STRUCTURAL CALCULATIONS

FOR

Example 3 - 157' Building, flat terrain

Guide to Wind Load Procedures of ASCE 7-02

Code Search

Code: ASCE 7 - 02

Occupancy:

Occupancy Group = B Business

Occupancy Category & Importance Factors:

Occupancy Category =	II
Wind factor =	1.00
Snow factor =	1.00
Seismic factor =	1.00

Type of Construction:

Fire Rating:

Roof =	0.0 hr
Floor =	0.0 hr

Building Geometry:

Roof angle (θ)	0.00 / 12	0.0 deg
Building length (L)	200.0 ft	
Least width (B)	100.0 ft	
Mean Roof Ht (h)	157.0 ft	
Parapet ht above grd	160.0 ft	
Minimum parapet ht	3.0 ft	

Live Loads:

Roof

0 to 200 sf: 20 psf
200 to 600 sf: 24 - 0.02Area, but not less than 12 psf
over 600 sf: 12 psf

Floor

Typical Floor	50 psf
Lobbies & first floor corridors	100 psf
Corridors above first floor	80 psf
Mechanical	100 psf
Stairs & Exitways	100 psf
Balcony / Deck	50 psf
Partitions	20 psf

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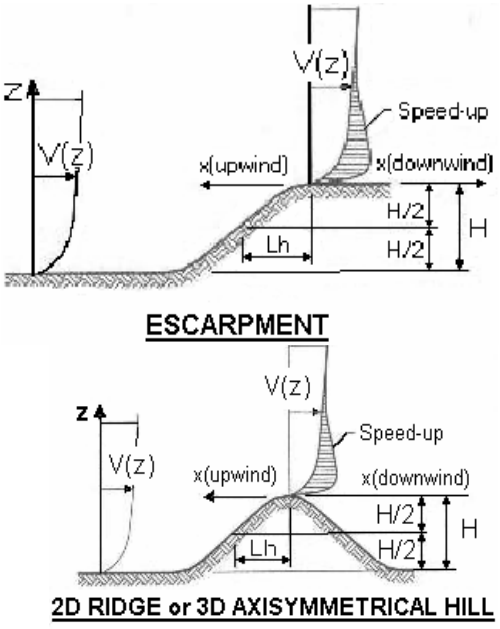
Wind Loads :

Importance Factor	1.00
Basic Wind speed	120 mph
Directionality (Kd)	0.85
Exposure Category	B
Enclosure Classif.	Partially Enclosed
Internal pressure	+/-0.55
Kh case 1	1.124
Kh case 2	1.124
Type of roof	Monoslope

Topographic Factor (Kzt)

Topography		Flat
Hill Height	(H)	80.0 ft
Half Hill Length (Lh)		100.0 ft
Actual H/Lh	=	0.80
Use H/Lh	=	0.50
Modified Lh	=	160.0 ft
From top of crest: x=		50.0 ft
Bldg up/down wind?		downwind

H/Lh= 0.50 K_1 = 0.000
x/Lh = 0.31 K_2 = 0.792
z/Lh = 0.98 K_3 = 1.000
At Mean Roof Ht:
Kzt = $(1+K_1K_2K_3)^2$ = 1.00



Gust Effect Factor

h = 157.0 ft
B = 100.0 ft
/z (0.6h) = 94.2 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).
However, if building h/B < 4 then probably rigid structure (rule of thumb).
h/B = 1.57 Therefore, probably rigid structure

G = 0.83 Using rigid structure formula

Rigid Structure

/ε =	0.33
l =	320 ft
z_{min} =	30 ft
c =	0.30
g_Q, g_v =	3.4
L_z =	453.9 ft
Q =	0.83
I_z =	0.25
G =	0.83

Flexible or Dynamically Sensitive Structure

Natural Frequency (n_1) =	0.0 Hz				
Damping ratio (β) =	0				
/b =	0.45				
/α =	0.25				
Vz =	102.9				
N_1 =	0.00				
R_n =	0.000				
R_h =	28.282	η =	0.000	h =	157.0 ft
R_B =	28.282	η =	0.000		
R_L =	28.282	η =	0.000		
g_R =	0.000				
R =	0.000				
G =	0.000				

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Enclosure Classification

Test for Enclosed Building: A building that does not qualify as open or partially enclosed.

