So, you need to size a pole

Everything you need to size a pole and, how to do it.

1/9/23

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1. Introduction

What is “sizing a pole”?

What does it mean to "size" a pole?

Pole shafts come in several **diameters** and **wall thicknesses** that vary based on the **shape** and **material** of the pole.

Example:

SSS		
Series	**Nominal fixture mounting height**	**Nominal shaft base size/wall thickness[2]**
SSS[1]	10'-39' (for 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.)	4C 4" 11g (0.120") 4G 4" 7g (0.179") 5C 5" 11g (0.120") 5G 5" 7g (0.179") 6G 6" 7g (0.179")

SSA		
Series	**Nominal fixture mounting height**	**Nominal shaft base size/wall thickness[1]**
SSA	8'-35' (for 1/2 ft increments, add -6 to the pole height. Ex: 20-6 equals 20ft 6in.)	4C 4" (0.125") 4G 4" (0.188") 5G 5" (0.188") 6G 6" (0.188") 6J 6" (0.250") 7J 7" (0.250")

Selecting the correct combination of shaft diameter and wall thickness to ensure structural stability of the pole is what we call "sizing a pole". Sizing a light pole for your project's application, always requires careful consideration.

Why do we need to “size” a pole?

Why?

To ensure that the pole will not be overstressed from the loading forces applied, causing a safety hazard if the pole were to fail and fall due to excessive loading forces.

What is required to “size” a pole?

Selecting the correct pole size can be a confusing process. To help remove the vail, we are going to go over the required information to correctly and accurately size the pole for your specific application, how to find it and an example.

Required information for sizing a pole:

1. The Design Criteria of your job site
2. The anticipated maximum wind speed of your job site based on the selected design criteria
3. Static loading forces: Non-variable loads of mounted items
4. Dynamic loading forces: Variable loads of mounted items created by the pressure of wind on the pole assembly
5. Pole Height

2. Design Criteria and Wind Speeds

What are they and what is their relation to selecting a pole size?

Design Criteria

The first requirement to size a pole

Pole Design Criteria is a set of standards and calculations developed using ASCE wind maps, engineering design experience, and testing.

The criteria is created by governing bodies such as the American Association of State Highway and Transportation Officials (AASHTO), IBC (International Building Code) and FBC (Florida Building Code).

Design Criteria can be found in the project's spec.

It is chosen based on:

- The job site's location
- Governing bodies
- Local and state jurisdictions
- Contractors

2.4 POLES

Provide poles designed for wind loading of 161 km/hr determined in accordance with AASHTO LTS while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of 65 by 130 mm. Handhole cover shall be secured by stainless steel captive screws. Metal poles shall

What is a Wind Map?

Wind maps provide anticipated maximum wind speeds for any location in the United States. They are produced by the American Society of Civil Engineers (ASCE). As new wind maps are developed, the way wind speeds are measured becomes more and more stringent.

There are 3 main wind maps used for poles. There are other, newer wind maps from ASCE but, they are not often used for pole sizing and design.

1. **ASCE 7-93:** Made in 1993, Wind speeds on this map are formulated using the least stringent method of measurement.
2. **ASCE 7-05:** Made in 2005, Is quickly becoming the most commonly used wind speed map for poles.
3. **ASCE 7-10:** Made in 2010, Becoming more common in high-risk, coastal areas and its method of wind speed calculation is the most stringent of the 3 listed here.

Because each of these maps use a different systems of measurement, they will all provide different anticipated maximum wind speeds for the same location.

Anticipated Maximum Wind Speed

The second requirement to size a pole

Design Criteria is the first requirement because you must know this to determine the correct wind map to find the second requirement, the anticipated maximum wind speed for your job site's location.

As new design criteria are developed along side the more stringent wind maps, the anticipated maximum wind speed increases.

Anticipated maximum wind speed is required in order to know the pole's limits for static loads (weight) and dynamic loads (EPA). These limits decrease as the wind speed increases.

Once you know the job site's design criteria, you can use the ASCE wind map associated with that criteria to determine the maximum windspeed needed to size your pole.

Putting it all Together

Based on the Design Criteria chosen for a job, the anticipated maximum wind speed for your location can change drastically. The higher the wind speed, the larger the pole size must be to prevent overstressing.

Example: Miami, FL

- Commercial Criteria
  ASCE 7-93
  110 mph
- FBC 2004
  ASCE 7-05
  145 mph
- FBC 2010
  ASCE 7-10
  170 mph

Example: Chicago, IL

- AASHTO 1994
  ASCE 7-93
  80 mph
- AASHTO 2013
  ASCE 7-05
  90 mph
- AASHTO 2015
  ASCE 7-10
  120 mph

Example: Oakland, CA

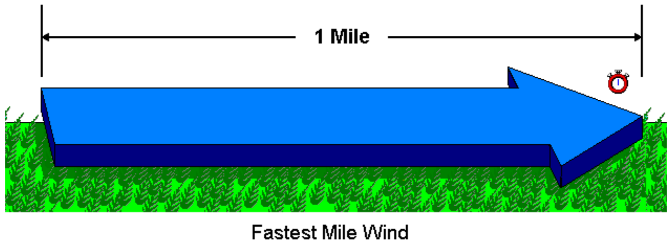
- Commercial Criteria
  ASCE 7-93
  70 mph
- AASHTO 2013
  ASCE 7-05
  85 mph
- AASHTO 2015
  ASCE 7-10
  110 mph

The Design Criteria can be the determining factor on whether your pole sizing, with it's mounted items, passes or fails for your location.

