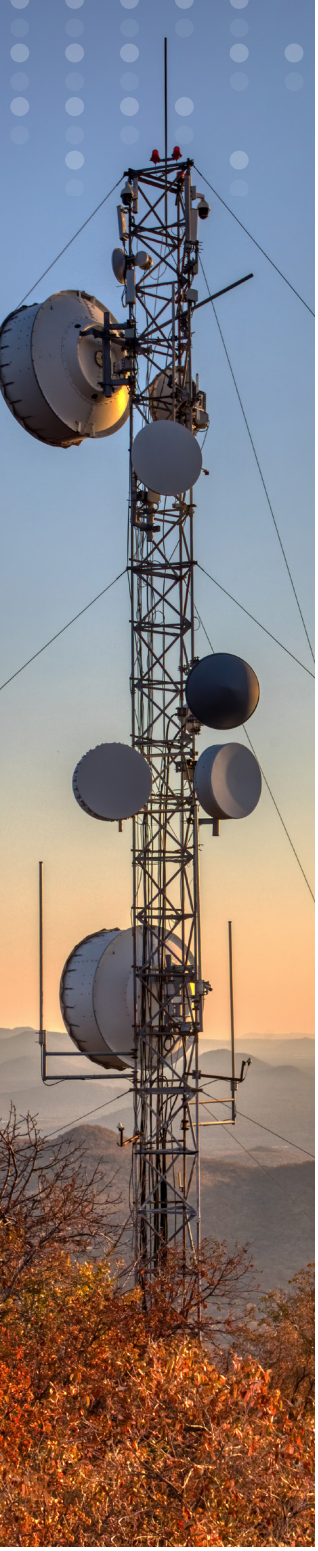

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PLANNING ADVISORY NOTICE

Post Installation Inspection and Post Modification Inspection

The intent of this planning advisory notice (PAN) is to educate upon the importance of a Post Installation Inspection (PII) and Post Modification Inspection (PMI), which play a crucial role in ensuring proper installation in accord with the design documents, asset data capture, the performance of telecommunications infrastructure, and network integrity. A Post Installation Inspection ensures the telecommunication structure is installed properly; PII is referenced in the normative Annex N of ANSI/TIA-222 Rev. H, specifically N.2. A Post Modification Inspection is an inspection of the executed modifications to an existing antenna supporting structure to ensure proper installation. Conducting timely Post Installation Inspections and Post Modification Inspections improves the quality, safety, and efficiency of telecommunications infrastructure for all stakeholders; this PAN will review best practices and outline the direct benefits that stakeholders receive from these inspections.

To begin with, ANSI/TIA-222 Rev. H (Structural Standard for Antenna Supporting Structures, Antennas, and Small Wind Turbine Support Structures) §18.0 and Annex N: Initial Construction Inspection (Normative) requires that a PII be conducted during and after the construction of antenna supporting structures. While this practice is commonly completed on traditional telecommunication towers, it is less common on antenna mounting structures (though still required as it is an antenna supporting structure). As telecommunication equipment advances, so have the demands for the supporting antenna mounting structure. As such, a benefit to completing a PII for antenna mounting structures is that it ensures the client's asset and proposed equipment is properly installed, and that value is attained. The vast majority of failures in the industry are not due to design, but rather installation faults where structures, modifications, or equipment are not properly installed. This is where the PII, properly supported, ensures value as well as efficiency. For instance, when End Users review close-out packages, they are generally only focused on RF components. While this is critical, it omits a review of the structural components of an installation. Incorporating a PII closes this gap and creates value by ensuring that the structural components are installed correctly; and if the structural components are installed correctly there will be less rework at a site, which increases efficiency. Effectually engaging the Engineer of Record (EOR) for the PII is another way to improve quality, safety, and efficiency of installations. When the EOR is engaged during the PII they are able to improve future design install-ability of telecommunications infrastructure by incorporating feedback from contractors as well as eliminating assumptions that may have been made by the EOR as part of the design. The EOR also increases the efficiency of the installation by providing the contractor with access to the engineer that designed the structure, versus having to find an engineer unfamiliar with the scope of work. In addition, this allows for efficiencies on the next touch of the site because of the possible data management.

