Table G3–30 Design Wind Pressures, Longitudinal Direction

Building surface	(GC_{pf})	Design pressure (psf)	
		$(+GC_{pi})$	$(-GC_{pi})$
1	0.40	4.0	10.5
2	–0.69	–15.6	–9.2
3	–0.37	–9.9	–3.4
4	–0.29	–8.5	–2.0
5	–0.45	–11.3	–4.9
6	–0.45	–11.3	–4.9
1E	0.61	7.7	14.2
2E	–1.07	–22.5	–16.0
3E	–0.53	–12.8	–6.3
4E	–0.43	–11.0	–4.5

Application of Pressures on Building Surfaces 2 and 3

Note 8 of Figure 6-10 of the Standard states that when the roof pressure coefficient, GC_{pf}, is negative in Zone 2, it shall be applied in Zone 2 for a distance from the edge of the roof equal to 0.5 times the horizontal dimension of the building measured parallel to the direction of the MWFRS being designed or $2.5h$, whichever is less. The remainder of Zone 2 that extends to the ridge line shall use the pressure coefficient GC_{pf} for Zone 3. Thus, the distance from the edge of the roof is the smaller of

$$0.5(200) = 100 \text{ ft for transverse direction}$$
$$0.5(250) = 125 \text{ ft for longitudinal direction}$$
$$\text{or} \quad (2.5)(36.7) = 92 \text{ ft for both directions (controls)}$$

Therefore, Zone 3 applies over a distance of 105 – 92 = 13 ft in what is normally considered to be Zone 2 (adjacent to ridge line)for transverse direction and 125 – 92 = 33 ft for longitudinal direction.

3.7.6 Loading Cases

Because the building is symmetrical, the four loading cases provide all the required combinations provided the design is accomplished by applying loads for each of the four corners. The load combinations illustrated in **Figures G3–19** through **G3–22** are to be used to design the rigid frames, the “wind truss” spanning across the building in the 200-ft direction, and the rod/cable bracing in the planes of the walls (see **Figure G3–13** in Section 3.6 of this guide).

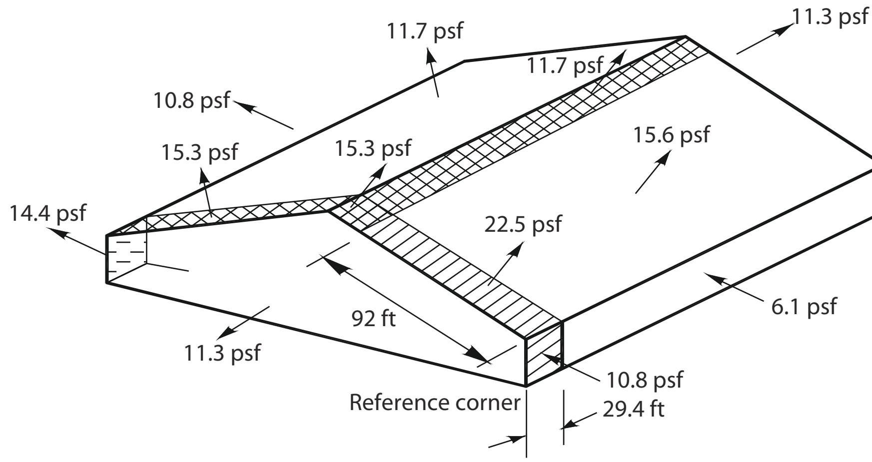

Figure G3–19 Design Pressures for Transverse Direction with Positive Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

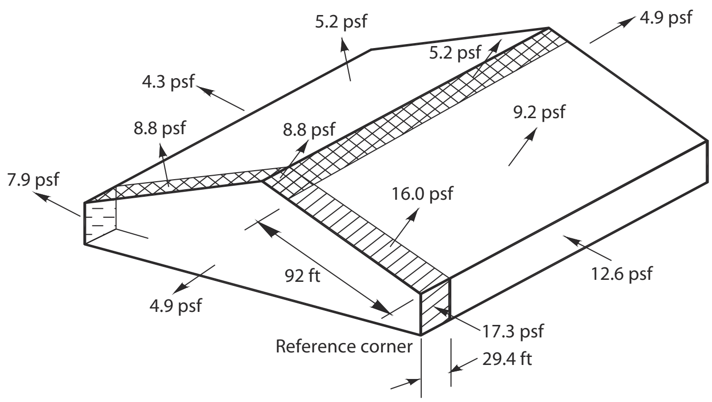

Figure G3–20 Design Pressures for Transverse Direction with Negative Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

