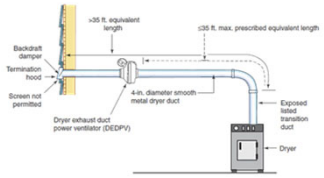


§M1502
&G2439

241

Clothes Dryer Exhaust Systems

- Dryer Exhaust Duct Power Ventilator
  - Per manufacturer

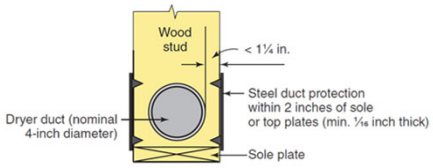


§M1502
&G2439
booster fans are prohibited.

242

Clothes Dryer Exhaust Systems

- Protection of concealed dryer duct

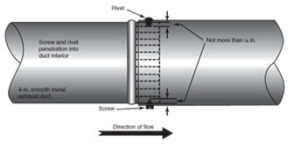


§M1502
&G2439

243

Dryer Exhaust Duct

- 4” smooth metal duct
  - Min. No. 28 gage
- Insert in direction of flow
- Max. ⅛” screw penetration



§M1502
&G2439

244

Whole-house Mechanical Ventilation System

- Prescriptive airflow rate basis
  - Dwelling unit floor area
  - Number of bedrooms
  - Continuous or intermittent
- System design
  - Supply or exhaust fans or both
  - Outdoor air ducts connected to return permitted to supply ventilation

Floor Area	Bedrooms	
	2 – 3	4 – 5
	CFM Airflow	
< 1,500	45	60
1,501 – 3,000	60	75
3,001 – 4,500	75	90

Example Dwelling
- 3500 ft²
- 3 bedrooms

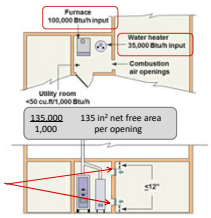
M1505.4.3

245

APPLICATION

Combustion Air from **Inside** the Building

- Combustion air can draw from adjacent rooms if
  - Volume of adjacent space is >50 ft³ per 1,000 Btu/h
  - At least 2 openings
  - Free area of openings per
    - Btu/h input rating of all appliances
    - 1 in² per 1,000 Btu/h



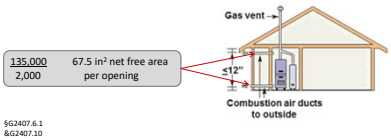
§G2407.5

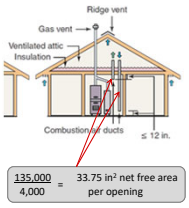
246

APPLICATION

Combustion Air from **Two Outdoor** Openings

- Direct openings
- Vertical ducts
  - Free area ≥1 in² per 4,000 Btu/h of total input rating
- Horizontal ducts
  - Free area ≥1 in² per 2,000 Btu/h of total input rating





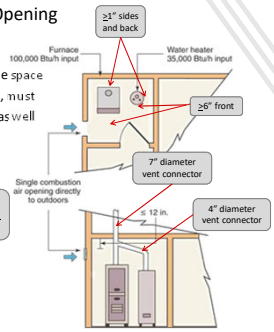
§G2407.6.1 &G2407.10

247

APPLICATION

Combustion Air from **Single Outdoor** Opening

- Free area of opening ≥1 in² per 3,000 Btu/h
- Free area ≥ sum of all vent connectors areas in the space
- Minimum clearances required around appliances, must meet manufacturer installation instructions as well



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

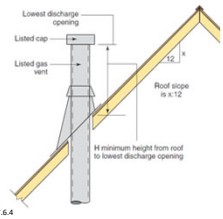
Larger of the two = 51 in²

§G2407.6.2

249

Gas Vent Roof Termination

- Termination height for gas vents with cross section ≤12" and ≥8' from a vertical wall based on roof slope