Test for Open Building: All walls are at least 80% open.
$Ao \geq 0.8Ag$

Test for Partially Enclosed Building:

	Input
Ao	0.0 sf
Ag	0.0 sf
Aoi	0.0 sf
Agi	0.0 sf

	Test
$Ao \geq 1.1Aoi$	YES
$Ao > 4' / 0.01Ag$	NO
$Aoi / Agi \leq 0.20$	NO

Building is NOT Partially Enclosed.

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:
Ao >= 1.1Aoi
Ao > smaller of 4' or 0.01 Ag
Aoi / Agi <= 0.20
Where:
Ao = the total area of openings in a wall that receives positive external pressure.
Ag = the gross area of that wall in which Ao is identified.
Aoi = the sum of the areas of openings in the building envelope (walls and roof) not including Ao.
Agi = the sum of the gross surface areas of the building envelope (walls and roof) not including Ag.

Reduction Factor for large volume partially enclosed buildings (Ri) :

If the partially enclosed building contains a single room that is unpartitioned , the internal pressure coefficient may be multiplied by the reduction factor Ri.

Total area of all wall & roof openings (Aog): 0 sf
Unpartitioned internal volume (Vi) : 0 cf
Ri = 1.00

Altitude adjustment to constant 0.00256 :

Altitude = 0 feet
Constant = 0.00256
Average Air Density = 0.0765 lbm/ft^3

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Wind Loads - MWFRS all h (Enclosed/partially enclosed only)

Kh (case 2) =	1.12	h =	157.0 ft	GCpi =	+/-0.55
Base pressure (q_h) =	**35.2 psf**	ridge ht =	157.0 ft	G =	0.83
Roof Angle =	0.0 deg	L =	200.0 ft	z for qi :	157.0 ft use 90.00
Roof tributary area - (h/2)*L:	15700 sf	B =	100.0 ft	qi =	30.0 psf for positive internal pressures
(h/2)*B:	7850 sf				

Surface Pressures (psf) / Surface	Wind Normal to Ridge (psf) B/L = 0.50		h/L = 1.57		Wind Parallel to Ridge (psf) L/B = 2.00		h/L = 0.79	
	Cp	q_hGC_p	w/+q_iGC_{pi}	w/-q_hGC_{pi}	Dist.*	Cp	q_hGC_p	w/ +q_iGC_{pi}	w/ -q_hGC_{pi}
Windward Wall (WW)	0.80	23.5	see table below			0.80	23.5	see table below	
Leeward Wall (LW)	-0.50	-14.7	-31.2	4.7		-0.30	-8.8	-25.3	10.6
Side Wall (SW)	-0.70	-20.6	-37.1	-1.2		-0.70	-20.6	-37.1	-1.2
Leeward Roof (LR)		**				Included in windward roof			
Windward Roof: 0 to h/2*	-1.04	-30.5	-47.1	-11.2	0 to h/2*	-0.98	-28.8	-45.3	-9.4
> h/2*	-0.70	-20.6	-37.1	-1.2	h/2 to h*	-0.79	-23.1	-39.6	-3.7
					h to 2h*	-0.61	-18.0	-34.6	1.3

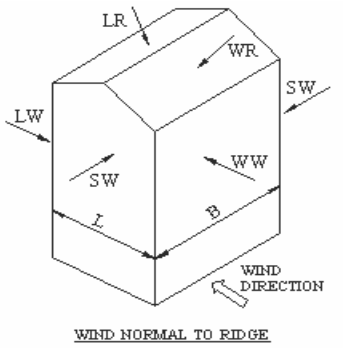
**Roof angle < 10 degrees. Therefore, leeward roof is included in windward roof pressure zones.

*Horizontal distance from windward edge

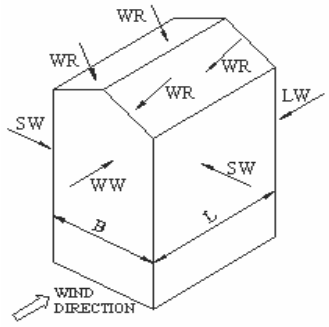
For monoslope roofs, entire roof surface is either windward or leeward surface.

