CHAPTER 5

Special Cases

OVERHANGS

To be treated as an overhang, slotted and louvered shading devices must have the slats arranged so that no direct solar radiation penetrates the overhang at any time during the cooling season.

If a window shading device is adjustable, such as Bahama shutters, the overhang ratio must be overhang is at its most extended level. See Figure 15.

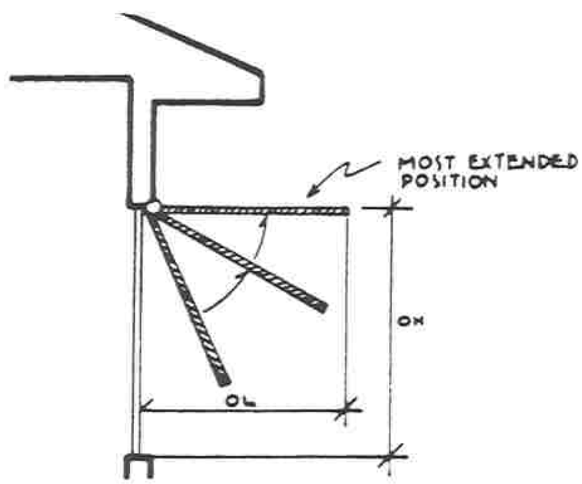


Figure 15: *Overhang Measurements for Adjustable Shading Devices*

If part of the window is higher than the bottom of the overhang at the required extension, the window should be divided into two parts for calculation purposes. The square footage of the glass that is higher than the bottom of the overhang may use the Method A multiplier for an overhang ratio of 2.74 or overhang length of 20 feet. The overhang ratio for the remaining glass (lower than the bottom of the overhang) should be calculated by the same procedure as any other window. See Figure 16.

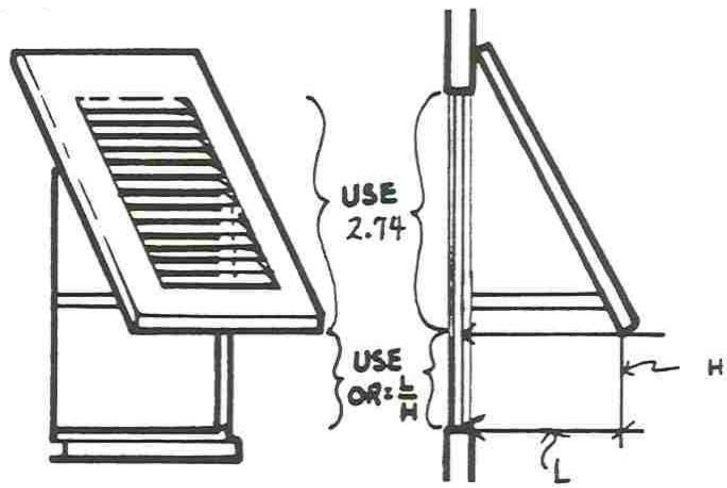


Figure 16: *Overhang Measurements for Shading Devices Lower than the Top of the Window*

NON-RECTANGULAR WALLS

If a house includes non-rectangular walls, such as walls in a room with a sloping ceiling, calculate the area as follows. Sketch the wall as shown in Figure 17 below.