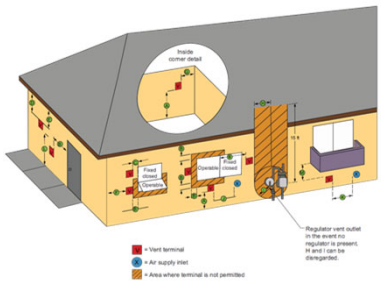


ROOF SLOPE	MINIMUM HEIGHT (ft) FROM ROOF TO LOWEST DISCHARGE OPENING
Flat to 6:12	1.0
Over 6:12 to 7:12	1.25
Over 7:12 to 8:12	1.5
Over 8:12 to 9:12	2.0
Over 9:12 to 10:12	2.5
Over 10:12 to 11:12	3.25
Over 11:12 to 12:12	4.0
Over 12:12 to 14:12	5.0
Over 14:12 to 16:12	6.0
Over 16:12 to 18:12	7.0
Over 18:12 to 20:12	7.5
Over 20:12 to 21:12	8.0
[Ref. Figure G2427.6.4]	

§G2427.6.4

250

Direct-vent Appliance Vent Termination



§G2427.8

Direct-vent appliances often produce lower-temperature flue gases

252

Direct-vent Appliance Vent Termination

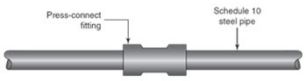
FIGURE CLEARANCE	CLEARANCE LOCATION	MINIMUM CLEARANCE FOR DIRECT-VENT TERMINALS	
A	Clearance above finished grade level, veranda, porch, deck or balcony	12 inches	
B	Clearance to window or door that is openable	**Appliance Btu/Hr Rating**	**Minimum Clearance to Terminal**
		≤ 10,000	6 inches
		≤ 50,000	9 inches
		≤ 150,000	12 inches
		> 150,000	Use manufacturer's instructions and at least nondirect-vent clearances

Table G2427.8

253

Gas Pipe Materials

- Steel, stainless steel and wrought-iron
  - Minimum Schedule 10
- Approved seamless metallic tubing
  - Gas not corrosive to pipe material
- Corrugated stainless steel tubing (CSST)
- Exterior underground locations only
  - Approved plastic pipe, tubing and fittings

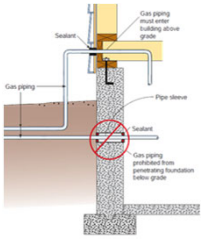


§G2414

254

Prohibited Locations for Gas Piping

- Piping cannot be installed
  - Within
    - Air ducts
    - Clothes chutes
    - Chimneys
    - Gas vents
  - Through any other townhouse unit
  - Entering a building below grade

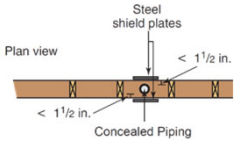


§G2415.3
&G2415.6

255

Gas Piping Protection

- Concealed piping installed through holes or notches in studs, joists, rafters must be
  - >1½" from nearest edge of member or
  - Protected by No. 16 Gage nail shield plates
- CSST protection per manufacturer's instructions

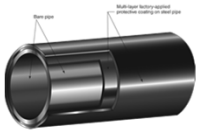


§G2415.7

256

Other Gas Piping Installation Requirements

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

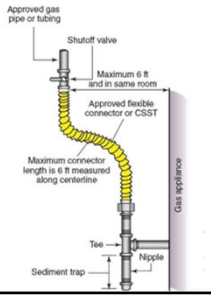


§G2415
&G2417

257

Gas Appliance Connections

- Materials
  - Rigid metallic piping
  - CSST
  - Listed and labeled
    - Appliance connectors
    - Quick-disconnects
- Installation
  - Can pass through appliance housing
  - Cannot pass through walls, floors, partitions, ceilings

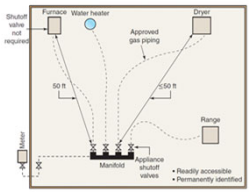


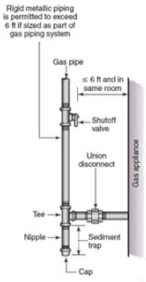
§G2420.5 &G2422

258

Gas Appliance Connections

- Shut-off valve
  - ≤6′ or
  - <50′ when connected to manifold



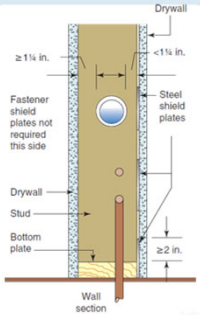


§G2420.5 &G2422

259

Plumbing Piping Protection

- Concealed piping installed through studs, joists or rafters
- If < 1¼" from edge
  - 16-gage steel shield plates
    - Extends ≥ 2" above bottom plates and below top plates
- Exception for cast iron and galvanized steel pipe

