SINGLE PLY ROOFING INDUSTRY

Approved American National Standard

ANSI/SPRI GD-1

Structural Design Standard for Gutter Systems Used with Low-Slope Roofs

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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 Purpose (See Commentary C1.0)

1.1 This standard provides designers, contractors, and building code officials information for proper structural design of **Gutters** used with low-slope roofing.

2.0 Scope (See Commentary C2.0)

2.1 This standard specifies structural design for external **Gutters** used with low-slope, (2 in 12 or less) roofing on buildings less than or equal to 60 ft (18 m) in height.

2.2 This standard does not address water removal or the water-carrying capability of the **Gutter** as other building codes already address this issue. This Standard does not consider downspouts or leaders.

2.3 Minimum Safety Factor
This document includes a minimum "**Safety Factor**" of 1.67. The design professional or authority having jurisdiction may apply a greater **Safety Factor**, but shall not use a factor less than 1.67.

3.0 Definitions (See Commentary C3.0)

3.1 Expansion Joint
A device to accommodate thermal and building movement.

3.2 Fastener
A device appropriate to attach the **Gutter**, **Gutter Strap** or **Gutter Bracket** to the nailer or building substrate.

3.3 Gutter
Generally U-shaped channel for collecting roof water and leading it to an outlet.

3.4 Gutter Bracket
A device that supports a **Gutter** from underneath.

3.5 Gutter Strap
A device that helps support a **Gutter** from the top.

3.6 Gutter System
A system consisting of **Gutter**, **Gutter Straps**, **Gutter Brackets**, Joints, **Fasteners** and **Roof Flange**.

3.7 Importance Factor
A factor that accounts for the degree of hazard to human life and damage to property.

3.8 Nailer
A longitudinal member to which a **Gutter** is fastened to a building. Such fastening can be direct or through **Gutter Brackets** or **Gutter Straps**.

3.9 Outlet
An opening in a **Gutter** that allows water discharge.

3.10 Safety Factor
A multiplier to design calculations selected to cover uncertainties in the calculation results and to address normally anticipated application variances and deterioration/aging of materials.

3.11 Splice
A watertight joint between adjacent sections of **Gutter**.

4.0 Design Considerations (See Commentary C4.0)

The **Gutter** shall be designed to withstand both wind and static loads.

4.1 Wind Load

Design for prevention of failure because of wind force shall use wind pressure coefficients from ASCE 7-05.

4.1.1 Design Pressure (See Commentary C4.1.1)

The design pressure (P) shall be calculated using the formula

$$P = GC_p \times q_z \times I$$

in which:

P = Design Pressure (psf),

GC_p = Perimeter Load Coefficient from Table I

q_z = Design Pressure at roof height, z (Equation 6.15, ASCE 7-05[1])

I = **Importance Factor**

These calculations have been combined in Table IV using CORNER REGION GC_p factors from Table I.

Note: Where topological features (hill, ridge or escarpment) are present, Topologic Factor, Kzt shall be calculated according to ASCE 7-05 and applied to the Roof Edge Design Pressure, P as calculated in this standard.

Table I
External Pressure Coefficient GC_p

Type of Loading	Location	Roof Height ≤ 60 ft (18.3 m)	Table IV Multipliers*
Horizontal GC_p (acting outward on the **Gutter**)	Perimeter	-1.1	.8
	Corner	-1.4	1.0
Vertical GC_p (acting upward on the **Gutter**)	Perimeter	-1.7	.6
	Corner	-2.8	1.0

*Multiply Table IV values by these multipliers for reduced loads in perimeter regions when perimeters not within "corner regions" are to be designed separately from corner regions.

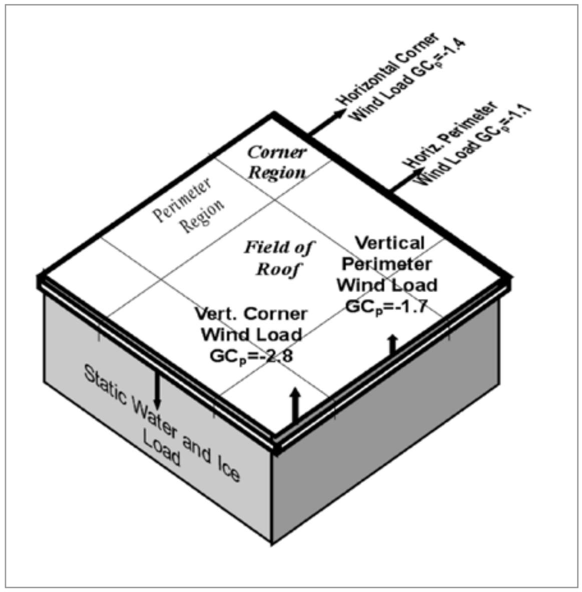


Figure 1. Diagram of Gutter System Loads

4.1.2 Basic Wind Speed

Basic wind speed shall be derived from Attachment I or the authority having jurisdiction

4.1.3 Special Wind Regions (mountains or valleys)

Refer to Section 6.5.4.1 of ASCE 7-05. The basic wind speed should be increased where records or experience indicate that the wind speeds are higher than those reflected in Attachment I. Mountainous terrain, gorges and special regions shown in Attachment I shall be examined for unusual wind conditions.

The authority having jurisdiction, if necessary, shall adjust the values given in Attachment I to account for higher local wind speeds.

Note: Where topological features (hill, ridge or escarpment) are present, a Topologic Factor, shall be calculated according to ASCE 7-05 and applied to the Roof Edge Design Pressure, P as calculated in this standard.

Limitation

Wind conditions above basic wind speeds (e.g. tornadoes) were not considered in developing the basic wind speed distributions.

4.1.4 Building Height

The building height shall be measured from the ground to the eave of the roof. Specific topographic features, such as hills, shall be considered when calculating building height. This document considers only building heights of 60 ft (18 m) or less. For building heights greater than 60 ft (18 m), consult ASCE 7-05 or other appropriate code documents for pressure coefficients.

4.1.5 Exposure Category (See Commentary C4.1.5)

The building shall be classified as **Category B**, **C** or **D** according to **Table II**.

For each wind direction considered, the upwind exposure category shall be based on ground surface roughness that is determined from natural topography, vegetation, and constructed facilities.

Table II
Surface Roughness and Exposure Categories

Surface Roughness B	Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.
Surface Roughness C	Open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions.
Surface Roughness D	Flat, unobstructed areas and water surfaces outside hurricane prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.
Exposure B	Exposure B shall apply where the ground surface roughness condition, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 2,600 ft (792 m) or 20 times the height of the building, whichever is greater. **Exception:** For buildings whose mean roof height is less than or equal to 30 ft, the upwind distance may be reduced to 1,500 ft (457 m).
Exposure C	Exposure C shall apply for all cases where Exposures B or D do not apply.
Exposure D	Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, 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 extend into downwind areas of Surface Roughness B or C for a distance of 600 ft (200 m) or 20 times the height of the building, whichever is greater. For a site located in the transition zone between exposure categories, the category resulting in the largest wind forces shall be used. **Exception:** An intermediate exposure between the preceding categories is permitted in a transition zone provided that it is determined by a rational analysis method defined in the recognized literature.

4.1.6 Importance Factor

Buildings shall have an **"Importance Factor"** as defined in Table III. The wind and static load values shall be multiplied by the **Importance Factor** included in design calculations.

Table III
Importance Factor from Table 6.1 ASCE 7-05

Nature of Occupancy	Category
Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: ▶ Agricultural facilities ▶ Certain temporary facilities ▶ Minor storage facilities	I
All buildings and other structures except those listed in Categories I, III, and IV	II
Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: ▶ Buildings and other structures where more than 300 people congregate in one area ▶ Buildings and other structures with day care facilities with capacity greater than 150 ▶ Buildings and other structures with elementary school or secondary school facilities with capacity greater than 250 ▶ Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities ▶ Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities ▶ Jails and detention facilities ▶ Power generating stations and other public utility facilities not included in Category IV ▶ Buildings and other structures not included in 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 sufficient quantities of hazardous materials to be dangerous to the public if released. ▶ Buildings and other structures containing hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the hazardous material does not pose a threat to the public.	III
Buildings and other structures designated as essential facilities including, but not limited to: ▶ Hospitals and other health care facilities having surgery or emergency treatment facilities ▶ Fire, rescue, ambulance, and police stations and emergency vehicle garages ▶ Designated earthquake, hurricane, or other emergency shelters ▶ Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response ▶ Power generating stations and other public utility facilities required in an emergency ▶ Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Category IV structures during an emergency ▶ Aviation control towers, air traffic control centers, and emergency aircraft hangars ▶ Water storage facilities and pump structures required to maintain water pressure for fire suppression ▶ Buildings and other structures having critical national defense functions ▶ 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, hazardous waste, or explosives) containing extremely hazardous materials where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction. ▶ Buildings and other structures containing extremely hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the extremely hazardous material does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.	IV

4.2 Static Load (See Commentary C4.2)

The **Gutter System** shall withstand a downward force per unit length equal to the density of water times the cross-sectional area of the water when the **Gutter** is filled to capacity.

$$F_s = S_f \times \rho_w \times A_w \times I$$

in which:

F_s = Downward static load per unit length of **Gutter**.

A_w = Cross-sectional area of the water when the **Gutter** is filled to capacity, and

ρ_w = Density of water.