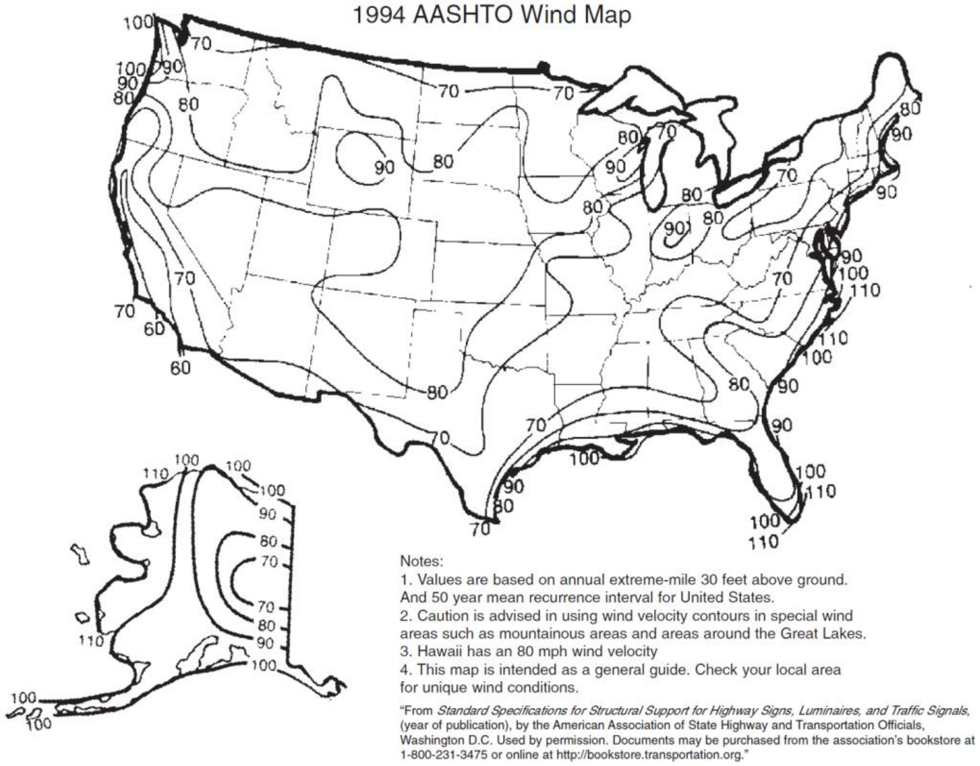
Different Design Criteria

AASHTO 1994 Design Criteria, uses wind map ASCE 7-93: It uses the Fastest-mile wind speed calculation. This is the average speed during the time required for the wind passage over an anemometer of a volume of air with a horizontal length of one mile.

This measurement of wind speed is the least stringent used for poles.

