



Factory Mutual

**LPDS 1-28 and 1-29
Updates 2020**

FM Wind Uplift Design Resources

- www.roofnav.com
- FM PLPDS 1-28
- FM PLPDS 1-29
- ASCE 7 2005
- ASCE 7 2016



FM Global Property Loss Prevention Data Sheets

1-28

October 2015
Interim Revision February 2020
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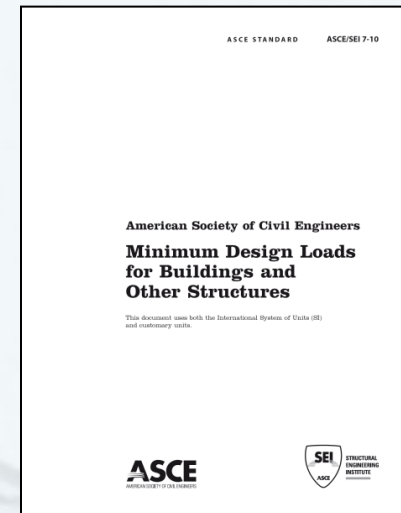
WIND DESIGN

FM Global Property Loss Prevention Data Sheets

1-29

January 2016
Interim Revision February 2020
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ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS



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

Wind Uplift Load Determination

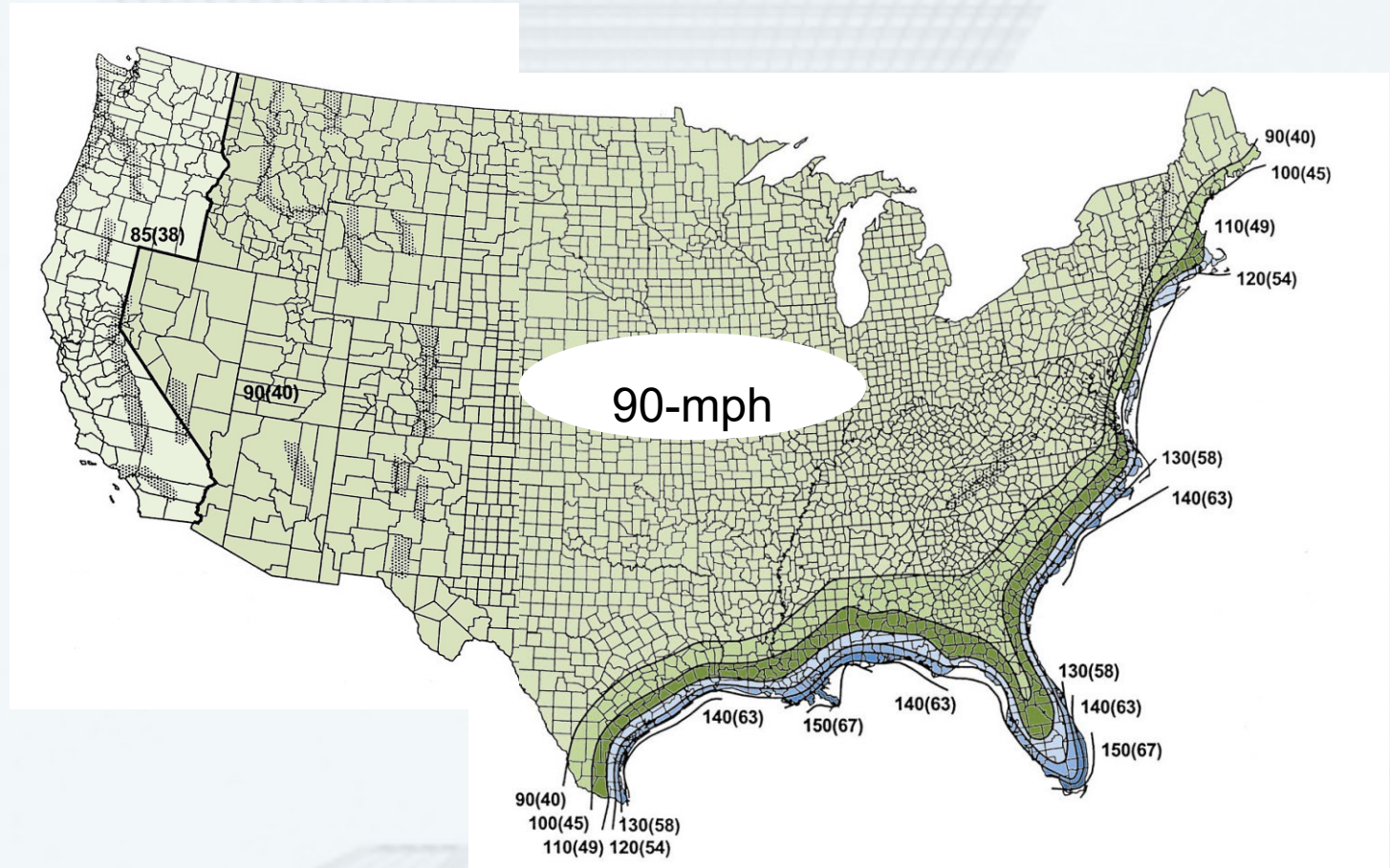
Key Factors

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



FM PLPDS 1-28 Wind Map

(3 sec Peak Gust Wind)



100-year MRI

Interpolation between isolines is not acceptable

Search Information

Address: Charlotte, NC, USA
Coordinates: 35.2270869, -80.8431267
Elevation: 763 ft
Timestamp: 2020-04-24T13:03:00.747Z
Hazard Type: Wind



ASCE 7-16

MRI 10-Year 73 mph
 MRI 25-Year 81 mph
 MRI 50-Year 86 mph
 MRI 100-Year 93 mph
 Risk Category I 103 mph
 Risk Category II 111 mph
 Risk Category III 118 mph
 Risk Category IV 124 mph

ASCE 7-05

ASCE 7-05 Wind Speed 90 mph

ASCE 7-10

MRI 10-Year 76 mph
 MRI 25-Year 84 mph
 MRI 50-Year 90 mph
 MRI 100-Year 96 mph
 Risk Category I 105 mph
 Risk Category II 115 mph
 Risk Category III-IV 120 mph

<https://hazards.atcouncil.org/>

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

ASCE 7-05

Velocity Pressure Formula

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

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

$$P = q_z \{ GC_p - GC_{pi} \}$$

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

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/sqft)	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	-104.6	105
Zone 3	21.08	-3.0	0.18	2	-142.5	150

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

Charlotte, NC

	ASCE 7-05	ASCE 7-16	FM PLPDS 1-28
40-ft high			
Exposure "C"			
Enclosed Bldg			
Category IV			
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

