Twist, Plumb and Tension for Guyed Towers

Guyed tower maintenance has been and always will remain an area of telecommunications that requires competent and well-trained individuals. This Planning Advisory Notice (PAN) is intended to focus on twist, plumb and tension (TPT) of a guyed tower. We will discuss the minimum industry standards that must be referenced for this type of work, they are the ANSI/ASSP A10.48, ANSI/TIA-222 and ANSI/TIA-322.

What is a TPT? This is a process that ensures that the tower does not have excessive twist, is not out of vertical plumb and that the guy tensions are compliant with the engineer's specifications derived using the proper design standards.

Proper TPT is accomplished through the use of the guy and anchor systems working together with the tower structure to ensure that there is less than 5° of total twist in the tower and that it does not exceed 0.5° in any 10′ vertical span on the structure. The tower shall be vertically plumb to within 0.25% of a vertical span and finally, the guy tensions shall be set within 10% of the engineer's design initial tension. [Note: Tension ± 5% for guys greater than 1″ diameter per ANSI/TIA 222 section 13.3.2]. The design initial tension* (often referred to as initial tension) is often confused with the breaking strength of the guy. In the analysis and design process an engineer may vary the initial tension from 7-15% of a given guy's breaking strength and be in compliance with ANSI/TIA-222. [NOTE: there are times when an engineer may need to go outside of the 7-15% and when this is required the engineer considers the sensitivity of the structure's behavior to the variation in initial design tensions.] Once the engineer has completed the analysis for the structure, the design initial tension is what is specified in the analysis documents.

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The engineer's calculations are based on the breaking strength of the guys at 60°F to provide a point of consistency. A change in ambient temperature from 60° does not change the ultimate strength of the guy, it does change the sag and it is this change in sag that causes a change in the guy tension measured and must be accounted for.

As an example, let's assume that we have a guyed tower with 5/8" diameter Extra High Strength (EHS) guy strand wires assigned a design initial tension of 9% of the breaking strength, at an ambient air temperature of 60°F. The breaking strength of the wire is 42,400 pounds. The design initial tension the contractor is seeking to achieve is 3,816 pounds (9% of the 42,400 pounds). Knowing that the final tension can deviate as much as 10% from the design initial tension, the contractor's competent and authorized persons can set the final tension from 3,434 pounds to 4,198 pounds (10% variance from the goal of 3,816 pounds) and still be in compliance with the standard. The calculations must take into account when the temperatures vary from 60°F due to expansion and contraction of the wires; but the allowable deviation from the design initial tension specified in the analysis documents remains 10%.

When erecting, maintaining or modifying a guyed tower, the TPT are essential for the structure to perform as designed. In most cases the best approach is to understand if twist needs to be adjusted. The next step is to verify if the plumb is in compliance with the engineer's design. Then the needed tension adjustments can be accomplished to address any issues with twist and plumb while staying ± 10% of the design initial tension.

There are two basic methods that are recognized in ANSI/TIA-222-H for guy initial tensions in the field, the Direct Method and the Indirect Method **.

1. The Direct Method is the use of a dynamometer (load cell) with a length adjustment device, such as a come-along attached to the guy system by clamping onto the guy just above the dead-end grip and onto the anchor or rigging attachment point below the turnbuckle. What this method does is place the load cell directly in line with the load path through the guy. It can be a very accurate method to determine the tension when the load cell is properly calibrated. The challenge with this method is that it can be difficult to determine when the full load has transferred from the load cell back to the anchor hardware (turnbuckle, hairpin, etc.). This can cause the tension to be set incorrectly due to transferring the load back to the anchor hardware.

2. The three common techniques for the Indirect measurements are listed below:

   i. The Pulse Method – This method involves the creation of an oscillation (pulse) into the guy. The time it takes the pulse or wave to move up and down the guy is measured. From this recorded time, the tension in the guy can be calculated. In the hands of a properly trained technician this method can be very accurate, however effective documentation can be laborious and lacks a control point. Training and supervision are critical with this method as is commonly the case with much of the work we do in our industry. One of the exciting things happening now is the development of tools to aid with accuracy and consistency when this method is chosen. There are several different technologies that are being implemented which may address many of the underlying concerns with this method.

   ii. The Tangent Intercept Method – This method requires sighting up a guy and having a direct line of sight that continues to the tower in the same plane as the guy leaves the anchor. This intercept point will be the sag of the guy. Next you determine the vertical height from where that direct line intercepts the tower and where the guy is attached to the tower. The use of the equations provided in Annex K of ANSI/TIA-222 provide the tension in the guy. Accuracy of this method could be improved if there were more tools to effectively measure the points of intercept. Due to consistency issues, this method is normally reserved for towers with larger guys and specialized crews that have the extensive training, equipment, knowledge, and experience required to utilize this method.