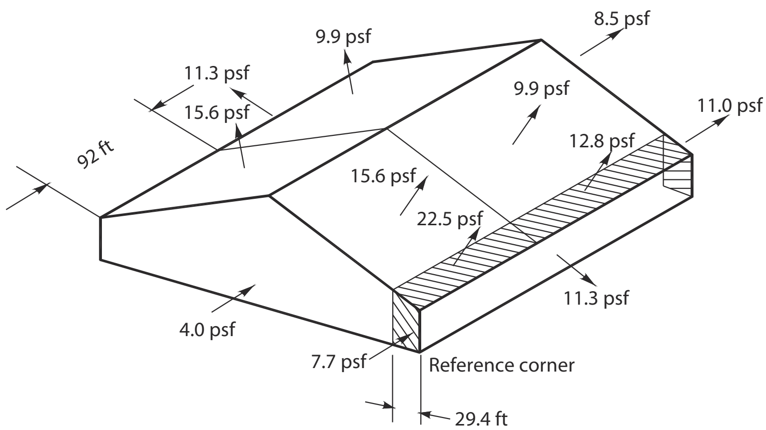

Figure G3–21 Design Pressures for Longitudinal Direction with Positive Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

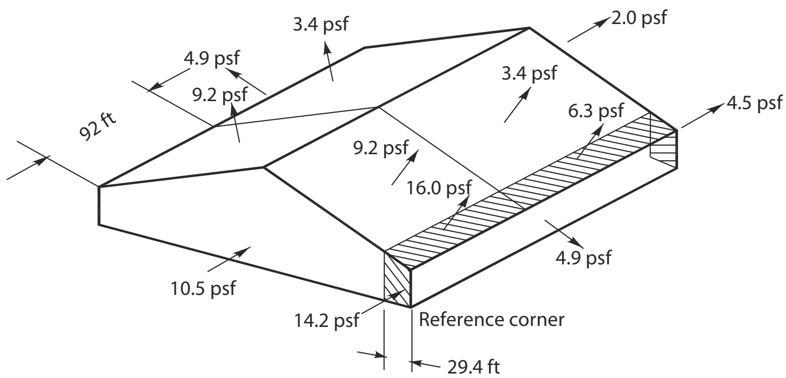

Figure G3–22 Design Pressures for Longitudinal Direction with Negative Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

Torsional Load Cases

Since the mean roof height, h = 36.7 ft, is greater than 30 ft and if the roof diaphragm is assumed to be rigid, torsional load cases need to be considered (see exception in Note 5 in Figure 6-10 of the Standard if building is designed with flexible diaphragm). Pressures in "T" zones are 25% of the full design pressures; the "T" zones are shown in Figure 6-10 of the Standard. Other surfaces will have the full design pressures. The "T" zone pressures with positive and negative internal pressures for transverse and longitudinal directions are shown in **Tables G3–31** and **G3–32**, respectively.

Figures G3–19 through **G3–26** show design pressure cases for one reference corner; these cases are to be considered for each corner.

3.7.7 Design Wind Pressures for C&C

The design pressures for C&C are the same as shown for Ex. 6 (Section 3.6 of this guide).

Table G3–31 Design Wind Pressure for Zone "T," Transverse Direction

	Design pressures (psf)	
Building surface	($+GC_{pi}$)	($-GC_{pi}$)
1T	1.5	3.2
2T	–3.9	–2.3
3T	–2.9	–1.3
4T	–2.7	–1.1

Table G3–32 Design Wind Pressure for Zone "T," Longitudinal Direction

Building surface	Design pressures (psf) ($+GC_{pi}$)	($-GC_{pi}$)
1T	1.0	2.6
2T	–3.9	–2.3
3T	–2.5	–0.9
4T	–2.1	–0.5

