

Residential Energy Code TAG

Meeting Notes

Date: Monday, October 16, 2023

Meeting Location: Hybrid – Washington Room/WebEx

Call to order:

Steve Shold

Attendance:

TAG Members present: Steve Shold (DLI), Greg Metz (DLI), Chris Rosival (DLI), John Smith (practical engineering applications), Rebecca Olson (MN Center for Energy & Environment), Eric Fowler (Fresh Energy), Eric Boyd (Housing First Minnesota), Alyssa Jagdfeld (MN AIA), Jim Kumon (Heirloom Properties), Mike Allen (BAM), Steve Ubl (building officials), Alison Lindburg (Midwest Energy Efficiency Alliance)

TAG Members absent: Mike Robertson

Guests attending: Amanda Spuckler (DLI), Brittany Wysokinski (DLI), Don Sivigny (DLI), Tim Manz (DLI), Nick Erickson, David Alseth, Gary Thaden, Lucas Rutherford, Ben Rabe, David McDonald, Eric Lacey, Isaac Elnecave, Isabella Gross, Jared Johnson, Jay Crandell, Michael Robertson, Marcy Conrad Nutt, Mark Mikkelson, Matthew Friedlander, Michael Allen, Mike Moore, Nick Conniff, Patrick Murray, Patrick Nielsen, Paul Swett, Peter Kulczyk, Rebecca Olson, Rick Cobbs, Rob Buchanan, Stacy Miller, Tom Henningsen, Mike Wilson

1. Call to order

2. Review of code change proposals for the residential provisions of the 2021 IECC Table R402.1.3 through R402.2.12 as described below.

Table R402.1.3 Insulation minimum R-values and fenestration requirements by component

TAG members reviewed the wall insulation requirements, including continuous insulation options, IRC vapor retarder requirements, and [revised UA data](#). The UA data included the temperature of the wall cavity dependent on the wall construction option and moisture design temperatures. TAG members considered the potential for moisture buildup within the cavity and the need to dry it out as well as the necessity of vapor retarders. TAG members also considered modifying the R-20 cavity insulation plus R-5 continuous insulation requirement to require R-7.5 continuous insulation to mitigate the potential for moisture buildup on the backside of the

sheathing. However, an increase in the thickness of the insulation can increase building costs for other elements such as siding and fasteners. The TAG consensus is to accept the wall insulation requirements of the 2021 IECC pending the results of the building durability study.

Section R402.1.4 R-value computation

The TAG consensus is to accept the 2021 IECC language as written.

Section R402.1.5 Total UA alternative

A code change proposal will be submitted to provide a total UA backstop.

Section R402.2.6 Steel-frame ceilings, walls and floors and Table R402.2.4 Steel-frame ceiling, wall, and floor insulation R-values

The TAG consensus is to accept the 2021 IECC language as written.

Section R402.2.7 Floors

TAG members discussed modifying this section for clarity. The section was tabled for discussion with duct requirements.

Section R402.2.8 Basement walls and Section R402.2.8.1 Basement wall insulation installation

These sections will be discussed after receiving the building durability study.

Section R402.2.9.1 Slab-on-grade floor insulation installation

The TAG consensus is to accept the 2021 IECC language as written.

Section R402.2.10 Crawl space walls and R402.2.10.1 Crawl space wall insulation installation

TAG members discussed aligning the requirements for crawl spaces with those for basement walls because crawl spaces in Minnesota are generally conditioned.

Section R402.2.11 Masonry veneer

The TAG consensus is to accept the 2021 IECC language as written.

Section R402.2.12 Sunroom and heated garage insulation

TAG members discussed separating requirements for sunrooms and heated garages. TAG members also discussed limiting the heating of garages, whether the reduction in insulation for heated garage is warranted, and implications on a limitation on heating for garages serving multifamily structures.

