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FM Wind Uplift

Design Resources

- www.roofnav.com
- FM PLPDS 1-28 (2024)
- FM PLPDS 1-29 (2022)
- ASCE 7 2005
- ASCE 7 2016



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FM PLPDS 1-28

FM Insured Building's pressures should be determined by using Rating Calculator on FM RoofNav Website www.roofnav.com

Note that this is not part of the building code and is not a consensus standard

- Calculations Formula based on ASCE 7-05
- Wind Map based on ASCE 7-05 (100-yr MRI)
- Results are Allowable Stress Design (ASD)
- Safety Factor x2
- GCp based on ASCE 7-16
- Roof Zones based on ASCE 7-16

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FM PLPDS 1-28

January 2024, Interim revision. The following changes were made:

A. The tornado guidance formerly in Appendix D has been transferred to new Sections 2.11 and 3.12, and to existing Section 4.2. All tables, figures and equations have been re-numbered to the new sections. Appendix D has been deleted in its entirety.

B. Guidance on FM Approved Roof Anchors was added to Sections 2.6 and 3.6. FM Approved Roof Anchors are now available and can be used to provide additional securement for roof mounted equipment to prevent overturning.

C. Modifications were made to the pressure coefficient for the vertical force equation in Section 2.6. Conditions where the ratio of the distance of elevated roof mounted equipment from the roof surface to the bottom of the equipment in relation to the mean roof height for the building (C*1) is > C 0.3 allows for a lower pressure coefficient.

D. The map in Figure 11-b "Basic wind speeds for areas in Canada in a tropical cyclone prone region" was added and replaces certain select cities in Canada within the Canadian Maritimes.

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Wind Uplift Load Determination
Key Factors

- Building Height
- Building Location (Local Wind Speed)
- Exposure Category (B, C, or D)
- Importance Category III/IV
- Openings (Partial or Enclosed)

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FM PLPDS 1-28 Wind Map
(3 sec Peak Gust Wind)

100-year MRI

Interpolation between isolines is not acceptable

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Importance Categories
(Building Use)

Importance Category I – Low risk to human life (Agricultural or storage)

Importance Category II – Not I, III, & IV (Commercial Buildings)

Importance Category III/IV – Substantial risk to human life
(Schools, Public Buildings, Hospitals, Power Plants, etc.)
Importance Factor I = 1.15

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ASCE 7-05

Velocity Pressure Formula

$qz = 0.00256 \times KZ \times KZt \times Kd \times V^2 \times I$

Variable	Building	ASCE 7-05
Kz	Height & Terrain (40' Exp C)	1.04
Kzt	Topography	1
Kd	Wind Directionality	0.85
V	100-yr MRI Winds	90 mph
I	Importance Cat III/IV	1.15
q_z	**Results**	**21.08**

$$P = qz \{ GCp - GCpi \}$$

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ASCE 7-16
Roof Zone GCp Coefficients

Roof Zones for Bldgs. < 90'	ASCE 7-16 GCp Coefficient
Zone 1'	0.9
Zone 1	1.7
Zone 2	2.3
Zone 3	3.0

Roof Zones for Bldgs. ≥ 90'	ASCE 7-16 GCp Coefficient
Zone 1'	N/A
Zone 1	1.4
Zone 2	2.3
Zone 3	3.0

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Factory Mutual's Adaptation of ASCE 7-16

GCpi = internal pressure coefficient

Opening Types	Amount of Openings	ASCE 7-16 GCpi Coefficient
Enclosed	Less than 10%	.18
Partially Enclosed	10% or greater openings	.55

P = qz (GCp – Gcpi)*SF

Roof Area	qz	GCp	GCpi	Safety Factor	Result (lbs/sq ft)	FM Rating
Zone 1'	21.08	-0.9	0.18	2	-45.5	60
Zone 1	21.08	-1.7	0.18	2	-79.3	90
Zone 2	21.08	-2.3	0.18	2	-104.8	105
Zone 3	21.08	-3.0	0.18	2	-142.5	150

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Example Results ASCE 7-05 & ASCE 7-16 vs. FM 1-28

Charlotte, NC

40-ft high
Exposure "C"
Enclosed Bldg
Category IV

	ASCE 7-05	ASCE 7-16	FM PLPDS 1-28
Local Wind Speed	90 mph	124 mph	90 mph
Zone 1'	N/A	21 psf	60 psf
Zone 1	25 psf	39 psf	90 psf
Zone 2	42 psf	52 psf	105 psf
Zone 3	63 psf	71 psf	150 psf

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FM PLPDS 1-29

This is not part of the building code and is not a consensus standard, nor has it been adopted by the Florida Building Code

