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PLANNING ADVISORY NOTICE

Microwave Antenna Mount Installation

The level of scrutiny on structural antenna mounts has risen in recent years due to the increase in structural utilization, failures, quantity, and weight of the equipment placed on antenna supporting structures due to the requirements of 5G and other telecommunications network build-outs currently underway. While a tremendous focus is placed on the structural performance of antenna mounts, the importance of the microwave antenna mounting systems must not be overlooked. With the ever-increasing demands to train new personnel in our industry, it is critical that we support our fellow engineers and installers who may not be familiar with the mechanisms of failure in a microwave system and how to avoid potentially dangerous and costly issues. This PAN's intent is to support and educate the fine men and woman of our industry who endeavor to perform quality work in the safest manner by passing on the knowledge of best practices in the successful design, installation, and maintenance of microwave antenna mounting systems.

The system design of a microwave network is outside the scope of this PAN but has been covered in a previous PAN titled "Why You Can't Rush a Communications Tower Site Build." That said, it is critical to understand the microwave engineer's design intent for the microwave path as well as the desired reliability and how the antenna manufacturer's specific requirements apply. This PAN will focus on the microwave antenna mounting systems that provide the necessary reliability of a telecommunications network. Always refer to the microwave engineer's requirements as well as the antenna manufacturer's specifications.

The installation of a microwave antenna is made up of many components working together in harmony with the primary elements being the mount, the strut(s) (AKA tie backs, kickers, stiff arms, etc.), the support structure (typically a tower or pole), and the elliptical waveguide, coax, or hybrid cable. When reviewing a site, we need to look at all elements individually.

Figure 1: Six-foot (6') Antenna with Proper Installation. *(NOTE: Best Practice is to cut the strut off twelve inches (12") past the attachment point and galvanize with Zinga or Zinc Coat.)*

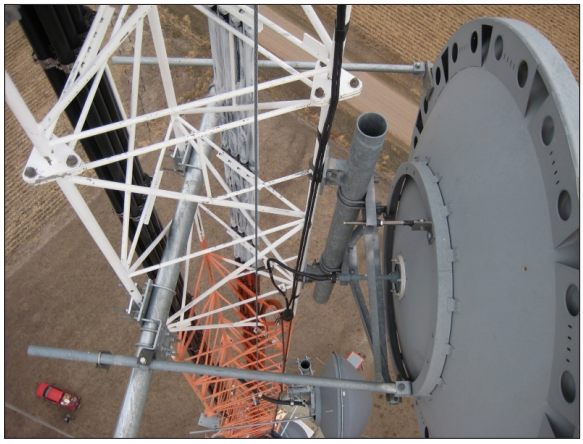

Figure 2: Eight-foot (8') Antenna with Proper Installation of the In-Board / Out-Board Struts with a Common Strut Support.

Mounts are typically selected to be supported from a single leg, but for proper microwave alignment, and to protect the underlying structure, it may be necessary to utilize a face mount connected to two adjacent legs. This is where the structural engineer must review the

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tower for the twist and sway requirements to maintain the microwave path. During this initial review, the strut connection to the tower should be analyzed as this element is crucial to proper alignment and stability of a microwave system.

When installing the mount, antenna, and struts on a sunny day it is important to think of how well it will perform when the weather is adverse and remember that microwave antennas are typically designed to perform in winds up to 125 MPH. Improperly loading the structures' critical support members, such as diagonals, can have a serious impact on the underlying supporting structure. As a rule, tower diagonals should never be used for strut connections unless they have been reviewed and approved for such use by a qualified engineer.

Lastly, the structure's member shapes (i.e., pipe and solid rounds vs. angle and bent plates) and material (i.e., steel vs. concrete vs. wood) should be analyzed to ensure they are compatible with the mount of choice and the intended loads to be supported. It is important to understand the interaction between all these elements and how they work together to support the microwave antenna mounting system. The following content will dive deeper into the multiple components and provide examples of problems, causes, and insights to challenges often encountered.

Figure 3:
Remember: Look Up Before You Climb!

When selecting a mount, the microwave antenna, structure type, and the absence or presence of an ice shield drives the selection of mount type. Additionally, the load capability of the mount, number of strut supports needed, clear space behind the reflector, normal or inverted mounting capabilities, and offset needs are all factors that must be considered. Clearly, a 4' microwave antenna has different needs of that of an 8' microwave antenna. The antenna azimuth is crucial as this helps determine the position of the mount relative to the tower as well as the proper orientation of the microwave for positioning of the strut(s). It is at this point one must decide whether a leg or face mount is needed and if a horizontal tower strut support is required. If the proper mount is not selected and procured, then the installation may not be done correctly or at best will be delayed waiting on additional parts and/or engineering support. When assessing the proper placement of the microwave antenna, the engineer should always consider the azimuth in conjunction with the climbing facilities.