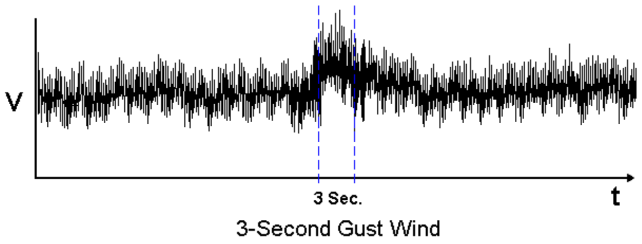


EPA (ft²) with 1.3 Gust Factor

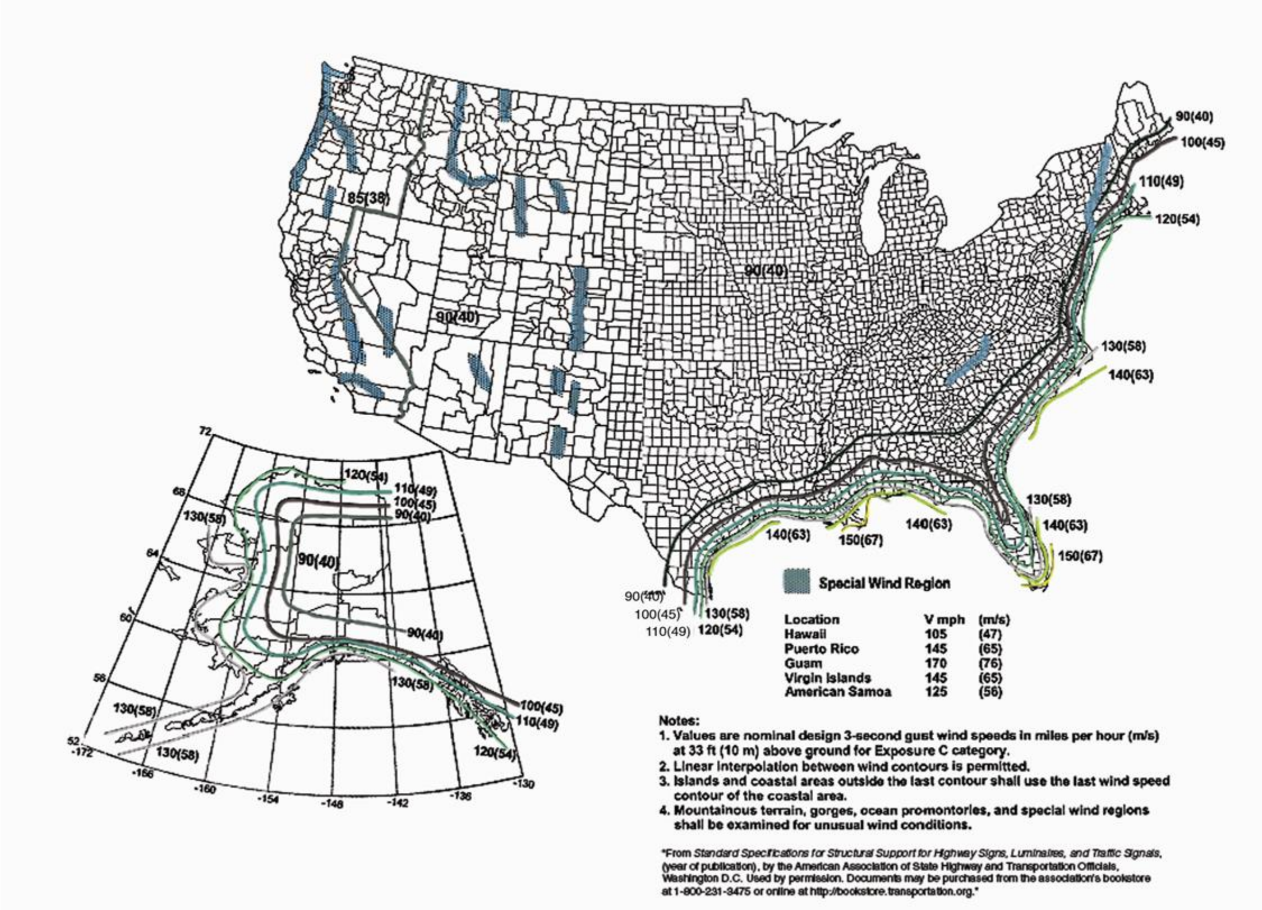


Different Design Criteria Cont.

AASHTO 2001 Design Criteria, uses wind map ASCE 7-95: It uses the 3-second gust wind speed calculation. This is the average speed of the wind during a peak 3-second interval.

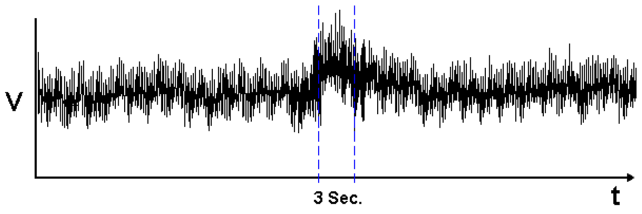


EPA (ft^2) with 1.14 Gust Factor



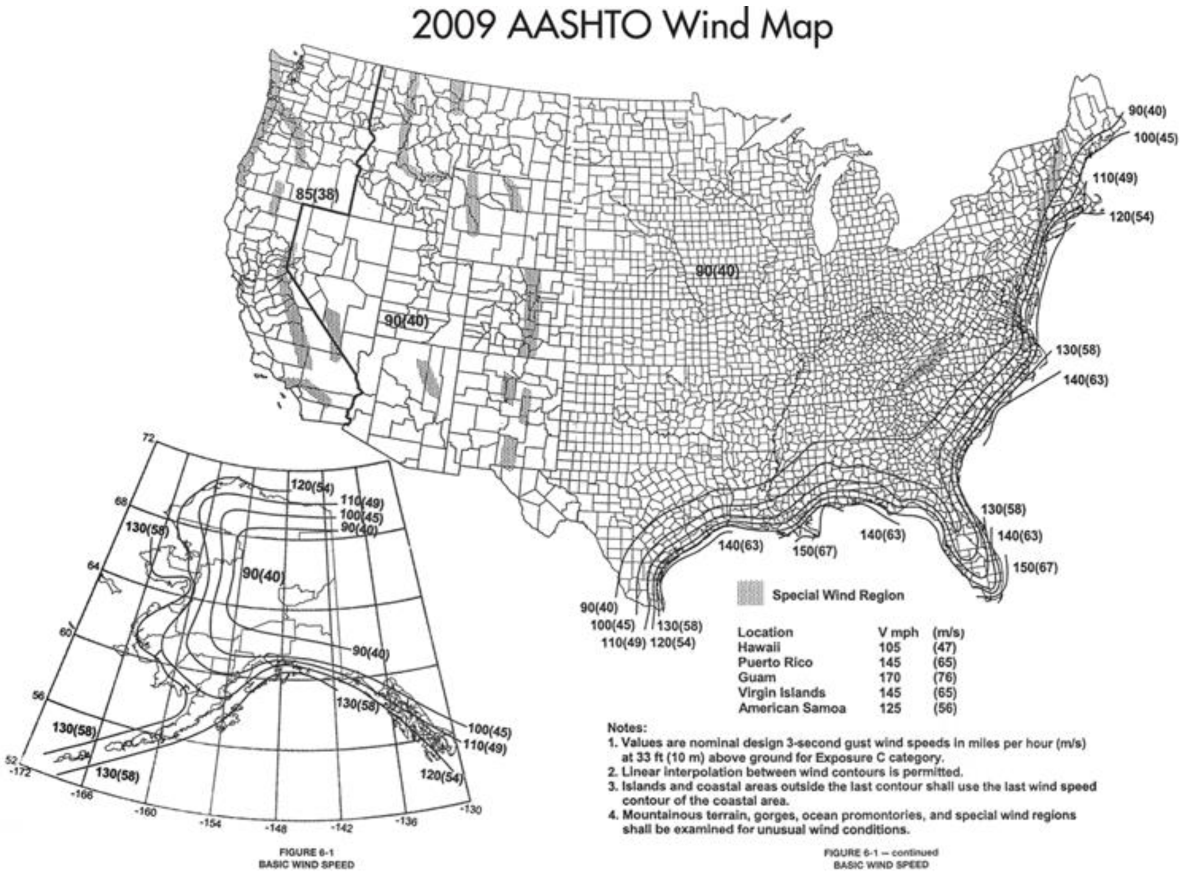
Different Design Criteria Cont.

AASHTO 2009 Design Criteria, used wind map ASCE 7-05: This also uses the <u>3-second gust</u> wind speed calculation but, in miles per hour (m/s) at 33ft (10m) above ground for Exposure C Category.