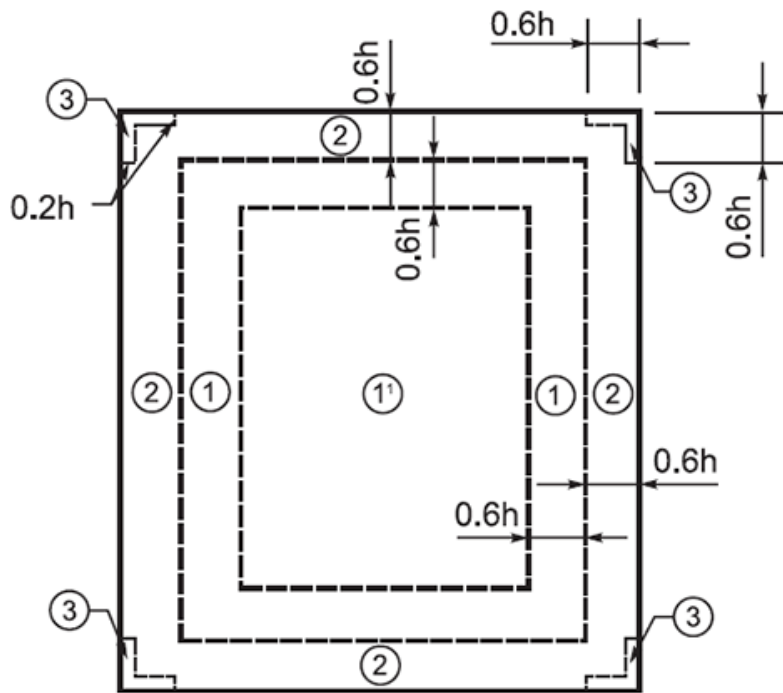
FM PLPDS 1-29

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

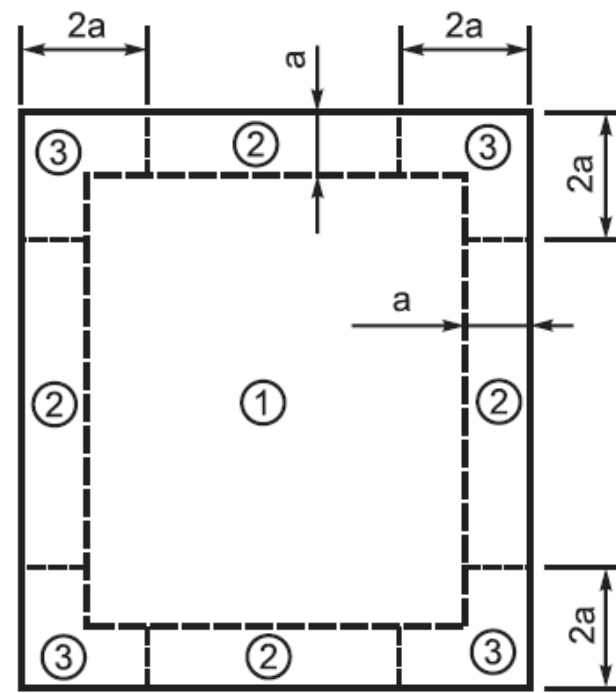
- Prescriptive Criteria is based on Zone 1, not Zone 1'
- Prescriptive Criteria Limitations:
 - Zone 1 Rating \leq **1-90** (90-psf)
 - Zone 1 Rating \leq **1-105** (105-psf) and in a Non-Tropical Cyclone-Prone Region
- Prescriptive enhancements redefined
 - Insulation securement for adhered roof covers: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

Roof Zone Layout

h = roof height (ft)