Next Meeting:

Date: Monday, October 30, 2023

Time: 1:00 PM

Location: Hybrid – Minnesota Room/WebEx Event

Meeting Adjourned: 3:00 PM

Prepared by: Steve Shold

6	0.30	0.55	NR	60	30 or 20&5ci ^h or 13&10ci ^h or 0&20ci ^h	15/20	30	15ci or 13&t
7 and 8	0.30	0.55	NR	60	30 or 20&5ci ^h or 13&10ci ^h or 0&20ci ^h	19/21	38	15ci or 13&t

TABLE R702.7(1) VAPOR RETARDER MATERIALS AND CLASSES

CLASS	ACCEPTABLE MATERIALS
I	Sheet polyethylene, nonperforated aluminum foil or other approved materials with a perm rating less than or equal to 0.1.
II	Kraft-faced fiberglass batts, vapor retarder paint or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating greater than 0.1 and less than or equal to 1.0.
III	Latex paint, enamel paint or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating greater than 1.0 and less than or equal to 10.0.

TABLE R702.7(2) VAPOR RETARDER OPTIONS

CLIMATE ZONE	VAPOR RETARDER CLASS		
	CLASS I ^a	CLASS II ^b	CLASS III
1, 2	Not Permitted	Not Permitted	Permitted
3, 4 (except Marine 4)	Not Permitted	Permitted ^c	Permitted
Marine 4, 5, 6, 7, 8	Permitted ^b	Permitted ^c	See Table R702.7(3)

- a. Class I and II vapor retarders with vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B) shall be allowed on the interior side of any frame wall in all climate zones.
- b. Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.
- c. Where a Class II vapor retarder is used in combination with foam plastic insulating sheathing installed as continuous insulation on the exterior side of frame walls, the continuous insulation shall comply with Table R702.7(4) and the Class II vapor retarder shall have a vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B).

TABLE R702.7(3) CLASS III VAPOR RETARDERS

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR: ^{a, b}
Marine 4	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with <i>R</i> -value ≥ 2.5 over 2 x 4 wall.
	Continuous insulation with <i>R</i> -value ≥ 3.75 over 2 x 6 wall.
5	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with <i>R</i> -value ≥ 5 over 2 x 4 wall.
	Continuous insulation with <i>R</i> -value ≥ 7.5 over 2 x 6 wall.
6	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with <i>R</i> -value ≥ 7.5 over 2 x 4 wall.
7	Continuous insulation with <i>R</i> -value ≥ 11.25 over 2 x 6 wall.
	Continuous insulation with <i>R</i> -value ≥ 10 over 2 x 4 wall.
8	Continuous insulation with <i>R</i> -value ≥ 15 over 2 x 6 wall.
	Continuous insulation with <i>R</i> -value ≥ 12.5 over 2 x 4 wall.

- a. Vented cladding shall include vinyl, polypropylene, or horizontal aluminum siding, brick veneer with a clear airspace as specified in Table R703.8.4(1), and other approved vented claddings.
- b. The requirements in this table apply only to insulation used to control moisture in order to permit the use of Class III vapor retarders. The insulation materials used to satisfy this option also contribute to but do not supersede the thermal envelope requirements of Chapter 11.

TABLE R702.7(4) CONTINUOUS INSULATION WITH CLASS II VAPOR RETARDER

CLIMATE ZONE	CLASS II VAPOR RETARDERS PERMITTED FOR: ^a
3	Continuous insulation with <i>R</i> -value ≥ 2 .
4, 5 and 6	Continuous insulation with <i>R</i> -value ≥ 3 over 2 x 4 wall.
	Continuous insulation with <i>R</i> -value ≥ 5 over 2 x 6 wall.
7	Continuous insulation with <i>R</i> -value ≥ 5 over 2 x 4 wall.
	Continuous insulation with <i>R</i> -value ≥ 7.5 over 2 x 6 wall.
8	Continuous insulation with <i>R</i> -value ≥ 7.5 over 2 x 4 wall.
	Continuous insulation with <i>R</i> -value ≥ 10 over 2 x 6 wall.

- a. The requirements in this table apply only to insulation used to control moisture in order to permit the use of Class II vapor retarders. The insulation materials used to satisfy this option also contribute to but do not supersede the thermal envelope requirements of Chapter 11.

