



ANSI/SPRI Wind Design Standard Practice for Roofing Assemblies

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Disclaimer

This standard is for use by architects, engineers, roofing contractors and owners of low slope roofing systems.

SPRI, ITS MEMBERS AND EMPLOYEES DO NOT WARRANT THAT THIS STANDARD IS PROPER AND APPLICABLE UNDER ALL CONDITIONS.

1.0 Introduction

This Wind Design Standard Practice provides general building design considerations as well as a methodology for determining rooftop design wind uplift pressures, then selecting an appropriate roofing system assembly to meet those pressures. This Standard Practice is appropriate for non-ballasted Built-Up, Modified Bitumen, and Single-Ply roofing system assemblies installed over any type of roof deck. (Refer to the Related Reference Documents section of the standard, item 8, for the ballasted roofing system design standard reference).

First Part

The rooftop wind uplift design pressures for the field, perimeter and corner areas of a building shall be determined using the Quick Reference Tables provided in this Standard Practice or as directed by ASCE/SEI 7-10, Standard, *Minimum Design Loads for Buildings and Other Structures*. The Quick Reference Tables in this Standard Practice are based on Chapter 30, Part 1 (for buildings with a height $h \leq 60$ ft) and Part 3 (for buildings with a height $h > 60$ ft) of ASCE 7-10, and shall only be used if a particular building meets the criteria identified in Appendix A of this document. Wind uplift design pressure loads in the Quick Reference Tables are allowable strength loads. Wind uplift pressure loads determined using ASCE 7-10 are ultimate strength loads and must be multiplied by 0.6 to convert them to allowable strength loads.

Second Part

An appropriate roofing system assembly shall be selected by comparing the tested wind uplift resistance of that assembly to the wind uplift design pressures determined from the **First Part**. The appropriate safety factor shall be applied to the tested wind uplift resistance before comparison to the design pressures.

A Commentary section is provided at the end of this document to offer explanatory and supplementary information designed to assist users in complying with this Standard Practice. It is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements, or to provide other clarification.

This Wind Design Standard Practice shall be used in conjunction with the installation specifications and requirements of the manufacturer or supplier of the specified roofing system assembly. This Standard Practice is applicable to new roofing projects, reroofing projects (removing the existing materials and replacing with new materials) and recovering projects (covering over the existing materials with new materials).

2.0 Definitions

2.1 Building Height

The distance measured from the ground or finished grade around the building to the eave of the roof.

2.2 Building Openings

All buildings shall be categorized into one of the following:

2.2.1 Enclosed Building

A building shall be considered enclosed if it does not comply with the requirements for open or partially enclosed buildings.

2.2.2 Open Building

A building having each wall at least 80% open.

2.2.3 Partially Enclosed Building

A building that complies with both of the following conditions:

2.2.3.1 The total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10%, **and**

2.2.3.2 The total area of openings in a wall that receives positive external pressure exceeds 4 ft² (0.37m²) or 1% of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20%.

2.3 Risk Category of Buildings (Building Importance Factor)

Classification of buildings according to the hazard to human life in the event of a failure as described in the following table.

Risk Category of Buildings and Other Structures

Use or Occupancy of Buildings and Structures	Risk Category
► Buildings and other structures that represent a low risk to human life in the event of failure.	I
► All buildings and other structures except those listed in Risk Categories I, III, and IV.	II
► Buildings and other structures, the failure of which could pose a substantial risk to human life. ► Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure. ► Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.	III
► Buildings and other structures designated as essential facilities. ► Buildings and other structures, the failure of which could pose a substantial hazard to the community. ► Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released. ► Buildings and other structures required to maintain the functionality of other Risk Category IV structures.	IV

2.4 Eave of the Roof

The lower border of the roof that over hangs or intersects the wall.

2.5 Parapet Wall

A wall along the edge of a roof.

2.6 Roof Areas

Field, perimeter, ridge and corner areas shall be defined as follows:

2.6.1 Perimeter

The outer boundary of the roof with a width equal to 40% of the building height or 10% of the building's least horizontal dimension, whichever is smaller, but not less than either 4% of the least horizontal dimension or 3 ft (0.9 m).

2.6.2 Corners

The portion of the perimeter area, beginning at the intersection of two roof edges, and proceeding in both directions, a distance equal to the width of the perimeter area for gable roofs ≤ 60 ft in height, and a distance of twice the width of the perimeter area for all roofs > 60 ft in height. (Refer to Chapter 30 of ASCE 7-10 for corner definitions of non-gabled roofs ≤ 60 ft in height). Corner areas on buildings with minimum 3 ft high continuous parapet walls and a maximum roof slope of 7° (1.5 in per ft) shall be treated as perimeter areas.

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2.6.3 Ridge

The high point in a roof area formed by two intersecting planes with a slope greater than 10° (2 in per ft). The ridge area shall be measured from that point, down the slope in both directions, a distance equal to the width of the perimeter area.

2.6.4 Field

That portion of the roof area that is not included in the perimeter, ridge or corner areas.

2.7 Roof Slope

The distance of vertical rise (in inches) that occurs over a 1 ft horizontal run distance. Slope is expressed in inches per ft or in degrees. The degree of roof slope shall be determined using the following calculation: Inverse Tangent of (rise, in inches) divided by (run, in inches).

2.8 Roof Structure

The structural support system of the building to which the roof deck is attached.

2.9 Roofing System Assembly

The roofing system that includes any of the following, when applicable: the waterproof membrane, insulation, coverboards, thermal barriers, vapor or air barriers, adhesives, fasteners and plates, and the deck.

2.10 Surface Roughness/Exposure Categories

2.10.1 Surface Roughness/Exposure B

Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. For buildings with a mean roof height of less than or equal to 30 ft (9.1 m), Exposure B shall apply where this ground surface roughness prevails in the upwind direction for a distance greater than 1,500 ft (457 m). For buildings with a mean roof height greater than 30 ft (9.1 m), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance greater than 2,600 ft (792 m) or 20 times the height of the building, whichever is greater.

2.10.2 Surface Roughness/Exposure C

Open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country and grasslands. Exposure C shall apply for all cases where exposures B or D do not apply.

2.10.3 Surface Roughness/Exposure D

Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice. Exposure D shall apply where this ground surface roughness, prevails in the upwind direction for a distance greater than 5,000 ft (1,524 m) or 20 times the building height, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 ft (183 m) or 20 times the building height, whichever is greater, from an Exposure D condition as defined in the previous sentence.

3.0 Design Considerations

The following factors shall be considered as a matter of course prior to the calculation of the rooftop wind uplift design pressure for any building and the actual installation of any roofing system assembly.

3.1 Roof Structure

The building owner shall consult with a qualified and licensed professional such as an architect, architectural engineer, civil engineer or structural engineer to verify that the structure and deck will support the installed roofing system load in combination with all other design loads. The roof deck shall also be examined by the owner or his designated professional representative to verify that it supports the fastener design load requirements. If fasteners are used, on-site pullout tests shall be conducted, as directed by the owner or his designated professional representative, to verify that the fastener/deck will provide acceptable holding

power. (Refer to the ANSI/SPRI/FM 4435/ES-1 Standard for the methodology of conducting the pullout tests, available at the spri.org website.) When pullout tests are conducted, the fastener density shall be based on either the spacing of the fasteners determined as outlined in Section 4.2 or the spacing needed based on the pullout tests, whichever is more conservative.

3.2 Roof Slope

Determine the slope of the roofing system assembly as defined in Section 2.7.

3.3 Wind Speed

Determine the basic wind speed for the building location by referring to Appendix B of this Standard Practice or the Basic Wind Speed Maps (Figures 26.5-1A, 26.5-1B or 26.5-1C) of ASCE 7-10.

3.4 Building Height

Determine the height of the building as defined in Section 2.1. Specific topographic features such as hills shall be considered when calculating building height (refer to Section 26.8 of ASCE 7-10). For roof slopes greater than 10° (2 in per ft), the mean roof height shall be used.

3.5 Roof Areas

Wind impacts different areas of the roof in different ways, so separate design considerations are required. Determine the field, perimeter, ridge and corner areas of the roof as defined in Section 2.6.

3.6 Surface Roughness/Exposure Categories

The terrain surrounding a building will influence the degree of exposure of that building to the wind. Determine the surface roughness category classification as defined in Sections 2.10.1 to 2.10.3.

3.7 Risk Category of Buildings (Building Importance Factor)

Classify the building according to the hazard to human life in the event of a failure. Determine the Risk Category as defined in Sections 2.3.

3.8 Building Openings

Determine if the building is an Enclosed Building, an Open Building or a Partially Enclosed Building as defined in Section 2.2.1 to 2.2.3.2.

3.9 Roof Overhangs, Parapet and Rooftop Equipment

Design wind pressures for roof overhangs, parapets and rooftop equipment shall be determined using Section 30.1.1, Part 6 of ASCE 7-10.

3.10 Wind Speed-Up Over Hills, Ridges and Escarpments

Wind speed-up effects at isolated hills, ridges and escarpments constituting abrupt changes in the general topography, located in any exposure category, shall be included in the wind uplift design calculation when all of the conditions of Section 26.8.1 of ASCE 7-10 are met.

3.11 Roof Edging/Parapet Wall

The performance of the roofing assembly depends not only on the membrane and insulation attachment, but also on the attachment of the roof edging and on the parapet wall height. Roof edging installation shall be completed in accordance with the requirements of the ANSI/FM/SPRI ES-1 Standard.

4.0 Two-Part Methodology

4.1 First Part

Calculate the wind uplift design loads for the field, perimeter and corner areas of a building

The design wind uplift load shall be calculated for the field, perimeter (or ridge) and corner areas of the roof in accordance with current ASCE 7 Standard (as referenced in the International Building Code).

As a matter of convenience, quick reference design wind uplift load tables have been created and are included in Appendix A of this document. These tables shall be applicable when the building under consideration meets the criteria noted for each table. If the criteria do not match, the design loads shall be calculated in accordance with the current ASCE 7 Standard.

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4.2 Second Part

Select an appropriate roofing system assembly by comparing the tested wind uplift resistance capacity to the calculated design loads

The wind uplift resistance load capacity of a roofing system assembly shall be determined by testing in accordance with ANSI/FM 4474, FM 4450, FM 4470, UL 580, UL 1897 or CSA A123.21-10. (Tested wind uplift load capacity values are available from the roofing system assembly supplier as well as from reports, publications and websites provided and maintained by various third party testing laboratories.) When using ANSI/FM 4474, FM 4450, FM 4470, UL 580 or UL 1897, a safety factor of 2.0, unless otherwise specified, shall be applied to the tested value to obtain the Factored Tested Load Capacity. A safety factor of 1.5 shall be used when the CSA A123.21-10 test method is utilized. The Factored Tested Load Capacity shall be calculated as follows:

Factored Tested Load Capacity=tested uplift capacity (L_t)/safety factor, psf

Select an appropriate roofing system assembly for use on a particular building by comparing the factored tested load capacity of the assembly to the design loads of the building. When the factored tested load capacity meets or exceeds the design load for the field of the roof, the system is suitable for use. The factored tested load capacity shall then be compared to the perimeter and corner design loads. When the factored tested load capacity meets or exceeds both of these values, the assembly, as tested, is suitable for use across the entire roof area.

