Nonresidential Appendix NA8-2008

NA8 – Envelope Tradeoff Procedure

NA8.1 Scope

This reference appendix describes the calculations that shall be used for making building envelope tradeoffs which are referenced in §143(b) of the Standard. The methodology in this reference appendix yields estimates of TDV energy for both the standard design and the proposed design building envelope. Compliance is achieved with §143(b) when the total TDV energy of the proposed design is no greater than the TDV energy of the standard design, as determined by the methods described in this appendix. In making the calculations, it shall be assumed that the orientation and area of each envelope component of the standard design are the same as in the proposed design. In most cases, the window area and skylight area of the standard design shall be the same as the proposed design, however, in some instances, the window and/or skylight area of the standard design may be reduced to limits established by the prescriptive standards. This is addressed in more detail below.

The requirements of §143(c) may not be traded off through this procedure.

NA8.2 TDV Energy of the Standard Design

Equation NA8-1 shall be used to calculate the TDV energy of the standard design. Values for wall, floor, roof, door and glazing U-factors shall be taken from the prescriptive requirements for the relevant climate zone and occupancy from Table 143-A, Table 143-B or Table 143-C as appropriate. Values for window solar heat gain coefficients shall be taken from the prescriptive relative solar heat gain requirement from Table 143-A, Table 143-B or Table 143-C as appropriate. For roof replacements that trigger insulation upgrades and cool roof requirements, the criteria are specified in §149 of the Standard. The value for visible light transmittance (VLT) of each window component shall be 1.2 times the solar heat gain coefficient (SHGC) of the window.

Equation NA8-1

$$\begin{aligned}TDV_{std} = &\sum_{i=1}^{nW} c_{Wu,i} \times \left(A_{W,i}^{Std} \times U_{W,i}^{Std}\right) + \sum_{i=1}^{nG} A_{G,i}^{Std} \times \left[\left(c_{Gu,i} \times U_{G,i}^{Std}\right) + \left(c_{Gs,i} \times SHGC_{G,i}^{Std}\right) + \left(c_{Gt,i} \times VLT_{G,i}^{Std}\right)\right] \\ &+ \sum_{i=1}^{nR} c_{Ru,i} \times \left(A_{R,i}^{Std} \times U_{R,i}^{Std}\right) + \sum_{i=1}^{nS} A_{S,i}^{Std} \times \left[\left(c_{Su,i} \times U_{S,i}^{Std}\right) + \left(c_{Ss,i} \times SHGC_{S,i}^{Std}\right) + \left(c_{St,i} \times VLT_{S,i}^{Std}\right)\right] \\ &+ \sum_{i=1}^{nF} c_{Fu,i} \times \left(A_{F,i} \times U_{F,i}^{Std}\right) + \sum_{i=1}^{nD} c_{Du,i} \times \left(A_{D,i} \times U_{D,i}^{Std}\right)\end{aligned}$$

Where:

TDV_{std}	=	TDV energy of the standard design, for space cooling and heating only
W, F, R, G, S, D	=	Index for the building envelope component type (wall, floor, roof, glazing/window, skylight, and door, respectively)

i	=	Index representing each unique combination of occupancy type (nonresidential, 24-hour, and retail); orientation (applicable only for walls, doors and windows); and coefficient category. For roofs, the categories are attic, light (HC<7) and mass (HC>=7). For floors the categories are light and mass. For walls, the categories are light, medium mass (7≤HC<15) and heavy mass (HC≥15).
nW, nF, nR, nG, nS, nD	=	Number of components of the applicable envelope feature of the standard design (wall, floor, roof, glazing/window, skylight, door)
$A^{Std}_{W,i}$, $A_{F,i}$, $A^{Std}_{R,i}$ $A^{Std}_{G,i}$, $A^{Std}_{S,i}$, $A_{D,i}$	=	Exterior surface area of each building envelope component (in ft²). The index "i" shall indicate each unique combination of construction class and orientation (when appropriate). The window and skylight areas in the standard design may be smaller than the proposed design when adjustments are necessary. When window and/or skylight area is reduced, the area of the parent wall/roof is increased so that the gross area of wall/roof for the standard design is the same as the proposed design.
$U^{Std}_{W,i}$, $U^{Std}_{F,i}$, $U^{Std}_{R,i}$ $U^{Std}_{G,i}$, $U^{Std}_{S,i}$, $U^{Std}_{D,i}$	=	The standard design U-factor in Btu/h- ft²-°F for the wall , floor, roof, window, skylight and door from TABLE 143-A, TABLE 143-B or TABLE 143-C. When the prescriptive requirements varies with class of construction or orientation, the class of construction or orientation used to determine the criteria shall be the same as the proposed design.
$SHGC^{Std}_{G,i}$, $SHGC^{Std}_{S,i}$	=	The relative solar heat gain coefficient for windows and skylights from TABLE 143-A, TABLE 143-B or TABLE 143-C, as applicable.
$VLT^{Std}_{G,i}$, $VLT^{Std}_{S,i}$	=	The visible light transmittance for the corresponding A_G and A_S. The VLT for the standard design shall be calculated as 1.2 times the standard design SHGC.
$c_{Wu,i}$, $c_{Fu,i}$, $c_{Ru,i}$, $c_{Gu,i}$, $c_{Su,i}$	=	U-factor coefficients for the wall, floor, roof, windows, skylights and doors, respectively. The index "i" represents a unique combination of occupancy, orientation, and coefficient type. The coefficient type is determined based on the table from Joint Appendix 4 that is used to select the proposed design construction. See Table NA8-1 below for a mapping of the Joint Appendix 4 tables to coefficient categories.
$c_{Gs,i}$, $c_{Ss,i}$	=	Solar heat gain coefficients for the windows and skylights, respectively. The coefficient "i" is a unique combination of occupancy type and orientation.
$c_{Gt,i}$, $c_{St,i}$	=	Visible light transmission coefficients for the windows and skylights, respectively. The coefficient "i" is a unique combination of occupancy type and orientation.