Windward Wall Pressures at "z" (psf)

	z	Kz	Kzt	Windward Wall q_zGC_p	Windward Wall w/+q_iGC_{pi}	Windward Wall w/-q_hGC_{pi}	Combined WW + LW Normal to Ridge	Combined WW + LW Parallel to Ridge
	0 to 15'	0.57	1.00	12.0 psf	-4.5 psf	31.4 psf	26.7 psf	20.8 psf
	30.0 ft	0.70	1.00	14.6	-1.9	34.0	29.3	23.4
	50.0 ft	0.81	1.00	16.9	0.4	36.3	31.6	25.7
	80.0 ft	0.93	1.00	19.4	2.8	38.7	34.1	28.2
	120.0 ft	1.04	1.00	21.8	5.2	41.1	36.4	30.6
h=	157.0 ft	1.12	1.00	23.5	7.0	42.9	38.2	32.3



WIND NORMAL TO RIDGE



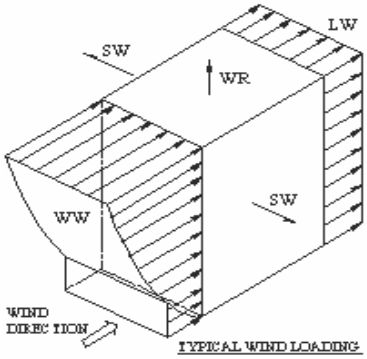
WIND PARALLEL TO RIDGE

NOTE:
See figure 6-9 of ASCE7 for the application of full and partial loading of the above wind pressures. There are 4 different loading cases.

Parapet

z	Kz	Kzt	qp (psf)
160.0 ft	1.13	1.00	35.4

Windward parapet: 63.7 psf (GCpn = +1.8)
Leeward parapet: -39.0 psf (GCpn = -1.1)



TYPICAL WIND LOADING

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Wind Loads - Components & Cladding : h > 60'

Kh (case 1) =	1.12	h =	157.0 ft
Base pressure (qh) =	**35.2 psf**	a =	10.0 ft
Minimum parapet ht =	3.0 ft	GCpi =	+/-0.55
Roof Angle =	0.0 deg	qi =	30.0 psf for positive internal pressures

Roof

	GCp			Surface Pressure (psf)			**User input**	
Area	10 sf	100 sf	500 sf	10 sf	100 sf	500 sf	50 sf	250 sf
Negative Zone 1	-1.40	-1.11	-0.90	-65.8 psf	-55.5 psf	-48.2 psf	-58.6 psf	-51.3 psf
Negative Zone 2	-2.30	-1.89	-1.60	-97.5 psf	-83.0 psf	-72.9 psf	-87.4 psf	-77.3 psf
Negative Zone 3	-2.30	-1.89	-1.60	-97.5 psf	-83.0 psf	-72.9 psf	-87.4 psf	-77.3 psf
Positive Zones 1-3	-	-	-	10.0 psf	10.0 psf	10.0 psf	10.0 psf	10.0 psf

Negative zone 3 = zone 2, since parapet >= 3ft.

Parapet

qp = 35.4 psf

CASE A = pressure towards building
CASE B = pressure away from building

	Surface Pressure (psf)			**User input**
Solid Parapet Pressure	10 sf	100 sf	500 sf	40 sf
CASE A : Interior zone:	113.3 psf	93.4 psf	77.9 psf	102.3 psf
Corner zone:	113.3 psf	93.4 psf	77.9 psf	102.3 psf
CASE B : Interior zone:	-63.7 psf	-54.9 psf	-46.0 psf	-59.9 psf
Corner zone:	-95.6 psf	-76.1 psf	-56.7 psf	-87.2 psf

Walls

	GCp			Surface Pressure at "h"			**User input**	
Area	20 sf	100 sf	500 sf	20 sf	100 sf	500 sf	28 sf	55 sf
Negative Zone 4	-0.90	-0.80	-0.70	-48.2 psf	-44.7 psf	-41.2 psf	-47.5 psf	-46.0 psf
Negative Zone 5	-1.80	-1.40	-1.00	-79.9 psf	-65.8 psf	-51.8 psf	-77.1 psf	-71.1 psf
Positive Zone 4 & 5	0.90	0.75	0.60	51.1 psf	45.8 psf	40.5 psf	50.0 psf	47.8 psf

NOTE: Negative zones 4 & 5 pressures apply to all heights. Positive pressures vary with height, see below.

