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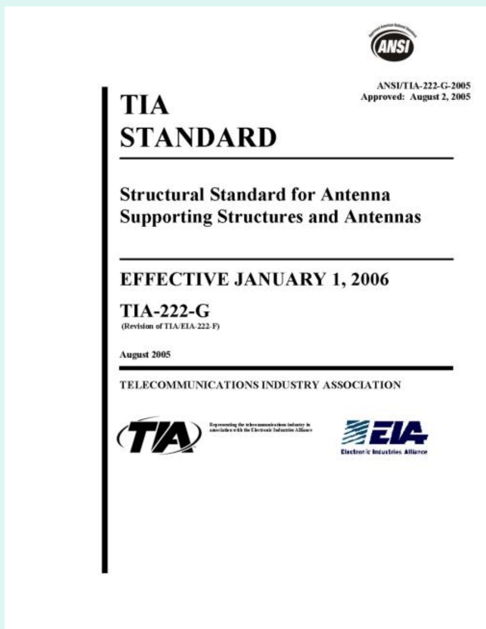
ANSI/TIA-222-G Explained

Introduction

ANSI/TIA-222-G-2005

- A big change – the biggest since 1986
- 9 years of Work
- Published August 2005
- Addendum 1 published October 2006
- Addendum 2 published by January 2008


ANSI/TIA-222-G-2005
Approved: August 2, 2005

TIA
STANDARD

Structural Standard for Antenna Supporting Structures and Antennas

EFFECTIVE JANUARY 1, 2006

TIA-222-G
(Revision of TIA/EIA-222-F)

August 2005

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

Revision G Philosophy – Why Change?

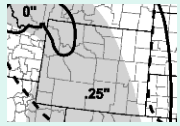
- New Technology
  - Engineering Theory – LRFD vs. ASD – Explicit Impact
    - Controversial – LRFD is not universally used
    - ASD has not been updated since 1989
    - A merged LRFD and ASD manual may appear in the future
  - Computing Resources – Implicit impact
    - Increase computing power allows greater calculation/programming sophistication
  - Research – Implicit Impact
    - Bracing capacity - ERI
    - Wind Tunnel Studies - PiRod
    - Greater Understanding of Wind Loads - EUROCODE

Revision G Philosophy – Why Change?

- Building Code Consolidation
  - Simplify building permit process nationally
  - Unify the application –
    - Development of the IBC
      - Consolidation of
        - » SBC
        - » UBC
        - » BOCA

Revision G Philosophy – Why Change?

- Changes in Environmental Loads
  - New Wind Speed Measurement Techniques
    - Shift from Fastest mph to 3-Second Gust
    - Government Mandated Change
  - Development of National Ice Loads
    - ASCE-7 ’05 will make ice loads mandatory
    - Study now covers the entire United States



  - Seismic Loading
    - May govern in very special circumstances

Revision G Philosophy – Why Change?

- A desire by the Main Committee to improve buyer/user confidence
  - Eliminate the “interpretations” that may not be compatible with theory or the intent of the standard
  - Define the rules. Less reliance on “Engineering Judgment”
  - Acknowledgement that revision F did not always allow the user/buyer to make a confident competent comparison of competing designs
  - Raise the bar
  - Create an International Standard (IASS Moscow Feedback)

Loads – Different Type

ANSI/TIA-222-G

2.3.2 Strength Limit State Load Combinations

Structures and foundations shall be designed so that their design strength equals or exceeds the load effects of the factored loads in each of the following limit state combinations:

1. $1.2\,D + 1.0\,D_g + 1.6\,W_o$
2. $0.9\,D + 1.0\,D_g + 1.6\,W_o$
3. $1.2\,D + 1.0\,D_g + 1.0\,D_i + 1.0\,W_i + 1.0\,T_i$
4. $1.2\,D + 1.0\,D_g + 1.0\,E$
5. $0.9\,D + 1.0\,D_g + 1.0\,E$

Exceptions:

1. Temperature effects need not be considered for self-supporting structures.
2. Ice and earthquake loading need not be considered for Class I structures.
3. No load factor shall be applied to the initial tension of guys.
4. Load combinations 2 and 5 apply to self-supporting structures only.

Notes:

1. A limit state conversion factor for ice load is applied to ice thickness in 2.6.8
2. Unfactored dead loads shall be used to determine earthquake loads, E, in loading combinations 4 and 5.
3. For foundation designs, the weight of soil and substructure shall be considered as dead load in all loading combinations.

Developing a Wind Load

- Classify the structure by use and risk
  - Classification will adjust the return period.
  - How will the structure be used (Ham Operation vs. 911)?
  - What is the risk to life and Property (Located in a urban environment vs. Rural)?
- What is the local environment?
  - Exposure to wind (surface roughness). Exposure Categories: B, C, and D.
  - Topography (flat or on top of a hill). Topographic Categories 1 through 5.

Return Periods

- Class I – 25 year return Period
  - Probability of occurrence in one year = **0.04**
  - Importance Factor, I = 0.87
    - Creates a wind pressure that is
      - 13% less than Class II, (7% decrease in windspeed)
      - 24% less than Class III (13% decrease in windspeed)
- Class II – 50 year return Period
  - Probability of occurrence in one year = **0.02**
  - Importance Factor, I = 1.00
    - Creates a wind pressure that is
      - 13% Greater than Class I, (7% increase in windspeed)
      - 15% less than Class III, (7% decrease in windspeed)
- Class III – 100 year return Period
  - Probability of occurrence in one year = **0.01**
  - Importance Factor, I = 1.15
    - Creates a wind pressure that is
      - 13% Greater than Class II, (7% increase in windspeed)
      - 24% Greater than Class I (13% increase in windspeed)

Exposure Categories – Exposure B

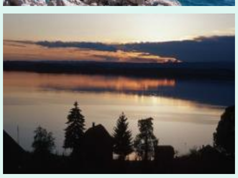
- Urban and Suburban
- Wooded Areas
- Filled with Obstructions the Size of Single Family Dwellings
- Must surround the structure at least 2,630 ft or 10 times the structure height ***in all directions*** whichever is greater

Exposure Categories – Exposure C

- Open terrain with scattered obstructions having heights generally less than 30 ft [9.1 m].
- This category includes flat, open country, grasslands and shorelines in hurricane prone regions.

Exposure Categories – Exposure D

- Flat, unobstructed shorelines exposed to wind flowing over open water (excluding shorelines in hurricane prone regions) for a distance of at least 1 mile [1.61 km].
- Shorelines in Exposure D include inland waterways, lakes and non-hurricane coastal areas. Exposure D extends inland a distance of 660 ft [200 m] or ten times the height of the structure, whichever is greater.
- Smooth mud flats, salt flats and other similar terrain shall be considered as Exposure D.



Wind

- Shift from “Fastest mph” to “3-second Gust” wind speed
  - Government changed the measurement standard in the early 1990’s (ASCE 7-95)
  - Conversion Factors

Wind

ANSI/TIA-222-G

ANNEX L: WIND SPEED CONVERSIONS (Normative)

This annex provides conversion of wind speeds based on various averaging periods to the 3-sec gust wind speed. Wind data based on other averaging periods are to be converted to a 3-sec gust wind speed for use with the Standard.

3-sec gust (mph)	Fastest-mile		10-min avg. (mph)	Hourly mean (mph)
	Wind speed (mph)	Averaging period (sec)		
60	50	72	42	40
70	58	62	49	46
80	66	55	56	53
85	70	51	59	56
90	75	48	62	60
95	78	46	66	63
100	80	45	69	66
105	85	42	73	70
110	90	40	76	73
115	95	38	80	76
120	100	36	83	79
125	105	34	87	83
130	110	33	90	86
135	115	31	94	89
140	120	30	97	93
145	125	29	101	96
150	130	28	104	99
155	135	27	108	103
160	140	26	111	106
165	145	25	115	109
170	150	24	118	113

Notes: 1. For conversion to [m/s] multiply the above values by 0.447.
2. Linear interpolation may be used between the values shown.

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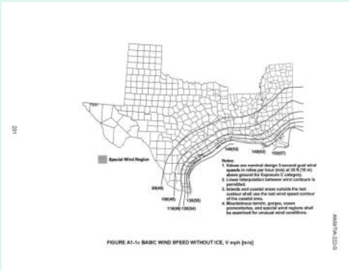
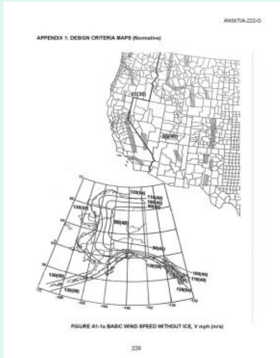
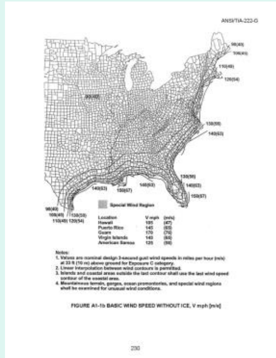
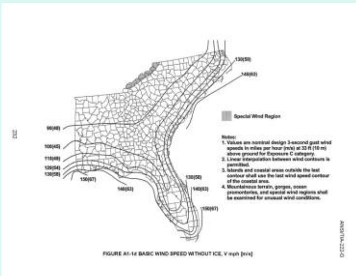
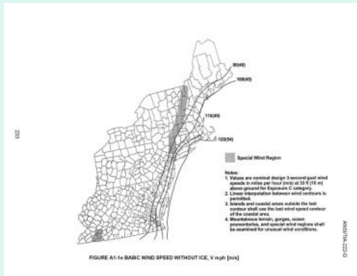
Wind









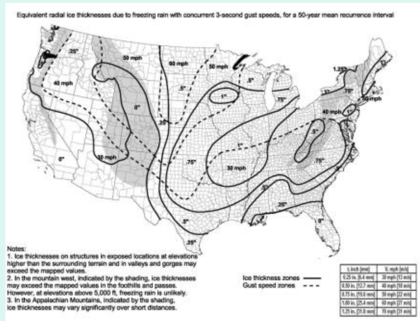


Wind on Ice & Ice

- Ice map is developed for Glaze only.
- It does not include Rime Ice
- An analytical estimate based upon computer modeling and empirical observations
- The Wind on Ice and Ice thickness listed cannot be separated.   The model is based upon a wind mechanism that drives ice accumulation.   Lower winds will result in a different ice thickness and vice versa.

