Residential Trade-Off Worksheet User's Guide

2007 New York State Energy Conservation Construction Code

Inside This Guide

Introduction

The trade-off approach is a pencil-and-paper method that can be used for one- and two-family (referred to as single-family) and multifamily residential buildings. This approach allows for trade-offs between all building envelope components, and heating and cooling equipment efficiencies. You may trade off ceiling, wall, floor, basement wall, slab-edge, and crawl space wall insulation; heating and cooling equipment efficiencies; window area; and window and door U-factors. The trade-off approach determines whether your building as a whole meets the code insulation and window requirements (refer to the *Basic Requirements* for additional requirements that must also be satisfied).

To determine compliance, you must complete the *Trade-Off Worksheets* provided with this guide. Refer to this worksheet while reading the following sections. To complete the *Trade-Off Worksheets*, enter the area, R-value, and U-factor of each component in your proposed building and calculate the total proposed UA. UA is the value of a building assembly times the surface area of that assembly through which heat flows. The UA for the entire building is the sum of all UAs for each assembly in the building envelope, giving a total UA for the building envelope. A larger UA indicates more heat loss, either because of a larger surface area or higher U-factors (or both).

Next, find the required U-factors for your zone from Table 11 and calculate the total required UA. If high efficient HVAC equipment is to be taken into account, complete the Equipment Trade-off worksheet. If the proposed UA is less than or equal to the required UA, your building complies with the code insulation and window requirements.

When applying the trade-off approach to multifamily buildings, the building can be considered as a whole or a separate worksheet can be completed for each individual

dwelling unit. Where individual units are identical, one worksheet may be submitted as representative of the others.

Table 302.1: Climatic Conditions - New York State

COUNTY	WINTER DESIGN DRY-BULB TEMP.	SUMMER DESIGN DRY-BULB TEMP.	COINCIDENT WET-BULB TEMP.	HEATING DEGREE DAYS	ZONE	COUNTY	WINTER DESIGN DRY-BULB TEMP.	SUMMER DESIGN DRY-BULB TEMP.	COINCIDENT WET-BULB TEMP.	HEATING DEGREE DAYS	ZONE
Albany	-7	86	70	6894	14A	Niagara	2	86	73	6747	14A
Allegany	1	86	71	6734	15	Oneida	-5	86	70	7244	15
Bronx	13	89	73	4910	11B	Onondaga	-3	86	71	6834	14A
Broome	-2	82	69	7273	15	Ontario	1	86	71	6734	14A
Cattaraugus	2	85	73	6747	15	Orange	6	83	73	5750	12B
Cayuga	-3	85	71	6834	14A	Orleans	1	86	71	6734	14A
Chautauqua	2	85	73	6747	13A	Oswego	-3	85	71	6834	14A
Chemung	-2	87	71	6845	15	Otsego	-5	86	70	7244	15
Chenango	-2	82	69	7273	15	Putnam	6	83	73	5750	12B
Clinton	-9	83	69	7837	15	Queens	13	89	73	4910	10B
Columbia	-7	86	70	6894	13A	Rensselaer	-7	86	70	6894	14A
Cortland	-2	82	69	7273	15	Richmond	13	89	73	4910	11B
Delaware	-5	86	70	7244	15	Rockland	13	89	73	4910	12B
Dutchess	2	88	72	6391	13A	St Lawrence	-15	84	71	9255	15
Erie	2	85	73	6747	14A	Saratoga	-5	86	70	7244	14A
Essex	-15	84	71	8255	16	Schenectady	-7	86	70	6894	14A
Franklin	-15	84	71	8255	16	Schoharie	-7	86	70	6894	15
Fulton	-7	86	70	6894	15	Schuyler	-2	87	71	6845	15
Genessee	1	86	71	6734	14A	Seneca	1	86	71	6734	14A
Greene	-7	86	70	6894	14A	Steuben	1	86	71	6734	15
Hamilton	-10	85	71	7635	16	Suffolk	11	83	74	5750	11B
Herkimer	-5	86	70	7244	15	Sullivan	6	83	73	6750	15
Jefferson	-12	83	70	7540	15	Tioga	-2	87	71	6845	15
Kings	13	89	73	4910	10B	Tompkins	-2	82	69	7273	15
Lewis	-12	83	70	7540	15	Ulster	6	83	73	6750	15
Livingston	1	86	71	6734	14A	Warren	-10	85	71	7635	15
Madison	-5	86	70	7244	14A	Washington	-10	85	71	7635	15
Monroe	1	86	71	6734	14A	Wayne	1	86	71	6734	14A
Montgomery	-7	86	70	6894	14A	Westchester	7	84	73	5750	12B
Nassau	13	89	73	4910	11B	Wyoming	1	86	71	6734	14A
New York	13	89	73	4910	10B	Yates	1	86	71	6734	14A

Figure 1. Design Conditions

Instructions for Using the Trade-Off Approach

The *Trade-Off Worksheet* documents compliance with the insulation and window requirements of the code. The following instructions explain how to complete these worksheets. Figure 2 shows an example *Trade-Off Worksheet*. The numbers in Figure 2 identify the various locations on this worksheet that correspond to the following steps.

Step 1: Find Your Climate Zone

Based on the county in which your building is to be located, determine your climate zone number. Your zone number can be found in *Figure 1 or Chapter 3 of the 2007 ECCC of New York State*.

Step 2: Complete the General Information Section

Fill in the information at the top of the worksheet. Be sure to record the climate zone number found in Step 1.

Step 3: Complete the PROPOSED Section

On the left side of the worksheet, provide the area, R-value, and U-factor for each building component. U-factors are a measure of how well a material conducts heat. Tables 1 through 10 can be used to determine the proposed U-factors needed for completing the *Envelope Trade-Off Worksheet*. If your particular construction type is not included in these tables, use U-factors derived through testing or calculation procedures accepted by your local jurisdiction.

Ceilings, Skylights, and Floors Over Outside Air

Ceilings Enter the R-value of the insulation to be installed in each ceiling component in the *Insulation R-Value* column. R-values for ceilings represent the sum of the cavity insulation plus insulating sheathing (if used). For ventilated ceilings, insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof (typically applied to the trusses or rafters immediately behind the drywall or other ceiling finish material). Sheathing placed on the roof deck over a ventilated attic does not qualify.

Based on the insulation R-value for each ceiling component, find the corresponding U-factor from Table 1 and enter it in the *Proposed U-Factor* column. If the ceiling is to be constructed so the insulation achieves its full insulation thickness over the plate lines of exterior walls, U-factors from the *Raised Truss* column may be used and this should be noted on the worksheet. Otherwise, U-factors from the *Standard Truss* column must be used.

