



Montgomery County Building Regulations

Trade-Off Energy Analysis for 1, 2 and 3 Family Dwellings

Based upon 2006 International Energy Conservation Code Requirements for Zone 5

Job Name _____ Date _____

Job Address _____ Township/City _____

See instructions starting on page 2

Your House (Proposed)					Code House(Allowable for Climate Zone 5)
	Insulation R-value	Area A in Sq. Ft.	System U or R-Values	Overall U-factor - UA	
Roof / Ceiling					Roof / Ceiling
1. Roof/Ceiling	_____	A _____	x U _r _____ = _____		Maximum U _O <u>.030</u>
2. Floor Cantilevers	_____	A _____	x U _r _____ = _____		A (total area in Sq. Ft.) x _____
Subtotal Roof/Clg.		A _____	3. _____		Max UA Allowed = _____ C.
4. Skylights		A _____	x U _O _____ = 5. _____		A _____ x U _O <u>.60</u> = UA _____ D.
Wood Frame Exterior Walls					Wood Frame Exterior Walls
6. Opaque Wall ⁵	_____	A _____	x U _W _____ = _____		Maximum U _O <u>.060</u>
7. Opaque Wall ⁵	_____	A _____	x U _W _____ = _____		A (total area in Sq. Ft.) x _____
8. Opaque Wall ⁵	_____	A _____	x U _W _____ = _____		Max UA Allowed = _____ G.
9. Floor Bands	_____	A _____	x U _W _____ = _____		
10. Others	_____	A _____	x U _O _____ = _____		
Subtotal		A _____	11. _____		
Exterior Mass Walls					Exterior Mass Walls
12. Opaque Mass Walls ^{3,5}		A _____	x U _O _____ = 13. _____		A _____ x U _O <u>.082</u> = UA _____ H.
Wall Fenestrations					Wall Fenestrations
14. Doors w/o glass		A _____	x U _O _____ = _____		To obtain UA for door and window area on your house, use the U-factor provided by the manufacturer for the entire window or door assembly or select typical U-factors from the attached tables. If you only have an R-value for the window or door divide the R-value into 1 to obtain a U-factor. Example 1/1.5 = .66
15. Doors with glass		A _____	x U _O _____ = _____		
16. Other Door		A _____	x U _O _____ = _____		
17. Window		A _____	x U _O _____ = _____		
18. Window		A _____	x U _O _____ = _____		
19. Bsm't. Window		A _____	x U _O _____ = _____		
Subtotals (Fenestrations)		A _____	20. _____		
					A (total area in Sq. Ft.) x _____
					Max UA Allowed = _____ K.
Foundation / Floor					Foundation / Floor
21. Slab Insulation ²		A* _____	÷ R _____ = 22. _____		A _____ ÷ R ² _____ = UA _____ L.
		*Area = 2 feet height x lineal feet of the perimeter of the slab			R = 15 for heated slabs, R = 10 for unheated slabs
23. Floor over unheated space		A _____	x U _O _____ = 24. _____		A _____ x U _O <u>.033</u> = UA _____ M.
25. Crawlspace Wall ¹		A ⁴ _____	x U _O _____ = 26. _____		A _____ x U _O <u>.065</u> = UA _____ N.
27. Basement Wall ⁴		A _____	x U _O _____ = 28. _____		A _____ x U _O <u>.059</u> = UA _____ O.
29. Basement Wall ⁴		A _____	x U _O _____ = 30. _____		A _____ x U _O <u>.059</u> = UA _____ P.
Total UA					Total UA
UA from insulation to be installed					Maximum UA: Lines
Total lines 3+5+11+13+20+22+24+26+28+30 = 31. _____					C+D+G+H+K+L+M+N+O+P = _____ Q.