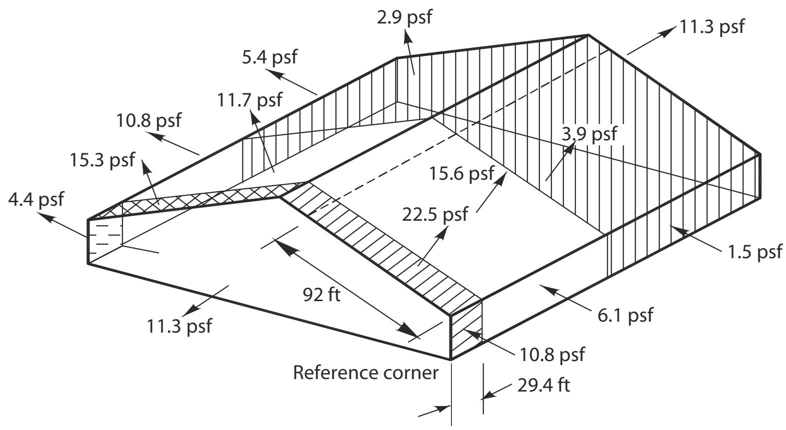

Figure G3–23 *Torsional Load Case for Transverse Direction with Positive Internal Pressure. Notes: The pressures are assumed to be uniformly distributed over each of the surfaces shown. Roof pressures of 22.5, 15.6, and 3.9 psf apply up to 92 ft; the remaining 13 ft up to the ridge line will have pressure of 15.3, 11.7, and 2.9 psf.*

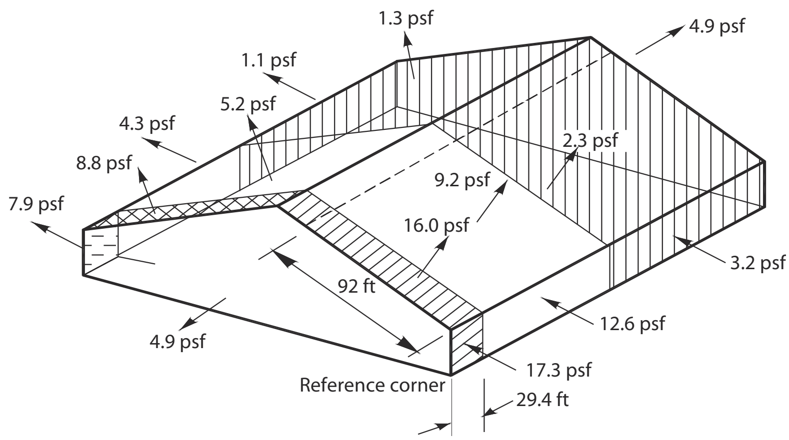

Figure G3–24 *Torsional Load Case for Transverse Direction with Negative Internal Pressure. Notes: The pressures are assumed to be uniformly distributed over each of the surfaces shown. Roof pressures of 16.0 9.2, and 2.3 psf apply up to 92 ft; the remaining 13 ft up to the ridge line will have pressure of 8.8, 5.2, and 1.3 psf.*

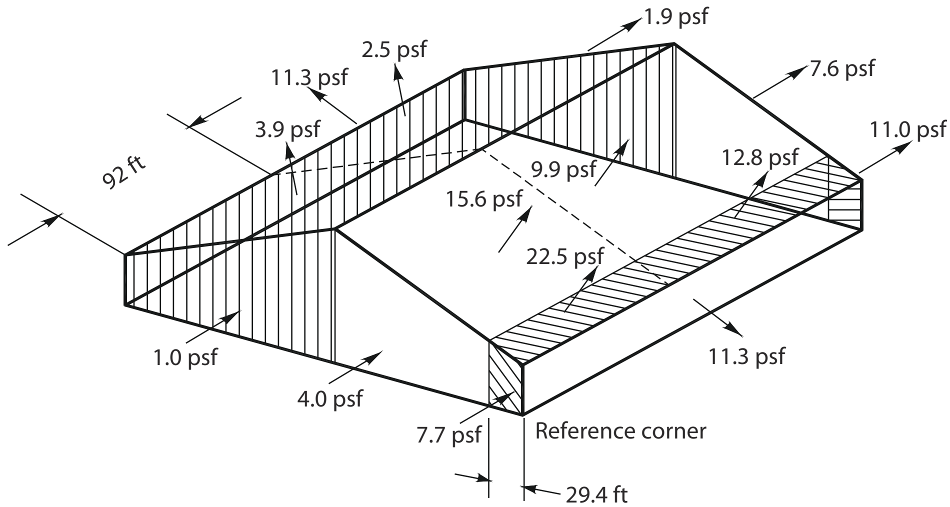

Figure G3–25 Torsional Load Case for Longitudinal Direction with Positive Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

