TO	Network Wide
FROM	Manager Engineering Services
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SUBJECT	ETS-09-00 - Technical Note
TITLE	ETN-09-09 Technical Note - Capacity Assessment of Existing Wind-Sensitive Non-Bridge Structures v1.0

1. References

AS 1170.2: Structural Design Actions, Part 2: Wind actions

AS 1170: Structural Design Actions (Parts 0 and 1)

AS 4100: Steel Structures

AS 3600: Concrete Structures

AS 5100.7: Bridge Design, Part 7: Bridge Assessment

2. Background

ARTC owns and manages a large number of tall structures, including but not limited to lattice, monopole, and guyed towers used for telecommunications, communications, lighting, water infrastructure, and billboards.

To effectively manage related projects, whether initiated by ARTC or third parties, it is important to understand the structural capacity and utilisation of these structures before and after any changes. These changes may involve adding, upgrading, removing, or relocating equipment such as telecommunications antennas and other data transmission or infrastructure equipment.

AS 1170.2:2021 is a modern wind design standard and is primarily intended for the design of new structures under wind actions. The standard has undergone several revisions since its original publication in 1971, whereas many of the older or legacy ARTC assets were designed and constructed in the 1970s and 1980s. As a result, some apparent design deficiencies, numerically overstressed members (especially in the Ultimate Limit State-ULS), and non-compliances with current changes may be identified when assessing these older or legacy structures against the current 2021 standard, and based on this, consultants may recommend strengthening of numerically overstressed members. These changes, which cause these non-compliances, include, but are not limited to: peak gust wind data, design principles (such as design importance levels, design working life, or annual probability of exceedance), regional wind speeds, and additional or revised multipliers or coefficients for calculating wind speed and pressure.

This Technical Note aims to standardise the management process and specifies ARTC requirements and recommendations for the capacity assessment of existing wind-sensitive non-bridge structures.

Due to the lack of historical information, drawings, and structural models of older or legacy tall structures, it is often challenging for ARTC to review or refine assessments undertaken by others, particularly where consultants, on behalf of third parties, propose modifications to ARTC towers.

This Technical Note excludes structures designed in accordance with AS 1170.2:2002 or later, which are typically supported by design drawings documenting key design parameters generally more aligned with modern wind loading practices. As these structures adopt limit state design principles with closer design parameters to AS 1170.2:2021, they are less likely to exhibit significant differences when assessed against the new version of the wind design Code. However, some requirements and recommendations outlined in this Technical Note may still apply to these newer structures.

Where requirements and recommendations are not specified in this Technical Note, relevant Australian Standards shall be applied, or appropriate engineering judgement or risk assessment shall be undertaken by the designer in consultation with the ARTC representatives to ensure the project process is properly managed.

3. Scope

This Technical Note applies to existing older or legacy tall structures, including but not limited to lattice, monopole, and guyed towers used for telecommunications, communications, lighting, water infrastructure, and billboards owned or managed by ARTC. It is intended to support ARTC Subject Matter Experts (SMEs) and asset/project managers in the management of both ARTC-owned and third-party projects, including the structural capacity assessment of these towers where required, as outlined above.

4. ARTC Acceptance Criteria

4-1- Where an ARTC-owned or third-party project involves a “like-for-like” replacement of existing equipment on an ARTC tower with modern equipment that produces the same or only minimally changed global and local loading effects (including negligible changes in weight and wind loading effects), as clearly stated in the executive summary of the engineering assessment report (refer to Cl. 4.2.1 below); an ARTC Subject Matter Expert (SME) or a project/asset manager holding a certificate of scoping/acceptance of structures designs in accordance with ARTC Engineering and Design Matrix EGP0103F-03 may approve the adequacy of the existing structural capacity based on its structural performance to date, without further detailed investigation. This is subject to a close inspection confirming that there are no structurally overstressed members, no elements exhibiting apparent physical deficiencies, and that the overall as-is condition of the metal structure and foundation (where visible) is satisfactory, with no structural defects. Under these conditions, the existing foundation may also be deemed acceptable for the modern equipment without further investigation.

4-2- Where an ARTC-owned or third-party project does not involve a “like-for-like” replacement of existing equipment as above, as clearly stated in the executive summary of the engineering assessment report (refer to Cl. 4.2.1 below), the structure shall be assessed before and after changes in global and local loadings and stress due to the new installation, upgrade, removal, or relocation. In this case, the following procedure shall be taken:

4-2-1 **Structure designer:** The structure designer shall undertake a structural assessment of the tower using limit state design principles in accordance with the relevant Australian Standards. This assessment shall include evaluation of both the Ultimate Limit State (ULS) and the Serviceability Limit State (SLS). A fatigue verification is not normally required; however, where considered necessary, it may be carried out in accordance with AS 1170.2 and other Australian Standards. The engineering assessment report shall include an executive summary outlining the project's intent and the scope of the assessment work undertaken. Additionally, this report shall contain calculations supported by a structural model that incorporates both the as-new and as-is structural conditions (refer to ARTC ETS-09-01 for definitions of inspections and assessments). The engineering assessment report shall also address any changes to the structure resulting from the installation, upgrade, removal, or relocation of the proposed third-party equipment, as well as any required structural modifications or remedial works (if necessary) to ensure that such changes do not adversely affect the acceptable stress levels in members or the overall stability and strength of the tower.