S_f **=** **Safety Factor** = 1.67

I = **Importance Factor** from Table III.

The **Gutter System** shall be therefore subjected to downward loads of

F_w = $104 \times A_w \times I$ with F_w in pounds per foot and A_w in ft^2 or

($F_w \times 142 \times A_w \times I$ with F_w in N/m and A_w in m^2)

4.2.1 Ice Considerations (See Commentary 4.2.1)

Ground Snow Load, pg shall be derived from Attachment II (ASCE 7-05 Figure 7.1).

In regions where Ground Snow loads are greater than zero, the force of ice forming around the **Gutter** shall be considered in static load design. Static load on the **Gutter** shall be the downward static load as defined in 4.2 above plus 2.0 times the Ground Snow Load, p_g with p_g = maximum 20 lb/ft² (0.96 kN/m²).

$$F_s = S_f \times \rho_w \times A_w + 2.0 \times p_f \times A_w \times I$$

In which p_f = Flat Roof Snow Load

In regions where $p_g \leq 20$ lb/ft², then

$p_f = p_g$

Regions exceeding 20 lb/ft² (0.96 kN/m²),

p_f = 20 lb/ft² ($p_f = 0.96$ kN/m²)

Ground Snow Load, p_g shall be derived from Attachment II (ASCE 7-05 Figure 7.1).

4.3 Attachment Considerations

4.3.1 Water Control (See Commentary C4.3.1)

The outward edge of the **Gutter** shall be minimum 1 in (25 mm) below the top of the back flange of the **Gutter**. Suitable means shall be provided to prevent water from seeping behind the **Gutter**.

4.3.2 Wind Resistance of Gutter Systems

The vertical face of the **Gutter System** shall be tested using SPRI Test G-1 for resistance to outward (horizontal) loads and using SPRI Test G-2 for upward (vertical) loads. Test results shall meet or exceed design wind pressures of Table IV. A **Safety Factor**, S_f =1.67 has been applied to Table IV values.

4.4 Thermal Expansion

Provision shall be provided to accommodate longitudinal movement of the **Gutter** and building.

4.5 Galvanic Compatibility and Resistance (See Commentary C4.5)

The **Gutter System** shall consist of components (**Gutter**, **Gutter Brackets**, **Gutter Straps, Splices** etc.) of the same kind of metal, or shall be galvanically compatible metal pairs. Compatible metal pairs shall be selected from the following list:

- Aluminum-Galvanized Steel
- Aluminum-Galvalume®
- Aluminum-Stainless Steel
- Copper-Stainless Steel
- Other pairs that can be shown to provide satisfactory galvanic compatibility.

Fasteners shall be galvanically compatible with the other roof edge system components. When used with aluminum, steel **Fasteners** shall have a dielectric resistive coating.

Copper shall not be used in combination with mild steel, zinc or aluminum. Only copper, brass or stainless steel **Fasteners** shall be used with copper.

Exception: Copper may be used with anodized aluminum.

Precaution: Copper Pop®-Rivets having ferrous mandrels shall not be used.

4.6 Securement

The design of the **Nailer (substrate)** securement shall provide a minimum resistance specified in SPRI Tests G-1, G-2 and G-3.

The spacing between **Fasteners** securing **Nailers** shall not be greater than two rows at maximum 24 in (600 mm) centers for each row.

4.7 Packaging and Identification

Gutter system components or packaging shall contain written documentation which identifies the components which have complied with the ANSI/SPRI GD-1 Standard. Documentation, in the form of a label or printed product literature, shall be available to the building owner or owner's representative.

Table IV A
Exposure B—Upward and Outward Corner Design Wind Loads psf (kPa) for Gutter Design*

I = 1.0 Exposure B S_f =1.67								
3-second Gust, mph (M/sec)	Direction of Load	Building Height, z ft (M)						
		15 (4.6)	20 (6.1)	25 (7.6)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)
85 (38)	Upward	-59.87 (-2.87)	-59.87 (-2.87)	-59.87 (-2.87)	-59.87 (-2.87)	-65.00 (-3.11)	-69.27 (-3.32)	-72.98 (-3.49)
	Outward	-29.93 (-1.43)	-29.93 (-1.43)	-29.93 (-1.43)	-29.93 (-1.43)	-32.50 (-1.56)	-34.64 (-1.66)	-36.49 (-1.75)
90 (40)	Upward	-67.12 (-3.21)	-67.12 (-3.21)	-67.12 (-3.21)	-67.12 (-3.21)	-72.87 (-3.49)	-77.66 (-3.72)	-81.82 (-3.92)
	Outward	-33.56 (-1.61)	-33.56 (-1.61)	-33.56 (-1.61)	-33.56 (-1.61)	-36.43 (-1.74)	-38.83 (-1.86)	-40.91 (-1.96)
100 (45)	Upward	-82.86 (-3.97)	-82.86 (-3.97)	-82.86 (-3.97)	-82.86 (-3.97)	-89.96 (-4.31)	-95.88 (-4.59)	-101.01 (-4.84)
	Outward	-41.43 (-1.98)	-41.43 (-1.98)	-41.43 (-1.98)	-41.43 (-1.98)	-44.98 (-2.15)	-47.94 (-2.30)	-50.50 (-2.42)
110 (49)	Upward	-100.26 (-4.80)	-100.26 (-4.80)	-100.26 (-4.80)	-100.26 (-4.80)	-108.85 (-5.21)	-116.02 (-5.55)	-122.22 (-5.85)
	Outward	-50.13 (-2.40)	-50.13 (-2.40)	-50.13 (-2.40)	-50.13 (-2.40)	-54.43 (-2.61)	-58.01 (-2.78)	-61.11 (-2.93)
120 (54)	Upward	-119.32 (-5.71)	-119.32 (-5.71)	-119.32 (-5.71)	-119.32 (-5.71)	-129.54 (-6.20)	-138.07 (-6.61)	-145.45 (-6.96)
	Outward	-59.66 (-2.86)	-59.66 (-2.86)	-59.66 (-2.86)	-59.66 (-2.86)	-64.77 (-3.10)	-69.03 (-3.31)	-72.73 (-3.48)
130 (58)	Upward	-140.03 (-6.70)	-140.03 (-6.70)	-140.03 (-6.70)	-140.03 (-6.70)	-152.03 (-7.28)	-162.04 (-7.76)	-170.70 (-8.17)
	Outward	-70.02 (-3.35)	-70.02 (-3.35)	-70.02 (-3.35)	-70.02 (-3.35)	-76.02 (-3.64)	-81.02 (-3.88)	-85.35 (-4.09)
140 (63)	Upward	-162.41 (-7.78)	-162.41 (-7.78)	-162.41 (-7.78)	-162.41 (-7.78)	-176.32 (-8.44)	-187.93 (-9.00)	-197.98 (-9.48)
	Outward	-81.20 (-3.89)	-81.20 (-3.89)	-81.20 (-3.89)	-81.20 (-3.89)	-88.16 (-4.22)	-93.96 (-4.50)	-98.99 (-4.74)
150 (67)	Upward	-186.44 (-8.93)	-186.44 (-8.93)	-186.44 (-8.93)	-186.44 (-8.93)	-202.41 (-9.69)	-215.73 (-10.33)	-227.27 (-10.88)
	Outward	-93.22 (-4.46)	-93.22 (-4.46)	-93.22 (-4.46)	-93.22 (-4.46)	-101.20 (-4.85)	-107.87 (-5.16)	-113.63 (-5.44)
160 (72)	Upward	-212.12 (-10.16)	-212.12 (-10.16)	-212.12 (-10.16)	-212.12 (-10.16)	-230.29 (-11.03)	-245.46 (-11.75)	-258.58 (-12.38)
	Outward	-106.06 (-5.08)	-106.06 (-5.08)	-106.06 (-5.08)	-106.06 (-5.08)	-115.15 (-5.51)	-122.73 (-5.88)	-129.29 (-6.19)
170 (76)	Upward	-239.47 (-11.47)	-239.47 (-11.47)	-239.47 (-11.47)	-239.47 (-11.47)	-259.98 (-12.45)	-277.10 (-13.27)	-291.91 (-13.98)
	Outward	-119.73 (-5.73)	-119.73 (-5.73)	-119.73 (-5.73)	-119.73 (-5.73)	-129.99 (-6.22)	-138.55 (-6.63)	-145.96 (-6.99)

* Table IV values shall be multiplied by an **Importance Factor** determined by Table III. In corner regions only, values may be reduced by the multipliers shown in Table I.