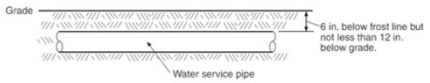


§P2603

260

Protection from Freezing

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

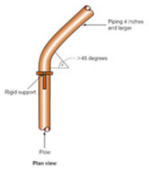


§P2603.5

261

Plumbing Piping Support

- Support
  - Maintains alignment and slope
  - Prevents sagging
  - Allows for expansion and contraction



- Underground
  - Continuous support
  - Suitable bedding materials
  - Not supported on rocks or blocks
  - Backfill free of debris, rocks, concrete, and frozen material
  - Protection of footings

§P2604 &P2605

262

Aboveground Piping Support

- Mid-story guide required for vertical plastic piping ≤2” diameter

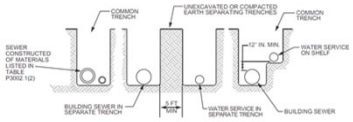
PIPING MATERIAL	MAX. HORIZONTAL SPACING (ft)	MAX. VERTICAL SPACING (ft)
ABS	4	10
Cast-iron, < 10 ft lengths	5	15
Cast-iron, 10 ft lengths	10	15
Copper or copper alloy , ≥ $1^1/_2$ in. dia.	10	10
PEX, ≤ 1 in. dia.	2.67	10
PVC	4	10

§P2604 &P2605

263

Water Service

- Sewer pipe listed for underground use
  - Water service pipe permitted in same trench with building sewer (e.g. cast-iron or schedule 40 PVC DWV)
- Sewer pipe not approved for underground use
  - 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 highest point of building sewer

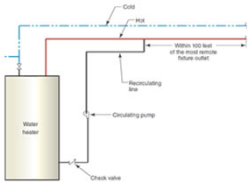


§P2906.4.1

264

Water Supply System Design Criteria

- Water service at building entrance
  - Max 80 psi, Min ¾" pipe
- Distribution system pipe size based on
  - Fixture unit values, Developed length of piping, and Water pressure
- Fixture flow rates & consumption limited to conserve water
- Shut-off valve
  - At each fixture other than showers and tubs

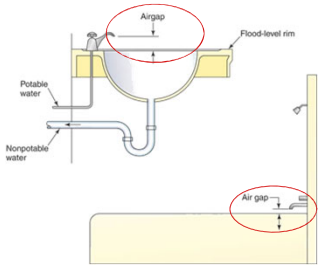


§P2903

265

Water Supply Protection

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

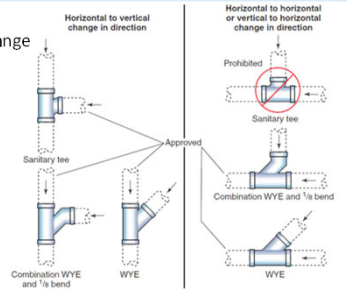


§P2902 &P2904

266

Sanitary Drainage

- Approved fittings for change in direction

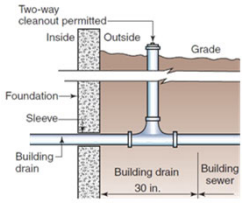


§P3003
&P3005.1
Proper operation of the sanitary drainage system

267

Cleanouts

- Cleanouts required:
  - Where horizontal drain lines change direction >45°
  - Within 10' of building drain / sewer connection
- Where more than one change of direction occurs
  - Only one cleanout is required in each 40'
- Readily removable fixture may serve as cleanout
  - Water closet or Sink fixture trap



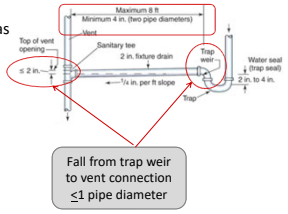
Cleanout required near building drain/sewer connection

§P3005.2

268

Fixture Vents

- Distance from trap to vent limited
  - Self-siphoning fixtures such as water closets not limited
- Vent connection not permitted below trap weir