Table NA8-1 – Coefficient Categories to Use with Construction Types

Table from Joint Appendix 4 where Proposed Design is Selected	Coefficient Category
Table 4.2.1 – U-factors of Wood Framed Attic Roofs	Roof, Attic
Table 4.2.2 – U-factors of Wood Framed Rafter Roofs	Roof, Light
Table 4.2.3 – U-factors of Structurally Insulated Panels (SIPS) Roof/Ceilings	Roof, Light
Table 4.2.4 – U-factors of Metal Framed Attic Roofs	Roof, Attic
Table 4.2.5 – U-factors of Metal Framed Rafter Roofs	Roof, Light
Table 4.2.6 – U-factors for Span Deck and Concrete Roofs	Roof, Mass
Table 4.2.7 – U-factors for Metal Building Roofs	Roof, Light
Table 4.2.8 – U-factors for Insulated Ceiling with Removable Panels	Roof, Light
Table 4.2.9 – U-factors for Insulated Metal Panel Roofs and Ceilings (Metal SIPS)	Roof, Light
Table 4.3.1 – U-factors of Wood Framed Walls	Wall, Light
Table 4.3.2 – U-factors of Structurally Insulated Wall Panels (SIPS)	Wall, Light
Table 4.3.3 – U-factors of Metal Framed Walls for Nonresidential Construction	Wall, Light
Table 4.3.4 – U-factors for Metal Framed Walls for Low –Rise Residential Construction	Wall, Light
Table 4.3.5 – Properties of Hollow Unit Masonry Walls	Either wall, light; medium; or heavy depending on HC of selected assembly
Table 4.3.6 – Properties of Solid Unit Masonry and Solid Concrete Walls	
Table 4.3.7 – Properties of Concrete Sandwich Panels	
Table 4.3.11 – Thermal Properties of Log Home Walls	
Table 4.3.8 – U-factors for Spandrel Panels and Glass Curtain Walls	Wall, Light
Table 4.3. 9– U-factors for Metal Building1 Walls	Wall, Light
Table 4.3.10 – U-factors for Insulated Metal Panel Walls (Metal SIPS)	Wall, Light
Table 4.3.12 – Thermal and Mass Properties of Straw Bale Walls	Wall, Light
Table 4.4.1 – Standard U-factors for Wood-Framed Floors with a Crawl Space	Floor, Light
Table 4.4.2 – Standard U-factors for Wood Framed Floors without a Crawl Space	Floor, Mass
Table 4.4.3 – Standard U-factors for Wood Foam Panel (SIP) Floors	Floor, Light
Table 4.4.4 – Standard U-factors for Metal-Framed Floors with a Crawl Space	Floor, Light
Table 4.4.5 – Standard U-factors for Metal-Framed Floors without a Crawl Space	Floor, Light
Table 4.4.6 – Standard U-factors for Concrete Raised Floors	Floor, Mass
Table 4.5.1 – Opaque Doors	Wall, Light

Window Area Limits for the Standard Design

The gross wall area of the standard design is the same as the corresponding component of the proposed design. However, it may be necessary to reduce the window area of the standard design and increase the opaque wall area of the standard design when the window-wall-ratio of the proposed design (WWR_{prop}) is more than the prescriptive limit. This is accomplished by the following procedures:

Adjust Total Window Area

Step 1 Calculate the maximum allowed total window area ($A_{WndwTotal,sd}$) for the standard design. This is the greater of 6 ft times the display perimeter or 40% of the gross wall area.

Step 2 Calculate the maximum allowed window-wall-ratio ($WWR_{Total,sd}$) for the standard design by dividing the maximum allowed window area ($A_{WndwTotal,sd}$) determined in the previous step by the gross wall exterior area.

Step 3 Calculate the proposed window-wall-ratio ($WWR_{Total,\ pd}$) by dividing the proposed total window area by the gross exterior wall area.