- Prescriptive Criteria is based on Zone 1, not Zone 1'
- Prescriptive Criteria Limitations:
  - Zone 1 Rating ≤ 1-90 (90-psf)
    - Zone 1 Rating ≤ 1-105 (105-psf) and in a Non-Tropical Cyclone-Prone Region
- Prescriptive enhancements redefined
  - Insulation securement for adhered roof covers:
    - Fasteners & Adhesives
  - Roof cover securement for mechanically attached roof covers:
    - Linear in-seam
    - Induction Welded

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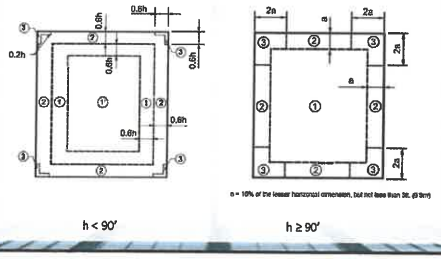
Roof Zone Layout

h = roof height (ft)



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Adhered Membrane Prescriptive Enhancement

Fastened Insulation

Zone 2: 50% more fasteners and plates than the field, but not less than 1 fastener 2 ft› and not more than 1 fastener per 1 ft›

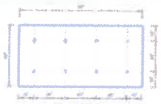
Zone 3: 1 fastener per 1 ft›

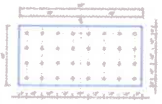
Example

Zone 1: 8 per 4' x 8' board (1 fastener per 4 ft›)

Zone 2: The larger of +50% of 8 per board (12) or 1 fastener per 2 ft› (16)

Zone 3: 1 fastener per 1 ft› (32)





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Adhered Membrane Prescriptive Enhancement

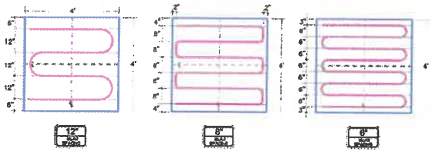
Adhesive Ribbon Spacing

Adhered membrane with substrate adhered in ribbons

Zone 2: 67% closer ribbons spacing than the field (rounded down)

Zone 3: 50% closer ribbon spacing than the field (rounded down)

Example: Zone 1: 12 inches, Zone 2: 8 inches, Zone 3: 6 inches



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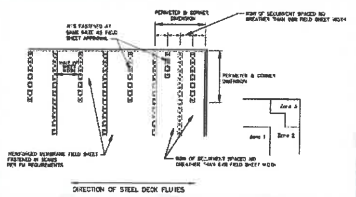
Mechanically Fastened Membrane Prescriptive Enhancements
Zone 2 and Zone 3 – In-Seam Attachment Option 1

Zone 2: Row spacing no greater than 67% of the field rows
Zone 3: Row spacing no greater than 50% of the field rows

Example: Zone 1: 7.5 ft
Zone 2: (7.5*.67)=5 ft
Zone 3: (7.5*.5)=3.75 ft



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Mechanically Fastened Membrane Prescriptive Enhancements
Zone 2 and Zone 3 – In-Seam Attachment Option 2

Note: This option is similar to ANSI/SPRI WD-1 & RAS 137

- Determine Zone 1 Pressure and Uplift Rating of assembly
- The sheet width from the Zone 1 assembly is allowed to reduce proportionally to the wind uplift increases in Zone 2 and Zone 3 respectively, rounded up to the nearest 15 PSF

Example: Zone 1 = -80 psf (uplift rating 90 psf)

Zone 1 roof system is 7.5 ft wide rows at 6 inches (0.5 ft) on center

[(Zone 1 Rating)*(Zone 1 Row)]/(Zone 2 or Zone 3 Rating) = Zone 2 or Zone 3 Row

Zone 2: Example Results: (90*7.5)/105 = 6.43 ft. rows
Zone 3: Example Results: (90*7.5)/150 = 4.5 ft. rows

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Mechanically Fastened Membrane Prescriptive Enhancements
Induction Weld

Plate & Fastener Density for Membrane Induction Weld
Zone 2: Reduce fastener contributory area to 67% of Zone 1
Zone 3: Reduce fastener contributory area to 50% of Zone 1

Zone 1 Fastening Rate: 1 fastener per 5.33 sq. ft. = 6 per board

Zone 2 Fastening Rate=5.33*0.67=3.57 sq. ft. per fastener
32 sq. ft. per board/3.57 = 9 per board

Zone 3 Fastening Rate=5.33*0.5=2.67 sq. ft. per fastener
32 sq. ft. per board/2.67 = 12 per board

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