Exceptions, Variations, Substitutions and Engineering Judgments

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Sr. Research Manager, Building Sciences

- 27 years at JM
- Based in Denver, CO
- Experience in Building Science, Acoustics, Energy Efficiency
- Industry involvement:
  ASTM, ASHRAE, US DOE, NAIMA, SFC

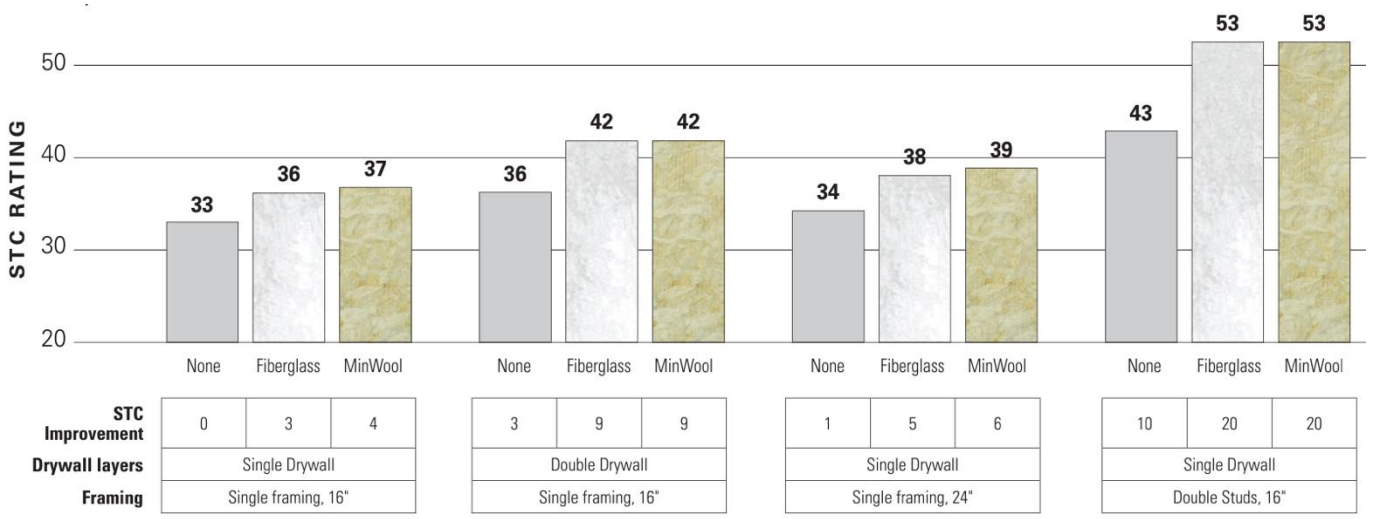
Definitions

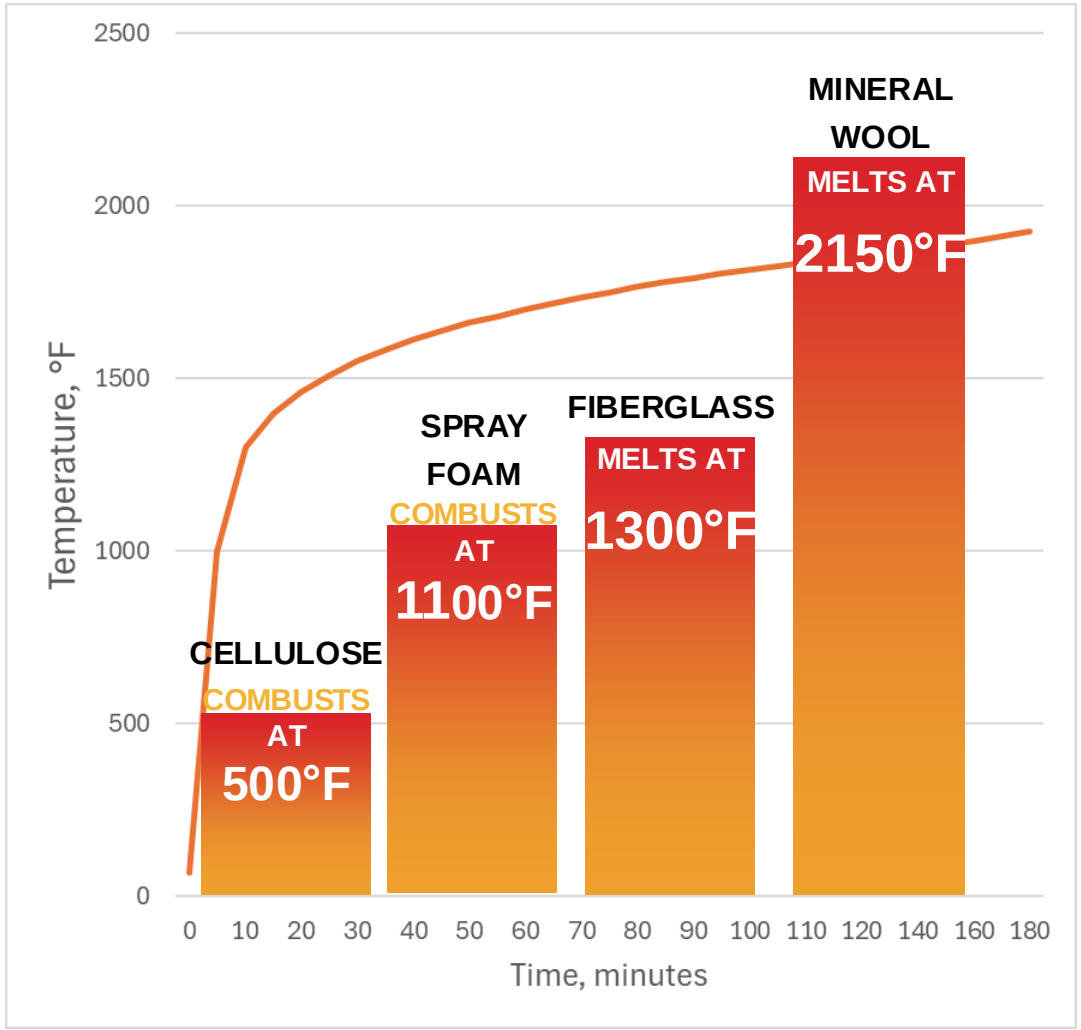
- Substitutions – Swap one material for another
- Exceptions – Exceptions written in the code
- Variations – Allowed and written in the code
- Engineering Judgments – “Approved designs,” could rely on all of the above

Substitutions

Fiberglass for Mineral Wool?