Step 4 If $WWR_{Total,pd}$ is less than or equal to $WWR_{Total,sd}$, then set the window area of the standard design equal to the window area of the proposed design. If $WWR_{Total,pd}$ is greater than

$WWR_{Total,\ sd}$, then the area of each window in the standard design shall be reduced from the proposed design by multiplying each window area by the ratio of $WWR_{Total,sd}$ / $WWR_{Total,pd}$.

Adjust West Window Area

After adjusting the total window area (if necessary), a separate test shall be made for the west facing windows.

Step 1 Calculate the maximum allowed window area ($A_{WndwWest,sd}$) for the standard design on the west facades. This is the greater of 6 ft times the display perimeter of the west facades or 40% of the west-facing gross wall area.

Step 2 Calculate the maximum allowed window-wall-ratio ($WWR_{West,sd}$) for the standard design on the west façade by dividing the maximum allowed window area ($A_{West,sd}$) determined in the previous step by the west facing gross exterior wall area.

Step 3 Calculate the proposed adjusted window-wall-ratio ($WWR_{West,\ pd}$) by dividing the standard design west facing window area determined in the total window area adjustments by the west-facing gross exterior wall area.

Step 4 If $WWR_{West,pd}$ is less than or equal to $WWR_{West,sd}$, then no additional adjustments are made to west facing windows. If $WWR_{West,pd}$ is greater than $WWR_{West,\ sd}$, then the area of each west facing window in the standard design shall be further reduced by multiplying each west facing adjusted window area by the ratio of $WWR_{West,sd}$ / $WWR_{West,pd}$.

Skylight Area Limits for the Standard Design

The gross roof area of the standard design is the same as the proposed design. However, it may be necessary to reduce the skylight area of the standard design and increase the opaque roof area of the standard design when the skylight-roof-ratio of the proposed design (SRR_{prop}) is more than the prescriptive maximum allowed. This is accomplished by the following procedure:

Step 1 Calculate the maximum allowed skylight area ($A_{Skyl,sd}$) for the standard design. This is the sum of 10% of the roof area over atria and 5% of other roof areas.

Step 2 Calculate the maximum allowed skylight-roof-ratio (SRR_{sd}) for the standard design by dividing the maximum allowed skylight area ($A_{Skyl,sd}$) determined in the previous step by the gross exterior roof area.

Step 3 Calculate the proposed skylight-roof-ratio (SRR_{pd}) by dividing the proposed design skylight area by the gross exterior roof area.

Step 4 If SSR_{pd} is less than or equal to SSR_{sd}, then no adjustments are made to skylight area of the standard design. If SSR_{pd} is greater than SSR_{sd}, then the area of each skylight in the standard design shall be reduced by multiplying the area of each skylight by ratio of SRR_{sd} / SRR_{pd}.

NA8.3 TDV Energy of the Proposed Design

Equation NA8-11 shall be used to calculate the TDV energy of the proposed design. The proposed design equation includes two multipliers for cool roofs and overhangs that are explained in subsequent sections.

Equation NA8-2

$$
\begin{aligned}
TDV_{prop} = & \sum_{i=1}^{nW} c_{Wu,i} \times \left(A_{W,i} \times U_{W,i}^{Prop}\right) + \sum_{i=1}^{nG} A_{G,i} \times \left[\left(c_{Gu,i} \times U_{G,i}^{Prop}\right) + \left(c_{Gs,i} \times SHGC_{G,i}^{Prop} \times M_{OH,i}\right) + \left(c_{Gt,i} \times VLT_{G,i}^{Prop}\right)\right] \\
& + \sum_{i=1}^{nR} c_{Ru,i} \times \left(A_{R,i} \times U_{W,i}^{Prop} \times M_{CR,i}\right) + \sum_{i=1}^{nS} A_{S,i} \times \left[\left(c_{Su,i} \times U_{S,i}^{Prop}\right) + \left(c_{Ss},i \times SHGC_{S,i}^{Prop}\right) + \left(c_{St},i \times VLT_{S,i}^{Prop}\right)\right] \\
& + \sum_{i=1}^{nF} c_{Fu,i} \times \left(A_{F,i} \times U_{W,i}^{Prop}\right) + \sum_{i=1}^{nD} c_{W} \times \left(A_{D,i} \times U_{D,i}^{Prop}\right)
\end{aligned}
$$

Where:

TDV_{prop}	=	TDV energy of the proposed design, for space cooling and heating only.
W,F,R,G,S,D	=	Index for the building envelope component type (wall, floor, roof, window, skylight, door)
i	=	Index for each unique occupancy type, orientation, and coefficient category.
nW, nF, nR, nG, nS, nD	=	Number of components of the applicable envelope feature of the proposed design (wall, floor, roof, window, skylight, door).
$A_{W,i}, A_{F,i}, A_{R,i}$ $A_{G,i}, A_{S,i}, A_{D,i}$	=	Exterior surface area of each building envelope component (in ft²) of the proposed building. The index "i" shall indicate each unique combination of construction class and orientation (when appropriate).
$U_{W,i}^{Prop}, U_{F,i}^{Prop}, U_{R,i}^{Prop}$ $U_{G,i}^{Prop}, U_{S,i}^{Prop}, U_{D,i}^{Prop}$	=	The proposed design U-factor in Btu/h- ft²-°F for the wall , floor, roof, window, skylight and door component indicated by index i.
$SHGC_{G,i}^{Prop}, SHGC_{S,i}^{Prop}$	=	The solar heat gain coefficient of windows and skylights based on NFRC ratings or CEC defaults.
$VLT_{G,i}^{Prop}, VLT_{S,i}^{Prop}$	=	The ~~window~~ visible light transmittance of windows and skylights from NFRC data or 1.2 times CEC defaults for SHGC.
$SHGC_{G,i}^{Prop}$	=	The solar heat gain coefficient for the window of the proposed building corresponding to index i. Note that overhangs are treated by the overhang multiplier, $M_{OH,i}$.
$SHGC_{S,i}^{Prop}$	=	The skylight SHGC for the corresponding A_S.
$VLT_{G,i}^{Prop}$	=	The window visible light transmittance for the corresponding A_G. The VLT for the standard design shall be calculated as 1.2 x $SHGC_{G,std}$.
$VLT_{S,i}^{Prop}$	=	The skylight visible light transmittance for the corresponding A_S. The VLT for the standard design shall be calculated as 1.2 x $SHGC_{S,std}$.
$c_{Wu,i}$, $c_{Fu,i}$, $c_{Ru,i}$, $c_{Gu,i}$, $c_{Su,i}$	=	U-factor coefficient for the wall, floor, roof, windows, skylights and doors, respectively. Coefficients match those used in the standard design.
$c_{Gs,i}$, $c_{Ss,i}$	=	Solar heat gain weighting coefficients for the windows and skylights, respectively.
$c_{Gt,i}$, $c_{St,i}$	=	Visible light transmittance coefficients for the windows and skylights,

		respectively.
$M_{CR,i}$	=	Cool roof multiplier, as defined below.
$M_{OH,i}$	=	Overhang multiplier as defined below.

Cool Roof Multiplier (M_{CR})

The cool roof multiplier is an adjustment to the roof component of TDV energy. It is calculated from the following equation:

Equation NA8-3

$$M_{CR,i} = 1 + c_{Ref} \times \left(\rho_{aged,prop} - \rho_{aged,std}\right) + c_{Emit} \times \left(\varepsilon_{prop} - \varepsilon_{std}\right)$$

Where: .

$M_{CR,i}$	=	A multiplier that accounts for differences between the prescriptive cool roof requirement and the reflectance and emittance of the proposed design.
c_{Ref}	=	Coefficient for the reflectance of the roof. This depends on occupancy type and climate zone.
C_{Emit}	=	Coefficient for the emittance of the roof. This depends on occupancy type and climate zone.
$\rho_{aged,prop}$	=	Proposed aged design reflectance of the roof outside surface. This data is from the three-year aged reflectance from CRRC. If aged reflectance is not available from CRRC, then an estimate of the aged reflectance shall be used based on the CRRC initial reflectance. Use the following equation to estimate the aged reflectance: $\rho_{aged,prop} = 0.2 + 0.7 \times (\rho_{init,prop} - 0.2)$ If neither initial or aged reflectance data is available from CRRC for the proposed roof, then a default aged reflectance of 0.1 shall be used.
$\rho_{aged,std}$	=	Standard design aged solar reflectance, as required by the prescriptive requirements of §143(a) and summarized in Table NA8-2.
ε_{prop}	=	Proposed design thermal emittance of the roof outside surface from CRRC data. If CRRC data is not available, then a default value of 0.75 shall be used.
ε_{std}	=	Thermal emittance of the roof outside surface of the standard design, as defined in Table NA8-1

Table NA8-2 – Standard design values for solar reflectance and thermal emittance

	Aged Solar Reflectance	Thermal Emittance
Low-Rise, Low-Sloped, CZ2 through CZ15	0.55	0.75
Low-Rise, Low-Sloped, CZ1 and CZ16	0.1	0.75
High-Rise, Low Sloped, CZ10 through CZ15	0.55	0.75
High-Rise, Low Sloped, CZ1-9 and CZ16	0.1	0.75
Steep-sloped, CZ2 through CZ15	0.25	0.75
Steep-sloped, all other	0.1	0.75

Overhang Multiplier (M_{OH})

The solar gains component of window TDV energy is adjusted when overhangs provide shading. The size and configuration of the overhang is approximated by a projection factor (PF), which is defined below.

