TIA / OSHA

Working Together to Provide Safe Working Environments for Communication Structures Through Understanding and Application of the Standards

Agenda

- Overview of Telecommunications Industry Association (TIA)
- ANSI/TIA-222-H Overview
- ANSI/TIA-322 & ANSI/ASSE A10.48 Overview
- TIA 5053
- TIF White papers
- TIF foundation
- Climbing facilities
- Q&A

TIA by the Numbers

430+
Members

ICT manufacturers and suppliers, network operators and service enablers, distributors and system integrators

3,609
Standards Developed

9
Standards Technical Committees

~2M
Workers Employed Worldwide

107
Working Groups

2,500
Individuals Engaged Across Communities

$3T
Contributed to the World Economy by TIA Members

70%
of TIA Member Companies are Small-to-Medium Size Businesses with <$20 Million in Revenue

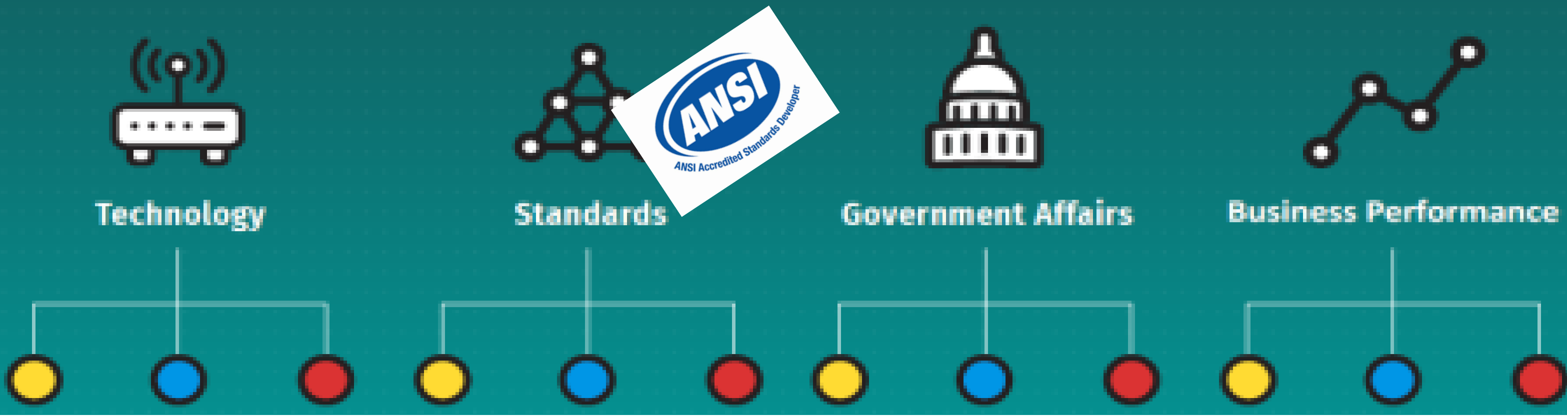
Telecommunications Industry Association

- Accredited by the American National Standards Institute (ANSI)
- Develop voluntary, consensus-based industry standards for a wide variety of communications products and systems

Convening and Enabling Communities of Interest

At TIA we bring together and facilitate numerous communities of interest within **four key verticals:** Technology, Standards, Government Affairs and Business Performance.

Within these many communities, TIA advances strategic programs, products and services to tackle unique challenges the ICT industry faces. The solutions these communities drive provide tangible value to our members that enhance their bottom line.



Smart Buildings / Cities	Edge Data Center	NFV / CO To DC Transition	Network Service Assurance	Device Assurance/ Registration

Core Competency: **Network Infrastructure, Connectivity, Quality**

Standards SDO

Technology

Government Affairs

Business

- TR-8 I Mobile and Personal Private Radio Standards
- TR-14 I Structural Standards for Communication
- TR-34 I Satellite Equipment & Systems
- TR-41 I Performance and Accessibility Communications
- TR-42 I Telecommunications Cabling Systems
- TR-45 I Mobile and Point-to-Point Communications Stds
- TR-51 I Smart Utility Networks – IOT

- TR-60 I ICT Lifecycle Management

Definition
Benchmark
TL9000 QM
QF / TIA Tools
Assurance
Certification
Registration
Sustainability

Communities Of Interest

TIA "Technology & Standards"

TR-14 Structural Standards for Communication and Small Wind Turbine Support Structures

Why Standards?

- Creates uniformity
- These standards ensure that the network will perform to all participants expectations
- Eliminates confusion
- The National Technology Transfer and Advancement Act of 1995 directs the federal government to adopt private-sector standards whenever possible, in lieu of creating proprietary, non-consensus standards

Artificial Intelligence - The executive order on AI issued by Pres. Trump in February 2019
The EO directs the National Institute of Standards and Technology (NIST) to create “a plan for Federal engagement in the development of technical standards and related tools in support of reliable, robust, and trustworthy systems that use AI technologies.” NIST is committed to fulfilling that responsibility in a timely way, engaging the public and private sectors in producing a plan within 180 days.
Plan for federal engagement in the development of technical standards and related tools 10, August 2019

TIA will participate and take a lead

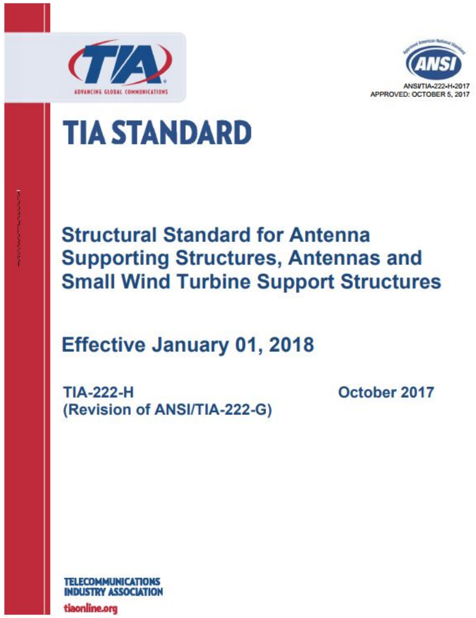
ANSI/TIA-222-H

Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures

TIA-222-H Overview

ANSI/TIA-222: Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures

- For all communication structures
- TIA-222 is applied to (but not limited to):
  - ***Radio***
  - ***Cellular***
  - ***TV***
  - *International*
  - *Federal*
  - *Small cell*
- Design, analysis and assessment
- Procurement

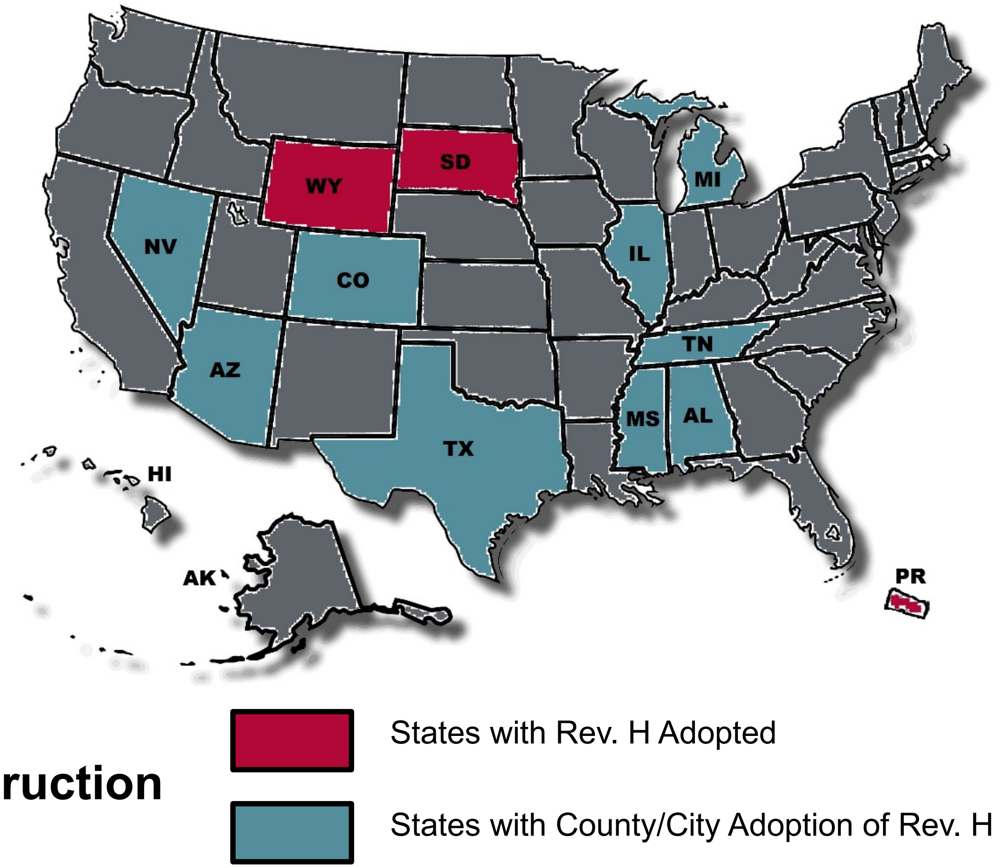

TIA
ADVANCING GLOBAL COMMUNICATIONS
ANSI
ANSI/TIA-222-H-2017
APPROVED: OCTOBER 5, 2017
TIA STANDARD
Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures
Effective January 01, 2018
TIA-222-H
(Revision of ANSI/TIA-222-G)
October 2017
TELECOMMUNICATIONS INDUSTRY ASSOCIATION
tiaonline.org

Leadership of John Erichsen, Mark Malouf, Bryan Lanier, Dave Brinker, Stephen Yeo, John Wahba, James Ruedlinger, Scott Kisting and Michelle Kang, etc.

TIA-222-H Overview

Changes from Revision G:

- **Loading**
- Analysis
- **Strength**
- Chapters 5 – 8
- Foundations and Grounding
- **Climbing Facilities**
- Maintenance/Inspection
- **Existing Structures**
- Small Wind Turbines
- Seismic
- **Mounts**
- Monopole Baseplates
- **Pre, In-Process and Post Construction**



Most Significant Changes

Impact	Improvement
▼	Anchor Rods & Grout Consideration
—	Climbing Facilities
—	Construction Practices
—	Corrosion and Inspection Control Standards
▲	Earthquakes
▲	Existing Structures and Grandfathering
▲	Ground Elevation Factor
▲	*Modification Factor / Reliability Factor*
—	Mount Analysis

Impact	Topic
—	Risk Category & Site Hardening
▼	*Rooftop Converging Wind*
—	*Small Cell Standards*
▲	Single Angles
▲	Topographic Factor
—	Verification Inspections
—	*Wind Direction Probability*
▲	Wind Speeds

Risk Categories & Site Hardening

https://global.ihs.com/foundation_white_papers.cfm

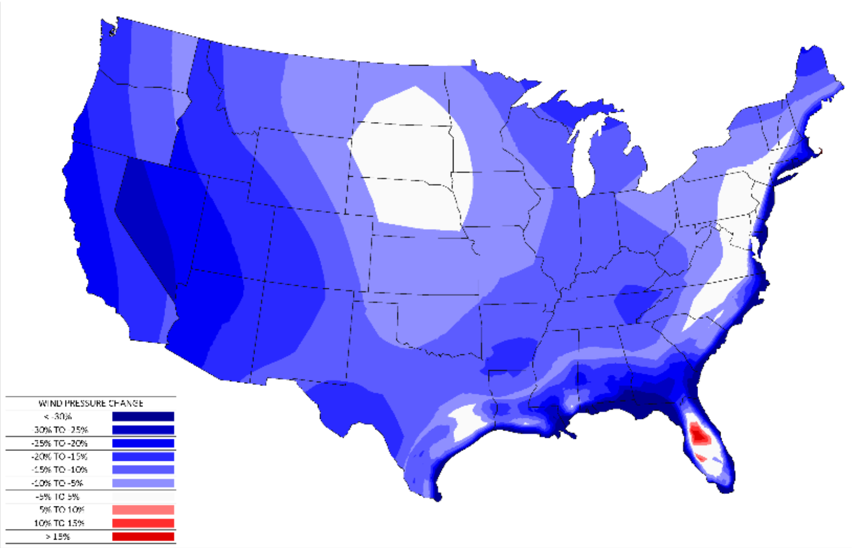
Risk Category I

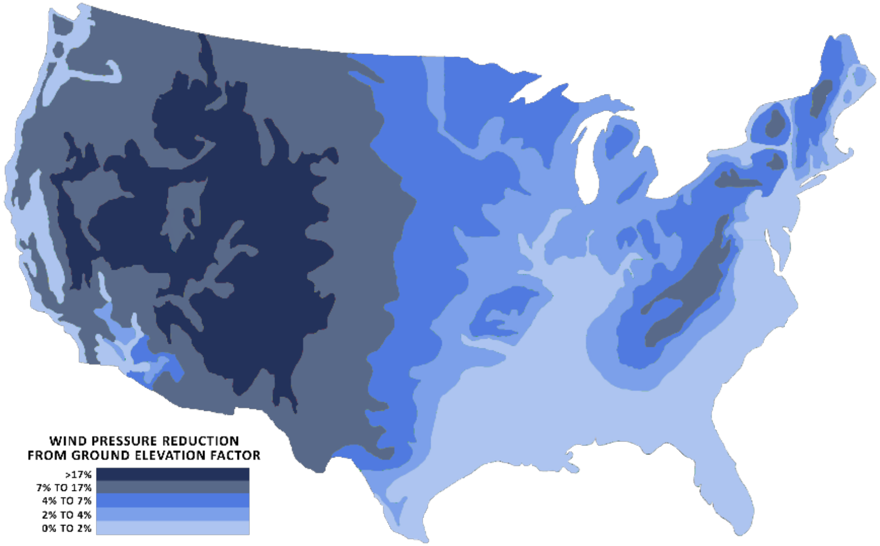
Risk Category II

Risk Category III

Risk Category IV

Wind Speed and Ground Elevation Factor





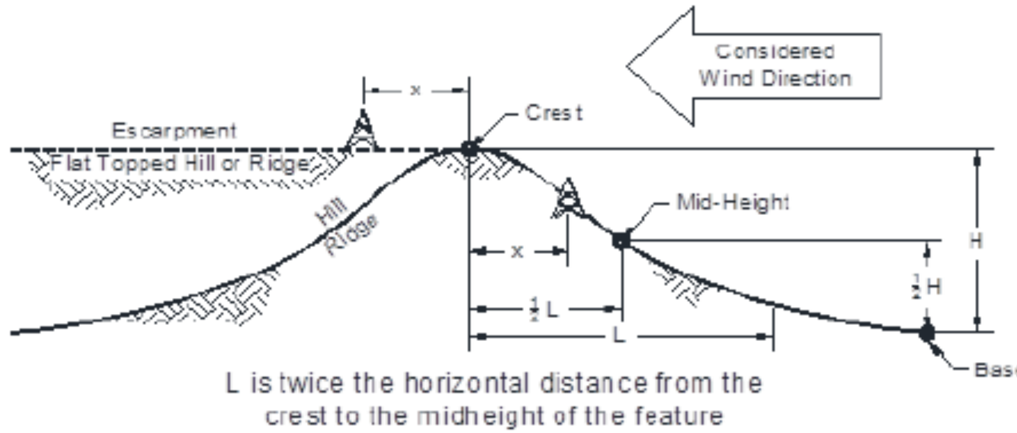
AGL MAGAZINE FEBRUARY 2018 – DENNIS ABEL

<u>Windspeed</u> <u>Elevation</u>

- As the color darkens the wind load and air density drops increasing the capacity available