> *It is acceptable to obstruct climbing facilities, if necessary, but it is never permissible to cause damage to the climbing facilities, safety climb, or other system installed upon the structure.*

Determining the placement of the struts creates the largest opportunity for mistakes. This is why planning is so critical while on site, and some teams will do an "orange stake walk" on site prior to assembling the antenna. The purpose is to walk 80% to 90% of the install height away from the tower on the intended azimuth path and install a brightly colored stake that can be seen from the tower to aid in setting the antenna on its initial azimuth. This now allows the team to look back at the install location and identify mounting obstructions or opportunities to determine if the planned leg and strut placement will work, or if the antenna needs to be installed inverted.

It is important to understand that a strut is a structural component carrying a specific load from the microwave antenna into the supporting structure and must be connected to a structural member capable of supporting the loads. Because the strut is supporting a portion of the wind from the front face of the microwave dish, installing the strut incorrectly will create problems with the alignment (e.g., loss of signal and increase maintenance requirements) and can reduce the life of the mount and structure (e.g., metal fatigue, stress fractures, and bending of structural components). To put this in perspective, on a typical 6' diameter microwave antenna, the strut is part of a 3-point connection transferring as much as 1,400 pounds of force into the supporting structure. When that strut is not positioned properly in both the installation planes (e.g., 25° in the horizontal and 5° in the vertical plane, manufacture dependent) and at its attachment placement (i.e., tower, antenna, or mount attachment), the mounting solution can create a situation where the mounting system can be damaged and fail to maintain alignment. In addition, forces from a misplaced strut onto a member of the supporting structure can result in damage to that member.

Because the waveguide path requires proper planning to rig and transition elliptical coax through the "E" (Easy) and "H" (Hard) planes indicative to bending of the elliptical coax, the path can dictate your best position of the mount and antenna. When left to chance, you increase the complexity of the install and may risk damage to the elliptical. In most instances, the elliptical coax should be supported from 12" from the connector and through the transition bends. Advanced planning should position the antenna to best utilize the tower as a means for coax support.

To summarize, many variables can cause a system failure or poor performance of a microwave antenna mounting system, as depicted in Figure 4 and Figure 5 below.

Figure 4:
Improper Installation. The strut angle is too severe, and it is not mounted to the correct location on the microwave antenna. In-Board / Out-Board Struts with a Common Strut Support.

Figure 5:
Improper Installation. In-board strut has too steep of a vertical angle, and the out-bound strut is improperly attached to the tower diagonal.

Some common examples of variables that cause system failure and poor performance are:

- Strut(s) not in the specified position (e.g., 25° and 5° in the horizontal and vertical plane).
- Strut(s) not attached to an approved structural tower member or not attached to the antenna correctly.
- Remember, diagonals are typically not intended to see load in the manner a strut would apply to them.
- Lack of the proper quantity of struts and deviations from their approved positions.
- Creative strut mounting transitions (i.e., use of provided components in a manner in which they were not designed and/or the use of additional components that were not provided in order to attach the strut to the structure).
- Antenna mount orientations that do not allow the mounting system to support the wind forces.
- Position of the mount on the wrong leg/face causing undue pressure on the structure.
- Damage from/to adjacent mounting systems.

Proper planning starts with an evaluation of the supporting structure, antenna design requirements, azimuth, climbing facilities, other appurtenances installed on the tower. Whether you are the engineer planning a design using photographs and site plans or a contractor bidding the job, it is crucial that you understand the intended microwave path in relation to the supporting structure. Review the structure and the adjacent members to determine the best way to support the microwave antenna mounting system. This goes for any structure: guyed, self-support, monopole, water tank, or rooftop. It starts with the following best practices:

- Determine how many struts are needed and how to best orient the microwave antenna to meet the manufacturer guidelines for strut supports and their intended loads.
- Choose the right mount to not only support the gravity and wind forces to satisfy the ANSI/TIA-222 requirements, but also to best meet twist and sway requirements of the antenna.
- Review the intended path for your elliptical or lines and verify compliance.
- Determine if ice shields or waveguide supports are needed.
- Avoid obstruction to the structure's lighting, markings, and safety climb facility for a successful rigging plan.
- Obstructions should not halt your plans, keep in mind that you can involve your Engineer of Record or Original Equipment Manufacturer for changes if needed.
- Address any other site-specific requirements.

In conclusion, the understanding of a successful microwave antenna mounting system is more than pulling together a few parts, loading them up, and driving to the site. It involves a comprehensive look at all components of

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the entire system to successfully complete the job. Training is available from many mount manufacturers and can be helpful for both new and experienced personnel. Discuss with others that have experience to learn and share your knowledge when possible. Always remember to focus on the SSS (Structure, Safety, & System) as planning is critical to your success.

Figure 6:
Example of a Proper Installation.