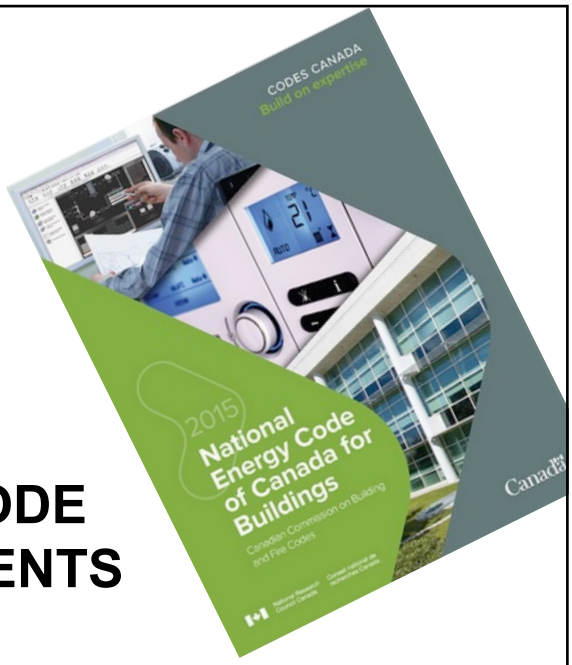
What is the worst
you can get away with?

ENERGY CODE REQUIREMENTS



14

14

Representative Manitoba Climate Zones

	HDD	
Winnipeg	5670	
Brandon	5760	ZONE 7A
Portage la Prairie	5600	
Steinbach	5700	
Flin Flon	6440	
Island Lake	6900	ZONE 7B
The Pas	6480	
Thompson	7600	
Churchill	8950	ZONE 8
Lynn Lake	7770	

11

NRC·CNRC

15

MBC

- Part 9, using NBC 9.36 (as of Apr 2016)
- New Approach- **Effective R-values**
  - All layers matter to thermal resistance
  - big thermal bridges are accounted for
- Review:
  - U-values = 1 / R_{SI}
  - R_{SI} values = 1 / U-values
  - R_{SI} * 5.678 = R-value