- Depends on the fire rating of the assembly
- Acoustics will be nearly identical
- Engineering Judgement (based on testing) may allow a substitution





Substitutions

Kraft-faced or Unfaced (or FSK or PSK)

- Unfaced
  - No vapor retarder
  - Typically non-combustible
- Kraft-faced
  - Class II vapor retarder
  - Can’t be left exposed
- FSK-faced
  - Class I vapor retarder
  - 25/50 fire performance
  - Can usually be left exposed
- PSK-faced
  - Class I vapor retarder (unless perforated)
  - Can usually be left exposed

Substitutions

Open cell vs. closed cell spray foam

- Open cell
  - R-3.7 to 3.8 per inch
  - Water vapor open
  - Provides air seal @ > 3.5”
- Closed cell
  - R-6.8 to 7 per inch
  - Class II VR @ ≥ 1.1” (CB III)
  - Air seals @ >1” thick (CB III)

Substitutions

Different types of CI

Function	EPS	XPS	Polyiso	Ext. ccSPF	Mineral Wool
WRB	w/ tape & testing			✓	No
Air barrier	w/ tape & testing			✓	No
Below grade	✓	✓	✓	✓	✓
Vapor retarder (1”)	2-6 perm	1.2 perm	0.02 w/foil 1-2 w/o foil	1.1 perm	~110 perm
R-value	~4/inch	5/inch	≥6/inch	7/inch	≥4/inch
Fire	Melts & drips Look for testing		Chars & remains solid Look for testing		Non-combustible

Exceptions

IECC R503.1.1, Exception 2

- Cavities already filled with insulation do not have to not meet prescriptive R-values
- For alterations/renovations

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Exceptions

Vapor Retarders, per R702.7

- Basement walls, below-grade portion of any wall
- CZ 1, 2 & 3
- Any construction where accumulation, condensation or freezing of moisture will not damage the materials.

Since 2021:

Climate Zone	Class I	Class II	Class III
1, 2	Not Permitted	Not Permitted	Permitted
3, 4	Not Permitted	Table R702.7(4)	Permitted
Marine 4, 5-8	Permitted*	Table R702.7(4)	Table R702.7(3)

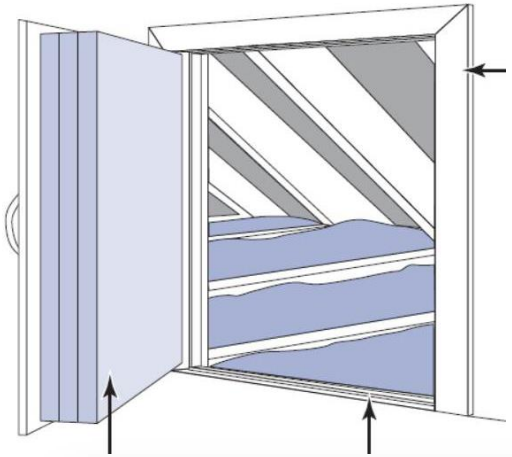
* Class I VR on interior and exterior requires an approved design

Exceptions

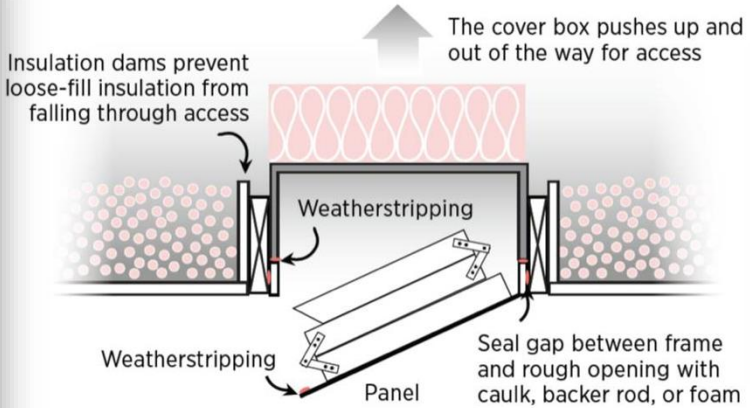
Attic access hatches and doors per R402.2.4

1. Vertical doors meet fenestration instead of insulation

CZ 0-1	CZ 2	CZ 3 & 4	CZ 4C, 5 & 6	CZ 7 & 8
R-2 (U-0.5)	R-2.5 (U-0.4)	R-3.33 (U-0.3)	R-3.57 (U-0.28)	R-3.7 (U-0.27)