Enter the net ceiling area (ft^2) of each component in the *Area* column. The net ceiling area includes the following:

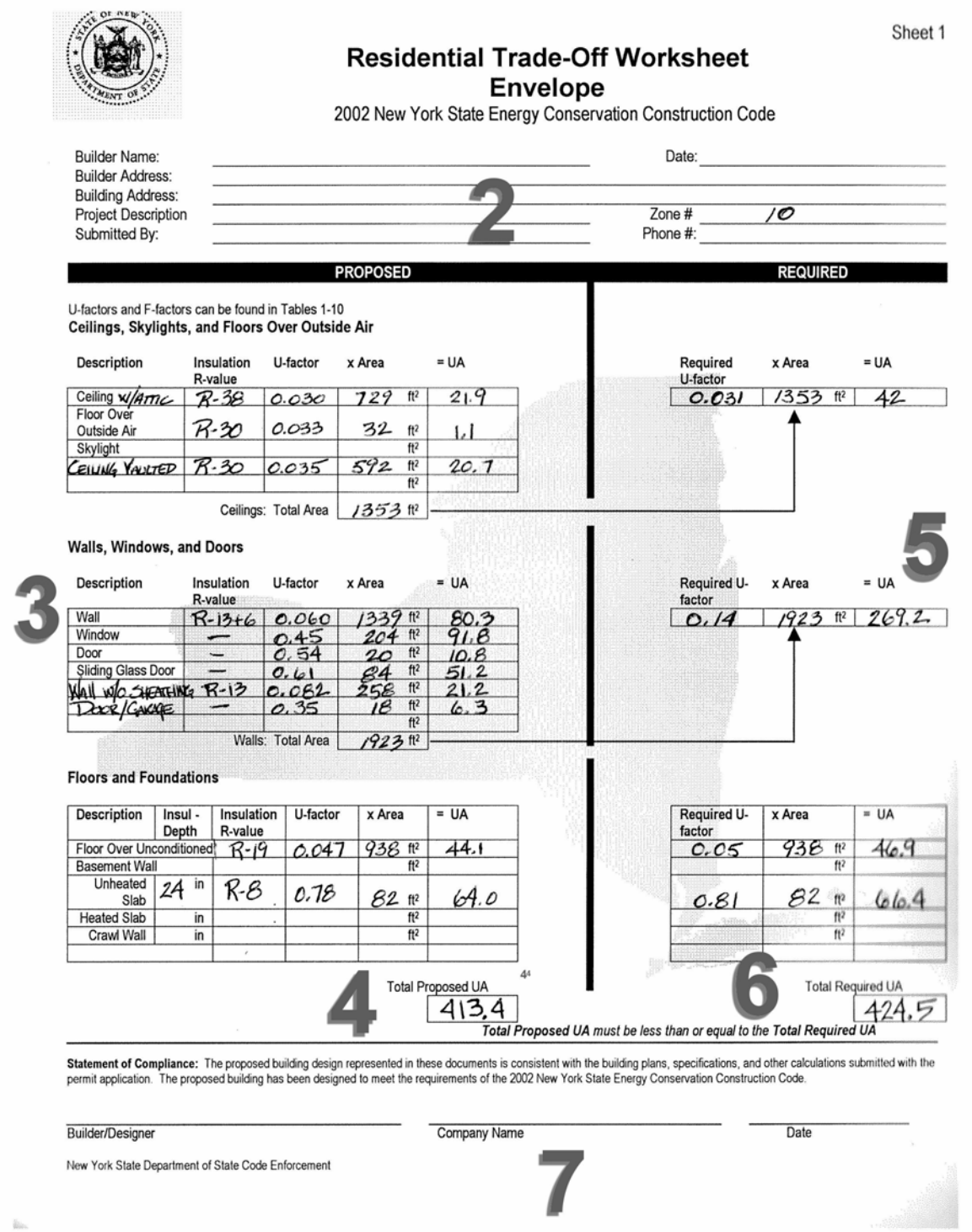
- flat and cathedral ceilings (excluding skylights)
- dormer roofs
- bay window roofs.

Ceiling area should be measured on the slope of the finished interior surfaces. All ceiling components with the same U-factor can be entered on the worksheet as a single component along with their combined area.

Floors Over Outside Air Enter the R-value of the cavity insulation to be installed in each floor over outside air component in the *Insulation R-Value* column. Based on the insulation R-value of the floor component, find the corresponding U-factor from Table 5 and enter it in the *Proposed U-Factor* column.

Floors over outside air include the following:

- floor cantilevers
- floors of an elevated building
- floors of overhangs (such as the floor above a recessed entryway or open carport).



Sheet 1

Residential Trade-Off Worksheet
Envelope
2002 New York State Energy Conservation Construction Code

Builder Name: _____ Date: _____
Builder Address: _____
Building Address: _____
Project Description _____ Zone # 10
Submitted By: _____ Phone #: _____

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PROPOSED	REQUIRED

U-factors and F-factors can be found in Tables 1-10
Ceilings, Skylights, and Floors Over Outside Air

Description	Insulation R-value	U-factor	x Area	= UA
Ceiling w/attic	R-38	0.030	729 ft²	21.9
Floor Over Outside Air	R-30	0.033	32 ft²	1.1
Skylight			ft²	
Ceiling Vaulted	R-30	0.035	592 ft²	20.7
			ft²	
		Ceilings: Total Area	1353 ft²	

Required U-factor	x Area	= UA
0.031	1353 ft²	42

Walls, Windows, and Doors

3

Description	Insulation R-value	U-factor	x Area	= UA
Wall	R-13+6	0.060	1339 ft²	80.3
Window	—	0.45	204 ft²	91.8
Door	—	0.54	20 ft²	10.8
Sliding Glass Door	—	0.61	84 ft²	51.2
Wall w/o Sheathing	R-13	0.082	258 ft²	21.2
Door/Garage	—	0.35	18 ft²	6.3
			ft²	
		Walls: Total Area	1923 ft²	

5

Required U-factor	x Area	= UA
0.14	1923 ft²	269.2

Floors and Foundations

Description	Insul - Depth	Insulation R-value	U-factor	x Area	= UA
Floor Over Unconditioned		R-19	0.047	938 ft²	44.1
Basement Wall				ft²	
Unheated Slab	24 in	R-8	0.78	82 ft²	64.0
Heated Slab	in			ft²	
Crawl Wall	in			ft²	

Required U-factor	x Area	= UA
0.05	938 ft²	46.9
	ft²	
0.81	82 ft²	66.4
	ft²	
	ft²	

4

Total Proposed UA: 413.4

6

Total Required UA: 424.5

Total Proposed UA must be less than or equal to the Total Required UA

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the requirements of the 2002 New York State Energy Conservation Construction Code.

Builder/Designer _____ Company Name _____ Date _____

New York State Department of State Code Enforcement

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Skylights Enter the proposed U-factor of the skylight in the *U-Factor* column. U-factors for skylights must be tested and documented by the manufacturer in accordance with the NFRC test procedure or taken from Table 9(a).

Enter the area (ft^2), as measured on the roof slope, of the skylight assembly (including frames and elevated curbs) in the *Area* column.

Additional Components Use the blank lines for additional entries if required. For example, if you have two different skylight types with different U-factors, enter each type on a separate line. You can modify or write in descriptions to better fit your proposed building.

Sum the areas of all ceiling, floor over outside air, and skylight components and enter this sum in the space labeled *Ceilings: Total Area*.

Walls, Windows, and Doors

Walls Enter the R-value of the insulation to be installed in each wall component in the *Insulation R-Value* column. R-values for walls represent the sum of the wall cavity insulation plus insulating sheathing (if used). For example, R-13 cavity insulation plus R-6 sheathing is considered R-19 wall insulation. However, the use of insulating sheathing should be specifically indicated on the worksheet. For example, if R-13 batt insulation is to be used with R-6 insulating sheathing, enter "R-13 + R-6" in the *Insulation R-Value* column.

Based on the insulation R-value of the wall component and the type of construction, find the corresponding proposed U-factor for each component in Tables 2, 3 or 4 and enter it in the U-factor column. For above-grade concrete and masonry walls, use the *16 in. O.C. Wall U-Factor* column of Table 2.