RDH

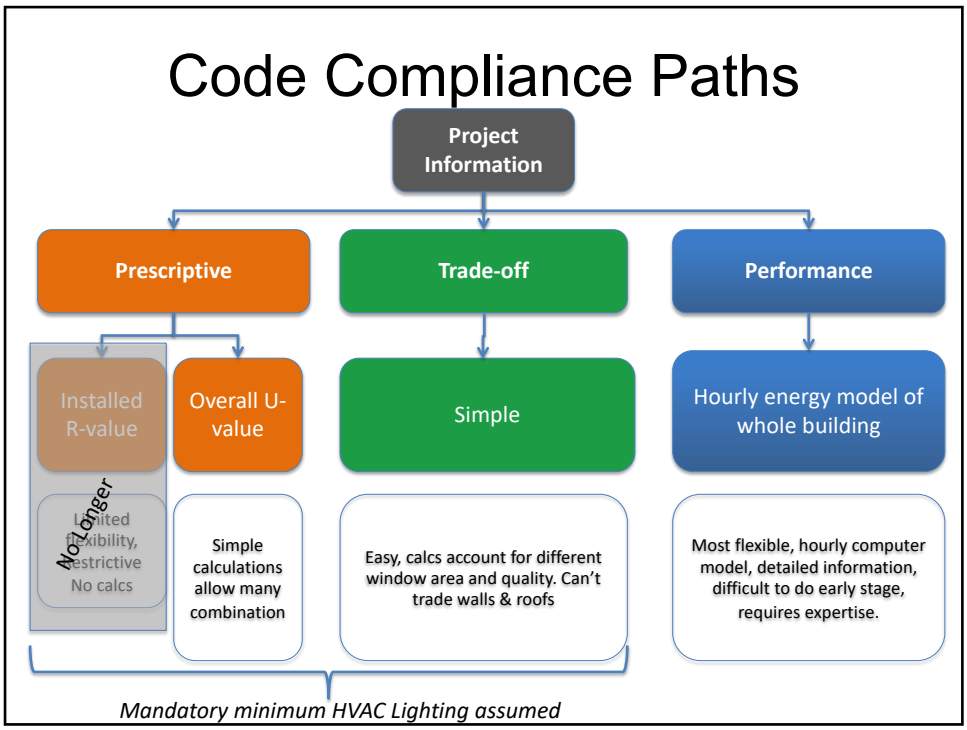
16

16

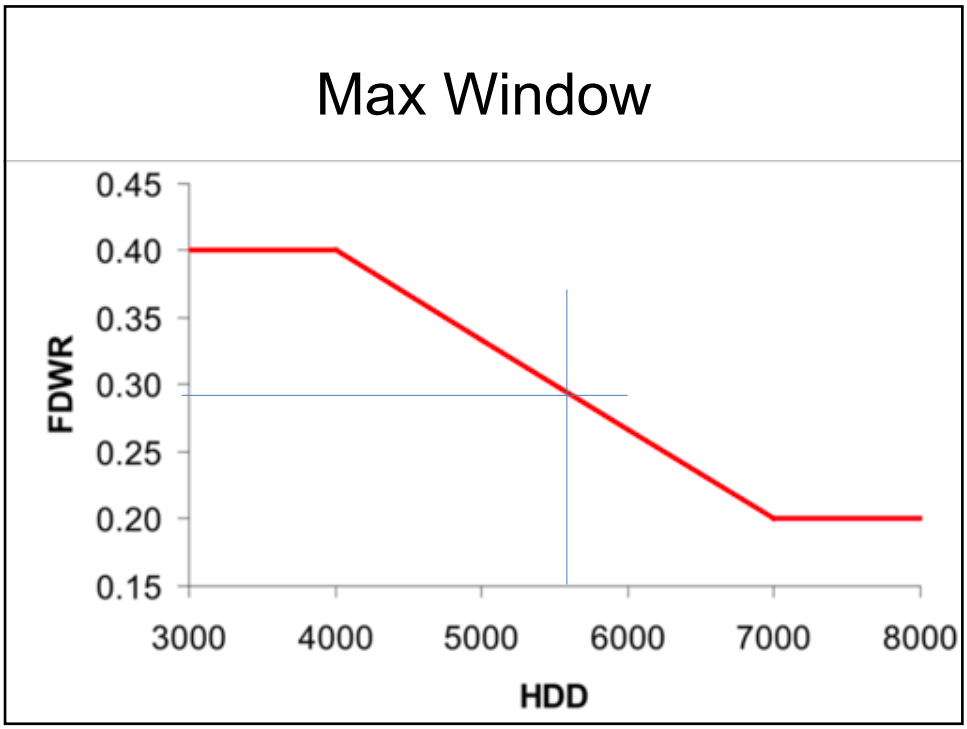
NECB 2011 (Dec 2014)

	Heating Degree-Days of Building Location					
	Zone 4 < 3000	**Zone 5** 3000 to 3999	**Zone 6** 4000 499	**Zone 7A** 5000 to 5999	**Zone 7B** 6000 to 6999	**Zone 8** 7000 to 7999
	Maximum Overall Thermal Transmittance (U-value), in W/(m²-K) NECB-2011 Table 3.2.2.2					
Walls	0.315	0.278	0.247	0.21	0.21	0.18
Windows	2.4	2.2	2.2	2.2	2.2	1.6
Roofs	0.227	0.183	0.183	0.162	0.162	0.142
Floors	0.227	0.183	0.183	0.162	0.162	0.142
	Approximate **Minimum Overall R-value / RSI-value**					
Walls	18 / 3.2	20 / 3.6	23 / 4.0	**27** / 4.8	**27** / 4.8	**32** / 5.6
Windows	2.4 / 0.42	2.6 / 0.45	2.6 / 0.45	2.6 / 0.45	2.6 / 0.45	3.5 / 0.63
Roofs	25 / 4.4	31 / 5.5	31 / 5.5	35 / 6.2	35 / 6.2	40 / 7.0
Floors	25 / 4.4	31 / 5.5	31 / 5.5	35 / 6.2	35 / 6.2	40 / 7.0

17


Code Compliance Paths
Project Information
Prescriptive
Trade-off
Performance
Installed R-value
Overall U-value
Simple
Hourly energy model of whole building
No Longer
Limited flexibility, restrictive No calcs
Simple calculations allow many combination
Easy, calcs account for different window area and quality. Can't trade walls & roofs
Most flexible, hourly computer model, detailed information, difficult to do early stage, requires expertise.
Mandatory minimum HVAC Lighting assumed