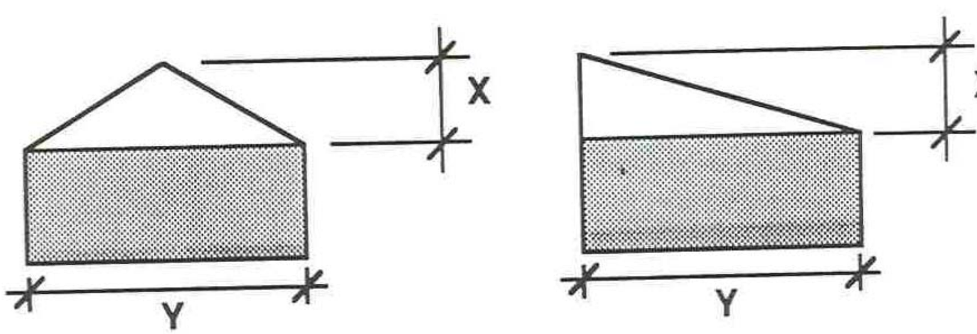


Figure 17. *Calculating the Area of Non-Rectangular Walls.*

Find the area of the shaded rectangular part of the wall (length times height). Then, find the area of the remainder of the wall, the triangular part, by multiplying the height (measurement X) by the base (measurement Y) and dividing by two (2).

This triangular part may be either:

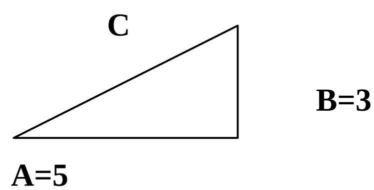
+ Part of a wall that divides the room from the outside, or
+ Part of a wall that divides the room from the attic.

If this triangle is part of an outside wall, add it to the shaded rectangular wall area just calculated. Include this area with other like wall areas in the wall area calculation.

If this triangular part of a wall separates the room from the attic, the triangular area should be treated as if it were a ceiling. Even though this space is vertical, like a wall, it is exposed to the same conditions (that is, a very hot attic in the summer) as the ceiling. As with the ceiling, the minimum insulation level used for such walls should be R-19. Add this area to other like R-value ceiling areas.

An equation you may find helpful when working with right triangles is $C^2 = A^2 + B^2$. A right triangle is one with a right (90 degree) angle. If you know the length of two sides of a right triangle, you can find the length of the third side by using this equation. "C" must be the length of the side opposite the right angle. An example is provides as follows:

$$\mathbf{C^2 = A^2 + B^2}$$
$$\mathbf{C^2 = 5^2 + 3^2}$$
$$\mathbf{C^2 = (5x5) + (3x3)}$$
$$\mathbf{C^2 = 25 + 9}$$
$$\mathbf{C^2 = 34}$$
C = 5.8 feet
C = 5 feet 10 inches



NOTE: Most calculators have a square root (√) function.

SLOPED CEILINGS

Typically, sloped ceilings are made up of one rectangular section, as shown in Figure 18-1 below, or two rectangular sections, as shown in Figure 18-2 and 18-3. Using the house plans, determine the length (line A-B) and width (line A-C) of each rectangular ceiling section. See the formula for calculating the sides of a right triangle above. The area of the sloped ceiling will be larger than the floor area of the room. Calculate the area by multiplying the length (measurement A-B) times the width (measurement A-C) for each ceiling section. Add this area to other like ceiling areas.

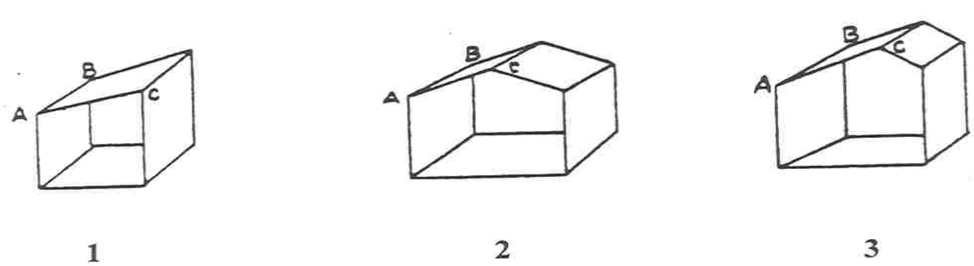


Figure 18. *Calculating the Area of Sloped Ceilings.*

INTERPOLATIONS

Where multipliers (insulation, heating system, etc.) are given for a range of conditions, you may obtain the lowest multiplier possible by interpolation. Generally, the multiplier given for a range corresponds to the lowest value of that range (reference rating), but slightly lower, more advantageous multipliers can be interpolated. For solar heat gain coefficients, where a lower rating denotes better efficiency, the multiplier corresponds to the highest value of that range (reference range). To interpolate multipliers, use the following equation.