$h < 90'$



$a = 10\%$ of the lesser horizontal dimension, but not less than 3ft. (0.9m)

$h \geq 90'$

Adhered Membrane Prescriptive Enhancement Fastened Insulation

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

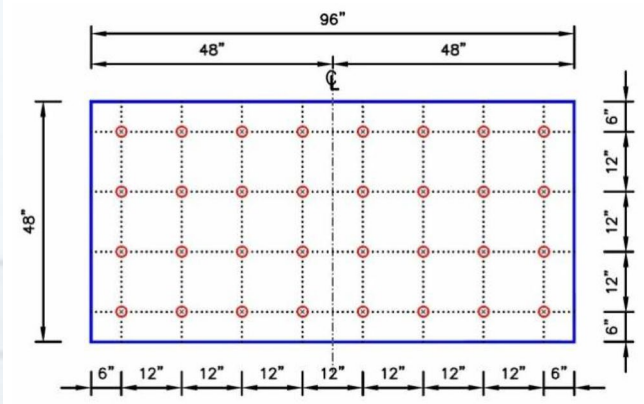
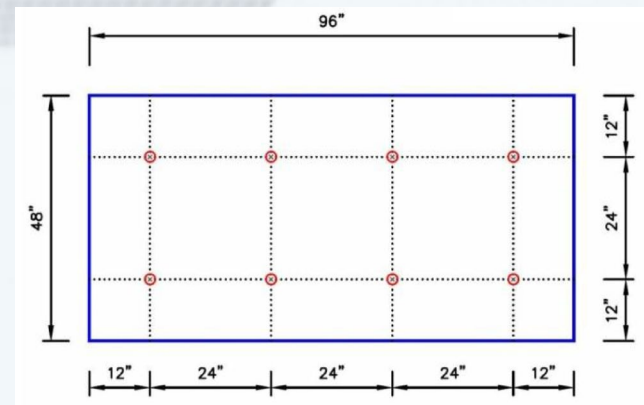
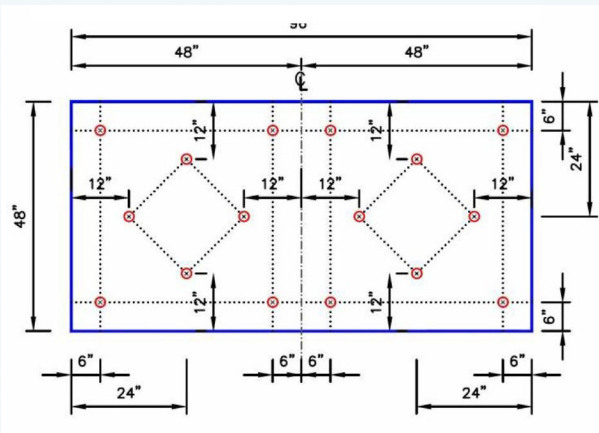
Zone 3: 1 fastener per 1 ft^2

Example

Zone 1: 8 per $4' \times 8'$ board (1 fastener per 4 ft^2)

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

Zone 3: 1 fastener per 1 ft^2 (32)