18


Max Window
0.45
0.40
0.35
0.30
0.25
0.20
0.15
FDWR
3000
4000
5000
6000
7000
8000
HDD

19

Trade-off

•

	Wall	window			Wall	window	
Code	4.8	2.2		proposed			
RSI	4.8	0.45454545		RSI	2.8	0.55	
U	0.2083	2.2		U	0.3571	1.818181818	
Percent	71	29		Percent	71	29	
UA	0.1479	0.6380	0.7859	UA	0.2536	0.5273	0.7808
				R-wall	15.90	3.12	

20

Which R-value?

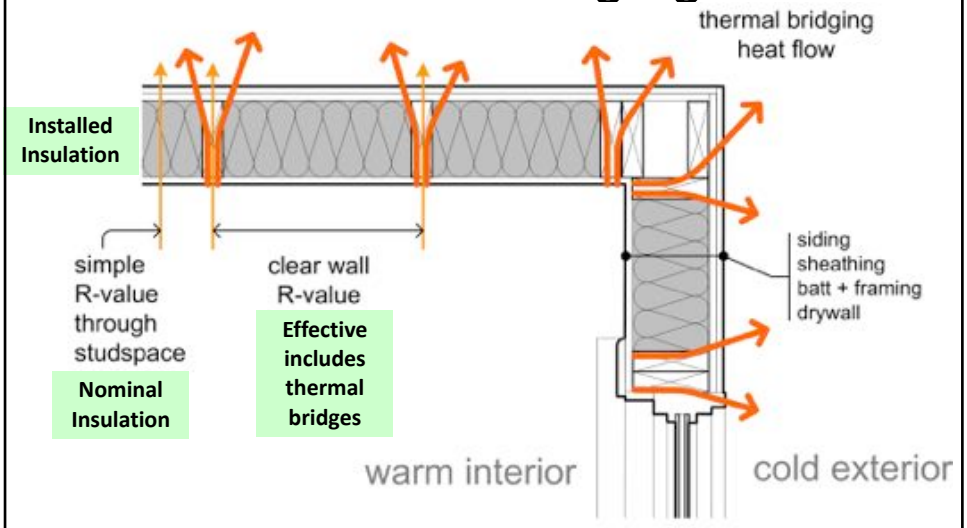
- Installed R-value
- Center-of-Cavity R-value
- Effective R-value
  - Term defined by code
  - includes some thermal bridges
  - ignores some thermal bridges

RDH

21

21

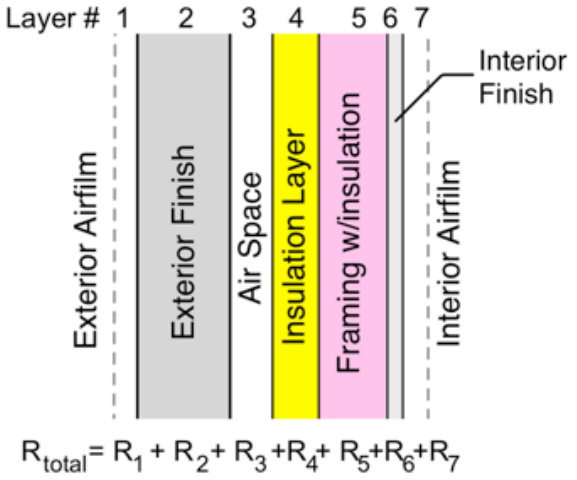
Thermal bridging



22

Calculating R-value

- Just add the layer *R-values* for center of cavity



23

Calculating RSI

- No longer just report what is “in the bag”
- Now: add up all the layers
  - Interior air film + gypsum (R-1.13)
  - **Stud** and **batt** *together* (looked at next)
  - Exterior sheathing, gap (if any) siding
  - Add any insulating sheathing
- Lot of R-value is still in cavity