Wind on Ice & Ice

1. The importance factors shift the ice loading return periods in the same manner as the 3-second gust wind speed.
2. It is a defined requirement.
3. 1/4” ice can be ignored.
4. Pay close attention to special wind regions indicated by the shaded areas.
5. All values represent zones. No interpolation.
6. Pay attention to the notes in the figure.



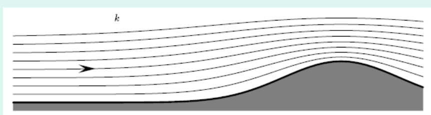
Northwest

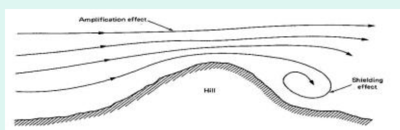
Columbia River Basin

Lake Superior Region

Alaska

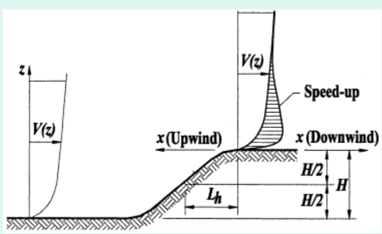
Terrain Features (Topography)



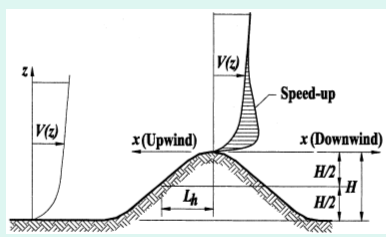


EIA Standard has adopted the 5 categories defined by ASCE

However, the calculations were simplified.



Escarpment



2-D Ridge or 3-D Axisymmetrical Hill

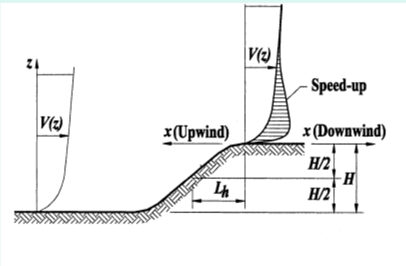
Terrain Features

Category 1: No abrupt changes in general topography, e.g. flat or rolling terrain, no wind speed-up consideration shall be required.

Category 1 – No Impact,
Terrain Features are ignored.

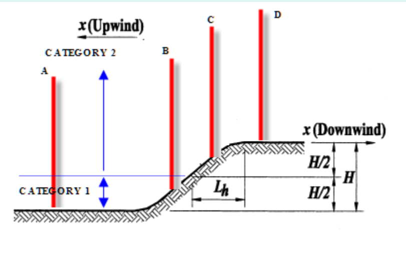
Terrain Features

Category 2: Structures located at or near the crest of an escarpment. Wind speed-up shall be considered to occur in all directions. Structures located on the lower half of an escarpment or beyond 8 times the height of the escarpment from its crest, shall be permitted to be considered as Topographic Category 1.



Structures A & B – Category 1

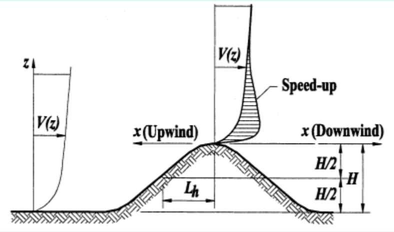
Structures C & D – Category 2



Category 1 – No Impact,
Terrain Features are ignored.

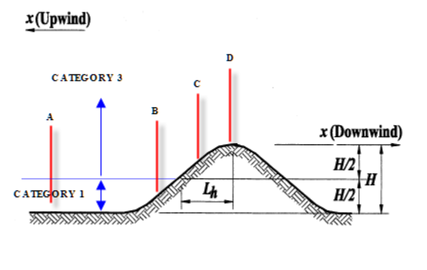
Terrain Features

Category 3: Structures located in the upper half of a hill. Wind speed-up shall be considered to occur in all directions. Structures located in the lower half of a hill shall be permitted to be considered as Topographic Category 1.



Structures A & B – Category 1

Structures C & D – Category 3

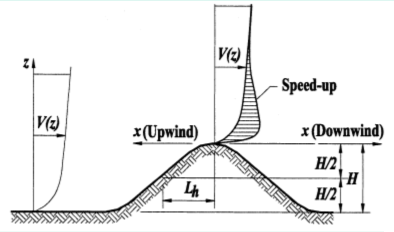


A hill is a rise from average terrain in all directions.

Category 1 – No Impact,
Terrain Features are ignored.

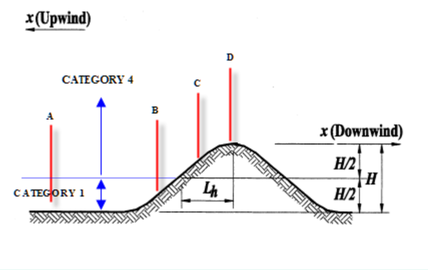
Terrain Features

Category 4: Structures located in the upper half of a ridge. Wind speed-up shall be considered to occur in all directions. Structures located in the lower half of a ridge shall be permitted to be considered as Topographic Category 1.



Structures A & B – Category 1

Structures C & D – Category 4

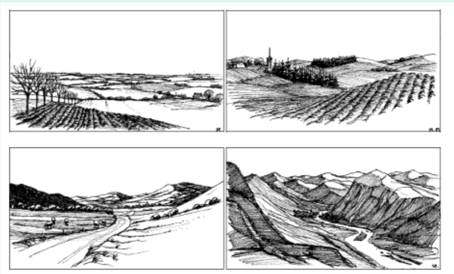


A ridge is a rise from average terrain in two directions.

Category 1 – No Impact,
Terrain Features are ignored.

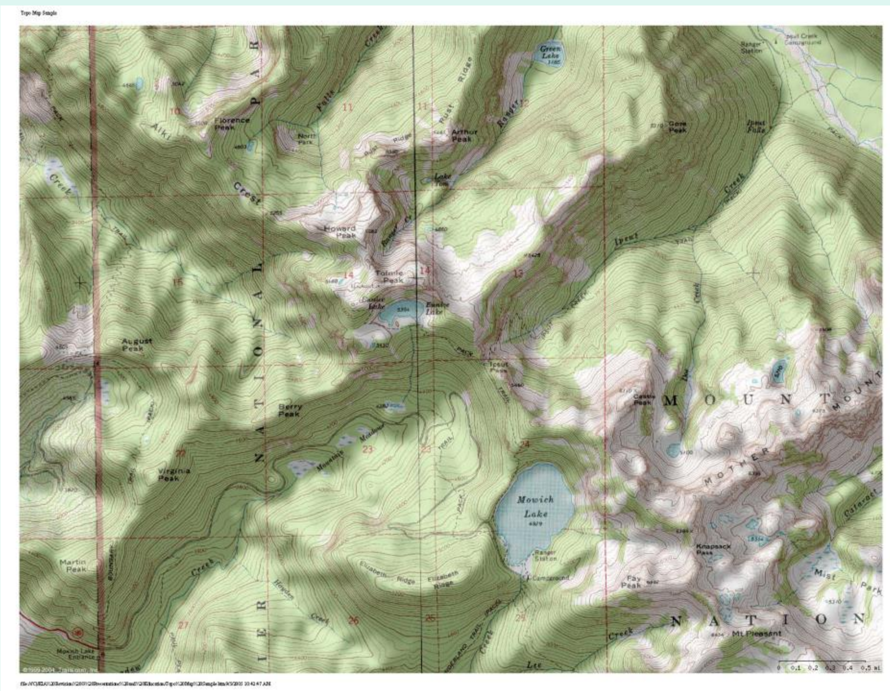
Terrain Features

Category 5: Wind speed-up criteria based on a site-specific investigation.

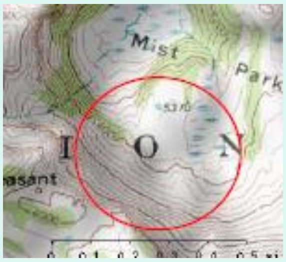


For topographic category 5, K_{zt} shall be based on recognized published literature or research findings.