Equation NA8-4

$$M_{OH,i} = 1 + a_i \times PF_i + b_i \times PF_i^2$$

where

a_i	=	First coefficient for the projection factor. Varies by orientation and climate
b_i		Second coefficient for the projection factor. Varies by orientation and climate.
PF_i		Projection Factor. $PF = \frac{H}{V}$. *PF* should be capped at 1.
H		Horizontal projection of the overhang from the surface of the window in feet, but no greater than *V*
V		Vertical distance from the window sill to the bottom of the overhang, in feet.

NA8.4 Coefficients

Table NA8-3 – Nonresidential Coefficients

Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	73.39	98.24	43.41	55.58	47.25	9.71	13.89	25.69	45.16	65.72	104.71	90.66	89.40	120.37	118.03	161.72
c_F (mass)	54.09	50.23	10.68	10.90	9.60	0.00	0.00	0.00	0.00	16.73	57.42	40.41	44.74	69.08	65.81	125.78
a (east)	-0.67	-0.73	-0.72	-0.77	-0.77	-0.78	-0.78	-0.77	-0.73	-0.76	-0.68	-0.71	-0.73	-0.71	-0.72	-0.63
b (east)	0.52	0.29	0.32	0.31	0.33	0.32	0.32	0.29	0.27	0.30	0.29	0.29	0.31	0.28	0.30	0.27
a (north)	-0.29	-0.32	-0.31	-0.34	-0.32	-0.42	-0.43	-0.39	-0.36	-0.38	-0.25	-0.26	-0.28	-0.28	-0.31	-0.17
b (north)	0.12	0.15	0.15	0.16	0.14	0.20	0.21	0.19	0.16	0.18	0.12	0.13	0.14	0.14	0.14	0.09
a (south)	-1.53	-0.98	-1.17	-1.09	-1.15	-1.04	-0.98	-0.77	-0.87	-1.00	-1.08	-1.02	-1.15	-0.98	-1.00	-1.14
b (south)	1.16	0.53	0.68	0.62	0.61	0.56	-0.04	0.38	0.41	0.46	0.62	0.57	0.67	0.54	0.43	0.71
a (west)	-0.70	-0.73	-0.76	-0.70	-0.73	-0.77	-0.78	-0.70	-0.74	-0.69	-0.65	-0.68	-0.70	-0.68	-0.71	-0.66
b (west)	0.30	0.27	0.29	0.23	0.30	0.30	0.32	0.32	0.30	0.26	0.22	0.24	0.24	0.24	0.05	0.22
c_R (attic)	116.49	181.54	115.85	140.76	114.81	90.71	94.64	117.99	131.00	156.42	180.36	173.69	171.47	207.36	191.53	224.18
c_R (light)	100.03	172.08	101.52	134.56	105.40	83.90	94.40	113.67	127.80	155.30	163.51	159.38	158.48	191.36	187.17	198.47
c_R (mass)	82.85	82.19	56.84	58.34	45.13	24.18	32.67	40.21	37.33	56.14	100.03	89.76	91.75	113.76	96.06	142.00
c_{Emit}	0.02	-0.31	-0.28	-0.43	-0.38	0.19	-0.93	-0.96	-0.84	-0.78	-0.46	-0.42	-0.66	-0.48	-0.90	-0.18