Table IV B
Exposure C—Upward and Outward Corner Design Wind Loads psf (kPa) for Gutter Design*

I = 1.0 Exposure C S_f =1.67								
3-second Gust, mph (M/sec)	**Direction of Load**	**Building Height, z ft (M)**						
		15 (4.6)	**20 (6.1)**	**25 (7.6)**	**30 (9.1)**	**40 (12.2)**	**50 (15.2)**	**60 (18.3)**
85 (38)	Upward	-72.54 (-3.47)	-77.07 (-3.69)	-80.77 (-3.87)	-83.93 (-4.02)	-89.18 (-4.27)	-93.46 (-4.48)	-97.12 (-4.65)
	Outward	-36.27 (-1.74)	-38.53 (-1.85)	-40.39 (-1.93)	-41.97 (-2.01)	-44.59 (-2.13)	-46.73 (-2.24)	-48.56 (-2.33)
90 (40)	Upward	-81.32 (-3.89)	-86.40 (-4.14)	-90.56 (-4.34)	-94.10 (-4.51)	-99.98 (-4.79)	-104.78 (-5.02)	-108.88 (-5.21)
	Outward	-40.66 (-1.95)	-43.20 (-2.07)	-45.28 (-2.17)	-47.05 (-2.25)	-49.99 (-2.39)	-52.39 (-2.51)	-54.44 (-2.61)
100 (45)	Upward	-100.40 (-4.81)	-106.67 (-5.11)	-111.80 (-5.35)	-116.17 (-5.56)	-123.43 (-5.91)	-129.36 (-6.19)	-134.42 (-6.44)
	Outward	-50.20 (-2.40)	-53.33 (-2.55)	-55.90 (-2.68)	-58.09 (-2.78)	-61.71 (-2.95)	-64.68 (-3.10)	-67.21 (-3.22)
110 (49)	Upward	-121.48 (-5.82)	-129.07 (-6.18)	-135.28 (-6.48)	-140.57 (-6.73)	-149.35 (-7.15)	-156.53 (-7.49)	-162.65 (-7.79)
	Outward	-60.74 (-2.91)	-64.53 (-3.09)	-67.64 (-3.24)	-70.28 (-3.37)	-74.67 (-3.58)	-78.26 (-3.75)	-81.33 (-3.89)
120 (54)	Upward	-144.57 (-6.92)	-153.60 (-7.35)	-160.99 (-7.71)	-167.29 (-8.01)	-177.73 (-8.51)	-186.28 (-8.92)	-193.57 (-9.27)
	Outward	-72.29 (-3.46)	-76.80 (-3.68)	-80.49 (-3.85)	-83.64 (-4.00)	-88.87 (-4.25)	-93.14 (-4.46)	-96.79 (-4.63)
130 (58)	Upward	-169.67 (-8.12)	-180.27 (-8.63)	-188.94 (-9.05)	-196.33 (-9.40)	-208.59 (-9.99)	-218.62 (-10.47)	-227.18 (-10.88)
	Outward	-84.84 (-4.06)	-90.13 (-4.32)	-94.47 (-4.52)	-98.17 (-4.70)	-104.30 (-4.99)	-109.31 (-5.23)	-113.59 (-5.44)
140 (63)	Upward	-196.78 (-9.42)	-209.07 (-10.01)	-219.12 (-10.49)	-227.70 (-10.90)	-241.92 (-11.58)	-253.55 (-12.14)	-263.47 (-12.62)
	Outward	-98.39 (-4.71)	-104.53 (-5.01)	-109.56 (-5.25)	-113.85 (-5.45)	-120.96 (-5.79)	-126.78 (-6.07)	-131.74 (-6.31)
150 (67)	Upward	-225.90 (-10.82)	-240.00 (-11.49)	-251.55 (-12.04)	-261.39 (-12.52)	-277.71 (-13.30)	-291.07 (-13.94)	-302.46 (-14.48)
	Outward	-112.95 (-5.41)	-120.00 (-5.75)	-125.77 (-6.02)	-130.69 (-6.26)	-138.85 (-6.65)	-145.53 (-6.97)	-151.23 (-7.24)
160 (72)	Upward	-257.02 (-12.31)	-273.07 (-13.07)	-286.20 (-13.70)	-297.40 (-14.24)	-315.97 (-15.13)	-331.17 (-15.86)	-344.13 (-16.48)
	Outward	-128.51 (-6.15)	-136.53 (-6.54)	-143.10 (-6.85)	-148.70 (-7.12)	-157.99 (-7.56)	-165.58 (-7.93)	-172.06 (-8.24)
170 (76)	Upward	-290.15 (-13.89)	-308.27 (-14.76)	-323.10 (-15.47)	-335.74 (-16.08)	-356.70 (-17.08)	-373.86 (-17.90)	-388.49 (-18.60)
	Outward	-145.08 (-6.95)	-154.13 (-7.38)	-161.55 (-7.73)	-167.87 (-8.04)	-178.35 (-8.54)	-186.93 (-8.95)	-194.24 (-9.30)

* Table IV values shall be multiplied by an **Importance Factor** determined by Table III. In corner regions only, values may be reduced by the multipliers shown in Table I.

Table IV C
Exposure D—Upward and Outward Corner Design Wind Loads psf (kPa) for Gutter Design*

I = 1.0 Exposure D S_f =1.67								
3-second Gust, mph (M/sec)	Direction of Load	Building Height, z ft (M)						
		15 (4.6)	20 (6.1)	25 (7.6)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)
85 (38)	Upward	-89.10 (-4.27)	-93.67 (-4.49)	-97.38 (-4.66)	-100.52 (-4.81)	-105.67 (-5.06)	-109.86 (-5.26)	-113.39 (-5.43)
	Outward	-44.55 (-2.13)	-46.84 (-2.24)	-48.69 (-2.33)	-50.26 (-2.41)	-52.84 (-2.53)	-54.93 (-2.63)	-56.70 (-2.71)
90 (40)	Upward	-99.89 (-4.78)	-105.02 (-5.03)	-109.17 (-5.23)	-112.69 (-5.40)	-118.47 (-5.67)	-123.16 (-5.90)	-127.13 (-6.09)
	Outward	-49.95 (-2.39)	-52.51 (-2.51)	-54.59 (-2.61)	-56.35 (-2.70)	-59.24 (-2.84)	-61.58 (-2.95)	-63.56 (-3.04)
100 (45)	Upward	-123.32 (-5.90)	-129.65 (-6.21)	-134.78 (-6.45)	-139.12 (-6.66)	-146.26 (-7.00)	-152.05 (-7.28)	-156.95 (-7.51)
	Outward	-61.66 (-2.95)	-64.83 (-3.10)	-67.39 (-3.23)	-69.56 (-3.33)	-73.13 (-3.50)	-76.02 (-3.64)	-78.47 (-3.76)
110 (49)	Upward	-149.22 (-7.14)	-156.88 (-7.51)	-163.09 (-7.81)	-168.34 (-8.06)	-176.98 (-8.47)	-183.98 (-8.81)	-189.91 (-9.09)
	Outward	-74.61 (-3.57)	-78.44 (-3.76)	-81.54 (-3.90)	-84.17 (-4.03)	-88.49 (-4.24)	-91.99 (-4.40)	-94.95 (-4.55)
120 (54)	Upward	-177.59 (-8.50)	-186.70 (-8.94)	-194.09 (-9.29)	-200.34 (-9.59)	-210.62 (-10.08)	-218.95 (-10.48)	-226.00 (-10.82)
	Outward	-88.79 (-4.25)	-93.35 (-4.47)	-97.04 (-4.65)	-100.17 (-4.80)	-105.31 (-5.04)	-109.48 (-5.24)	-113.00 (-5.41)
130 (58)	Upward	-208.42 (-9.98)	-219.11 (-10.49)	-227.78 (-10.91)	-235.12 (-11.26)	-247.18 (-11.84)	-256.96 (-12.30)	-265.24 (-12.70)
	Outward	-104.21 (-4.99)	-109.56 (-5.25)	-113.89 (-5.45)	-117.56 (-5.63)	-123.59 (-5.92)	-128.48 (-6.15)	-132.62 (-6.35)
140 (63)	Upward	-241.72 (-11.57)	-254.12 (-12.17)	-264.17 (-12.65)	-272.68 (-13.06)	-286.67 (-13.73)	-298.02 (-14.27)	-307.62 (-14.73)
	Outward	-120.86 (-5.79)	-127.06 (-6.08)	-132.09 (-6.32)	-136.34 (-6.53)	-143.34 (-6.86)	-149.01 (-7.13)	-153.81 (-7.36)
150 (67)	Upward	-277.48 (-13.29)	-291.72 (-13.97)	-303.26 (-14.52)	-313.03 (-14.99)	-329.09 (-15.76)	-342.11 (-16.38)	-353.13 (-16.91)
	Outward	-138.74 (-6.64)	-145.86 (-6.98)	-151.63 (-7.26)	-156.51 (-7.49)	-164.54 (-7.88)	-171.06 (-8.19)	-176.57 (-8.45)
160 (72)	Upward	-315.71 (-15.12)	-331.91 (-15.89)	-345.04 (-16.52)	-356.16 (-17.05)	-374.43 (-17.93)	-389.25 (-18.64)	-401.79 (-19.24)
	Outward	-157.86 (-7.56)	-165.95 (-7.95)	-172.52 (-8.26)	-178.08 (-8.53)	-187.21 (-8.96)	-194.62 (-9.32)	-200.89 (-9.62)
170 (76)	Upward	-356.41 (-17.06)	-374.69 (-17.94)	-389.52 (-18.65)	-402.07 (-19.25)	-422.70 (-20.24)	-439.42 (-21.04)	-453.58 (-21.72)
	Outward	-178.20 (-8.53)	-187.35 (-8.97)	-194.76 (-9.33)	-201.03 (-9.63)	-211.35 (-10.12)	-219.71 (-10.52)	-226.79 (-10.86)

* Table IV values shall be multiplied by an **Importance Factor** determined by Table III. In corner regions only, values may be reduced by the multipliers shown in Table I.