Use IBC or ASCE 7-05

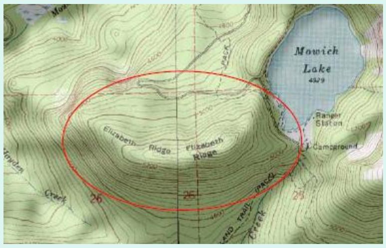


Topographic Features



Escarpment

Hill



Ridge

Default Environmental Values

As listed in

ANNEX A: PROCUREMENT AND USER GUIDELINES

- Default Structure Class: **II**
- Exposure Category **C**
- Topographic Category **1**
- Assume the guy elevations are **equal** to the base elevation
- Default Seismic Site Class **D (Stiff Soil)**

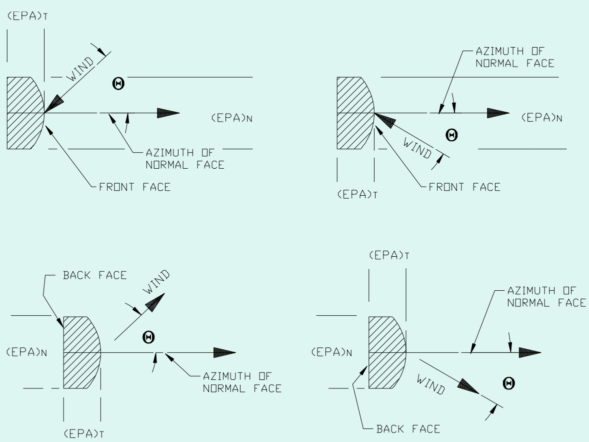
Antenna Loads

- Area calculations derived utilizing a standardized approach
- Less latitude for the designer.
- Must include antenna pipes – Depends on the direction under consideration

- Design Wind Force on Appurtenances
  - The design wind force on appurtenances (either discrete or linear but excluding microwave antennas), F_A, shall be determined from the equation:
  - $F_A = q_z\, G_h\, (EPA)_A$
  - Where $(EPA)_A = K_a[(EPA)_N \cos^2(\theta) + (EPA)_T \sin^2(\theta)]$
    - $(EPA)_N = \Sigma(C_a\, A_A)_N$
    - $(EPA)_T = \Sigma(C_a\, A_A)_T$

- Equivalent flat plate areas based on Revision C of this Standard shall be multiplied by a force coefficient, C_a, equal to 2.0 except when the appurtenance is made up of **round members only**, a force coefficient of 1.8 may be applied.

Appurtenances



Appurtenances

Member Type		Aspect Ratio ≤ 2.5	Aspect Ratio = 7	Aspect Ratio ≥ 25
		C_a	C_a	C_a
Flat		1.2	1.4	2.0
Round	C < 32 [4.4] (Subcritical)	0.70	0.80	1.2
	32 ≤ C ≤ 64 [4.4 ≤ C ≤ 8.7] (Transitional)	$3.76/(C)^{0.485}$ $[1.43/(C)^{0.485}]$	$3.37/(C)^{0.415}$ $[1.47/(C)^{0.415}]$	$38.4/(C)^{1.0}$ $[5.23/(C)^{1.0}]$
	C > 64 [8.7] (Supercritical)	0.50	0.60	0.60

Where:

C = (I Kzt Kz)0.5 (V)(D) for D in ft [m], V in mph [m/s]

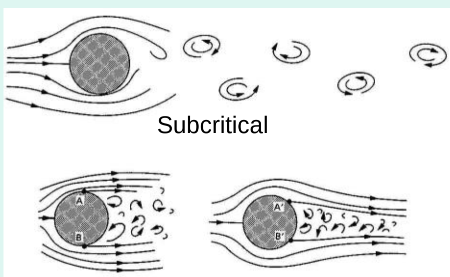
V is the basic wind speed for the loading condition under investigation.

D is the outside diameter of the appurtenance.

Aspect ratio is the overall length/width ratio in the plane normal to the wind direction. (Aspect ratio is independent of the spacing between support points of a linear appurtenance, and the section length considered to have uniform wind load).

Wind Speed Domains

- Subcritical – Reynolds Numbers, Re < 2.78×10^5
- Transitional - 2.78×10^5 ≤ Reynolds Numbers, Re ≤ 5.56×10^5
- Supercritical – Reynolds Numbers, Re > 5.56×10^5



Supercritical

Windspeed Domain – Subcritical to Transitional to Supercritical

Exposure B

Exposure	α	z_g	K_{zt}	I	Z_{min}	Z_{max}	K_{zmin}
B	7.00	1200	1.00	1.00	30.00	1200.00	0.70

Critical Heights:

	Basic Windspeed (mph)												
Diameter (in.)	30	40	50	60	70	80	90	100	110	120	130	140	150
1.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
1.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
2.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	951.1	586.8
2.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	1078.9	586.8	335.1	199.5	123.1
3.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	586.8	301.1	163.8	93.5	55.7	34.3
3.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	951.1	417.0	199.5	102.4	55.7	31.8	Transitional	Transitional
4.00	Subcritical	Subcritical	Subcritical	Subcritical	951.1	373.5	163.8	78.3	40.2	Transitional	Transitional	951.1	586.8
4.50	Subcritical	Subcritical	Subcritical	Subcritical	417.0	163.8	71.8	34.3	Transitional	Transitional	700.5	417.0	257.3
5.00	Subcritical	Subcritical	Subcritical	586.8	199.5	78.3	34.3	Transitional	1078.9	586.8	335.1	199.5	123.1
5.50	Subcritical	Subcritical	1078.9	301.1	102.4	40.2	Transitional	1078.9	553.7	301.1	171.9	102.4	63.1
6.00	Subcritical	Subcritical	586.8	163.8	55.7	Transitional	Transitional	586.8	301.1	163.8	93.5	55.7	34.3
6.50	Subcritical	Subcritical	335.1	93.5	31.8	Transitional	700.5	335.1	171.9	93.5	53.4	31.8	Supercritical
7.00	Subcritical	951.1	199.5	55.7	Transitional	951.1	417.0	199.5	102.4	55.7	31.8	Supercritical	Supercritical
7.50	Subcritical	586.8	123.1	34.3	Transitional	586.8	257.3	123.1	63.1	34.3	Supercritical	Supercritical	Supercritical
8.00	Subcritical	373.5	78.3	Transitional	951.1	373.5	163.8	78.3	40.2	Supercritical	Supercritical	Supercritical	Supercritical
9.00	Subcritical	163.8	34.3	Transitional	417.0	163.8	71.8	34.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
10.00	586.8	78.3	Transitional	586.8	199.5	78.3	34.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
11.00	301.1	40.2	1078.9	301.1	102.4	40.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
12.00	163.8	Transitional	586.8	163.8	55.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
13.00	93.5	Transitional	335.1	93.5	31.8	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
14.00	55.7	951.1	199.5	55.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
15.00	34.3	586.8	123.1	34.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
16.00	Transitional	373.5	78.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
17.00	Transitional	244.3	51.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
18.00	Transitional	163.8	34.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
19.00	840.2	112.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
20.00	586.8	78.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical

Windspeed Domain – Subcritical to Transitional to Supercritical

Exposure C

Exposure	α	z_g	K_{zt}	I	Z_{min}	Z_{max}	K_{zmin}
C	9.50	900	1.00	1.00	15.00	900.00	0.85

Critical Heights:

	Basic Windspeed (mph)												
Diameter (in.)	30	40	50	60	70	80	90	100	110	120	130	140	150
1.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
1.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
2.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	656.5	340.8
2.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	779.0	340.8	159.3	78.8	40.9
3.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	340.8	137.8	60.3	28.2	Transitional	Transitional
3.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	656.5	214.4	78.8	31.9	Transitional	Transitional	Transitional	Transitional
4.00	Subcritical	Subcritical	Subcritical	Subcritical	656.5	184.6	60.3	22.2	Transitional	Transitional	Transitional	656.5	340.8
4.50	Subcritical	Subcritical	Subcritical	Subcritical	214.4	60.3	19.7	Transitional	Transitional	Transitional	433.5	214.4	111.3
5.00	Subcritical	Subcritical	Subcritical	340.8	78.8	22.2	Transitional	Transitional	779.0	340.8	159.3	78.8	40.9
5.50	Subcritical	Subcritical	779.0	137.8	31.9	Transitional	Transitional	779.0	315.0	137.8	64.4	31.9	16.5
6.00	Subcritical	Subcritical	340.8	60.3	Transitional	Transitional	Transitional	340.8	137.8	60.3	28.2	Supercritical	Supercritical
6.50	Subcritical	Subcritical	159.3	28.2	Transitional	Transitional	433.5	159.3	64.4	28.2	Supercritical	Supercritical	Supercritical
7.00	Subcritical	656.5	78.8	Transitional	Transitional	656.5	214.4	78.8	31.9	Supercritical	Supercritical	Supercritical	Supercritical
7.50	Subcritical	340.8	40.9	Transitional	Transitional	340.8	111.3	40.9	16.5	Supercritical	Supercritical	Supercritical	Supercritical
8.00	Subcritical	184.6	22.2	Transitional	656.5	184.6	60.3	22.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
9.00	Subcritical	60.3	Transitional	Transitional	214.4	60.3	19.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
10.00	340.8	22.2	Transitional	340.8	78.8	22.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
11.00	137.8	Transitional	779.0	137.8	31.9	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
12.00	60.3	Transitional	340.8	60.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
13.00	28.2	Transitional	159.3	28.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
14.00	Transitional	656.5	78.8	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
15.00	Transitional	340.8	40.9	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
16.00	Transitional	184.6	22.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
17.00	Transitional	103.8	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
18.00	Transitional	60.3	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
19.00	554.9	36.1	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
20.00	340.8	22.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical

Windspeed Domain – Subcritical to Transitional to Supercritical

Exposure D

Exposure	α	z_g	K_d	I	Z_{min}	Z_{max}	K_{zmin}
D	11.50	700	1.00	1.00	15.00	700.00	1.03

Critical Heights:

	Basic Windspeed (mph)												
Diameter (in.)	30	40	50	60	70	80	90	100	110	120	130	140	150
1.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
1.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical
2.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	477.8	216.1
2.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	587.8	216.1	86.1	36.7	16.6
3.00	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	216.1	72.2	26.5	Transitional	Transitional	Transitional
3.50	Subcritical	Subcritical	Subcritical	Subcritical	Subcritical	477.8	123.3	36.7	Transitional	Transitional	Transitional	Transitional	Transitional
4.00	Subcritical	Subcritical	Subcritical	Subcritical	477.8	102.9	26.5	Transitional	Transitional	Transitional	Transitional	477.8	216.1
4.50	Subcritical	Subcritical	Subcritical	Subcritical	123.3	26.5	Transitional	Transitional	Transitional	Transitional	289.1	123.3	55.8
5.00	Subcritical	Subcritical	Subcritical	216.1	36.7	Transitional	Transitional	Transitional	587.8	216.1	86.1	36.7	16.6
5.50	Subcritical	Subcritical	587.8	72.2	Transitional	Transitional	Transitional	587.8	196.4	72.2	28.8	Supercritical	Supercritical
6.00	Subcritical	Subcritical	216.1	26.5	Transitional	Transitional	Transitional	216.1	72.2	26.5	Supercritical	Supercritical	Supercritical
6.50	Subcritical	Subcritical	86.1	Transitional	Transitional	Transitional	289.1	86.1	28.8	Supercritical	Supercritical	Supercritical	Supercritical
7.00	Subcritical	477.8	36.7	Transitional	Transitional	477.8	123.3	36.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
7.50	Subcritical	216.1	16.6	Transitional	Transitional	216.1	55.8	16.6	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
8.00	Subcritical	102.9	Transitional	Transitional	477.8	102.9	26.5	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
9.00	Subcritical	26.5	Transitional	Transitional	123.3	26.5	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
10.00	216.1	Transitional	Transitional	216.1	36.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
11.00	72.2	Transitional	587.8	72.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
12.00	26.5	Transitional	216.1	26.5	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
13.00	Transitional	Transitional	86.1	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
14.00	Transitional	477.8	36.7	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
15.00	Transitional	216.1	16.6	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
16.00	Transitional	102.9	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
17.00	Transitional	51.2	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
18.00	Transitional	26.5	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
19.00	389.8	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical
20.00	216.1	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical	Supercritical

Appurtenances

Defined Default Cellular Antenna Areas for bids

Carrier Type	No ice		Ice $t_i \le 0.50”$ [$t_i \le 13$ mm]		Ice $0.50” < t_i \le 1.50”$ [$13 < t_i \le 38$ mm]		Transmission Lines
	$(EPA)_A$ ft^2 [m^2]	Wt kips [kN]	$(EPA)_A$ ft^2 [m^2]	Wt kips [kN]	$(EPA)_A$ ft^2 [m^2]	Wt kips [kN]	
Light (9 antennas max)	55 [6.5]	0.75 [3.3]	75 [7.9]	1.00 [3.3]	110 [10.2]	1.50 [6.7]	(9) 1 5/8 in. diameter (2.0 in. [51 mm] OD)
Heavy (12 antennas max)	80 [8.4]	1.20 [5.3]	100 [9.3]	1.20 [5.3]	135 [12.6]	2.00 [8.9]	(12) 1 5/8 in. diameter (2.0 in. [51 mm] OD)

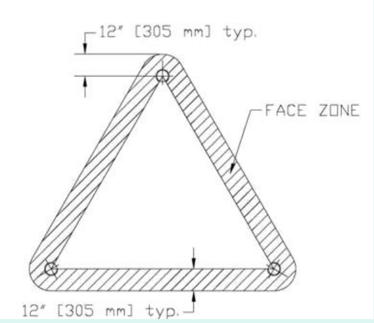
Line Loads

- LINE LOADS CAN NO LONGER BE CONSIDERED AS PART OF THE SECTION AREA!
- It is an appurtenance. No longer a distinction between discrete and linear
- The designer will utilize the same force coefficients, C_a, factors that are applied to antennas, and other "discrete" appurtenances.

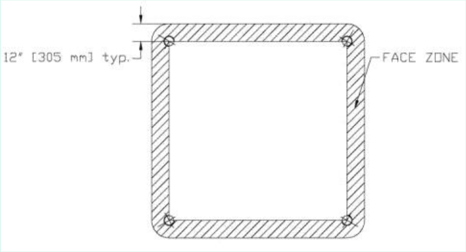
Line Loads

<u>Sheltering:</u>

- Based upon voids ratio (1- ε)
- Only applicable to sub-critical flow.
- Sheltering effects allowed when the line loads are entirely on the inside of the structure or is outside the cross section of the and entirely within the face zone.



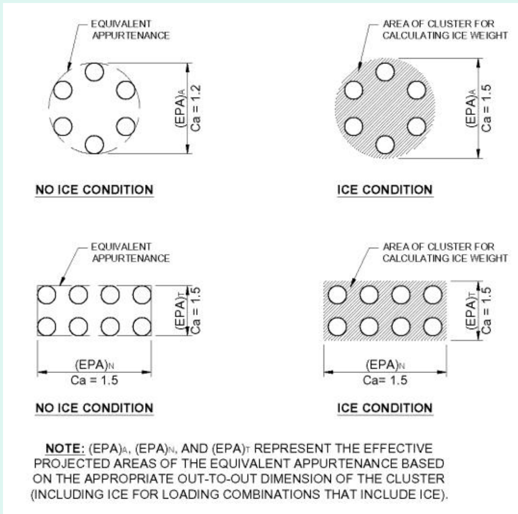
Triangular Cross Section



Square Cross Section

Line Clusters

$(EPA)_A = K_a[(EPA)_N \cos^2(\theta) + (EPA)_T \sin^2(\theta)]$



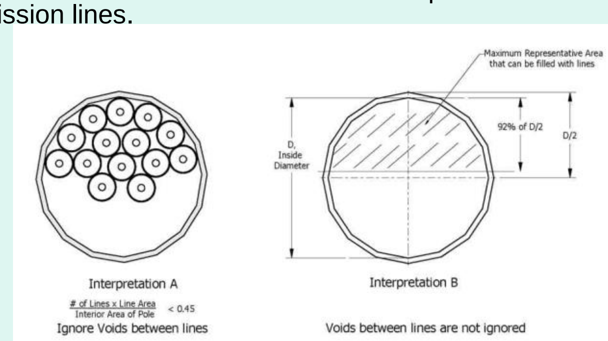
Can be treated as individual lines.

Must treat as rectangular line clusters utilizing $(EPA)_A$ Approach

Lines and Monopoles

- Section 2.6.9.1.2

  Note: ***In the absence of a detailed transmission line layout and installation bend radii of the lines***, the minimum diameter of a pole structure shall not be less than the diameter which results in ***45% utilization*** of the cross-section for the placement of internal transmission lines.



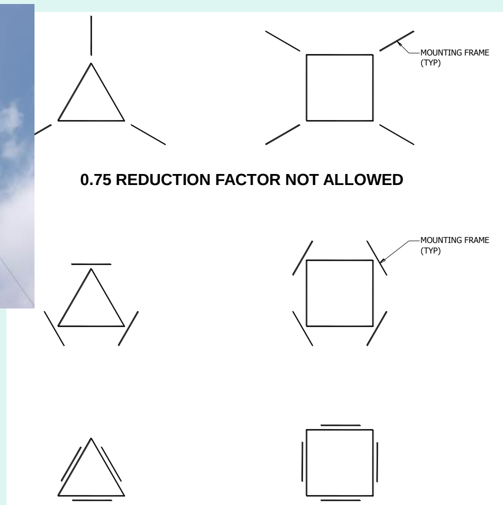
USE INTERPRETATION A !