Additionally, structural modifications are to be inspected as prescribed in ANSI/TIA-222 Rev. H §15.8.4 and Annex O: Existing Structures Modification Inspection. It should be noted that some jurisdictions require compliance or require that the EOR determine which requirements of Chapter 17 Special Inspection requirements from the International Building Code (IBC) apply to a project. To accomplish

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this, EORs incorporate inspection requirements into the design documents. If these inspection requirements are not complied with, the EOR is not able to verify proper installation and the structure owner assumes considerable risk. When the EOR requirements are met, the industry performs some level of PMI on structural modifications. However, the level of detail, consistency, and accuracy of the PMIs vary greatly. In larger part, the accuracy of the PMI is heavily dependent on the individuals capturing the data for the inspection and the person conducting the inspection or review of the PMI documentation. Additionally, amongst the industry there is inconsistency on when the PMI is conducted and who is performing them as well as when it is necessary to have a third party or to perform from desktop review. While the industry has improved the consistency and quality of PMIs that are typically completed on tower structures; it is not as common for PMI to be completed on appurtenance mounting systems. ANSI/TIA-222 Rev. H and the IBC require these inspections on all antenna supporting structures including the mounting systems. It is acceptable for the EOR to complete a desktop review of the PMI/PII based on information supplied by the contractor completing the modifications/installations or other stakeholders. However, the structure owner must ensure that processes are enacted allowing the EOR to receive the necessary data. Third party inspections may also be used during situations where the original EOR is not capable or qualified to perform the PMI/PII review.

Common reasons for a PII or PMI to not be completed are due to a lack of understanding as it relates to inspection requirements and the stakeholders not considering the inherent value that a PII or PMI brings to quality, safety, and efficiency. Conducting a proper PMI provides a reduction in risk and improves quality, not just for a single collocation, but of future designs as a PMI ensures that structural components are installed correctly. Add to this the impact on safety; mounts installed incorrectly do not meet design requirements which can lead to an unsafe environment. Additionally, contractors are more effectively supported when a PMI is performed because the engineer must support the installing contractor directly and is held accountable to review the PII/PMI data. Lastly, the data management that is revealed, when properly managed, improves the quality, safety, and efficiency because the engineer is reviewing the installed state, minimizing the need for assumptions the next time work is performed at the site. It should also be considered that there are code-based requirements that impact the project's intended purpose, enforcement by the jurisdiction, as well as project schedule impacts and cost overruns that can be mitigated by an effective PII/PMI program. The TIF White Paper *Intended Use of Structures with Emphasis on Small Cell: 2020 Update* reviews, in detail, how the intended use of the antenna supporting structure is used to determine the code/standard governing the requirements on a given site.

ANSI/TIA-222 Rev. H §15.8.4, Annex O, and Chapter 17 of the IBC lay the framework for the requirements of proper verification of structural modifications. More importantly, §15.8.4 states that the requirements specified in the "design documents" are to be followed. The A&E firm responsible for the design documents should clearly assess the design and outline all items to be inspected and by whom. The contractor will then see the PMI scope and account for the scope in their bidding and planning for the project. This portion alone has been shown to have a great positive impact as it clearly defines success for the contractor and allows them to plan effectively. To minimize project delays and costs; it is best practice for the contractor to gather the necessary data to fulfill the PMI requirements while still on-site or within site proximity. The EOR should prioritize the review of the PMI package and coordinate any remediation necessary with the contractor in as timely of a manner as possible. The EOR and contractor are to partner together to ensure all required special inspections are completed by competent individuals as outlined in Ch.17 of the IBC. Additionally, Annex O of the ANSI/TIA-222 Rev. H provides guidelines for inspections of modifications before, during, and after the construction phase. Most structural modifications come with their own project specific inspections list to be completed as part of the PMI.

Ideally, these inspections are completed immediately after the installation of the modifications and any subsequent remediations to be completed within 180 days or sooner depending on the severity and impact to the structure. However, it is advisable based on the scope of work to complete this assessment as close to the initial installation as possible. A notable exception is a guyed tower installation. There it can be effective to wait 4-6 months to allow the guy wires to adjust, providing an effective window for twist, plumb, and tension assessment as part of this inspection.

The installation or change of equipment can be considered a modification to the structure and it should be noted that the PII/PMI can be used to help ensure that the equipment scope was installed accurately against the design documents. Often times, equipment models are changed, and installation layouts vary from the original design drawings and these changes are not captured in

the As-Builts and only found later in audits or mappings. It is best practice to perform a PII/PMI while the contractor is on-site. The client or A&E can perform a desktop review with As-Built CDs, photographs, and the design documents. This helps ensure that the equipment scope was installed as it was considered across all the design documents. Any deviations from the design documents can be communicated in real time and properly documented or revised. It is important to ensure any deviations do not negatively impact the structural integrity of the mount. In either the PMI or PII, the EOR can review the final close out package to verify the installation was properly done in accordance with the design documents.