c_{Ref}	-0.60	-1.29	-1.50	-1.81	-1.74	-2.16	-3.27	-2.89	-2.52	-2.30	-1.70	-1.68	-2.07	-1.69	-2.54	-0.95
c_{Ss}	190.85	683.06	514.21	742.41	428.13	773.32	1022.94	912.55	881.51	908.10	888.35	852.55	947.90	942.23	1871.93	605.53
c_{St}	-5.87	-0.17	18.68	26.57	78.44	29.42	68.03	13.06	14.79	3.46	21.96	23.90	8.57	20.69	-198.51	-11.00
c_{Su}	34.67	32.96	7.38	10.35	15.98	0.00	0.00	0.00	0.00	0.00	38.87	33.85	18.62	44.70	-81.19	91.84
c_W (heavy mass)	46.28	33.04	18.60	15.07	2.80	0.00	0.00	5.54	4.30	18.44	68.89	51.09	58.69	66.67	76.15	98.43
c_W (light)	72.49	135.26	79.89	105.29	87.01	69.49	75.52	104.30	119.13	142.74	153.46	137.84	148.52	169.93	201.13	164.16
c_W (medium mass)	58.27	58.05	35.10	35.11	18.39	8.10	11.97	25.05	29.00	44.35	92.08	74.85	81.20	97.68	105.31	122.08
c_{Gs} (east)	50.79	256.16	170.33	293.91	238.39	297.25	279.82	367.47	376.81	411.91	378.11	356.38	418.51	431.91	666.01	220.11
c_{Gt} (east)	-5.10	-18.76	2.55	-11.89	-1.11	7.68	5.40	-7.11	-6.51	-24.04	-10.30	-9.85	-16.06	-21.54	-28.86	-18.99
c_{Gu} (east)	27.93	30.86	16.35	15.65	12.73	0.00	1.81	5.25	11.32	20.26	43.74	31.60	30.33	48.65	40.08	69.96
c_{Gs} (north)	60.86	131.95	94.93	147.24	115.89	138.86	151.32	173.12	183.41	207.77	188.48	172.21	194.08	206.89	303.70	137.30
c_{Gt} (north)	-8.69	-12.18	-3.30	-6.61	-6.33	4.05	0.67	-2.47	-6.51	-22.40	-16.83	-14.82	-15.45	-14.30	-20.19	-28.12
c_{Gu} (north)	30.51	47.12	20.83	18.33	16.50	0.00	4.97	9.87	19.34	20.02	53.06	43.82	42.90	62.07	54.49	81.90
c_{Gs} (south)	69.67	312.07	203.98	313.44	319.53	319.30	-20.69	367.01	493.59	520.67	406.32	356.94	403.75	395.22	586.58	247.63
c_{Gt} (south)	-5.14	-23.27	6.31	-6.32	3.85	12.57	127.19	4.61	-8.79	-30.06	-12.54	-8.10	-19.63	-26.04	-33.07	-21.99
c_{Gu} (south)	32.54	44.30	26.07	28.81	23.64	1.72	60.43	32.56	18.35	24.03	57.44	48.62	45.22	56.49	32.84	81.45
c_{Gs} (west)	85.68	340.91	206.01	364.57	239.59	340.91	348.89	483.20	468.46	492.09	555.65	473.69	544.08	560.24	713.09	292.21
c_{Gt} (west)	-7.74	-18.68	8.34	-3.20	-3.62	9.81	1.89	-10.69	-11.13	-30.03	-57.41	-17.47	-27.51	-32.01	-30.12	-33.80
c_{Gu} (west)	29.06	41.19	20.45	20.48	13.65	0.00	2.92	4.01	16.78	19.85	50.45	40.90	39.45	59.06	51.41	81.01