Remember: "***In the absence of a detailed transmission line layout and installation bend radii of the lines***"

Mount Loads

- Mount loads will be defined and calculation procedures are established.
- Divided into broad approaches
  - Mounting Frames
  - Symmetrical Frame/Truss Platform
  - Low Profile Platform
  - Symmetrical Circular Ring Platform
  - $(EPA)_A = K_a[(EPA)_N \cos^2(\theta) + (EPA)_T \sin^2(\theta)]$ -

Mounting Frames



0.75 REDUCTION FACTOR APPLIES
(MINIMUM OF 3 MOUNTING FRAMES REQUIRED)

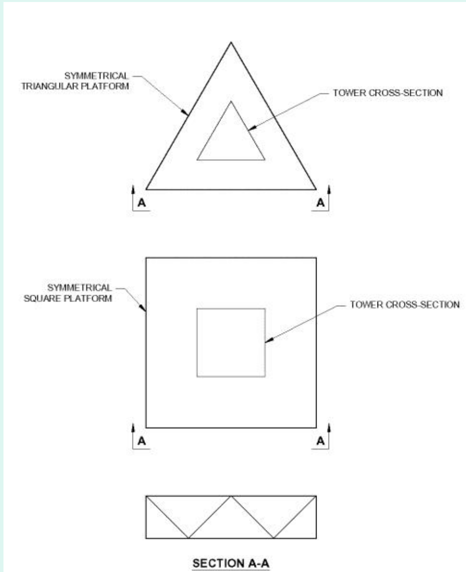
Figure 2-6: Multiple Mounting Frames

K_a = 0.8 can be applied to antennas and antenna mounting pipes mounted on the Symmetric Frame/Truss Platform. Subcritical Flow Only!

A reduction of the structure forces is not allowed

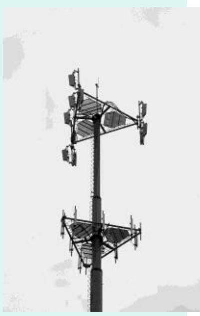
K_a = 0.8 can be applied to antennas and antenna mounting pipes mounted on the Symmetric Frame/Truss Platform. Subcritical Flow Only!

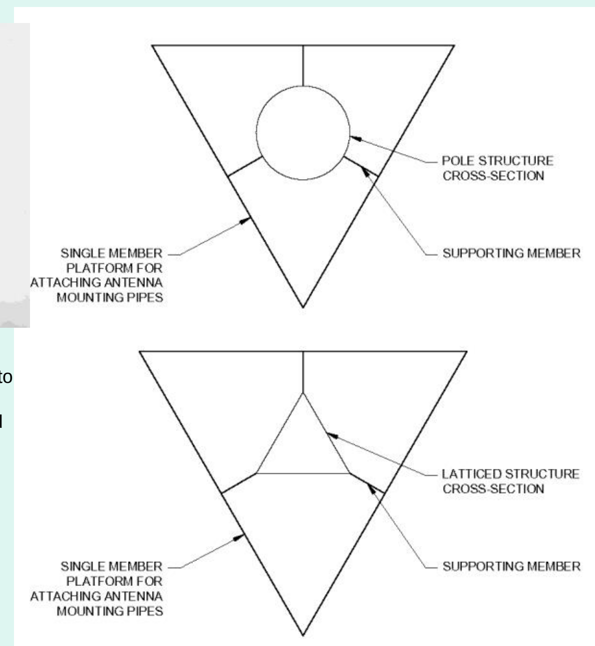
A reduction of the structure forces is not allowed



(TRUSS TYPE)

Figure 2-7: Symmetrical Frame/Truss Platforms





K_a = 0.8 can be applied to antennas and antenna mounting pipes mounted on the Symmetric Frame/Truss Platform. Subcritical Flow Only!

A reduction of the structure forces is not allowed

Figure 2-8: Low Profile Platforms

K_a = 0.8 can be applied to antennas and antenna mounting pipes mounted on the Symmetric Frame/Truss Platform. Subcritical Flow Only!

A reduction of the structure forces is not allowed

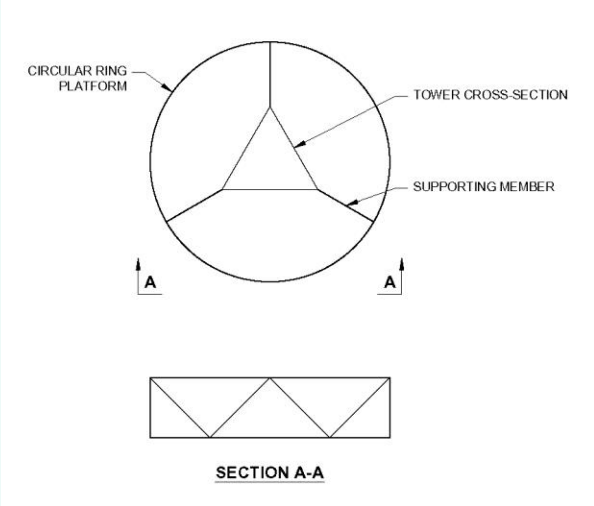


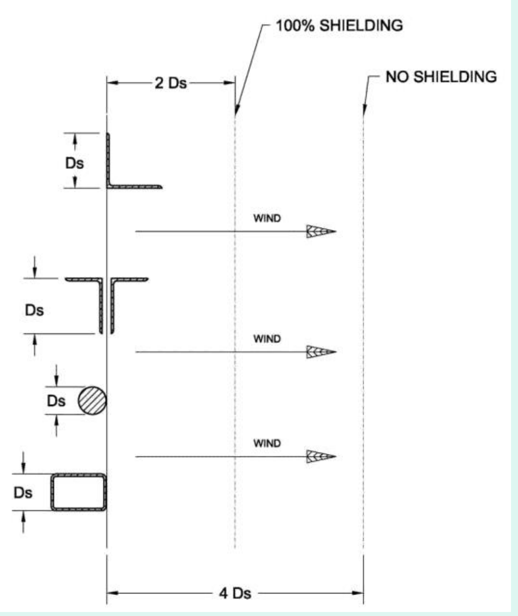
Figure 2-9: Circular Ring Platforms

Mounts – Universal Issues

- Notes for all mounting frame/platform types:
  - K_a shall equal 1.0 for antennas and antenna mounting pipes under transitional or supercritical flow conditions.
  - Grating and other horizontal working surfaces need not be included in the effective projected area.

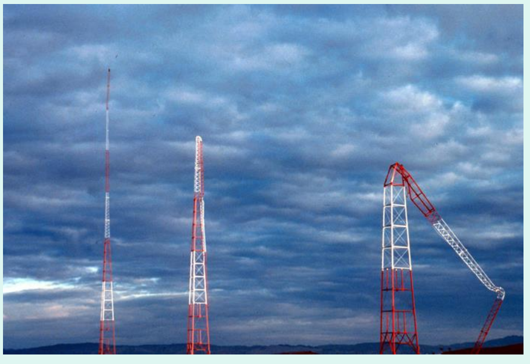
Shielding

K_a = 1.0 if the shielding principals listed are to be applied.



Seismic Loads

- New Section – A response to changes in building codes and a greater understanding of how seismic loads occur.



Seismic – Earthquake Loads

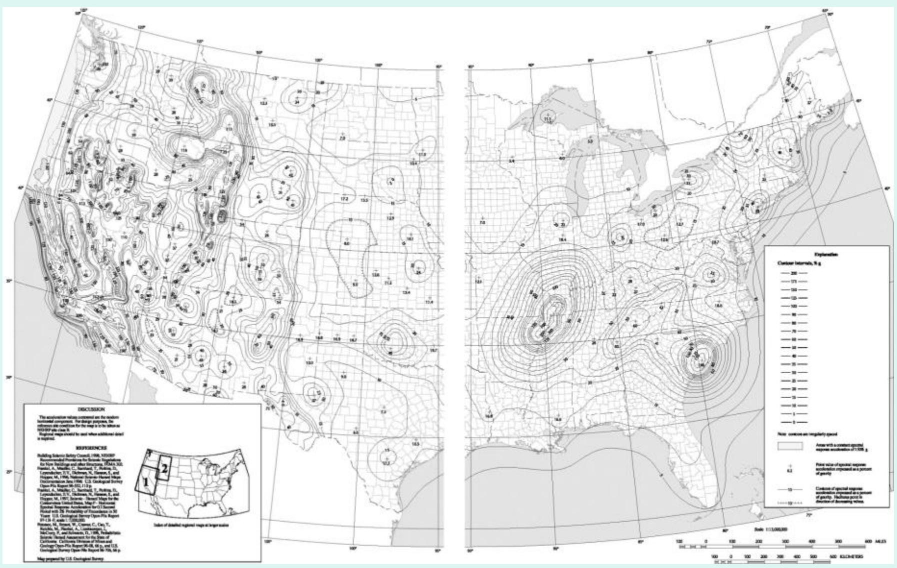
- Based upon
  - Site Classification – Ignored for Site Class I
  - Structure irregularities
  - Not required if the Short Period (S_s) is less than 1.00.
  - Not required for structure there is a structural irregularity and when the equivalent seismic base shear is less the 50% of the 50 year return period wind loading.

Table 2-1
Classification of Structures

Description of Structure	Class
Structures that due to height, use or location represent a low hazard to human life and damage to property in the event of failure and/or used for services that are optional and/or where a delay in returning the services would be acceptable.	I
Structures that due to height, use or location represent a substantial hazard to human life and/or damage to property in the event of failure and/or used for services that may be provided by other means.	II
Structures that due to height, use or location represent a high hazard to human life and/or damage to property in the event of failure and/or used primarily for essential communications.	III

Table 2-3
Importance Factors

Structure Class	Wind Load Without Ice	Wind Load With Ice	Ice Thickness	Earthquake
I	0.87	N/A	N/A	N/A
II	1.00	1.00	1.00	1.00
III	1.15	1.00	1.25	1.50
Note: Ice and earthquake loads do not apply to Class I structures				



Structure Irregularities

Type	Description
Torsional Irregularity	Center of mass of a section including appurtenances is offset from the vertical alignment of the structure by more than 30% of the smallest plan dimension of the section.
Stiffness Irregularity	Average bending stiffness of a section (I_S/L_S) varies by more than 50% from an adjacent section.
Mass Irregularity	Mass per unit length (M_S/L_S) of a section including appurtenances varies by more than 200% from an adjacent section.