3-Second Gust Wind

EPA (ft²) with 1.14 Gust Factor



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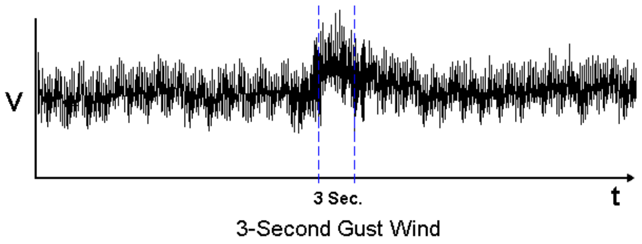
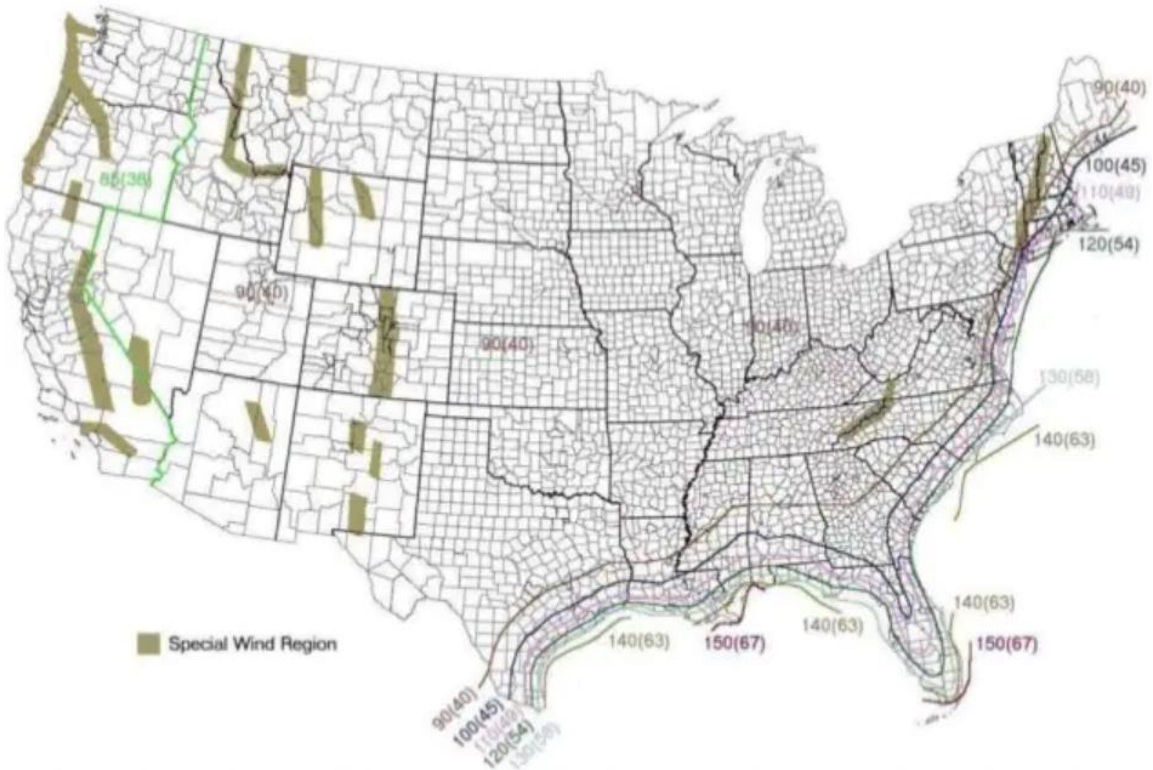
Different Design Criteria Cont.

AASHTO 2013 Design Criteria, uses ASCE 7-05: This also uses the <u>3-second gust</u> wind speed calculation at 33' above ground and also accounts for fatigue of poles on high mast poles (55' +).

This measurement of wind speed is <u>most stringent</u> used for poles.



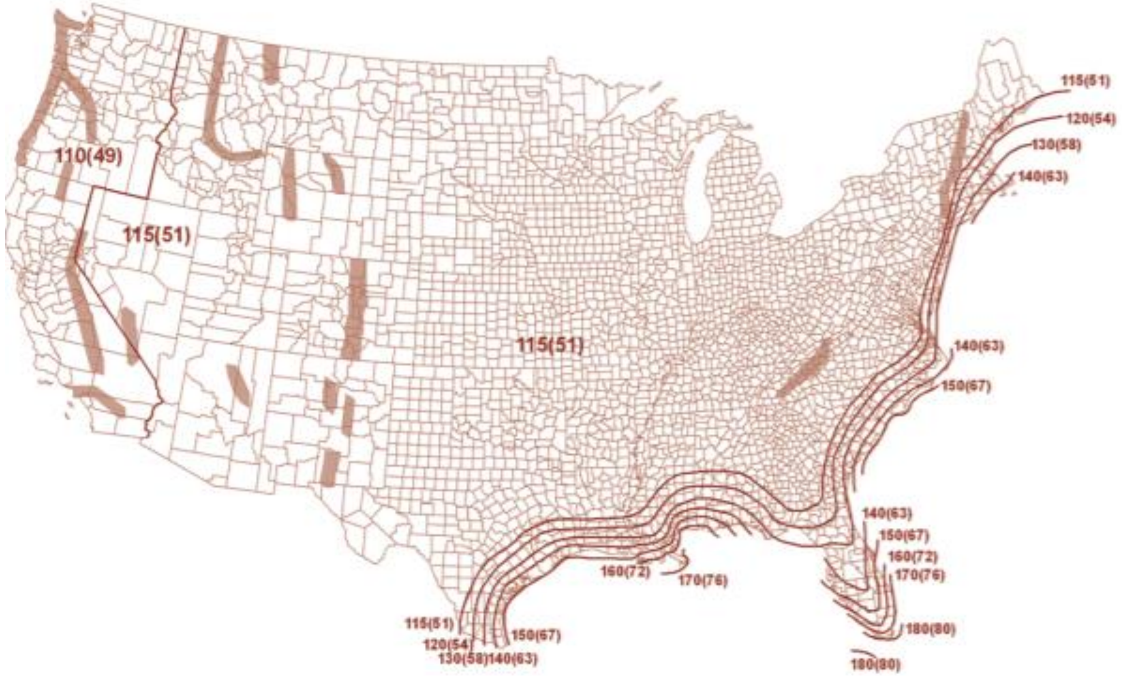
EPA (ft^2) with 1.14 Gust Factor



Different Design Criteria Cont.