When the factored tested load capacity is less than the design load for the field of the roof, the assembly shall not be used on that particular building.

In some instances, the factored tested load capacity will exceed the field design load, but will be less than the perimeter and/or corner design loads. When this occurs, one of the extrapolation methods described below shall be used to enhance the roofing system assembly to be able to meet the perimeter and corner design loads.

4.2.1 Extrapolation Method—Adhered System Assemblies

The adhered roofing system assembly extrapolation method shall only be used when all of the following criteria are met:

1. The adhered roofing system assembly utilizes either mechanical fasteners or ribbons/beads of an adhesive for insulation attachment, **and**
2. The tested wind uplift load capacity of the proposed adhered roofing system assembly was determined utilizing a test chamber of sufficient size to allow side-by-side positioning of a minimum of three full-size insulation/coverboard/substrate boards/panels on the test frame, **and**
3. The calculated field design load does not exceed 53 psf.

This extrapolation shall not be used for adhered roofing system assemblies when the insulation layer(s) is (are) attached using a 100% coverage rate of any adhesive.

Mechanically Attached Insulation

For insulation attached with mechanical fasteners, the increased number of fasteners per insulation board (F_n) needed to meet the calculated design load(s) shall be determined using the following equation:

$$F_n = (F_t \times L_d) / L_t$$

Where

F_n is the number of fasteners per board needed to meet the design load.

F_t is the number of fasteners per board used to achieve the tested load capacity.

L_d is the calculated design load for the perimeter or corner area of a roof, psf.

L_t is the factored tested load capacity, psf.

Refer to Commentary A for a practical example of extrapolation for an adhered system assembly utilizing mechanically attached insulation.

Ribbon/Bead Adhesive Attached Insulation

For insulation attached with ribbons/beads of an adhesive, the reduced ribbon/bead spacing (R_n) needed to meet the calculated design load(s) shall be determined using the following equation:

$$R_n = R_t / (L_d / L_t)$$

Where

R_n is the ribbon/bead spacing needed to meet the design load, inches.

R_t is the ribbon/bead spacing used to achieve the tested load capacity, inches.

L_d is the calculated design load for the perimeter or corner area of a roof, psf.

L_t is the factored tested load capacity, psf.

Note: When ribbon/bead-attached insulation is applied directly to a fluted steel deck, the ribbon/bead spacing will be dictated by the center-to-center spacing of the top (high) flutes of the steel deck. The extrapolated ribbon/bead spacing shall be rounded down (when necessary) to coincide with a top (high) flute spacing. If the extrapolated ribbon/bead spacing is less than the center-to-center spacing of the top (high) flutes of a steel deck, ribbon/bead attachment of the insulation in that area shall not be acceptable.

Refer to Commentary A for a practical example of extrapolation for an adhered system assembly utilizing ribbon/bead-attached insulation.

Cautionary Note

The F_n and R_n equations shall only be used to increase the number of fasteners or decrease the spacing of ribbons/beads of adhesive needed in the perimeter and corner areas. These equations shall not be used to extrapolate backwards and reduce the number of fasteners or increase the spacing of ribbons/beads of adhesive used in the field of the roof.

4.2.2 Extrapolation Method—Mechanically Fastened System Assemblies

The mechanically fastened roofing system assembly extrapolation method shall only be used when the following criteria are met:

1. The tested wind uplift load capacity of the proposed linearly-attached (rows) mechanically fastened roofing system assembly was determined utilizing a test chamber of sufficient size such that the tested row spacing did not exceed one half of the table length, and that one attachment row was centered along the length of the table. The minimum frame width shall be 8 ft (2.4 m).
2. The tested wind uplift load capacity of the proposed spot-attached mechanically fastened roofing system assembly was determined utilizing a test chamber of sufficient size to allow positioning of a minimum of nine attachment locations on the test frame. The minimum frame width shall be 8 ft.

For mechanically fastened system assemblies, the influence area per fastener for the tested assembly (IA_t) shall be determined by multiplying the row spacing by the fastener spacing (along the row). For spot attached systems, multiply the distance between the attachment locations in each direction (2 ft × 2 ft, 2 ft × 3 ft etc. (61 cm × 61 cm) (61 cm × 91 cm). This gives the number of square feet of membrane held in place by one fastener. The influence area needed to meet the design load shall be determined using the following equation:

$$IA_n = (L_t \times IA_t) / L_d$$

Where

IA_n is the area of membrane needed to be held in place by one fastener to meet the design load, ft².

IA_t is the area of membrane held in place by one fastener for the tested assembly, ft².

L_d is the calculated design load for the perimeter or corner area of a roof, psf.

L_t is the factored tested load capacity, psf.

The fastener row spacing or the spot attachment grid spacing of the assembly being evaluated shall be reduced so the ft² area of membrane held in place by each fastener does not exceed **IA_n**. For linearly-attached assemblies, the fastener spacing (along the row) shall be the same as was tested.

Refer to Commentary A for a practical example of extrapolation for membrane attachment on a mechanically fastened roofing system assembly. It shall be permissible, as explained in Commentary A, to use the perimeter fastener row spacing in the corner areas provided the perimeter rows are installed in both directions.

Cautionary Note: For mechanically fastened system assemblies with linear (row) attachment, only the spacing between fastener rows shall be reduced to meet **IA_n**. This extrapolation method shall not be used to reduce the spacing between fasteners along the row (12 in to 6 in (12 in to 18 in) (30 cm to 15 cm) (30 cm to 46 cm), for example) in place of reducing the spacing between fastener rows. This extrapolation method also shall not be used to extrapolate backwards and increase the spacing between fasteners along the row (12 in to 18 in, for example) or increase the spacing between fastener rows (8 ft to 10 ft (2.4 m to 3 m), for example).

Appendix A

Quick Reference Tables

Reference Design Load Tables have been developed using the ASCE 7-10 Standard (*Minimum Design Loads For Buildings And Other Structures*) and are contained in Appendix A of this document. The tables were developed using Part 1 of ASCE 7-10 for buildings ≤ 60 ft in height and using Part 3 of ASCE 7-10 for buildings > 60 ft in height. The External Pressure Coefficient (G_{Cp}) used in the calculations for buildings ≤ 60 ft in height were 1.0 for the field, 1.8 for the perimeter and 2.8 for the corner (from Figure 30.4-2). The External Pressure Coefficient (G_{Cp}) used in the calculations for buildings > 60 ft in height were 1.4 for the field, 2.4 for the perimeter and 3.2 for the corner (from Figure 30.6-1). The values contained in the Quick Reference Tables are allowable strength loads. These values are lower than the values contained in the tables of Part 2 and Part 4 of Chapter 30 of ASCE 7-10 because the Chapter 30 table values are ultimate strength values. The ultimate strength values must be multiplied by 0.6 (as indicated in Section 2.4.1, line item 7, of ASCE 7-10) to convert them to allowable strength loads.

These Quick Reference Tables are applicable to buildings in exposure categories B, C and D when *all* of the following criteria are met:

1. The building is not situated on a hill, ridge or escarpment (Refer to Section 3.4, Building Height, of this document or Section 26.8 of ASCE 7-10).
2. The building is Risk Category II (Refer to Section 2.3, Risk Category of Buildings (Building Importance Factor), of this document or Table 1.5-1 of ASCE 7-10).
3. The building is enclosed (Refer to Section 2.2, Building Openings, of this document or Section 26.2 of ASCE 7-10).
4. The roof slope does not exceed 2 in per ft (10°).

When a building is exposed to factors such as wind directionality, wind gust effect or large volume reduction factors, or the building is situated on a hill, ridge or escarpment, or the roof slope is greater than 10° (2 in per ft), these Quick Reference Tables shall not be used. When these Quick Reference Tables are not usable, the design loads shall be calculated using the methodology of the current ASCE 7 Standard for Components and Cladding (C&C).

To use the Reference Tables, simply match the building criteria with the proper table. The design load is listed for the field, perimeter and corner areas based on building height.

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Quick Reference Tables for Surface Roughness/Exposure B—Pages 10–12

Exposure B applies to urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. For buildings with a mean roof height of less than or equal to 30 ft (9.1 m), Exposure B shall apply where this ground surface roughness prevails in the upwind direction for a distance greater than 1,500 ft (457 m). For buildings with a mean roof height greater than 30 ft (9.1 m), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance greater than 2,600 ft (792 m) or 20 times the height of the building, whichever is greater.

Quick Reference Tables for Surface Roughness/Exposure C—Pages 13–15

Exposure C applies to open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country and grasslands. Exposure C shall apply for all cases where exposures B or D do not apply.

Quick Reference Tables for Surface Roughness/Exposure D—Pages 16–18

Exposure D applies to flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice. Exposure D shall apply where this ground surface roughness, prevails in the upwind direction for a distance greater than 5,000 ft (1,524 m) or 20 times the building height, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 ft (183 m) or 20 times the building height, whichever is greater, from an Exposure D condition as defined in the previous sentence.

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Quick Reference Tables

Building Risk Category II, Exposure B

110 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-15.4	-25.8	-38.8
20	-15.4	-25.8	-38.8
25	-15.4	-25.8	-38.8
30	-15.4	-25.8	-38.8
40	-16.7	-28.0	-42.1
50	-17.8	-29.8	-44.9
60	-18.6	-31.3	-47.1
70	-26.1	-41.0	-55.9
80	-27.3	-42.9	-58.4
90	-28.2	-44.2	-60.3
100	-29.1	-45.6	-62.2
120	-30.5	-47.9	-65.3
140	-32.0	-50.2	-68.5
160	-33.2	-52.1	-71.0
180	-34.4	-53.9	-73.5
200	-35.2	-55.3	-75.4
250	-37.6	-59.0	-80.4
300	-39.6	-62.2	-84.8
350	-41.4	-65.0	-88.6
400	-43.2	-67.8	-92.3
450	-44.6	-70.1	-95.5
500	-45.8	-71.9	-98.0

115 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-16.8	-28.2	-42.4
20	-16.8	-28.2	-42.4
25	-16.8	-28.2	-42.4
30	-16.8	-28.2	-42.4
40	-18.2	-30.6	-46.0
50	-19.4	-32.6	-49.0
60	-20.4	-34.2	-51.5
70	-28.6	-44.8	-61.1
80	-29.8	-46.9	-63.9
90	-30.8	-48.4	-65.9
100	-31.8	-49.9	-68.0
120	-33.4	-52.4	-71.4
140	-35.0	-54.9	-74.8
160	-36.3	-56.9	-77.6
180	-37.6	-58.9	-80.3
200	-38.5	-60.5	-82.4
250	-41.1	-64.5	-87.9
300	-43.3	-68.0	-92.7
350	-45.3	-71.0	-96.8
400	-47.2	-74.1	-100.9
450	-48.8	-76.6	-104.4
500	-50.1	-78.6	-107.1