Wall surface pressure at 'z'				Positive zone 4 & 5 (psf)			**User input**	
z	Kz	Kzt	qz (psf)	20	100	500	28 sf	55 sf
0 to 15'	0.70	1.00	22.0	39.1	35.8	32.5	38.5	37.1
30.0 ft	0.70	1.00	22.0	39.1	35.8	32.5	38.5	37.1
50.0 ft	0.81	1.00	25.4	42.2	38.4	34.6	41.5	39.8
80.0 ft	0.93	1.00	29.1	45.5	41.2	36.8	44.7	42.8
120.0 ft	1.04	1.00	32.6	48.7	43.8	38.9	47.8	45.7
h = 157.0 ft	1.12	1.00	35.2	51.1	45.8	40.5	50.0	47.8

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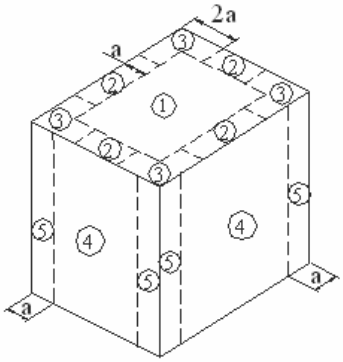
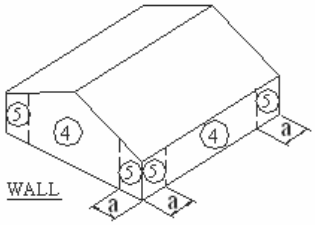
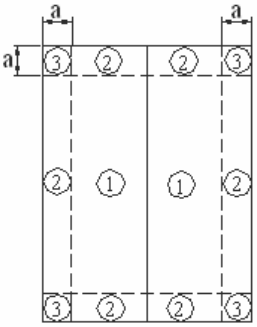
Location of Wind Pressure Zones



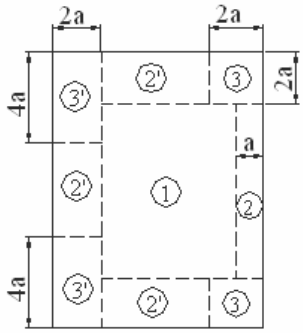
Roofs w/ $\theta \leq 10°$ and all walls
h > 60'



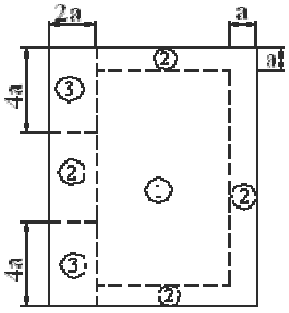
Walls h ≤ 60'
& alt design h<90'



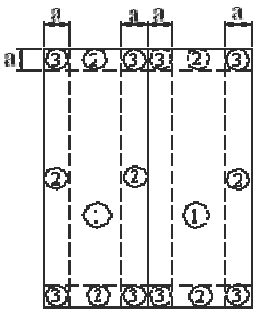
Gable, Sawtooth and Multispan Gable $\theta \leq 7$ degrees & Monoslope ≤ 3 degrees
h ≤ 60' & alt design h<90'



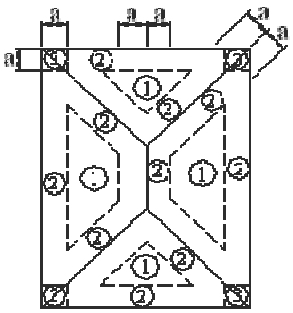
Monoslope roofs
$3° < \theta \leq 10°$
h ≤ 60' & alt design h<90'



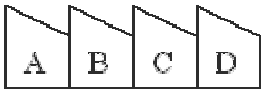
Monoslope roofs
$10° < \theta \leq 30°$
h ≤ 60' & alt design h<90'