Topography

Figure 2-1: Isolated Topographic Feature

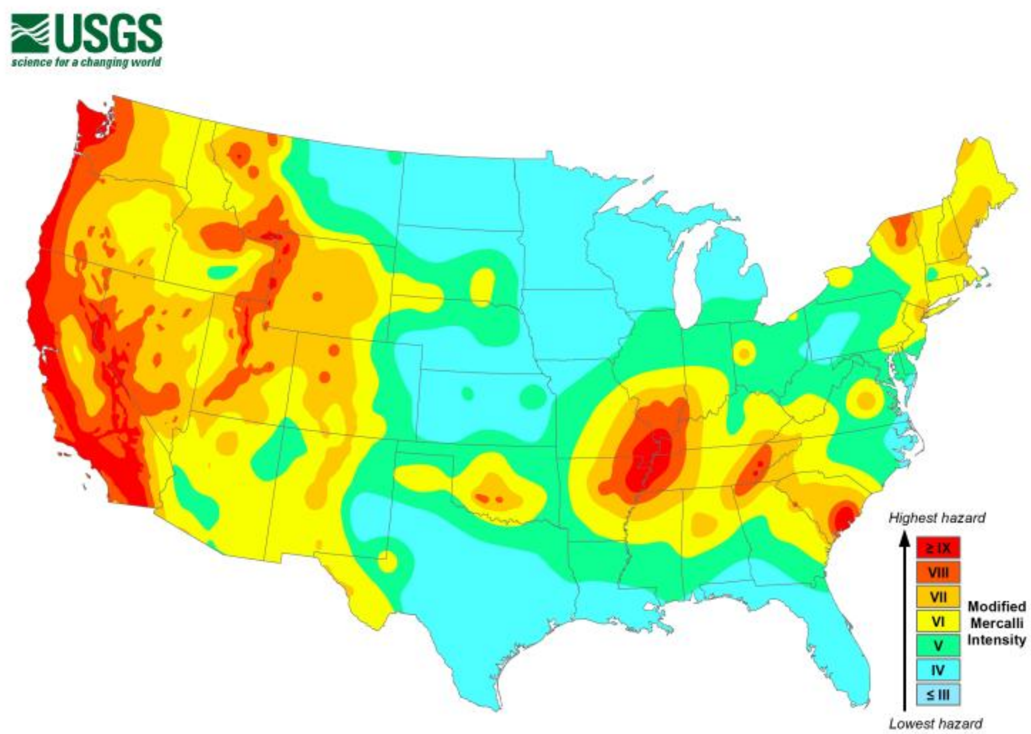


Method	Type	Notes
1	Simplified	Similar to formal Rev. G method
2	Rigorous	Adopts SEAW-RSM-03.
3	Site-Specific	Requires recognized published literature and/or research

Earthquakes / Seismic Loading

Significant Improvements

- Mandatory all towers
- Mandatory all locations
- No exemptions
- Monopoles impacted



USGS map showing the intensity of potential earthquake ground shaking that has a 2% chance of occurring in 50 years

Climbing Facilities

Significant Changes

- Obstruction to climbing facilities addressed
- Fall protection anchorage strength reduced from 5000 lbs. (22 kN) to 3600 lbs. (16 kN)
- Step bolts, ladder rungs, platforms, support rails, etc. NOT to be considered as anchorages
- Inspection and assessment requirements after initial installation, before each use and after each structure modification
- New standards for step bolts
- Step bolt load and material requirements
- Improved definitions
- Applicable to new structures

Climbing Facilities Continued

- The procurer of a structure has the ability to exceed the minimum standards herein when preparing the procurement document to request additional climbing facilities
- Existing facilities are satisfactory as designed, if maintained

Climbing Facilities Continued

Maintenance

Corrosion and Inspection Control Standards

Significant Changes

- 3 – 5 year cycles (or shorter for Risk Category IV)
- Inspection after climatic events
- Weld cracks
- Anchor rods
- Managed Program

Existing Structures and Grandfathering

Significant Changes

- Inclusion of mounts
- Older structures
- 105% DCR limit
- Comprehensive
- Feasibility
- Type of analysis
- Data sources
- Modifications
- Assumed material grade

Changed Condition Definition: A 5% change in member forces when compared to a baseline analysis. A baseline analysis is the original structural analysis or the last modification analysis that represents as modified. Note: The 5% cannot be stacked.

Construction Practices and Verification Inspections

Significant Changes

- Modification work of existing structures required to be inspected prior to, during and after construction completion

- Pre-Construction:
  - Fabricator certification
  - Weld inspection
  - Material Test Reports
- During/Post-Construction:
  - Concrete placement
  - Post-installed anchor rods
  - Welding procedures
  - Bolts
  - Structural components
  - Guy tensions
- Post Modification Inspection
- Mandatory

Mount Analysis

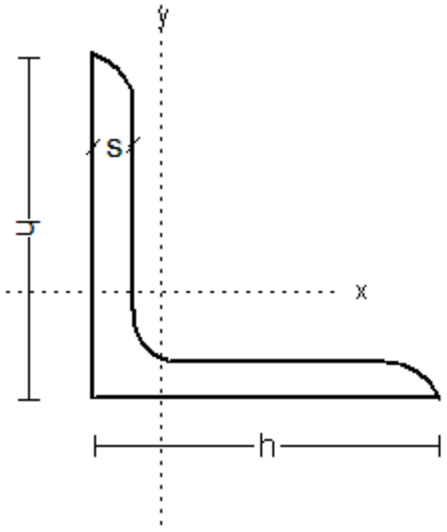
Impact

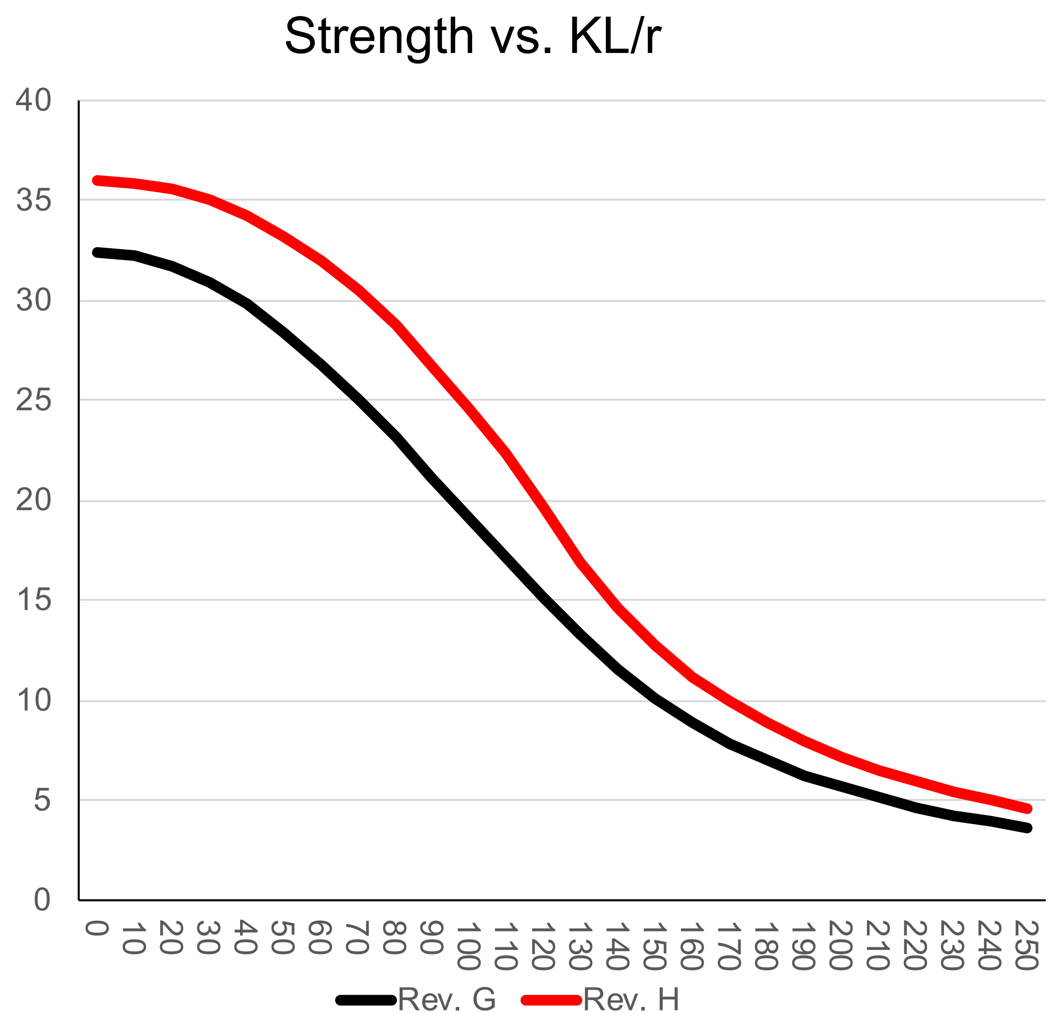
- Mandatory for all significant changed antenna conditions
- Engineer of record for the tower can be different than the engineer of record for the mount
- Only mount being affected must be analyzed
- Specific design criteria includes wind, ice, seismic and climber loads
- Improved definitions (e.g. support rails, not handrails)

Angle Strengths

Strength

- Strength provisions updated to reflect ASCE10-15
- 11 – 30% increase

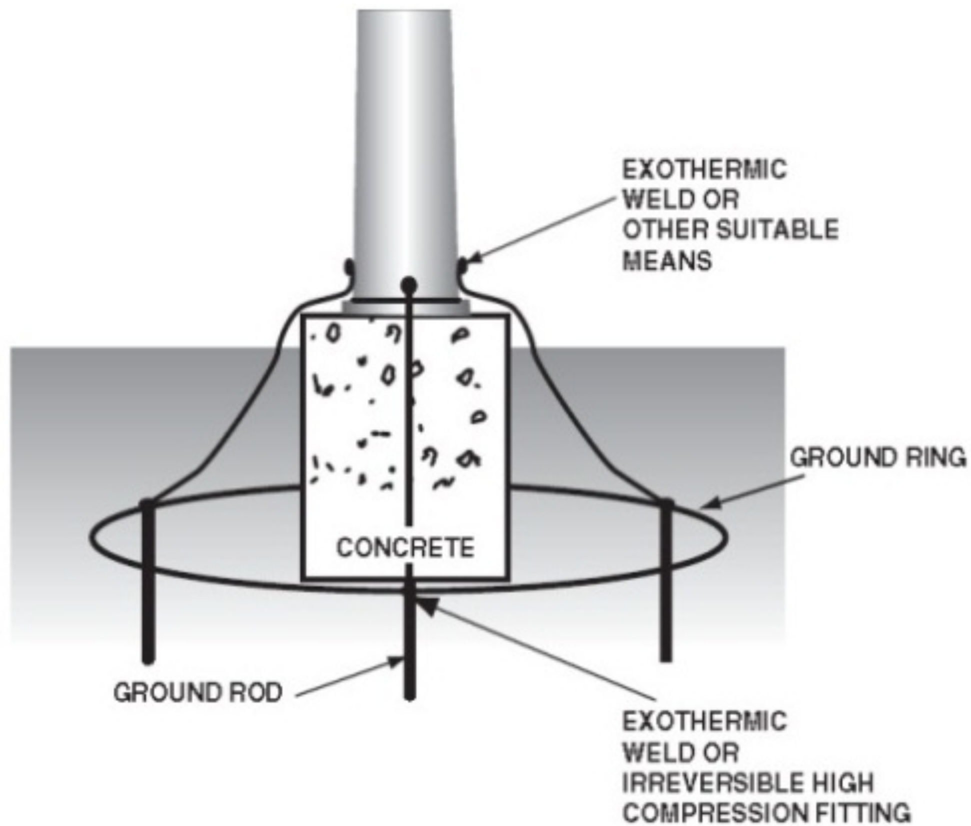




TIA-222-H Overview

Foundation and Grounding

- Strength reduction factors clarified
- Flexible vs. rigid analysis of drilled piers
- Grounding standards updated and simplified



TIA-222-H Overview

Small Wind Turbines

- Design criteria provided for small wind turbines
- Fatigue

TIA-5053

- Why it was created
  - *To drive consistency in mount design*
  - *To better define maintenance loading*
  - *Enhance documentation requirements*
  - *Achieve theoretical mount design capacity*
  - *Better forecasting ability for future network upgrades*

TIA-5053

- Mount Classification System

M1000R(1550)-4[6]	Used at the beginning of each mount identification.
M**1000**R(1550)-4[6]	The maximum factored horizontal force, F, considered for design under extreme wind condition at each mounting pipe location.
M1000**R**(1550)-4[6]	Classification category.
M1000R**(1550)**-4[6]	Maximum factored vertical force, Fzi, considered for design under extreme ice condition at each mounting pipe location.
M1000R(1550)**-4**[6]	The mount is designed for four mounting pipe locations.[1]
M1000R(1550)-4**[6]**	The centerline of the maximum horizontal concentrated force, F, may be offset vertically from the mount centerline by up to 6 inches.

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Working Together to Provide Safe Working Environments for Communication Structures Through Understanding and Application of the Standards

OVERVIEW FOCUS

- ANSI/TIA-322 & ANSI/ASSE A10.48 Overview
- Roles & Responsibilities
- Standardized Common Terminology & Definitions
- Construction Classes & Rigging Plans
- Structure Strength Requirements Under Construction
- Rigging Forces
- Rigging Components
- Gin Poles
- ANSI/TIA-322 & ANSI/ASSP A10.48 Updates

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

ANSI/TIA-1019 (published in 2004)

- Represented the first uniform engineering and operational use telecommunications construction standard for highly specialized lifting devices known as gin poles
- Developed by leading experts representing TIA and NATE through a partnership with OSHA, NIOSH, and the OTI to drive construction safety initiatives within the industry

ANSI/TIA-1019-A (published in 2011)

- Expanded on TIA-1019 to include combined structure analysis and design criteria during construction along with means and methods (aka procedures and practices) beyond strictly gin pole activities
- Identified key roles in the telecommunications construction process

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

ANSI/TIA-1019-A Shortcomings:

- Developed by leading experts representing primarily Broadcast related work which represents only a small niche in the telecommunications industry (*assumed baseline user knowledge*)
- Mixed design and operational use content proved to be difficult to locate and clearly identify in practical application
- Did not cover (or only touched on):
  - *Fall Protection and Rescue*
  - *RF Safety*
  - *Pre-Job Planning/Site Risk Assessment*
  - *Demolition*
  - *Training*
- Lifting content focused on gin pole applications and neglected specific concerns with more common lifting block arrangements on smaller structures
  - *Tag Forces*
  - *Load Line and Tag Line Forces*
  - *Rigging Attachments*
- Confusion in Construction Classes

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Confusion with ANSI/TIA-1019-A Construction Classes

- Did not define how to determine “rigging forces” for Construction Class limits
- No lifting limit established for Class III
- Did not distinguish between external lifting systems (e.g. cranes, lifts, etc.) and systems attached to the structure
- Construction activities requiring engineering involvement not well clarified (what activities constitute Class IV)

Rigging forces?