AASHTO 2015 Design Criteria, uses wind map ASCE 7-10: This uses the <u>Ultimate 3-second gust </u>wind speed calculation. The wind speed for your location will vary greatly and is defined by the Risk category for your location.

This measurement is not commonly used for poles.



Summary - Design Criteria, Wind Maps and Wind Calculations

Least Stringent Measurement ⟷ **Most Stringent Measurement**

Fastest Mile

- 1.3 gust factor
- Wind Maps used: ASCE 7-93
- Design criteria's that use this calculation:
  - Commercial Criteria
  - AASHTO 1994

3-second gust

- 1.14 gust factor
- Wind Maps used: ASCE 7-95 and ASCE 7-05
- Design criteria's that use this calculation:
  - AASHTO 2001, 2009 & 2013
  - FBC 2004 & 2007
  - IBC 2000, 2006 & 2009

Ultimate 3-second gust

- 1.14 gust factor
- Wind Maps used: ASCE 7-10
- Design criteria's that use this calculation:
  - AASHTO 2015
  - IBC 2012 & 2015
  - FBC 2010 & 2014

2. Static and Dynamic Loads

How are they calculated and used with design criteria?

Static vs. Dynamic Loads

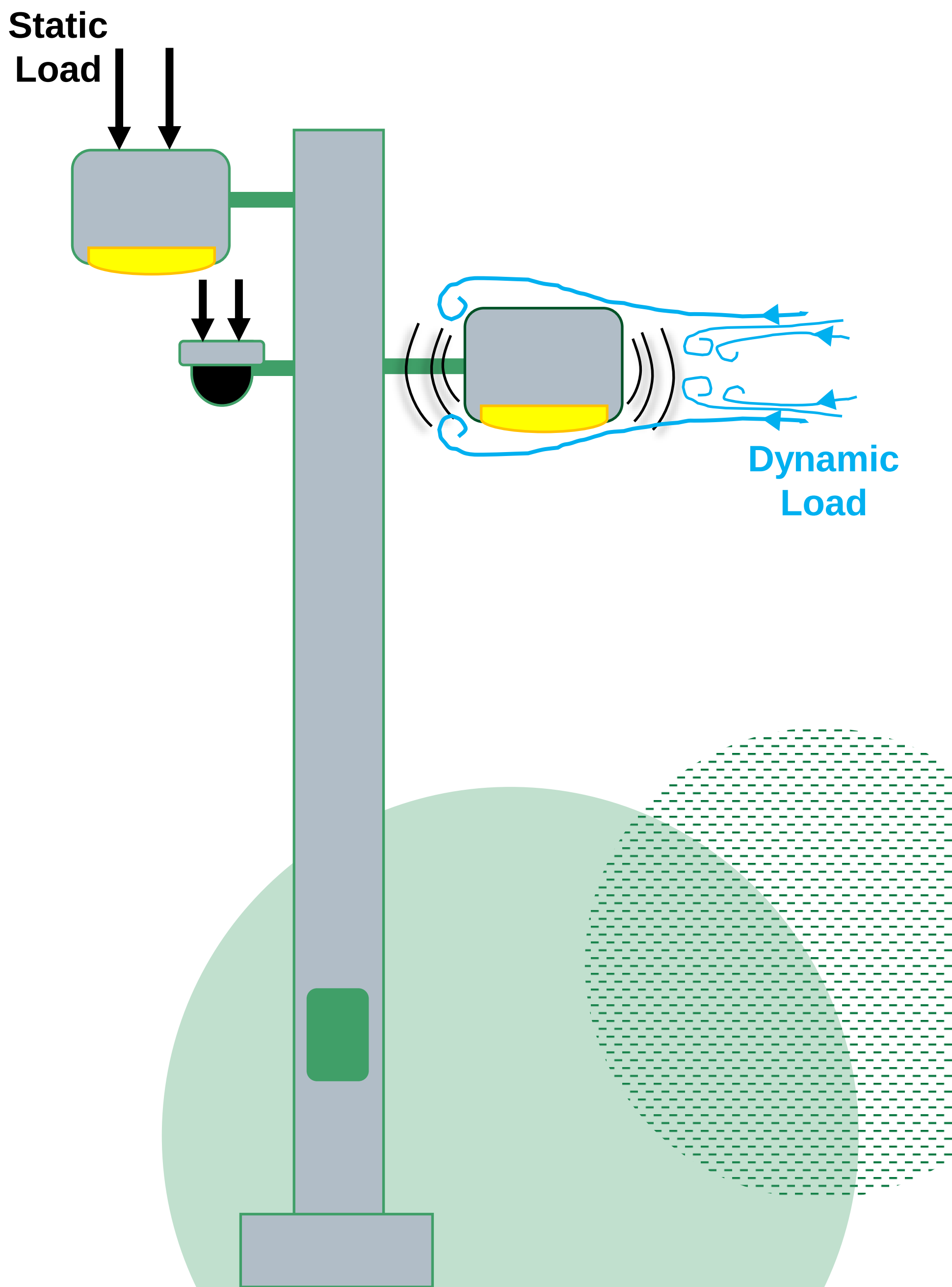
The third and fourth requirements to size a pole

Static loads: Non-variable loads applied to an object or assembly.