Adhered Membrane Prescriptive Enhancement

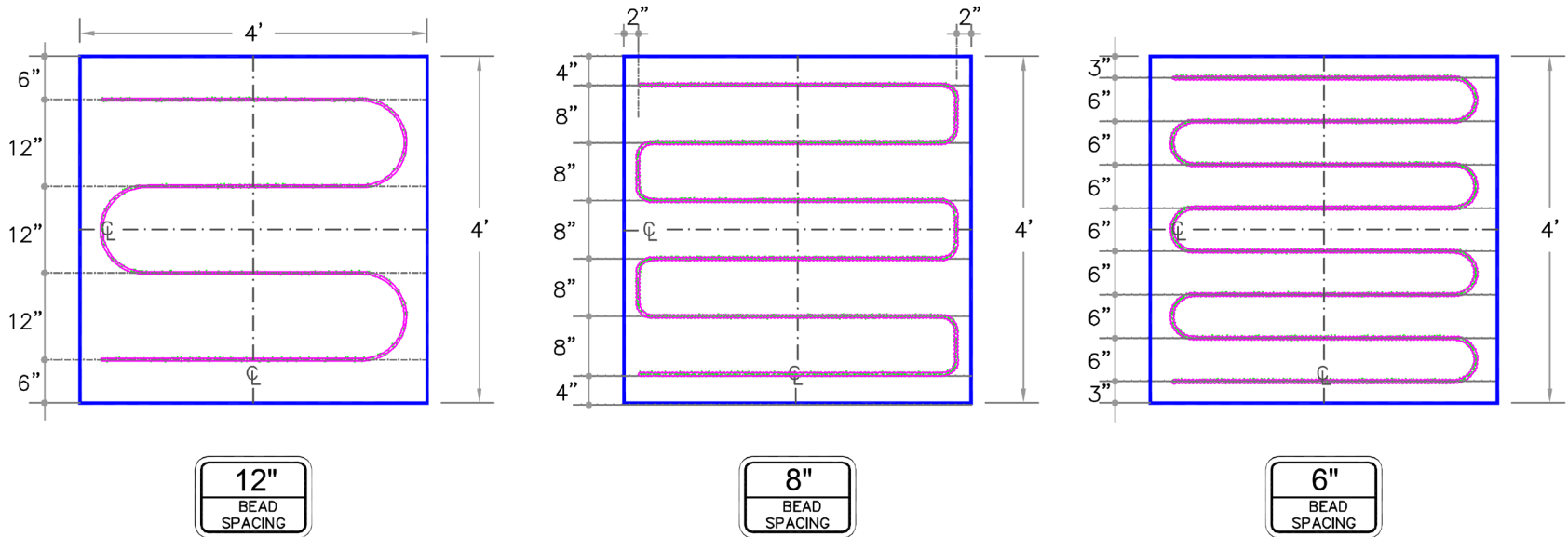
Adhesive Ribbon Spacing

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



Mechanically Fastened Membrane Prescriptive Enhancements

Zone 2 and Zone 3 – In-Seam Attachment Option 1

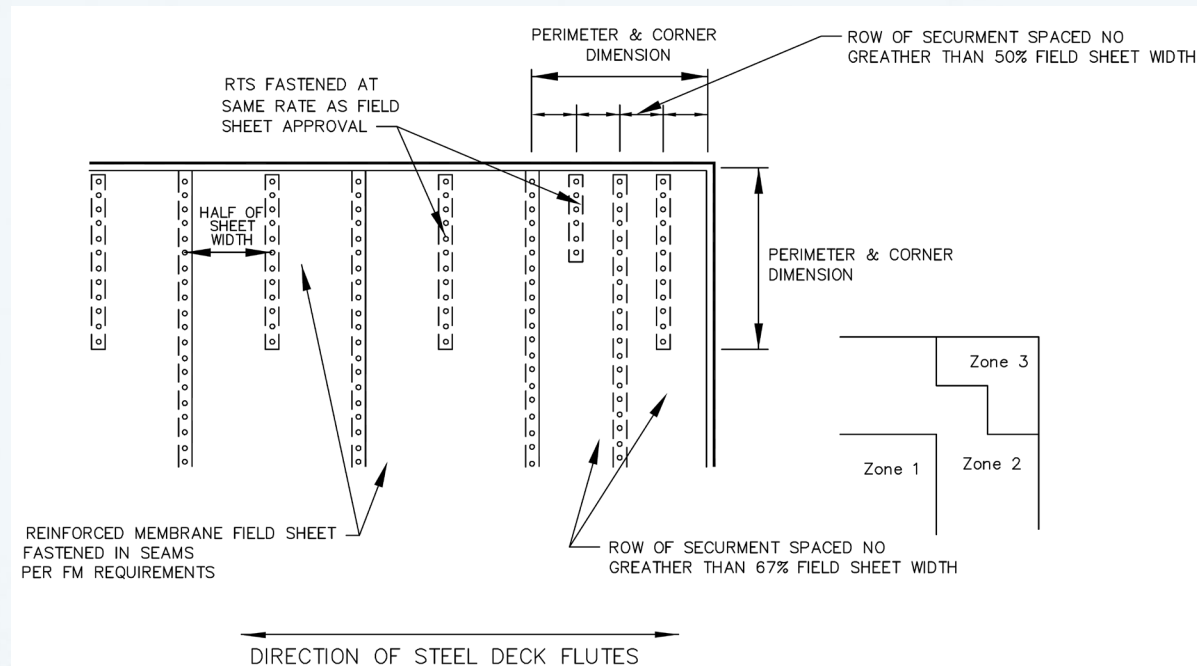
Zone 2: Row spacing no greater than 67% of the field rows