5.0 SPRI Test Method G-1 & G-2 (See Commentary C5.0)

Wind Resistance Tests for **Gutters**—SPRI G-1 & G-2

Gutter system designs shall pass SPRI tests G-1, G-2 and G-3. Test G-1 measures the resistance of the **Gutter System** to wind forces acting outwardly (away from the building.) Test G-2 measures the resistance of the **Gutter System** to wind forces acting upwardly tending to lift the **Gutter** off the building. Test G-3 measures the resistance of the **Gutter System** to static forces of water and ice acting downwardly.

5.1 Wind Load Testing

5.1.1 Apparatus

The description of the apparatus is general in nature. Any equipment capable of performing the test procedure within ±5% of measured load shall be permitted. A schematic drawing of this apparatus is shown in Figures 2 and 3. The test apparatus shall be constructed so that the performance of individual components are unaffected by edge or end constraints on the test sample.

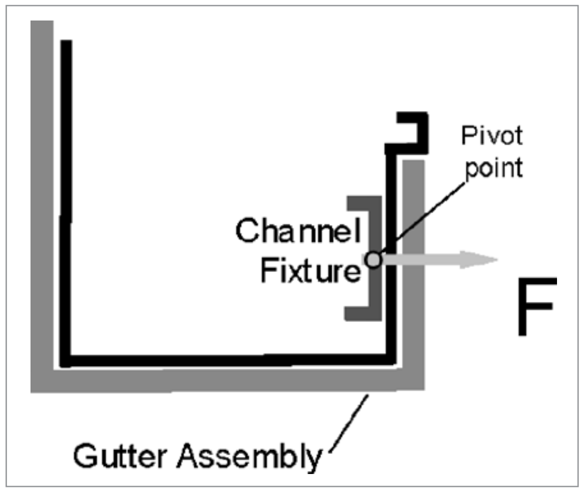


Figure 2 Test Setup for SPRI Test G-1

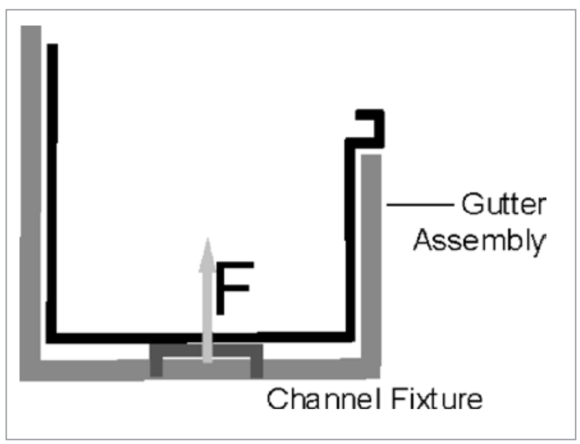


Figure 3 Test Setup for SPRI Test G-2

5.1.2 Safety Precautions
Proper precautions shall be taken to protect the operating personnel and observers in case of any failure.

5.1.3 Test Specimens
All **Gutter Straps, Gutter Brackets** and **Fasteners** of the test specimen shall be identical to the standard fabricated product except that **Gutter** length shall be minimum 8 ft (2.4 m) and maximum 12 ft (3.7 m).

5.1.4 Procedure
Separate tests shall be performed independently, pulling outward (horizontally) and upward (vertically).

SPRI Test G-1: Horizontal Test
A continuous ½ in x 1 in x ½ in x 0.125 in (12 mm x 25 mm x 12 mm x 3 mm) steel channel shall be fitted behind the face of the **Gutter**. Rods, chains or cables shall be attached to the continuous steel channel on maximum 122-inch (300 mm) centers, each penetrating the **Gutter** face on vertical centerline of the **Gutter** face, and attached to load cells. Fixture shall be free to pivot to conform to the slope of the face where the load is applied. Care shall be taken to avoid penetration at a **Gutter Bracket** location. A gauge shall be attached to the centerline of each loaded surface to detect movement. Stabilization of the test shall be when the gauge ceases to show movement.

SPRI Test G-2: Vertical Test
A continuous ½ in x 1 in x ½ in x 0.125 in (12 mm x 25 mm x 12 mm x 3 mm) steel channel shall be fitted under the base of the **Gutter** assembly. Rods or cables shall be attached to the continuous steel channel on maximum 12-inch (300 mm) centers, each penetrating the **Gutter** bottom, half-way between the back and the leading edge of the **Gutter**, and attached to load cells at a **Gutter Bracket** location. A gauge shall be attached to the centerline of each loaded surface to detect movement. Stabilization of the test shall be when the gauge ceases to show movement.

5.1.5 Gravity
Any influence from gravity that does not occur in the field shall be omitted from the test. If the test specimen is inverted, a gravity correction shall be made in the determination of the allowable superimposed loading.

5.1.6 Stabilization (See Commentary C5.1.6)
A dial gauge shall be attached to the centerline of each loaded surface to detect movement. Stabilization of the test shall be when the gauge ceases to show movement.

5.1.7 Loading (See Commentary C5.1.7)
Loading shall be applied uniformly on the horizontal centerline of the bottom face of the **Gutter** on centers no greater than 12 in (300 mm). Loads shall be applied at a rate which achieves full load in five seconds or more. Loads shall be applied incrementally and held for not less than 60 seconds after stabilization has been achieved at each incremental load. Between incremental loads, the loading shall be reduced to zero until the specimen stabilizes, or for five minutes, whichever happens first. After the recovery period, initiate the next higher incremental load. Loading to the face of the **Gutter System** shall be applied in increments not to exceed 10 lbf/ft^2 (1.2 kPa) until approximately 150 lbf/ft^2 (7.2 kPa) is obtained. Thereafter, increments of load shall not exceed 10 lbf/ft^2 (0.5 kPa). Loading speed shall be such that each incremental load up to and including 150 lbf/ft^2 (7.2 kPa) shall be achieved in 5–60 seconds. Above 150 lbf/ft^2 (7.2 kPa), incremental loading shall be achieved in 5–120 seconds.

Loading shall proceed as indicated until the test specimen either fails or exceeds the required design pressure. The increments of load application shall be chosen so that a sufficient number of observations are made to determine the exact load at failure. The last sustained 60-second load without failure is the maximum load recorded as the design value.

5.1.8 Failure (See Commentary C5.1.8)

Failure shall be either loss of securement of any component of the **Gutter System** or permanent deformation of the **Gutter** measured as a permanent stretching, in any direction, of the upper leading edge of the **Gutter** by more than 25% of the distance between that edge and the back of the **Gutter**.

5.1.9 Test Results

The forces at the highest load tested shall be recorded and summed for a total force measurement.

For SPRI Test G-2, this total force shall be converted to pressure by dividing the total force by the area of the **Gutter** face:

$$\text{Pressure} = \frac{\text{Force}}{\text{Face Height} \times \text{Length}}$$

Force is in Pounds (N) and is the sum of the readings on the load cells. Height is the **Gutter** face height in feet (meter) [ft (m)], and pressure is in lbf/ft^2 (kPa). If test results exceed the design outward wind pressure, the **Gutter System** has acceptable outward wind resistance.

For SPRI Test G-1, this total force shall be converted to pressure by dividing the total force by the total width of the **Gutter**:

$$\text{Pressure} = \frac{\text{Force}}{\text{Gutter Width} \times \text{Length}}$$

Gutter Width is the full **Gutter** width from back to leading edge in feet (meter) [ft (m)]. See Figure 4.

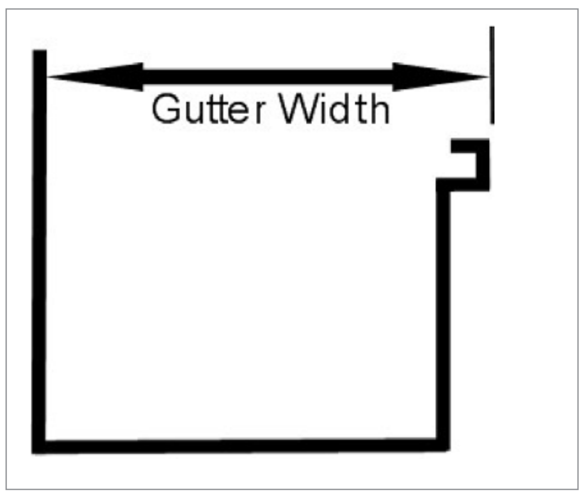


Figure 4: Gutter Width

5.1.10 Precision and Bias

The precision and bias of these tests is undetermined and will be dependent upon the actual test equipment used.

6.0 SPRI Test Method G-3

Static Test for **Gutter**

6.1 Static Loads

6.1.1 Apparatus

This description of the apparatus is general in nature. Any equipment capable of performing the test procedure within ±5% of measured load shall be permitted. A schematic drawing of this apparatus is shown in Figure 5. The test apparatus shall be constructed so that the performance of individual components are unaffected by edge or end constraints on the test sample.