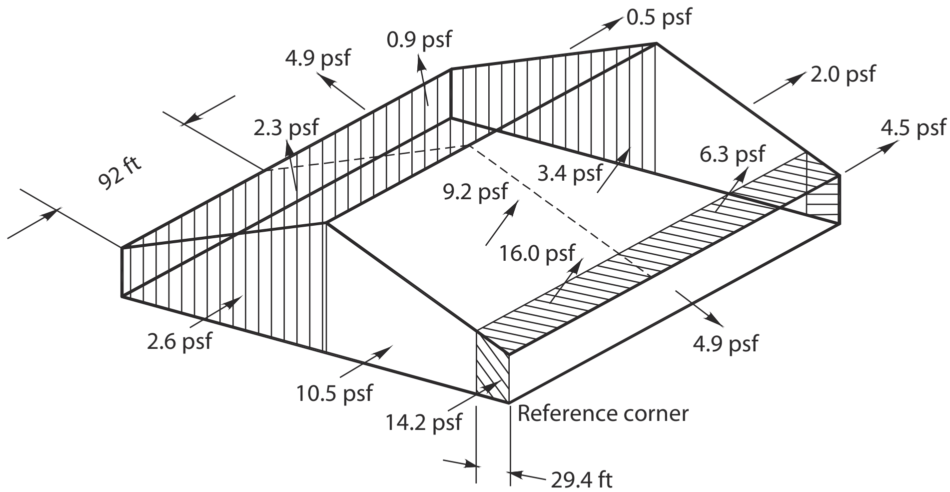

Figure G3–26 Torsional Load Case for Longitudinal Direction with Negative Internal Pressure. Note: The pressures are assumed to be uniformly distributed over each of the surfaces shown.

3.8 Example 8: 40-ft × 80-ft Commercial Building with Monoslope Roof with Overhang

In this example, design pressures for a typical retail store in a strip-mall are determined. The building's dimensions are shown in **Figure G3–27.** The building data are as shown here.

Location	Boston, Massachusetts, within 1 mi of the coastal mean high watermark
Topography	Homogeneous
Terrain	Suburban
Dimensions	40 ft × 80 ft in plan Monoslope roof with slope of 14° and overhang of 7 ft in plan Wall heights are 15 ft in front and 25 ft in rear
Framing	Walls of CMU on all sides supported at top and bottom; steel framing in front (80-ft width) to support window glass and doors. Roof joists span 41.2 ft with 7.2-ft overhang spaced at 5 ft on center
Cladding	Glass and door sizes vary; glazing is debris-impact–resistant and occupies 50% of front wall (80 ft in width) Roof panels are 2 ft wide and 20 ft long

3.8.1 Building Classification, Enclosure Classification, and Exposure Category

The building is not an essential facility, nor is it likely to be occupied by more than 300 persons at any one time. Use Category II (see Table 1-1 of the Standard). Importance Factor $I = 1.00$ (see Table 6-1 of the Standard).

The building is sited in a suburban area and satisfies the criteria for Exposure B (see Section 6.5.6 of the Standard).

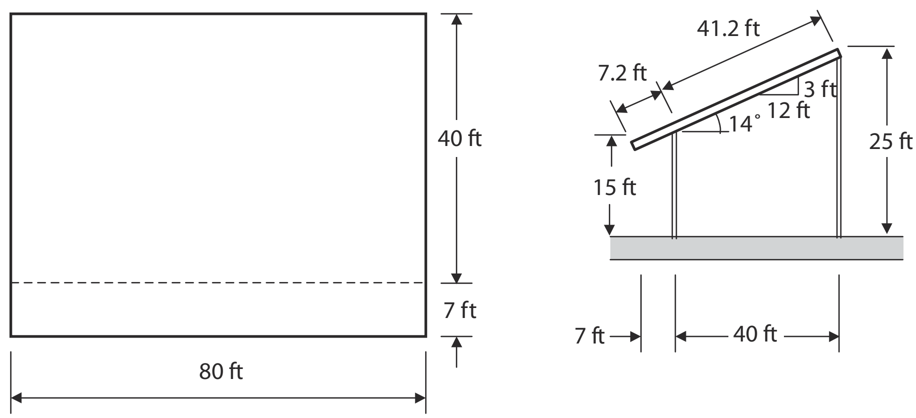

Figure G3–27 Building Characteristics for Example 8, Commercial Building with Monoslope Roof and Overhang