Table NA8-4 – 24-Hour Coefficients

Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	271.87	242.47	195.46	175.15	192.00	111.38	90.07	111.94	124.22	153.72	225.65	212.82	195.34	247.84	193.39	346.76
c_F (mass)	265.55	190.18	176.41	130.67	161.91	94.94	72.35	77.35	77.35	109.94	183.94	161.28	157.65	203.10	131.40	296.44
a (east)	-0.90	-0.45	-2.33	-0.62	-0.61	-1.26	-0.73	-0.74	-0.68	-0.68	-0.51	-0.54	-0.59	-0.61	-0.67	0.33
b (east)	0.25	0.36	0.77	0.39	1.58	0.85	0.39	0.35	0.29	0.29	0.21	0.26	0.22	0.26	0.27	0.12
a (north)	-1.55	-0.06	1.61	-0.15	0.52	-0.17	-0.34	-0.31	-0.31	-0.31	-0.13	-0.14	-0.17	-0.19	-0.28	0.11
b (north)	0.70	0.04	-0.72	0.08	-0.18	0.09	0.17	0.15	0.15	0.15	0.07	0.08	0.09	0.10	0.13	-0.03
a (south)	-0.96	-1.14	-2.18	-1.31	-1.49	-0.84	6.68	-0.74	-0.94	-1.07	-1.04	-0.92	-1.07	-0.96	-0.77	-1.51
b (south)	0.20	0.91	7.87	0.95	1.49	0.71	-4.08	0.25	0.54	0.57	0.65	0.62	0.64	0.61	0.33	1.66
a (west)	-0.88	-0.70	-0.73	-0.91	0.12	-0.43	-0.80	-0.46	-0.72	-0.59	-0.70	-0.65	-0.65	-0.63	-0.44	-0.51
b (west)	0.15	0.48	1.51	0.54	1.91	0.22	0.35	0.12	0.27	0.20	0.22	0.21	0.24	0.24	0.03	0.31
c_R (attic)	218.71	267.29	191.99	215.08	181.95	140.70	132.27	163.28	175.64	217.56	270.93	258.22	246.21	300.35	256.90	345.32
c_R (light)	241.17	315.45	218.07	257.77	222.35	181.96	171.95	199.83	213.39	263.87	288.29	286.43	268.75	324.85	282.17	371.78
c_R (mass)	213.10	190.51	167.97	153.94	148.23	113.99	96.47	109.89	107.07	134.27	205.92	186.46	184.10	229.38	175.33	287.74
c_{Emit}	0.52	0.15	0.29	0.01	0.27	0.15	-0.10	-0.20	-0.27	-0.26	-0.11	-0.04	-0.17	-0.05	-0.61	0.10
c_{Ref}	0.95	-0.12	0.28	-0.54	0.20	-0.50	-1.24	-1.15	-1.13	-1.04	-0.67	-0.56	-0.84	-0.56	-1.38	-0.07
c_{Ss}	-511.67	289.49	32.51	562.51	91.92	-5.02	555.73	818.12	800.55	761.50	734.20	687.40	801.77	771.69	819.20	252.00
c_{St}	-51.54	-29.37	-39.75	12.83	-60.27	162.57	7.51	-40.07	11.11	-4.27	7.76	-2.23	-8.10	-10.96	214.91	-47.41
CSU	166.28	117.60	105.42	64.12	92.03	117.35	31.65	21.47	42.05	67.76	122.26	110.92	86.08	115.49	111.68	207.95
c_W (heavy mass)	144.37	85.71	89.78	66.34	60.49	40.67	42.95	32.17	37.51	58.24	138.33	102.57	118.12	131.67	137.53	196.09
c_W (light)	170.52	215.98	160.68	182.30	162.30	125.38	122.18	155.91	171.92	217.44	253.22	227.71	232.08	269.21	284.47	300.86
c_W (medium mass)	158.57	111.64	108.56	89.88	79.05	55.77	44.86	54.81	63.88	90.76	164.42	133.55	146.34	165.76	163.64	220.44
c_{Gs} (east)	-220.04	106.38	-44.31	146.32	26.74	145.21	181.28	267.11	312.11	371.67	287.84	232.53	357.10	349.93	752.41	62.81
c_{Gt} (east)	-33.13	-23.20	-25.04	-17.18	-24.28	-9.63	-8.40	-17.30	-13.55	-32.71	-23.27	-21.58	-27.25	-34.44	-41.35	-38.95
c_{Gu} (east)	123.09	94.63	88.88	75.43	79.35	50.86	38.34	47.45	49.60	61.28	107.09	97.42	83.16	103.58	76.27	167.89
c_{Gs} (north)	-58.35	97.29	20.14	108.58	22.48	65.25	106.49	140.11	167.07	193.30	180.33	149.43	188.07	194.13	335.65	116.98
c_{Gt} (north)	-42.93	-38.97	-34.72	-26.94	-33.55	-17.04	-13.36	-19.23	-19.71	-26.90	-33.99	-32.02	-30.64	-38.94	-37.50	-52.47
c_{Gu} (north)	115.96	96.83	93.03	76.91	85.01	54.01	42.62	51.95	57.11	70.12	112.00	101.93	93.13	116.61	89.97	169.17
c_{Gs} (south)	-224.68	171.07	10.18	207.71	88.05	162.72	-21.62	264.42	526.65	436.65	351.29	323.50	362.71	381.46	871.10	94.34
c_{Gt} (south)	-26.79	-26.68	-31.56	-15.73	-34.75	-7.91	69.33	-7.61	-56.84	-34.25	-24.43	-47.00	1.76	-39.62	-62.58	-47.18
c_{Gu} (south)	116.16	98.97	84.66	74.36	72.95	43.88	60.50	70.26	33.01	57.95	115.89	102.94	110.86	105.67	72.92	169.10
c_{Gs} (west)	-218.97	201.76	23.54	242.73	9.66	165.34	258.32	359.99	424.09	461.66	403.63	379.28	514.35	541.92	1259.14	146.50
c_{Gt} (west)	-30.33	-39.35	-36.99	-22.89	-35.94	-30.52	-13.15	-20.92	-24.36	-43.40	-27.87	-34.29	-38.40	-48.38	-213.11	-57.34
c_{Gu} (west)	120.45	87.80	81.97	63.44	79.44	36.04	34.27	42.83	51.84	57.71	115.34	95.23	86.55	105.27	29.63	166.61