Enter the net area (ft^2) of each wall component in the *Area* column. The net wall area includes the following:

- the opaque area of all above-grade walls enclosing conditioned spaces (excluding doors and windows)
- the area of the band joist and subfloor between floors
- the opaque wall area of conditioned basements with an average depth less than 50% below grade (excluding basement doors and windows but including the below-grade portion of the wall). For further clarification, refer to the basement wall examples given later in this chapter.

The net areas of all wall components with the same U-factor may be combined and entered as a single component on the worksheet.

Glazing Enter the proposed U-factors of glazing assemblies (such as windows and sliding glass doors) in the *U-Factor* column. U-factors for skylights should be tested and documented by the manufacturer in accordance with the NFRC test procedure or taken from Tables 9(a). Center-of-glass U-factors cannot be used.

In the *Area* column, enter the total area (ft^2) of all glazing assemblies located in the building envelope. The area of a glazing assembly is the interior surface area of the entire assembly, including glazing, sash, curbing, and other framing elements. The nominal area or rough opening is also acceptable for flat windows. The area of windows in the exterior walls of conditioned basements should be included (windows in unconditioned basements are *NOT* included). Do not include the area of skylights; skylights are entered in the *Ceilings, Skylights, and Floors Over Outside Air* section of the worksheet.

Doors In the *U-Factor* column, enter the proposed U-factors for all doors in the building envelope. U-factors for doors must be tested and documented by the manufacturer in accordance with the NFRC test procedure or taken from Table 10.

If an opaque door with glazing is rated with an aggregate R-value (an R-value that includes both the glass and opaque area), the following equation applies:

$$\text{U - Factor} = \frac{1}{\text{R - Value}}$$

If a door contains glass and an aggregate R-value or U-factor rating for that door is not available, include the glass area of the door with your glazing and use the opaque door R-value or U-factor to determine compliance of the door. The U-factors listed in Table 10 are only for doors without glass.

Enter the nominal area (ft^2) or rough opening area of all doors in the *Area* column. Include doors located in the walls of conditioned basements.

Additional Components Use the blank lines for additional entries if required. For example, if you have two different window types with different U-factors, enter each type on a separate line. You can modify or write in descriptions to better fit your proposed building.

Sum the areas of all wall components and enter this sum in the space labeled *Walls: Total Area*.

Floors and Foundations

Floors Floors over unconditioned spaces include floors over unconditioned crawl spaces, basements, and garages. Floors over outside air should be entered in the *Ceilings, Skylights, and Floors Over Outside Air* section. Enter the R-value of the insulation to be installed in each floor over unconditioned space component in the *Insulation R-Value* column. Enter the corresponding U-factor from Table 5 in the *U-Factor or F-Factor* column. Enter the floor area (ft^2) in the *Area or Perimeter* column.

Basement Walls Enter the R-value of the insulation to be installed in each basement wall component in the *Insulation R-Value* column. If you intend to install insulation on both the exterior and interior of the wall, enter the sum of both R-values. Enter the corresponding proposed U-factor from Table 6 in the *U-Factor or F-Factor* column. Basement walls must be insulated from the top of the basement wall to a depth specified in Fiqure 3a below ground level or to the basement floor, whichever is less. The RES*check* software enables you to trade off the basement wall insulation depth as well as the insulation R-value.

Enter the opaque wall area (ft^2) of the basement walls in the *Area or Perimeter* column. Include the entire opaque area of any individual wall with an average depth 50% or more below grade that encloses a conditioned space. The entire area of any basement wall less than 50% below grade is included with above-grade walls and is subject to the above-grade wall requirement. The following examples help to clarify the treatment of wood kneewalls, walk-out basements, and basement walls constructed from specialty foundation systems.

Example 1: Wood Kneewalls

Assume a basement is to be constructed in Zone 8 with 3-ft-high wood kneewalls built on a 5-ft-high concrete foundation. R-13 insulation will be installed in the wood kneewall cavities and R-5 rigid insulation will be installed on the concrete foundation walls. The wood kneewalls are completely above grade and fully insulated. The concrete foundation walls are 4 ft below grade and fully insulated.

FOUNDATION INSULATION DEPTH

HEATING DEGREE DAYS	DEPTH BELOW GRADE
Less Than or Equal to 5000	24"
5001 - 6000	24"
6001 - 7000	48"
7001 - 8000	48"
8001 - 9000	84"

Figure 3a. – Foundation Insulation Depth

Each basement wall (as measured from the top of the kneewalls to the basement floor) is at least 50% below grade. Therefore, both the masonry foundation walls and the wood kneewalls must be entered in the *Trade-Off Worksheet* as basement wall components under the *Floors and Foundations* section. Since the kneewalls will be insulated to a different level than the masonry foundation walls, you will need to enter the basement on two lines in the *Trade-Off Worksheet* (use the line labeled *Basement Wall* and use the blank line for the second entry). Refer to Table 6 for U-factors that correspond to both the masonry foundation wall insulated to R-5 (0.115) and the wood kneewalls insulated to R-13 (0.059). All proposed basement wall U-factors should be taken from Table 6, including wood-frame basement walls. Table 11 lists the basement U-factor requirement for Zone 8 as 0.09. This requirement applies to both the masonry and wood portions of the wall, and should be entered on the right side of the worksheet across from both basement wall entries.

Example 2: Walk-Out Basement

Assume an 8 ft basement is to be built in Zone 8 on a slope so that the front wall is 7 ft below grade and the rear wall is totally above grade. The ground level along both side walls is sloped so that approximately 50% of each wall is below grade. The rear basement wall will be wood-frame construction with R-19 insulation. The other three walls will be concrete with R-10 insulation. All four walls will be fully insulated.

Because the front and side walls are at least 50% below grade, they must be entered on the *Trade-Off Worksheet* as a basement wall component under the *Floors and Foundations* section. Refer to Table 6 for the basement U-factor that corresponds to R-10 insulation (0.072). The rear wall is not 50% below grade, however, and should be entered as an above-grade wall under the *Walls, Windows, and Doors* section. Refer to Table 2 for the U-factor that corresponds to a 16-in. o.c. above-grade wood-frame wall insulated to R-19 (0.060).

Note that the basement floor along the rear wall should be considered a slab-on-grade component. Slab insulation should be installed along the basement floor for the length of the rear wall. Refer to Table 7 for the F-factor corresponding to the R-value and depth of insulation that will be installed.

Example 3: Specialty Foundation Systems

Manufacturers of insulating foam concrete form systems and pre-manufactured concrete panels with integrated insulation generally supply R-value ratings for the entire wall, not

just the insulation. Where the R-value of the insulation alone is not known, the manufacturer overall wall R-value rating may be used in place of the insulation R-value. Refer to Table 6 for the U-factor corresponding to this R-value. For example, if the manufacturer reports an overall wall R-value of R-19, the corresponding U-factor from Table 6 is 0.043.

Slabs Enter the R-value of the slab insulation to be installed around the perimeter of each slab-on-grade component in the *Insulation R-Value* column. Enter the corresponding F-factor (slab-edge U-factors are sometimes referred to as F-factors) from Table 7 in the *U-Factor or F-Factor* column. Table 7 offers F-Factors for slab insulation depths of 24 in. or 48 in.