The building is sited in a wind-borne debris region. It has glazing (that must be impact resistant) occupying 50% of a wall that receives positive pressure. The building should be classified as enclosed (see Sections 6.5.9.3 and 6.2 of the Standard). The Standard does not require that the building be classified as enclosed if it is located in a wind-borne debris region, just that the openings are required to be protected with impact-resistant glazing or are protected. The wind-borne debris region is defined in Section 6.2.

The building does not meet the requirements of Method 1, Simplified Procedure (Section 6.4 of the Standard), because the roof is neither flat nor gabled. Therefore, Method 2, Analytical Procedure, is used (see Section 6.5.3 of the Standard). The roof is not gabled; hence, the low-rise building provisions may not be used.

The values in Figure 6-10 were obtained from wind tunnel studies of rigid, gable-framed buildings. Their use for a monoslope roof requires considerable judgment. The design examples presented in Ex. 7 (Section 3.7 of this guide) illustrate use of the pressure coefficients of Figure 6-10, and the Commentary in the Standard gives the background for (GC_{pf}) values.

3.8.2 Basic Wind Speed

The wind speed contour of 110 mph traverses over Boston, Massachusetts (Figure 6-1c of the Standard); use a basic wind speed of 110 mph.

3.8.3 Velocity Pressures

The velocity pressures (**Table G3–33**) are calculated using the following equation (see Section 6.5.10 of the Standard):

$$\begin{aligned} q &= 0.00256 K_z K_{zt} K_d V^2 I \text{ (psf)} \\ &= 0.00256 K_z (1.0)(0.85)(110)^2(1.0) \\ &= 26.33 K_z \text{ (psf) (Eq. 6-15)} \end{aligned}$$

Table G3–33 Velocity Pressures, q_z, q_i, and q_h (psf)

Height (ft)	*MWFRS*		*C&C*	
	Exposure B, Case 2	q_z, q_i	*Exposure B, Case 1*	q_h
0–15	0.57	15.01		
$h = 20$	0.62	16.32*	0.70	18.43
25	0.66	17.38		

* q_h = 16.32 psf for MWFRS.

where

K_z = Value obtained from Table 6-3 of the Standard

K_{zt} = 1.0 homogeneous terrain

I = 1.0 for Category II building (see Table 6-1)

K_d = 0.85, see Table 6-4

The provisions of the Standard require the use of the external pressure coefficients, C_p, from Figure 6-6; hence, the exposure coefficients, K_z, are based on Exposure B, Case 2, for MWFRS and Exposure B, Case 1, for C&C (see Table 6-3).

3.8.4 Design Pressures for MWFRS

The equation for rigid buildings of all heights is given in Section 6.5.12.2 of the Standard.

$$p = qGC_p - q_i(GC_{pi}) \qquad \text{(Eq. 6-17)}$$

where

q = q_z for windward wall

q_i = q_h for windward and leeward walls, side walls and roof

G = Value determined from Section 6.5.8 of the Standard

C_p = Value obtained from Figure 6-6 of the Standard

(GC_{pi}) = Value obtained from Figure 6-5 of the Standard

For positive internal pressure evaluation, the Standard permits q_i to be conservatively evaluated at height h ($q_i = q_h$).

Gust Effect Factor

The gust effect factor for non-flexible (rigid) buildings is given in Section 6.5.8 of the Standard as $G = 0.85$. The size of the building would not permit a reduction in G based on Eq. 6-4 of the Standard.

Wall External Pressure Coefficients

The coefficients for the windward and side walls in **Table G3–34** are given in Figure 6-6 of the Standard as C_p = +0.8 and –0.7, respectively. The values for the leeward wall depend on L/B; they are different for the two directions: (1) wind parallel to roof slope (normal to ridge), and (2) wind normal to roof slope (parallel to ridge).

Roof External Pressure Coefficients

Since the building has a monoslope roof, the roof surface for wind directed parallel to the slope (normal to ridge) may be a windward or a leeward surface.