RDH

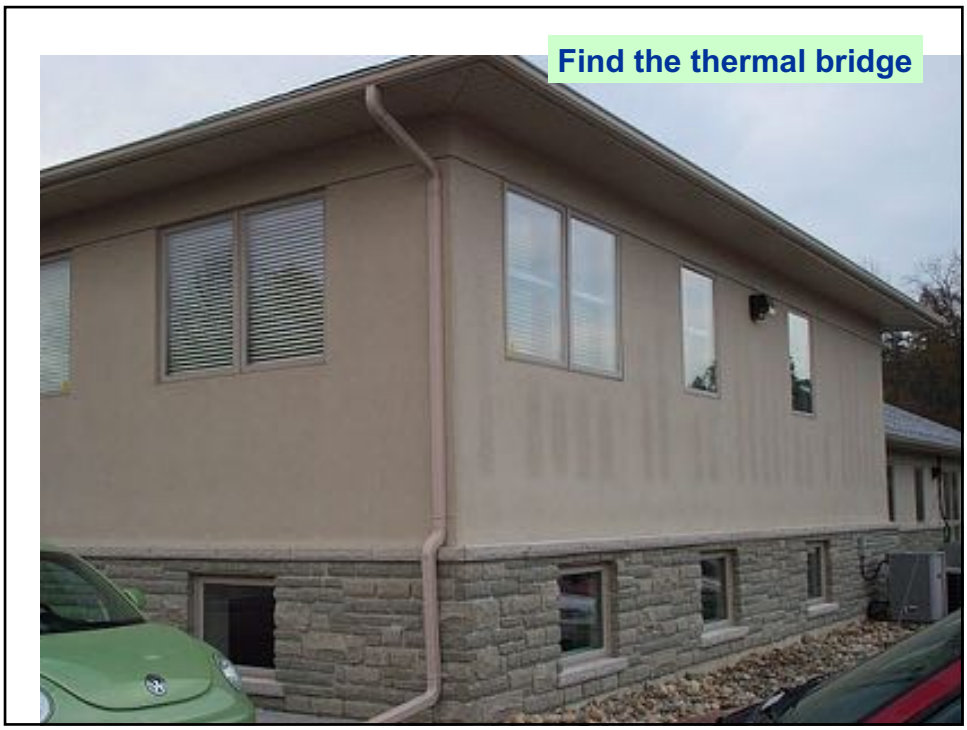
24

24

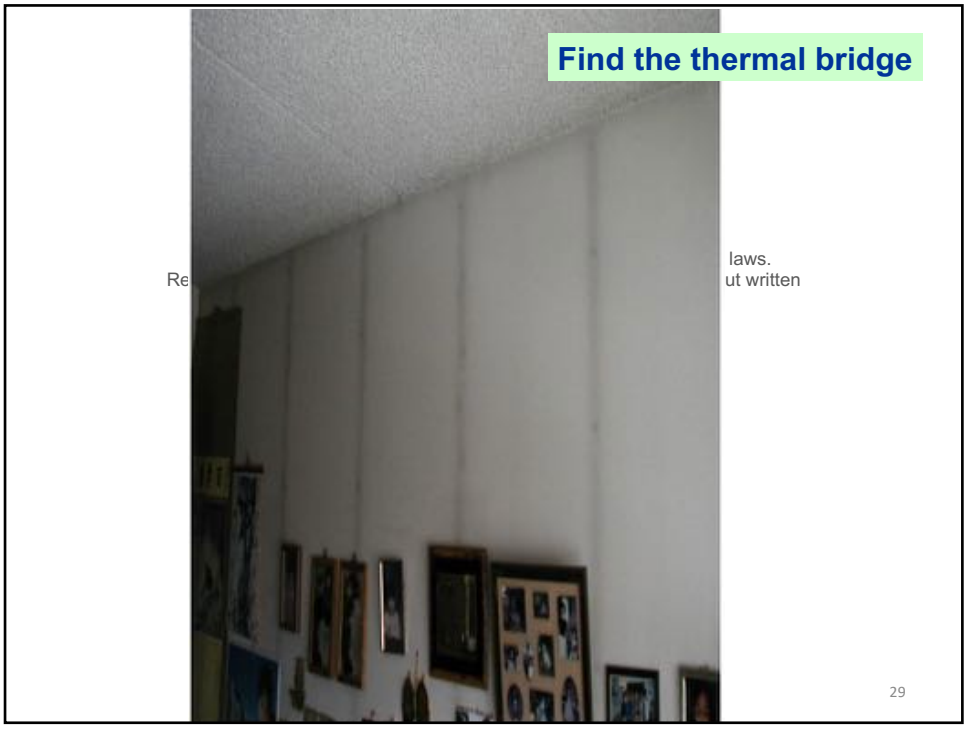
25

26

27


Find the thermal bridge

28


Find the thermal bridge
Re
laws.
ut written
29

29

How much is wood framing

Table A-9.36.2.4.(1)
Framing and Cavity Percentages for Typical Wood-frame Assemblies[2]