No lifting limit

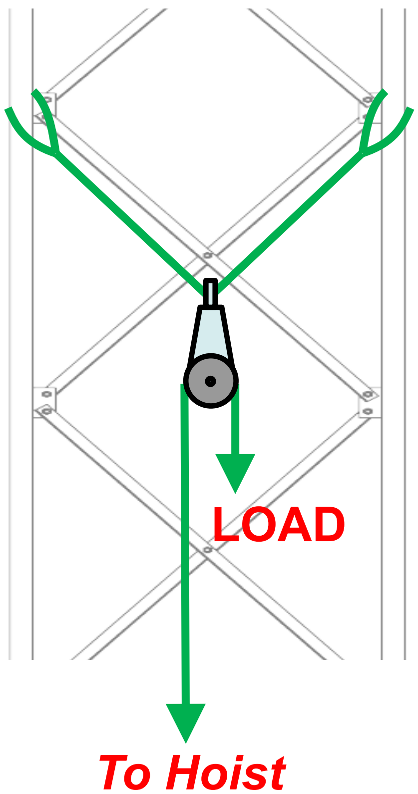
Activities not well clarified

Table 2-1: Construction Classifications

Class	Description	Minimum Level of Responsibility
I	The scope of work does not affect the integrity of the structure and the proposed rigging loads are minor in comparison to the strength of the structure, but not exceeding rigging forces greater than 650 lbs.	Competent Rigger
II	The scope of work involves the removal or the addition of appurtenances, mounts, platforms, etc. that involve minor rigging loads in comparison to the strength of the structure, but not exceeding rigging forces greater than 1,000 lbs.	Competent Rigger
III	Rigging plans that involve work outside the scope of Class I, II or IV construction.	Qualified Person
IV	The scope of work involves custom or infrequent construction methods, removal of structural members or unique appurtenances, special engineered lifts, and unique situations.	Qualified Person with Qualified Engineer

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

ANSI/TIA-1019-A "Rigging Forces"



Example:

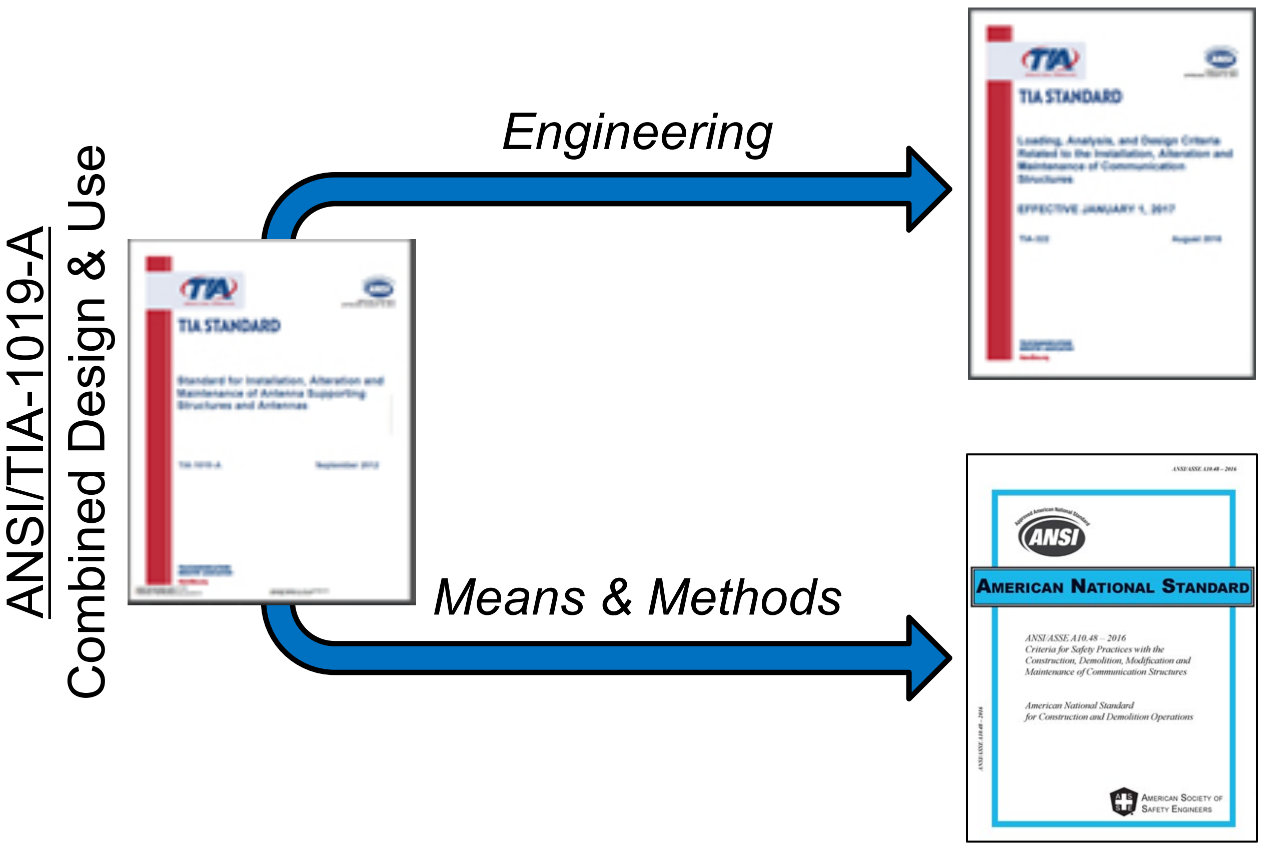
Gross Load = 300 lbs
Straight Tag Lift with Load Angle of 7º and Tag Angle of 60º
Load Line Force = 384 lbs
Tag Line Force = 94 lbs
Top Block Force = 767 lbs (7º Included Angle)
Top Bridle Sling Forces = 443 lbs ea. (60º Sling Angle)
Heel Block Force = 543 lbs (90º Included Angle)
Heel Bridle Slings = 314 lbs ea. (60º Sling Angle)

What is the effective "Rigging Forces"?

Under ANSI/ASSE A10.48, lifting limits are based on **Gross Load**

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

- **As of January 1, 2017, the ANSI/TIA-1019-A replaced by the ANSI/TIA-322 and ANSI/ASSE A10.48**



ANSI/TIA-322
Engineer's Standard

ANSI/ASSE A10.48
Contractor's Standard

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

- ANSI/TIA-322 and ANSI/ASSE A10.48 build upon core engineering and accepted safe work practice concepts presented in the ANSI/TIA-1019-A with expanded and focused content to facilitate greater understanding and improved communications between engineers and contractors when planning and assessing tower construction activities

- General conformance to all minimum construction requirements set forth in the ANSI/TIA-1019-A are satisfied or exceeded through proper application of the minimum criteria now established within the ANSI/TIA-322 and ANSI/ASSE A10.48 standards

- When properly utilized, results in reduced construction costs through planning, better procedures, increased risk identification and mitigation, and substantial improvements to overall construction safety and work quality

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Roles & Responsibilities

Roles & Responsibilities

General Contractor

- For all Classes of construction, GC must provide a designated and qualified onsite "Competent Rigger" to identify hazards, take corrective measures to mitigate hazards, and to implement all necessary construction means and methods.
- For Class III and IV construction, GC must provide or engage a designated and qualified "Qualified Person" to assist in developing the rigging plan and to communicate construction requirements to all stakeholders.
- For Class IV construction, GC's "Qualified Person" must assist in rigging plan development while coordinating and engaging necessary involvement of a "Qualified Engineer" to assess supporting structure under all pertinent construction phases

Roles & Responsibilities

Competent Rigger

- **ANSI/ASSE A10.48 Definition:**
  - A person, who understands the applicable industry standards, has the knowledge, skill and ability with the procedures and equipment common to the communication structures industry and has been trained to identify hazards and is authorized to take corrective measures.

- **Intended alignment with OSHA's definition of Competent Person**
  - Capability to identify existing and predictable hazards
  - Authorized to take prompt corrective action to mitigate hazards

- **Employer designates the authority to take action and deems competency based upon training, education, demonstrated proficiency, and experience**

Roles & Responsibilities

Competent Rigger

- HSE Manual and general industry knowledge,
- First Aid/CPR,
- Competent Climber/Rescuer certification,
- Basic rigging and RF/EME training,
- Basic applicable equipment training; Capstan, Base Mount Hoist, Gin pole and Cranes, (as necessary),
- Have a working understanding of ANSI/TIA 1019-A standard,
- A minimum of three years' general knowledge, climbing and working experience on the installation of various systems,
- Understand when operational and non-operational conditions must be part of the rigging plan,
- Understand how the construction sequence and duration affect the structure,
- Have the knowledge and ability to complete the applicable load testing and field monitoring,
- The ability to comprehend and write a detailed rigging plan,
- Able to read construction drawings and comprehend the scope of work,
- Understand the various classes of work,
- Communicate with the applicable stakeholders depending on the type of plan,
- Have the knowledge and ability to calculate rigging forces applied to the structure,
- Have the knowledge and ability to determine the Gross Load weight,
- Have the knowledge and ability to calculate the tag force applied to the system,
- Temporary support understanding for anchors, guy wires and structural members.

Roles & Responsibilities

Qualified Person

- **Competent rigger knowledge and understanding.**
- **Advanced ability to recognize construction loading and/or structure strength and stability concerns requiring engagement of a Qualified Engineer.**
- **Have good communication and writing skills to communicate with all stakeholders (CR and QE).**
- **A working understanding of construction drawings and scopes of work to plan project sequence and equipment requirements.**

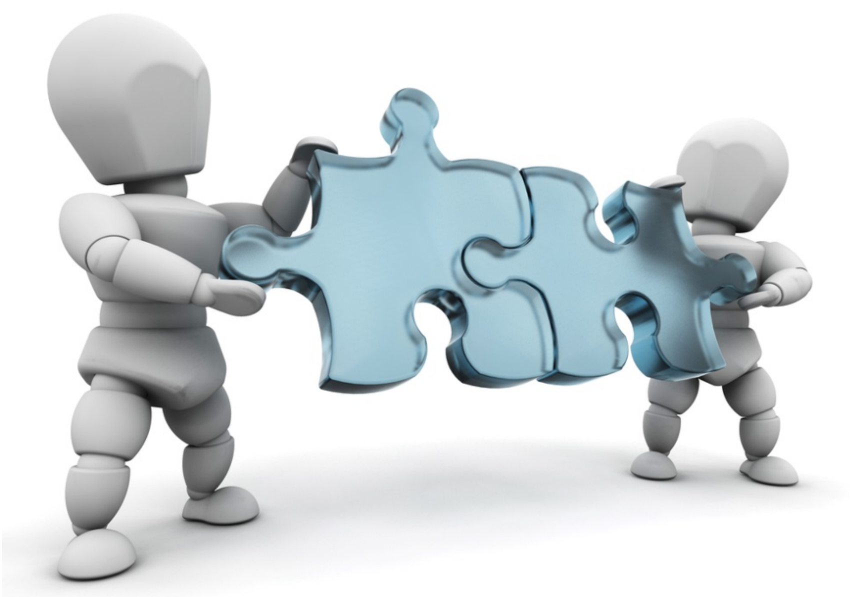
- ***Note: A Qualified Person may not have the same physical skills as a Competent Rigger but must have the same general knowledge and understanding of the processes involved with all construction and/or maintenance work they are responsible for.***

Roles & Responsibilities

Competent Rigger vs. Qualified Person

Competent Rigger:

- *Required for ALL classes of construction*
- *Must be onsite*
- *Communicates directly with Qualified Person when questions arise on construction activities*



Qualified Person:

- *Only required on Class III and IV construction activities*
- *May be onsite, in office, or same individual serving as either Competent Rigger or Qualified Engineer (aka Supervising Engineer)*
- *Communicates directly with Qualified Engineer when questions arise on construction activities*

Roles & Responsibilities

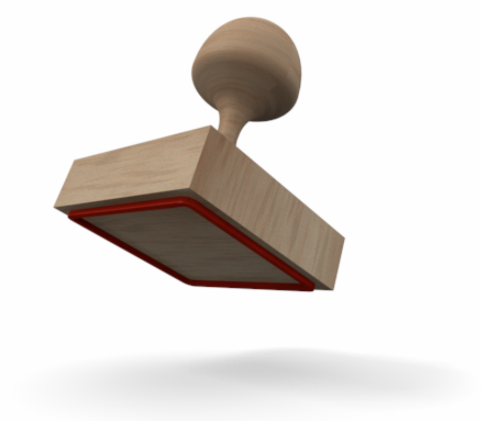
Engineering

- Engineer of Record (EOR)
- Qualified Engineer
- Supervising Engineer

Roles & Responsibilities

Engineer of Record (EOR)

- Registered professional engineer with expertise in the discipline applicable to the scope of work and who assumes responsibility for the design and structural adequacy of the structure in its *COMPLETED* state



Roles & Responsibilities

Qualified Engineer

- Registered professional engineer who is knowledgeable and experienced in the communication structures industry and capable of understanding the contractor’s rigging plan and the scope of work impact upon the structure, and is responsible for analyzing the structure’s strength and stability while accounting for construction loads in accordance with the ANSI/TIA 322 standard

- The Qualified Engineer does **NOT** have the responsibility for development of the rigging plan, field supervision, or implementation of the construction means and methods

Roles & Responsibilities

Supervising Engineer

- Accepts all responsibilities as defined for a Qualified Engineer and assumes or shares the additional responsibilities as defined for a Qualified Person, and may have responsibility in specifying certain portions of the construction means and methods

- *Simply put, a Supervising Engineer assumes all or a portion of the responsibilities in developing the rigging plan and may additionally provide field supervision or other means of oversight to verify execution of the planned construction means and methods*

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Standardized Common Terminology & Definitions

Standardized Common Terminology & Definitions

Standardized terminology and definitions used for setting a common language to facilitate and improve communications between engineers and contractors

- *Competent Rigger*
- *Qualified Person*
- *Engineer of Record*
- *Qualified Engineer*
- *Supervising Engineer*
- *Rigging Plan*
- *Construction Loads*
- *Gross Load*
- *Load Chart*
- *Crown/Top Block*
- *Heel/Base Block*
- *Traveling Block*
- *Load Control Line*
- *Tag Line*
- *Trolley Tag*
- *Means and Methods*
- *Panel Point*
- *Special Engineered Lift*
- *Strength Efficiency Factor*

Standardized Common Terminology & Definitions

- Establishes key stakeholder titles and responsibilities
- Standardizes terminology for common equipment and components involved in telecommunications construction
- Provides standard set of symbols and notations for consistency in load charts and construction engineering reviews

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Construction Classes & Rigging Plans

Construction Classes & Rigging Plans

Overview

- **Construction Class determines the minimum personnel which must be provided or engaged by the contractor in the development, review, and implementation of their Rigging Plan**

Construction Classes & Rigging Plans

When Is A Rigging Plan Required?

- **In short, a rigging plan in accordance with ANSI/ASSE A10.48 is required for ALL tower construction activities including, but not limited to:**
  - Tower installation and/or decom of equipment/appurtenances
  - Tower structural modifications to members/components
  - Tower installation or decom/demo
  - Tower foundation installation/modification
  - Any construction activity involving telecommunication structure

- **ANSI/ASSE A10.48 provides four Construction Classes.**
  - Construction classes have lifted load limits
  - Categorized by potential impact to supporting structure’s strength/stability
  - Categorized by personnel involved in planning/implementation process
  - Require varying levels of documentation and involvement by project stakeholders

- **Rigging plans for Class II, III, and IV construction must be documented**

Construction Classes & Rigging Plans

Construction Class Considerations

Four Construction Classes With Three Basic “Buckets” Which Determine Class:

1) Construction Scope of Work

- Includes any potential impacts to supporting structure’s strength and/or stability (includes foundation)

2) Maximum Gross Load Weight when Lift System is Attached to Structure

- Tiered maximum limits at 350 lbs, 500 lbs, and 2,000 lbs

3) Construction Procedures

- Includes construction sequencing and duration
- Must account for individuals’ experience implementing work

Construction Classes & Rigging Plans

Rigging Plan Overview

Rigging Plan:

A systematic and detailed presentation showing the equipment and procedures required for construction in accordance with the ANSI/ASSE A10.48 that will provide for the safety of personnel and for the stability of the structure and lifted components.