All stakeholders benefit from the proper implementation of a PMI and PII. These benefits range from limiting risk and exposure to reduced maintenance costs. Further explanation of the roles and responsibilities for stakeholders can be found in the TIF White Paper *Appurtenance Installation Impact to Climbing Facilities and Antenna Supporting Structures*. Specifically, stakeholders can expect to provide the following benefits by properly completing a PII or PMI.

Contractor

Contractors have the incredible responsibility of installing the appurtenance, or modifications to the appurtenance. Many times, the contractor is left to just "make them work" without support from the EOR. However, properly incorporating a PII or PMI ensures that the EOR is accessible to the Contractor and there to support throughout the construction/modification. Feedback from contractors allow the engineers to continually improve the install ability of their modifications. By compiling a PMI package for review, contractors reduce their liability arising from installation issues if they have documented evidence that the EOR approved their installation. This also allows an effective means to ensure that assumptions made by the EOR have been addressed. Finally, this increases the quality, safety, and efficiency of the build because the key role of the contractor is effectively supported.

Structure Owner

The PII/PMI process is critical to the structure owner as they are reassured that their asset is in the condition that the structural analysis indicates and that there is no damage or unanticipated obstruction to the safety climb, climbing facilities, or any other known system installed upon the structure. This allows the structure owner to move forward with future collocations without the worry of structural integrity or unanticipated costs, all while improving their data management. In addition, the structure owner has a responsibility to communicate that they do not want damage to their structure or climbing facilities. Finally, it should be noted that the PII/PMI process does allow the structure owner to allow speed to market for others as they now have a valid post installed state of the structure.

End User

The authors engaged with some of their end user clients; having worked to complete PMIs on a significant number of sites and it has been seen that the failure rate exceeds 20%. These installation faults were captured and able to be corrected through an effective PMI process. The PMI process was what enabled the understanding and communication to achieve quality. The most common installation faults identified were:

- The contractor purchases a different mount or modification kit than what the EOR specifies thinking they are "equivalent." The EOR should be involved in these decisions. The TIA-5053 Standard allows the EOR to perform minimal calculations to provide an alternative solution.
- Multiple engineers in chain (MA engineer, SA engineer, A&E engineer) with no one coordinating deliverables to ensure consistency.
- Non-engineers reviewing the PMI documentation are not looking at structural details to ensure consistency with the structural deliverables.
- The contractor did not install per the design documents, and this led to a lack of design performance in the structure.
- Impact to the safety climb, climbing facilities, or other known system installed upon the structure. This is especially concerning as these are meant for the contractor to safely access and egress from the work location.

The end user should note that by not properly conducting a thorough PMI they are taking on unnecessary risk and liability. The PMI process by design helps protect all stakeholders from situations as those described above.

Engineer

Through the PMI process, engineers can act as faithful agents and facilitate communication between the various stakeholders. Their role is in design and final approval. To do so, they must solicit feedback from all stakeholders to ensure effective and constructable designs are achieved in the future.