$$M_i = M_t - \frac{(R_i - R_t) \text{ X } (M_t - M_n)}{R_n - R_t}$$

Where:

- **M_i =** Multiplier for rating of installed component
- **M_n =** Multiplier for next (more efficient) range
- **M_t =** Multiplier for range within which installed component falls
- **R_i =** Efficiency rating of installed component
- **R_n =** Reference rating for next (more efficient) range
- **R_t =** Reference rating for range within which installed component falls

For example, if you are planning to add insulation with an R-value of 1.7 to the outside of concrete block exterior walls, you may interpolate to obtain a more favorable summer multiplier as follows.

Find Table 6A-2 on page 3 of Form 600A-04.

Look up the multipliers and ratings for the range into which the 1.7 falls, and the next range up.

WALL SUMMER POINT MULTIPLIERS (SPM)

FRAME					CONCRETE BLOCK			
	WOOD		STEEL			INT. INSULATION NORMAL WT.		EXT. INSUL. NOR. WT.
	EXT	ADJ	EXT	ADJ	R-VALUE	EXT	ADJ	EXT
		2.2	8.9	2.9	0-2.9	2.5	.9	2.5
		.8	4.1	1.3	3-4.9	1.4	.7	.7
		.7	3.0	1.0	5-6.9	1.0	.6	.3
			2.8	0.9	7-10.9	.8	.4	.1
			2.4	0.8	11-18.9	.4	.3	0
			1.3	0.4	19-25.9	.2	.2	
					26 & Up	.1	.1	

Put these numbers in the formula and complete the calculation.

$M_n = 1.4$
$M_t = 2.5$
$R_i = 1.7$
$R_n = 3.0$
$R_t = 0$

$$M_i = 2.5 - \frac{(1.7 - 0) \times (2.5 - 1.4)}{3.0 - 0} = 2.5 - \frac{(1.7) \times (1.1)}{3.0} = 2.5 - \frac{1.87}{3.0} =$$

$$2.5 - .623 = 1.88 = 1.9$$

This means that instead of using the 2.5 multiplier from Table 6A-2, you can use the 1.9 multiplier on the summer As-Built side of the calculation. Follow the same procedure for a new winter wall multiplier. The EnergyGauge Fla/Res computer program does this automatically; that is why the multipliers on the computer printout are not always the same as those on the form.

Extrapolations of multipliers above the highest value given or below the lowest values given are not permitted.

DUAL DUCT INSULATION LEVELS

If parts of the house are served by ductwork of different R-values, or by ducts in conditioned space, the duct calculation may be done by one of the following methods.

1. The multiplier for the lowest installed R-value of the ducts in unconditioned space may be used; or
2. Each of the duct multipliers for the different R-values may be multiplied by the percent of total duct length which has that insulation rating. The results are then summed. The following equation may be used to calculate the new duct multiplier

$$DM_{new} = \frac{L_1}{L_t} DM_1 + \frac{L_2}{L_t} DM_2$$

Where:

DM_{new} = duct multiplier to be used with total gross points
L_1 = length at R-value #1 or in conditioned space
L_2 = length at R-value #2
DM_1 = duct multiplier for R-value #1 or in conditioned space
DM_2 = duct multiplier for R-value #2
L_t = $L_1 + L_2$

For example, if you have a two story house with one-half of the duct work (40 linear feet) in conditioned space, and the other half (40 linear feet) located in the attic with an R-value of 6, you would find an improved duct multiplier as follows.

Find the multipliers for L_1 and L_2 on Table 6A-7 on page 3 of Form 600A-04.