Equivalent Wall Constructions allowed by IECC

www.ASHRAE-meteo.info

Weather data:	Dec	Jan	Feb	Avg	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme	
MSP	21.8	15.9	20.2		15.9	9.3	-6	9	-16.8	72F/30% RH is 38.9F dewpoint
Duluth	16.9	10.8	14.9		10.8	4.2	-12.1	2.9	-23.3	72F/20% RH is 29.2F dewpoint
Grand Marais	14.5	9.0	12.0		9.0	1.8	-15	0	-24	-20F/80% RH is -23.9F dewpoint

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

Assume wall is 75% cavity and 25% framing
Wall cavity is R30
 Wall framing is 2 x 8 for R=9.06

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	30.00
2 x 8 Framing:	9.06	0.00
Sheathing:	0.79	0.79
CI Rigid:	0.00	0.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	11.31	32.25
U:	0.088	0.031

Wall Overall U_o: **0.045**

Ratio Exterior/Interior Insul	0.00
Ratio Ext/Int Insul w/siding:	0.01
Ratio Ext/Total:	0.00

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	68.4	70.7
1/2" sheetrock:	66.0	69.9
Batt insulation:	66.0	13.9
2 x 6 Framing:	17.7	13.9
Sheathing:	13.5	12.4
CI Rigid:	13.5	12.4
Siding:	12.7	12.1
Outdoor airfilm:	11.8	11.8

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R5 CI
 Wall framing is 2 x 6 for R=6.88 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	5.00	5.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	14.12	27.25
U:	0.071	0.037

Wall Overall U_o: **0.045**

Ratio Exterior/Interior Insul	0.25
Ratio Ext/Int Insul w/siding:	0.26
Ratio Ext/Total:	0.20

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	69.1	70.5
1/2" sheetrock:	67.2	69.5
Batt insulation:	67.2	25.3
2 x 6 Framing:	37.9	25.3
Sheathing:	34.5	23.6
CI Rigid:	13.2	12.5
Siding:	12.5	12.2
Outdoor airfilm:	11.8	11.8

Assume wall is 75% cavity and 25% framing
Wall cavity is R13 plus R10 CI
 Wall framing is 2 x 4 for R=4.38 + R10 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	13.00
2 x 4 Framing:	4.38	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	16.63	25.25
U:	0.060	0.040

Wall Overall U_o: **0.045**

Ratio Exterior/Interior Insul	0.77
Ratio Ext/Int Insul w/siding:	0.78
Ratio Ext/Total:	0.43

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	69.5	70.4
1/2" sheetrock:	67.9	69.3
Batt insulation:	67.9	38.3
2 x 4 Framing:	32.0	38.3
Sheathing:	49.2	36.4
CI Rigid:	13.0	12.6
Siding:	12.4	12.2
Outdoor airfilm:	11.8	11.8

Assume wall is 75% cavity and 25% framing
Wall cavity is R0 plus R20 CI
 Wall framing is 2 x 4 for R=4.38 + R20 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	0.00
2 x 4 Framing:	4.38	0.00
Sheathing:	0.79	0.79
CI Rigid:	20.00	20.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	26.63	22.25
U:	0.038	0.045

Wall Overall U_o: **0.043**

Ratio Exterior/Interior Insul	#DIV/0!
Ratio Ext/Int Insul w/siding:	#DIV/0!
Ratio Ext/Total:	1.00

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	70.5	70.2
1/2" sheetrock:	69.4	68.9
Batt insulation:	69.4	68.9
2 x 4 Framing:	39.5	68.9
Sheathing:	57.8	66.8
CI Rigid:	12.5	12.7
Siding:	12.2	12.3
Outdoor airfilm:	11.8	11.8

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R7.5 CI
 Wall framing is 2 x 6 for R=6.88 + R7.5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	7.50	7.50
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	16.62	29.75
U:	0.060	0.034

Wall Overall U_o: **0.040**

Ratio Exterior/Interior Insul	0.38
Ratio Ext/Int Insul w/siding:	0.38
Ratio Ext/Total:	0.27

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	69.5	70.6
1/2" sheetrock:	67.9	69.7
Batt insulation:	67.9	29.2
2 x 6 Framing:	42.0	29.2
Sheathing:	40.1	27.6
CI Rigid:	13.0	12.5
Siding:	12.4	12.1
Outdoor airfilm:	11.8	11.8