In the context of poles, it is the dead weight of luminaires and other items mounted to the pole. An exception of an intermittent change and increase in this load, would be due to icing in cold climates. The heavier the item, the greater the load, the larger the pole will need to be.

Dynamic loads: Variable loads that change over time.

In the context of poles, dynamic loads are created by the pressure of wind based on its velocity against the surface area of the pole, its luminaire and other mounted items. This surface area is expressed as Effective Projected Area (EPA).



What is Effective Projected Area (EPA)?

Effective Projected Area: A measurement used by the lighting industry to determine the wind-induced, dynamic load any mounted item will apply to a pole or bracket at a given wind velocity.

The EPA of a luminaire is calculated by multiplying the luminaire's Projected Area (A) by it's Drag Coefficient (C_d).

$$\textbf{EPA (ft}^2\textbf{)} = A \times C_d$$

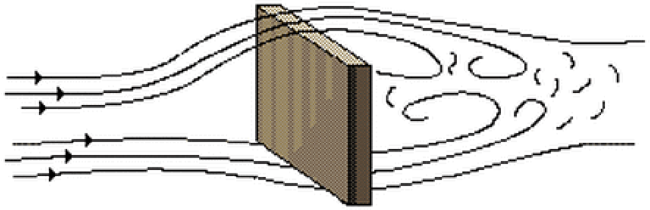
Projected Area:
The frontal area of the luminaire subjected to wind.

Drag Coefficient:
Varies based on the luminaire's shape and size and can be defined as the wind resistance the luminaire creates.

EPA Cont.

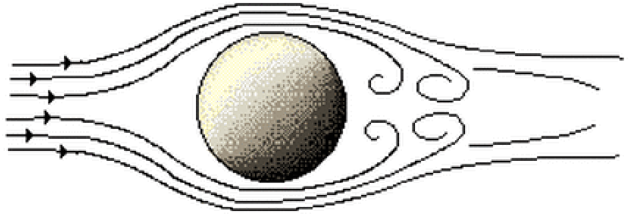
SO….The greater the Projected Area and Drag Coefficient, the higher, or worse the EPA measurement will be for the mounted item, increasing the dynamic load on the pole.

Example: A large shoebox or square luminaire will have a higher EPA and present more resistance to the wind than a wing shape.



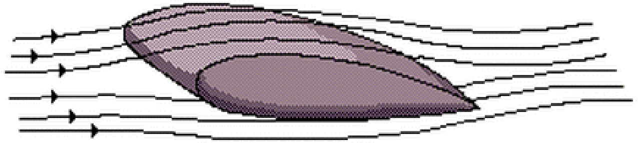
Square

Flat edged objects like boxes experience the highest amount of drag



Sphere

Spherical objects like baseballs experience a medium amount of drag



Airfoil (wing)

The shape of an airplane wing experiences the least amount of drag

How are Static and Dynamic loads used with Design Criteria and Maximum Wind Speeds?

As mentioned earlier, each specific design criteria has its own set of standards, calculations and anticipated maximum wind speeds for a given location.

Engineers combine these standards, calculations and anticipated maximum wind speeds with factors like pole height specifications, shape, wall thickness to determine **maximum static load (weight)** *and* **maximum dynamic load (EPA)** the pole can handle until it's overstressed and fails.

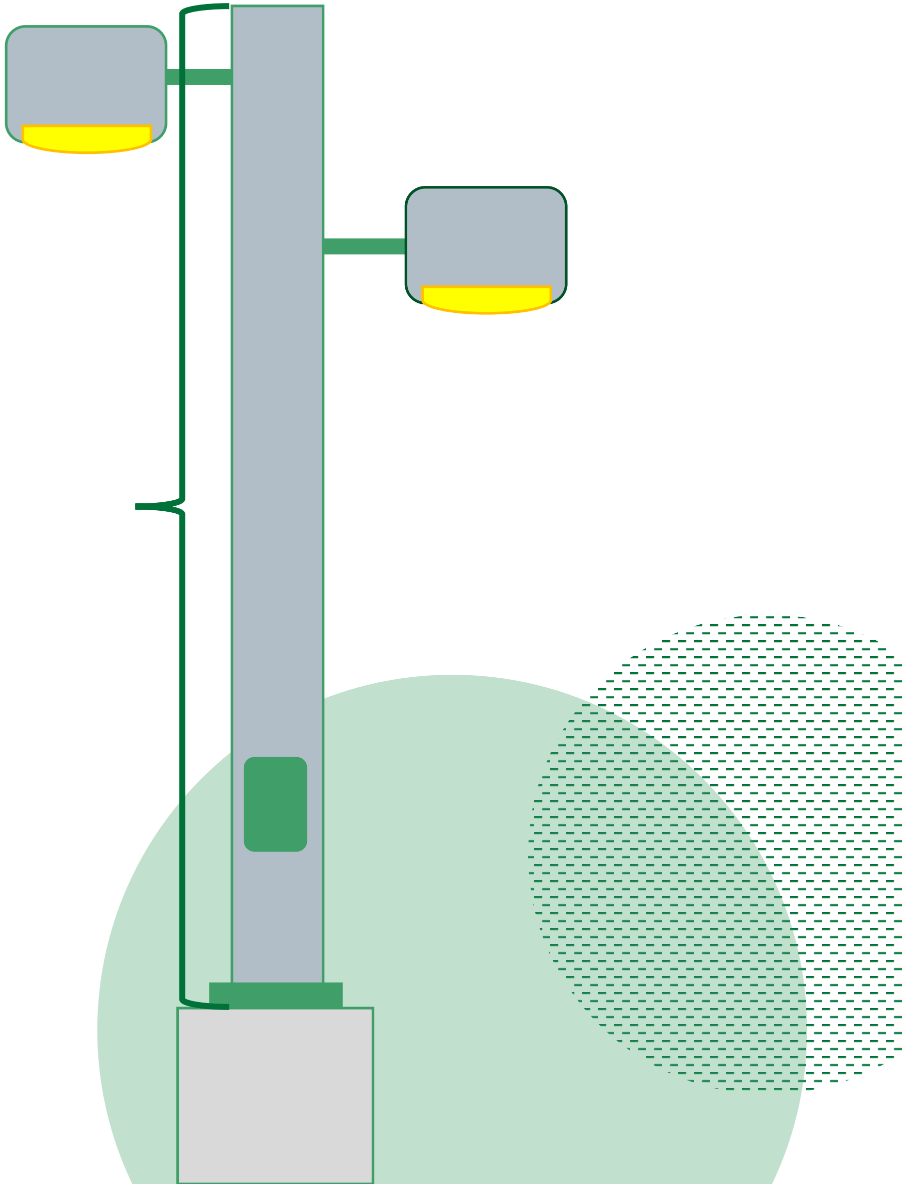
These maximums decrease with:

- Increased pole height
- Increased wind speed
- A more stringent Design Criteria

Pole Height

The fifth requirement to size a pole

The last requirement to size a pole is the height. The pole height is the dimensions from the base plate of the pole to the top of the pole, the foundation height is not included. This is determined by the desired mounting height of the luminaire which is based on the lighting layout, the light fixture optics and the application (commercial parking lot vs. highway) The taller the pole required, the thicker the wall and shaft diameter will need to be.



4. How to Size a Pole

Putting it all together to ensure your pole is structurally sound.

Sizing a Pole to Pass Wind Loading

The process of sizing a pole combines *all* of the mounted item's dynamic loads (EPA), static loads (weight), the anticipated maximum wind speed based on design criteria and the pole height, to determine the mounting requirements for a particular application.

Mounted items include, but are not limited to:

- Luminaires
- Cameras
- Signs
- Brackets
- Banners
- Cables and catenary systems

The total EPA and weight of these items MUST NOT exceed the maximums listed for the pole selected at the anticipated maximum wind speed for the required design criteria. If the total weight OR EPA exceeds, then the pole shaft diameter or wall thickness must be increased to one that is suitable for both.

Special Considerations when Sizing Poles

Poles in areas of known abnormal conditions or known excessive loading conditions will require special consideration. Including but not limited to:

1. Applications that require Florida Building Code (FBC design criteria) or if the pole specification sheet does not have a “Technical Information” chart for the required design criteria.
2. Poles located near or on airport property.
3. Poles located on top of parking decks, bridges or catwalks.
4. Poles located in expansive, flat locations with few things to block wind.
5. Applications needing more than 3 festoons or handholes.
6. Catenary and cable systems applications.
7. Banner arm applications.

Special Considerations when Sizing Poles Cont.

If your pole falls into any of these categories, a request for wind load calculations with a completed “Wind Load & Anchorage Verification Form_090722” should be provided to Tech Support Outdoor.

Once they verify all pertinent information is on the form, formal calculations will be completed.

- If the **pole passes,** the calculations will be provided.
- If the **pole does not pass,** alternate sizes will be provided.

It is VERY important to include ALL required information and to be as detailed as possible. Poles will be sized incorrectly and WILL FAIL if information, like the pole’s mounting height @ 28ft above grade, is missing.

Acuity Brands Lighting, Inc
One Lithonia Way Conyers, GA 30012
Telephone: 770-922-9000

Wind Loading and Anchorage Verification Form

Note: If any information or documentation is not clear, we will return the request with “Needs Clarification”. Please be sure to attach all information for the request for this PDF.

Basic Information:

Agency Name, Rep Name (*Required)	Agile Quote Number
Requestor Email Address or Phone Number (*Required)	Bid Date
Job Name (*Required)	Job Location (City, State)
Wind Zone Speed and Design Criteria (*Required) (i.e. AASHTO year, IBC, etc.) Wind Zone Link	

Specifications Available to Submit:

Check off documentation included in request and attach to this PDF.

- ☐ Reference Drawings
  If yes, please attach to PDF
- ☐ Anchorage Verification Form
  (*Required for modified base or to match existing anchorage, form found below)
- ☐ Pictures; Images
  If yes, please attach to PDF
- ☐ Specification Sheets
  If yes, please attach to PDF
- ☐ Competitor drill pattern
  If yes, please attach to PDF
- ☐ Regulations; Compliance
  If yes, please specify >
- ☐ Other
  If yes, please specify >

Pole and Fixture Information: (*Required)

Pole Description: (i.e. SSS 20 4C DM19AS VD EHH4A DDBXD)	Pole Base Mounting Height: (i.e. at grade, foundation or parking garage height, etc.)
Fixture Weight and EPA (per fixture):	Fixture Mounting Details if not Standard: (i.e. competitor drill pattern, special tenon size, non-standard drill height or orientation, etc.)