Basic Rigging Plan Elements Include:

- Project/Site Specific Information
- Key Stakeholders Responsible for Construction Planning and Implementation
- Construction Class
- Scope of Work
- Supporting Structure Information & Site Layout
- Construction Sequence and Duration
- Lifting System Details/Info & Lifted Load(s) Information
- Construction Equipment and Rigging Information Including Size and WLL Capacity, and Attachment/Anchorage Details
- Any Special Procedures, Details, or Documents Needed to Ensure A Safe Work Environment During Construction
  - ➢ *Monitoring requirements, proof testing requirements, etc.*

Construction Classes & Rigging Plans

CLASS IV
CLASS III
CLASS II
CLASS I

Class I Rigging Plans

"Minimum" Required Class For The Following:

- Gross lift loads for lift systems attached to the structure shall not exceed 350 lbs. (excludes cranes or other lifting systems not attached to structure)
- Construction activities do **NOT** adversely impact the strength or stability of the supporting structure and SOW does not require any special, custom, or unique construction methods.
- Prepared by Qualified Person and/or Competent Rigger

Construction Classes & Rigging Plans

CLASS IV
CLASS III
CLASS II
CLASS I

Class II Rigging Plans

"Minimum" Required Class For The Following:

- Gross lift loads for lift systems attached to the structure shall not exceed 500 lbs. (excludes cranes or other lifting systems not attached to structure)
- Construction activities do **NOT** adversely impact the strength or stability of the supporting structure and SOW does not require any special, custom, or unique construction methods.
- Prepared by Qualified Person and/or Competent Rigger

Construction Classes & Rigging Plans

CLASS IV
CLASS III
CLASS II
CLASS I

Class III Rigging Plans

"Minimum" Required Class For The Following:

- Gross lift loads for lift systems attached to the structure shall not exceed 2,000 lbs. (excludes cranes or other lifting systems not attached to structure)
- All new structure and foundation construction
- All construction activities involving cranes or other lifting devices not attached to structure
- Construction activities do **NOT** adversely impact the strength or stability of the supporting structure and SOW does not require any special, custom, or unique construction methods.
- Prepared by Competent Rigger and/or Qualified Person

Construction Classes & Rigging Plans

CLASS IV
CLASS III
CLASS II
CLASS I

Class IV Rigging Plans

- Any planned lift exceeding 2,000 lbs where the rigging system is directly attached to structure (excludes cranes or other lifting systems not attached to structure)
- Removal of structural members, or any activities involving reduced supporting structure strength or stability (i.e. structural member removal/replacement, guy wire installation/removal/replacement, significant foundation work impacting stability, etc.)
- Removal of unique appurtenances where either imposed construction loading, or supporting structure strength/stability is questioned by Contractor
- SOW involves custom or infrequent construction methods
- Special engineered lifts
- Unique situations
- All tower decom/demolition
- Prepared by Competent Rigger and/or Qualified Person with a Qualified Engineer

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Structure Strength Requirements Under Construction

Structure Strength Requirements Under Construction

ANSI/TIA-222-G used for the basis of all supporting structure strength and stability investigations

- **Operational Loads**
  - Construction loads imposed during active operations (e.g. lifting, pulling guy wires, etc.)
  - Structure reviewed using a uniform effective 30 mph wind speed along with all applicable construction loads using a minimum impact factor of 1.3
  - Over 30 mph considered special condition (material handling concerns, etc.)

- **Non-Operational Loads**
  - Construction loads imposed during inactive times from rigging system, material, equipment, etc. (work breaks, overnight, etc.)
  - Structure reviewed using non-operational wind load based upon construction duration (not less than 45 mph)
  - Must account for varying stages in construction

Structure Strength Requirements Under Construction

Operational Strength Load Combination:

$$1.2\ D_s + 1.0\ D_g + 1.6\ I_c\ C_1 + 1.6\ W_1$$
$$0.9\ D_s + 1.0\ D_g + 1.6\ I_c\ C_1 + 1.6\ W_1$$

Where:

D_s – Structure Dead Load
D_g – Guy Dead Load
I_c – Impact Factor (Min 1.3)
C_1 - Operational Construction Loads
W_1 - Operational Wind Load (30 MPH)

Structure Strength Requirements Under Construction

Non-Operational Strength Load Combination:

$$1.2\ D_s + 1.0\ D_g + 1.6\ C_2 + 1.6\ W_2$$
$$0.9\ D_s + 1.0\ D_g + 1.6\ C_2 + 1.6\ W_2$$

Where:

D_s – Structure Dead Load
D_g – Guy Dead Load
C_2 – Non-Operational Construction Loads
W_2 – Non-Operational Wind Load (Based on Duration)

NOTE: Non-operational construction loading combinations shall be evaluated regardless of the anticipated duration of the construction activity to account for unforeseen delays.

Structure Strength Requirements Under Construction

Non-Operational Loads

- Appropriate construction durations utilized for the analysis of each configuration phase impacting structures' strength of stability

Construction Duration	Non-Operational Wind Requirement
One Work Day	***45 mph***
Less Than 24 hours	***54 mph***
24 hours to Less Than 1 Week	***60 mph***
1 Week to Less Than 6 Weeks	***68 mph***
6 Weeks to 6 Months	***72 mph***
Greater Than 6 Months	***90 mph***

- *Reduced wind loads account for reduced reference period (i.e. maintain same serviceable lifetime structure reliability over shorter exposure period)*

- *For durations greater than 1 week during hurricane season, appropriate plans that can be implemented before the onset of a forecasted hurricane must be prepared and included in the rigging plan (down rig, install additional bracing/shoring, temp guys, etc.) to meet strength requirements for full site hurricane wind speeds*

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

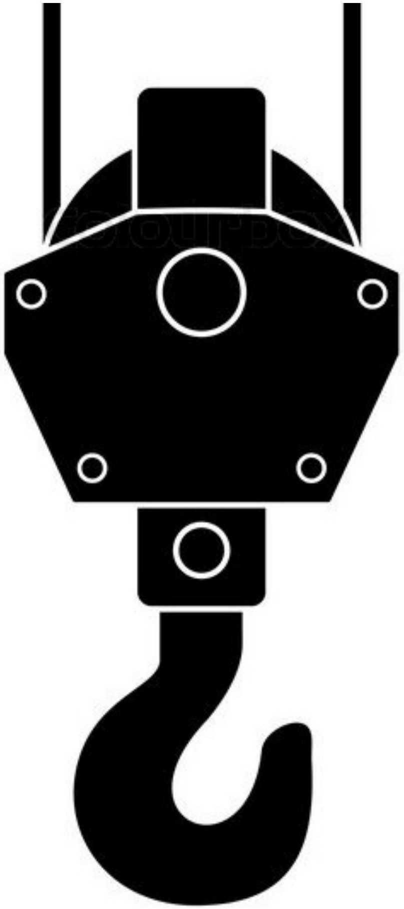
Rigging Forces

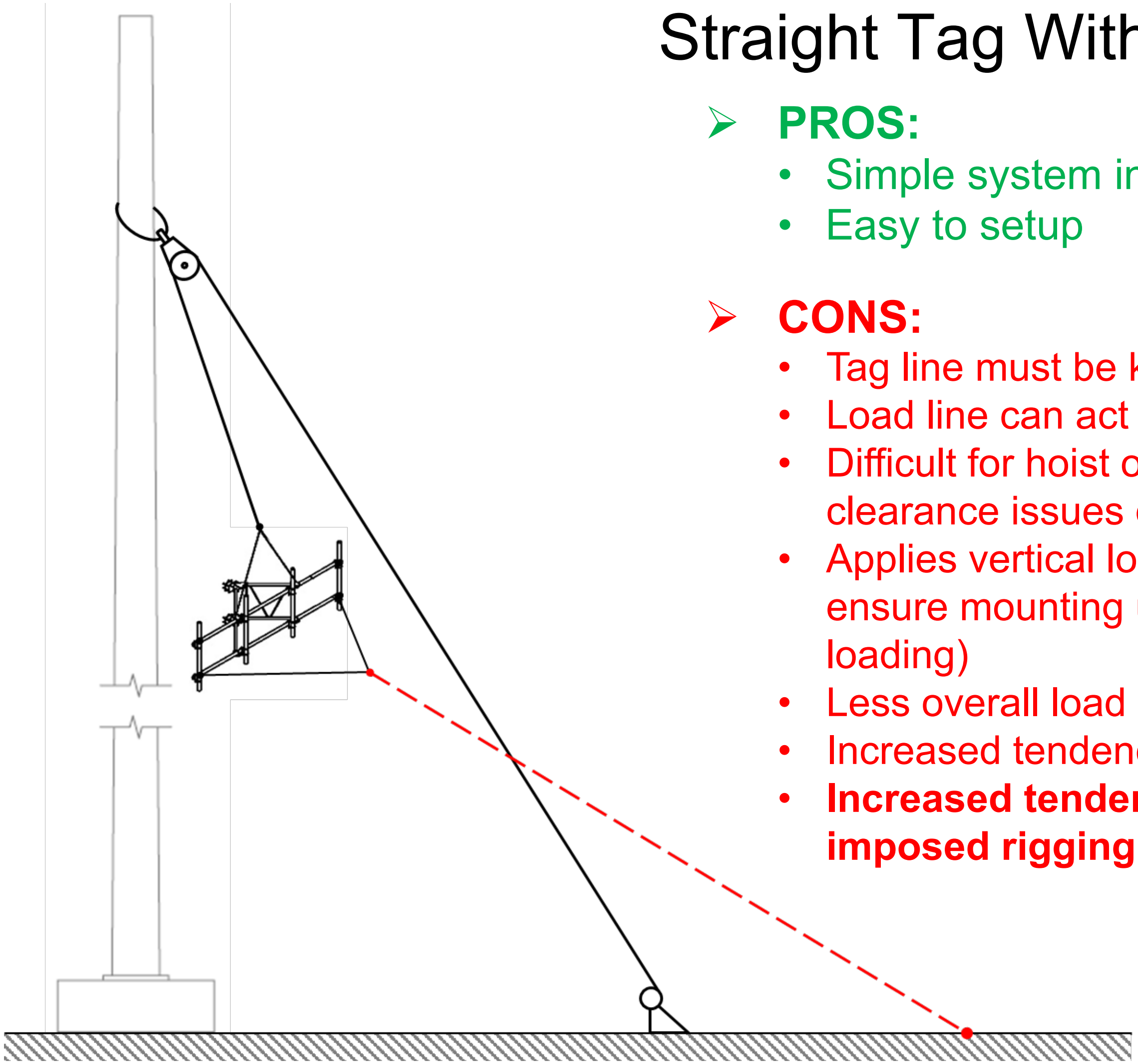
Rigging Forces

Hoisting Principles

Four Standard Lifting Block Arrangements:

1) Top Block Only With Straight Tag
2) Top And Heel Blocks With Straight Tag
3) Integrated Trolley (aka Self-Trolley)
4) Dedicated Trolley



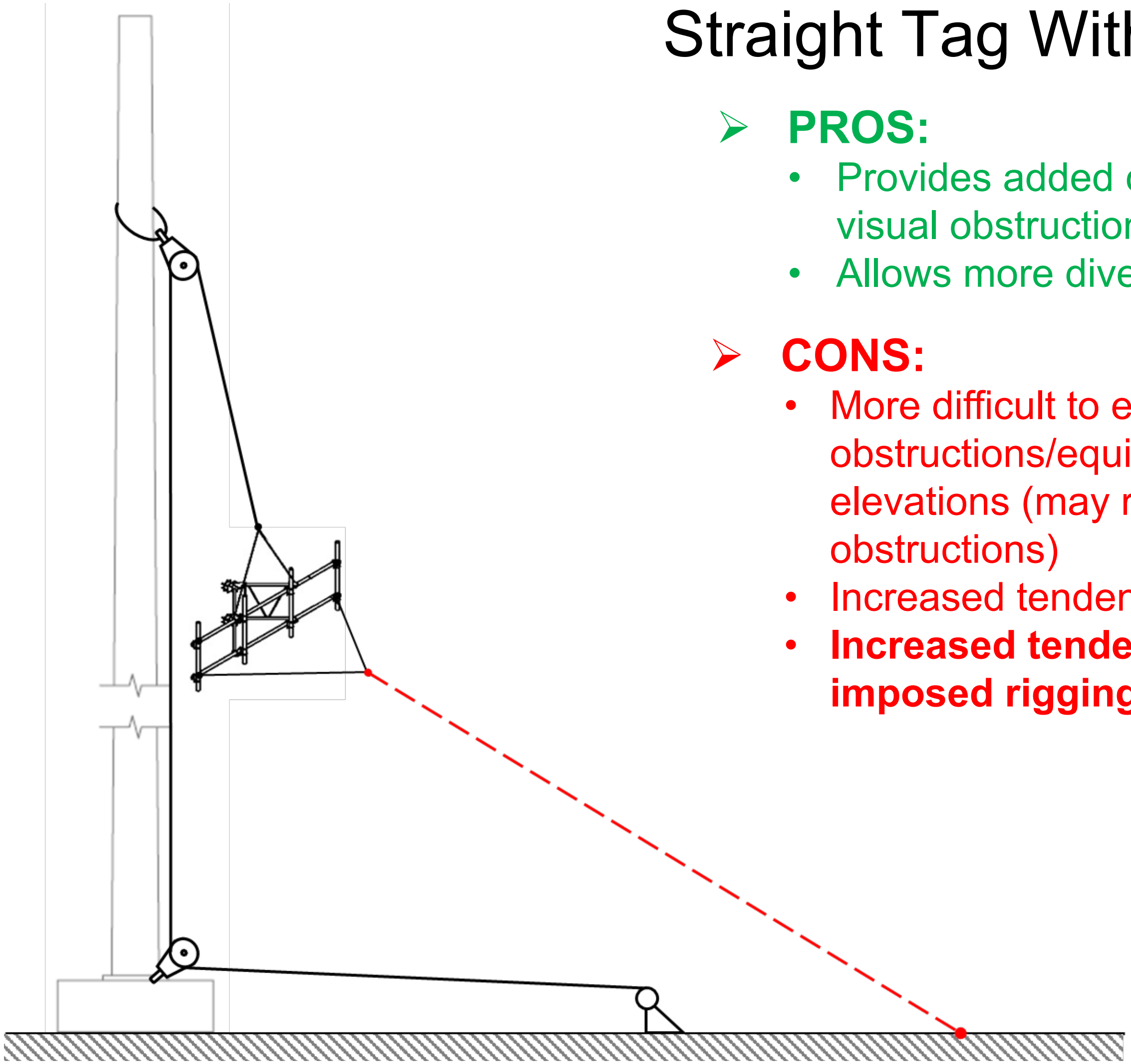


Straight Tag With Top Block Only:

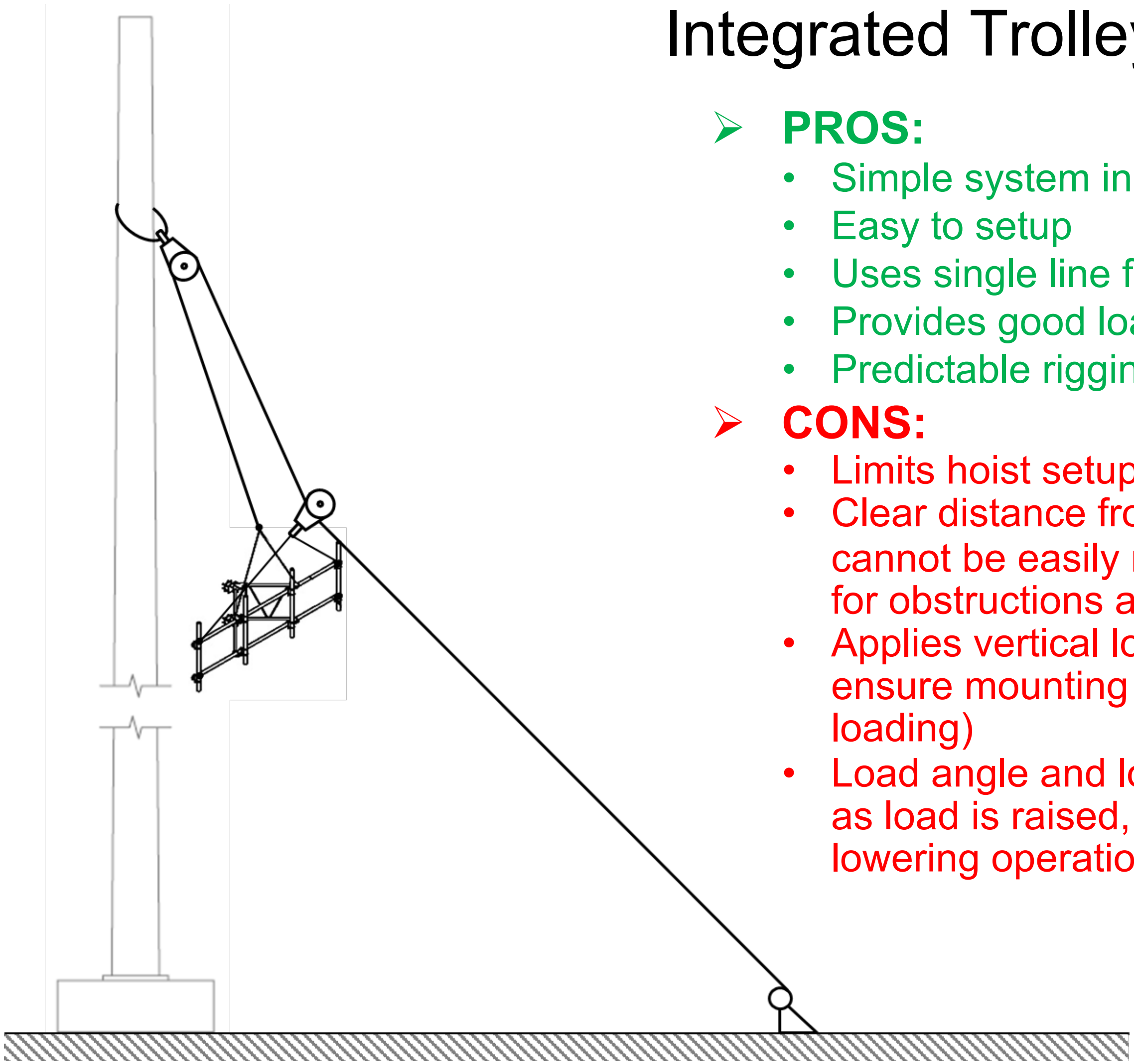
- **PROS:**
  - Simple system incorporating only one block
  - Easy to setup

- **CONS:**
  - Tag line must be kept away from load line
  - Load line can act as a visual obstruction
  - Difficult for hoist operator to visually identify clearance issues during hoisting
  - Applies vertical load to hoisting unit (must ensure mounting unit is rated for vertical loading)
  - Less overall load control
  - Increased tendency for shock/impact loads
  - **Increased tendency for developing high imposed rigging forces due to tag forces**

Straight Tag With Top and Heel Blocks:

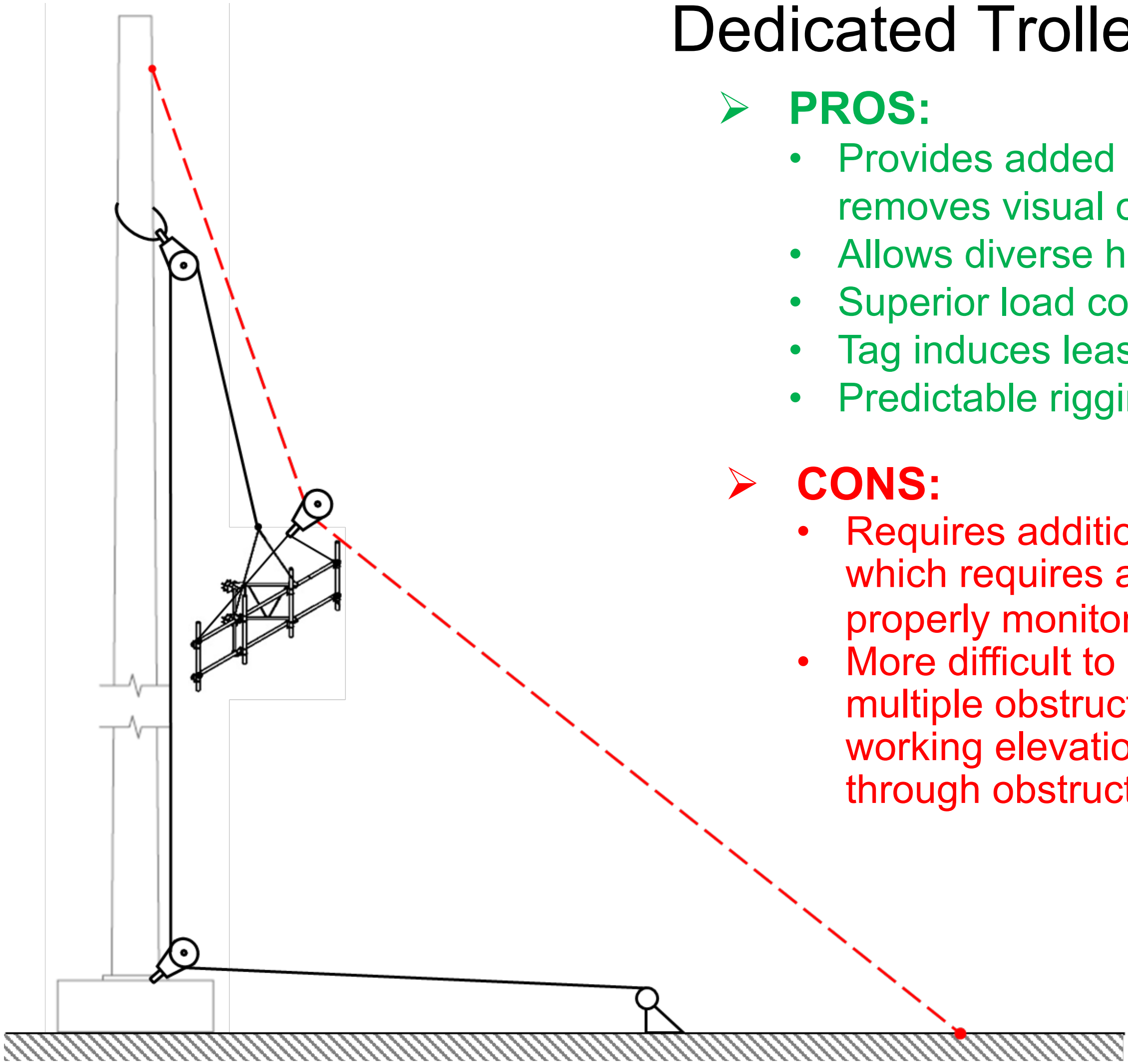


- **PROS:**
  - Provides added control to lead line and removes visual obstruction
  - Allows more diverse hoist setup options
- **CONS:**
  - More difficult to employ on towers with multiple obstructions/equipment below working elevations (may require reeving through obstructions)
  - Increased tendency for shock/impact loads
  - **Increased tendency for developing high imposed rigging forces due to tag forces**



Integrated Trolley (aka Self-Trolley):

- **PROS:**
  - Simple system incorporating only one block
  - Easy to setup
  - Uses single line for both lifting and control
  - Provides good load control
  - Predictable rigging forces in load line
- **CONS:**
  - Limits hoist setup locations
  - Clear distance from structure/obstructions cannot be easily manipulated during lift (issue for obstructions and multiple work elevations)
  - Applies vertical load to hoisting unit (must ensure mounting unit is rated for vertical loading)
  - Load angle and load line clear distance reduces as load is raised, and is significantly less during lowering operations due to sheave friction



Dedicated Trolley:

- **PROS:**
  - Provides added control to lead line and removes visual obstruction
  - Allows diverse hoist setup options
  - Superior load control
  - Tag induces least force onto load
  - Predictable rigging forces in load line

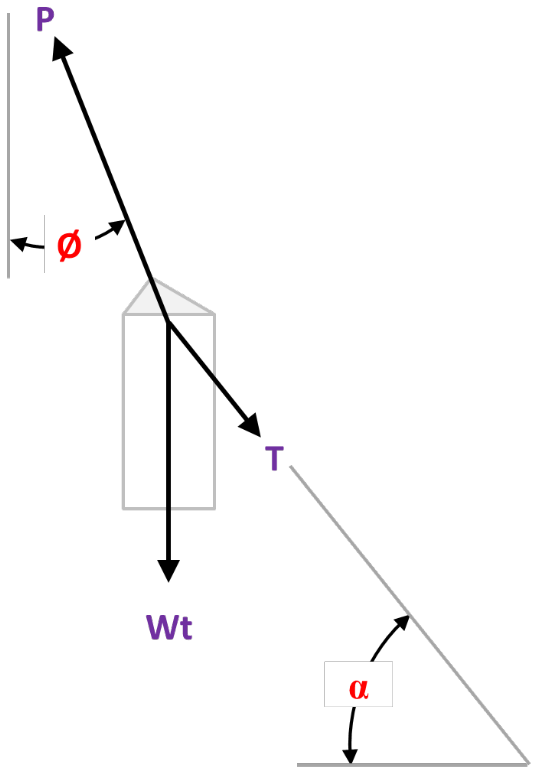
- **CONS:**
  - Requires additional rigging attachments which requires additional crew members to properly monitor
  - More difficult to employ on towers with multiple obstructions/equipment below working elevations (may require reeving through obstructions)

Rigging Forces

Resulting Rigging Forces From Straight Tag Lift Systems

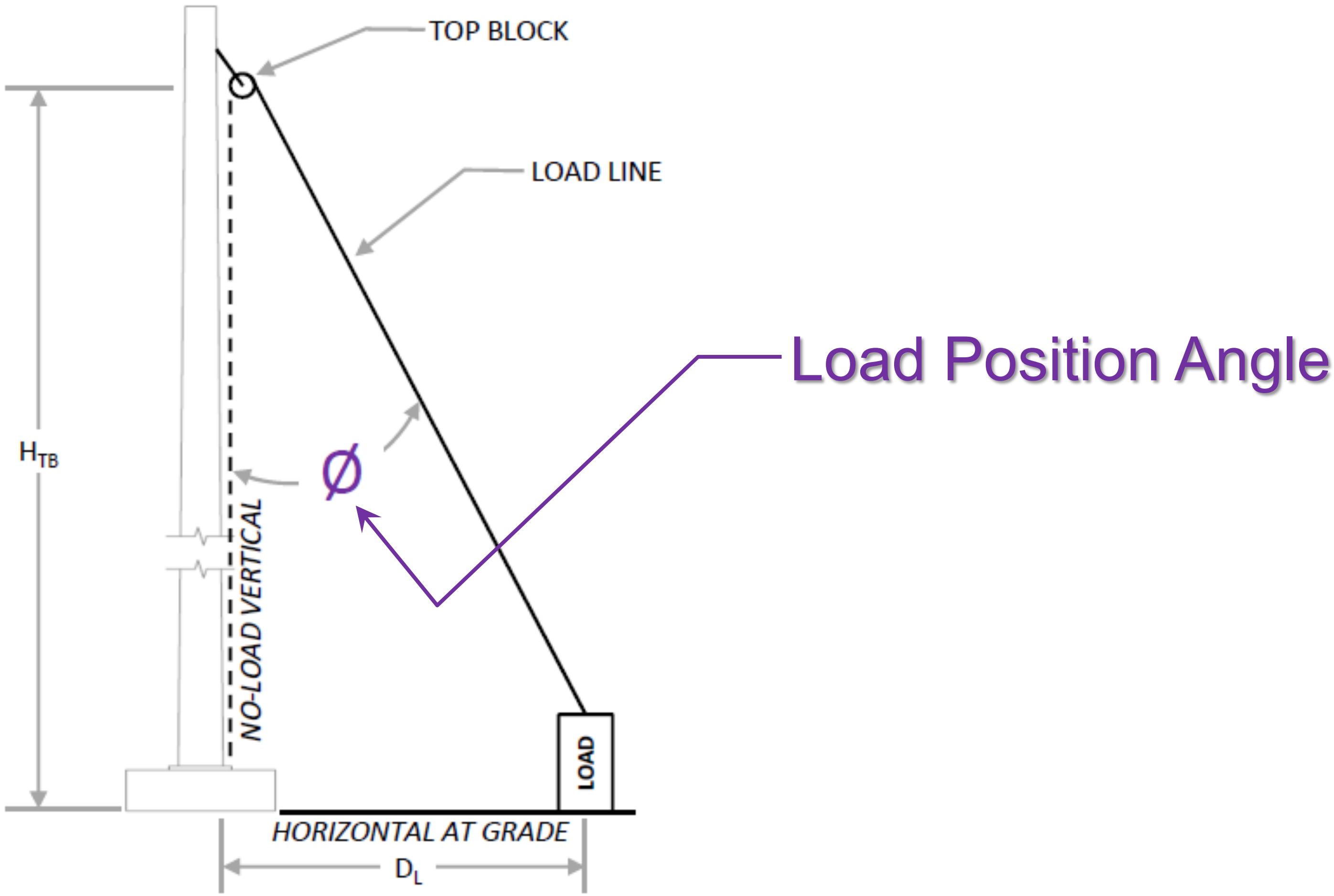
Two critical angles must be identified and considered when determining resulting rigging forces:

1. Load Position Angle, Ø
2. Max Tag Angle, α



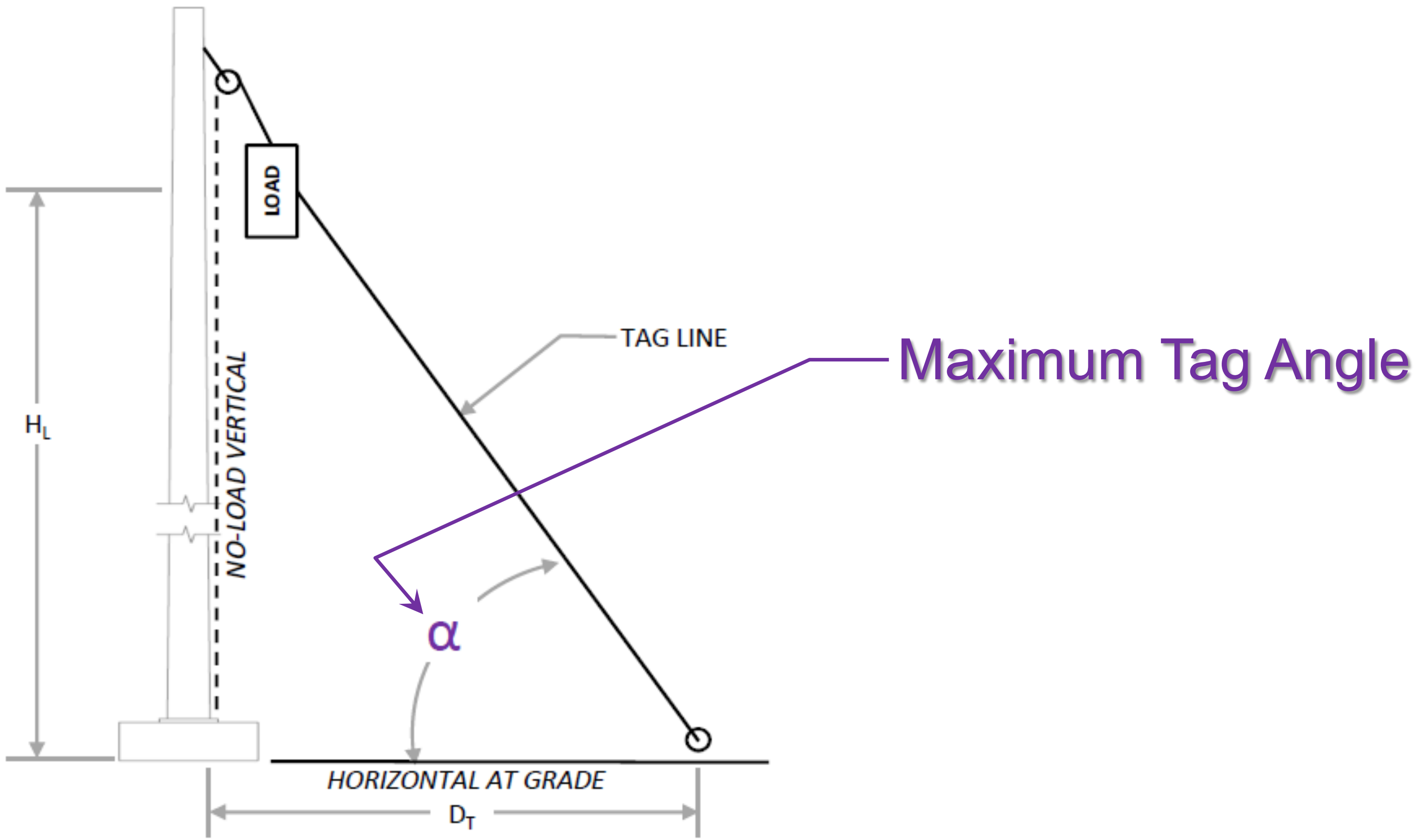
Rigging Forces

Lift System Load Position Angle, Ø



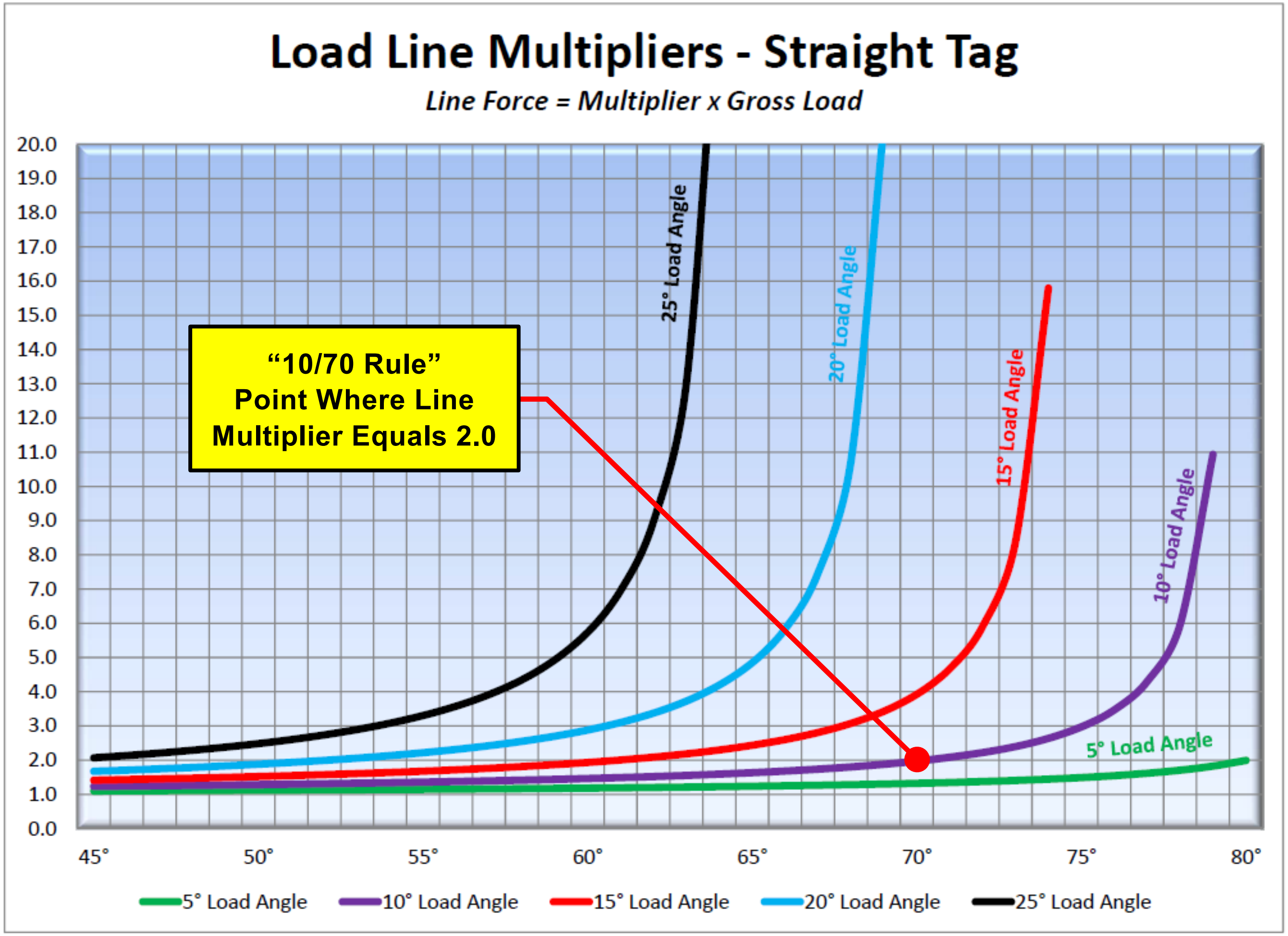
Rigging Forces

Lift System Maximum Tag Angle, α



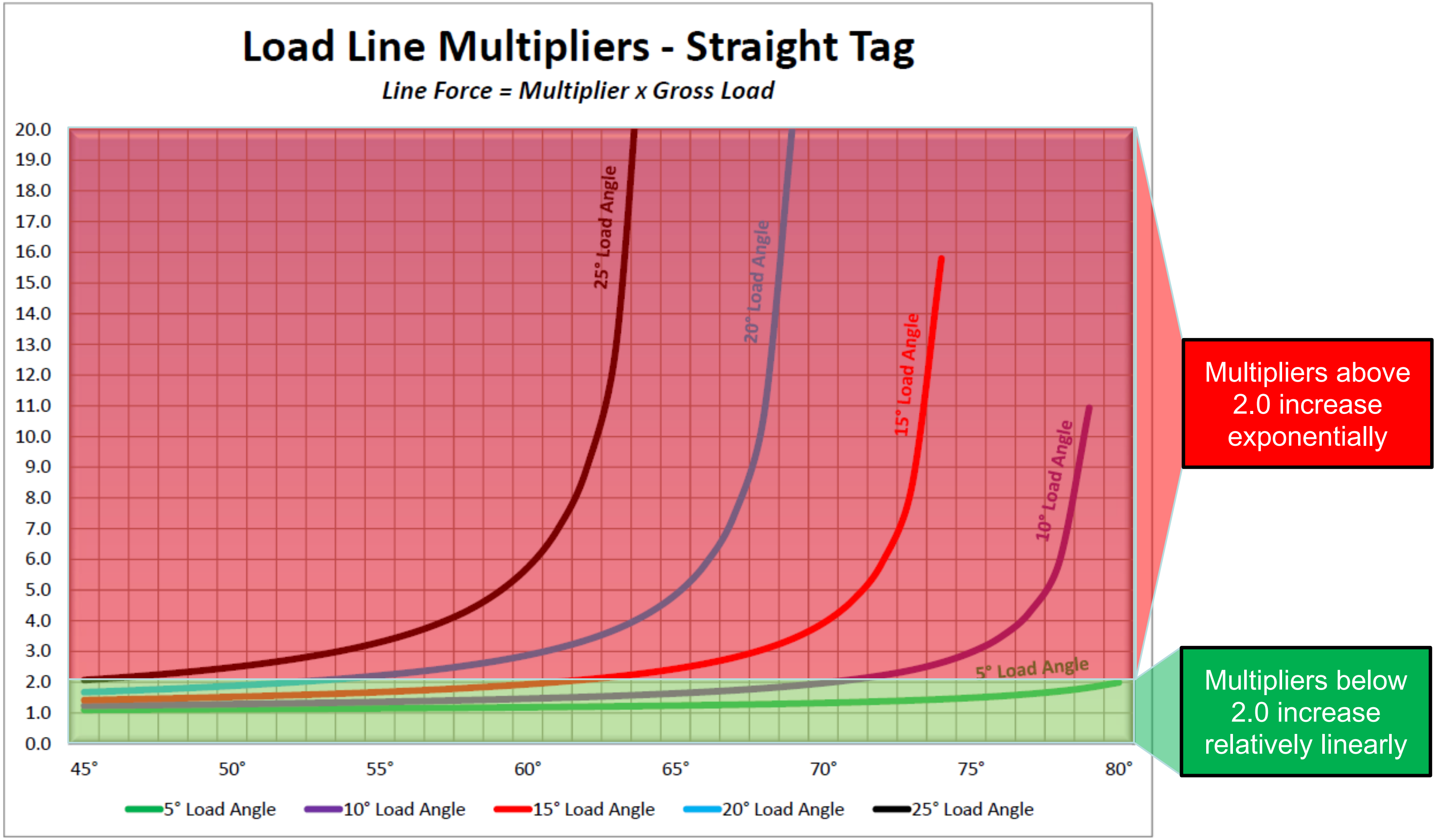
Rigging Forces

Load Line Multiplier for Straight Tag Applications



Rigging Forces

Load Line Multiplier for Straight Tag Applications



Rigging Forces

ANSI/ASSE A10.48 Line Multiplier Chart

- **Provides Simple Line Multipliers**
- **Identifies 10º/70º Boundary**

A-13(f) Load and Tag Line Multipliers for Straight Tag Lift Arrangements

This chart and example calculation illustrates line multipliers that can be used to determine load line and tag line forces based upon the gross load, load angle and tag angle for straight tag configurations.

LOAD ANGLE, θ	LINE MULT.	TAG ANGLE, α						
		45	50	55	60	65	70	75 and Up
3	PM	1.057	1.068	1.082	1.101	1.128	1.170	Not Recommended (See Note 2)
	TM	0.078	0.087	0.099	0.115	0.140	0.179	
4	PM	1.078	1.094	1.114	1.141	1.179	1.241	
	TM	0.106	0.119	0.135	0.159	0.195	0.253	
5	PM	1.100	1.121	1.147	1.183	1.236	1.321	
	TM	0.136	0.152	0.174	0.206	0.255	0.337	
6	PM	1.124	1.149	1.183	1.229	1.298	1.414	
	TM	0.166	0.187	0.216	0.257	0.321	0.432	
7	PM	1.149	1.180	1.222	1.280	1.368	1.520	
	TM	0.198	0.224	0.260	0.312	0.394	0.542	
8	PM	1.175	1.213	1.263	1.335	1.445	1.645	
	TM	0.231	0.263	0.307	0.372	0.476	0.669	
9	PM	1.203	1.248	1.308	1.395	1.533	1.792	
	TM	0.266	0.304	0.357	0.437	0.568	0.820	
10	PM	1.233	1.286	1.357	1.462	1.633	1.970	
	TM	0.303	0.347	0.411	0.508	0.671	1.000	
11 and Up	PM	Not Recommended (See Note 2)						
	TM							

Rigging Forces

Rigging Attachments to Structure

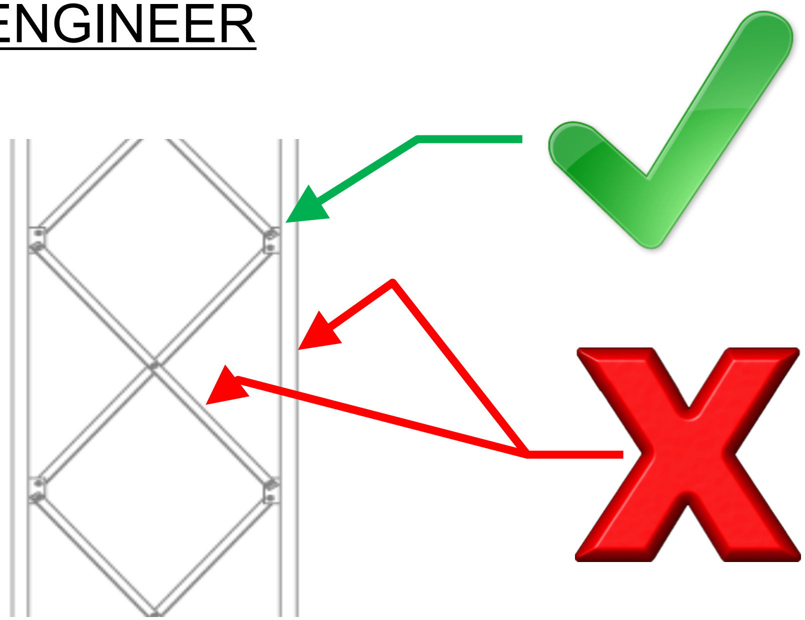
- For lattice structures, rigging attachments should be made around a tower leg with the slings nestled into a “**Panel Point**”.
- For monopole structures, rigging attachments should be made around the pole shaft.
- Attachments to alternate points require review and approval by a Qualified Engineer.
  - *Rigging to Bracing*
  - *Rigging to Mounts*

Rigging Forces

Rigging Attachments to Structure

Panel Point:

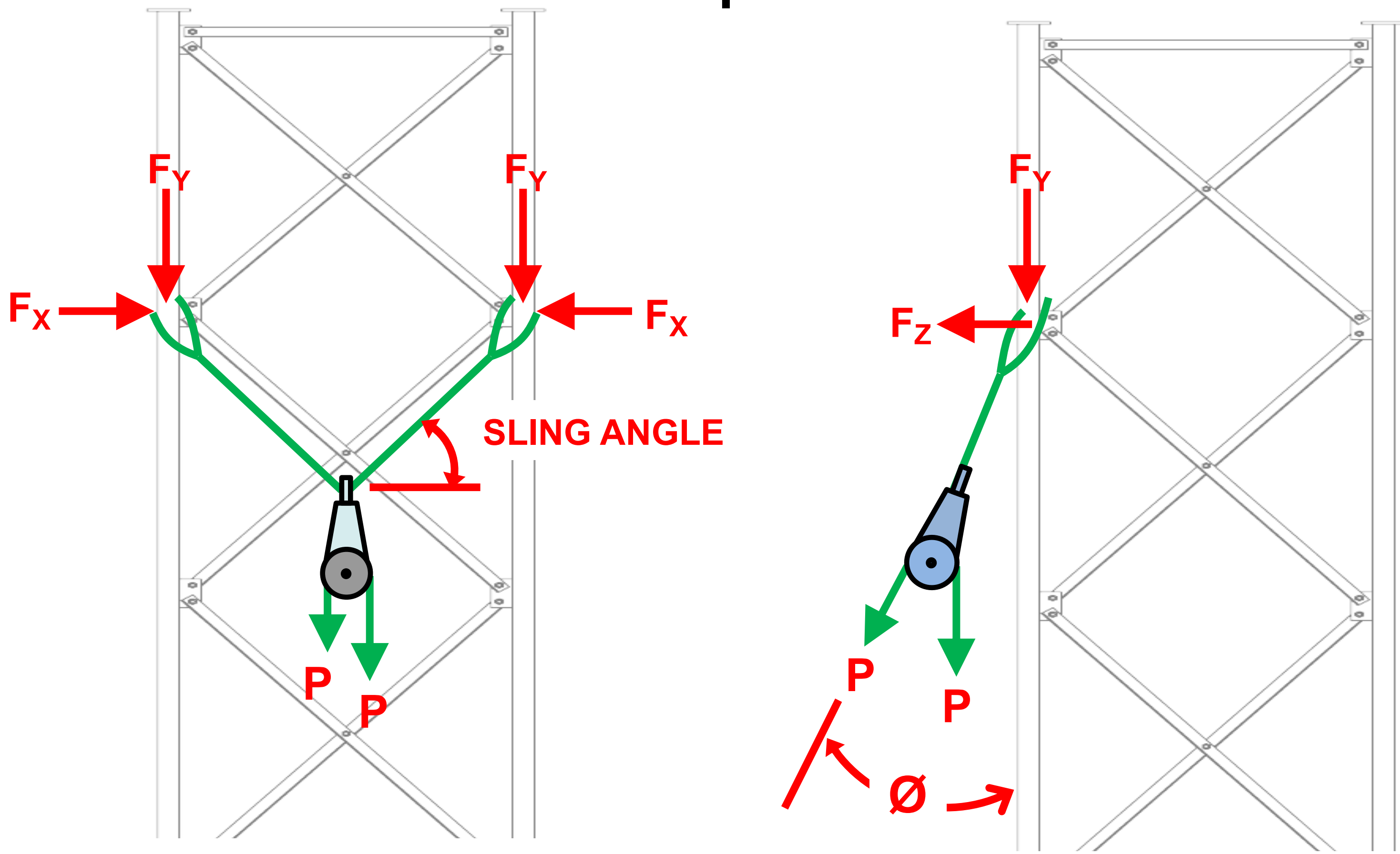
- The point where horizontal and diagonal bracing members intersect a vertical leg member of a latticed structure.
- <u>RIGGING SHOULD ALWAYS BE ATTACHED AROUND LEG AT PANEL POINTS, UNLESS ALTERNATE POINT HAS BEEN REVIEWED BY ENGINEER</u>