Proposed for Zone 7 in RE-6
 Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R10 CI
 Wall framing is 2 x 6 for R=6.88 + R10 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	19.12	32.25
U:	0.052	0.031

Wall Overall U_o: **0.036 NOT EQUIVALENT**

Ratio Exterior/Interior Insul	0.50
Ratio Ext/Int Insul w/siding:	0.51
Ratio Ext/Total:	0.33

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	69.9	70.7
1/2" sheetrock:	68.4	69.9
Batt insulation:	68.4	32.6
2 x 6 Framing:	46.4	32.6
Sheathing:	44.3	31.1
CI Rigid:	12.8	12.4
Siding:	12.3	12.1
Outdoor airfilm:	11.8	11.8

Proposed for Zone 7 in RE-6
 Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R14 CI
 Wall framing is 2 x 6 for R=6.88 + R14 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	14.00	14.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	23.12	36.25
U:	0.043	0.028

Wall Overall U_o: **0.032 NOT EQUIVALENT**

Ratio Exterior/Interior Insul	0.70
Ratio Ext/Int Insul w/siding:	0.71
Ratio Ext/Total:	0.41

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	70.2	70.9
1/2" sheetrock:	69.1	70.1
Batt insulation:	69.1	36.9
2 x 6 Framing:	51.2	36.9
Sheathing:	49.1	35.6
CI Rigid:	12.6	12.3
Siding:	12.2	12.1
Outdoor airfilm:	11.8	11.8

Existing Code
 Assume wall is 75% cavity and 25% framing
Wall cavity is R21
 Wall framing is 2 x 6 for R=6.88

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	21.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	0.00	0.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	9.13	23.25
U:	0.110	0.043

Wall Overall U_o: **0.060 0.048 equiv.**

Ratio Exterior/Interior Insul	0.00
Ratio Ext/Int Insul w/siding:	0.01
Ratio Ext/Total:	0.00

Indoor Temp, F **72.0**

Outdoor Temp, F **11.8**

Temperature - outside surface of component

	Framing	Cavity
Indoor airfilm:	67.5	70.2
1/2" sheetrock:	64.5	69.1
Batt insulation:	64.5	14.7
2 x 6 Framing:	19.2	14.7
Sheathing:	14.0	12.7
CI Rigid:	14.0	12.7
Siding:	12.9	12.2
Outdoor airfilm:	11.8	11.8

Comparing to prescriptive overall UA_o values, what would the required wall U_w be for increasing glass?

	Prescriptive Code	
	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	5.00	5.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	14.12	27.25
U:	0.071	0.037
Wall Overall U_o:	0.045	
Fenestration U_g:	0.30	

% Glass	% Framing	% Cavity	U _g		U _g --->	Wall UA _o	Alternate Design Opaque Wall U (Note 1)					
			0.30	0.045			Increasing Glass U Value					
15.00%	21.25%	63.75%	0.083	0.045	!	0.045	0.27	0.32	0.34	0.36	0.38	0.40
20.00%	20.00%	60.00%	0.096	0.045	!	0.045	0.051	0.042	0.038	0.035	0.031	0.028
25.00%	18.75%	56.25%	0.109	0.045	!	0.045	0.053	0.040	0.035	0.030	0.025	0.020
30.00%	17.50%	52.50%	0.122	0.045	!	0.045	0.055	0.039	0.032	0.025	0.019	0.012
35.00%	16.25%	48.75%	0.134	0.045	!	0.045	0.058	0.037	0.028	0.020	0.011	0.002
40.00%	15.00%	45.00%	0.147	0.045	!	0.045	0.061	0.034	0.024	0.013	0.002	---
45.00%	13.75%	41.25%	0.160	0.045	!	0.045	0.065	0.032	0.019	0.005	---	---
50.00%	12.50%	37.50%	0.173	0.045	V	0.045	0.070	0.029	0.012	---	---	---
							0.075	0.025	0.005	---	---	---

Note 1: The opaque wall U value will require decreasing so that the overall U_o does not exceed the U_o with 0.30 glass and 0.045 wall construction at the identified percentages
 For example: 30% glass option cannot exceed an overall U_o of 0.122

Reasonable wall UA minimum of 0.030 in orange

If we place a hard stop on the overall building UA_o of 0.11, what would the required wall U_w be for increasing glass U?