Where: I_S = average moment of inertia of a section
M_S= total mass of a section
L_S = length of a section

Notes:
1.A section of a structure shall be considered as the portion between leg connections for latticed structures and the distance between splices in tubular pole structures, not to exceed 50 ft [15 m] for any structure.
2.The mass and stiffness of guys for guyed masts shall be excluded when determining irregularities.
3.Torque arms, star mounts, etc. shall not be considered as a stiffness irregularity.
4.Mounting frames, antenna mounts, platforms, etc, shall not be considered as a stiffness irregularity.

Seismic Analysis Procedure Methods

Analysis Procedure Method Description [1]	Height Limitations on Analysis Procedure Methods					
	No mass or stiffness irregularities per Table 2-9			With mass or stiffness irregularities per Table 2-9		
	Self-Supporting		Guyed Masts [2]	Self-Supporting		Guyed Masts [2]
	Poles	Latticed		Poles	Latticed	
Equivalent Lateral Force, Method 1 in accordance with 2.7.7	50 ft [15 m]	100 ft [30 m]	No Limit	N/A	N/A	1500 ft [457 m]
Equivalent Modal Analysis, Method 2 in accordance with 2.7.8	No Limit	No Limit	N/A	200 ft [61 m]	600 ft [183 m]	N/A
Modal Analysis, Method 3 in accordance with 2.7.9	No Limit	No Limit	N/A	No Limit	No Limit	N/A
Time-History Analysis, Method 4 in accordance with 2.7.10	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit

Notes:
1.Vertical seismic forces may be ignored for Methods 1, 2 & 3.
2.Method 4 shall be used when the horizontal distance from the base of the structure to any guy anchor point exceeds 1000 ft [305 m].

Seismic – Earthquake Loads

There is a procedure defined in the Standard

When required, earthquake loads shall be evaluated in accordance with the seismic analysis procedures specified in 2.7.4.

1. An importance factor I shall be determined from Table 2-3 based on the structure classification listed in Table 2-1.
2. Determine an appropriate seismic analysis procedure method for the structure from Table 2-10.
3. Determine the maximum considered earthquake spectral response acceleration (expressed as a ratio to the acceleration due to gravity) at short periods (S_s) and at 1 second (S_1) from 2.7.5.
4. Determine the Site Class based on the soil properties at the site in accordance with Table 2-11.
5. Modification factors F_a and F_v, based on the Site Class, shall be determined from Tables 2-12 and 2-13 respectively.
6. The design spectral response acceleration at short periods (SDS) and at 1 second (SD1) shall be determined in accordance with 2.7.6.






Seismic – Site Class

The soil type will define the **Shake of the Quake**

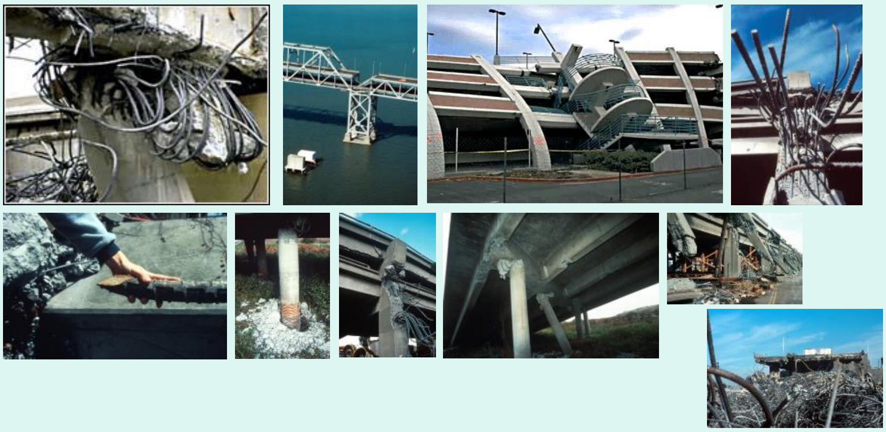
Site Class	Description of Upper 100 ft [30.5 m] of Soil for the Site Location	Standard Penetration Resistance, N Cohesionless Soils PI ≤ 20	Undrained Shear Strength, S_u Cohesive Soils PI > 20
A	Hard rock with 10 ft [3 m] or less of soil overburden.	N/A	N/A
B	Competent rock with moderate fracturing and weathering with 10 ft [3 m] or less of soil overburden.	N/A	N/A
C	Very dense soil, soft rock or highly fractured and weathered rock.	> 50	> 2 ksf [100 kPa]
D	Stiff soil.	15 to 50	1.0 to 2.0 ksf [50 to 100 kPa]
E	Weak soil (excluding site class F).	< 15	< 1.0 ksf [50 kPa]
		Soil profiles over 10 ft [3 m] thick with PI ≥ 20, moisture content ≥ 40%, S_u < 0.5 ksf [25 kPa]	
F	Soils vulnerable to potential failure or collapse under seismic loading.	Soil profiles containing any of the following: peat and/or highly organic clays over 10 ft [3 m] thick, very high plasticity clays (PI > 75) over 25 ft [7.6 m] thick, soft/medium clays over 120 ft [36.6 m] thick, liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils.	

Analogy: Rock (Site Class A) vs. Jell-O (Site Class E-F)

Earthquake Detailing

Still driven by building codes and engineering practices. Not a part of the standard.

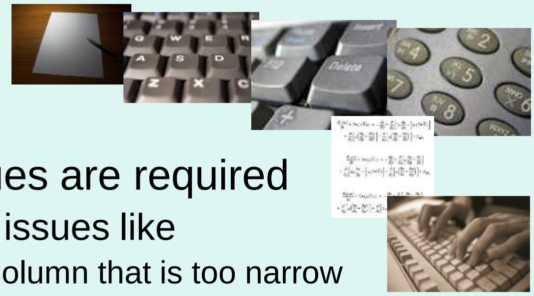
Considered covered as a product of the
"Standard of Practice of the Engineering Profession"



Serviceability

- The standard lists a minimum recommendation.
- 60 mph 3-second gust windspeed recommended.
- Serviceability should be derived based upon performance and reliability of the system. Consider Issues such as
  - Redundancy -
  - Economic loss – Cost of the structure is inversely proportional to increasing the serviceability requirements of the structure. (Does not include RF Issues)
  - Acceptable risk – Life and property (Consider impact upon society, Communications role in society.)
- Values used:
  - $1.0\,D + 1.0\,D_g + 1.0\,W_o$ (Refer to 2.3.1)
    - D_g – Dead load of guys
    - D – Dead Load of the structure and appurtenances, excluding guys
    - W_o – wind load without ice.
  - Importance Factor = 1.0 (Remember this is a return period modifier)
  - Exposure Category and Topography Factors should remain unchanged.

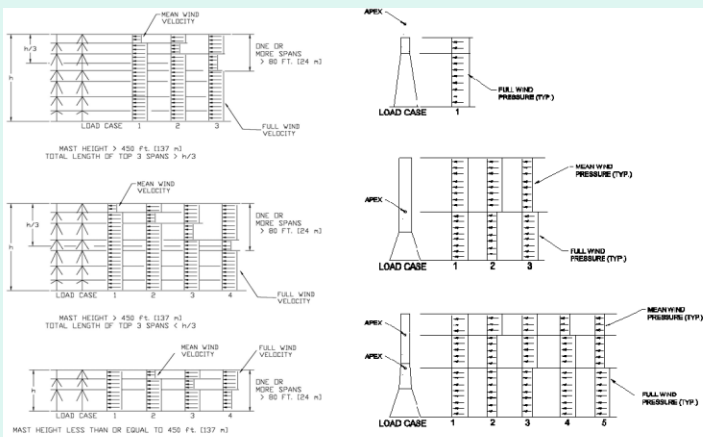
Analysis



- Specific techniques are required
  - Meant to correct issues like
    - A guyed tower Column that is too narrow
    - Guy spans that are too large
    - Underestimating loads
      - Tuning the member selection process too closely to the results of the wind analysis.
      - Inflection points reflect a mathematical concept.
      - A tall tower is subjected to wind that will move up and down the tower in approximately 180 ft long segments. The movement of gusts up and down the tower will eliminate the "inflection points."

Analysis - General Issues

Patch Loading



Analysis Techniques – What is acceptable? Section 3.4

(a) Self-Supporting Latticed Towers

1. An elastic three-dimensional truss model made up of straight members pin connected at joints producing only axial forces in the members.

2. An elastic three-dimensional frame-truss model where continuous members (legs, K-type bracing horizontals without plan bracing) are modeled as 3-D beam elements producing both moments and axial forces in the members while the remaining members which are subjected primarily to axial loads may be modeled as 3-D truss elements producing only axial forces in the members.