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

Example: Zone 1: 7.5 ft

Zone 2: $(7.5 \times .67) = 5$ ft

Zone 3: $(7.5 \times .5) = 3.75$ ft



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

$[(\text{Zone 1 Rating}) * (\text{Zone 1 Row})] / (\text{Zone 2 or Zone 3 Rating}) = \text{Zone 2 or Zone 3 Row}$

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

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

Mechanically Fastened Membrane Prescriptive Enhancements

Induction Weld

Plate & Fastener Density for Membrane Induction Weld

Zone 2: Reduce fastener contributory area to 67% of Zone 2

Zone 3: Reduce fastener contributory area to 50% of Zone 3

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

Zone 2 Fastening Rate= $5.33 \times .67 = 3.57$ sq. ft. per fastener
 $32 \text{ sq. ft. per board} / 3.57 = 9 \text{ per board}$

Zone 3 Fastening Rate= $5.33 \times .5 = 2.67$ sq. ft. per fastener
 $32 \text{ sq. ft. per board} / 2.67 = 12 \text{ per board}$

Manufacturer's Responsibility Testing

Tested Assemblies \geq Uplift Pressures

Manufacturer assembly tests:

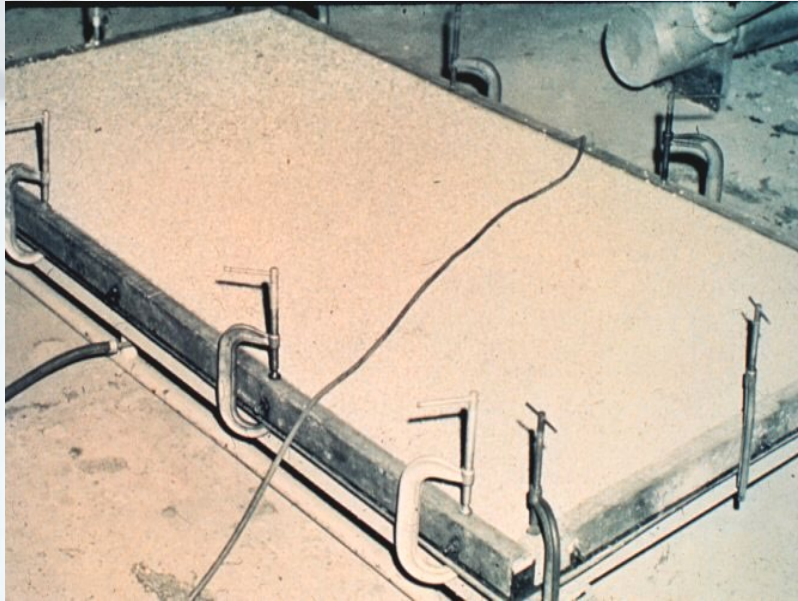
These tests certify the uplift rating for the specified assembly from lab testing