The slab description on the worksheet should indicate the proposed insulation depth (24 in. or 48 in.). The software approach enables you to select additional slab perimeter insulation depths. The slab description should also indicate whether or not the slab is heated. A heated slab is a slab with ducts or hydronic heating elements in or under the slab.

Slab insulation can be installed using any of several different configurations. Refer to the glossary definition of *Slab Insulation* for a description and illustration of acceptable configurations.

Enter the slab perimeter (ft) in the *Area or Perimeter* column of the worksheet.

Crawl Space Walls The crawl space wall R-value requirements are for walls of unventilated crawl spaces (i.e. not directly vented to the outside). Enter the R-value to be installed in each crawl space wall component in the *Insulation R-Value* column. Enter the corresponding proposed U-factor from Table 8 in the *U-Factor or F-Factor* column. The crawl space wall insulation must extend from the top of the wall to the inside finished grade or to at least 12 in. below the outside finished grade whichever is greater. If the distance from the outside finished grade to the top of the footing is less than 12 in., the insulation must extend a total vertical plus horizontal distance of 24 in. from the outside finished grade. Enter the total vertical plus horizontal distance of the insulation to be installed in the *Insulation Depth* column.

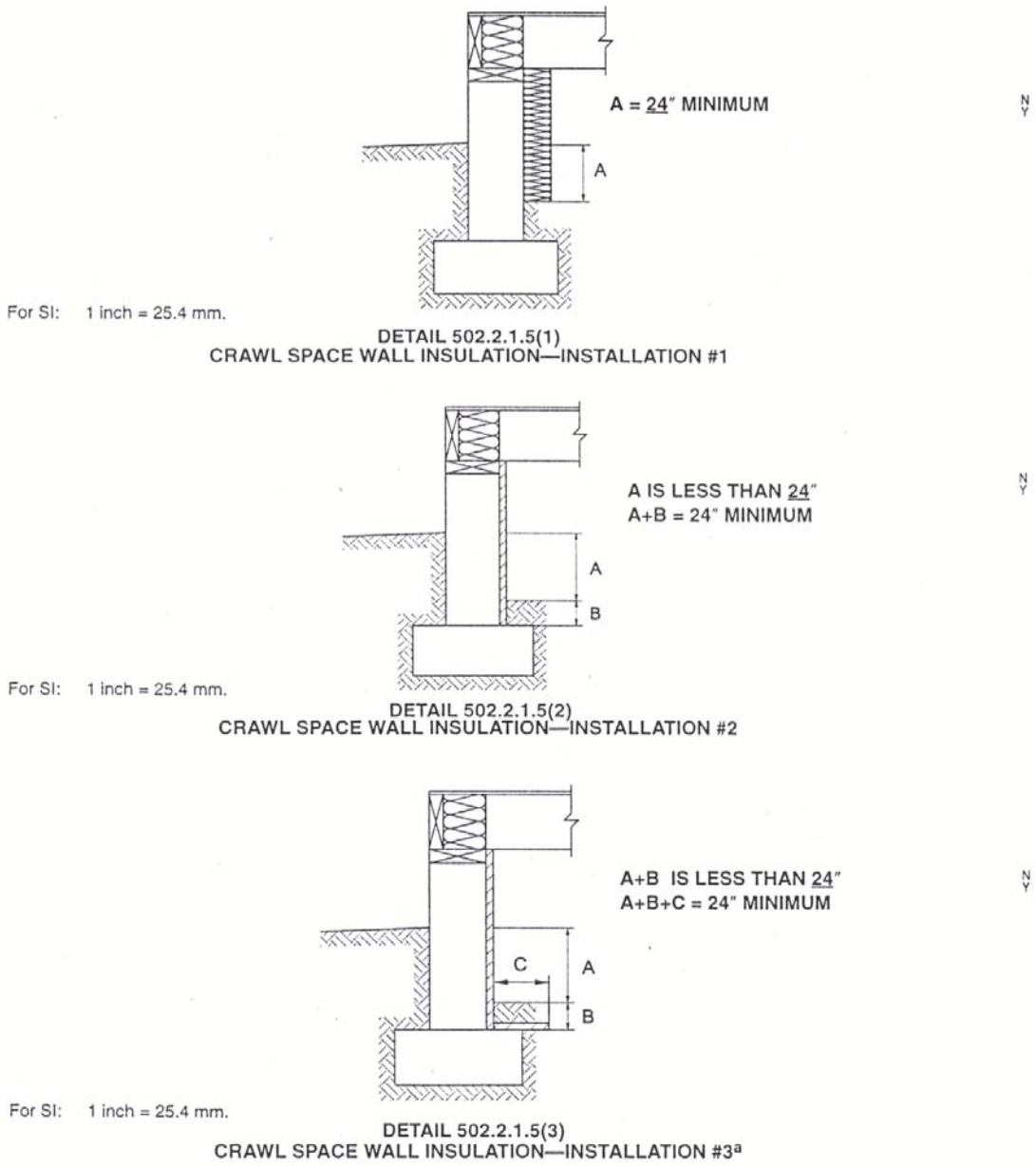

Figure 3. Crawl Space Wall Insulation Depth Requirements

Enter the opaque wall area (ft^2) of the crawl space walls in the *Area or Perimeter* column.

Step 4: Compute the Total Proposed UA

Multiply all proposed U-factors by their corresponding area; multiply all proposed slab F-factors by their corresponding perimeter. Enter the results in the *UA* column. Sum the proposed UAs on the left side of the worksheet and enter this sum in the *Total Proposed UA* box. This sum is the total UA of your proposed building.

Step 5: Complete the REQUIRED Section

Table 11 lists ceiling, wall, floor, basement wall, slab-edge, and crawl space wall U-factor and F-factor requirements for each climate zone (your climate zone number can be found in Appendix E of the RES*check Workbook* or on the state map included with the prescriptive packages). Enter the required U-factors and F-factors for your zone in the appropriate *Required U-Factor* column.

Copy the total ceiling and wall areas to the *Area* column on the right side of the worksheet. Copy the area or perimeter of all floor and foundation components to the corresponding box in the *Area or Perimeter* column on the right side of the worksheet.

Step 6: Compute the Total Required UA

Multiply U-factors in the *Required U-Factor* column by their corresponding area; multiply F-factors by their corresponding perimeter. Enter the results in the *UA* column. Sum the UAs on the right side of the worksheet. Record this sum in the *Total Required UA* box. This value is the total UA of the code building (a building with the same dimensions as your building but insulated to the minimum code requirements).

Step 7: Check for Compliance

If the *Total Proposed UA* (Step 4) is less than or equal to the *Total Required UA* (Step 6), then your building complies with the code insulation and window requirements. If not, you must adjust the insulation R-values, window or door U-factors, or areas in your proposed building. For example, increasing insulation R-values or reducing the glass area may bring the building design into compliance.

When you are satisfied that your building complies, sign and date the worksheet in the blanks provided. Transfer the proposed R-value and U-factor information from your worksheet to your building plans or specifications.

Quick Compliance

If your proposed ceiling, floor, basement wall, and crawl space wall U-factors and slab-edge F-factors are all less than or equal to the required U-factors and F-factors, no further calculations are required for ceilings and foundations. You do not need to calculate proposed or required building UAs or enter areas in the *Ceilings, Skylights, and Floors Over Outside Air* or *Floor and Foundations* sections. However, you will still need to demonstrate that your wall, window, and door components meet the code requirements by completing the *Walls, Windows, and Doors* section.