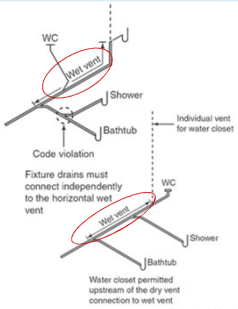


§P3105
Provides air to equalize pressure

269

Wet Venting

- Permitted for 1 or 2 bathroom groups on same level
- Vent piping diameter
  - At least ½ of required diameter of drain served
  - >1¼"
  - Vents >40' increase one pipe size

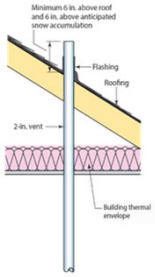


§P3108

270

Vent Termination

- Warmer climates
  - 97.5% outside design temperature > 0°F

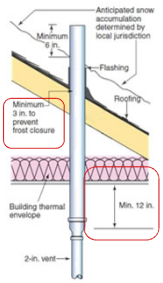


§P3103
For sloped roofs not used for other purposes

271

Vent Termination

- Frost closure
  - 97.5% outside design temperature ≤ 0°F
  - Increase to 3" at point ≥ 12" inside building envelope



§P3103

272

Protection Against Scalding

- Required temperature control devices

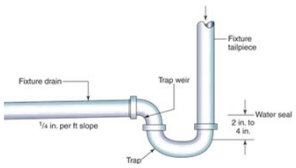
FIXTURE	MAX. TEMPERATURE	APPROVED DEVICE	STANDARD
Shower or tub-shower combination	120°F	Balanced-pressure valve or Thermostatic valve or Combination balanced-pressure/ thermostatic valve	ASSE 1016/ASME A112.1016/CSA B125.16
Bathtub or whirlpool bathtub	120°F	Water-temperature-limiting device	ASSE 1070/ASME A112.1070/CSA B125.70
Bidet	110°F		

§P2708.4
&P2713.3
&P2721.2

273

Fixture Traps

- Traps provide water seal to prevent sewer gases from entering the building
- Floor drains require trap-primer or deep-seal design to prevent loss of water seal by evaporation

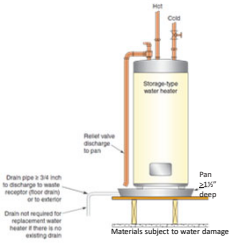


§P3201.2
&P3002.3.1

274

Water Heaters

- 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



§P2801
&P2804

275

Electrical Services

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

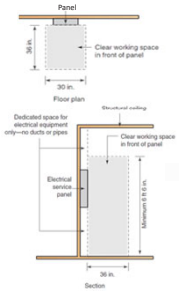
§E3601.2

Based on the National Electrical Code (NEC)

276

Equipment Location

- Readily accessible service disconnect
- Light source nearby
- Not in clothes closets or bathrooms
  - Electrical panels
  - Service disconnects
  - Circuit breakers

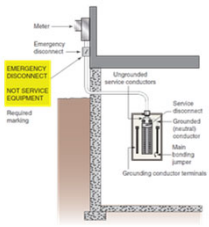


§E3405
§E3601

277

Electrical Service Size & Rating

- Service rating
  - Minimum 100 amp for single-family dwellings
  - Minimum 60 amp for other installations
- Ampacity of ungrounded service conductors and disconnect ≥ load served

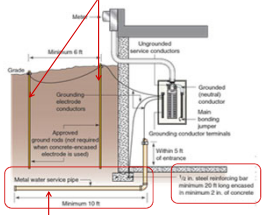


278

Grounding Electrode System

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

If a single ground rod has a resistance of >25 ohms, then a 2nd ground rod is required



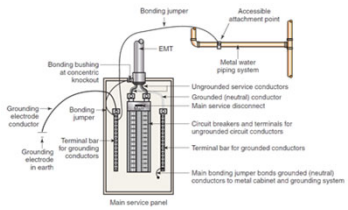
Requires at least one additional electrode

Provides a fault current path to earth

279

Bonding

- Connection of grounding system to grounded (neutral) conductors occurs at main service disconnect



As a general rule, the main service disconnect enclosure is the only location where the code permits unmodified the grounding system to the grounded (neutral) conductor. They are isolated from each other elsewhere to prevent creating a parallel fault path.