% Glass	% Framing	% Cavity	U _g		U _g --->	Wall UA _o	Alternate Design Opaque Wall U (Note 1)					
			0.30	0.045			Increasing Glass U Value					
15.00%	21.25%	63.75%	0.110	0.110	!	0.110	0.27	0.32	0.34	0.36	0.38	0.40
20.00%	20.00%	60.00%	0.110	0.110	!	0.110	0.082	0.073	0.069	0.066	0.062	0.059
25.00%	18.75%	56.25%	0.110	0.110	!	0.110	0.070	0.058	0.053	0.048	0.043	0.038
30.00%	17.50%	52.50%	0.110	0.110	!	0.110	0.057	0.040	0.033	0.027	0.020	0.013
35.00%	16.25%	48.75%	0.110	0.110	!	0.110	0.041	0.020	0.011	0.003	---	---
40.00%	15.00%	45.00%	0.110	0.110	!	0.110	0.024	---	---	---	---	---
45.00%	13.75%	41.25%	0.110	0.110	!	0.110	---	---	---	---	---	---
50.00%	12.50%	37.50%	0.110	0.110	V	0.110	---	---	---	---	---	---

1994 Minnesota Energy Code required an overall U_o of 0.110 for walls, 0.026 for roofs/ceilings and 0.04 for floors
 Allowing designed building to meet UA overall based on components that comply with table 402.1.2 requirements will increase the overall U_o as the percent of fenestration increases which is not a desired condition.

Reasonable wall UA minimum of 0.030 in orange

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R5 CI
 Wall framing is 2 x 6 for R=6.88 + R5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	5.00	5.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	14.12	27.25
U:	0.071	0.037

Wall Overall U_o: 0.045

Ratio Exterior/Interior Insul	0.25
Ratio Ext/Int Insul w/siding:	0.26
Ratio Ext/Total:	0.20

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R10 CI
 Wall framing is 2 x 6 for R=6.88 + R10 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	19.12	32.25
U:	0.052	0.031

Wall Overall U_o: 0.036

Ratio Exterior/Interior Insul	0.50
Ratio Ext/Int Insul w/siding:	0.51
Ratio Ext/Total:	0.33

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 plus R14 CI
 Wall framing is 2 x 6 for R=6.88 + R14 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	14.00	14.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	23.12	36.25
U:	0.043	0.028

Wall Overall U_o: 0.032

Ratio Exterior/Interior Insul	0.70
Ratio Ext/Int Insul w/siding:	0.71
Ratio Ext/Total:	0.41

Assume wall is 75% cavity and 25% framing
Wall cavity is 0 plus R20 CI
 Wall framing is 2 x 6 for R=6.88 + R20 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	20.00	20.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	29.12	22.25
U:	0.034	0.045

Wall Overall U_o: 0.042

Ratio Exterior/Interior Insul	#DIV/0!
Ratio Ext/Int Insul w/siding	#DIV/0!
Ratio Ext/Total:	1.00

Assume wall is 75% cavity and 25% framing
Wall cavity is R21
 Wall framing is 2 x 6 for R=6.88

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	21.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	0.00	0.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	9.12	23.25
U:	0.110	0.043

Wall Overall U_o: 0.060

Ratio Exterior/Interior Insul	0.00
Ratio Ext/Int Insul w/siding:	0.01
Ratio Ext/Total:	0.00

Assume wall is 75% cavity and 25% framing
Wall cavity is R20 + R7.5 CI
 Wall framing is 2 x 6 for R=6.88 + R7.5 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	20.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	7.50	7.50
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	16.62	29.75
U:	0.060	0.034

Wall Overall U_o: 0.040

Ratio Exterior/Interior Insul	0.38
Ratio Ext/Int Insul w/siding:	0.38
Ratio Ext/Total:	0.27

Assume wall is 75% cavity and 25% framing
Wall cavity is R13 + R10 CI
 Wall framing is 2 x 6 for R=6.88 + R10 CI