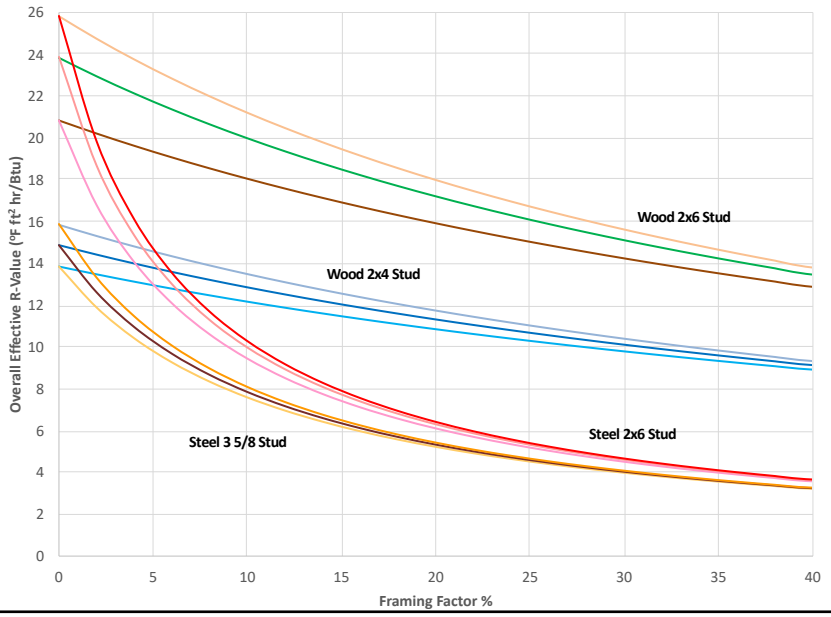
Wood-frame Assemblies	Frame Spacing, mm (in.) o.c.									
	304 (12)		406 (16)		488 (19.2)		610 (24)		1220 (48)	
	% Area		% Area		% Area		% Area		% Area	
	Fram-ing	Cavity	Fram-ing	Cavity	Fram-ing	Cavity	Fram-ing	Cavity	Fram-ing	Cavity
Floors										
lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
I-joists and truss	–	–	9	91	7.5	92.5	6	94	–	–
Roofs/Ceilings										
ceilings with typical trusses	–	–	14	86	12.5	87.5	11	89	–	–
ceilings with raised heel trusses	–	–	10	90	8.5	91.5	7	93	–	–
roofs with lumber rafters and ceilings with lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
roofs with I-joist rafters and ceilings with I-joists	–	–	9	91	7.5	92.5	6	94	–	–
roofs with structural insulated panels (SIPs)	–	–	–	–	–	–	–	–	9	91
Walls										
typical wood-frame	24.5	75.5	23	77	21.5	78.5	20	80	–	–
advanced wood-frame with double top plate[2]	–	–	19	81	17.5	82.5	16	84	–	–
SIPs	–	–	–	–	–	–	–	–	14	86

Choose from spacing

Note: SIPS is not zero

30

Framing Effect on R-values

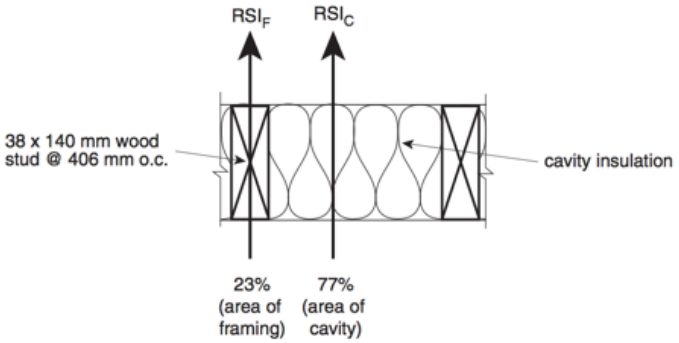


31

Thermal bridging

- $RSI_{effective} = \dfrac{100}{\dfrac{\%\ \text{area of framing}}{RSI_F} + \dfrac{\%\ \text{area of cavity}}{RSI_C}}$