2. Pull stairs in CZ 0-4, U-0.10 (R-10 average) plus size limits and weather-stripped



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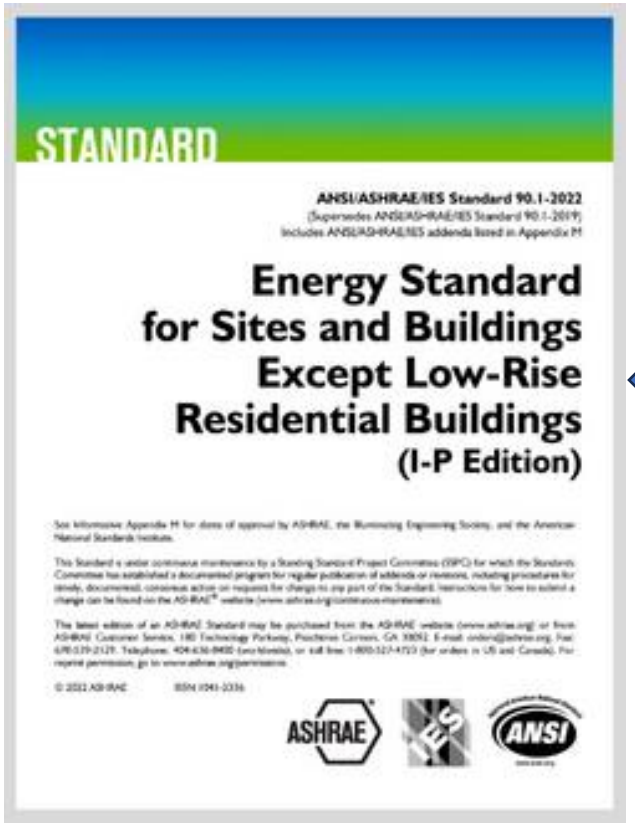
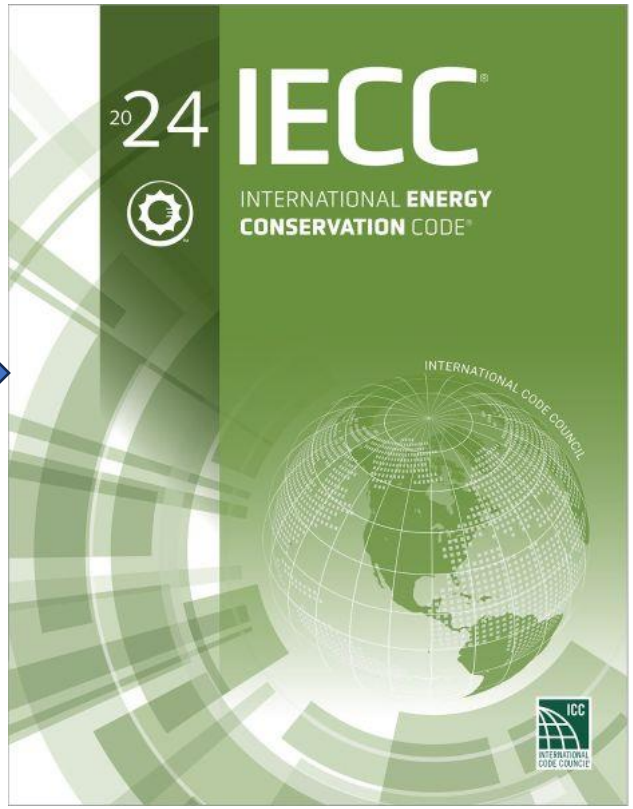
Variations - Compliance

C401.2.2 - ASHRAE 90.1 2022 is an alternate compliance path to 2024 IECC

- 90.1-2019 ↔ 2021 IECC
- 90.1-2016 ↔ 2018 IECC
- 90.1-2013 ↔ 2015 IECC
- IECC may be amended
- Main differences are inputs
  - Lighting Power Density
  - Equipment Power Density
  - Equipment efficiencies
- Minimal insulation differences in walls

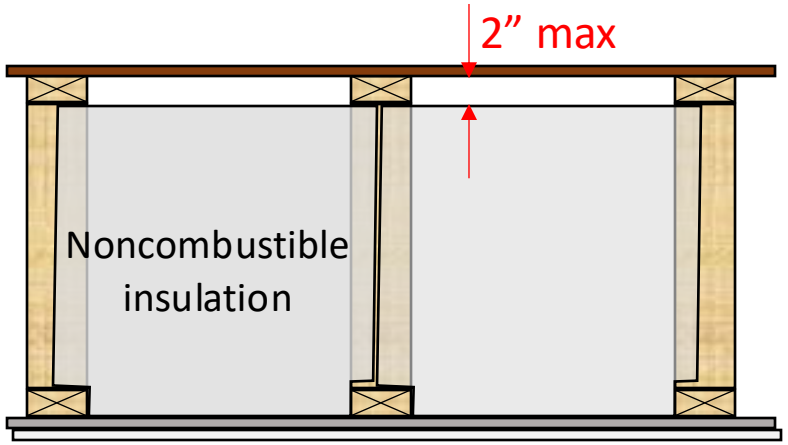




Variations – NFPA 13

Sprinklers can be omitted in concealed spaces filled with noncombustible insulation

- 2” max gap
- Loose-fill needs coverage chart and bag count (and takes longer)



Layers of insulation ≥ min. thickness

Variations – NFPA 13

Substituting tented insulation as an alternative to antifreeze
Insulation must be sufficient to keep the pipe ≥ 40 °F

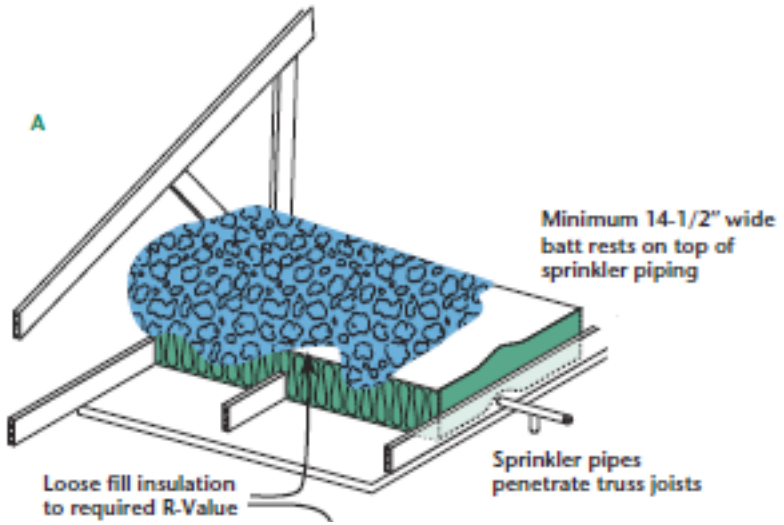


Image from https://insulationinstitute.org/wp-content/uploads/2015/12/BI505-Recommended-Practices-For-Insulating-Fire-Sprinkers-0915-1536.pdf