If your building meets the following criteria, you can use the Quick Compliance method to demonstrate that your building complies.

- There are no skylight components, and
- all ceiling U-factors are less than or equal to the ceiling U-factor requirement, and
- all floor, basement wall, and crawl space wall U-factors are less than or equal to their corresponding U-factor requirements, and
- all slab F-factors are less than or equal to the slab F-factor requirement, and
- the total proposed UA for the *Walls, Windows, and Doors* section is less than or equal to the required UA for the *Walls, Windows, and Doors* section.

Figure 4 shows a *Trade-Off Worksheet* filled out using the Quick Compliance method. All proposed ceiling, floor, and foundation components have U-factors and F-factors that are less than their corresponding required U-factors and F-factors. Therefore, areas and UA calculations are not required for these components. Note that the total proposed UA for the *Walls, Windows, and Doors* section (219.3) is less than the total required UA (309.7). Hence, the building complies.

Sheet 1

Residential Trade-Off Worksheet
Envelope
2002 New York State Energy Conservation Construction Code

Builder Name: IMPECCABLE CONSTRUCTION CO. Date: 2/15/2002
Builder Address: 2 COMPASSANT DR., SCHENECTADY, NY 12308
Building Address: 1 SOMEWHERE TR. ZONETEN, NY.
Project Description: ONE-FAMILY DWELLING Zone # 10
Submitted By: IAN B. SAVER Phone #:

PROPOSED | **REQUIRED**

U-factors and F-factors can be found in Tables 1-10

Ceilings, Skylights, and Floors Over Outside Air

Description	Insulation R-value	U-factor	x Area	= UA	Required U-factor	x Area	= UA
Ceiling	R-38	0.030	ft²		0.31	ft²	
Floor Over Outside Air			ft²				
Skylight			ft²				
			ft²				
			ft²				
Ceilings: Total Area			ft²				

Walls, Windows, and Doors

Description	Insulation R-value	U-factor	x Area	= UA	Required U-factor	x Area	= UA
Wall	R-19	0.060	1960 ft²	117.6	0.14	2212 ft²	309.7
Window		0.40	214 ft²	85.6			
Door		0.37	18 ft²	6.7			
Sliding Glass Door			ft²				
DOOR/ENTRY		0.47	20 ft²	9.4			
			ft²				
			ft²				
Walls: Total Area			2212 ft²				

Floors and Foundations

Description	Insul - Depth	Insulation R-value	U-factor	x Area	= UA	Required U-factor	x Area	= UA
Floor Over Unconditioned		R-19	0.047	ft²			ft²	
Basement Wall		R-9	0.077	ft²			ft²	
Unheated Slab	in	.		ft²			ft²	
Heated Slab	in	.		ft²			ft²	
Crawl Wall	in			ft²			ft²	

Total Proposed UA: 219.3

Total Required UA: 309.7

Total Proposed UA** must be less than or equal to the **Total Required UA

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the requirements of the 2002 New York State Energy Conservation Construction Code.

I. B. SAVER — Builder/Designer
IMPECCABLE CONSTRUCTION CO. — Company Name
2/16/2002 — Date

New York State Department of State Code Enforcement

Figure 4. Trade-Off Worksheet Using Quick Compliance

Table 1. Ceiling U-Factors[(a)]

Insulation R-Value[(a)]	Standard Truss U-Factor	Raised Truss U-Factor[(b)]	Insulation R-Value[(a)]	Standard Truss U-Factor	Raised Truss U-Factor[(b)]
R-0	0.568	0.568	R-33	0.033	0.029
R-7	0.119	0.119	R-34	0.032	0.028
R-8	0.108	0.108	R-35	0.032	0.028
R-9	0.098	0.098	R-36	0.031	0.027
R-10	0.089	0.089	R-37	0.031	0.026
R-11	0.082	0.082	R-38	0.030	0.025
R-12	0.076	0.076	R-39	0.030	0.025
R-13	0.070	0.070	R-40	0.029	0.024
R-14	0.066	0.066	R-41	0.029	0.024
R-15	0.062	0.061	R-42	0.028	0.023
R-16	0.059	0.058	R-43	0.028	0.023
R-17	0.056	0.055	R-44	0.027	0.022
R-18	0.053	0.052	R-45	0.027	0.022
R-19	0.051	0.049	R-46	0.027	0.021
R-20	0.048	0.047	R-47	0.026	0.021
R-21	0.047	0.045	R-48	0.026	0.020
R-22	0.045	0.043	R-49	0.026	0.020
R-23	0.043	0.041	R-50	0.026	0.020
R-24	0.042	0.040	R-51	0.025	0.019
R-25	0.040	0.038	R-52	0.025	0.019
R-26	0.039	0.037	R-53	0.025	0.019
R-27	0.038	0.035	R-54	0.025	0.018
R-28	0.037	0.034	R-55	0.024	0.018
R-29	0.036	0.033	R-56	0.024	0.018
R-30	0.035	0.032	R-57	0.024	0.018
R-31	0.034	0.031	R-58	0.024	0.017
R-32	0.034	0.030	R-59	0.024	0.017

a. R-values represent the sum of the ceiling cavity insulation plus the R-value of insulating sheathing (if used). For example, R-19 cavity insulation plus R-2 sheathing is reported as R-21 ceiling insulation. For ventilated ceilings, insulating sheathing must be placed between the conditioned space and the ventilated portion of the roof (typically applied to the trusses or rafters immediately behind the drywall or other ceiling finish material).

b. To receive credit for a raised truss, the insulation must achieve its full thickness over the plate lines of exterior walls.

Table 2. Wood-Frame Wall U-Factors [a, b]

Insulation R-Value [c]	16-in. O.C. Wall U-Factor	24-in. O.C. Wall U-Factor
R-0	0.238	0.241
R-7	0.105	0.104
R-8	0.099	0.097
R-9	0.094	0.092
R-10	0.090	0.088
R-11	0.089	0.087
R-12	0.085	0.083
R-13	0.082	0.080
R-14	0.079	0.077
R-15	0.077	0.074
R-16	0.066	0.064
R-17	0.064	0.062
R-18	0.062	0.060
R-19	0.060	0.059
R-20	0.059	0.057
R-21	0.057	0.056
R-22	0.056	0.054
R-23	0.055	0.053
R-24	0.054	0.052
R-25	0.053	0.051
R-26	0.052	0.050
R-27	0.051	0.049
R-28	0.050	0.048

a. U-factors are for uncompressed insulation.

b. U-factors in this table were developed for wood-frame walls, but the *16-in. O.C. Wall U-Factor* column can also be used for above-grade concrete, masonry, and log walls.

c. Wall R-values are the sum of the cavity insulation plus insulating sheathing (if used).