Line 31 (Your House Total) must be less than or equal to line Q (Code House Total)
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Footnotes:

1. Per IECC 402.2.8: As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches. Exposed earth in unvented crawl space foundations shall be covered with a continuous vapor retarder. All joints of the vapor retarder shall overlap by 6 inches and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches up the stem wall and shall be attached to the stem wall.
2. Slab perimeter insulation depth is 2 feet minimum, from the top of the slab. A heated slab is defined as a slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under the slab.
3. Mass walls for the purposes of this form shall be considered walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs. The provisions of IECC Section 402.1.1 for mass walls shall be applicable when at least 50 percent of the required insulation R -value is on the exterior of, or integral to, the wall. Walls that do not meet this criterion for insulation placement shall meet the wood frame wall insulation requirements of Section IECC 402.1.1.
4. Per IECC 402.2.6 Basement walls associated with conditioned basements shall be insulated from the top of the basement wall down to 10 feet below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with IECC Sections 402.1.1 and 402.2.5.
5. Opaque wall means area of wall minus the window and door openings.

Additional Notes:

Per IECC 403.2.1: Supply and return ducts shall be insulated to a minimum of R-8. Ducts in floor trusses shall be insulated to a minimum of R-6. Exception: Ducts or portions thereof located completely inside the building thermal envelope

Per IECC 403.3: Mechanical system piping capable of carrying fluids above 105 ° F or below 55 ° F shall be insulated to a minimum of R-2.

Per IECC 403.4: All circulating service hot water piping shall be insulated to at least R-2. Circulating hot water systems shall include an automatic or readily accessible manual switch that can turn off the hot water circulating pump when the system is not in use.

Prepared by _____ Phone _____

INSTRUCTIONS FOR USING THE TRADE-OFF WORKSHEET

The trade-off worksheet compares “Your House” with a virtual identical “Code House” that complies with the Energy Code through the component performance evaluation process. If “Your House” uses equal or less energy than “Code House”, it complies with the Energy Code. The following line-by-line instructions will assist the user in completing the trade-off worksheet.

LINE 1. ROOF / CEILING (attic): Enter the R-value of the attic insulation you will install under “Insulation R-value”. Consult your building plans and calculate the areas of the ceiling and enter under “Area A”. From Table A obtain the system U_r -value for the R-value of insulation proposed. Multiply the area of ceiling times the system U_r -factor to obtain the UA and enter it under the UA column.

LINE 2. FLOOR CANTILEVERS: Enter the R-value of the attic insulation you will install under “Insulation R-value”. Consult your building plans and calculate the areas of the floor cantilever and enter under “Area A”. From table A obtain the system U_r -factor for the R-value of insulation proposed. Multiply the area of floor cantilever times the system U_r -factor to obtain the UA and enter it under the UA column.

LINE 3. ROOF/CEILING Subtotals. Add the areas to obtain an area subtotal. Then add lines 1&2 UA to obtain the total UA for the Roof /Ceiling assembly. Enter the total UA on line 3.

LINE 4. SKYLIGHTS: Obtain the U_o -factor (average of the entire unit) from Table D or from the skylight manufacturer. Enter the total area (from your building plans) under “Area A and enter the U_o -factor under the System U-factor. Multiply the area of skylights times the system U_o -factor to obtain the total UA for the skylights. Enter the total UA on line 5

LINE 6-8. OPAQUE WALL: This section includes above grade walls excluding window and door rough openings plus floor to ceiling area of any basement wall less than 50% below grade. Enter the R-value of the wall insulation you will install under “Insulation R-value”. Consult your building plans and calculate the areas of the walls and enter under “Area A”. From Table B obtain the system U_w -factor for the R-value of insulation proposed. Multiply the area

of wall times the system U_w -factor to obtain the UA and enter it under the UA column. Use lines 7 and 8 for different wall construction that must be calculated separately.

LINE 9. FLOOR BANDS: Enter the R-value of the floor band insulation you will install under "Insulation R-value". Consult your building plans and calculate the areas of the floor band and enter under "Area A". From Table B obtain the system U_w -factor for the R-value of insulation proposed. Multiply the area of floor band times the system U_w -factor to obtain the UA and enter it under the UA column.

Line 10. OTHER: Include here any other assembly having a unique U_o -factor.