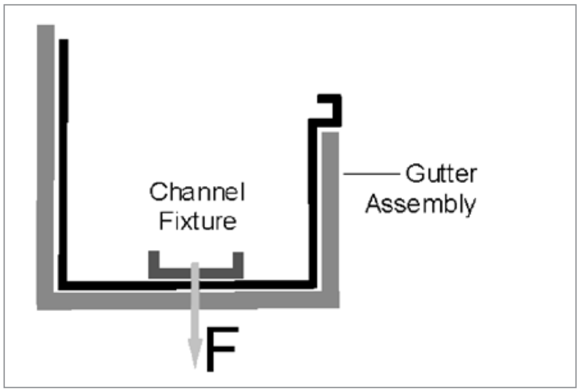


Figure 5 Test Setup for SPRI Test G-3

6.1.2 Safety Precautions

Proper precautions shall be taken to protect the operating personnel and observers in case of any failure.

6.1.3 Test Specimens

All **Gutter Straps**, **Gutter Brackets** and **Fasteners** of the test specimen shall be identical to the standard fabricated product except that **Gutter** length shall be minimum 8 ft (2.4 m) and maximum 12 ft (3.7 m).

6.1.4 Procedure

A continuous ½ in x 1 in x ½ in x 0.125 in (12 mm x 25 mm x 12 mm x 3 mm) steel channel shall be fitted above the bottom of the **Gutter**. Rods or cables shall be attached to the continuous steel channel on maximum 12-inch (300 mm) centers, each penetrating the **Gutter** bottom, half-way between the back and the leading edge of the **Gutter**, and attached to force gauges. Care shall be taken to avoid penetration at a **Gutter Bracket** location.

6.1.5 Gravity

Any influence from gravity that does not occur in the field shall be omitted from the test. If the test specimen is inverted, a gravity correction shall be made in the determination of the allowable superimposed loading.

6.1.6 Loading (See Commentary C6.1.6)

Loading shall be applied uniformly to the bottom of the **Gutter** on centers no greater than 12 in (300 mm). Loads shall be applied at a rate which achieves full load in five seconds or more. Loading shall proceed as indicated until the test specimen either fails or exceeds the required design load.

6.1.7 Failure (See Commentary C6.1.7)

Failure shall be either loss of securement of any component of the **Gutter System** or permanent deformation of the **Gutter** measured as a permanent stretching, in any direction, of the upper leading edge of the **Gutter** by more than 25% of the distance between that edge and the back of the **Gutter**.

6.1.8 Test Results

The forces at the highest load tested shall be recorded and summed for a total force measurement. This total force shall be converted to unit load by dividing the force by the length of the **Gutter** sample:

$$\text{Load} = F_w = \frac{\text{Force}}{\text{Length}}$$

Force is in Pounds Force (Newtons) and is the sum of the readings on the load cells. Length is the test sample length in feet (meter) [ft (m)] and F_w is in Pounds per Foot (Newtons per Meter). If test results exceed the design load, the **Gutter System** has acceptable static load resistance.

6.1.9 Precision and Bias (See Commentary C6.1.9)

The precision and bias of these tests is undetermined and will be dependent upon the actual test equipment used.

Attachment I

Basic Wind Speed

(From ASCE 7-05 Figure 6)

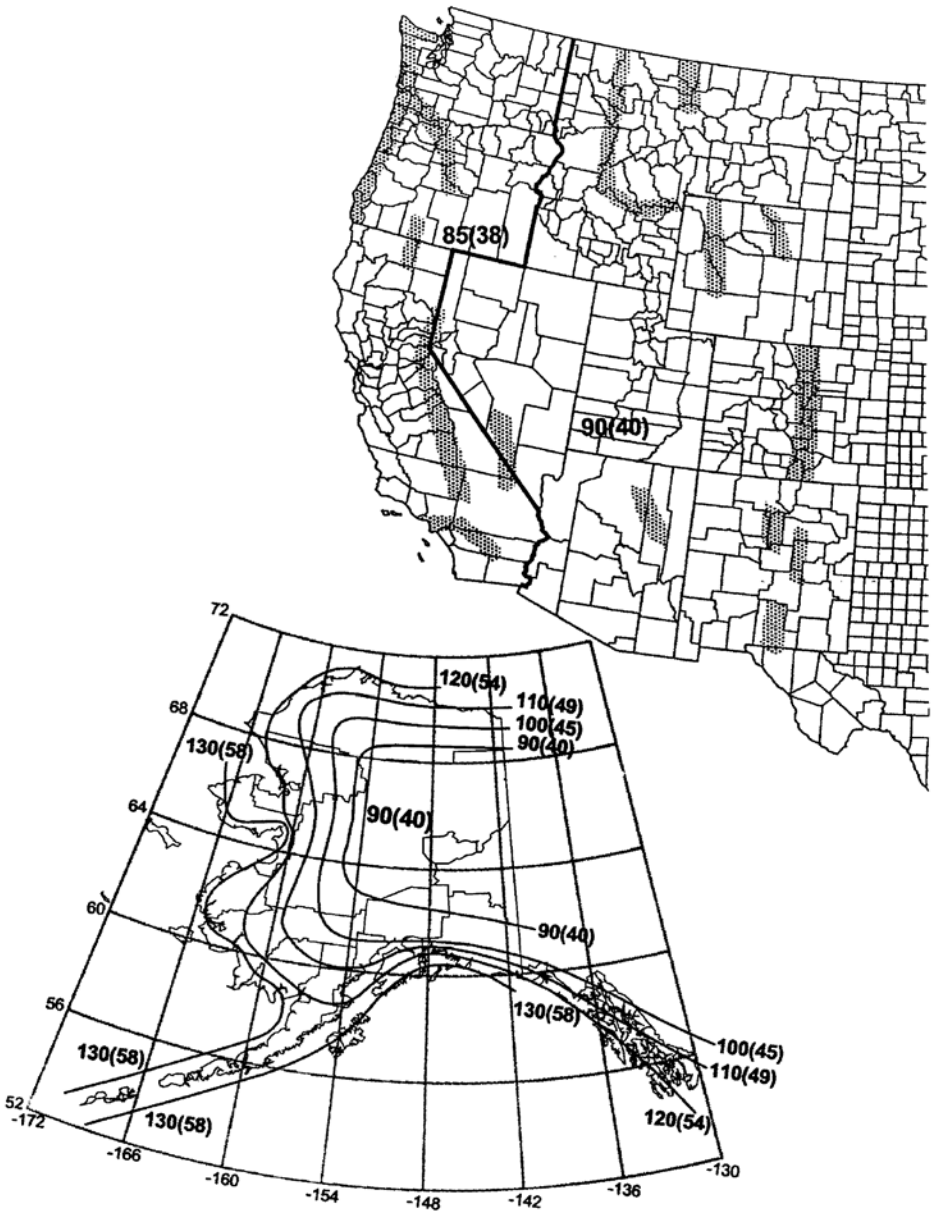


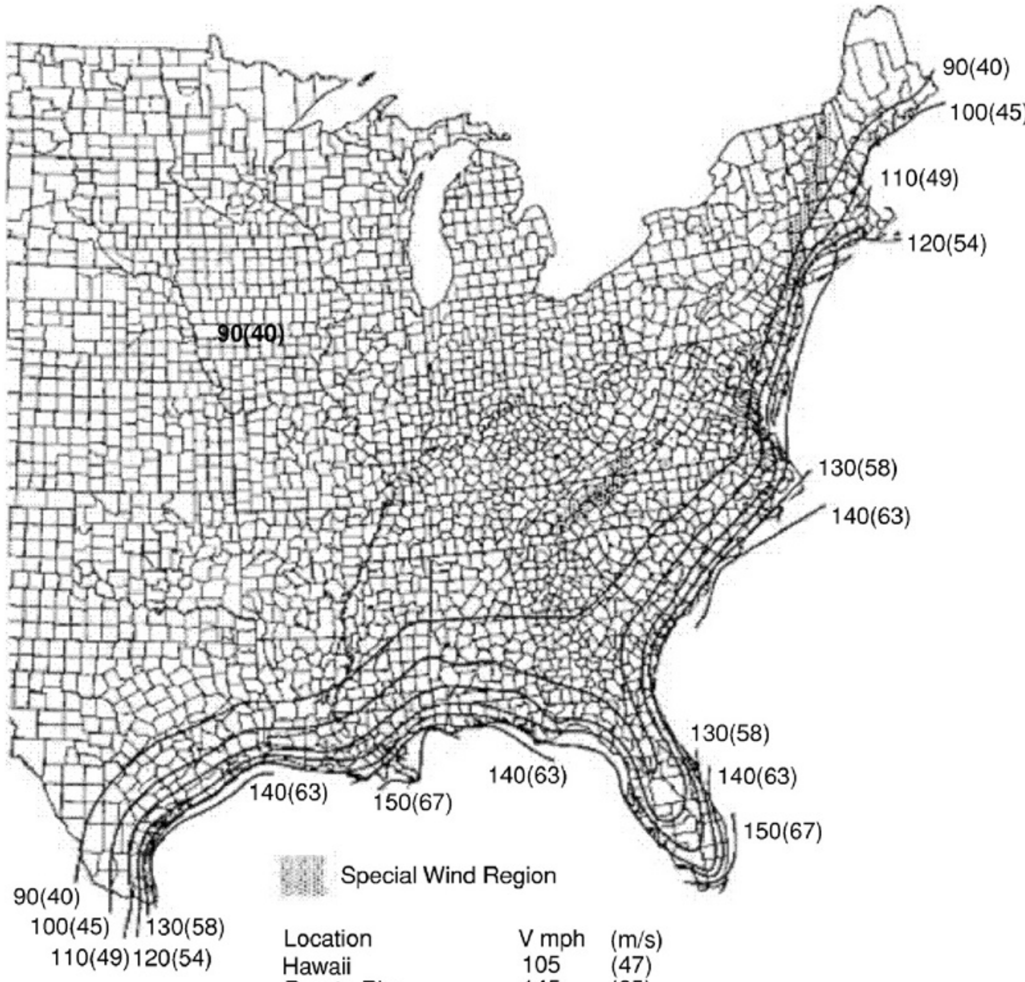
FIGURE 6-1 BASIC WIND SPEED

32 ASCE 7-05

ANSI/SPRI GD-1
Structural Design Standard for Gutter Systems Used with Low-slope Roofs

Approved October 7, 2010

Basic Wind Speed



Location	V mph	(m/s)
Hawaii	105	(47)
Puerto Rico	145	(65)
Guam	170	(76)
Virgin Islands	145	(65)
American Samoa	125	(56)

Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear interpolation between wind 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.

