



Structure, Tower &
Antenna Council
Conseil des structures,
pylônes et antennes

STAC Bulletin

Monopole Vortex Shedding Issues – Inspection and Mitigation Recommendations

Ref. # SB-0002

March 1, 2018

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Bulletin Reference #: SB-0002

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ISSUE:

Several flagpoles and shrouded monopoles (circular and semi-circular) across the country have experienced in recent years signs of fatigue including fatigue cracks in the monopole shaft, as well as in the anchor bolts. Upon investigation, it was determined that these cracks were caused by Vortex Shedding, which is a form of cross-wind vibrations.

It was determined that current CSA S37 requirements specifying an increased gust factor of 2.5 do not adequately account for fatigue resulting from Vortex Shedding.

For more information about this issue, please see [STAC Alert SA-0003 \(December 14, 2017\)](#).

PURPOSE:

The purpose of this bulletin is to provide site owners and contractors with recommended best practices for identifying and inspecting flagpoles and shrouded monopoles that may be potentially affected by Vortex Shedding fatigue and for mitigating the potential damages caused by repetitive Vortex Shedding vibrations, up to and including structural fatigue causing failure. Vortex Shedding tends to happen when wind is blowing steadily at lower wind speeds in the range of 18 km/hr to 60 km/hr. Generally, the height and the diameter of the pole determine the wind speed at which these vibrations will occur. The wind speed at which these vibrations occur is known as the **critical wind speed**.

This bulletin also provides recommendations relating to inspection frequency of flagpoles and shrouded monopoles, as well as mitigation strategies for new towers. These recommendations are expected to serve as stop-gap measures until the release of the CSA S37-18 standard, which will provide further guidance on the design requirements.

Please note that a related bulletin was previously released providing information about a similar issue relating to shrouded tripoles. For more information, please see [STAC Bulletin SB-0001 \(February 16, 2018\)](#).

WARNING: NOT HEEDING THIS BULLETIN MAY RESULT IN FLAGPOLES OR SHROUDED MONOPOLES SUFFERING FROM EARLY FATIGUE, AND COULD POSE A PUBLIC HAZARD IF LEFT UNATTENDED.



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RECOMMENDED STEPS FOR TOWER OWNERS:

It is recommended that all site owners with flagpoles and shrouded monopoles perform the following actions immediately to assess their tower inventory for potentially hazardous situations caused by Vortex Shedding vibrations. Detailed description of each step follows in the sections below:

1. Identify affected towers
2. Inspect potentially affected towers
3. Perform a dynamic analysis
4. Mitigation (as necessary)

DETAILED RECOMMENDATIONS FOR TOWER OWNERS:

1. Identification

STAC recommends that site owners immediately assess their entire inventory of **shrouded monopoles** to determine which, if any, have a circular or semi-circular shrouded portion that is equal or greater in height than 3X the diameter of the shroud. For example, a monopole would be considered within this grouping if it has a diameter of 1.2 meters and the shroud is at least 3.6 meters in height.

STAC recommends that site owners immediately assess their entire inventory of **flagpoles** to determine which, if any, have a shrouded diameter that is the same as the pole diameter, and which have no or very little external attachments on the outside of the pole (attachments include ladders, antennas, lines, etc ...).

Note, this phenomenon impacts shrouded poles (flagpoles, shrouded monopoles, guyed monopole, lollipop monopoles) that have no or very little external attachments on the outside of the pole (attachments include ladders, antennas, lines, etc ...).

Site owners who have any monopoles with these characteristics in their inventory should proceed to Recommendation 2 (Inspection) for each monopole matching this description.



The above images show examples of smooth, shrouded monopoles and flagpoles that should be considered at risk of Vortex Shedding vibrations.



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The above images show examples of monopoles that are not smooth and round on the outside (due to lines, antennas or other appurtenances), and which are not considered at risk of Vortex Shedding vibrations.

2. Inspection

STAC recommends that site owners who identify potentially affected monopoles in their inventory move forward with condition assessment inspections of each potentially affected monopole. All such inspections should only be completed by, or with the assistance of, one or more qualified engineer(s), and should put emphasis on the following elements:

1. Inspect tower for signs of fatigue, including:

- Weld cracks
- Concrete foundation cracks
- Anchor bolt cracks
- Sheared bolts or excessive number of loose bolts
- If any cracks are discovered, discontinue all other work on or near the tower and take immediate action to repair the cracks under the direct supervision of a qualified engineer. Once all cracks are repaired, proceed to Recommendation 3 (Dynamic Analysis) and Recommendation 4 (Mitigation)
- If no cracks are discovered, complete inspection and proceed to Recommendation 3 (Dynamic Analysis) and Recommendation 4 (Mitigation)
- Note: Even if there are no visible signs of cracking on or around the tower, it is possible that cracks and other effects of Vortex Shedding vibrations can manifest in the near future.

2. Measure “actual damping” and “natural frequency”

- It may be efficient to take site measurement of the structural damping at the same time inspections are carried out as it provides valuable information for the dynamic analysis. This is achieved by instrumenting and recording accelerations of the structure.
- This is particularly pertinent to the previously identified subset of monopoles, including flagpoles, shrouded monopoles, guyed monopoles, and lollipop monopoles that have no or very little external attachments on the outside of the pole (attachments include ladders, antennas, lines, etc ...).



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3. Dynamic analysis

After completing inspections on all flagpoles and shrouded monopoles matching the profile outlined above, STAC recommends that site owners perform a dynamic analysis on each such tower to determine each tower's dynamic susceptibility to Vortex Shedding vibrations. A fatigue life assessment can be completed to help the owner to decide on the appropriate next steps. These analyses will also determine the critical wind speed at which these vibrations are likely to happen and must be completed by a qualified engineer who is knowledgeable in the field of structural dynamics.

4. Mitigation

Depending on the outcome of the results of Recommendation 3 (Dynamic Analysis), the engineer responsible for the dynamic analysis may recommend mitigation solutions, especially for the most susceptible towers that have a critical wind speed for vibrations that is between 18 km/hr and 35 km/h. These solutions include removing the shroud or installing a vibration dampening device (such as a tuned liquid dampener or a tuned mass dampener). These are the only solutions that have been proven to be effective.

Notably, while fatigue cracks can develop over a long period of time, cracks caused by Vortex Shedding vibrations can also develop over a very short period of time compared to other common fatigue issues, including in as little as six months. As such, STAC strongly recommends that site owners place a high priority on mitigating any shrouded monopoles that are identified as being susceptible to Vortex Shedding vibrations.

ADDITIONAL APPLICATION – NEW TOWERS:

With regards to new shrouded monopoles currently under consideration or development, STAC recommends that all such towers be subjected to a dynamic analysis to determine their susceptibility to Vortex Shedding vibrations, so as to ensure the towers' safety.

Site owners may want to consider incorporating a vibration mitigation device for structures that are determined to be susceptible to these types of vibrations.

Note: For new tower designs, follow the guidelines outlined in CSA S37-18 Annex N. If this document is not yet available, please see the "Contact" section below to request additional detail.

ADDITIONAL APPLICATION – INSPECTION CYCLE:

Finally, STAC also recommends that future inspections of shrouded monopoles should occur every four years going forward, even if the above recommendations have been followed and mitigation strategies employed. This recommendation represents an increased inspection frequency compared to the current six-year inspection cycle for these towers that is recommended by CSA S37-13 Annex D.



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CONTACT:

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