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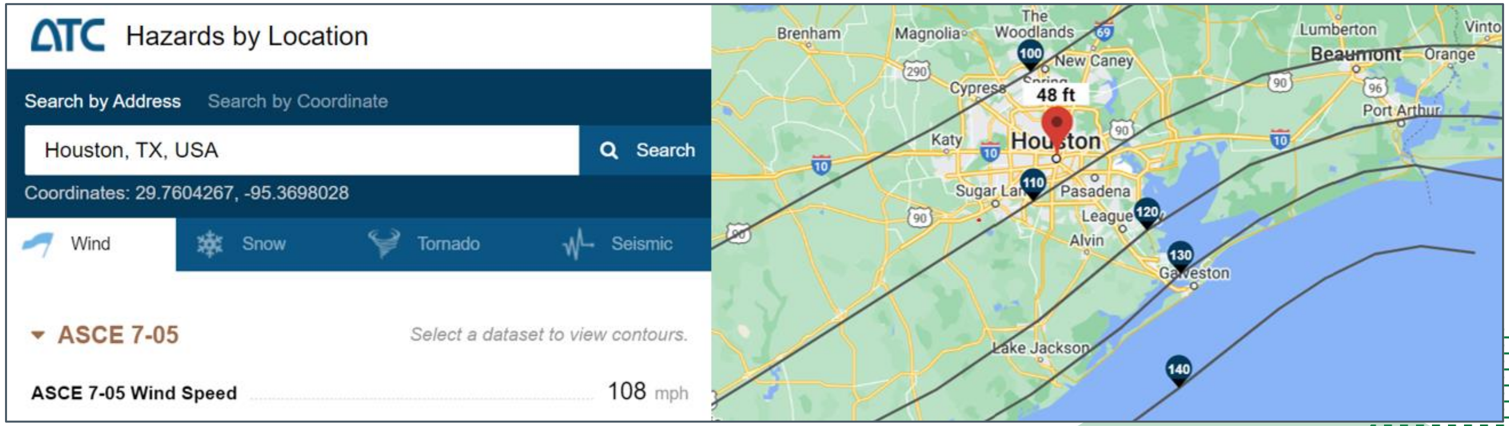
Example: Sizing a Pole to Pass Wind Loading

Example: Customer wants to install a square straight steel, 20ft pole in Houston, TX and will be drill mounting a quantity of 2, DSX2's on to the pole. The required building design criteria has been determined to be AAHSTO 2013.

Step 1: Identify the wind speed in Houston, TX under AASHTO 2013 Design Criteria using wind map ASCE 7-05. It is **108 mph**.

ASCE wind map link: https://hazards.atcouncil.org/



Step 2: Calculate total EPAft^2 and Weight of all mounted items on the pole

DSX2 EPA = 1.1ft^2 x Qty2 = **2.2 ft^2**

DSX2 Weight = 36lbs x Qty2 = **72lbs**

Example: Sizing a Pole to Pass Wind Loading

Step 3: Identify the EPA and Weight maximums for the square straight steel 20' pole with 110 mph (rounded up from 108mph) / AASHTO 2013 criteria.

TECHNICAL INFORMATION — EPA (ft²) WITH 3-SECOND GUST PER AASHTO 2013																		
Series	Mounting Height (ft)*	Shaft Base Size	90 MPH	Max. weight	100 MPH	Max. weight	110 MPH	Max. weight	120 MPH	Max. weight	130 MPH	Max. weight	140 MPH	Max. weight	150 MPH	Max. weight	Approximate ship weight (lbs.)
SSS	10	4C	20	500	16	400	13	325	10.5	263	8.5	213	7	175	6	150	75
SSS	12	4C	16	400	13	325	10	250	8	200	6.5	163	5	125	4	100	90
SSS	14	4C	13.5	338	10	250	7.5	188	6	150	4.5	113	3.5	88	2.5	63	100
SSS	16	4C	10.5	263	7.5	188	5.5	138	4	100	3	75	1.5	38	1	25	115
SSS	18	4C	8	200	5.5	138	4	100	2.5	63	1.5	38	0.5	13	-	-	125
SSS	18	4G	13	325	9.5	238	7	175	5	125	3.5	88	2.5	63	1.5	38	185
SSS	18	5C	13	325	9.5	238	6.5	163	4.5	113	3	75	1.5	38	.5	13	170
SSS	20	4C	6	150	4	100	2.5	63	1	25	-	-	-	-	-	-	140
SSS	20	4G	10.5	263	7.5	188	5.5	138	3.5	88	2	50	1	25			205
SSS	20	5C	10	250	7	175	4.5	113	2.5	63	1	25	-	-	-	-	185
SSS	20	5G	20	500	15	375	11.5	288	8.5	213	6	150	4.5	113	3	75	265
SSS	25	4C	2	50	0.5	13	-	-	-	-	-	-	-	-	-	-	170
SSS	25	4G	5.5	138	3	75	1.5	38	-	-	-	-	-	-	-	-	245
SSS	25	5C	4.5	113	2	50	-	-	-	-	-	-	-	-	-	-	225
SSS	25	5G	12	300	8.5	213	5.5	138	3	75	1.5	38	-	-	-	-	360
SSS	25	6G	19	475	13.5	338	9	225	5.5	138	3	75	1	25			445
SSS	30	4G	1.5	38	-	-	-	-	-	-	-	-	-	-	-	-	291
SSS	30	5C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	265
SSS	30	5G	6.5	163	3.5	88	1	25	-	-	-	-	-	-	-	-	380
SSS	30	6G	11	275	6	150	2.5	63	-	-	-	-	-	-	-	-	520
SSS	35	5G	2	50	-	-	-	-	-	-	-	-	-	-	-	-	440
SSS	35	6G	4	100	-	-	-	-	-	-	-	-	-	-	-	-	540
SSS	39	6G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	605

Solution: SSS 20 4G will be the correct selection. Based on the AASHTO 2013 chart with 110 mph, the pole's maximum EPA is **5.5ft²** and maximum weight is **138lbs,** well over the quantity of 2 DSX2 fixtures, where as the 4C's EPA maximum may be okay but the weight maximum is less than quantity of 2 DSX2s.

DSX2 EPA = 1.1ft² x Qty2 = **2.2 ft²**

DSX2 Weight = 36lbs x Qty2 = **72lbs**

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Questions?

What you need in order to size a pole and how to do it.

Thank you!

Elaine Boone
Poles Product Manager