FIGURE 6-1 continued
BASIC WIND SPEED

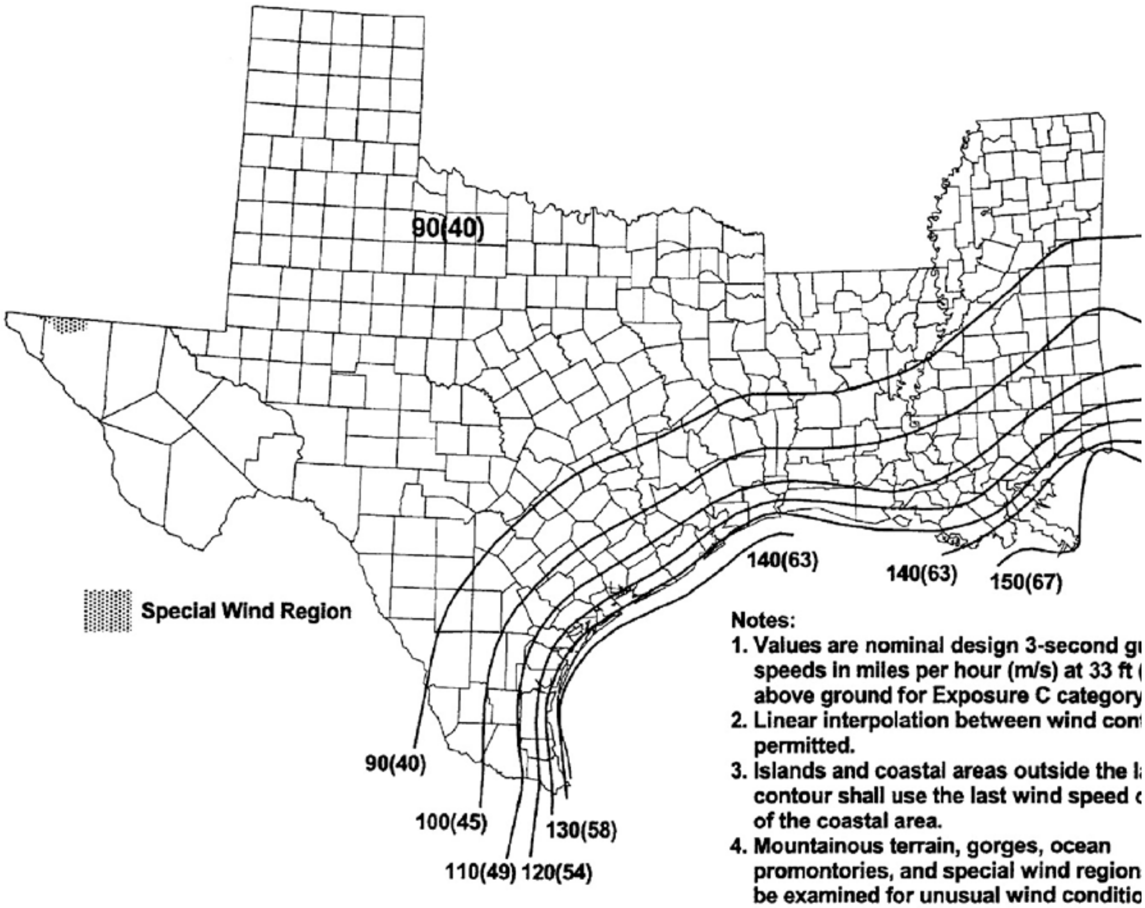


FIGURE 6-1A BASIC WIND SPEED—WESTERN GULF OF MEXICO HURRICANE COASTLINE

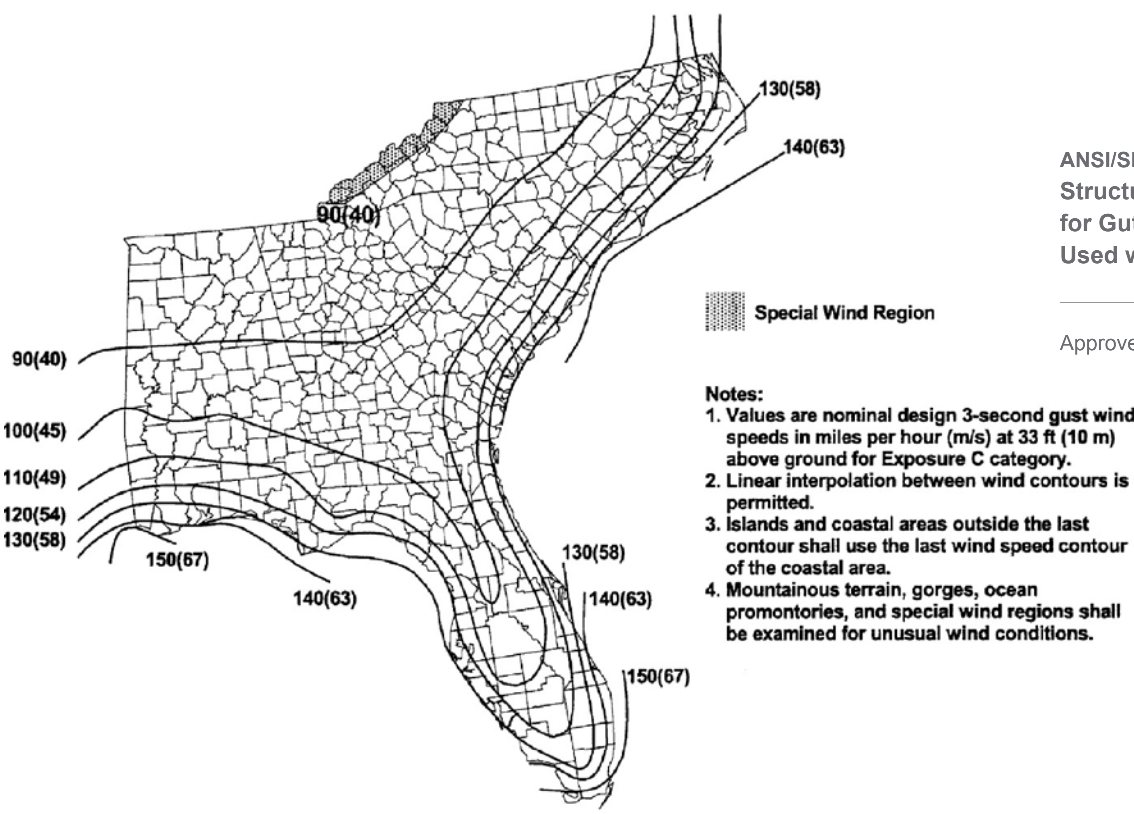


FIGURE 6-1B—BASIC WIND SPEED—EASTERN GULF OF MEXICO AND SOUTHEASTERN US HURRICANE COASTLINE

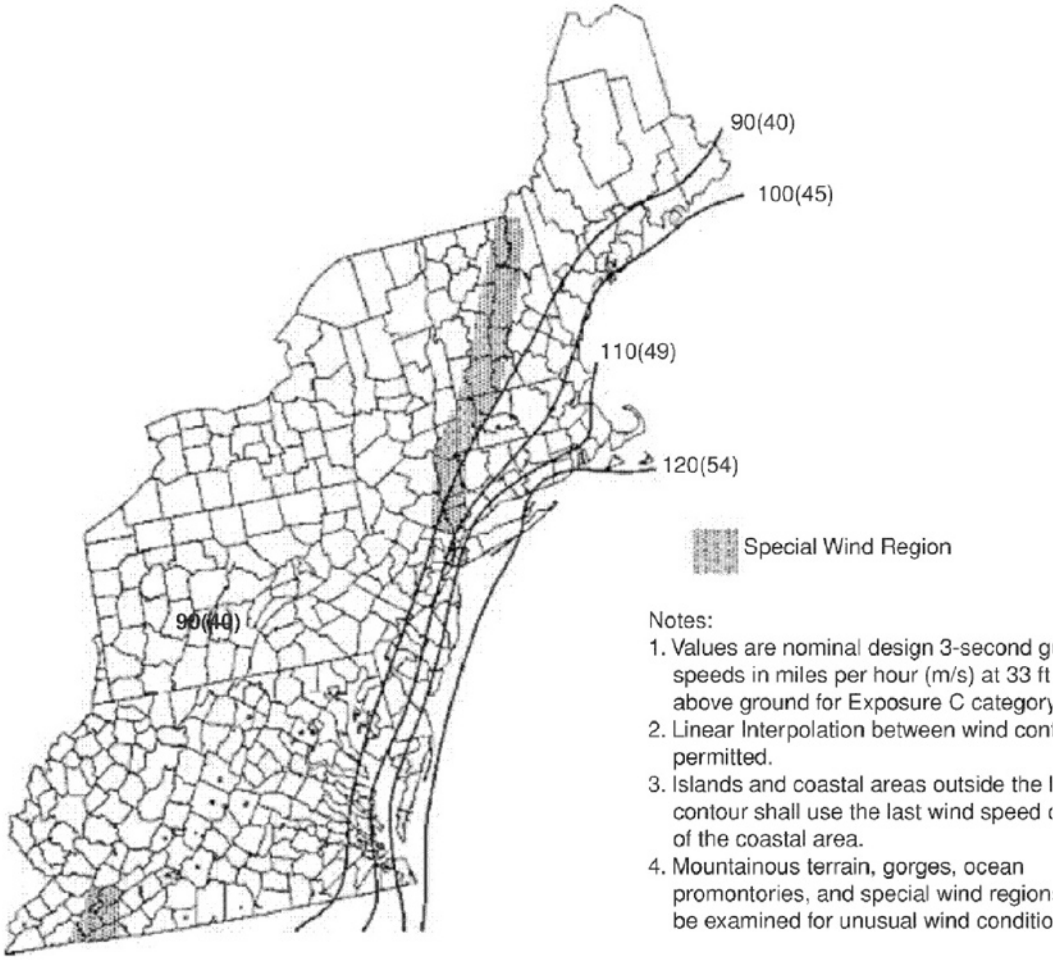
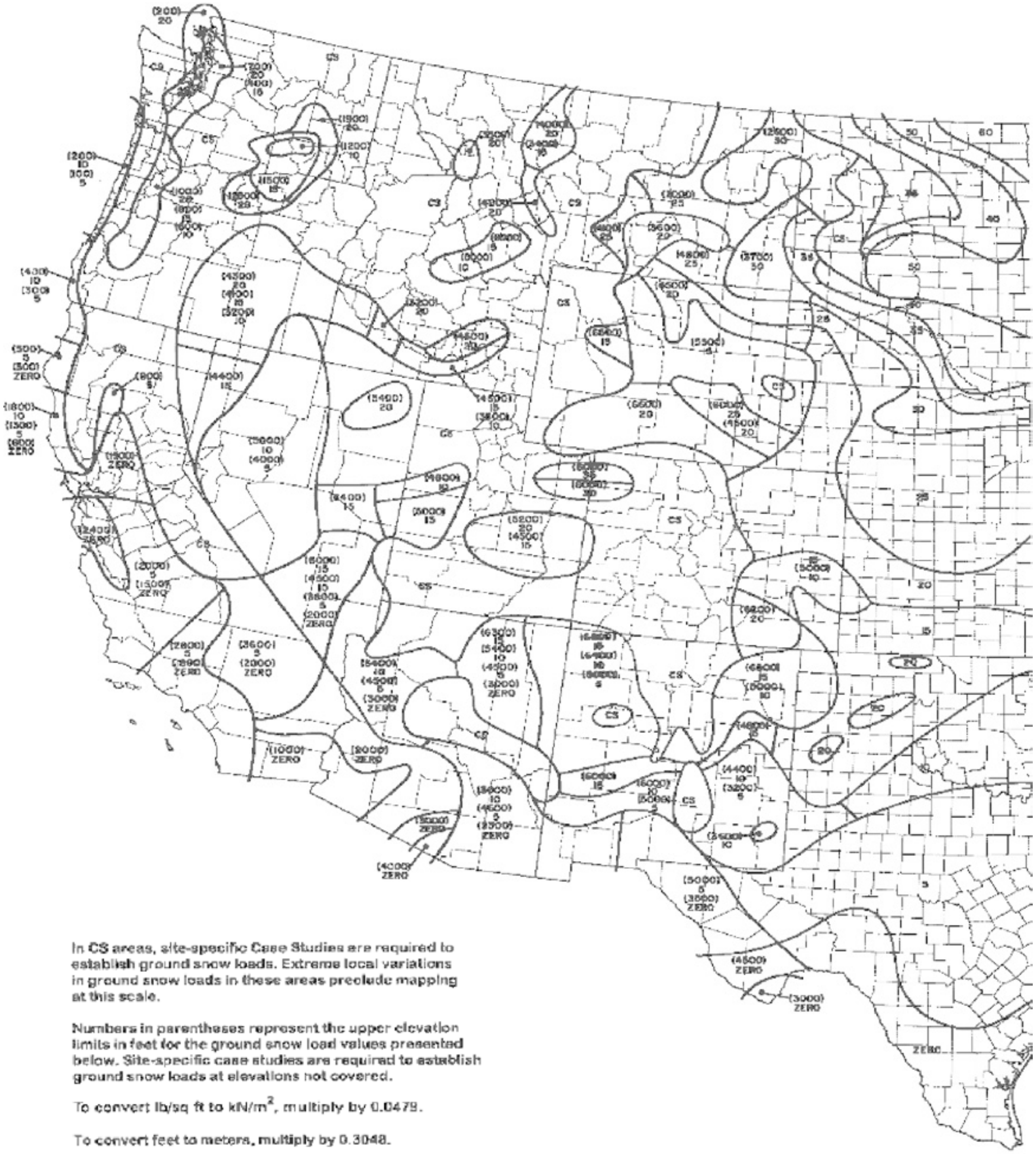