Table 3. 16-in. O.C. Steel-Frame Wall U-Factors

Cavity R-Value	Insulating Sheathing R-Value										
	R-0	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10
R-0	0.270	0.258	0.205	0.170	0.146	0.127	0.113	0.101	0.092	0.084	0.078
R-11	0.120	0.118	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057
R-13	0.114	0.111	0.100	0.091	0.084	0.077	0.072	0.067	0.063	0.059	0.056
R-15	0.109	0.107	0.096	0.088	0.081	0.075	0.070	0.065	0.061	0.058	0.054
R-19	0.101	0.099	0.090	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052
R-21	0.098	0.096	0.088	0.081	0.075	0.070	0.065	0.061	0.058	0.054	0.052
R-25	0.094	0.093	0.085	0.078	0.073	0.068	0.063	0.060	0.056	0.053	0.051

Table 4. 24-in. O.C. Steel-Frame Wall U-Factors

Cavity R-Value	Insulating Sheathing R-Value										
	R-0	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10
R-0	0.270	0.258	0.205	0.170	0.146	0.127	0.113	0.101	0.092	0.084	0.078
R-11	0.106	0.104	0.095	0.086	0.080	0.074	0.069	0.064	0.060	0.057	0.054
R-13	0.100	0.098	0.090	0.082	0.076	0.071	0.066	0.062	0.058	0.055	0.052
R-15	0.094	0.093	0.085	0.078	0.073	0.068	0.063	0.060	0.056	0.053	0.051
R-19	0.088	0.086	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049
R-21	0.085	0.084	0.077	0.072	0.067	0.063	0.059	0.056	0.053	0.050	0.048
R-25	0.081	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.046

Table 5. Floor U-Factors

Insulation R-Value	Floor U-Factor
R-0	0.249
R-7	0.096
R-11	0.072
R-13	0.064
R-15	0.057
R-19	0.047
R-21	0.044
R-26	0.037
R-30	0.033

Table 6. Basement U-Factors[(a)]

Insulation R-Value	Basement Wall U-Factor	Insulation R-Value	Basement Wall U-Factor
R-0	0.360	R-10	0.072
R-1	0.244	R-11	0.067
R-2	0.188	R-12	0.062
R-3	0.155	R-13	0.059
R-4	0.132	R-14	0.055
R-5	0.115	R-15	0.052
R-6	0.102	R-16	0.050
R-7	0.092	R-17	0.047
R-8	0.084	R-18	0.045
R-9	0.077	R-19	0.043
		R-20	0.041

a. Insulation R-values represent the sum of exterior and/or interior insulation. Basement walls must be insulated from the top of the basement wall to 10 ft below ground level or to the floor of the basement, whichever is less.

Table 7. Slab F-Factors

Perimeter Insulation R-Value	Slab F-Factor	
	2-ft Insulation Depth	4-ft Insulation Depth
R-0	1.04	1.04
R-1	0.91	0.89
R-2	0.86	0.83
R-3	0.83	0.79
R-4	0.82	0.76
R-5	0.80	0.74
R-6	0.79	0.73
R-7	0.79	0.71
R-8	0.78	0.70
R-9	0.77	0.69
R-10	0.77	0.68
R-11		0.68
R-12		0.67
R-13		0.66
R-14		0.66
R-15		0.65
R-16		0.65
R-17		0.65
R-18		0.64
R-19		0.64
R-20		0.64

Table 8. Crawl Space Wall U-Factors

Insulation R-Value	Crawl Space Wall U-Factor
R-0	0.477
R-1	0.313
R-2	0.235
R-3	0.189
R-4	0.158
R-5	0.136
R-6	0.120
R-7	0.107
R-8	0.096
R-9	0.088
R-10	0.081
R-11	0.075
R-12	0.069
R-13	0.065
R-14	0.061
R-15	0.057
R-16	0.054
R-17	0.051
R-18	0.049
R-19	0.047
R-20	0.045

Table 9a. U-Factors for Windows, Glazed Doors, and Skylights[(a)]

Frame Material and Product Type[(a)]	Single Glazed	Double Glazed
Metal Without Thermal Break		
Operable (including sliding and swinging glass doors)	1.27	0.87
Fixed	1.13	0.69
Garden window	2.60	1.81
Curtain wall	1.22	0.79
Skylight	1.98	1.31
Site-assembled sloped/ overhead glazing	1.36	0.82
Metal With Thermal Break		
Operable (including sliding and swinging glass doors)	1.08	0.65
Fixed	1.07	0.63
Curtain wall	1.11	0.68
Skylight	1.89	1.11
Site-assembled sloped/ overhead glazing	1.25	0.70
Reinforced Vinyl/Metal-Clad Wood		
Operable (including sliding and swinging glass doors)	0.90	0.57
Fixed	0.98	0.56
Skylight	1.75	1.05
Wood/Vinyl/Fiberglass		
Operable (including sliding and swinging glass doors)	0.89	0.55
Fixed	0.98	0.56
Garden window	2.31	1.61
Skylight	1.47	0.84
Glass Block Assemblies	0.60	

a. The U-factors in these tables can be used in the absence of test U-factors. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U-factor.

Table 9b. SHGC Values for Windows, Glazed Doors, and Skylights[a]

Product Description	Single Glazed				Double Glazed			
	Clear	Bronze	Green	Gray	Clear + Clear	Bronze + Clear	Green + Clear	Gray + Clear
Metal frames								
Operable	0.75	0.64	0.62	0.61	0.66	0.55	0.53	0.52
Fixed	0.78	0.67	0.65	0.64	0.68	0.57	0.55	0.54
Nonmetal frames								
Operable								
Fixed	0.63	0.54	0.53	0.52	0.55	0.46	0.45	0.44
	0.75	0.64	0.62	0.61	0.66	0.54	0.53	0.52

a. SHGC values may be adjusted to reflect the effects of any permanent exterior solar shading devices, such as shade screens.

Table 10. U-Factor Table for Non-Glazed Doors[a]

Steel Doors		
Without Foam Core	0.60	
With Foam Core	0.35	
Wood Doors	**Without Storm**	**With Storm**
Panel With 7/16-in. Panels	0.54	0.36
Hollow Core Flush	0.46	0.32
Panel With 1 1/8-in. Panels	0.39	0.28
Solid Core Flush	0.40	0.26

a. The U-factors in these tables can be used in the absence of test U-factors. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U-factor.

Table 11. U-Factor and F-Factor Requirements by Climate Zone

Climate Zone	Ceiling U-Factor	Single-Family Wall U-Factor	Multi-Family Wall U-Factor	Floor U-Factor	Basement Wall U-Factor	Unheated Slab U-Factor	Heated Slab U-Factor	Crawl Space Wall U-Factor
1	0.047	0.25	0.38	0.08	0.360	1.04	1.04	0.477
2	0.044	0.23	0.35	0.08	0.360	1.04	0.79	0.137
3	0.042	0.21	0.31	0.07	0.360	1.04	0.79	0.137
4	0.039	0.20	0.28	0.07	0.121	1.04	0.79	0.137
5	0.036	0.18	0.25	0.07	0.113	1.04	0.79	0.124
6	0.036	0.17	0.22	0.05	0.106	0.82	0.79	0.111
7	0.036	0.16	0.22	0.05	0.098	0.82	0.79	0.098
8	0.036	0.16	0.22	0.05	0.090	0.82	0.79	0.085
9	0.033	0.15	0.22	0.05	0.082	0.82	0.79	0.071
10	0.031	0.14	0.22	0.05	0.081	0.81	0.79	0.058
11	0.028	0.13	0.22	0.05	0.080	0.81	0.79	0.058
12	0.026	0.13	0.22	0.05	0.079	0.80	0.79	0.058
13	0.026	0.12	0.20	0.05	0.078	0.74	0.71	0.058
14	0.026	0.11	0.18	0.05	0.077	0.73	0.70	0.058
15	0.026	0.11	0.15	0.05	0.075	0.72	0.69	0.058
16	0.026	0.11	0.15	0.05	0.052	0.71	0.69	0.058
17	0.026	0.11	0.12	0.05	0.052	0.69	0.67	0.058
18	0.026	0.10	0.12	0.05	0.052	0.68	0.66	0.058
19	0.025	0.10	0.12	0.04	0.052	0.66	0.65	0.058

Compliance Example

Assume that you plan to build the house shown in Figure 5 on a lot located in Kings County and is designated as Zone 10.