120 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-18.3	-30.7	-46.1
20	-18.3	-30.7	-46.1
25	-18.3	-30.7	-46.1
30	-18.3	-30.7	-46.1
40	-19.8	-33.3	-50.1
50	-21.1	-35.5	-53.4
60	-22.2	-37.2	-56.0
70	-31.1	-48.8	-66.5
80	-32.5	-51.0	-69.5
90	-33.5	-52.7	-71.8
100	-34.6	-54.3	-74.0
120	-36.3	-57.0	-77.8
140	-38.1	-59.8	-81.5
160	-39.5	-62.0	-84.5
180	-40.9	-64.2	-87.5
200	-41.9	-65.8	-89.7
250	-44.7	-70.2	-95.7
300	-47.2	-74.1	-100.9
350	-49.3	-77.3	-105.4
400	-51.4	-80.6	-109.9
450	-53.1	-83.4	-113.6
500	-54.5	-85.6	-116.6

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Quick Reference Tables

Building Risk Category II, Exposure B

130 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-21.4	-36.0	-54.1
20	-21.4	-36.0	-54.1
25	-21.4	-36.0	-54.1
30	-21.4	-36.0	-54.1
40	-23.3	-39.1	-58.8
50	-24.8	-41.6	-62.7
60	-26.0	-43.7	-65.8
70	-36.5	-57.3	-78.1
80	-38.1	-59.9	-81.6
90	-39.4	-61.8	-84.2
100	-40.6	-63.7	-86.9
120	-42.7	-67.0	-91.2
140	-44.7	-70.2	-95.6
160	-46.3	-72.7	-99.1
180	-48.0	-75.3	-102.7
200	-49.2	-77.3	-105.3
250	-52.5	-82.4	-112.3
300	-55.4	-86.9	-118.4
350	-57.8	-90.8	-123.7
400	-60.3	-94.6	-129.0
450	-62.3	-97.9	-133.4
500	-64.0	-100.4	-136.9

140 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-24.9	-41.7	-62.8
20	-24.9	-41.7	-62.8
25	-24.9	-41.7	-62.8
30	-24.9	-41.7	-62.8
40	-27.0	-45.3	-68.2
50	-28.8	-48.3	-72.7
60	-30.2	-50.7	-76.3
70	-42.3	-66.4	-90.6
80	-44.2	-69.4	-94.6
90	-45.7	-71.7	-97.7
100	-47.1	-73.9	-100.7
120	-49.5	-77.6	-105.8
140	-51.8	-81.4	-110.9
160	-53.8	-84.4	-115.0
180	-55.7	-87.4	-119.1
200	-57.1	-89.6	-122.1
250	-60.9	-95.6	-130.2
300	-64.2	-100.8	-137.4
350	-67.1	-105.3	-143.5
400	-69.9	-109.8	-149.6
450	-72.3	-113.5	-154.7
500	-74.2	-116.5	-158.7

150 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-28.5	-47.9	-72.1
20	-28.5	-47.9	-72.1
25	-28.5	-47.9	-72.1
30	-28.5	-47.9	-72.1
40	-31.0	-52.0	-78.3
50	-33.0	-55.4	-83.4
60	-34.7	-58.2	-87.5
70	-48.6	-76.3	-104.0
80	-50.8	-79.7	-108.6
90	-52.4	-82.3	-112.1
100	-54.1	-84.9	-115.6
120	-56.8	-89.1	-121.5
140	-59.5	-93.4	-127.3
160	-61.7	-96.9	-132.0
180	-63.9	-100.3	-136.7
200	-65.5	-102.9	-140.2
250	-69.9	-109.7	-149.5
300	-73.7	-115.7	-157.7
350	-77.0	-120.8	-164.7
400	-80.3	-126.0	-171.7
450	-83.0	-130.3	-177.6
500	-85.2	-133.7	-182.2

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Building Risk Category II, Exposure B

160 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-32.5	-54.5	-82.0
20	-32.5	-54.5	-82.0
25	-32.5	-54.5	-82.0
30	-32.5	-54.5	-82.0
40	-35.3	-59.2	-89.1
50	-37.6	-63.1	-94.9
60	-39.4	-66.2	-99.6
70	-55.3	-86.8	-118.3
80	-57.8	-90.7	-123.6
90	-59.6	-93.6	-127.6
100	-61.5	-96.5	-131.6
120	-64.6	-101.4	-138.2
140	-67.7	-106.3	-144.9
160	-70.2	-110.2	-150.2
180	-72.7	-114.1	-155.5
200	-74.6	-117.0	-159.5
250	-79.5	-124.8	-170.1
300	-83.9	-131.6	-179.4
350	-87.6	-137.5	-187.4
400	-91.3	-143.4	-195.4
450	-94.4	-148.2	-202.0
500	-96.9	-152.1	-207.3

170 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-36.7	-61.5	-92.6
20	-36.7	-61.5	-92.6
25	-36.7	-61.5	-92.6
30	-36.7	-61.5	-92.6
40	-39.8	-66.8	-100.5
50	-42.4	-71.2	-107.1
60	-44.5	-74.7	-112.4
70	-62.4	-98.0	-133.5
80	-65.2	-102.4	-139.5
90	-67.3	-105.7	-144.0
100	-69.4	-109.0	-148.5
120	-72.9	-114.5	-156.0
140	-76.4	-120.0	-163.5
160	-79.3	-124.4	-169.5
180	-82.1	-128.8	-175.5
200	-84.2	-132.1	-180.0
250	-89.8	-140.9	-192.1
300	-94.7	-148.6	-202.6
350	-98.9	-155.2	-211.6
400	-103.1	-161.8	-220.6
450	-106.6	-167.3	-228.1
500	-109.4	-171.7	-234.1

180 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-41.1	-69.0	-103.8
20	-41.1	-69.0	-103.8
25	-41.1	-69.0	-103.8
30	-41.1	-69.0	-103.8
40	-44.6	-74.9	-112.7
50	-47.6	-79.8	-120.1
60	-49.9	-83.8	-126.1
70	-70.0	-109.8	-149.7
80	-73.1	-114.8	-156.4
90	-75.5	-118.5	-161.5
100	-77.8	-122.2	-166.5
120	-81.8	-128.4	-174.9
140	-85.7	-134.5	-183.3
160	-88.9	-139.5	-190.1
180	-92.0	-144.4	-196.8
200	-94.4	-148.1	-201.9
250	-100.6	-158.0	-215.3
300	-106.2	-166.6	-227.1
350	-110.9	-174.0	-237.2
400	-115.6	-181.4	-247.3
450	-119.5	-187.6	-255.7
500	-122.7	-192.5	-262.4

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Building Risk Category II, Exposure C

110 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-18.6	-31.3	-47.1
20	-19.7	-33.1	-49.8
25	-20.6	-34.6	-52.1
30	-21.5	-36.1	-54.3
40	-22.8	-38.3	-57.6
50	-23.9	-40.1	-60.4
60	-24.8	-41.6	-62.6
70	-34.4	-53.9	-73.5
80	-35.5	-55.8	-76.0
90	-36.4	-57.2	-77.9
100	-37.0	-58.1	-79.2
120	-38.5	-60.4	-82.3
140	-39.9	-62.7	-85.4
160	-40.8	-64.1	-87.3
180	-42.0	-65.9	-89.8
200	-42.9	-67.3	-91.7
250	-44.9	-70.5	-96.1
300	-46.7	-73.3	-99.9
350	-48.2	-75.6	-103.0
400	-49.6	-77.9	-106.2
450	-50.8	-79.7	-108.7
500	-52.0	-81.6	-111.2

115 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-20.4	-34.2	-51.5
20	-21.6	-36.2	-54.5
25	-22.5	-37.8	-56.9
30	-23.5	-39.4	-59.3
40	-24.9	-41.8	-63.0
50	-26.1	-43.8	-66.0
60	-27.1	-45.4	-68.4
70	-37.6	-58.9	-80.3
80	-38.8	-61.0	-83.1
90	-39.8	-62.5	-85.1
100	-40.4	-63.5	-86.5
120	-42.0	-66.0	-89.9
140	-43.6	-68.5	-93.4
160	-44.6	-70.0	-95.4
180	-45.9	-72.0	-98.2
200	-46.9	-73.6	-100.2
250	-49.1	-77.1	-105.0
300	-51.0	-80.1	-109.2
350	-52.6	-82.6	-112.6
400	-54.2	-85.1	-116.0
450	-55.5	-87.2	-118.8
500	-56.8	-89.2	-121.5

120 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-22.2	-37.2	-56.0
20	-23.5	-39.4	-59.3
25	-24.5	-41.2	-62.0
30	-25.6	-42.9	-64.6
40	-27.1	-45.5	-68.5
50	-28.4	-47.7	-71.8
60	-29.5	-49.5	-74.5
70	-40.9	-64.2	-87.5
80	-42.3	-66.4	-90.5
90	-43.3	-68.0	-92.7
100	-44.0	-69.1	-94.2
120	-45.8	-71.9	-97.9
140	-47.5	-74.6	-101.7
160	-48.6	-76.2	-103.9
180	-50.0	-78.4	-106.9
200	-51.0	-80.1	-109.1
250	-53.5	-83.9	-114.4
300	-55.6	-87.2	-118.9
350	-57.3	-90.0	-122.6
400	-59.1	-92.7	-126.3
450	-60.5	-94.9	-129.3
500	-61.9	-97.1	-132.3

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130 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-26.0	-43.7	-65.8
20	-27.6	-46.3	-69.6
25	-28.8	-48.3	-72.7
30	-30.0	-50.4	-75.8
40	-31.9	-53.5	-80.5
50	-33.4	-56.0	-84.3
60	-34.6	-58.1	-87.4
70	-48.0	-75.3	-102.7
80	-49.6	-77.9	-106.2
90	-50.9	-79.8	-108.8
100	-51.7	-81.1	-110.6
120	-53.7	-84.3	-114.9
140	-55.8	-87.6	-119.3
160	-57.0	-89.5	-122.0
180	-58.7	-92.1	-125.5
200	-59.9	-94.0	-128.1
250	-62.8	-98.5	-134.2
300	-65.2	-102.4	-139.5
350	-67.3	-105.6	-143.9
400	-69.3	-108.8	-148.3
450	-71.0	-111.4	-151.8
500	-72.6	-113.9	-155.3

140 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-30.2	-50.7	-76.3
20	-32.0	-53.6	-80.7
25	-33.4	-56.0	-84.3
30	-34.8	-58.4	-87.9
40	-36.9	-62.0	-93.3
50	-38.7	-65.0	-97.8
60	-40.1	-67.4	-101.4
70	-55.7	-87.4	-119.1
80	-57.6	-90.3	-123.1
90	-59.0	-92.6	-126.2
100	-59.9	-94.1	-128.2
120	-62.3	-97.8	-133.3
140	-64.7	-101.5	-138.4
160	-66.1	-103.8	-141.4
180	-68.0	-106.8	-145.5
200	-69.4	-109.0	-148.6
250	-72.8	-114.2	-155.7
300	-75.6	-118.7	-161.8
350	-78.0	-122.4	-166.9
400	-80.4	-126.2	-172.0
450	-82.3	-129.2	-176.0
500	-84.2	-132.2	-180.1