Analysis Techniques – What is acceptable? Section 3.4

(b) Self Supporting Pole Structures:

1. An elastic three-dimensional beam-column model producing moments, shears and axial forces in the pole structure.

2. Unless the analysis model considers second order effects within each element, the minimum number of beam elements shall be equal to five per pole section and the maximum beam element length shall not exceed 6 ft.

3. Note: Due to modeling complexity (e.g. meshing, element interconnection, …) of plate or shell models, the stresses obtained from such models shall not be less than the stresses obtained from the beam-column model noted above.

Analysis Techniques – What is acceptable? Section 3.4

(c) Guyed Masts

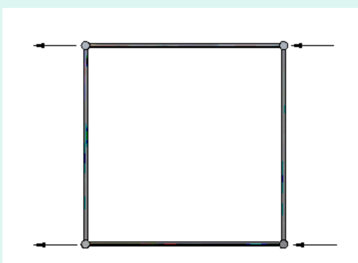
1. An elastic three-dimensional beam-column where the mast is modeled as equivalent three-dimensional beam-column members supported by cables represented either as non-linear elastic supports or cable elements. This analysis produces moments, shear and axial forces in the mast, which results in individual member forces.

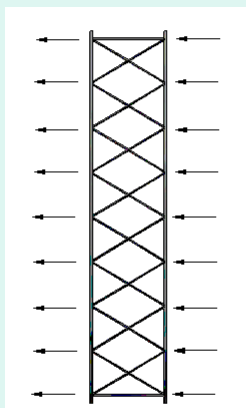
2. An elastic three-dimensional truss model where individual members of the mast are modeled as straight members connected at joints producing only axial forces in the members. The cables are represented as cable elements.

3. An elastic three-dimensional frame-truss model where continuous members (legs) of the mast are modeled as 3-D beam elements producing both moments and axial forces in the members while other members may be modeled as 3-D truss members. The cables are represented as cable elements.

Analysis Techniques – What is acceptable? Section 3.4

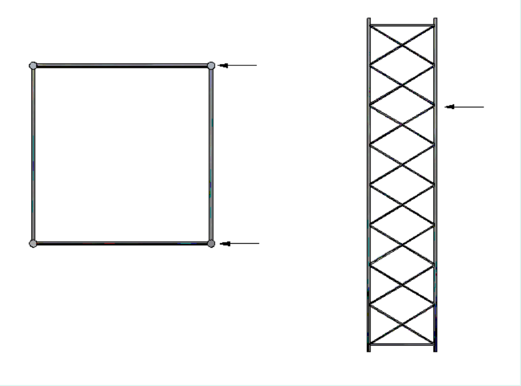
Loads must be equally distributed to each leg joint of the cross section at the panel points for three dimensional truss or frame models.





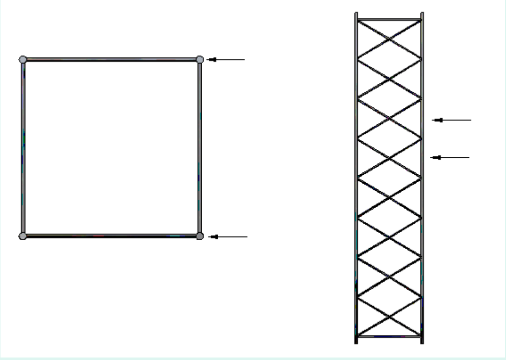
Analysis Techniques – What is acceptable? Section 3.4

The horizontal design wind force for appurtenances shall be distributed to each leg joint according to the location of the appurtenance.



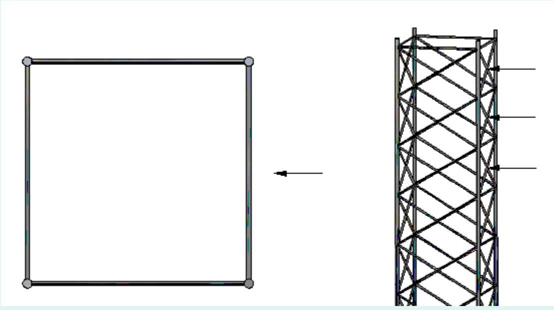
Analysis Techniques – What is acceptable? Section 3.4

Local bending shall be considered for structural components supporting appurtenances that are supported in the middle half of a component.



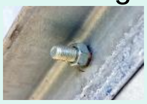
Analysis Techniques – What is acceptable? Section 3.4

For main bracing members, local bending shall be considered for the condition of wind normal to the plane of the bracing members with no axial load considered.



Design Strength

- Follows AISC LRFD Criteria
- Adjusted where appropriate – Ex. Guy Wires Link plates
- Longitudinal Welds for Tubular Pole Structures
- Research data that improves or supersedes AISC criteria –
  - Welded Sections Bracing “K-factors”
  - Redundant capacity
  - Angle Bracing Capacity – Tension Restraint.



Manufacturing – General Purpose

- Primary focus – Create some minimum qualitative requirements
  - Qualified vs. Pre-qualified Steel
    - Pre - qualified – List provided – Table 5-1
    - Qualified – must meet the minimums
  - Must obtain test reports from the steel fabricator or a testing laboratory
  - Misc.
    - Guy anchors and direct embedded steel exposed to soil must be protected from low resistivity soil (50 ohm-m) or measured pH values that are below 3 or greater than 9.
    - Acceptable Corrosion Protection techniques are listed in Annex H

Pre- Qualified Steel

Table 5-1
Pre-Qualified Structural Steels

API – 5L	API Specification (Spec. 5L)
ASTM A36	Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM A106	Seamless Carbon Steel Pipe.
ASTM A242	High-Strength Low-Alloy Structural Steel.
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
ASTM A501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
ASTM A514	High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
ASTM A529	High-Strength Carbon-Manganese Steel of Structural Quality.
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality.
ASTM A588	High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield
ASTM A606	Steel, Sheet and Strip, High-strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.
ASTM A618	Hot-Formed Welded and Seamless High-strength Low-Alloy Structural Tubing.
ASTM A633	Normalized High-Strength Low-Alloy Structural Steel Plates.
ASTM A871	High-Strength Low-Alloy Structural Steel Plate with Atmospheric Corrosion Resistance.
ASTM A913	High-Strength Low-Alloy Steel Shapes of Structural Quality.
ASTM A992	Steel for Structural Shapes for Use in Building Framing.
ASTM A1008/A	Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability
ASTM A1011	Steel, Sheet and Strip, Carbon, Hot-rolled Structural Quality.
CSA G40.20/.21	General Requirements for Rolled or Welded Structural Quality Steels.

Note: Shapes and sizes outside the scope of an ASTM standard shall be considered as non-pre-qualified steel.

Steel – Is it Pre-Qualified? If not what then?

- Carbon Equivalent cannot exceed 0.65
- Minimum elongation of 18%
- Charpy V-notch requirements – Thickness greater than 5”
- Well documented

Other Structural Materials – Why this section?

- The advent of unconventional materials requires the standard to ensure this does not become a hole.
- Example: Fiberglass/Poly-fiber reinforcement

Guy Assemblies – Some Changes

Modulus of Elasticity

In the absence of specific cable manufacturer's data, the modulus of elasticity of a steel cable used for analysis shall be **23,000 ksi** [159 MPa] except for pre-stretched cables 2-9/16 in. [65 mm] diameter and smaller, a modulus of elasticity of **24,000 ksi** [166 MPa] shall be used.

Proof Loading of Assemblies

Factory installed end sockets shall be proof loaded to **55 percent of the manufacturer's rated breaking strength** of the cable and held for a minimum of three cycles with a minimum duration of five minutes for each cycle.

Articulation

Articulation at both ends of guy assemblies shall be provided for assemblies consisting of non-metallic guys with rigid end connections such as end sockets or similar devices that do not include low frequency dampers. Articulation shall provide a minimum 10º rotation in both the vertical and the horizontal directions

Guy Dampers

For guyed masts with structure heights above **1200 ft** [366 m], high frequency dampers shall be provided for cables with rigid end connections such as bridge sockets or similar devices unless otherwise determined by a site-specific analysis.

Initial Tension

The initial tension in guys, for design purposes, at an ambient temperature of 60o F [16o C] shall be within upper and lower limits of **15 and 7 percent**, respectively, of the manufacturer's rated breaking strength of the strand. Values of initial tension beyond these limits may be used provided consideration is given to the sensitivity of the structure to variations in initial tension. The design ambient temperature may be adjusted based on site-specific data.

Insulators

ϕ_i = 0.5 for non-metallic fail-safe insulators
ϕ_i = 0.4 for other non-metallic insulators

Other Requirements

- Insulator assemblies shall be proof loaded to 60 percent of the manufacturer's rated ultimate strength.
- Insulator manufacturers shall provide the expected life of base and guy insulators.