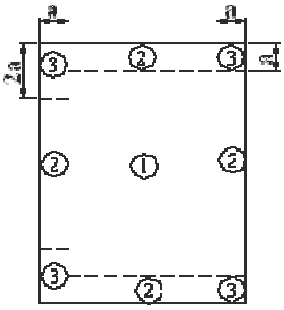


Multispan Gable & Gable $7° < \theta \leq 45°$

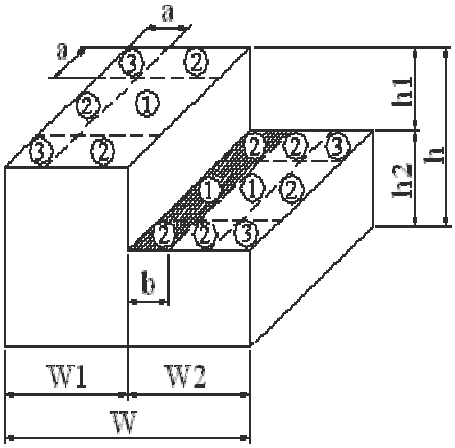


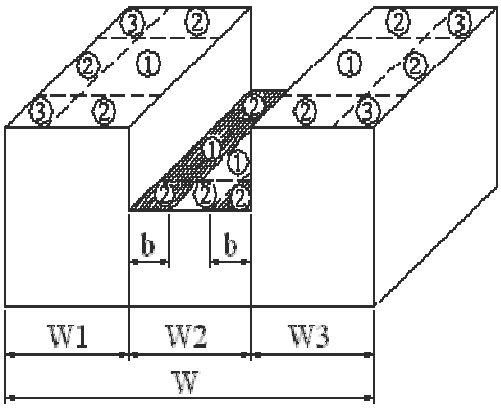
Hip $7° < \theta \leq 27°$





Sawtooth $10° < \theta \leq 45°$
h ≤ 60' & alt design h<90'





Stepped roofs $\theta \leq 3°$
h ≤ 60' & alt design h<90'

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Roof Design Loads

Items	Description	Multiple	psf (max)	psf (min)
Roofing	3 ply felt & gravel		5.5	5.0
Decking	Metal Roof deck, 1.5, 22 ga.		1.7	1.2
Framing	Steel roof joists & girders		3.0	2.0
Insulation	Rigid insulation, per 1"	x 2.0	3.0	1.5
Ceiling	Suspended acoustical tile		1.8	1.0
Sprinklers	Sprinklers		2.0	0.0
Mech & Elec	Mech. & Elec.		2.0	0.0
			0.0	0.0
		Actual Dead Load	○ 19.0	○ 10.7
		Use this DL instead	◉ 20.0	◉ 9.0
		Live Load	20.0	0.0
		Snow Load	0.0	0.0
		Wind (zone 2 - 100sf)	10.0	-83.0
ASD Loading		Dead + Live Load	40.0	-
		Dead + 0.75(Wind + Live) Load	42.5	-
		0.6*Dead + Wind Load	-	-77.6
LRFD Loading		1.2D + 1.6 Lr + 0.8W	64.0	-
		1.2D + 1.6W + 0.5Lr	50.0	-
		0.9D + 1.6W	-	-124.7

Roof Live Load Reduction Roof angle 0.00 / 12 0.0 deg

0 to 200 sf: 20.0 psf
200 to 600 sf: 24 - 0.02Area, but not less than 12 psf
over 600 sf: 12.0 psf

	300 sf	18.00 psf
	400 sf	16.00 psf
	500 sf	14.00 psf
User Input:	450 psf	15.00 psf

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Floor Design Loads

Items	Description	Multiple	psf (max)	psf (min)
Flooring	Carpet & pad		1.0	1.0
Topping	Concrete regular per 1"	x 4.3	53.1	51.0
Decking	Metal Floor deck - 2", 20ga		2.0	1.5
Framing	Steel floor bms/joists & girders		8.0	5.0
Topping	Deflection Concrete	x 0.8	9.4	1.5
Ceiling	Suspended acoustical tile		1.8	1.0
Sprinklers	Sprinklers		2.0	0.0
Mech & Elec	Mech. & Elec.		2.0	0.0
Misc.	Misc.		0.5	0.0
			0.0	0.0
		Actual Dead Load	◉ 79.8	◉ 61.0
		Use this DL instead	○ 100.0	○ 50.0
		Partitions	20.0	0.0
		Live Load	50.0	0.0
		Total Live Load	70.0	0.0
		Total Load	149.8	61.0