Photos from Building America Solution Center image gallery, https://basc.pnnl.gov/images

Variations

Crawlspace walls - alternative to floor above
- Not vented to the outside

IECC:
- Permanently fastened to the wall
- Exposed earth covered with Class I vapor retarder
- Joints overlap by 6” and sealed or taped
- Edges of VR extend ≥ 6” up stem walls and attached and sealed

IRC:
- All above plus
- Ventilation @ 1 cfm/50 ft² or dehumidification

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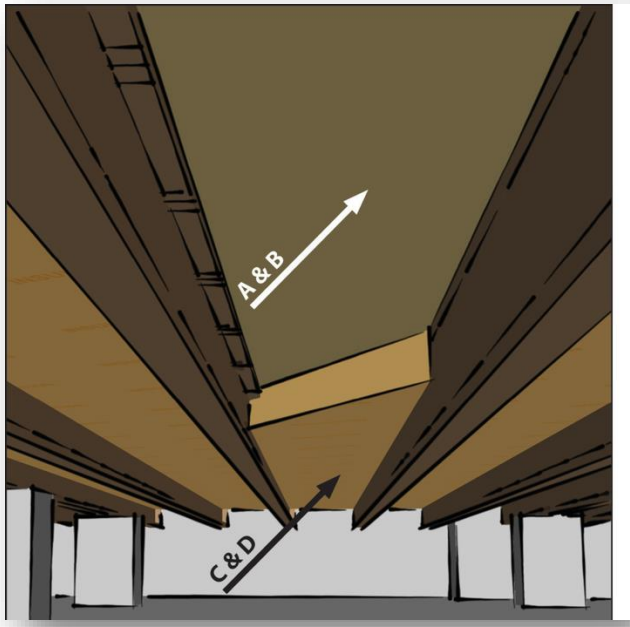
Unvented crawlspace is a design change

Variations

Basement walls versus ceiling

- Top of the basement wall 10' below grade or the basement floor
- Unconditioned basements too unless the floor overhead is insulated



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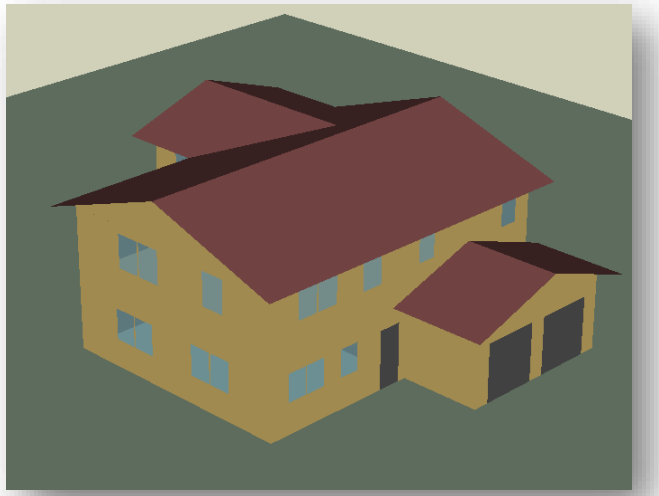
Variations

2 x 6 advanced framing walls can reduce other R-value requirements
2500 ft², CZ 3, 2015 IECC:

Component	16” o.c. walls	24” o.c. walls		
Ceiling	R-38 (U-0.03)	R-38 (U-0.03)	**R-30 (U-0.035)**	R-38 (U-0.035)
Walls	R-20 (U-0.059)	R-20 (U-0.057)	R-20 (U-0.057)	**R-18 (U-0.06)**
Windows	U-0.35			
Floor	R-19 (U-0.047)			
Total UA (388 max)	384	379	385	386

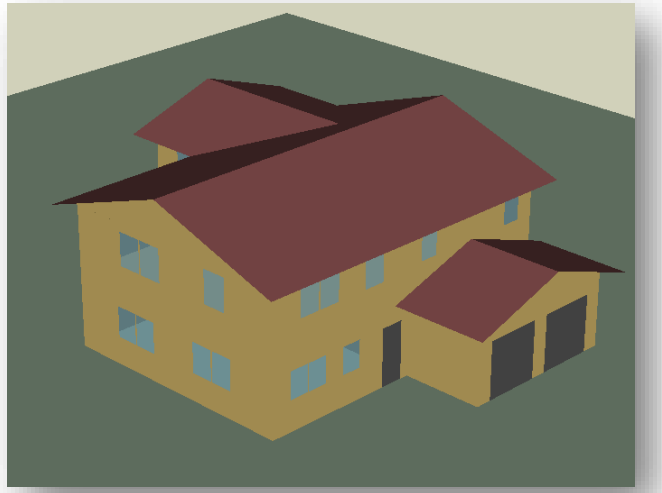


Need RESCheck™, Performance, or ERI for compliance

Variations

2 x 6 advanced framing walls can reduce other R-value requirements
2500 ft², CZ 3, 2021 IECC:

Component	16” o.c. walls	24” o.c. walls		
Ceiling	R-49 (U-0.026)	R-49 (U-0.026)	**R-38 (U-0.03)**	R-49 (U-0.026)
Walls	R-20 (U-0.059)	R-20 (U-0.057)	R-20 (U-0.057)	**R-18 (U-0.06)**
Windows	U-0.3			
Floor	R-19 (U-0.047)			
Total UA (457 max)	455	451	456	457



Need RESCheck™, Performance, or ERI for compliance

Variations

2 x 6 advanced framing walls can reduce other R-value requirements

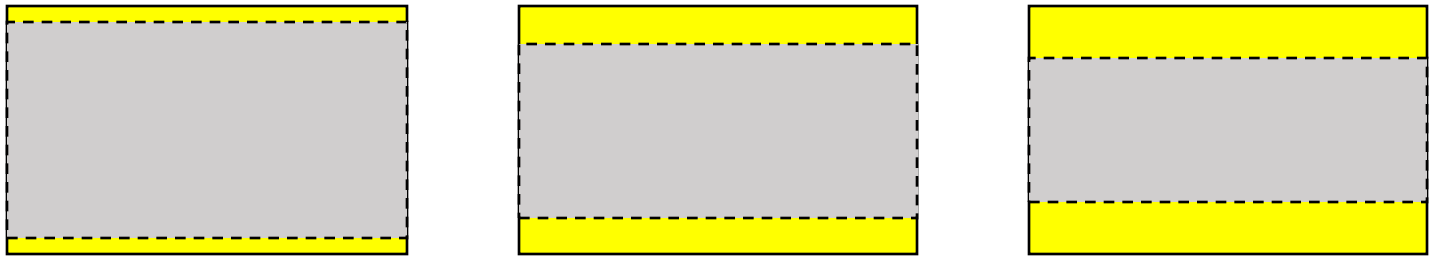
- What about eliminating CI?