Line 11. WOOD FRAME EXTERIOR WALL SUBTOTAL. Add the areas to obtain an area subtotal. Then add lines 6-10 UA to obtain the total UA for the Wood frame exterior wall assembly. Enter the total UA on line 11.

Line 12. OPAQUE MASS WALLS: This line is to be used for all mass walls. See chart footnote #3 for definition. Consult your building plans and calculate the area of the mass wall enter under "Area A". Obtain the System Mass wall U_o -factor from the mass wall supplier or insulation manufacturer. Enter the U_o -factor under System U factor. Multiply the area of mass wall times the system U_o -factor to obtain the UA and enter this number on line 13.

LINE 14. SOLID DOORS: (doors without glazing) Consult your building plans and calculate the areas of the solid door rough openings and enter under "Area A". From Table C obtain the system U_o -factors for the type of door used or obtain the U_o -factor from the door manufacturer. Multiply the area of the door times the system U_o -factor to obtain the UA and enter it under the UA column.

LINE 15 & 16. DOORS WITH GLAZING: Consult your building plans and calculate the areas of the doors with glazing, rough openings, and enter under "Area A". From Table D obtain the system U_o -factor for the type of door used or obtain the U_o -factor from the door manufacturer. Multiply the area of the door times the system U_o -factor to obtain the UA and enter it under the UA column. Use line 16 for different door construction that must be calculated separately.

LINE 17 & 18. WINDOWS: Consult your building plans and calculate the areas of the window rough openings, and enter under "Area A". From Table D obtain the system U_o -value for the type of window used or obtain the U_o -factor from the window manufacturer. If you obtain the U-factor from the window manufacturer, make sure you are using the system U-factor and not the "center of glass" U-factor. Multiply the area of the window times the system U_o -factor to obtain the UA and enter it under the UA column. Use line 18 for different window U-factors that must be calculated separately.

Line 19. BASEMENT WINDOWS: Use this line for windows in conditioned basements with different U-factors from line 12 and 13. Conditioned basements include all basements where the insulated envelope is at the exterior basement walls, and not at the floor between the basement and the first floor. See line 17 instructions to fill out this line.

Line 20. WALL FENESTRATION SUBTOTAL. Add the areas to obtain an area subtotal. Then add lines 14-19 UA to obtain the total UA for wall fenestrations. Enter the total UA on line 20.

Line 21. SLAB: Enter the R-value of the slab insulation you will install under "Insulation R-value" and the system R-value. Consult your building plans and calculate the lineal feet of the perimeter of the slab. Multiply the lineal feet times two feet high, the minimum height allowed in this zone. Enter this area under "Area A". Divide the system R-value into the "Area A" to obtain the UA for the slab and enter this number on line 22.

Line 23. FLOOR OVER UNHEATED SPACE. Unconditioned crawlspaces or basements. Enter the R-value of the floor insulation you will install under "Insulation R-value". Consult your building plans and calculate the areas of the floor and enter under "Area A". From Table E, obtain the system U_f -factor for the R-value of insulation proposed. Multiply the area of floor times the system U_f -value to obtain the UA and enter it at line 24.

Line 25. CRAWLSPACE WALL: Enter the R-value of the floor insulation you will install under "Insulation R-value". Consult your building plans and calculate the areas of the crawlspace wall, length times height. See chart footnote #1 for the required height. Enter this area under "Area A". From Table F, obtain the system U-factor for the R-value of insulation proposed. Multiply the area of floor times the system U-factor to obtain the UA and enter it at line 26.

Line 27 and 29. BASEMENT WALLS: Only the opaque portion of the basement walls that are 50% or more below grade are considered here. All basement windows and doors as well as opaque portions of basement walls that are less than 50% below grade are included in "Exterior Walls and Wall Fenestration" areas. Enter the R-value of the

basement wall insulation you will install under “Insulation R-value”. Consult your building plans and calculate the area of the basement wall and enter under “Area A”. From Table F, obtain the system U-factor for the R-value of insulation proposed. Multiply the area of the basement wall times the system U-factor to obtain the UA and enter it at line 28. Use line 30 for different wall construction or insulation values that must be calculated separately.