	Framing	Cavity
Indoor airfilm:	0.68	0.68
1/2" sheetrock:	0.45	0.45
Batt insulation:	0.00	13.00
2 x 6 Framing:	6.88	0.00
Sheathing:	0.79	0.79
CI Rigid:	10.00	10.00
Siding:	0.16	0.16
Outdoor airfilm:	0.17	0.17
R _{total} :	19.12	25.25
U:	0.052	0.040

Wall Overall U_o: 0.043

Ratio Exterior/Interior Insul	0.77
Ratio Ext/Int Insul w/siding:	0.78
Ratio Ext/Total:	0.43

Minnesota Residential Energy Code
 Overall UA Calculations
 12-Oct-23
 John G. Smith, P.E.

Thermal Climate Zone Definitions		
	IP Units	SI Units
Zone 6	7,200 < HDD65F ≤ 9,000	4000 < HDD18C ≤ 5000
Zone 7A	9,000 ≤ HDD65F ≤ 12,600	5000 < HDD18C ≤ 6000
Zone 7B		6000 < HDD18C ≤ 7000

www.ASHRAE-meteo.info

Weather data:	Dec	Jan	Feb	Avg Wtr	Coldest Mo.	Avg-10	ASHRAE 99%	99%+15F	Mean Extreme
MSP	21.8	15.9	20.2	19.3	15.9	9.3	-6	9	-16.8
Duluth	16.9	10.8	14.9	14.2	10.8	4.2	-12.1	2.9	-23.3
Grand Marais	14.5	9.0	12.0	11.8	9.0	1.8	-15	0	-24

Allowable to use average winter temperature for the outdoor air temperature for condensation evaluation (per Building Science Corp)

From BSD-163: Controlling Cold-Weather Condensation Using Insulation
 Table 1: Ratio of exterior-interior insulation to control air leakage condensation

Indoor	RH --->	20	25	30	35	40	50	60
Dewpoint	°F --->	26.6	32.0	36.6	40.5	44.0	49.9	54.8
T _{outdoors}	°F							
50		0.00	0.00	0.00	0.00	0.00	0.00	0.24
41		0.00	0.00	0.00	0.00	0.10	0.31	0.48
32		0.00	0.00	0.12	0.23	0.32	0.47	0.60
23		0.08	0.19	0.29	0.37	0.45	0.57	0.68
14		0.23	0.32	0.40	0.48	0.54	0.64	0.73
5		0.33	0.42	0.49	0.55	0.60	0.69	0.77
-4		0.41	0.49	0.55	0.60	0.65	0.73	0.80
-13		0.48	0.54	0.60	0.65	0.69	0.76	0.82
-22		0.53	0.59	0.64	0.68	0.72	0.78	0.84

72F/30% RH is 38.9F dewpoint
 72F/20% RH is 29.2F dewpoint
 -20F/80% RH is -23.9F dewpoint

Above values exclude exterior cladding. Adding cladding will decrease percentages.

CLIMATIC DATA DESIGN CONDITIONS			
City	Winter Design db °F		
	ASHRAE 99%	ASHRAE 99.6%	ASHRAE Aver Mean
Aitkin	-15	-20	-28
Albert Lea	-8	-11	-19
Alexandria AP	-13	-18	-23
Bemidji AP	-18	-23	-30
Brainerd	-13	-19	-27
Cloquet	-12	-18	-24
Crookston	-18	-24	-28
Duluth AP	-12	-17	-23
Ely	-20	-27	-34
Eveleth	-17	-23	-31
Faribault	-9	-14	-21
Fergus Falls	-15	-20	-26
Grand Marais	-15	-18	-24
Grand Rapids	-15	-20	-25
Hibbing/Chisholm	-18	-24	-31
International Falls AP	-21	-26	-35
Litchfield	-9	-15	-20
Little Falls	-13	-18	-26
Mankato	-8	-12	-16
Mpls/St. Paul AP	-6	-11	-17
Montivedeo	-9	-15	-19
Mora	-11	-18	-24
Morris	-11	-17	-23
New Ulm	-9	-14	-19
Owatonna	-9	-15	-19
Pequot Lakes	-17	-23	-31
Pipestone	-8	-12	-19
Redwood Falls	-9	-13	-19
Rochester AP	-8	-13	-19
Roseau	-18	-24	-31
St. Cloud AP	-11	-17	-24
Silver Bay	-15	-19	-28
Thief River Falls	-18	-22	-27
Tofte			-14
Virginia	-17	-22	-31
Warroad	-18	-24	-32
Wheaton	-11	-17	-23
Willmar	-17	-11	-22
Winona	-4	-9	-18
Worthington	-8	-11	-16