FIGURE 6-1C BASIC WIND SPEED—MID AND NORTHERN ATLANTIC HURRICANE COASTLINE

Attachment II

Ground Snow Loads lb/ft²

(From ASCE 7-05 Figure 7)



In CS areas, site-specific Case Studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.

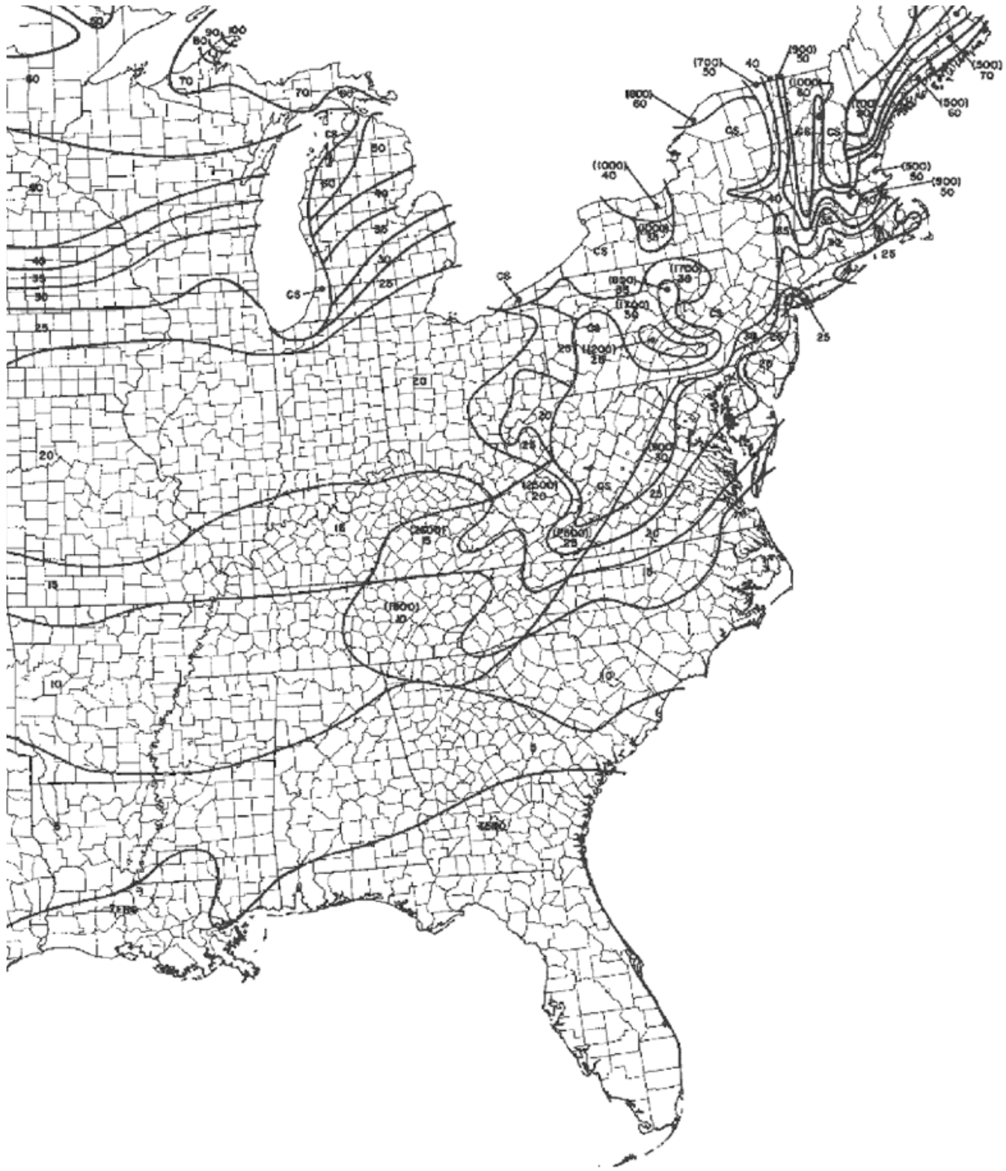
Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site-specific case studies are required to establish ground snow loads at elevations not covered.