   iii. The Shunt Dynamometer Method – This is the indirect method recently added to ANSI/TIA-222-H. This method involves the use of a tool that directly attaches to the guy and measures deflection as it applies a force to the guy. This deflection can then be converted into a tension and displayed on the device. This method has gained popularity because of cost, portability and ease of use. However, caution should be exercised when using these devices as they have a tendency to be inconsistent and inaccurate due to the need for frequent calibration. [Note: The manufacturers of these devices have formed a consensus committee to address some of these issues which will be published in a future PAN.]

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All methods require a competent person(s) to select the tools and processes that will ensure the accuracy required by the standard(s) while providing a safe working environment. This requires the application of not just ANSI/TIA-222, but may also involve ANSI/TIA-322 as well as the ANSI/ASSP A10.48. As with many SOW's (Scope of Work) performed in our industry there are other regulations/standards that may apply, and the contractor shall ensure they are compliant with additional requirements.

A proper understanding of the process is critical to the assessment of the infrastructure and not just for maintenance of the structure. When planning the work on a site that may involve the modification it is important to assess the TPT of the tower. This can also apply to an assessment after an adverse impact due to weather, earthquake or vandalism to determine if the tower has been damaged. Understanding the standards that govern TPT help create a safe working environment for everyone involved. This can also eliminate false reports of loose guys or issues with the guyed tower.

All components of the guy assemblies should be inspected for damage or improper installation prior to any adjustments made to TPT. Any discrepancies found should be communicated to the structure owner or engineer. The system on the tower should always be considered as well when performing adjustments to the TPT as these adjustments can cause issues with system performance. When the structure has a microwave path that will be impacted due to removing the twist from the tower there is the possibility of impacting the microwave systems performance. It is critical to communicate with the impacted parties. When performing

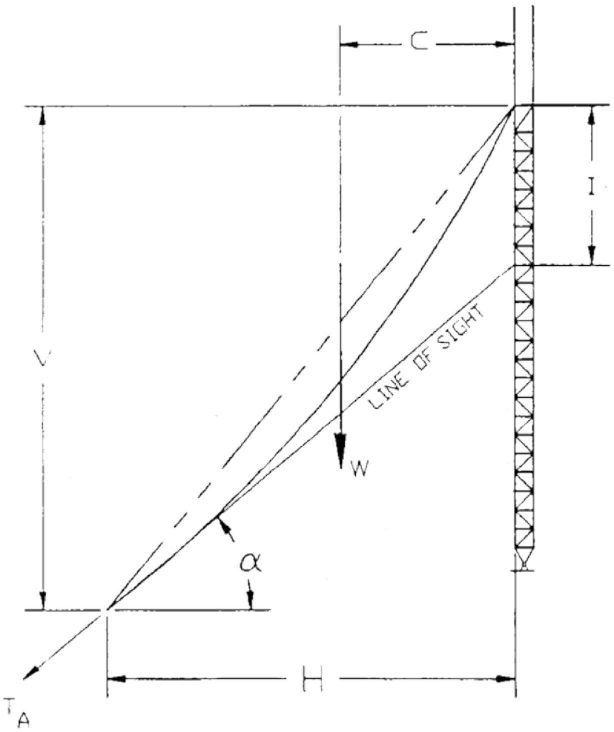

Figure K2

this type of work the proper tools must be selected to minimize impact on the guy component hardware when adjustments are being made. Hardware should also be treated to avoid corrosion due to tool marks.

The engineers work to create the design, the owners schedule the necessary maintenance to achieve long term service from the structure and the contractors must be supported with the proper information, training and equipment to measure the TPT. The means and methods are all in the dominion of the contractor, but they must meet or exceed the requirements established by the standards.

*Note that based on the distance from the tower and elevation of the anchors the tensions can vary from one anchor to another. All tensions do not need to be the same at each anchor, they do need to be within the 10% allowed from the initial design tension. It is critical to note that the ANSI/TIA standards do not speak to the means and methods to accomplish the work. The ANSI/ASSP A10.48 is the primary standard to address the means and methods to ensure safety and quality for work on a guyed tower site.

**Please reference Annex K of ANSI/TIA-222-H for additional information on these methods as this PAN is only a summary. ANSI/ASSP A10.48 is the primary standard to address the means and methods to ensure safety and quality for work on a guyed tower site. ■