Degree Days 65F Base	Degree Days 18C Base	Monthly Average Temperature			Condensation Design Options			
		Dec	Jan	Feb	Coldest Month	Winter Average	Average Minus 10F	ASHRAE 99%+15F
9040	5023	17.1	10.4	14.7	10.4	14.1	0.4	0
7559	4200	21.7	16.0	19.7	16.0	19.1	6.0	7
8576	4765	17.3	10.8	14.7	10.8	14.3	0.8	2
9494	5275	14.2	7.8	12.0	7.8	11.3	-2.2	-3
8639	4800	16.9	11.1	15.6	11.1	14.5	1.1	2
9273	5152	16.9	11.0	14.9	11.0	14.3	1.0	3
9415	5231	13.4	6.4	10.2	6.4	10.0	-3.6	-3
9173	5097	16.9	10.8	14.9	10.8	14.2	0.8	3
9956	5532	13.5	6.6	10.9	6.6	10.3	-3.4	-5
9526	5293	15.2	8.9	13.2	8.9	12.4	-1.1	-2
7648	4249	20.9	14.9	19.0	14.9	18.3	4.9	6
8575	4764	15.4	11.0	12.8	11.0	13.1	1.0	0
10290	5717	14.5	9.0	12.0	9.0	11.8	-1.0	0
9289	5161	15.6	9.5	13.7	9.5	12.9	-0.5	0
9822	5457	13.8	7.6	11.9	7.6	11.1	-2.4	-3
9984	5547	12.3	5.5	10.1	5.5	9.3	-4.5	-6
7950	4417	19.6	13.7	17.4	13.7	16.9	3.7	6
8555	4753	17.8	12.4	16.3	12.4	15.5	2.4	2
7586	4215	21.0	15.4	19.3	15.4	18.6	5.4	7
7396	4109	21.8	15.9	20.2	15.9	19.3	5.9	9
7818	4344	20.0	14.4	18.3	14.4	17.6	4.4	6
8547	4749	18.8	12.5	16.6	12.5	16.0	2.5	4
8476	4709	17.3	11.6	15.0	11.6	14.6	1.6	4
7728	4294	20.2	14.8	19.2	14.8	18.1	4.8	6
7632	4240	21.3	15.3	19.1	15.3	18.6	5.3	6
9433	5241	12.0	9.1	14.1	9.1	11.7	-0.9	-2
7737	4299	20.6	15.7	19.9	15.7	18.7	5.7	7
7727	4293	20.1	14.6	18.7	14.6	17.8	4.6	6
7779	4322	20.9	14.8	18.7	14.8	18.1	4.8	7
9547	5304	12.9	6.2	10.2	6.2	9.8	-3.8	-3
8350	4639	18.3	12.0	16.2	12.0	15.5	2.0	4
9772	5429	16.5	10.9	13.9	10.9	13.8	0.9	0
9514	5286	13.0	6.9	10.7	6.9	10.2	-3.1	-3
	0							1
9526	5293	15.2	8.9	13.2	8.9	12.4	-1.1	-2
9769	5428	12.9	6.0	9.5	6.0	9.5	-4.0	-3
8393	4663	17.9	12.0	15.3	12.0	15.1	2.0	4
8066	4481	19.0	12.6	17.2	12.6	16.3	2.6	-2
7052	3918	24.5	18.5	22.7	18.5	21.9	8.5	11
7757	4310	20.9	15.8	20.0	15.8	18.9	5.8	7

Current code: Walls UA: 0.048 appears to use 20% framing/80% cavity based on R value equivalent
 Glass: 0.32

Proposed code: Walls UA: 0.045 appears to use 25% framing/75% cavity based on R value equivalent
 Glass: 0.30