2x6 @ 24”o.c. cavity R-value	U-factor	2x4, R-13 + R-5ci U-0.057	2x4, R-13 + R-10ci U-0.044	2x6, R-20 + R-5ci U-0.045
18	0.061			
20	0.058	close		
21	0.057	✓		
23	0.054	✓		
25	0.052	✓		
30	0.047	✓	close	close
35	0.044	✓	✓	✓

Limited R-value trade-offs from advanced framing vs. CI

Variations

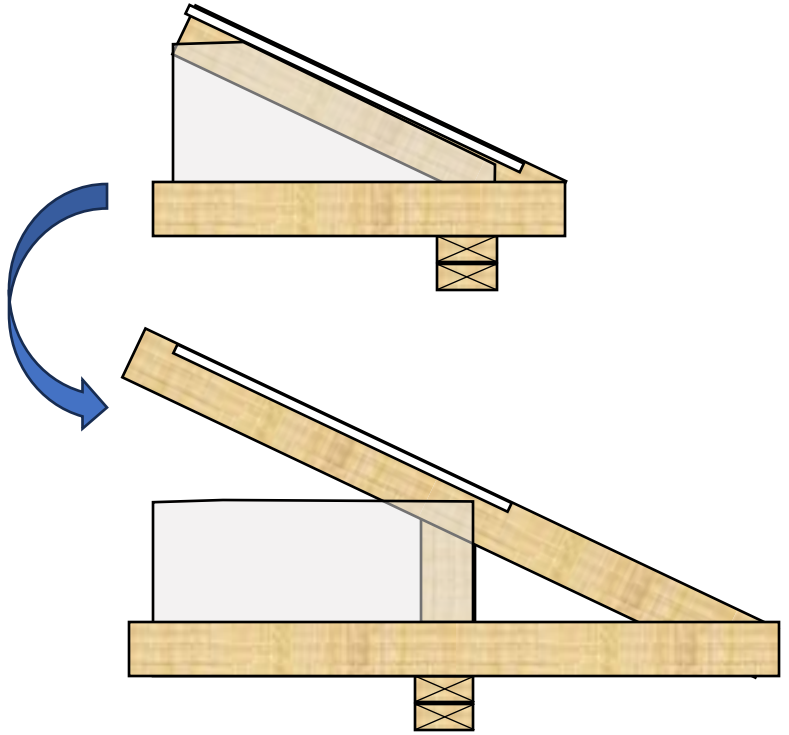
Ceilings with Attic Spaces
Per R402.2.1, R49 for R-60, R-38 for R-49, R-38 for R-30



R-38 R-49 R-60

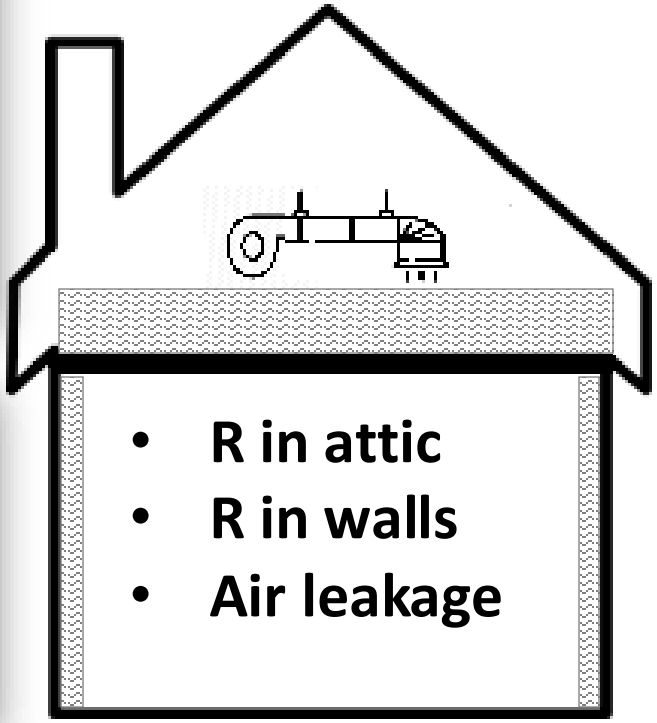
R-value	Loose-fill FG	Standard	Raised Heel
R-30	10¾”	U-0.035	U-0.032
R-38	13½”	U-0.030	U-0.025
R-49	17”	U-0.026	U-0.020
R-60	20¼”	U-0.024	U-0.017

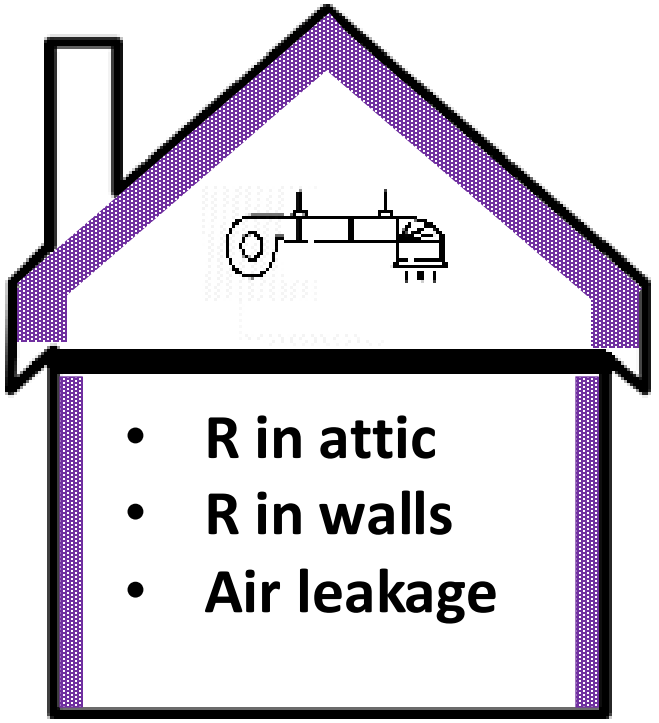
Lower R-value must cover wall top plate



Variations

How can R-20 in an attic be code compliant?