Foundations



- Recommends a geotechnical report for Class I and II structures
- Requires a geotechnical investigation for Class III structures
- Use Factored Load Reactions
  - ϕ_s = 0.50 for bearing on rock or soil for bases of guyed masts including spread footings driven piles, drilled caissons, steel grillages. (Approximate FS = 2.72)
  - ϕ_s = 0.75 for bearing on rock or soil for bases of self-supporting structures including spread footings, mats, driven piles, drilled caissons, steel grillages. (Approximate FS = 1.81)
  - ϕ_s = 0.75 for pull-out or uplift in rock or soil for foundations and anchorages including spread footings, deadman anchors, drilled caissons, steel grillages and battered piles. (Approximate FS = 1.81)
  - ϕ_s = 0.50 for pull-out or uplift in rock or soil for foundations and anchorages which utilize one rock/soil bolt, dowel or anchoring device. (Approximate FS = 2.72)
  - ϕ_s = 0.40 for pull-out or uplift in rock or soil for foundations and anchorages which utilize non-battered piles with a tapered cross-section. (Approximate FS = 3.4)
  - ϕ_s = 0.75 for friction or lateral resistance of soil or rock for all types of foundations. (Approximate FS = 1.81)




Note: assumes the aggregate factor applied to the reactions is approximately 1.36. A simplification.

- Minimum Frost depth is now required.


Plans, Assembly Tolerances and Marking


Plans, Assembly Tolerances and Marking

The tower plans shall detail the following data for the site specified used in the structural analysis:

- Basic wind speed (3 second gust, 50 year return period) without ice.
- Basic wind speed (50 year return period) with ice.
- Design ice thickness (50 year return period).
- Exposure category (B, C or D) for the site specified.
- Structure classification (I, II, or III) used to classify the structure.
- Topography category (1,2, 3,4, or 5).
- Earthquake spectral response acceleration at short periods.
- Foundation reactions for the loading combinations considered.
- Soil design parameters or source of data.

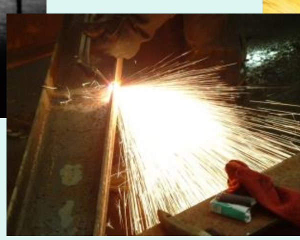
Plans, Assembly Tolerances and Marking

- The erectors responsibility is clearer
- Drawings must show the details and markings required to allow the proper installation of the structure.
- Must include:
  - Member sizes
  - Member yield strength
  - Grade of structure bolts
  - Foundation reactions – based upon factored loads
  - Loading:
    - Antennas: Height, quantity, model, number and size of lines
    - Mounts: Height, quantity, model, number and size of lines
    - Or, the total effective projected area representative of all of the antennas and mounts at each elevation

Plans, Assembly Tolerances and Marking

Tolerances – Well defined in the standard. I do not consider them conservative if your goal is to guarantee a user friendly assembly of the structure. Actual tolerances will be a product of the manufacturers philosophy and quality philosophy.

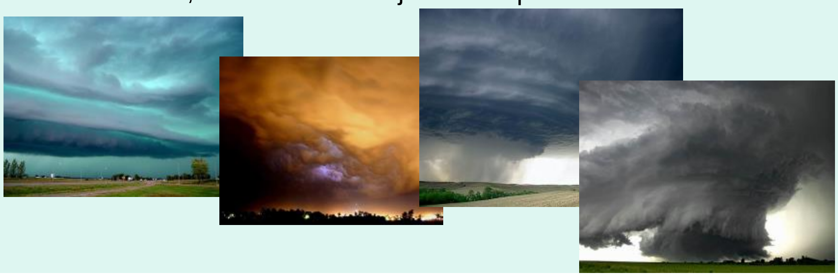
Markings – members must be permanently labeled (character height ½”)



Maintenance and Condition Assessment

Maintenance and condition assessment shall be performed as follows:

- **Three-year** intervals for **guyed** masts and **five-year** intervals for **self-supporting** structures.
- After severe wind and /or ice storms or other extreme conditions.
- Shorter inspection intervals may be required for Class III structures and structures in coastal regions, in corrosive environments, and in areas subject to frequent vandalism.

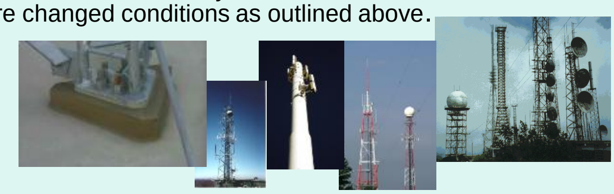


Existing Structures - Defined

As a minimum, existing structures shall be analyzed in accordance with this Standard, regardless of the standard used for the design of the original structure, under any of the following conditions:

- a change in type, size, or number of appurtenances such as antennas, transmission lines, platforms, ladders, etc.
- a structural modification, excepting maintenance, is made to the structure
- a change in serviceability requirements
- a change in the classification of the structure to a higher class in accordance with Table 2-1.

Note: Existing structures need not be re-analyzed for each revision of this Standard unless there are changed conditions as outlined above.



Existing Structures – Versions C to F

- The engineer performing an analysis of an existing structure can perform an analysis in accordance with previous revisions of the standard for informational purposes only.
- Previous versions of the standard are considered to be legally obsolete. (What is considered the Standards of the Practice of the Engineering Profession?)
- Must perform modifications in accordance with the latest revision of the standard.

Existing Structures – Types of Analysis

- **Feasibility Structural Analysis**
  - **Defines impact of proposed changes**
  - **Macro view of the structure**
  - **Does not include connections**
  - **May assume the structure is properly constructed and maintained.**
- **Rigorous Structural Analysis**
  - **May assume the structure is properly constructed and maintained.**
  - **Use to determine the final acceptance of proposed changes.**
  - **Must determine the overall stability and adequacy of the structural members, foundations and connection details.**
  - **Foundation analysis must be site specific**
  - **Assumptions about details that are not visible or cannot be discerned without extensive field testing is acceptable.**

Existing Structures – The minimums

- The report must state the type of analysis performed.
- A feasibility report shall state that final acceptance of changed conditions shall be based upon a rigorous structural analysis.
- Exemptions from the requirements of the main body:
  - Minimum mast shear and torsion
  - Minimum bracing resistance
  - Climbing facilities
  - Etc. See section 15.6

Existing Structures - Modifications

- Must be based upon a Rigorous Structural Analysis
- Design Document shall be prepared indicating modifications
- Prior to implementation of the modifications the data designated by the engineer shall be verified

Annex A – Procurement and User Guidelines

- Formerly called Customer Checklist
- Intended to guide purchaser
- Points the Purchaser to issues of concern
- Sets “default” values.

Annex B - County listings

- Lists the maximum and minimum values for
  - Wind, V
  - Wind on Ice, V_i
  - Ice, t_i
  - Short period S_s
- Pay attention to the notes, they will highlight special wind regions.
- Use the maximum if you do not have a site location within a county.

Annex C – Microwave Antennas

- Remain unchanged.
- Values are tailored to the 3-second gust

Annex D – Twist and Sway

- Remain conceptually unchanged
- Added equations, eliminated graphs

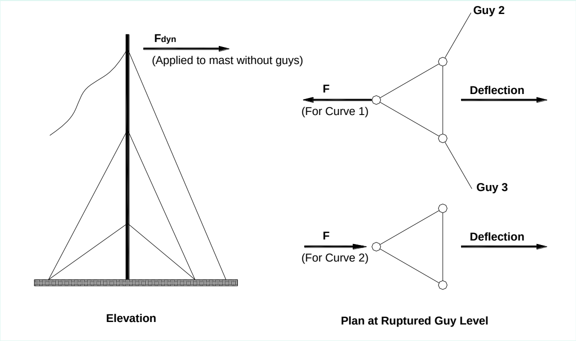
Annex E – What is a Guy Rupture? When does it apply?

It is a technique used to ensure tensile capacity in the leg connections.

It applies when the leg splices do not have a minimum design strength equal to the ***lower of 33%*** of the design compression force at the splice or ***500 kips***. Must include eccentricities.

If you meet the leg splice criteria, the guy rupture criteria is an option.

Very controversial



Annex E – Guy Rupture

An accurate analysis of a guyed mast for the dynamic effects caused by the sudden rupture of a guy is very complicated as it depends on the characteristics of the rupture, the damping of the structure, the vibration of the guys and the mast, etc.

As a result an equivalent, simplified static approach is employed to simulate the behavior of the structure immediately after a guy rupture.

Annex F – Presumptive Soil – The death of normal soil and the future.

- Normal Soil is abolished.
- Broken into two soil types:
  - Sand
  - Clay

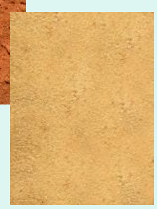



Table F-1: Presumptive Soil Parameters:

Soil Type	N (blows/ ft) [blows /m]	ϕ (deg)	γ (lb/ft3) [kN/m^3]	c (psf) [kPa]	Ultimate Bearing (psf) [kPa] Shallow Fnds.	Deep Fnds.	S_f (psf) [kPa]	k (pci) [kN/m^3]	ε_{50}
Clay	8 [26]	0	110 [17]	1000 [48]	5000 [240]	9000 [431]	500 [24]	150 [41,000]	.01
Sand	10 [33]	30	110 [17]	0	3000 [144]	7000 [335]	500 [24]	35 [9,500]	N/A

Annex G – Geotechnical Investigations

- Lists the minimum data that should be included in a “soil report”.
- Includes Soil pH and resistivity (Corrosion Control).
- A listing that can be given to the Geotechnical Engineer

Issues postponed to revision H and Beyond.

- Fatigue
- Monopole Base Plate Design
- Stress Concentrations
- New Technology
- Aluminum
- ASD
- Corrections and adjustments