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150 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-34.7	-58.2	-87.5
20	-36.7	-61.6	-92.7
25	-38.3	-64.3	-96.8
30	-40.0	-67.1	-100.9
40	-42.4	-71.2	-107.1
50	-44.5	-74.6	-112.3
60	-46.1	-77.3	-116.4
70	-63.9	-100.3	-136.7
80	-66.1	-103.7	-141.3
90	-67.7	-106.3	-144.8
100	-68.8	-108.0	-147.2
120	-71.5	-112.3	-153.0
140	-74.3	-116.6	-158.9
160	-75.9	-119.1	-162.4
180	-78.1	-122.6	-167.0
200	-79.7	-125.1	-170.5
250	-83.5	-131.1	-178.7
300	-86.8	-136.3	-185.7
350	-89.6	-140.6	-191.6
400	-92.3	-144.8	-197.4
450	-94.5	-148.3	-202.1
500	-96.7	-151.7	-206.8

Quick Reference Tables

Building Risk Category II, Exposure C

160 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-39.4	-66.2	-99.6
20	-41.8	-70.1	-105.5
25	-43.6	-73.2	-110.1
30	-45.5	-76.3	-114.8
40	-48.3	-81.0	-121.9
50	-50.6	-84.9	-127.7
60	-52.4	-88.0	-132.4
70	-72.7	-114.1	-155.5
80	-75.2	-118.0	-160.8
90	-77.0	-120.9	-164.8
100	-78.3	-122.9	-167.5
120	-81.4	-127.7	-174.1
140	-84.5	-132.6	-180.8
160	-86.4	-135.5	-184.7
180	-88.8	-139.5	-190.1
200	-90.7	-142.4	-194.0
250	-95.1	-149.2	-203.3
300	-98.8	-155.1	-211.3
350	-101.9	-159.9	-218.0
400	-105.0	-164.8	-224.6
450	-107.5	-168.7	-229.9
500	-110.0	-172.6	-235.2

170 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-44.5	-74.7	-112.4
20	-47.1	-79.1	-119.1
25	-49.2	-82.6	-124.3
30	-51.3	-86.1	-129.6
40	-54.5	-91.4	-137.6
50	-57.1	-95.8	-144.2
60	-59.2	-99.3	-149.5
70	-82.1	-128.8	-175.5
80	-84.9	-133.2	-181.5
90	-87.0	-136.5	-186.0
100	-88.4	-138.7	-189.0
120	-91.9	-144.2	-196.6
140	-95.4	-149.7	-204.1
160	-97.5	-153.0	-208.6
180	-100.3	-157.4	-214.6
200	-102.4	-160.7	-219.1
250	-107.3	-168.4	-229.6
300	-111.5	-175.0	-238.6
350	-115.0	-180.5	-246.1
400	-118.5	-186.0	-253.6
450	-121.3	-190.5	-259.6
500	-124.1	-194.9	-265.6

180 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-49.9	-83.8	-126.1
20	-52.9	-88.7	-133.5
25	-55.2	-92.6	-139.4
30	-57.5	-96.6	-145.3
40	-61.1	-102.5	-154.2
50	-64.0	-107.4	-161.7
60	-66.4	-111.3	-167.6
70	-92.0	-144.4	-196.8
80	-95.1	-149.3	-203.5
90	-97.5	-153.0	-208.6
100	-99.1	-155.5	-211.9
120	-103.0	-161.7	-220.4
140	-106.9	-167.9	-228.8
160	-109.3	-171.6	-233.8
180	-112.4	-176.5	-240.5
200	-114.8	-180.2	-245.6
250	-120.3	-188.8	-257.4
300	-125.0	-196.2	-267.5
350	-129.0	-202.4	-275.9
400	-132.9	-208.6	-284.3
450	-136.0	-213.5	-291.0
500	-139.2	-218.5	-297.7

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Building Risk Category II, Exposure D

110 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-22.6	-37.9	-57.0
20	-23.7	-39.7	-59.8
25	-24.6	-41.2	-62.0
30	-25.4	-42.7	-64.2
40	-26.8	-44.9	-67.6
50	-27.9	-46.7	-70.3
60	-28.7	-48.2	-72.6
70	-39.3	-61.8	-84.2
80	-40.5	-63.6	-86.7
90	-41.1	-64.5	-87.9
100	-42.0	-65.9	-89.8
120	-43.5	-68.2	-93.0
140	-44.6	-70.1	-95.5
160	-45.5	-71.4	-97.4
180	-46.4	-72.8	-99.3
200	-47.3	-74.2	-101.1
250	-49.3	-77.4	-105.5
300	-50.8	-79.7	-108.7
350	-52.3	-82.0	-111.8
400	-53.4	-83.9	-114.3
450	-54.6	-85.7	-116.8
500	-55.5	-87.1	-118.7

115 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-24.7	-41.4	-62.4
20	-25.9	-43.4	-65.4
25	-26.8	-45.0	-67.8
30	-27.8	-46.7	-70.2
40	-29.2	-49.1	-73.9
50	-30.4	-51.1	-76.9
60	-31.4	-52.7	-79.3
70	-43.0	-67.5	-92.0
80	-44.3	-69.5	-94.8
90	-44.9	-70.5	-96.1
100	-45.9	-72.0	-98.2
120	-47.5	-74.6	-101.6
140	-48.8	-76.6	-104.4
160	-49.7	-78.1	-106.4
180	-50.7	-79.6	-108.5
200	-51.7	-81.1	-110.5
250	-53.9	-84.6	-115.3
300	-55.5	-87.2	-118.8
350	-57.1	-89.7	-122.2
400	-58.4	-91.7	-125.0
450	-59.7	-93.7	-127.7
500	-60.7	-95.2	-129.8

120 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-26.9	-45.1	-67.9
20	-28.2	-47.3	-71.2
25	-29.2	-49.0	-73.8
30	-30.3	-50.8	-76.5
40	-31.8	-53.4	-80.4
50	-33.1	-55.6	-83.7
60	-34.2	-57.4	-86.3
70	-46.8	-73.5	-100.2
80	-48.2	-75.7	-103.2
90	-48.9	-76.8	-104.7
100	-50.0	-78.4	-106.9
120	-51.7	-81.2	-110.6
140	-53.1	-83.4	-113.6
160	-54.2	-85.0	-115.9
180	-55.2	-86.7	-118.1
200	-56.3	-88.3	-120.4
250	-58.7	-92.2	-125.6
300	-60.5	-94.9	-129.3
350	-62.2	-97.6	-133.1
400	-63.6	-99.8	-136.1
450	-65.0	-102.0	-139.1
500	-66.0	-103.7	-141.3

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Building Risk Category II, Exposure D

130 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-31.5	-52.9	-79.7
20	-33.1	-55.5	-83.5
25	-34.3	-57.6	-86.6
30	-35.5	-59.6	-89.7
40	-37.4	-62.7	-94.4
50	-38.9	-65.3	-98.2
60	-40.1	-67.3	-101.3
70	-55.0	-86.3	-117.6
80	-56.6	-88.8	-121.1
90	-57.4	-90.1	-122.8
100	-58.7	-92.1	-125.5
120	-60.7	-95.3	-129.9
140	-62.3	-97.9	-133.4
160	-63.6	-99.8	-136.0
180	-64.8	-101.7	-138.6
200	-66.0	-103.6	-141.3
250	-68.9	-108.2	-147.4
300	-71.0	-111.4	-151.8
350	-73.0	-114.6	-156.2
400	-74.6	-117.2	-159.7
450	-76.3	-119.7	-163.2
500	-77.5	-121.7	-165.8

140 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-36.6	-61.4	-92.4
20	-38.4	-64.4	-96.9
25	-39.8	-66.8	-100.5
30	-41.2	-69.1	-104.1
40	-43.3	-72.7	-109.5
50	-45.1	-75.7	-113.9
60	-46.5	-78.1	-117.5
70	-63.7	-100.0	-136.4
80	-65.6	-103.0	-140.4
90	-66.6	-104.5	-142.5
100	-68.0	-106.8	-145.5
120	-70.4	-110.5	-150.6
140	-72.3	-113.5	-154.7
160	-73.7	-115.7	-157.7
180	-75.2	-118.0	-160.8
200	-76.6	-120.2	-163.8
250	-79.9	-125.4	-171.0
300	-82.3	-129.2	-176.0
350	-84.7	-132.9	-181.1
400	-86.6	-135.9	-185.2
450	-88.5	-138.9	-189.3
500	-89.9	-141.1	-192.3

150 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-42.0	-70.5	-106.1
20	-44.0	-73.9	-111.2
25	-45.7	-76.6	-115.3
30	-47.3	-79.4	-119.5
40	-49.8	-83.5	-125.6
50	-51.8	-86.9	-130.8
60	-53.4	-89.6	-134.9
70	-73.2	-114.8	-156.5
80	-75.4	-118.3	-161.2
90	-76.4	-120.0	-163.5
100	-78.1	-122.6	-167.0
120	-80.8	-126.8	-172.9
140	-83.0	-130.3	-177.6
160	-84.6	-132.8	-181.1
180	-86.3	-135.4	-184.6
200	-87.9	-138.0	-188.1
250	-91.7	-144.0	-196.2
300	-94.5	-148.3	-202.1
350	-97.2	-152.6	-207.9
400	-99.4	-156.0	-212.6
450	-101.6	-159.4	-217.3
500	-103.2	-162.0	-220.8

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Quick Reference Tables

Building Risk Category II, Exposure D

160 MPH Peak Gust Wind Zone

Building Height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-47.8	-80.2	-120.7
20	-50.1	-84.1	-126.6
25	-52.0	-87.2	-131.2
30	-53.8	-90.3	-135.9
40	-56.6	-95.0	-143.0
50	-58.9	-98.9	-148.8
60	-60.8	-102.0	-153.5
70	-83.3	-130.7	-178.1
80	-85.7	-134.6	-183.4
90	-87.0	-136.5	-186.1
100	-88.8	-139.5	-190.1
120	-91.9	-144.3	-196.7
140	-94.4	-148.2	-202.0
160	-96.3	-151.2	-206.0
180	-98.2	-154.1	-210.0
200	-100.0	-157.0	-214.0
250	-104.4	-163.8	-223.3
300	-107.5	-168.7	-229.9
350	-110.6	-173.6	-236.6
400	-113.1	-177.5	-241.9
450	-115.6	-181.4	-247.2
500	-117.4	-184.3	-251.2