280

Conductor Sizing

- Ampacity tables for all wire sizes based on material and insulation type
- Variables when sizing wires > 30-amp circuits are
  - Temperature rating of
    - Conductor insulation
    - T Terminal
  - Derating for bundled conductors

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

§E3705

281

Overcurrent Protection Required

- Circuit breaker or fuse are required to protect all ungrounded branch circuit and feeder conductors

COPPER		ALUMINUM OR COPPER-CLAD ALUMINUM	
SIZE (AWG)	MAX. OVERCURRENT PROTECTION DEVICE RATING (amps)	SIZE (AWG)	MAX. OVERCURRENT PROTECTION DEVICE RATING (amps)
14	15	12	15
12	90	10	95
10	30	8	30

[Ref. Table E3705.5.3]

Overcurrent device locations
- Where branch circuit conductors receive their supply
- At service panel (typically)
- Where readily accessible
- Where not subject to damage
- Not in clothes closets or bathrooms
- Not located above a step

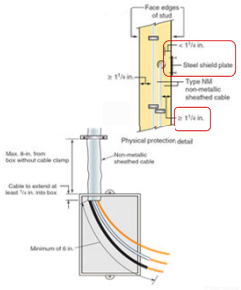
§E3705

An overcurrent device, either a circuit breaker or fuse

282

Wiring Methods

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



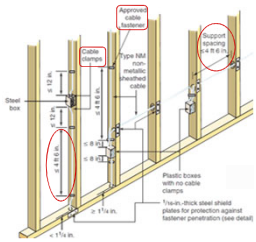
Type NM cable not permitted
- Underground
- Wet or damp locations
- Embedded in concrete

§E3801
&E3802

284

Wiring Methods

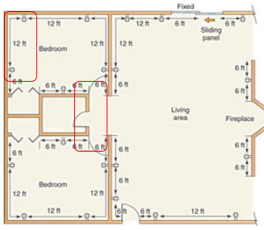
- Protection from physical damage
- Fasteners
  - Approved
  - Spacing
- Cable support



§E3801
&E3802

285

Receptacle Locations – Habitable Rooms



An outlet within 6' measured along wall

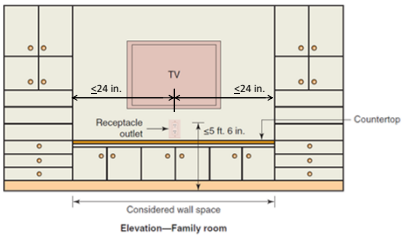
Wall spaces <2' wide are not included

Walls are measured around corners

§E3901

286

Receptacle Locations – Habitable Rooms

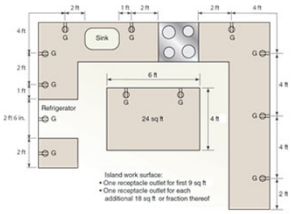


§E3901

*Countertop and work surface that is 12 inches or wider. Receptacle outlets shall be installed so that no point along the wall line is more than 24 inches, measured horizontally, from a receptacle outlet in that space.

287

Receptacle Locations – Kitchens



An outlet within 24" measured along wall

Counters ≥12" wide need an outlet

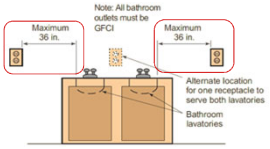
Outlet not required behind range or sink

Outlets shall have GFCI protection

§E3901

288

Receptacle Locations – Bathrooms



At least one outlet in each bathroom

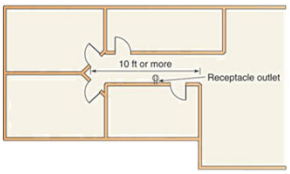
Outlet ≤36" of each lavatory

Outlets shall have GFCI protection

§E3901

289

Receptacle Locations – Hallways



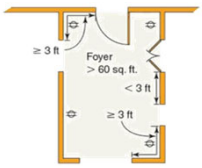
1 outlet required when hallway length ≥10′