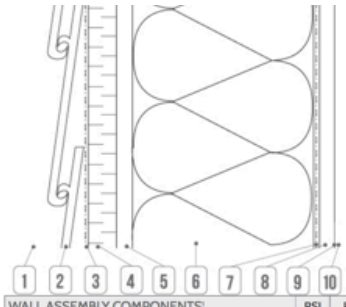
140 mm stud
RSI=1.19/ R-6.7
Listed in Table A-9.36.2.4



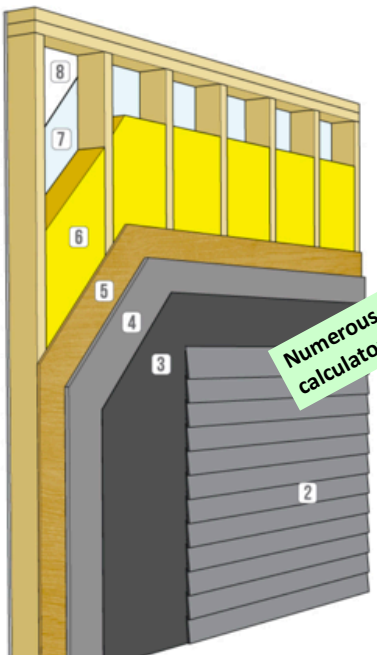
Can calculate in R-values or RSI so long as you are consistent

32

R-19 batt+R-5 XPS = R-21



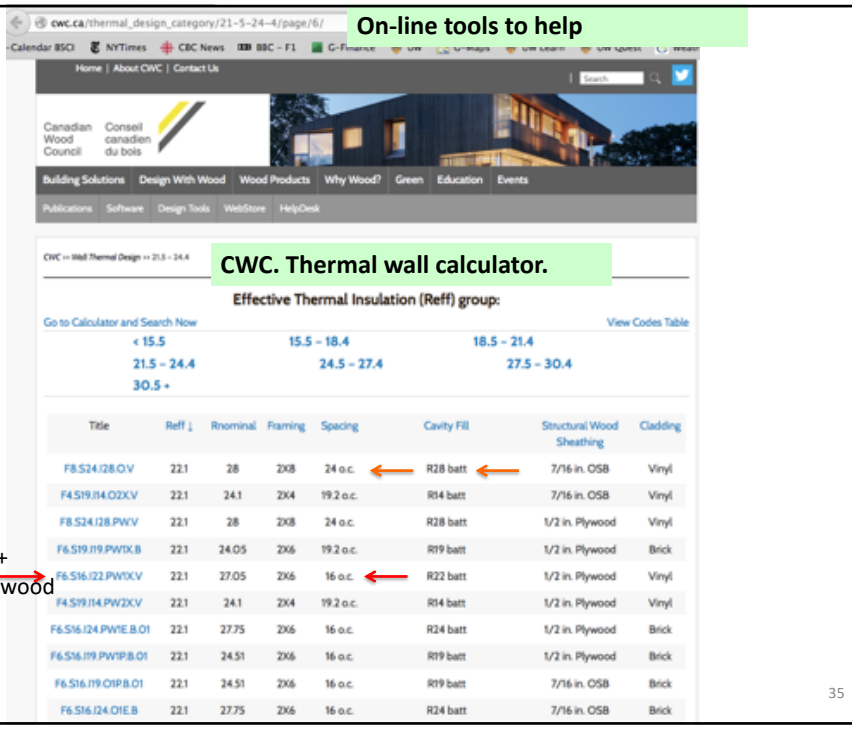
	WALL ASSEMBLY COMPONENTS	RSI	R
1	exterior air film	0.03	0.17
2	vinyl siding (no air space)	0.11	0.62
3	asphalt impregnated paper[2]	0.00	0.00
4	1" (25.4mm) extruded polystyrene type 3/4	0.89	5.05
5	7/16" (11.1mm) OSB sheathing	0.11	0.62
6	2x6 framing filled with R19 batt @ 16" o.c.	2.36	13.40
7	polyethylene	0.00	0.00
8	1/2" (12.7mm) gypsum board	0.08	0.45
9	finish: 1 coat latex primer and latex paint	0.00	0.00
10	interior air film	0.12	0.68
	Effective RSI / R Value of Entire Assembly	3.70	20.99
	Centre of Cavity RSI / R Value	4.68	26.59
	Installed Insulation RSI / R Value(nominal)	4.23	24.05
	Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC9.36.2.4.(1))	3.83	21.73