Table NA8-5 – Retail Coefficients

Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	11.80	59.12	0.00	10.77	0.00	0.00	0.00	0.00	5.02	31.07	84.21	63.89	70.65	111.25	110.58	141.89
c_F (mass)	0.00	13.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.95	11.69	13.62	43.83	51.70	86.00
a (east)	0.26	-2.16	-1.45	-2.11	-1.93	-1.74	-2.05	-2.09	-2.04	-2.07	-1.85	-2.10	-2.08	-2.21	-1.92	-1.96
b (east)	-0.25	1.05	0.71	0.99	0.89	0.74	1.05	1.00	0.99	1.00	0.83	1.00	0.96	1.00	0.91	0.87
a (north)	-1.19	-0.80	-1.01	-0.85	-1.06	-1.18	-1.05	-0.99	-0.94	-0.80	-0.63	-0.71	-0.68	-0.61	-0.72	-0.55
b (north)	0.61	0.42	0.53	0.45	0.55	0.62	0.56	0.52	0.49	0.42	0.33	0.38	0.36	0.33	0.38	0.29
a (south)	-5.20	-2.36	-2.97	-2.89	-3.01	-6.24	-2.58	-3.41	-2.31	-2.29	-2.66	-2.82	-2.80	-2.68	-2.13	-2.93
b (south)	4.45	1.25	1.88	1.75	1.74	3.93	1.49	1.37	1.22	1.13	1.56	1.64	1.61	1.57	1.04	1.79
a (west)	-2.44	-1.99	-2.03	-2.43	-2.02	-2.08	-2.10	-2.04	-1.92	-1.83	-1.94	-1.92	-2.23	-1.84	-1.85	-1.92
b (west)	1.36	0.84	0.78	1.03	0.91	4.24	0.94	0.90	0.82	0.82	0.74	0.76	1.23	0.68	0.75	0.77
c_R (attic)	107.40	194.26	108.65	145.19	100.00	70.90	87.23	116.13	137.90	167.33	201.41	186.53	192.12	235.28	219.81	250.01
c_R (light)	97.08	183.93	95.29	136.06	97.49	68.50	85.56	105.29	128.79	163.37	186.48	174.28	184.93	220.37	222.20	232.47
c_R (mass)	79.98	88.20	51.61	55.17	34.46	22.46	25.96	34.02	34.53	62.04	118.96	100.45	108.40	135.66	114.01	179.76
c_{Emit}	-0.20	-0.57	-0.55	-0.74	-0.81	-1.59	-1.05	-1.33	-1.12	-1.02	-0.64	-0.61	-0.81	-0.72	-1.00	-0.30
c_{Ref}	-0.80	-1.68	-2.08	-2.38	-2.32	-4.76	-4.05	-4.05	-3.07	-2.77	-1.93	-1.96	-2.33	-2.01	-2.48	-1.12
c_{Ss}	213.31	800.49	636.93	918.22	614.03	742.37	833.45	946.54	1011.98	1091.94	1073.16	1030.57	1207.88	1220.95	1570.86	731.66
c_{St}	11.13	13.34	6.66	50.68	34.66	57.09	50.78	118.53	46.93	20.76	41.11	39.97	-6.88	20.47	35.88	3.72
c_{Su}	-2.74	-8.65	-45.50	-39.87	-43.21	-61.17	-53.11	-30.92	-48.37	-36.13	-6.87	-19.28	-14.98	3.50	-27.31	45.99
c_W (heavy mass)	52.21	58.17	24.77	32.82	7.66	5.65	5.26	20.84	28.92	49.67	105.90	78.83	93.48	107.52	137.00	145.05
c_W (light)	73.60	159.34	76.79	117.60	90.20	60.81	60.42	112.38	136.11	172.29	192.53	166.40	189.65	213.97	253.96	202.87
c_W (medium mass)	59.37	86.25	39.15	54.95	22.71	16.45	21.76	45.19	56.46	81.75	131.91	104.67	122.30	144.65	167.49	167.59
c_{Gs} (east)	7.14	112.23	52.93	114.81	87.55	91.43	100.54	133.72	150.73	172.34	169.07	149.60	176.99	183.08	270.91	96.01
c_{Gt} (east)	3.22	-0.19	7.84	3.51	6.03	8.54	5.94	4.58	2.69	-2.66	0.19	1.73	-0.96	-4.94	-2.97	-1.17
c_{Gu} (east)	-1.16	7.49	-2.34	0.54	-2.30	-9.12	-5.98	-3.18	-1.14	4.92	12.23	7.69	9.73	14.15	18.73	19.62
c_{Gs} (north)	18.27	56.92	32.76	56.77	38.01	48.14	53.60	64.88	70.31	93.08	74.60	68.90	78.51	83.72	123.50	55.37
c_{Gt} (north)	2.87	-1.81	3.72	2.86	4.00	5.95	4.58	3.11	2.09	-5.58	-1.79	-1.19	-2.06	-3.98	-5.01	-5.02
c_{Gu} (north)	-0.40	7.05	-3.92	0.20	-4.08	-10.79	-7.25	-4.60	-0.69	4.12	13.70	9.42	11.30	16.60	17.76	22.70
c_{Gs} (south)	19.93	140.61	79.21	131.38	107.71	47.15	122.23	-105.32	197.44	219.92	186.54	163.26	182.41	183.11	311.65	115.11
c_{Gt} (south)	6.09	-1.66	8.42	4.80	6.56	40.94	7.58	102.93	4.77	-0.88	2.85	3.10	-1.13	-2.91	-7.90	-2.02
c_{Gu} (south)	1.91	10.61	-0.13	4.97	0.23	0.98	-3.24	42.55	2.83	7.53	18.99	13.23	14.80	20.02	17.55	24.93
c_{Gs} (west)	32.06	152.29	96.82	126.76	94.79	108.39	139.66	179.00	195.99	210.12	220.24	201.58	196.28	251.91	297.46	132.57
c_{Gt} (west)	4.20	-4.54	-0.42	15.93	2.83	-16.53	6.50	8.35	0.01	-1.33	-6.87	-1.22	-2.66	-7.14	-6.94	-7.95
c_{Gu} (west)	0.39	8.29	0.20	5.88	-4.68	-1.62	-5.85	-1.20	1.04	6.05	15.01	10.88	20.55	18.90	21.34	23.88