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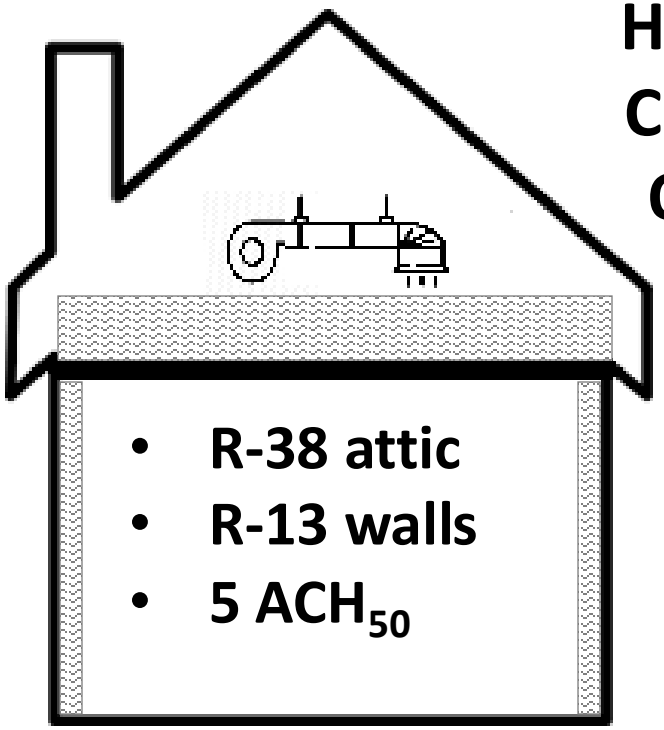
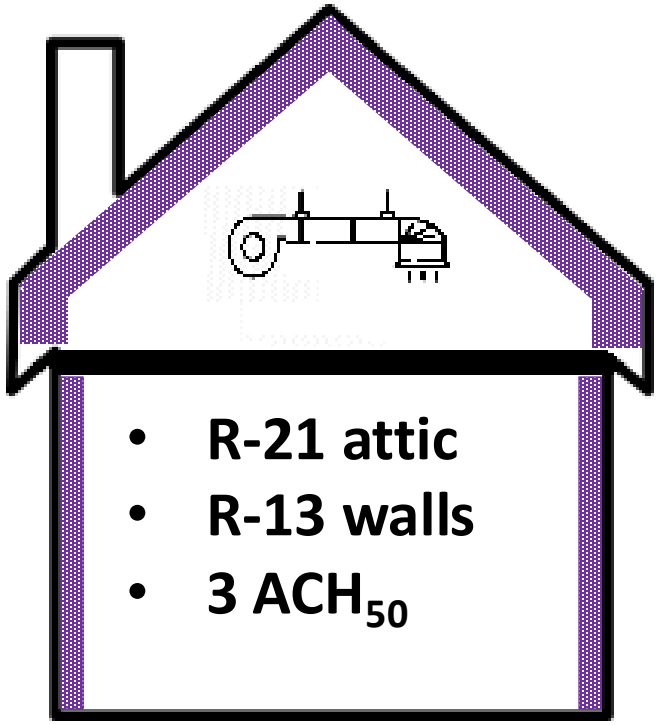


Savings

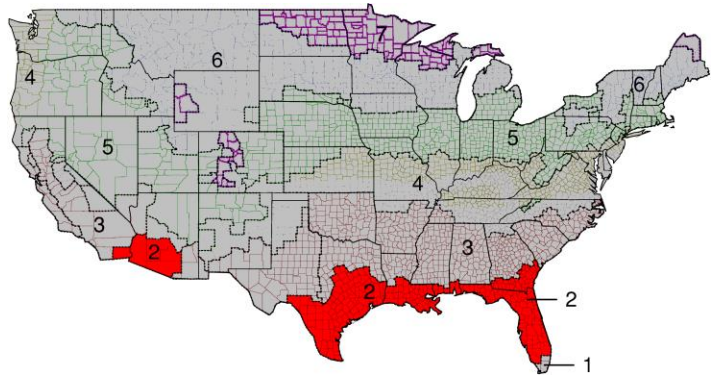
Heating 35%

Cooling 24%

Overall 8%

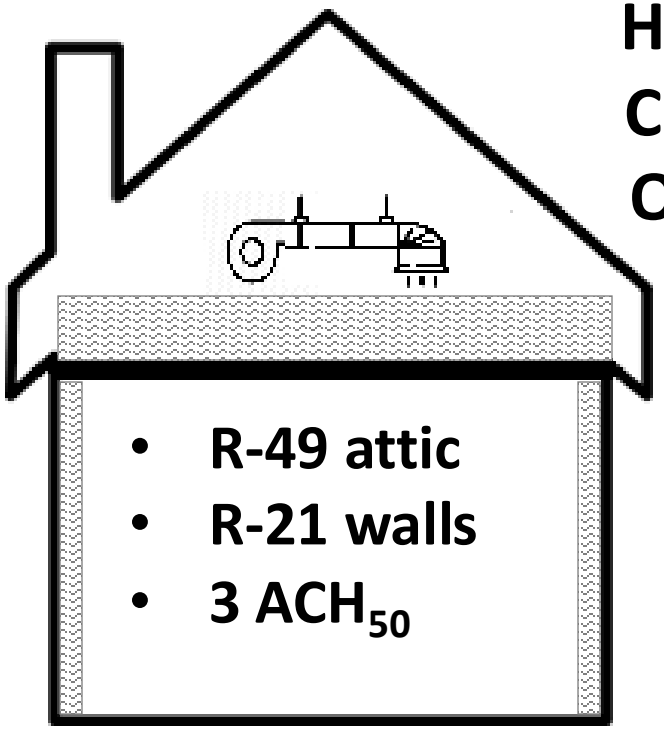


2015 IECC Baseline
CZ2



Variations

How can R-20 in an attic can be code compliant?