6A-8 DUCT MULTIPLIERS (DM)* SEE TABLE 610.1.ABC.2.1 FOR CODE MINIMUMS

SUPPLY DUCTS IN:	DUCT R-VALUE	RETURN DUCTS IN:		
		UNCONDITIONED SPACE	ATTIC WITH RBS	CONDITIONED SPACE
Unconditioned Space	4.2	1.065	1.061	1.059
	6.0	1.048	1.045	1.044
	8.0	1.037	1.035	1.034
Attic with Radiant Barrier (RBS)	4.2	10.46	1.043	1.040
	6.0	1.034	1.032	1.030
	8.0	1.026	1.025	1.024
Conditioned Space	4.2	1.003	1.002	1.0
	6.0	1.002	1.001	1.0
	8.0	1.001	1.001	1.0

***This is a partial table only. Additional categories for Interior Radiation Control Coatings and White Roof conditions are found on the form.

Put these numbers in the formula and complete the calculation.

$$\mathbf{L_1 = 40}$$
$$\mathbf{L_2 = 40}$$
$$\mathbf{DM_1 = 1.000}$$
$$\mathbf{DM_2 = 1.048}$$
$$\mathbf{L_t = 40 + 40 = 80}$$

$$\mathbf{DM_{new} = \frac{40}{80} \times 1.0 + \frac{40}{80} \times 1.048}$$
$$\mathbf{= (.5 \times 1.0) + (.5 \times 1.048)}$$
$$\mathbf{= 1.024}$$

This means that instead of using the 1.10 duct multiplier from Table 6A-7 for the entire duct system, you can use 1.024.

DUAL SYSTEMS: HVAC OR DOMESTIC HOT WATER

An average system multiplier may be calculated when two or more systems of the same type (electric strip, heat pump, natural gas, or other fuels) with different levels of efficiency serve different parts of the house. To select a multiplier for a dual system, the efficiency ratings for the two systems (SEER, COP, HSPF, AFUE, or EF) must be combined based on the percentage of the total capacity supplied by each system. The new efficiency rating to be used in selecting the multiplier from the table can be calculated by the following formula.

$$\mathbf{ER_{new} = \frac{CR_a \times ER_a}{CR_t} + \frac{CR_b \times ER_b}{CR_t}}$$

Where:

ER_{new} = Efficiency to be used in selecting multiplier
CR_a = Capacity Rating of system A
CR_b = Capacity Rating of system B
CR_t = Combined capacity of both systems
ER_a = Efficiency rating of system A
ER_b = Efficiency rating of system B
1 Ton = 12,000 Btuh

For example, if you have a 3,000 square foot house cooled by two systems; a 3 ton air conditioner with a SEER of 11.0 and a 2 ton unit with a SEER of 10.0, you would find the new average efficiency as follows.

$$CR_a = 3 \text{ tons} \times \frac{12{,}000 \text{ Btuh}}{\text{ton}} = 36{,}000 \text{ Btuh}$$

$$CR_b = 2 \text{ tons} \times \frac{12{,}000 \text{ Btuh}}{\text{ton}} = 24{,}000 \text{ Btuh}$$

$$CR_t = 36{,}000 \text{ Btuh} + 24{,}000 \text{ Btuh} = 60{,}000 \text{ Btuh}$$

$$ER_a = 11.0 \text{ SEER}$$

$$ER_b = 10.0 \text{ SEER}$$

$$ER_{new} = \frac{36{,}000 \times 11.0}{60{,}000} + \frac{24{,}000 \times 10.0}{60{,}000}$$

$$= \frac{396{,}000}{60{,}000} + \frac{240{,}000}{60{,}000}$$

$$= 6.6 + 4.0$$

$$= 10.6 \text{ SEER}$$

To apply the same procedure for domestic water heating, substitute the tank size in gallons for capacity ratings.

Where two or more dissimilar systems such as electric and fuel-fired systems are both used, separate calculations must be made for the separate zones of the structure serviced by each.