Rigging Forces

Rigging Attachments to Structure

It is critical to ensure structure attachments are located at sound points to distribute imposed forces into structure



Rigging Forces

Improper Attachment Examples

Rigging Attached to Climbing Facility

Rigging Attached to Mount Tie-Back

Rigging Forces

Improper Attachment Examples

Rigging Attached to Lattice Bracing

Rigging Attached to Lattice Bracing

ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Rigging Components

Rigging Components

Rigging Hardware

ANSI/ASSE A10.48, Section 10.5.2:

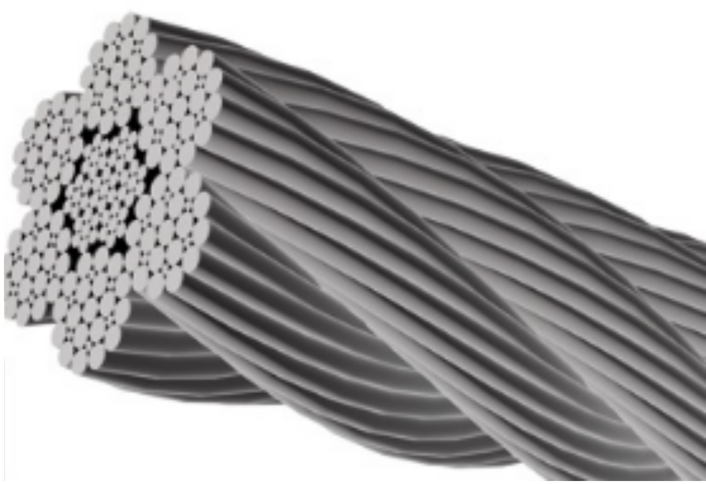
Standard rigging hardware and slings used for lifting and load handling purposes shall be specifically certified for such applications in accordance with applicable ***ASME B30*** *standards. The use of rigging hardware not specifically covered by ASME B30 standards is discouraged, but may be used if certified for lifting and load handling purposes by the component manufacturer or qualified engineer for the intended use and shall utilize a safety factor no less than 5.0.*

Rigging Components

Lifting & Control Lines

Two primary types of rope used for lifting and control lines:

1) **Steel Wire Rope**
2) **Synthetic Rope**



Rigging Components

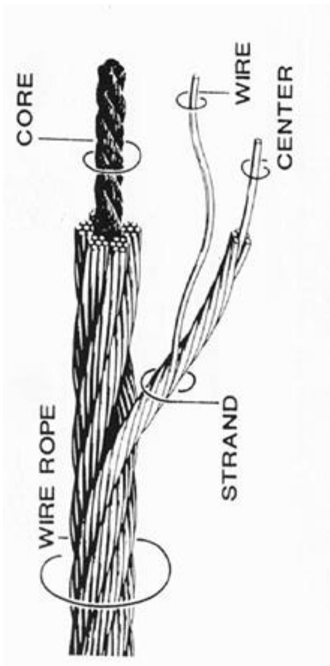
Synthetic Rope

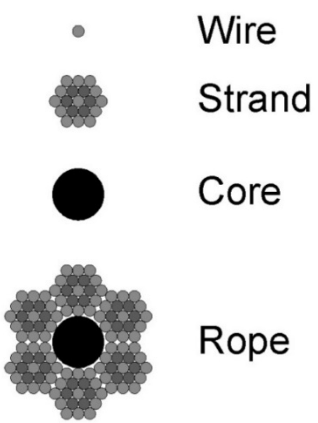
Steel Wire Rope:

•Made from various grades of both stainless steel and carbon steel strand wrapped in a uniform helix around a core

- ➢ Strands ~ act as muscles that carry load
  - ▪ *Common carbon steel wire grades include Plow Steel, Improved Plow Steel (IPS), Extra Improved Plow Steel (EIPS), or Extra Extra Improved Plow Strength (EEIPS)*
- ➢ Core ~ provides skeleton for maintaining strand shape/configuration
  - ▪ *Fiber Core ~ Heat rating to 200º, flexible and elastic, but less crush resistant*
  - ▪ *IWRC Core ~ Heat rating to 400ºF, stiff nature, and durable*

•Per A10.48, wire rope used for rigging shall have an IWRC core and be minimum grade of IPS





Rigging Components

Wire Rope

$$\text{WIRE ROPE WLL} = \frac{\text{MBS x EFF}}{5}$$

Where:

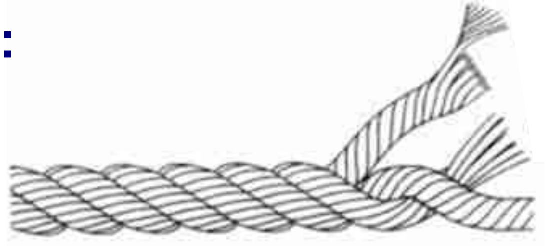
MBS = Minimum Breaking Strength
EFF = Minimum Wrap or End Efficiency

Rigging Components

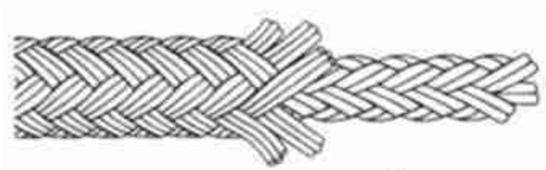
Synthetic Rope

Synthetic Rope:

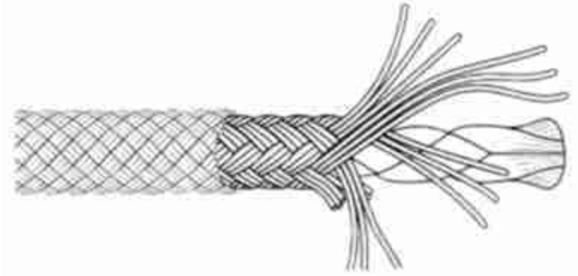
- **Three primary types used in tower construction:**



1) 3-Strand:
   a) *Easy to splice*
   b) *Inherent torque due to twisted construction*
   c) *Tendency to rotate/kink under load*
   d) *Poor abrasion resistance*
   e) *High stretch*
   f) *Typically used for reeving wire rope, as chase rope, and/or tag applications*



2) Double Braid:
   a) *Generally inner and outer braids equally carry load*
   b) *Typically used for lift/tag lines*



3) Kernmantle (Kern-Inner Core, Mantle-Outer Sheath):
   a) *Excellent abrasion resistance*
   b) *70%-100% of load is carried on inside*
   c) *Stiff with relatively slick outer sheath*
   d) *Typically used for safety lines and lift/tag lines*

Rigging Components

Synthetic Rope

$$\text{SYN ROPE WLL} = \frac{\text{MBS}}{10}$$

Where:

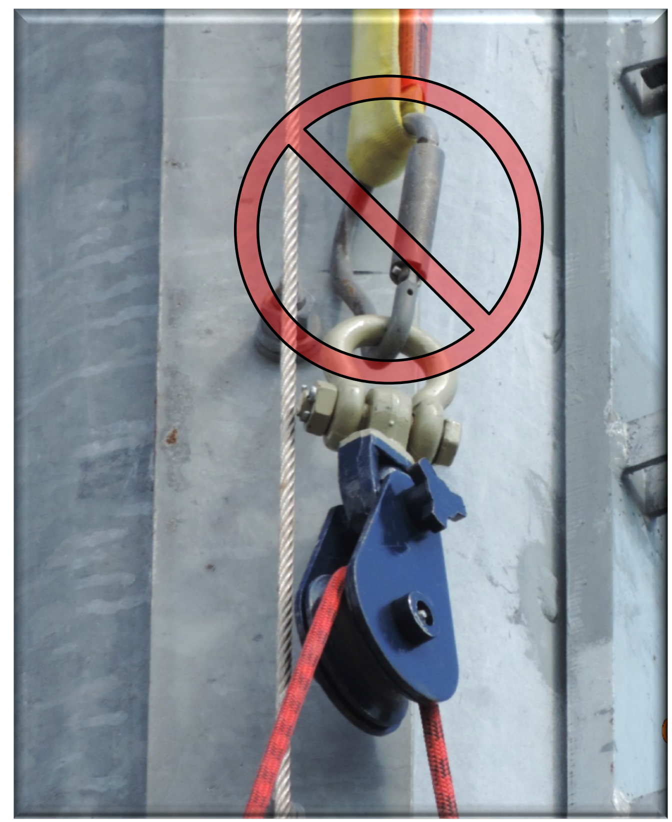
MBS = Minimum Breaking Strength

NOTE: Gross Safety Factor of 10 Accounts for Both Wrap and End Efficiencies (aka Knots) → Results in Net Safety Factor of Roughly 5

Rigging Components

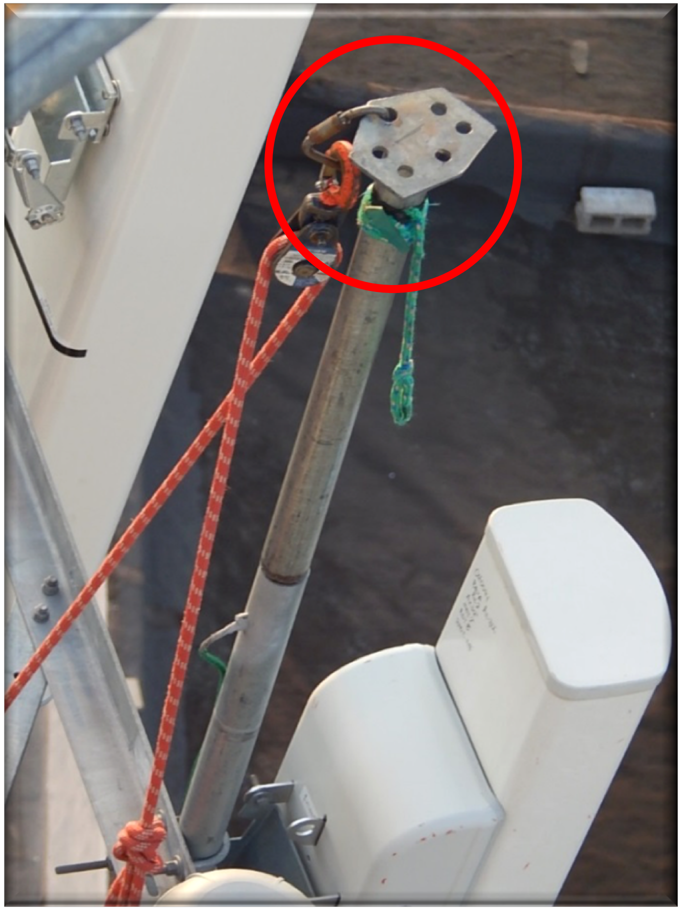
Unacceptable Components

- **PPE and/or Recreational Hardware/Gear Should Never Be Used For Rigging**



Rigging Components

Unacceptable Components



Carabiner & Makeshift Gin Pole

PPE Sling & Attached to Mount Standoff

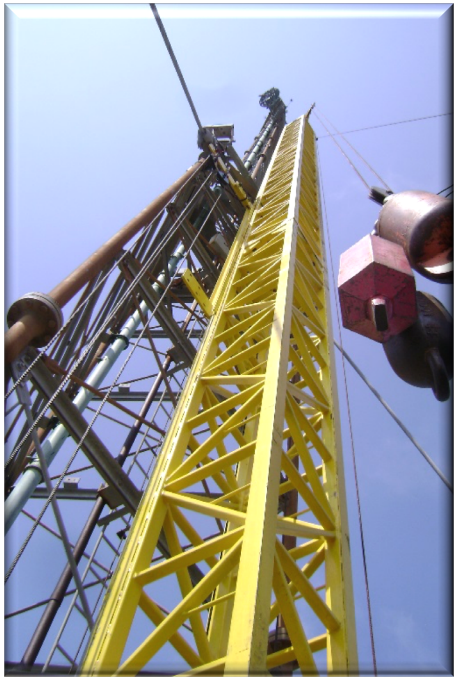
ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

Gin Poles

Gin Poles

Configurations

- **Two Primary Gin Pole Configurations**



Vertical

(Gin Pole Mast Within 1.5º Of Vertical)

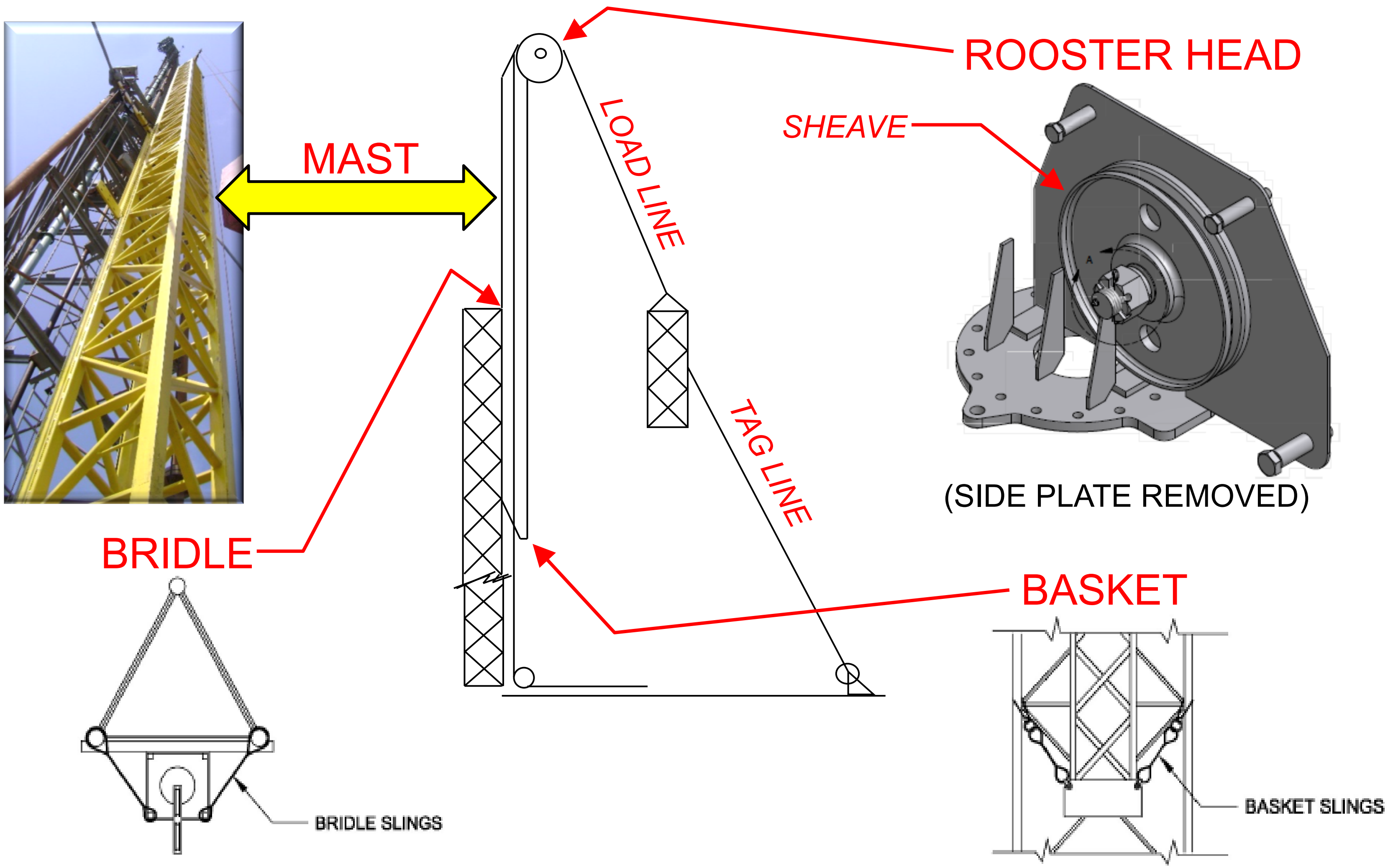
Tilted

Gin Poles

Typical Components

- **Typical Gin Pole Components:**
  - **MAST:** Triangular or square lattice sections are most common, but can be of a single pipe or member.
  - **ROOSTER HEAD:** Top sheave assembly capable of rotating load line 360 degrees.
  - **BRIDLE AND BASKET SUPPORTS:** Needed to hold or support gin pole on tower structure.
  - **LOAD, JUMP & TAG LINES:** Used to raise and lower gin pole, lift gross loads, and tag out and control a lifted load.
  - **TRACK:** May or may not be part of system, but when used aides in support of pole during its positioning on the tower.