Length measured along hallway centerline

§E3901

290

Receptacle Locations – Foyers

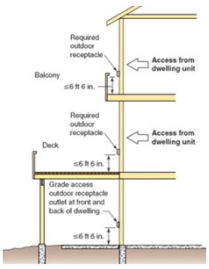


Foyers >60 ft^2 require an outlet on each wall ≥3′ wide

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

291

Receptacle Locations – Outdoors



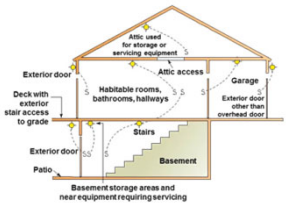
- 1 outlet in front and 1 outlet in back of dwelling
- 1 outlet for accessible balconies, decks, and porches
- Located ≤6’6” above grade
- Outlets shall have GFCI protection

§E3901

292

Lighting Outlets

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

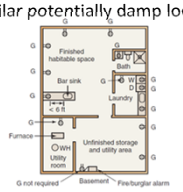


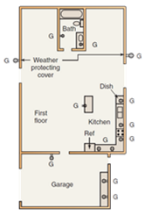
§E3903

293

Ground-Fault Circuit Interrupter

- GFCI protection required in bathrooms, laundry rooms and similar potentially damp locations like basements and garages





§E3903

protect people from shock hazards by de-energizing a circuit or receptacle when a fault current to ground is detected.

294

Arc-Fault Circuit Interrupter

- Detect unwanted arcing in branch circuit wiring
- Open circuit before excessive heat buildup can cause fire
- Installed in service panel or subpanel
- Required for
  - Living areas, Hallways, and Closets

§E3902

295

Receptacles

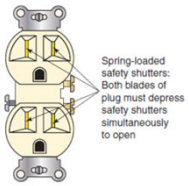
- Wet locations
  - Weatherproof enclosure when cord plugged in
  - Prohibited in or over tubs or showers

§E4002

296

Tamper-resistant Receptacles

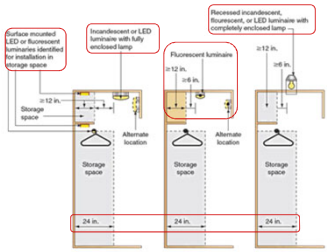
- Required where accessible to children
- Not required when
  - >5½' above floor
  - Part of luminaire or appliance
  - In dedicated appliance space



§E4002.14

297

Luminaires in Clothes Closets



298

APPLICATION

GFCI protection is required for all basement areas, whether finished or unfinished.

a) True
b) False

299

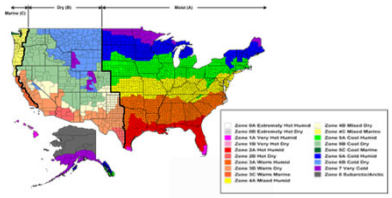
Energy Conservation

Chapter 11

300

Energy Efficiency

- IRC Chapter 11 is extracted from IECC applicable provisions



301

Compliance Paths

Projects shall comply with one of the following options

- Prescriptive
- Total Building Performance
- Energy rating index (ERI)
- Tropical Climate Region

302

Building Insulation

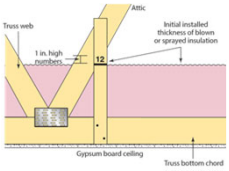
- Pieces of insulation ≥ 12” width must have
  - Visible R-value mark or
  - Installer certification
    - Insulation type
    - Manufacturer
    - R-value

§N1101.10

303

Blown-in or Sprayed Insulation

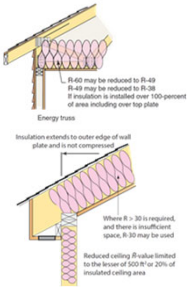
- Attic markers each 300 ft^2
- Certificate indicating
  - Initial installed thickness
  - Settled thickness
  - Settled R-value
  - Installed density and Coverage area
  - Number of bags installed



304

Roof Insulation

- Minimum R-values based on CZ
- Exceptions
  - Energy truss or raised-heel roof truss
  - Reduced R-values in shallow rafters

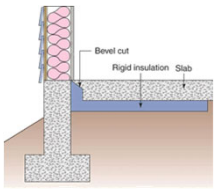


§N1102

305

Slab-on-Grade Insulation

- Floors with <12" below grade
- Combination of vertical and horizontal insulation
- Heavy termite areas exempt