170 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-54.0	-90.5	-136.3
20	-56.6	-94.9	-142.9
25	-58.7	-98.4	-148.2
30	-60.8	-102.0	-153.4
40	-63.9	-107.2	-161.4
50	-66.5	-111.6	-168.0
60	-68.6	-115.1	-173.3
70	-94.0	-147.5	-201.1
80	-96.8	-151.9	-207.1
90	-98.2	-154.1	-210.1
100	-100.3	-157.4	-214.6
120	-103.8	-162.9	-222.1
140	-106.6	-167.3	-228.1
160	-108.7	-170.6	-232.6
180	-110.8	-173.9	-237.1
200	-112.9	-177.2	-241.6
250	-117.8	-184.9	-252.1
300	-121.3	-190.5	-259.6
350	-124.8	-196.0	-267.1
400	-127.6	-200.4	-273.1
450	-130.5	-204.8	-279.1
500	-132.6	-208.1	-283.6

180 MPH Peak Gust Wind Zone

Building height, ft.	Field design load, psf	Perimeter design load, psf	Corner design load, psf
0–15	-60.5	-101.5	-152.8
20	-63.4	-106.4	-160.2
25	-65.8	-110.4	-166.1
30	-68.1	-114.3	-172.0
40	-71.6	-120.2	-180.9
50	-74.6	-125.1	-188.3
60	-76.9	-129.1	-194.3
70	-105.4	-165.4	-225.4
80	-108.5	-170.3	-232.1
90	-110.1	-172.8	-235.5
100	-112.4	-176.5	-240.5
120	-116.4	-182.7	-249.0
140	-119.5	-187.6	-255.7
160	-121.9	-191.3	-260.7
180	-124.2	-195.0	-265.8
200	-126.6	-198.7	-270.8
250	-132.1	-207.3	-282.6
300	-136.0	-213.5	-291.0
350	-140.0	-219.7	-299.4
400	-143.1	-224.6	-306.1
450	-146.3	-229.6	-312.9
500	-148.6	-233.3	-317.9

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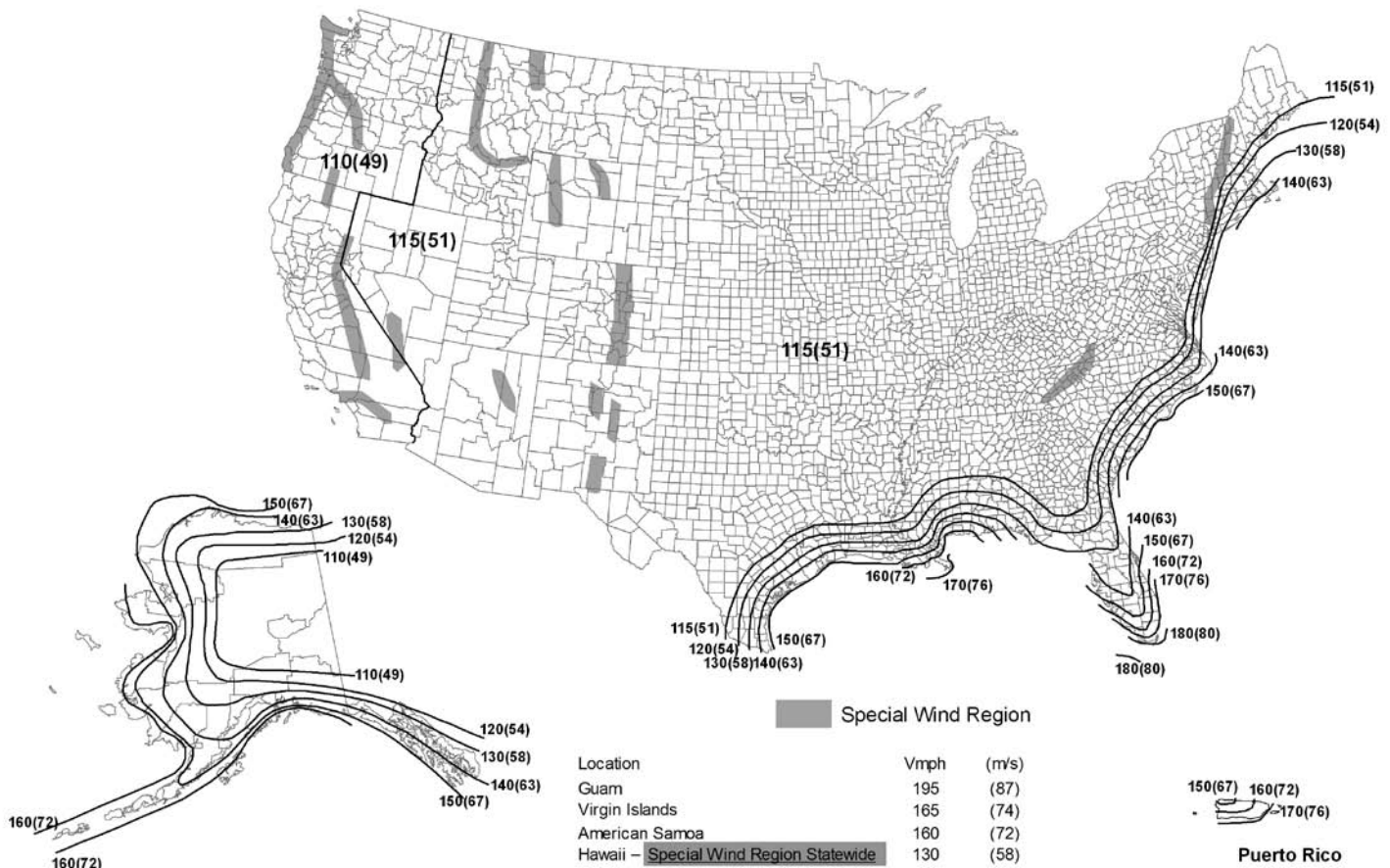
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Appendix B

Basic Wind Speed Maps, Insulation Fastening Patterns and General Metric Conversions

Pages 19–21	Basic Wind Speed Map for Occupancy Category II buildings. (Refer to Figure 26.5-1A of ASCE 7-10 for the Basic Wind Speed Map for Occupancy Category II0 buildings.) (Refer to Figure 26.5-1B of ASCE 7-10 for the Basic Wind Speed Map for Occupancy Category III buildings.) (Refer to Figure 26.5-1C of ASCE 7-10 for the Basic Wind Speed Map for Occupancy Category IV buildings).
Page 22	Insulation Board Fastening Patterns—4 ft×4 ft Boards
Page 23–25	Insulation Board Fastening Patterns—4 ft×8 ft Boards

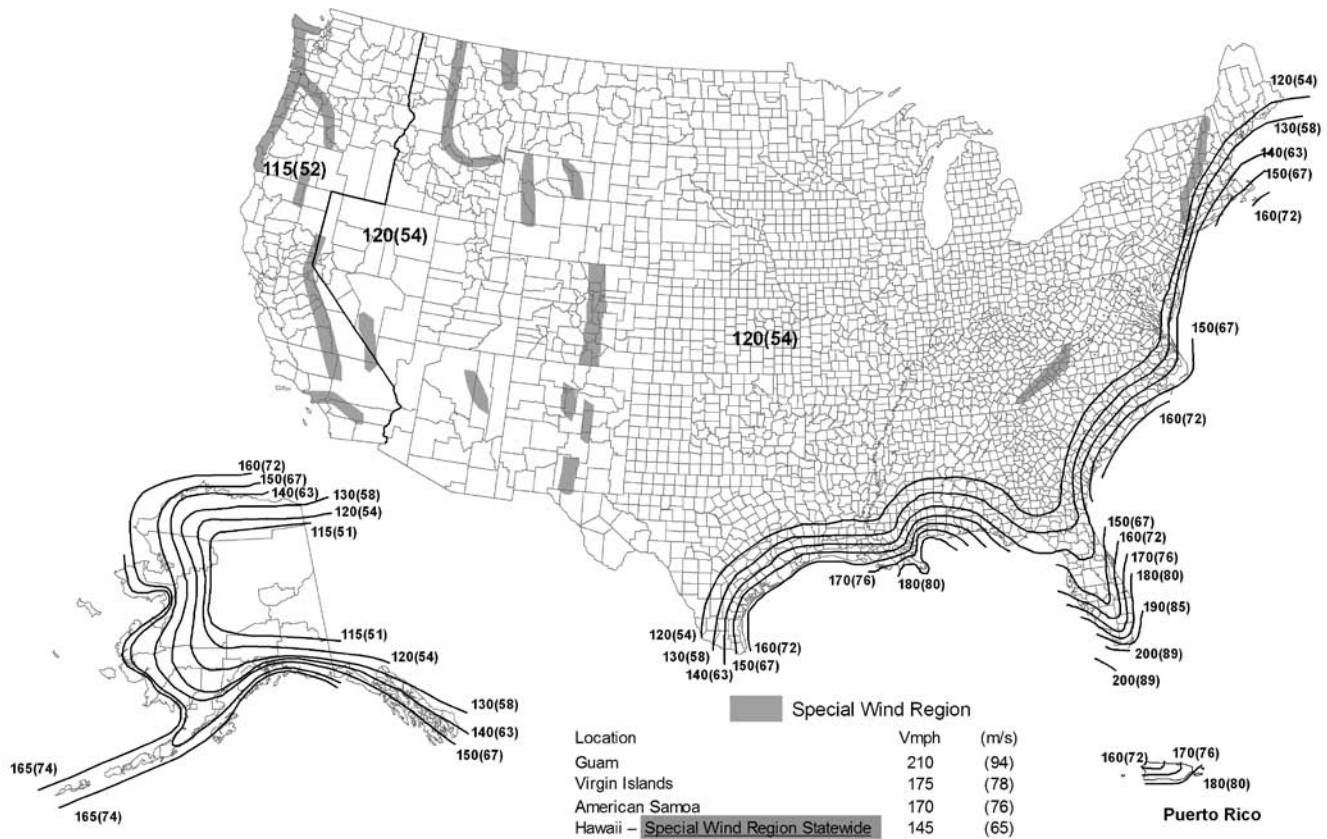
ASCE 7-10 Figure 26.5-1A
Basic Wind Speeds for Occupancy Category II Buildings.
Used with permission from ASCE.



Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**Basic Wind Speeds for Occupancy Category III and IV Buildings.
Used with permission from ASCE.**



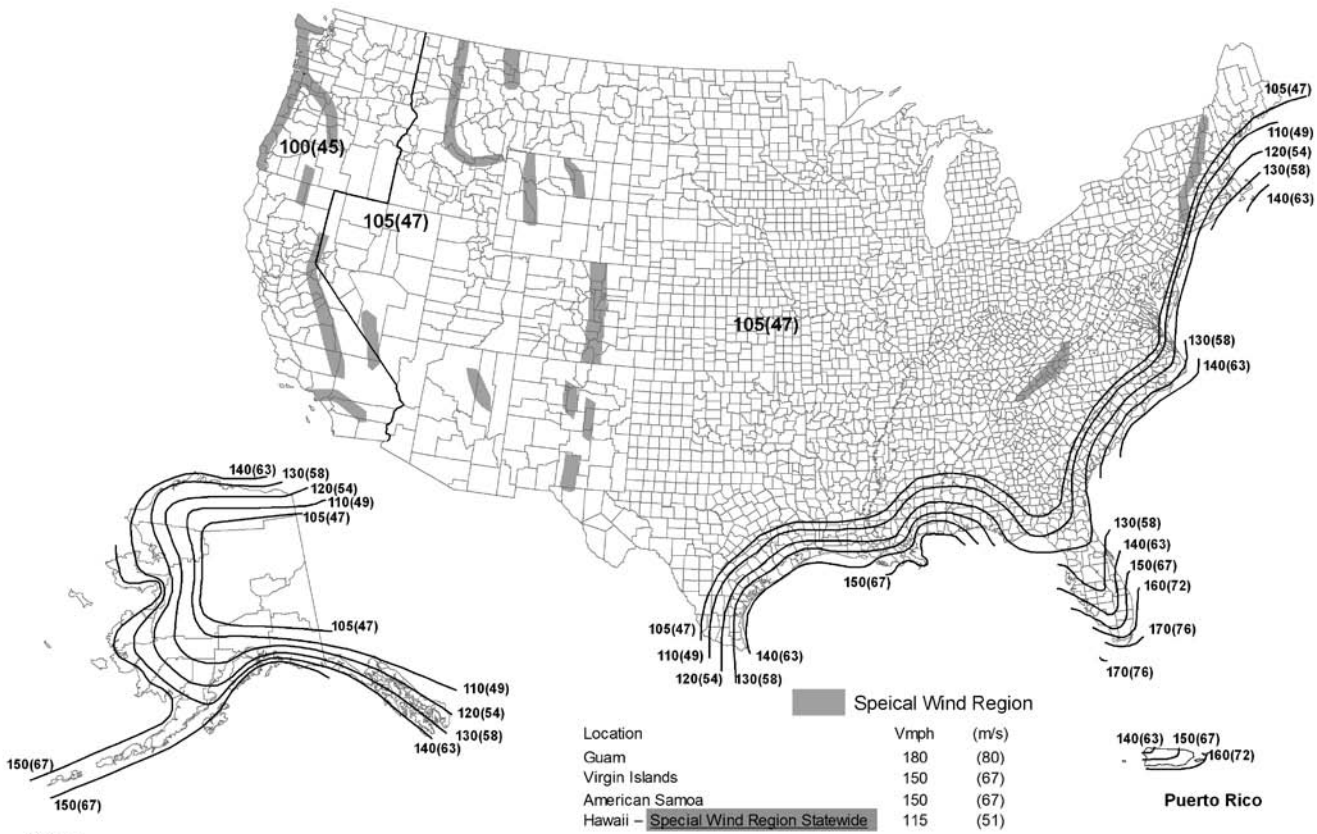
Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 Years).

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ASCE 7-10 Figure 26.5-1C
Basic Wind Speeds for Occupancy Category I Buildings.
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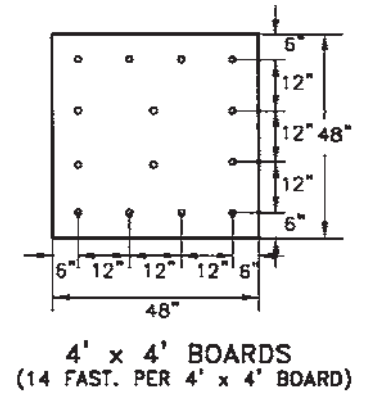
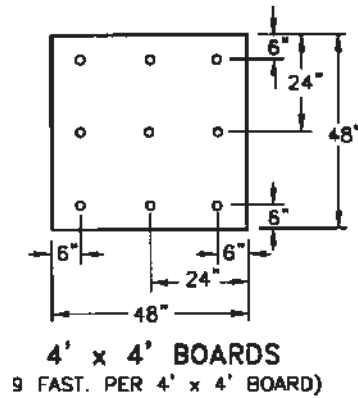
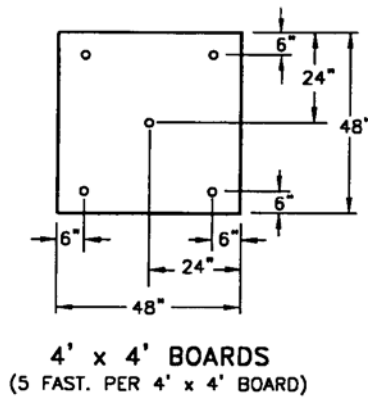
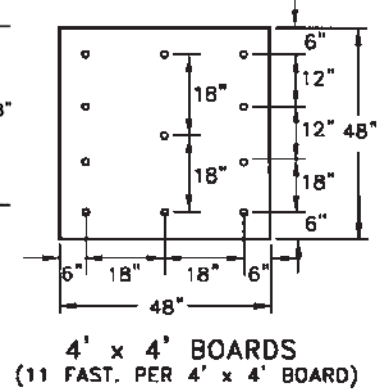
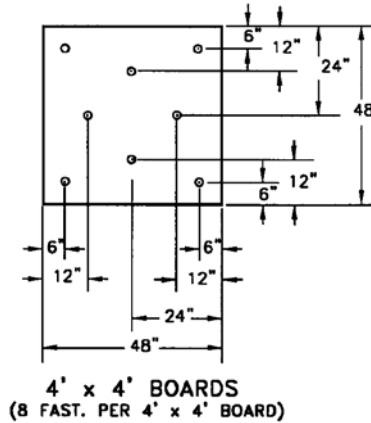
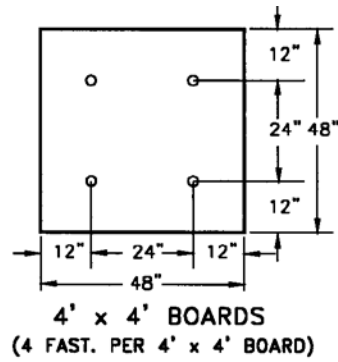
Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

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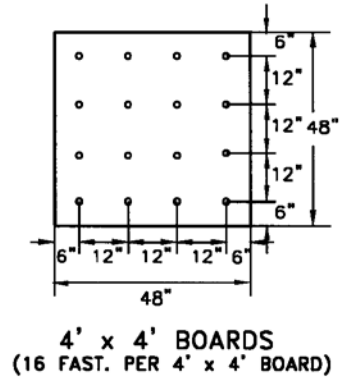
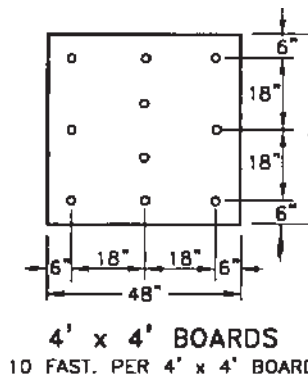
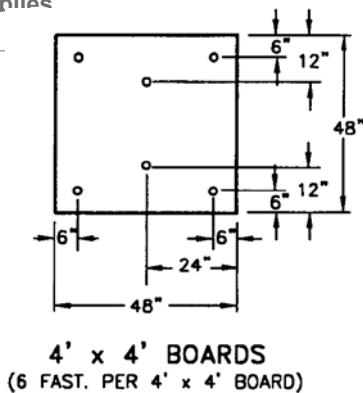
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Insulation Board Fastening Patterns—4 ft×4 ft Boards



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Metric conversions

6 in = 15 cm

12 in = 30 cm

18 in = 46 cm

24 in = 61 cm

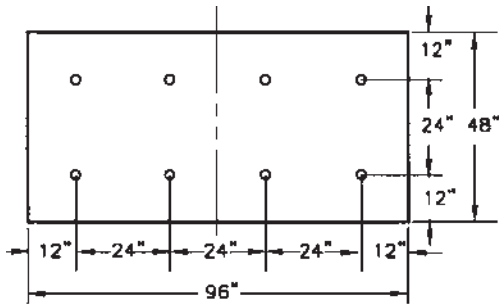
48 in = 122 cm (1.2 m)

96 in = 244 cm (2.4 m)

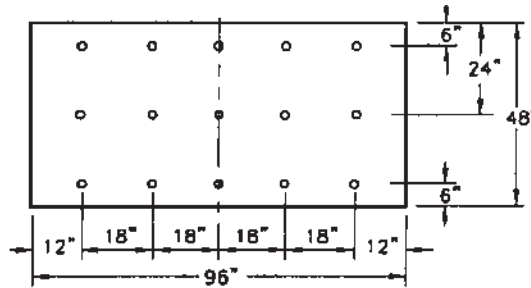
4 ft = 1.2 m

8 ft = 2.4 m

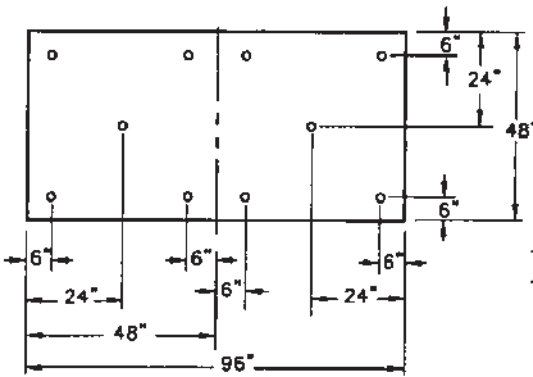
Insulation Board Fastening Patterns — 4 ft x 8 ft Boards



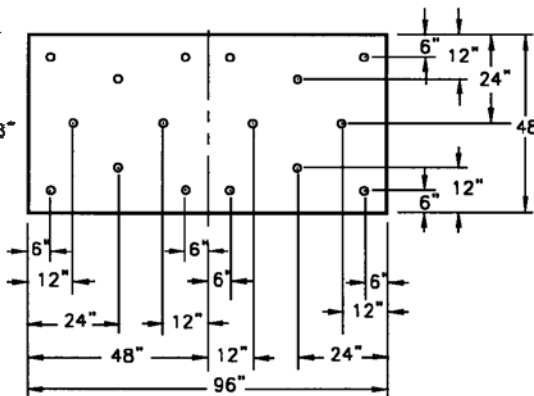
4' x 8' BOARDS
(8 FAST. PER 4' x 8' BOARD)



4' x 8' BOARDS
(15 FAST. PER 4' x 8' BOARD)



4' x 8' BOARDS
(10 FAST. PER 4' x 8' BOARD)

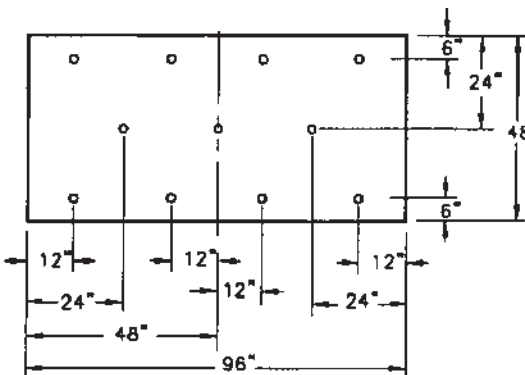


4' x 8' BOARDS
(16 FAST. PER 4' x 8' BOARD)