Gin Poles

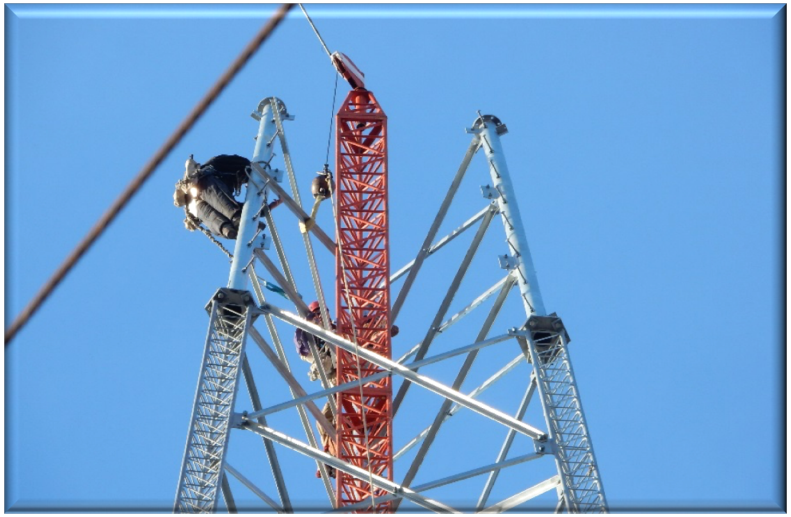


ROOSTER HEAD
SHEAVE
MAST
LOAD LINE
TAG LINE
(SIDE PLATE REMOVED)
BRIDLE
BASKET
BRIDLE SLINGS
BASKET SLINGS

Gin Poles

Types

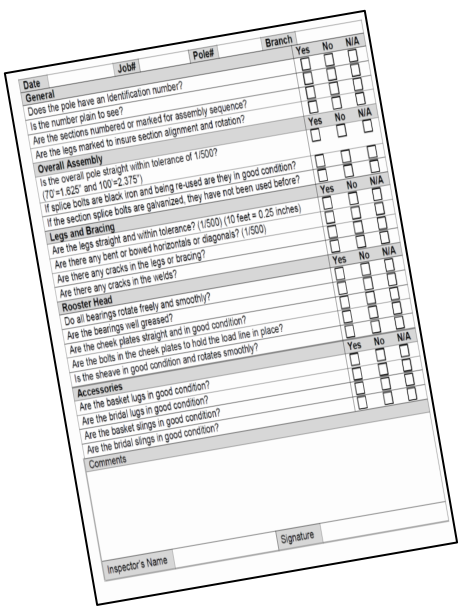
- Gin poles cover a broad spectrum of specialty lifting devices from a sophisticated latticed mast with a rooster head assembly to a simple tubular pole with a top block, and may utilize either steel wire rope or synthetic rope for the primary load line.



Gin Poles

Certification, Marking & Documentation Requirements

- Gin pole must be rated and certified to ANSI/TIA-322
- Gin poles and associated components must be permanently and clearly marked, and referenced to their applicable load chart(s)
- Minimum onsite documentation must include load chart(s), current inspection records, and any applicable assembly details


Date
Job#
Pole#
Branch

General — Yes / No / N/A
- Does the pole have an identification number?
- Is the number plain to see?
- Are the sections numbered or marked for assembly sequence?
- Are the legs marked to insure section alignment and rotation?

Overall Assembly — Yes / No / N/A
- Is the overall pole straight within tolerance of 1/500? (70'=1.625" and 100'=2.375")
- If splice bolts are black iron and being re-used are they in good condition?
- If the section splice bolts are galvanized, they have not been used before?

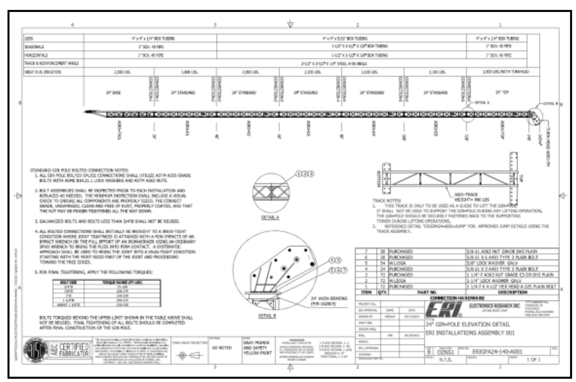
Legs and Bracing — Yes / No / N/A
- Are the legs straight and within tolerance? (1/500) (10 feet = 0.25 inches)
- Are there any bent or bowed horizontals or diagonals? (1/500)
- Are there any cracks in the legs or bracing?
- Are there any cracks in the welds?

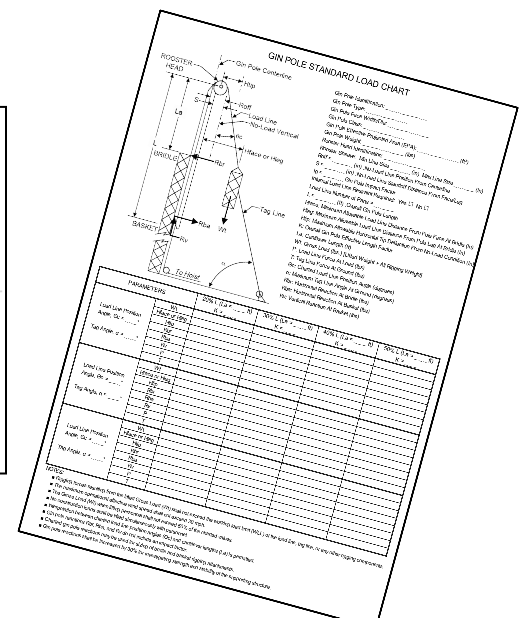
Rooster Head — Yes / No / N/A
- Do all bearings rotate freely and smoothly?
- Are the bearings well greased?
- Are the cheek plates straight and in good condition?
- Are the bolts in the cheek plates to hold the load line in place?
- Is the sheave in good condition and rotates smoothly?

Accessories — Yes / No / N/A
- Are the basket lugs in good condition?
- Are the bridal lugs in good condition?
- Are the basket slings in good condition?
- Are the bridal slings in good condition?

Comments

Inspector's Name
Signature





ANSI/TIA-322 & ANSI/ASSE A10.48 Overview

ANSI/TIA-322 & ANSI/ASSP A10.48 Updates

ANSI/TIA-322 UPDATE

- Highlights Of Current Change Proposals Under Consideration:
  - Clarification on engineering requirements for assessing rigging attachments made away from the primary support structure (i.e. away from monopole shaft or tower leg at panel point)
  - Review slip connections (in-line splices and lever type hoists)
  - Incorporate FBD for trolley lifting configurations
  - Expand upon gin pole analysis and load chart requirements for tilted gin pole applications
  - Expand K-Factor tables beyond current 20%-50% cantilevers
  - Define minimum load requirements for personnel included in construction analyzes
  - Reliability Factors
  - Critical Operations
  - Reference ANSI/TIA-222-H for all supporting structure strength and stability investigations
  - Coordinate change proposals with ANSI/ASSP A10.48 to ensure consistency between standards

ANSI/TIA-322 UPDATE

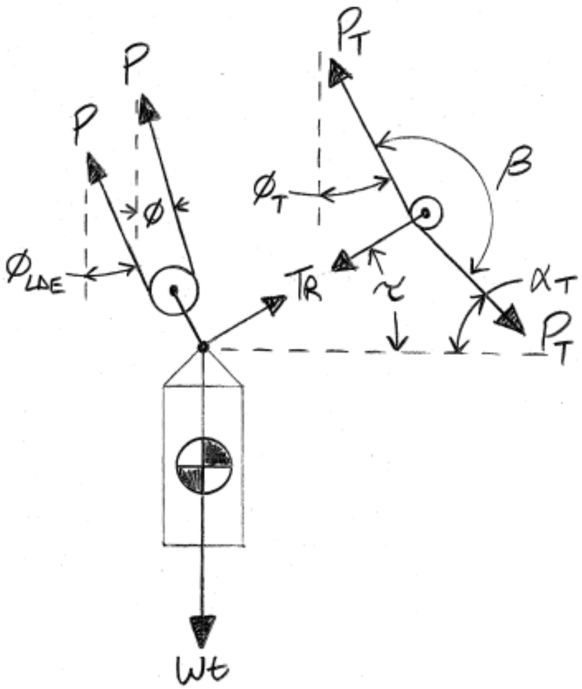
- Rigging Attachments:
  - Clarify engineering requirements for certifying rigging attachments made away from the primary support structure defined as the main pole shaft for monopoles or around the tower leg at a panel point for lattice towers

ANSI/TIA-322 UPDATE

- Connections Subject to Slippage:
  - In-line splices

ANSI/TIA-322 UPDATE

- Trolley Lifting Configurations

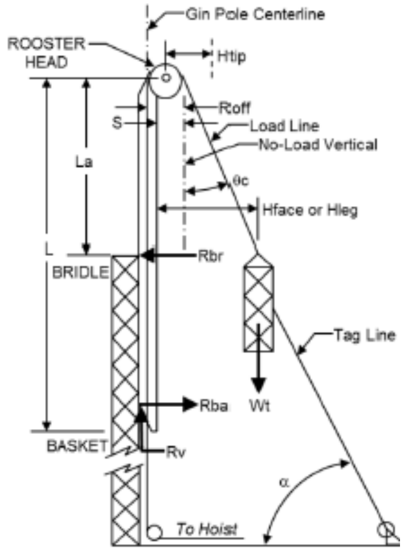


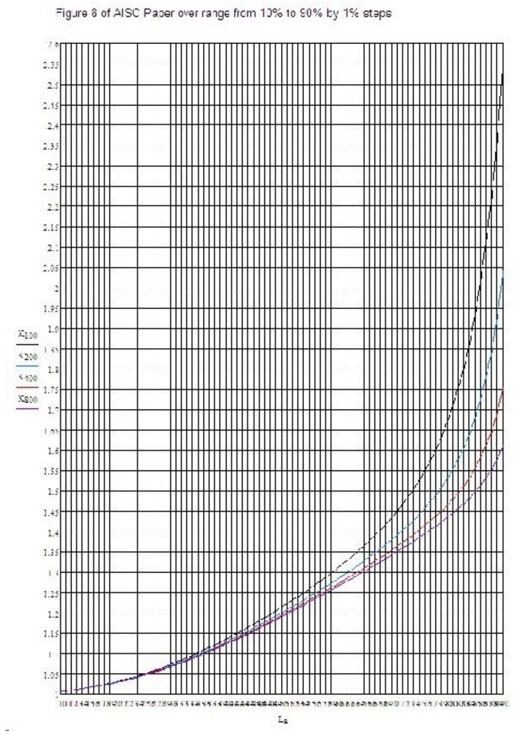
ANSI/TIA-322 UPDATE

- Tilted gin pole applications:
  - Additional stability concerns when booming in and out, and rotating
  - Load charts require multiple configuration reviews to properly assess safe ranges for tilted applications under both loaded and unloaded conditions

ANSI/TIA-322 UPDATE

- K-Factor:
  - Provide tabulated factors for cantilevers ranging from 10% to 90%





ANSI/TIA-322 UPDATE

- Personnel Loads:
  - Minimum load requirements for personnel included in construction analyzes

ANSI/TIA-322 UPDATE

- Reliability Factors:
  - Establish Reliability Factors for analysis purposes related to construction activities as a means to account for confidence associated with variations in the work
  - Lower factors would apply to operations where engineered control measures are established

ANSI/TIA-322 UPDATE

- Critical Operations:
  - Establish strength usage limit(s) for the supporting structure and/or construction equipment for identifying Critical Operations

75%

ANSI/TIA-322 UPDATE

- ANSI/TIA-222-H:
  - Update Section 4.0 to reference ANSI/TIA-222-H as basis for all supporting structure strength and stability investigations in addition to specific construction load combinations

ANSI/ASSP A10.48 UPDATE

- New name as of June 2018
  - ASSE → Now ASSP

The American Society of Safety Engineers

AMERICAN SOCIETY OF SAFETY PROFESSIONALS

New Website:
www.assp.org

ANSI/ASSP A10.48 UPDATE

- Revision Process Underway:
  - Chapter committee leads established for original (17) sections, plus (4) new sections
    - ❖ **Section 18:** Electrical Safety
    - ❖ **Section 19:** Aerial Work Platforms
    - ❖ **Section 20:** Crane Safety
    - ❖ **Section 21:** UAS
  - Kickoff Committee Meeting held in Feb 2019

ANSI/ASSP A10.48 UPDATE

- Highlights Of Current Change Proposals Under Consideration:
  - Focus content on *MINIMUM* criteria ~ Remove permissive language
  - Remove redundant content
  - Move to three (3) Construction Classes all requiring documented Rigging Plans
  - Added focus on inspection and usage requirements for synthetic rope
  - Expand on Roles and Responsibilities for key stakeholders
  - Clarification on requirements for rigging attachments made away from the primary support structure (i.e. away from monopole shaft or tower leg at panel point)
  - Expand on Proof Loading requirements
  - Expand on standard operational, annual, and 10-year inspection requirements for gin poles
  - New friction factor tables for standard sheave types
  - Multiple new definitions (redirect/deflector blocks, types of rooster heads, etc.)
  - New chapters (Electrical Safety, Aerial Work Platforms, Crane Safety, & UAS)

Questions?

Working Together to Provide Safe Working Environments for Communication Structures Through Understanding and Application of the Standards

Contact Information

Bryan Lanier	bryan.lanier@americantower.com	(919)302-4230
James Ruedlinger	jruedlinger@eriinc.com	(812) 459-2053
John Erichsen	john.erichsen@eetllc.net	(574) 277-0670 ext 701
Marianna Kramarikova	mkramarikova@tiaonline.org	(202) 701-9197
Scott Kisting	scott@ptsadvisors.com	(608) 341-7199
Michelle Kang	mkang@maserconsulting.com	(740) 973-5814
Brian Bicknese	b.Bicknese@verticallimit.com	(651) 755-3218
Dan Butterworth	dan.butterworth@Ericsson.com	(913) 485-9307
Scott Vance	svance@btgrp.com	(918) 587-4630
Dale Shumaker	dale.Shumaker@enertecresources.com	