No structural assessment shall be considered valid unless an as-is visual inspection has been completed, or ARTC structures specialist responsible for the asset confirms that the current condition of the structure is adequately understood and reflected in the engineering assessment report.

4-2-2 **Independent design verifier:** The independent design verifier shall review and verify the designer’s engineering report, including the accuracy of the structural model and its representation of the as-is members in the model and calculations. This shall include an independent design check, comprising a review of the designer’s engineering assessment report to verify that the design and any required and proposed structural modifications or remedial works comply with the relevant Australian Standards and are fit for their intended purpose.

4-2-3 **ARTC acceptance/rejection:** ARTC SME or a project/asset manager, holding a certificate of scoping/acceptance of structures design in accordance with ARTC Engineering and Design Matrix EGP0103F-03, shall accept/reject the third-party proposal based on the evaluations outlined above.

Where ARTC SME or project/asset manager determines that it is not required, Cl. 4-2-2 outlined above may be omitted.

5. Technical Requirements and Recommendations

5-1- Annual Probability of Exceedance

Where existing older towers are expected to remain in service for 50 years or more, and in the absence of original design drawings, the ULS annual probability of exceedance of 1/1000 may be reduced to 1/500, provided that the designer fully understands the applicable design importance levels and justifies and documents any such reduction of the levels specified in Tables F1 and F2 of AS 1170.0, or, if required, undertakes a risk assessment in consultation with ARTC representatives and obtains approval from ARTC.

In such processes, the ULS structural failure modes of the tower under 1/1000 and the reduced annual probability of exceedance shall be understood by the designer (i.e., global structural collapse due to failure of critical supporting members or foundations, or local failure of some members that does not compromise overall structural stability and may be practical and cost-effective to repair after such a wind event) to make the best decision moving forward.

In no case shall the adopted ULS annual probability of exceedance be less than 1/500.

The adopted SLS annual probability of exceedance should be selected considering acceptable tower deflection limits and the tolerance of the equipment to be operated on the tower.

5-2- Site Exposure Multipliers

For the assessment of existing older towers where towers exhibit many numerically distressed members, the topographic and terrain/height multipliers shall be refined using site-specific terrain information (such as hill height, slope, wind direction, and location), obtained from Google Earth or similar tools, rather than a simplified application of AS 1170.2, only to justify reductions in the multipliers.

5-3- Tower Analysis

The tower shall be analysed under the required separate ULS and SLS combinations in accordance with AS 1170.0.

In the absence of original drawings and material properties, the sections of “Structural Capacity”, “Assessment of Capacity Reduction Factors”, and Appendix A of AS 5100.7 should be thoroughly reviewed and applied for structural assessment.

Original drawings may be typical rather than as-built. Care shall be taken when using these drawings without verification through actual measurements, as actual member lengths and cross sections may differ from those shown on the original drawings, and discrepancies may exist. This is particularly critical, as numerical steel member failure in these towers is commonly associated with insufficient compression capacity of bracing members, often subjected to biaxial bending, or insufficient combined bending and axial capacity of tower legs. In some cases, refinement of the model may result in satisfactory utilisation of these members, whereas without such refinements, unnecessary strengthening may be imposed on the tower.

Assumptions regarding effective length factors of bracings shall reflect actual member restraint conditions. The use of unconservative factors should be avoided unless justified.

Buckling load factors derived from linear buckling analysis of a beam model do not account for local buckling or section compaction effects and shall not be solely relied upon for assessing member buckling capacity.

Second-order elastic analysis (global $P–\Delta$ and local $P–\delta$) shall be considered in the analysis where axial forces are significant. Linear static analysis alone may not be sufficient for slender tower structures.

The interaction between the tower and foundation (including fixity assumptions and soil-structure interaction) should be considered where it influences global behaviour.

5-4- Foundation

Where foundation details are not available from original drawings, but the foundation is partially exposed for close inspection and size measurements, conservative assumptions that may account for shallower foundation depth and conservative soil parameters (based on available geotechnical mapping or regional data, and where they can be justified), as well as conservative fixity conditions at the base of the tower, should be taken.

Global stability shall be assessed by verifying that overturning moments are within reasonable limits, sliding resistance is adequate, and uplift forces are consistent with typical foundation behaviour.

Where there is a risk of inadequate information on the foundation in the assumptions, while global analysis indicates unacceptable stress levels in critical tower members, the size of the foundation shall be further investigated, or a risk assessment shall be undertaken in consultation with ARTC representatives, the third party, and the consultant to address this issue before proceeding.

5-5- As-Is Reductions

Measured or assumed section loss due to corrosion shall be incorporated into the structural model and assessment. Where corrosion is present, reduced section properties shall be used in capacity calculations to incorporate the as-is capacity of the member.

For defects other than cross section losses, appropriate reduction factors should be incorporated in the model and calculations to account for such defects based on engineering principles and judgment.