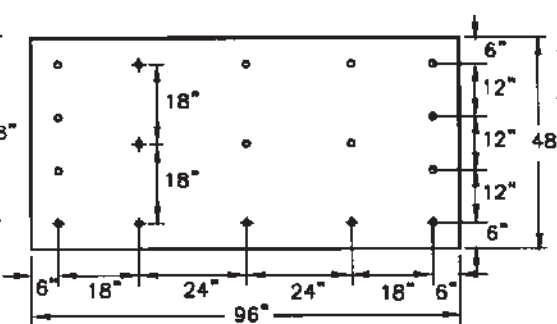
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4' x 8' BOARDS
(11 FAST. PER 4' x 8' BOARD)

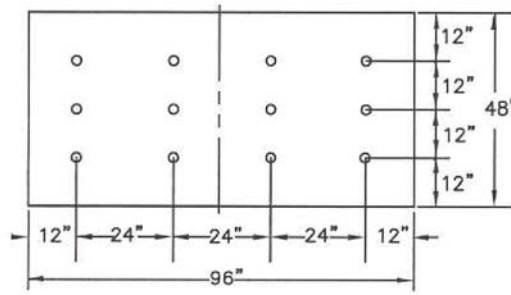


4' x 8' BOARDS
(17 FAST. PER 4' x 8' BOARD)

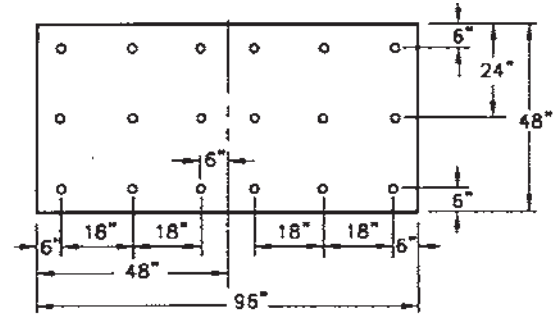
Metric conversions

6 in = 15 cm	12 in = 30 cm	18 in = 46 cm	24 in = 61 cm
48 in = 122 cm (1.2 m)	96 in = 244 cm (2.4 m)	4 ft = 1.2 m	8 ft = 2.4 m

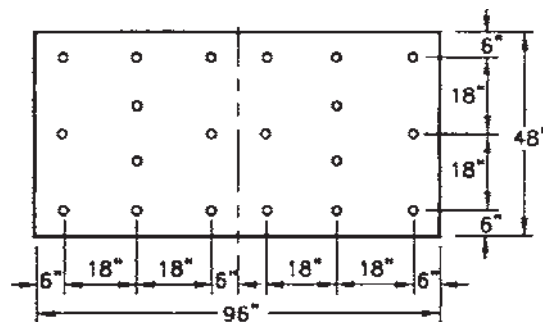
Insulation Board Fastening Patterns — 4 ft x 8 ft Boards



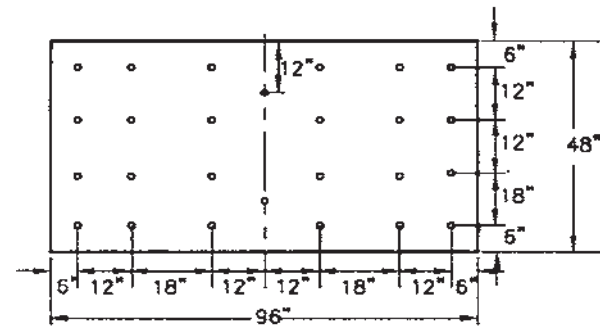
4' x 8' BOARDS
(12 FAST. PER 4' x 8' BOARD)



4' x 8' BOARDS
(18 FAST. PER 4' x 8' BOARD)



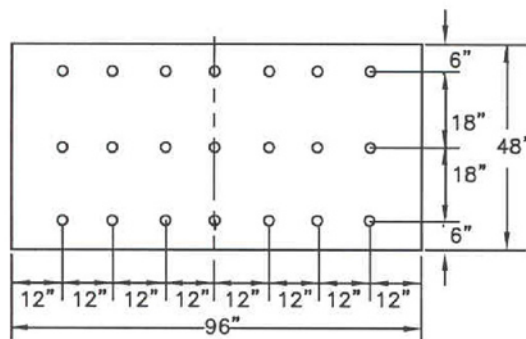
4' x 8' BOARDS
(20 FAST. PER 4' x 8' BOARD)



4' x 8' BOARDS
(26 FAST. PER 4' x 8' BOARD)

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4' x 8' BOARDS
(21 FAST. PER 4' x 8' BOARD)

Metric conversions

6 in = 15 cm

12 in = 30 cm

18 in = 46 cm

24 in = 61 cm

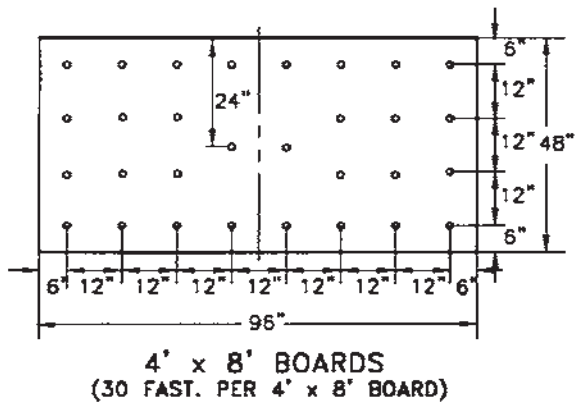
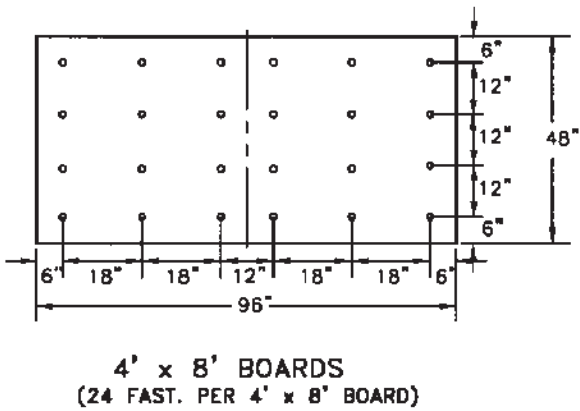
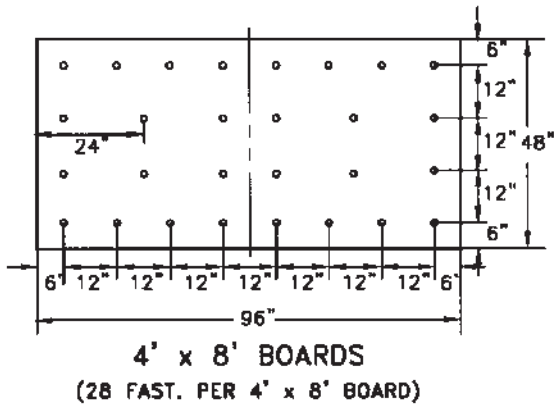
48 in = 122 cm (1.2 m)

96 in = 244 cm (2.4 m)

4 ft = 1.2 m

8 ft = 2.4 m

Insulation Board Fastening Patterns — 4 ft x 8 ft Boards



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Metric conversions

6 in = 15 cm	12 in = 30 cm	18 in = 46 cm	24 in = 61 cm
48 in = 122 cm (1.2 m)	96 in = 244 cm (2.4 m)	4 ft = 1.2 m	8 ft = 2.4 m

Commentary Section

This Commentary is not a part of this standard. It consists of explanatory and supplementary material designed to assist users in complying with the requirements. It is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements or to provide other clarifications. It therefore has not been processed in accordance with ANSI Essential Requirements, and may contain material that has not been subjected to public review or a consensus process. Thus it does not contain requirements necessary for conformance with the standard.

Commentary A

Practical Examples

Design Pressure Calculation and Roofing System Assembly Selection (for the following example building)

Example Building Criteria (used for all examples to follow)

A 30-ft high warehouse building located in Raleigh, NC (120 mph wind zone) has a plan dimension of 200 ft by 400 ft (61 m by 122 m). The building has metal roof deck with flutes spaced 6 in on center. The walls have no large openings. The roof slope is 1/2 inch per ft. The architect/designer has selected a 2.0 safety factor to be used for this project.

Task

Design three roofing system assemblies for this building using the two-part method outlined in Section 4.0 of this Standard Practice. The roofing system assemblies to be designed are as follows:

System 1—Adhered membrane over insulation attached with mechanical fasteners.

System 2—Adhered membrane over insulation attached with ribbons/beads of a cold adhesive.

System 3—Mechanically fastened membrane.

First Part

Calculate the wind uplift design loads for the field, perimeter and corner areas of the building which will be used for all three examples.

Step 1: Determine if the Quick Reference Tables contained in this document can be used

Building is Risk Category II (Section 2.3 of this document or Table 1.5-1 of ASCE 7-10).
Building is not situated on a hill.
Building is enclosed (Section 2.2 of this document or Section 26.2 of ASCE 7-10).
Roof slope does not exceed 2 in per ft (10°).

All the conditions referenced in Appendix A are met, so the Quick Reference Tables can be used. When the conditions of Appendix A are not met, the design loads shall be calculated in accordance with the current ASCE 7 Standard for Components & Cladding (C&C). The various methodologies contained in ASCE 7-10 for determining the design loads are outlined in Commentary C of this document.

Step 2: Determine Design Loads Using the Quick Reference Tables

Refer to the Quick Reference Tables for Building Risk Category II, Exposure C, 120 mph wind zone and a 60 ft height (page number 17 of this document):

Field Design Load = -25.6
Perimeter Design Load = -42.9
Corner Design Load = -64.6

The negative sign indicates that the uplift load is outward (away from the building). The negative sign will be ignored for calculation purposes.

Second part: Select an appropriate roofing system assembly by comparing the tested wind uplift resistance capacity of that assembly to the design loads.

System 1—Adhered Roofing System Assembly Selection Example for Mechanically Fastened Insulation

The adhered membrane roofing system assembly being considered for this building was tested on a 12 ft×24 ft (3.7 m×7.3 m) test chamber to a maximum wind uplift resistance capacity of 90 psf (L_t) using 16 fasteners (F_t) per board. Apply the 2.0 safety factor to the 90 psf tested value to determine the Factored Tested Load Capacity:

$$\text{Factored Tested Load Capacity} = L_t / 2.0 = 90 \text{ psf} / 2.0 = 45 \text{ psf}$$

The factored tested load capacity (45 psf) exceeds the design loads for both the field (25.6 psf) and perimeter (42.9 psf) areas of the roof but not the corner area (64.6 psf). Consequently, the as-tested assembly is acceptable for use in the field and perimeter areas. To determine if extrapolation is acceptable for the corner areas, check the extrapolation requirements of the Extrapolation Method—Adhered System Assemblies section of this document on page 6. Since all the extrapolation method requirements are satisfied, extrapolation is acceptable.

To determine the number of fasteners (F_n) needed per insulation board for the corner areas of the roof, use the equation $F_n = (F_t \times L_d) / L_t$

Where: F_n is the number of fasteners per board needed to meet the corner design load.

F_t is the number of fasteners per board used to achieve the tested load capacity.