Line 31. Total UA (UA from insulation to be installed): Add the subtotals on lines 3+5+11+13+20+22+24+26+28 and 30, and enter the grand total on line 31.

Code House: Enter the total areas from Your House side of the worksheet on the Code House side in the appropriate locations. Multiply the U_o -factors times the areas (or divide the slab area by the insulation R-value) to get the maximum allowable UA for each category. (ROOF/CEILING, WOOD FRAME EXTERIOR WALLS, EXTERIOR MASS WALL, WALL FENESTRATIONS AND FOUNDATION/FLOOR TYPES.) Add the Subtotals on line C+D+G+H+K+L+M+N+O and P, and enter the grand total on Line Q.

The Comparison: If the value in line 31 is less than the value in line Q, you meet the code. If the value on line 31 exceeds that on line Q, your design fails. In this case you must increase the amount or quality of insulation you propose to install or reduce some of the areas of components having low R-values until your proposed overall U-factor (Line 31) is less than or equal to the code house overall U-factor. Note that if you change the area of component, you need to recalculate both “Your House and the “Code House”.

Table A
Roof Ceiling Assemblies

R-value of Insulation	System U-value (U_r)
19	0.050
22	0.040
30	0.030
38	0.025

Table B
Wall Assemblies

Type and Spacing of Framing	R-value of Cavity insulation	R-value of Sheathing	Opaque Wall U_w
2X4 Studs 16" oc.	11	Non-insulating	0.085
	13	Non-insulating	0.076
	13	3	0.064
	13	5	0.056
	13	7	0.051
	15	Non-insulating	0.070
	15	3	0.059
	15	5	0.053
2X6 Studs 16" oc	15	7	0.048
	19	Non-insulating	0.058
	19	3	0.050
	19	5	0.046
	19	7	0.041
	21	Non-insulating	0.052
	21	3	0.046
	21	5	0.042
2X6 Studs 24" oc	21	7	0.038
	21	Non-insulating	0.050

Table C (IECC 102.3(2))
U-factor Default Table for Doors

Door Type	U- Factor
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazed double pane	0.35

Table D(IECC 102.1.32(1))
U-factor Default Table for Windows, Glazed Doors and Skylights

Frame Material and Product Type ^a	Single Glazing	Double Glazing
Metal without thermal break	1.20	0.80
Skylights	2.00	1.30
Metal with thermal break	1.10	0.65
Skylights	1.90	1.10
Non Metal or Metal Clad	.95	.55
Skylights	1.75	1.05
Glazed Block	0.60	

Table E
Floor Assemblies

R-value of Insulation	U _r
No Insulation	.32
7	0.11
11	0.08
19	0.05

Table F
Foundation Wall Assemblies

Wall Detail	Crawlspace Wall		Basement Wall	
	R-value of Insulation	U-Factor	R-value of Insulation	U-Factor
Wood Foundation	11	0.10	11	0.08
	13	0.09	13	0.08
	19	0.06	19	0.06
Concrete/Masonry foundation interior insulation	5	0.15	5	0.15
	10	0.08	6.5	0.12
	11	0.08	10	0.08
	13	0.07	11	0.08
	19	0.05	19	0.06
Concrete/Masonry foundation exterior insulation	3	0.20	3	0.20
	5	0.15	5	0.15
	10	0.08	10	0.09
	15	0.06	15	0.06
Insulating concrete form system (ICF) ^{a,b,c}	12	0.08	12	0.07
	15	0.06	15	0.06
	16	0.06	16	0.06
	17	0.06	17	0.05
	20	0.05	20	0.05
	22	0.04	22	0.05

- The R-value listed is the sum of the values for the exterior and interior insulation layers
- The manufacturer shall be consulted for the u-factor if the insulated concrete form system (ICF) uses metal ties to connect the interior and exterior insulation layers.
- These values shall be permitted to be used for concrete masonry wall assemblies with exterior and interior insulation layers.