Table 12 lists the components that make up the building envelope, the areas of each of these components, and the proposed insulation R-values and window and door U-factors. Figure 6 shows how to determine proposed and required U-factors using Tables 1 through 11. The completed *Trade-Off Worksheet* is shown in Figure 7.

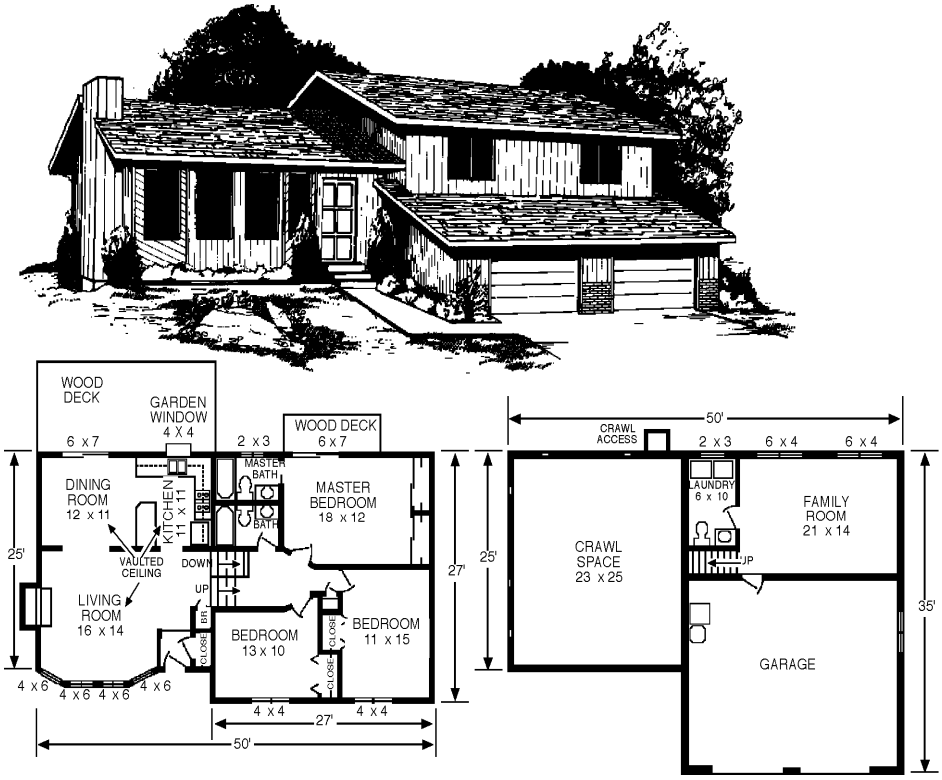

Figure 5. Example House

Table 12. Example House Specifications

Building Component	Area	Insulation Level
Ceilings		
With Attic (Std. Truss)	729 ft^2	R-38
Vaulted	592 ft^2	R-30
Walls (2x4 @ 16-in. O.C.)		
Without Sheathing(a)	276 ft^2 (gross) 258 ft^2 (net)	R-13
With Sheathing	1647 ft^2 (gross) 1339 ft^2 (net)	R-19 (R-13 cavity + R-6 sheathing)
Windows	204 ft^2	U-0.45
Sliding Glass Doors	84 ft^2	U-0.61
Doors		
Entrance	20 ft^2	U-0.54
Garage to Family Room	18 ft^2	U-0.35
Floors		
Over Garage	363 ft^2	R-19
Over Crawl Space	575 ft^2	R-19
Slab (Unheated)	82 ft^2 (perimeter)	R-8 (2-ft depth)
Bay Window Floor	32 ft^2	R-30
(a) Walls without sheathing are located between the family room and the garage, the laundry room and the crawl space, and the garage and the living room.		

Determine Which Components Are Part of the Building Envelope

Only the building components that are part of the building envelope are entered on the *Trade-Off Worksheet*. Building envelope components are those that separate conditioned spaces (heated or cooled rooms) from unconditioned spaces (rooms that are not heated or cooled) or from outside air. Walls, floors, and other building components separating two conditioned spaces are *NOT* part of the building envelope.

Walls In this example, the garage is unconditioned, so the exterior garage walls are not part of the building envelope. The wall between the conditioned family room and the unconditioned garage is part of the building envelope. Likewise, the wall between the garage and the living room is part of the building envelope.

Part of the laundry room wall separates the laundry room from the crawl space and the other part separates the laundry room from the kitchen. The portion adjacent to the crawl space is part of the building envelope because it separates the conditioned laundry from the unconditioned crawl space. The portion adjacent to the kitchen can be ignored. The wall between the portion adjacent to the kitchen can also be ignored. Likewise, the wall between the upstairs bathroom and the kitchen and the wall between the center bedroom and the living room are not part of the building envelope. Portions of both of these walls are also adjacent to outside air, and those portions are part of the building envelope. Table 13 lists the walls that are part of the building envelope and indicates whether sheathing is installed on them (which is relevant when determining the R-value of the wall).

Table 13. Walls Comprising the Building Envelope

Wall	Sheathing?	Gross Area	Net Area[(a)]
All walls between interior conditioned space and outside air	Yes	1647	1339
The wall between the family room and the garage	No	192	174
The wall between the garage and the living room	No	44	44
The wall between the laundry and the crawl space	No	40	40
(a) Net area does not include doors and windows.			

Floors The example house has a conditioned floor area of 1714 ft^2, but 378 ft^2 of the floor area is located over the family room and is not part of the building envelope (both the family room and the rooms above it are conditioned). The living room, dining room, and kitchen are over unheated crawl space. The family room and garage both have slab-on-grade floors. The floor of the bay window is a floor over outside air which is subject to the ceiling requirement rather than the requirement for floors over conditioned space.

Glazing and Doors There are two sliding glass doors in the building envelope – one leading from the dining room to the larger deck and one leading from the master bedroom to the smaller deck. There are two opaque doors in the building envelope – the front entry door and the door leading from the garage into the family room.

Complete the PROPOSED Section

Areas and proposed R-values for the example house are given in Table 12. Refer to the example Trade-Off Worksheet illustrated in Figure 7 when reading the following sections.

Ceilings, Skylights, and Floors Over Outside Air

The ceiling over the dining room, living room, and kitchen is vaulted – the rest is a flat ceiling under an attic space. Enter R-38 as the proposed insulation R-value for the portion of the ceiling with an attic. Use the blank space to create a second ceiling component for the vaulted ceiling and enter R-30 as the proposed insulation R-value for the vaulted ceiling. The floor of the bay window is a floor over outside air component. Enter R-30 as the proposed insulation R-value for the *Floor Over Outside Air* component.

Refer to Table 1 for the U-factors corresponding to your proposed ceiling R-values. Table 1 lists R-value to U-factor conversions for ceilings with standard and raised trusses. You are building a standard truss with R-38 insulation in the ceiling with an attic space, and R-30 insulation in the vaulted ceiling. R-38 insulation with a standard truss corresponds to a U-factor of 0.030. R-30 insulation corresponds to a U-factor of 0.035. Enter 0.030 in the *U-Factor* column for the *Ceiling w/Attic* component and enter 0.035 in the *U-Factor* column for the *Ceiling, Vaulted* component.