L_d is the calculated design load for the corner area of the roof, psf.

L_t is the factored tested load capacity.

$$F_n = (16 \text{ fasteners} \times 64.6 \text{ psf}) / 45 \text{ psf} = 23 \text{ fasteners per board}$$

The final design for this assembly scenario is to use 16 fasteners per insulation board in the field and perimeter areas and 23 fasteners per board in the corner areas. The extra 7 fasteners added to the corner areas shall be evenly distributed (as best as possible) around the tested fastener layout pattern. Fastening pattern examples for insulation boards are included in Appendix B of this document.

System 2—Adhered Roofing System Assembly Selection Example for Ribbon/Bead Adhesive Attached Insulation

The adhered membrane roofing system assembly being considered for this building was tested on a 12 ft×24 ft test chamber to a maximum wind uplift resistance capacity of 75 psf (L_t) using ribbons/beads of adhesive spaced 12 in on center (R_t) for insulation attachment. Apply the 2.0 safety factor to the 75 psf tested value to determine the Factored Tested Load Capacity:

$$\text{Factored Tested Load Capacity} = L_t / 2.0 = 75 \text{ psf} / 2.0 = 37.5 \text{ psf}$$

The factored tested load capacity (37.5 psf) exceeds the design load for the field (25.6 psf) of the roof but not the perimeter (42.9 psf) or corner (64.6 psf) areas. Consequently, the as-tested system assembly is acceptable for use only in the field of the roof. To determine if extrapolation is allowable for the perimeter and corner areas, check the extrapolation requirements of the Extrapolation Method—Adhered System Assemblies section of this document on page 6. Since all the extrapolation method requirements are satisfied, extrapolation is acceptable.

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To determine the reduced ribbon/bead spacing (R_n) for the perimeter and corner areas of the roof, use the equation $R_n = R_t / (L_d / L_t)$

Where: R_n is the ribbon/bead spacing needed to meet the design load, inches.
 R_t is the ribbon/bead spacing used to achieve the tested load capacity, inches.
 L_d is the calculated design load for the perimeter and corner areas of the roof, psf.
 L_t is the factored tested load capacity, psf.

Perimeter Area

$R_n = 12 \text{ in.} / (42.9 \text{ psf} / 37.5 \text{ psf}) = 10.5 \text{ in}$ maximum on center spacing for ribbons/beads

Corner Area

$R_n = 12 \text{ in.} / (64.6 \text{ psf} / 37.5 \text{ psf}) = 7.0 \text{ in}$ maximum on center spacing for ribbons/beads

Since the deck flutes are spaced 6 in on center, the perimeter and corner ribbons/bead spacing must be rounded down to 6 in on center. Therefore, the final design for this assembly scenario is to use ribbons/beads of adhesive spaced 12 in on center for insulation attachment in the field of the roof and ribbons/beads of adhesive spaced 6 in on center for insulation attachment in the perimeter and corner areas. Note: If the deck had a smooth (non-fluted) top surface such as concrete, cementitious wood fiber, wood, etc., or if the adhesive was being used to attach multiple layers of insulation, the final design for this assembly would be to use ribbons/beads of adhesive spaced 12 in on center in the field of the roof, 10.5 in on center in the perimeter and 7.0 in in the corners.

System 3—Mechanically Fastened Roofing System Assembly Example

The linearly-attached mechanically fastened roofing assembly being considered for this building was tested on a 12 ft×24 ft test chamber to a maximum wind uplift resistance capacity of 60 psf (L_t) using a 9.5 ft row spacing with fasteners spaced 18 in on center along the row. Apply the 2.0 safety factor to the 60 psf tested value to determine the Factored Tested Load Capacity:

Factored Tested Load Capacity = $L_t / 2.0 = 60 \text{ psf} / 2.0 = 30 \text{ psf}$

The factored tested load capacity (30 psf) exceeds the design load for the field (25.6 psf) of the roof, but not the perimeter (42.9 psf) or corner (64.6 psf) areas. Consequently, the as-tested assembly is acceptable for use only in the field of the roof. To determine if extrapolation is possible for the perimeter and corner areas, check the extrapolation requirements of the Extrapolation Method – Mechanically Fastened System Assemblies section of this document on page 7. Since all the extrapolation method requirements are satisfied, extrapolation is acceptable.

To determine the appropriate perimeter and corner row spacing, first calculate the influence area per fastener (IA_n) using the equation $IA_n = (L_t \times IA_t) / L_d$

Where: IA_n is the maximum area of membrane to be held in place by one fastener to meet the design load, ft².
 IA_t is the area of membrane held in place by one fastener for the tested assembly, ft².
 L_d is the calculated design load for the perimeter or corner area of the roof, psf.
 L_t is the factored tested load capacity, psf.

IA_t = fastener row spacing times the fastener spacing along the row
 $IA_t = 9.5 \text{ ft.} \times 1.5 \text{ ft} = 14.25 \text{ ft}^2$ per fastener

Perimeter Area

$IA_n = (30 \text{ psf} \times 14.25 \text{ ft}^2) / 42.9 \text{ psf} = 10.0 \text{ ft}^2$ maximum per fastener

Corner Area

$IA_n = (30 \text{ psf} \times 14.25 \text{ ft}^2) / 64.6 \text{ psf} = 6.6 \text{ ft}^2$ maximum per fastener

The row spacing for the corner and perimeter areas shall be determined by dividing IA_n by the tested fastener spacing, as follows:

Perimeter Areas: $10.0 \text{ ft}^2 / 1.5 \text{ ft.} = 6.7 \text{ ft}$

Corner Areas: $6.6 \text{ ft}^2 / 1.5 \text{ ft.} = 4.4 \text{ ft}$

There are two final designs for this assembly scenario. The first design is to use a maximum fastener row spacing of 11.5 ft in the field of the roof, maximum 6.7 ft in the perimeter areas and maximum 4.4 ft in the corner areas, all with fasteners spaced 18 in on center along the row. The second design is to use a maximum fastener row spacing of 11.5 ft in the field of the roof and a maximum 6.7 ft in the perimeter and corner areas. In this second design however, the perimeter rows must extend into the corners from both directions, creating a cross-hatched fastening pattern.

Commentary B

General Considerations

The following design and installation recommendations should be considered before starting a roofing project:

1. Consult with an architect or engineer to ensure the roof deck is adequately secured to resist the wind uplift forces that will be imposed upon it by the installed roofing system assembly.
2. Conduct fastener pullout tests, where appropriate, to ensure the selected fastener/deck combination will provide adequate wind uplift resistance to the forces that will be imposed upon it by the installed roofing system assembly. This is particularly important for steel roof decks and for recover (covering over an existing roofing system assembly) applications. Pullout testing should be conducted in accordance with the ANSI/SPRI FX-1 Standard.
3. Mechanical fasteners used for insulation or membrane securement should penetrate through the top flange of a steel deck whenever possible.
4. Rows of mechanical fastener, spaced greater than 3 ft apart, should be installed perpendicular to the steel deck ribs to avoid overloading a single rib.
5. Ensure that all mechanical fasteners have the proper penetration into the roof deck. Typical fastener penetrations include: 3/4 inch for steel, 1 inch for wood and 1-1/4 inch for structural concrete. Consult with the roofing system supplier for verification.
6. Install an edging detail, where appropriate, that will meet the requirements of the SPRI/FM 4435/ES-1 Standard.

Commentary C

ASCE 7-10 Design Wind Load Pressure Determination Components and Cladding Summary

Appendix A, Quick Reference Tables—Allowable Strength Load Conversion

The field, perimeter and corner design loads contained in the Quick Reference Tables of Appendix A are allowable strength loads and were calculated in accordance with ASCE 7-10. As stated in Section 1.3.1.2 under Section 1.3 (“Basic Requirements”) of ASCE 7-10, the load combinations of Section 2.4 are to be applied. In Section 2.4.1, line item 7, the calculated wind load W (as determined in accordance with the wind load chapters, Chapter 30 for components and cladding) is to be multiplied by 0.6 to convert the ultimate strength load to the allowable strength load. Therefore, once field, perimeter and corner loads are determined using ASCE 7-10, the loads are multiplied by 0.6. This is the opposite approach to that which was used in ASCE 7-05. In ASCE 7-05, the allowable strength load was directly calculated, so no conversion was necessary.

ASCE 7-10—Methodologies for determining wind uplift pressures on Components and Cladding

Chapter 30 of ASCE 7-10 provides six methodologies for determining wind pressures on Components and Cladding. To obtain a copy of the current ASCE 7 Document, visit the Codes & Standards link on the ASCE website, www.asce.org.

- ▶ Part 1 is applicable to enclosed or partially enclosed buildings with a height $h \leq 60$ ft and the wind pressures are calculated from an equation. Refer to Table 30.4-1 in ASCE 7-10 for step-by-step instructions.
- ▶ Part 2 is a simplified approach and applicable to enclosed buildings with a height $h \leq 60$ ft. The wind pressures are determined directly from a table. Refer to Table 30.5-1 in ASCE 7-10 for step-by-step instructions.
- ▶ Part 3 is applicable to enclosed or partially enclosed buildings with a height $h > 60$ ft the wind pressures are calculated from an equation. Refer to Table 30.6-1 in ASCE 7-10 for step-by-step instructions.
- ▶ Part 4 is a simplified approach and applicable to enclosed buildings with a height $h \leq 160$ ft. The wind pressures are determined directly from a table. Refer to Table 30.7-1 in ASCE 7-10 for step-by-step instructions.
- ▶ Part 5 is applicable to open buildings. Refer to Table 30.8-1 in ASCE 7-10 for step-by-step instructions.
- ▶ Part 6 is applicable to building appurtenances such as overhangs, parapets and rooftop equipment. Refer to Table 30.9-1 in ASCE 7-10 for step-by-step instructions.

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Related Reference Documents

1. ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures (available at www.asce.org)
2. FM 4450, Approval Standard for Class 1 Insulated Steel Deck Roofs (available at www.roofnav@fmglobal.com)
3. FM 4470, Approval Standard for Class 1 Roof Covers (available at www.roofnav@fmglobal.com)
4. UL 580, Standard for Tests for Uplift Resistance of Roof Assemblies (available at www.ul.com)
5. UL 1897, Standard for Uplift Tests for Roof Covering Systems (available at www.ul.com)
6. CSA A123.21-10, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems (available at www.cas.ca)
7. FM Global Loss Prevention Data Sheets 1-28, 1-29 and 1-49 (available at www.roofnav@fmglobal.com)
8. ANSI/SPRI RP-4, Wind Design Standard for Ballasted Single-Ply Roofing Systems (available at www.spri.org)
9. ANSI/SPRI FX-1, Standard Field Test Procedure For Determining The Withdrawal Resistance Of Roofing Fasteners (available at www.spri.org)
10. SPRI/FM 4435/ES-1, Wind Design Standard For Edge Systems Used With Low Slope Roofing Systems (available at www.spri.org)
11. SPRI Wind Load Design Guide For Low Sloped Flexible Membrane Roofing Systems (available at www.spri.org)

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