FM 4470

ANSI/FM 4474

UL 1897

Certification of Compliance



Uplift Rating Test

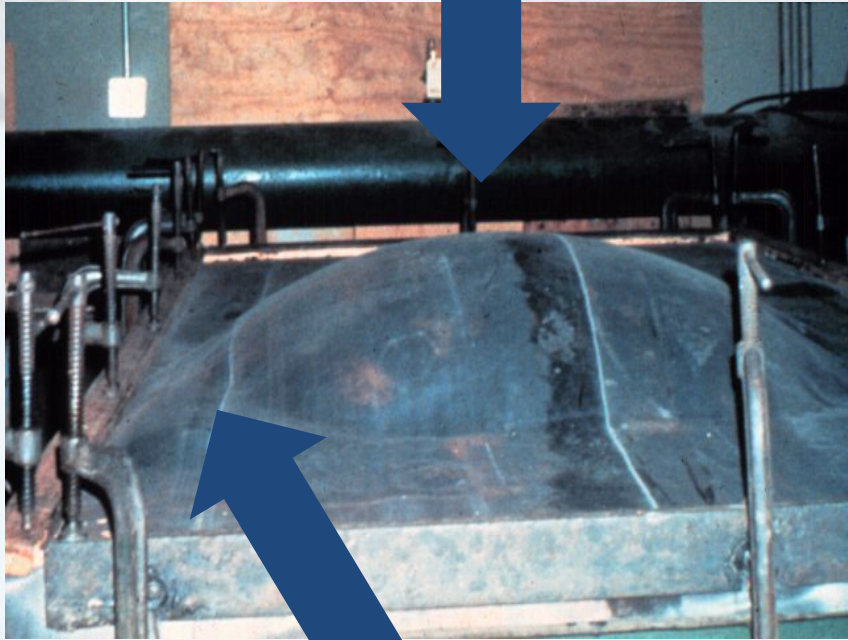
(ANSI/FM 4474)

- Test panel exposed to air pressure from below
- 15 psf levels, each level held for 1 minute
- Increased until failure

Ratings:

60 psf; 75 psf; 90 psf; 105 psf

Rating Limitations



Adhered Systems:

- If the membrane separates from insulation
- If the insulation facer delaminates
- If the insulation boards break

Board Breakage

Rating Limitations

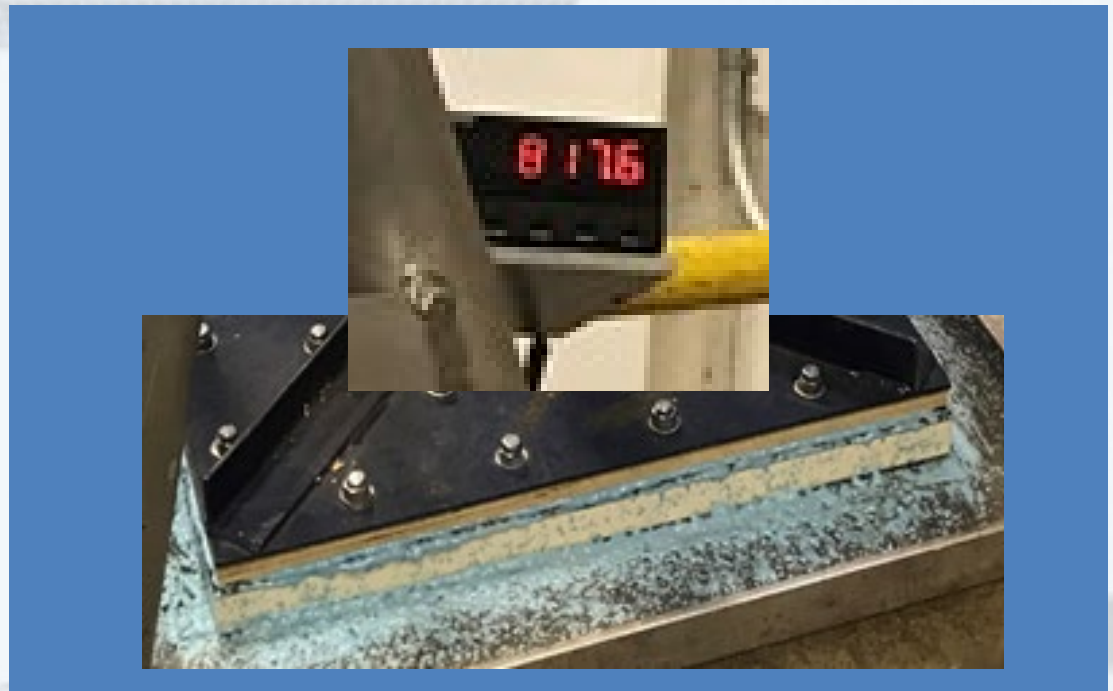
Mechanically Fastened Systems:

- If the fasteners pull out of the deck
- If the membrane ruptures



Rating Limitations

Monolithic Decks Pull Test





Demos

RoofNav & DORA Assembly Listings