Table G3–34 Wall Pressure Coefficients (C_p)

Surface	*Wind direction*	*L/B*	C_p
Leeward wall	‖ to roof slope	0.5	–0.5
Leeward wall	⊥ to roof slope	2.0	–0.3
Windward wall	—	—	0.8
Side walls	—	—	–0.7

The value of $h/L = 0.5$ in this case, and the proper coefficients are obtained from linear interpolation for $\theta = 14°$ (see **Table G3–35**).

When wind is normal to the roof slope (parallel to ridge), angle $\theta = 0$ and $h/L = 0.25$.

For the overhang, Section 6.5.11.4.1 of the Standard requires $C_p = 0.8$ for wind directed normal to 15-ft wall. The Standard does not address the leeward overhang for the case of wind directed toward 25-ft wall and perpendicular to roof slope (parallel to ridge). A $C_p = -0.5$ could be used (coefficient for leeward wall), but the coefficient has been conservatively taken as 0.

The building is sited in a hurricane-prone region less than 1 mi from the coastal mean high-water level. The basic wind speed is 110 mph and the glazing must be designed to resist wind-borne debris impact (or some other method of protecting the glazing is installed, such as shutters). Thus, as noted earlier, the building is classified as enclosed, for this example. The internal pressure coefficients, from Figure 6-5 of the Standard, are as follows $(GC_{pi}) = \pm 0.18$.

Typical Calculations of Design Pressures for MWFRS

For cases with wind parallel to slope with 15-ft windward wall (**Table G3–36**).

Pressure on Leeward Wall

$$p = q_h GC_p - q_h(\pm GC_{pi})$$

$= 16.3(0.85)(-0.5) - (16.3)(+0.18) = -9.9$ psf with positive internal pressure

and $= 16.3(0.85)(-0.5) - (16.3)(-0.18) = -4.0$ psf with negative internal pressure

Pressure on Overhang Top Surface

$$p = q_h GC_p = 16.3(0.85)(-0.74) = -10.3 \text{ psf}$$

Pressure on Overhang Bottom Surface (same as windward wall external pressure)

$$p = q_z GC_p = 15.0(0.85)(0.8) = 10.2 \text{ psf}$$

Note that q_z was evaluated for $z = 15$ ft for bottom surface of overhang as C_p coefficient is based on induced pressures at top of wall.

Table G3–35 Roof Pressure Coefficients (C_p)

Wind direction	h/L	$\theta°$	C_p
|| to roof slope	0.5	14	–0.74, –0.18* as windward slope
|| to roof slope	0.5	14	–0.50 as leeward slope
⊥ to roof slope	0.25	0	
distance from windward edge			
0–80 ft*			–0.18†
0–20 ft*			–0.90
20–40 ft			–0.50
40–80 ft			–0.30

* Distance from the windward edge of the roof.

† The values of smaller uplift pressures on the roof can become critical when wind load is combined with roof live load or snow load; load combinations are given in Sections 2.3 and 2.4 of the Standard. For brevity, loading for this value is not shown here.

Figures G3–28 and **G3–29** illustrate the external, internal, and combined pressure for wind directed normal to the 15-ft wall. **Figures G3–30** and **G3–31** illustrate combined pressure for wind directed normal to the 25-ft wall and perpendicular to slope (parallel to ridge line), respectively (**Table G3–37**).

3.8.5 Design Wind Load Cases

Section 6.5.12.3 of the Standard requires that any building whose wind loads have been determined under the provisions of Sections 6.5.12.2.1 and 6.5.12.2.3 shall be designed for wind load cases as defined in Figure 6-9 of the Standard. Case 1 includes the loadings shown in **Figures G3–28** through **G3–31**. The exception in Section 6.5.12.3 of the Standard indicates that a combination of windward (P_w) and leeward (P_L) loads is applied for Load Cases 3 only since mean roof height h of the building is less than 30 ft.

3.8.6 Design Pressures for C&C

The design pressure equation for C&C for building with mean roof height $h \leq 60$ ft is given in Section 6.5.12.4.1 of the Standard.

$$P = q_h[(GC_p) - (GC_{pi})] \qquad \text{(Eq. 6-22)}$$

where

q_h = Velocity pressure at mean roof height associated with Exposure B, Case 1 (q_h = 18.43 psf, previously determined)

(GC_p) = External pressure coefficients from Figures 6-11A, 6-11C, and 6-14B of the Standard