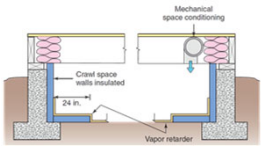


§N1102.2.9

306

Crawl Space Insulation

- Two options
  - Insulate floor above crawl space
    or
  - Insulate exterior walls
    - When crawl space is not ventilated
    - Vapor retarder on exposed earth



§N1102.2.10

307

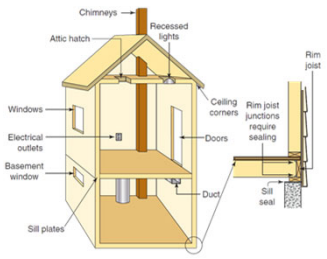
Windows and Doors

- Fenestration
  - Skylights
  - Windows
  - Doors
- U-factor
- Solar Heat Gain Coefficient (SHGC)

§N1102

308

Sealing Against Air Leakage

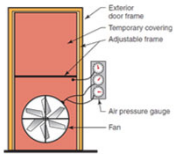


§N1102.4
limit air leakage and infiltration

309

Thermal Envelope Testing

- Blower door test required
- Allowable air-leakage rate via prescriptive path
  - Climate Zones 0 – 2: ≤ 5 ACH
  - Climate Zones 3 – 8: ≤ 3 ACH
- Mechanical ventilation required

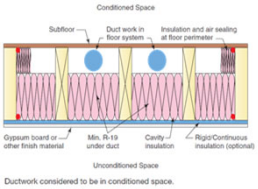


§N1102.4
&N1103.6

310

Duct Insulation and Sealing

- Insulation in unconditioned space
  - ≥ R-8 for ≥ 3" diameter
  - ≥ R-6 for < 3" diameter
- No duct insulation required in conditioned spaces
- Sealing of all ducts required
- Air leakage test required
- Cavities cannot be used as ducts or plenums



§N1103.3

311

Water Pipe Insulation

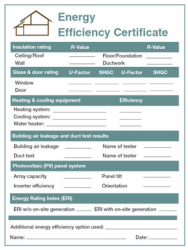
- ≥ R-3 for
  - ≥ ¾" diameter pipe in conditioned space
  - Piping serving >1 dwelling unit
  - Water Heater to distribution manifold
  - Outside conditioned space or under slab/underground
  - Supply and return piping in circulation and recirculation systems
  - Hydronic heating or cooling tubing
    - Designed to carry fluids >105°F or <55°F

§N1103.4
&N1103.5

312

Energy Certificate

- Completed by
  - Builder or Other approved party
- Listing
  - Code edition, Compliance path, Air testing results
  - Insulation & fenestration values
  - Equipment type & efficiency
- Permanent certificate posted in approved indoor location



Energy Efficiency Certificate

Insulation rating	R-Value		R-Value
Ceiling/Roof	_____	Floor/Foundation	_____
Wall	_____	Ductwork	_____
Glass & door rating	**U-Factor**	**SHGC**	**U-Factor**	**SHGC**
Window	_____	_____	_____	_____
Door	_____	_____	_____	_____
Heating & cooling equipment		**Efficiency**	
Heating system:	_____	_____	
Cooling system:	_____	_____	
Water heater:	_____	_____	
Building air leakage and duct test results			
Building air leakage	_____	Name of tester	_____
Duct test	_____	Name of tester	_____
Photovoltaic (PV) panel system			
Array capacity	_____	Panel tilt	_____
Inverter efficiency	_____	Orientation	_____
Energy Rating Index (ERI)			
ERI w/o on-site generation	_____	ERI with on-site generation	_____
Additional energy efficiency option used:	_____		
Name: _____		Date: _____	

§N1101.14

313

APPLICATION

What is the minimum *R*-value for ceilings in climate zones 4 through 8?

a) R30
b) R49
c) R60
d) R values are no longer applicable

314

315

Final Reflection

What? What happened and what was observed in the training?

So what? What did you learn? What difference did this training make?

Now what? How will you do things differently back on the job as a result of this training?

316

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