FLOOR LIVE LOAD REDUCTION (not including partitions)

NOTE: Not allowed for assembly occupancy or LL>100psf or passenger car garages, except may reduce columns 20% if 2 or more floors & non-assembly

$L=Lo(0.25+15/\sqrt{K_{LL}A_T})$

Unreduced design live load: Lo = 50 psf

Floor member K_{LL} = 2
Tributary Area A_T = 300 sf
Reduced live load: L = 43.1 psf

Columns (2 or more floors) K_{LL} = 4
Tributary Area A_T = 500 sf
Reduced live load: L = 29.3 psf

IBC alternate procedure
Smallest of:
R= .08%(SF - 150)
R= 23.1(1+D/L) = 60.0%
R= 40% beams; 60% columns

R = 12.0%
Reduced live load: L = 44.0 psf

R = 28.0%
Reduced live load: L = 36.0 psf

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CODE SUMMARY

Code: ASCE 7 - 02

Live Loads:

Roof	0 to 200 sf:	20 psf
	200 to 600 sf:	24 - 0.02Area, but not less than 12 psf
	over 600 sf:	12 psf

Typical Floor	50 psf
Lobbies & first floor corridors	100 psf
Corridors above first floor	80 psf
Mechanical	100 psf
Stairs & Exitways	100 psf
Balcony / Deck	50 psf
Partitions	20 psf

Dead Loads:

Floor	79.8 psf
Roof	20.0 psf

Wind Design Data:

Basic Wind speed	120 mph
Mean Roof Ht (h)	157.0 ft
Occupancy Category	II
Importance Factor	1.00
Exposure Category	B
Enclosure Classif.	Partially Enclosed
Internal pressure Coef.	+/-0.55
Directionality (Kd)	0.85

Roof Snow Loads:

Design Roof Snow load		=	0.0 psf
Flat Roof Snow Load	Pf	=	33.6 psf
Ground Snow Load	Pg	=	40.0 psf
Rain on Snow Surcharge		=	0.0 psf
Importance Factor	I	=	1.00
Snow Exposure Factor	Ce	=	1.00
Thermal Factor	Ct	=	1.20
Sloped-roof Factor	Cs	=	1.00

Earthquake Design Data:

Seismic Use Group :		=	II
Importance Factor	I	=	1.00
Mapped spectral response	Ss	=	60.00 %g
accelerations	S1	=	10.00 %g
Site Class		=	D
Spectral Response Coef.	Sds	=	0.528
	Sd1	=	0.160
Seismic Design Category		=	D
Basic Structural System		=	Bearing Wall Systems
Seismic Resisting System		=	Special reinforced concrete shear walls
Design Base Shear	V	=	0.036W
Seismic Response Coef.	Cs	=	0.036
Response Modification Factor	R	=	5
Analysis Procedure		=	Equivalent Lateral-Force Analysis

CODE SUMMARY- continued

Component and cladding wind pressures

Roof	Surface Pressure (psf)		
Area	10 sf	100 sf	500 sf
Negative Zone 1	-65.8	-55.5	-48.2
Negative Zone 2	-97.5	-83.0	-72.9
Negative Zone 3	-97.5	-83.0	-72.9
Positive Zones 1-3	10.0	10.0	10.0

Parapet	Solid Parapet Pressure (psf)		
Area	10 sf	100 sf	500 sf
CASE A: Interior zone	113.3	93.4	77.9
Corner zone	113.3	93.4	77.9
CASE B: Interior zone	-63.7	-54.9	-46.0
Corner zone	-95.6	-76.1	-56.7

Wall	Surface Pressure (psf)		
Area	20 sf	100 sf	500 sf
Negative Zone 4	-48.2	-44.7	-41.2
Negative Zone 5	-79.9	-65.8	-51.8
Positive Zone 4 & 5			
0 to 15'	39.1	35.8	32.5
30 ft	39.1	35.8	32.5
50 ft	42.2	38.4	34.6
80 ft	45.5	41.2	36.8
120 ft	48.7	43.8	38.9
h = 157 ft	51.1	45.8	40.5