Unfortunately, the impacts of not conducting a PMI or a

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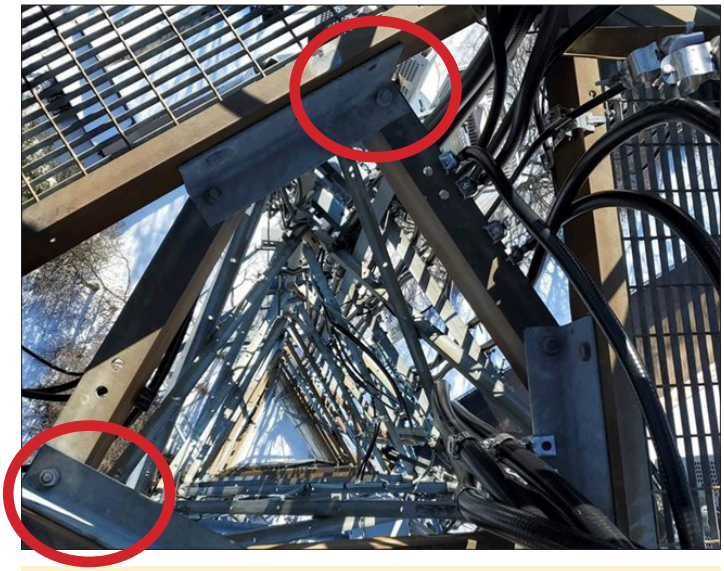
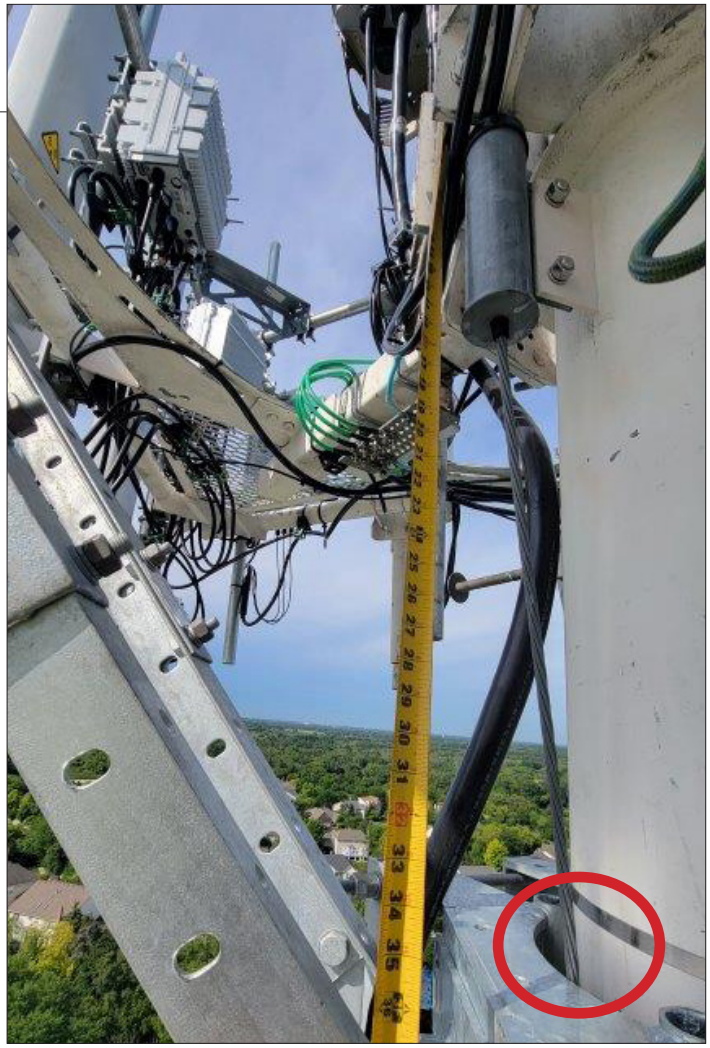
PII are felt long after the project is complete and normally not identified until the next field visit or project is being executed. This can create large project delays, longer downtime, and additional costs for the end user, structure owner, and contractor. As discussed in this PAN, not properly performing a PII or PMI also reduces quality, safety, and efficiency. Structure owners and end users should focus on having the right processes in place to ensure PMIs and PIIs are occurring. Additionally, it is critical that the individuals approving the installation are qualified to make this assessment. Depending on the scope of work, that individual may need to be the EOR for the project. Ensuring that these steps are completed will better the industry by making PMIs and PIIs a common practice for all.

Examples of Deficiencies Found During a PMI/PII

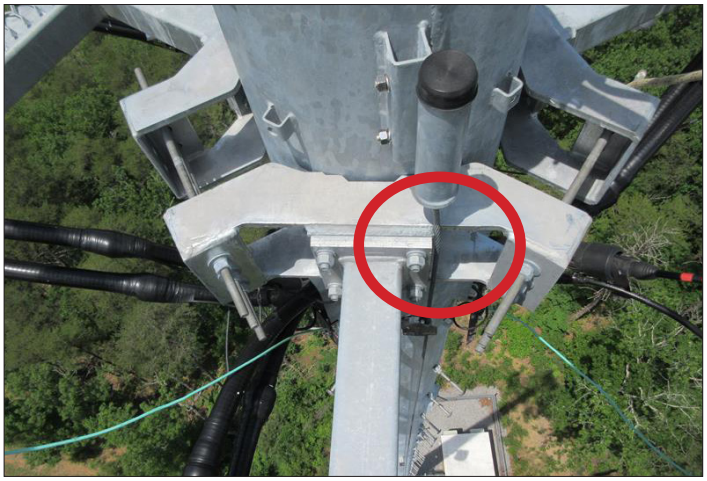


Example 1: Bolts missing from connection between mount and supporting structure.

Example 2: Bolts missing from primary connection between mount standoff and collar connection to supporting structure.



Example 3: Monopole safety climb cable pinned between mount collar and monopole supporting structure. Potential for future damage to safety climb cable and/or mount.



Example 4: Mount collar forcing safety climb cable out of plumb resulting in possible cable damage, mount damage, and safety climb system to not engage properly during a fall event.