Numerous Free on-line calculators available

Source: https://cwc.ca/design-tools/effective-r-calculator/

34



35

What to Include

9.36.2.4. Calculation of Effective Thermal Resistance of Assemblies

1) In calculating the effective thermal resistance of assemblies for the purpose of comparison with the requirements of Articles 9.36.2.6. and 9.36.2.8., the thermal bridging effect of closely spaced, repetitive structural members, such as studs and joists, and of ancillary members, such as lintels, sills and plates, shall be accounted for. (See Appendix A.)

2) Minor penetrations through assemblies, such as pipes, ducts, equipment with through-the-wall venting, packaged terminal air conditioners or heat pumps, shelf angles, anchors and ties and associated fasteners, and minor structural members that must partially or completely penetrate the *building* envelope to perform their intended function need not be taken into account in the calculation of the effective thermal resistance of that assembly.

3) Major structural penetrations, such as balcony and canopy slabs, beams, columns and ornamentation or appendages that must completely penetrate the *building* envelope to perform their intended function, need not be taken into account in the calculation of the effective thermal resistance of the penetrated assembly, provided

a) the insulation is installed tight against the outline of the penetration, and

b) the sum of the areas of all such major structural penetrations is limited to a maximum of 2% of the gross wall area calculated as described in Sentence 9.36.2.3.(2).

36

NECB 2011/2015

- Many thermal bridges can be ignored, but..
- 3.1.1.7(1)

1) In calculating the *overall thermal transmittance* of assemblies for purposes of comparison with the provisions in Section 3.2., the thermal bridging effect of closely spaced repetitive structural members, such as studs and joists, and of ancillary members, such as lintels, sills and plates, shall be accounted for as described in Article 1.1.4.2.

- Wood and steel studs need to be counted
- Repetitive framing like Z-girts

RDH

37

What to include

- The big stuff, not the screws, etc

Include in calculation	Exclude from Calculations
Repetitive structural members - Studs - Joists, lintels - Sills, plates	Minor penetrations - pipes, ducts - Packaged air conditioners - Shelf angles, anchors, fasteners
Credit for adjoining unconditioned spaces	Major structural penetrations - Balcony slabs, beams, columns, ornamentation, Provided: insulation is tight to penetrating element - Total area of all major structural penetration is limited to max 2% of wall area

RDH

38

38

Tall wood

- Lots of framing on lower floors

39

Thermal bridging nightmares

Building Science.com

40

Steel Framing

Cavity Depth mm	Cavity Depth inch	Rated Cavity Resistance	R-value @16" o.c.	R-value @24" o.c.
64	2.5	Empty	0.75	0.13
89	3.5	Empty	0.79	0.14
		RSI 2.1/R-13	6.0	1.06
		RSI 2.65/ R-15	6.4	1.13
152	6	Empty	0.84	0.15
		RSI 3.35/R-19	7.1	1.25
		RSI3.7/R-21	7.4	1.31
		RSI 4.2/R-24 (4" ccSPF)	7.6	1.34

41

Steel Framing w/ GWB

Cavity Depth mm	Cavity Depth inch	Rated Cavity Resistance	Layer RSI_{cw} @ 405 mm centres	Layer R_{cw}-value @ 16 inch centres
64	2.5	Empty	0.37	2.15
89	3.5	Empty	0.39	2.19
		RSI 2.1/R-13	1.31	7.4
		RSI 2.65/ R-15	1.38	7.8
152	6.0	Empty	0.39	2.24
		RSI 3.35/R-19	1.50	8.5
		RSI3.7/R-21	1.55	8.8
		RSI 4.2/R-24 (4" ccSPF)	1.59	9.0

Just add R of exterior insulation...

42

Thermal Bridge if > 2% of area

- Balconies, etc
- Exposed slab edges

43