Table 5 lists the U-factor for floors having R-30 insulation as 0.033. Enter 0.033 in the *U-Factor* column for the *Floors Over Outside Air* component.

In the *Area* column, enter 729 ft^2 for the ceiling with attic, 592 ft^2 for the vaulted ceiling, and 32 ft^2 for the bay window floor. Sum the areas of all ceiling components and enter this sum (1353 ft^2) in the space labeled *Ceilings: Total Area*.

There are no skylights in the example house, so the space for skylight components may be left blank.

Walls, Windows, and Doors

All walls that make up the building envelope will have R-13 cavity insulation, but not all of these walls will have R-6 exterior sheathing (see Table 13). Therefore, you must enter two wall components on the *Trade-Off Worksheet*. Enter R-13 + R-6 (R-13 cavity insulation plus R-6 sheathing) as the proposed insulation R-value for the walls with sheathing and R-13 as the proposed insulation R-value for the walls without sheathing. Use a blank line to record the second component. The example worksheet in Figure 7 illustrates how these two wall components are labeled.

Refer to Table 2 and the *16-in. O.C. Wall U-Factor* column for the U-factors that correspond to the proposed R-values. The walls with sheathing have an effective R-value of R-19, which corresponds to a U-factor of 0.060. The walls without sheathing have an R-value of R-13, which corresponds to a U-factor of 0.082. Enter 0.060 in the *U-Factor* column for the *Wall w/Sheathing* component and enter 0.082 in the *U-Factor* column for the *Wall w/o Sheathing* component.

Enter the net opaque wall area for each wall component in the *Area* column. The net wall area for each component will be equal to the gross wall area minus openings for windows, doors, sliding glass doors, etc. In this example, the only opening in the walls without sheathing is the door from the garage to the living room. The entry door, the windows, and the sliding glass doors are all subtracted from the gross area of the walls with sheathing.

Net Wall Area (with sheathing) = 1647 – 204 – 84 – 20 = 1339

Net Wall Are (without sheathing) = 276 – 18 = 258

Enter 1339 ft^2 for the wall with sheathing and 258 ft^2 for the wall without sheathing.

The windows and sliding glass doors have been rated and labeled by the manufacturer in accordance with the NFRC test procedure. The windows have a U-factor of 0.45 and the sliding glass doors have a U-factor of 0.61. Enter the window and sliding glass door areas and their corresponding U-factors.

Neither of the doors (entrance and garage) have tested U-factors, so use Table 10 to determine their default U-factors. The entry door is an opaque wood panel door with 7/16-in. panels and no storm door, corresponding to a U-factor of 0.54. The door from the garage to the family room is a metal door with foam core, corresponding to a U-factor

of 0.35. Because the doors have different U-factors, each must be entered on a separate line on the *Trade-Off Worksheet*. Enter the door areas and their corresponding U-factors.

Sum the areas of all wall components (including the windows and doors) and enter this sum (1923 ft^2) in the space labeled *Walls: Total Area*.

Floors and Foundations

Two floor and foundation components must be considered. The floor over the garage and the floor over the crawl space are floors over unconditioned spaces. R-19 insulation will be installed in both. Therefore, these floor components can be combined. The slab floor, however, must be considered separately. Enter R-19 as the proposed insulation R-value for the floors over conditioned spaces and R-8 as the proposed insulation R-value for the slab perimeter.

Refer to Table 5 for the floor U-factor corresponding to your proposed floor R-value. A floor R-value of R-19 corresponds to a U-factor of 0.047. Refer to Table 7 for the slab F-factor corresponding to your proposed slab R-value. Note that Table 7 lists R-value to F-factor conversions for insulation installed to either 24 in. or 48 in. The slab perimeter insulation will be installed to 24 in. A slab R-value of R-8 corresponds to an F-factor of 0.78 under the *24-in. Insulation Depth* column.

In the *Area or Perimeter* column, enter 938 ft^2 as the combined area of the two floor components over unconditioned space and 82 ft for the slab perimeter. Note that slab components require a perimeter -- not an area.

Compute the Total Proposed UA

For each building component, multiply the proposed U-factor or F-factor by its corresponding area or perimeter and enter the result in the proposed *UA* column. For example, the *Ceiling w/Attic* component has a U-factor of 0.030 and an area of 729 ft^2, resulting in a UA of 21.9.

Ceiling w/Attic UA = 0.030 x 729 = 21.9

Sum the UAs on the left side of the worksheet and enter this sum (413.4) in the space labeled *Total Proposed UA*.

Check for Compliance

The sum in the *Total Proposed UA* box (413.4) is less than the sum in the *Total Required UA* box (470.5), indicating that your building complies with the code insulation and window requirements (congratulations!). Sign and date the worksheet.

Residential Trade-Off Worksheet
Envelope

2002 New York State Energy Conservation Construction Code

Builder Name: IMPECCABLE CONSTRUCTION CO. Date: 2/15/02
Builder Address: 2 COMPLIASANT RD., SCHENECTADY, N.Y. 12308
Building Address: 1 SOMEWHERE DR. ZONETEN, N.Y.
Project Description: ONE-FAMILY DWELLING Zone # 10
Submitted By: IAN D. SAVER Phone #:

PROPOSED | **REQUIRED**

U-factors and F-factors can be found in Tables 1-10

Ceilings, Skylights, and Floors Over Outside Air

Description	Insulation R-value	U-factor	x Area	= UA
Ceiling w/Attic	R-38	0.030	729 ft²	21.9
Floor Over Outside Air	R-30	0.033	32 ft²	1.1
Skylight			ft²	
Ceiling Vaulted	R-30	0.035	592 ft²	20.7
			ft²	
Ceilings: Total Area			1353 ft²	

Required U-factor	x Area	= UA
0.031	1353 ft²	42

Walls, Windows, and Doors

Description	Insulation R-value	U-factor	x Area	= UA
Wall	R-13+6	0.060	1339 ft²	80.3
Window	—	0.45	204 ft²	91.8
Door	—	0.54	20 ft²	10.8
Sliding Glass Door	—	0.61	84 ft²	51.2
Wall w/o Sheathing	R-13	0.082	258 ft²	21.2
Door/Garage	—	0.35	18 ft²	6.3
			ft²	
Walls: Total Area			1923 ft²	

Required U-factor	x Area	= UA
0.14	1923 ft²	269.2

Floors and Foundations

Description	Insul - Depth	Insulation R-value	U-factor	x Area	= UA
Floor Over Unconditioned		R-19	0.047	938 ft²	44.1
Basement Wall				ft²	
Unheated Slab	24 in	R-8	0.78	82 ft²	64.0
Heated Slab	in			ft²	
Crawl Wall	in			ft²	

Required U-factor	x Area	= UA
0.05	938 ft²	46.9
	ft²	
0.81	82 ft²	66.4
	ft²	
	ft²	

Total Proposed UA: 413.4

Total Required UA: 424.5

Total Proposed UA** must be less than or equal to the **Total Required UA

Statement of Compliance: The proposed building design represented in these documents is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the requirements of the 2002 New York State Energy Conservation Construction Code.

IAN D. SAVER — Builder/Designer

IMPECCABLE CONSTRUCTION CO. — Company Name

2/16/2002 — Date

New York State Department of State Code Enforcement

Figure 7. Completed Trade-off Worksheet