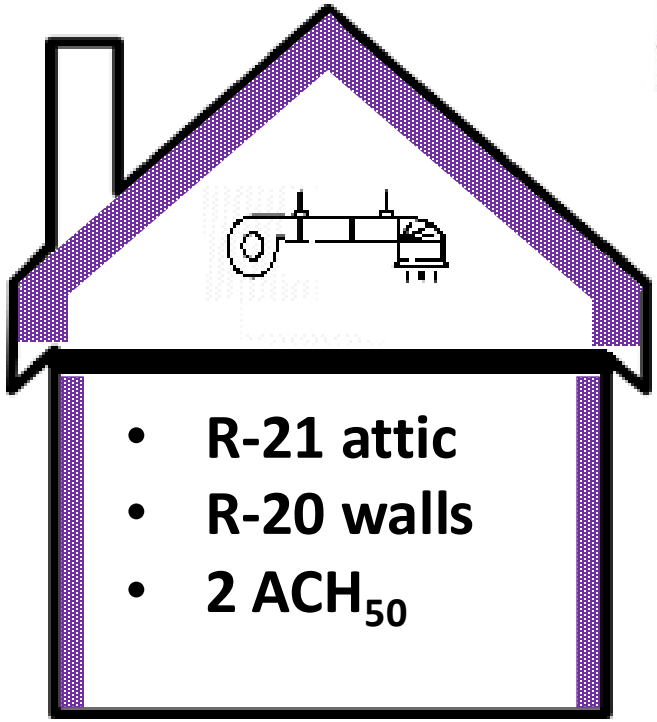


Savings

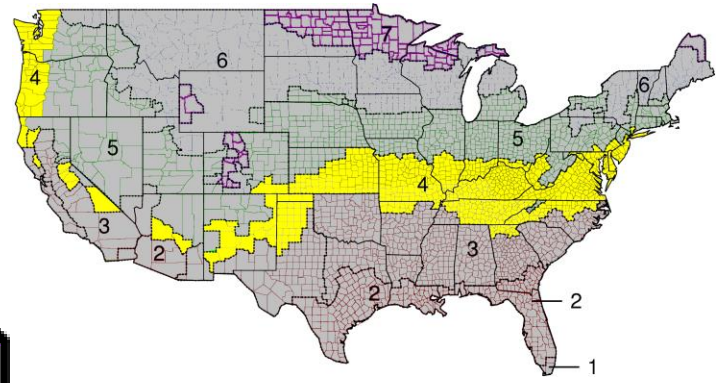
Heating 30%

Cooling 25%

Overall 12%

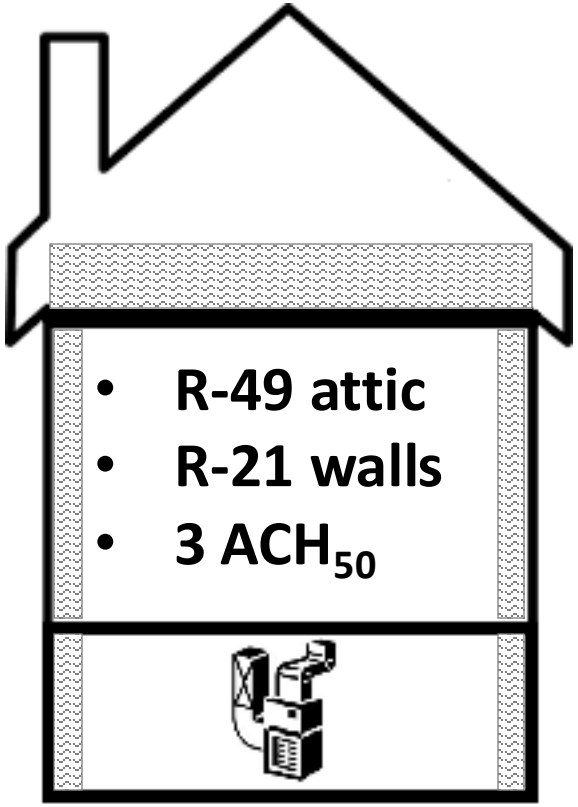


2015 IECC Baseline
CZ4



Variations

How can R-20 in an attic be code compliant?