T_{cavity,F} is the temperature at the cavity on the inside surface of the sheathing for OAT = 11.8 F (Entered in "Equiv Walls Prescriptive" tab)

Existing code wall construction options: (20% framing/80% cavity)	Zone 6	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}	Zone 7	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}
	U _{walls} = 0.048				U _{walls} = 0.048			
	R _{walls} : R-20	0.048		14.7	R _{walls} : R-21	0.048		14.7
	R _{walls} : R-13 plus R-5 CI	0.057	0.38	38.3				
	U _{glass} : 0.32				U _{glass} : 0.32			

Proposed code wall construction options: (25% framing/75% cavity)	Zone 6	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}	Zone 7	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}
	U _{walls} = 0.045				U _{walls} = 0.045			
	R _{walls} : R-30	0.045	0.00	13.9	R _{walls} : R-30	0.045	0.00	13.9
	R _{walls} : R-20 plus R-5 CI	0.045	0.25	25.3	R _{walls} : R-20 plus R-5 CI	0.045	0.25	25.3
	R _{walls} : R-13 plus R-10 CI	0.045	0.77	38.3	R _{walls} : R-13 plus R-10 CI	0.045	0.77	38.3
	R _{walls} : R-0 plus R-20 CI	0.043	1.00	68.9	R _{walls} : R-0 plus R-20 CI	0.043	1.00	68.9
	U _{glass} : 0.30				U _{glass} : 0.30			

Additional wall construction comparisons: (25% framing/75% cavity)	Zone 6	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}	Zone 7	U _{o-wall}	Ext/Cav Ratio	T _{cavity,F}
	U _{walls} = 0.045 (new code)	Base			U _{walls} = 0.045 (new code)	Base		
	R _{walls} : R-20 plus R-7.5 CI	0.040	0.38	29.2	R _{walls} : R-20 plus R-7.5 CI	0.040	0.38	29.2
RE 6.1	R _{walls} : R-20 plus R-10 CI	0.036	0.50	32.6	R _{walls} : R-20 plus R-14 CI	0.032	0.70	36.9
RE 6.1	R _{walls} : R-0 plus R-20 CI	0.042	1.00	68.9	R _{walls} : R-0 plus R-20 CI	0.042	1.00	13.9
	U _{glass} : 0.30	0.043			U _{glass} : 0.30			

From BSD-163: Controlling Cold-Weather Condensation Using Insulation
 Table 1: Ratio of exterior-interior insulation to control air leakage condensation

Indoor	RH	--->	20	25	30	35	40	50	60
Dewpoint	°C	--->	-3.0	0.0	2.5	4.7	6.6	9.9	12.7
	°F	--->	26.6	32.0	36.6	40.5	44.0	49.9	54.8
T _{outdoors}	°C	°F							
	10	50	0.00	0.00	0.00	0.00	0.00	0.00	0.24
	5	41	0.00	0.00	0.00	0.00	0.10	0.31	0.48
	0	32	0.00	0.00	0.12	0.23	0.32	0.47	0.60
	-5	23	0.08	0.19	0.29	0.37	0.45	0.57	0.68
	-10	14	0.23	0.32	0.40	0.48	0.54	0.64	0.73
	-15	5	0.33	0.42	0.49	0.55	0.60	0.69	0.77
	-20	-4	0.41	0.49	0.55	0.60	0.65	0.73	0.80
	-25	-13	0.48	0.54	0.60	0.65	0.69	0.76	0.82
	-30	-22	0.53	0.59	0.64	0.68	0.72	0.78	0.84

72F/30% RH is 38.9F dewpoint
 72F/20% RH is 29.2F dewpoint
 -20F/80% RH is -23.9F dewpoint

Above values exclude exterior cladding. Adding cladding will increase percentages.

Weather data:	Dec	Jan	Feb	Avg	Coldest Mo	Avg-10	ASHRAE 99%	99%+15F
MSP	21.8	15.9	20.2	19.3	15.9	9.3	-6	9
Duluth	16.9	10.8	14.9	14.2	10.8	4.2	-12.1	2.9
Grand Marais	14.5	9.0	12.0	11.8	9.0	1.8	-15	0