To convert lb/sq ft to kN/m^2, multiply by 0.0479.

To convert feet to meters, multiply by 0.3048.

0 100 200 300 miles

Ground Snow Loads lb/ft^2



GD-1 Commentary

This Commentary consists of explanatory and supplementary material designed to help designers, roofing contractors and local building authorities in applying the requirements of the preceding Standard.

This Commentary is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements.

The sections of this Commentary are numbered to correspond to sections of the Standard to which they refer. Since having comments for every section of the Standard is not necessary, not all section numbers appear in this Commentary.

C1.0 Purpose

Studies of the aftermaths of Hurricanes Frances and Ivan in the fall of 2003 revealed a need for better **Gutter System** design. SPRI developed this Standard in response to those studies.

C2.0 Scope

While the Standard is intended as a reference for designers and roofing contractors, the design responsibility rests with the "designer of record."

Installation requirements include installing a system that is designed and tested to resist the wind loads in accordance with G-1, G-2 and G-3. Testing requirements apply to the specific design of the system being installed

C3.0 Definitions

Terms defined in this section appear capitalized and in **Bold print** throughout this document.

C4.0 Design Considerations

C4.1 Wind Load

The **Gutter** is subject to both direct upward force from wind pushing up from the bottom and from eddy vacuum above. The **Gutter**, in this Standard is considered an overhang.

C4.1.1 Design Pressure

GC_p values in Table IV are for CORNER REGIONS.

In most instances, it should be more economical to manufacture a single **Gutter** design rather than one for perimeters and another for corners. Since the "corner region" could be quite large, (20–30 ft) little cost is saved by using a weaker product in the remaining edge. If only one design is used, it must, of course be the stronger one. This is the reason for providing Table IV for corner regions and not including the perimeter. Table I contains multipliers for designing at the perimeter when desired.

The designer is allowed to reduce the perimeter strength if desired, and factors are included in the /Standard to allow this.

For buildings height of 60 ft (18 m) or less, horizontal GC_p = -1.4 for a wall in the corner region and 1.1 between corner regions. (ASCE 7-05 Figure 6-11A). For an overhang, such as a **Gutter System**, GC_p = -1.7 at the perimeter and -2.8 in corner regions. (ASCE 7-05 Figure 6-11B). Because corner regions are the most critical, design Tables IV are calculated for these regions. A multiplier is offered on Table I to calculate regions between corner regions. The entire **Gutter System** may be designed for corner loads. However, if there is a relatively large quantity of material between corner regions, it may be economical to supply two classes of **Gutter System**: one for corner regions and one for the remainder of the project.

Resistance wind loads on the **Gutter System** depends not only upon the attachment of the **Gutter System** to the building, but also upon the integrity of the nailer or other substrate to which the **Gutter System** is attached. It is important to consider the load path from the nailer to the foundation of the building to assure proper wind load protection. The design professional or authority having jurisdiction should determine if the load path is complete and the appropriate **Safety Factor** is applied.

Topographic Factor

Refer to **Section 6.5.7** of ASCE 7-05 if the height of the hill or escarpment is greater than 15 ft (4.6 m) in exposure C or D and 60 ft (18.3 m) for exposure B. The intensifying effects of topography (hills or escarpments) are to be accounted for. Speedup over hills and escarpments is accounted for in ASCE 7-05 by means of a topographic factor, K_{zt}, which depends on the height of the building, the height and slope of the hill or escarpment, the distance of the crest upwind of the building, and whether the terrain is a hill or an escarpment.

C4.1.5 Exposure Category

The terrain surrounding a building will influence the exposure of that building to the wind. See ASCE 7-05 for more detail.

C4.2 Static Load (See Figure 6)

Static load per unit length is the weight of a **Gutter**, full of water. Plus two times the snow load to account for ice formation in cold climates. The factor of two is derived from **Section 7.4.5 of ASCE 7-05**.

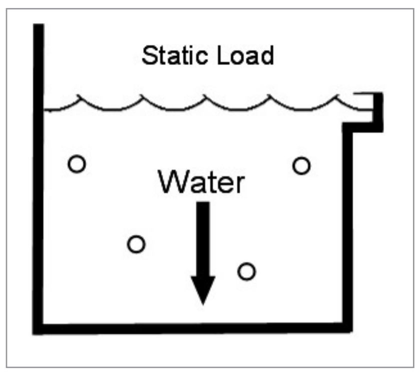


Figure 6 Static Load due to water in a Gutter

C4.2.1 Ice Considerations

ASCE 7-05 Section 7.4.5 addresses ice build-up as follows: "…drain water over their eaves shall be capable of sustaining a uniformly distributed load of $2p_f$ on all overhanging portions."

C4.3.1 Water Control

The purpose of this rule is so that water cannot flow behind the **Gutter System** and wet the building walls.

C4.5 Galvanic Compatibility and Resistance

Corrosion and strength should be considered in the choice of materials. This Standard focuses primarily on metal **Gutter Systems**. When plastic materials are used, corrosion is not usually a factor (although environmental deterioration must be considered); however, strength of the materials must be considered. Corrosive potential can be roughly predicted by knowing the placement of the two metals in the Galvanic Series. The farther apart the metals are in the Galvanic Series, the greater is this potential for corrosion. Metals adjacent to each other in the Series have little potential for corrosion. In **Table V**, the metals high on the list are defined as "more noble" and are "protected", while those lower on the list are "less noble" and are potentially corroded. Frequently, the corrosion rate of "sacrificed" metals will be low, even if there might be a potential for corrosion. Normally, there will generally be little corrosion between metals that are close to each other on the list, however, when they are in contact; the higher of a pair will be protected by the lower even if no perceptible corrosion is taking place. For this reason, steel, being higher on the list than zinc will be protected by the zinc, which is "sacrificed" to save the steel. Fortunately, although there is a potential for corrosion between zinc and steel, under most conditions, the rate of corrosion is minuscule so that the zinc lasts many years while electrolytically protecting the steel.

Normally, pairs of metals such as aluminum and zinc or aluminum and stainless steel will show no perceptible corrosion between them, because of their proximity to each other on the list. On the other hand, pairing copper with zinc or aluminum or steel must be avoided because copper is far from them in galvanic potential and the potential for corrosion is great.

Even if metals are not in contact, care should be taken to avoid runoff from more noble metals (e.g. copper) onto less noble metals (e.g. Zinc.)

Table V: Galvanic Series[2]

More Protected
Platinum
Gold
Graphite
Silver
316 Stainless steel (passive)
304 Stainless steel (passive)
Monel
Inconel (passive)
Nickel (passive)
70-30 cupro-nickel
Silicon bronze
Copper
Red brass
Admiralty bronze
Admiralty brass
Yellow brass
Hastelloy C (active)
Inconel (active)
Nickel (active)
Naval bronze
Muntz metal
Tin
Lead
316 Stainless steel (active)
304 Stainless steel (active)
400 Series stainless steels
50-50 lead-tin solder
13% Cr stainless steel (active)
Ni –resist
Cast iron
Wrought iron
Mild steel
Cadmium
Alclad
Aluminum
Aluminum 2024
Aluminum 3003
Aluminum 6053
Galvanized steel
Zinc
Magnesium alloys
Magnesium
More Corroded

C5.0 Testing

C5.1.6 Stabilization

Stabilization is necessary during loading to ensure that the specimen has reached equilibrium before considering a sustained load for a period of 60 seconds. As the specimen approaches its ultimate capacity, stabilization of the specimen will generally take longer to achieve.

C5.1.7 & C6.1.6 Loading

These test methods consist of applying loads on surfaces of a test specimen and observing deformations and the nature of any failures of principal or critical elements of the **Gutter System**. Loads are applied to simulate the static wind loading of the members.

A recovery period between increases in incremental loading is to allow the test specimen to attempt to assume its original shape prior to applying the next load level.

The rate of sustained loading can be a critical issue when subjecting specimens to continuously increasing load until failure is achieved. Loading rate has little meaning in these tests because these methods employ incrementally increased loads sustained for relatively long times followed by brief recovery periods. This incremental method is more stringent than continuous loading because of the requirement of holding a load for 60 seconds.

The Standard requires full-length specimens because end conditions of discreet sections of **Gutter Systems** can play a profound role in the failure mode of the materials.

C5.1.8 & C6.1.7 Failure

Some examples of component failure that will not enable the **Gutter System** to perform as designed would be:

- Full fastener pullout.
- Collapse of a **Gutter Bracket** or **Gutter Strap**.
- Disengagement of any component.

C5.1.10 & C6.1.9 Precision and Bias

These tests are new and to date, no studies of their precision and bias exist.

GD-1 End Notes

10/27/09

[1] ASCE 7-05 *Minimum Design Loads for Buildings and Other Structures*, AMERICAN SOCIETY OF CIVIL ENGINEERS, Reston, VA, 2006.

[2] *Handbook of Materials Selection for Engineering Applications*, G. T. Murray, CRC Press.