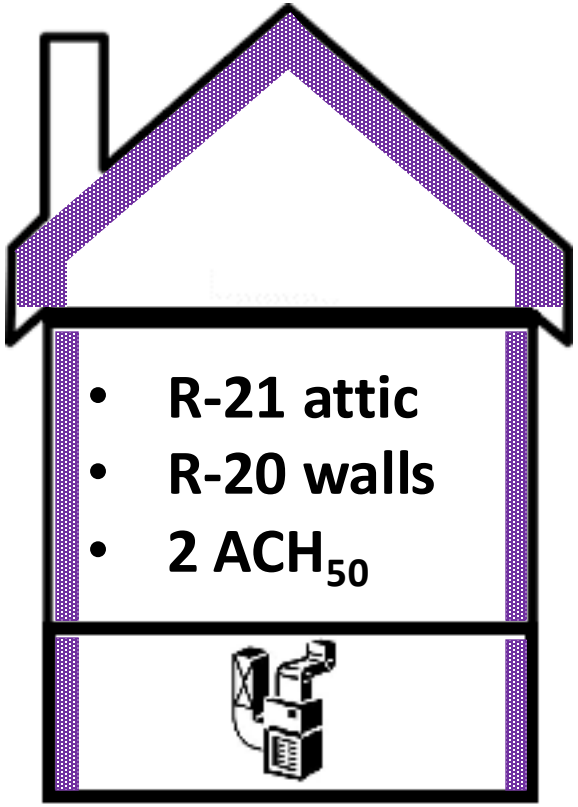


Savings

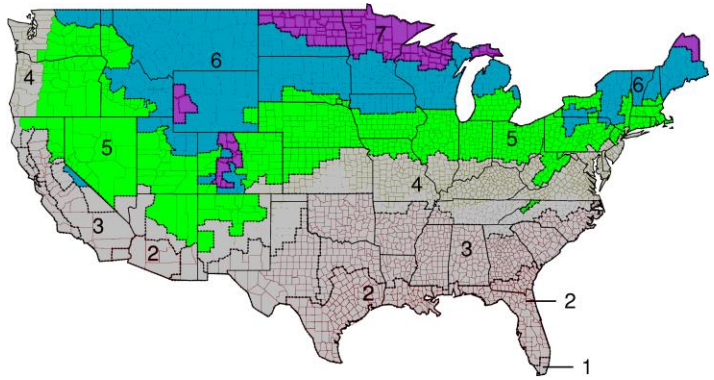
Heating -10%

Cooling -9%

Overall -6%



2015 IECC Baseline
CZ 5-7

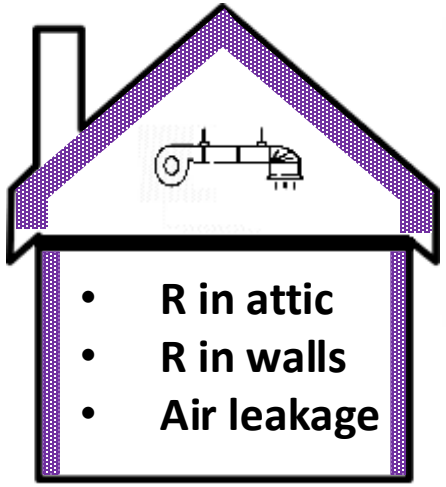


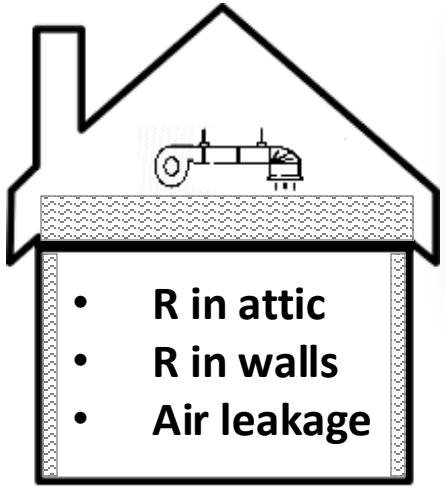
Variations

How can R-20 in an attic be code compliant?

- Performance not prescriptive
- Air sealing does not make up the difference
- Savings from duct and HVAC location

$R\text{-}20_{foam} \neq R\text{-}38_{fiberglass}$

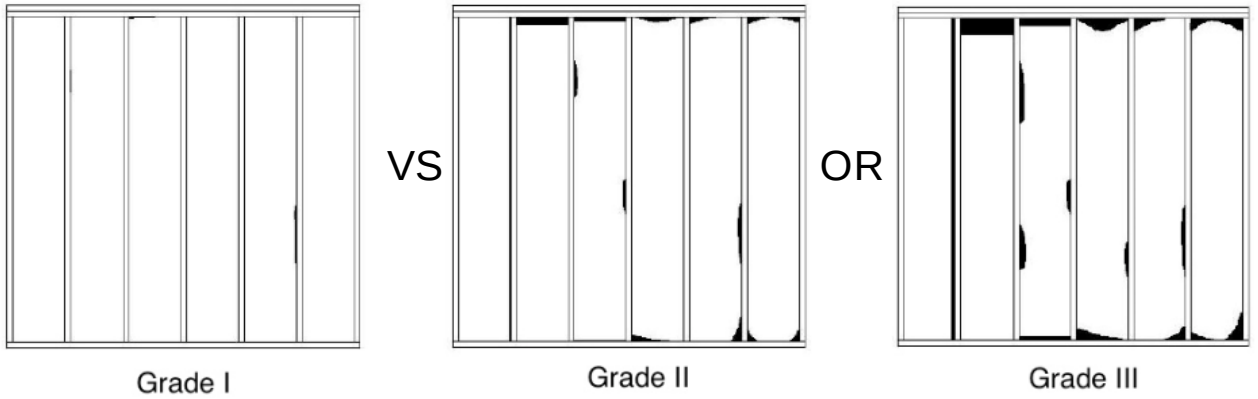




Variations

Grade I install, Inset vs. face stapling

- Inset stapling is OK
- Only tuck in the width of the flange



Engineering Judgments

Special Approval Tests in lieu of a thermal barrier IBC 2603.9

- NFPA 286 – room corner burn (preferred & meets IBC Chp. 8)
- FM 4880 – open corner burn
- UL 1040 – fire test of insulated walls
- UL 1715 – fire test of interior finish material (~NFPA 286)
- Engineering Judgment may accompany

Engineering Judgments

Special Approval Tests in lieu of a thermal barrier

- What about FSK?
  Needs testing
- NFPA 275 (thermal barrier)
- NFPA 286 (system room corner burn)

FSK not an approved thermal barrier over foam plastics

Engineering Judgments

EJs allow for NFPA 285 approvals

Variations in:

- Cladding
- WRB
- Ext. sheathing
- Cavity insulation
- Base wall

Engineering Judgments

Unvented attic approvals

- Typically for spray foam
- Requires outward-opening attic hatch/stairs

EJ allows for:
- Foam thickness
- Foam type
- Coverage of rafters
- Roof penetrations

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QUESTIONS?