

CALCULATIONS ON THE MECHANICAL SAFETY AREA AT TRANSMITTER TOWERS

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The transmitter towers for telecommunication are normally from 200 ft (ca. 60m) to 350 ft (ca. 100m) high and, in some cases even more, depending on the local elevation. To accommodate the construction, a site is required, being a square with a side length of about twice the towers height.

However, if available properties in desired locations are not big enough to accommodate this, in an area with lower wind activity the steel ropes (guys) that hold the tower in place are set at a steeper angle requiring a smaller area for construction, thus the square size is reduced allowing the use of a smaller piece of property. In higher wind load areas, where a steeper angle may not secure the tower safely, a big enough site must be found.

But according to the local office of Industry Canada, the above-outlined square size is not regulated and since those towers are considered utility structures, local building codes do not apply.

The size of the square depends only on the area needed for the actual construction of the tower with the anchors. Furthermore, the size of the security area (fence) is set to protect the site from outside hazards, and not to protect the public from hazards caused by the installation.

This distance by itself is, therefore, inadequate as a safety zone because it does not give a safe area in case of a serious mechanical failure at the tower. This is a serious flaw in the site selection process.

The following calculations are based on a worst case scenario to determine the area endangered in such a situation by mechanical failure at the tower. We assume for a worst-case scenario a total mechanical failure that can be caused by stress, extreme overload, defect in material, fatigue, corrosion, poor workmanship, insufficient maintenance, and sabotage, as well as any combination of these factors.

In the following calculations the let-

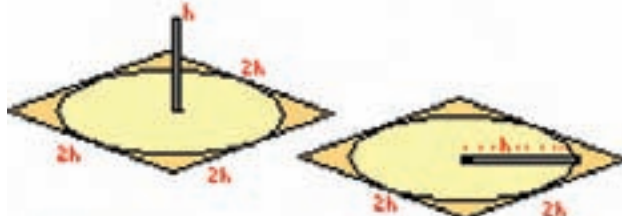


Figure 1 – Case A

ter h represents the height of a given tower.

CASE A) THE TOWER FALLS OVER

For a rigid structure (e.g. a pole or even a tree) the endangered zone is a circle with a radius of the structure's (tower) height, that is twice the height in diameter, it is accommodated by a square with such a side length, that is $2 \times h$. Most sites have exactly this size and are therefore declared sufficient by the operating company.

However, most of these towers are not single pole structures; they are cage element structures secured with steel ropes (guy wires) to ground anchors. The possible hazards of these wires add to the endangered area. The upper ones of these wires are reaching up to at least about 90% of the height of the tower; that is $0.9 h$. They are secured to an anchor in the ground that is positioned within the square. For the calculations, the anchors are assumed to be at a distance equal to 90% of the height from the center of the tower; that is also $0.9 h$. The length of the highest reaching wires calculates then to about 1.27 times the height of the tower, that is $1.27 h$.

(Apply Pythagorean Theorem: guy

wire length = square-root of $\{ (0.9 h)^2 + (0.9 h)^2 \} = 1.27 h$)

CASE B) THE GUY WIRE SNAPS AT THE TOP - LASHING OUT.

The whip-lashing and falling steel rope endangers an area with a radius given by its length around the anchor. The guy

anchors are assumed to be located at 90% of the height; that is $0.9 h$, from the center of the tower. Therefore, the endangered zone is $0.9 h + 1.27 h = 2.17 h$ reaching $1.17 h$ outside the normal tower site (a $2 h$ square).

With tie wires, this risk could be reduced, but a tie wire may give way under such conditions too. The theoretical distance endangered by such a wire is

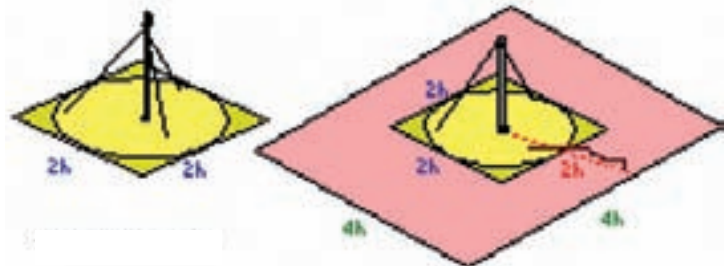


Figure 2 – Case B

therefore $2.17 h$ from the tower center. Taking into account bends in the falling wire and obstructions in the path, a reasonable reduction of this distance by 10 % can be made. The real danger zone for mechanical failure is, therefore, 90% of this distance, that is $0.9 \times 2.17 h = 1.953 h$, rounded to $2.0 h$, from the center of the tower. The danger area is a circle with $4 h$ in diameter.

Therefore, only if the site is a square with a side of at least 4 times the height of the tower, it encloses the danger zone in case of severe mechanical failure!

CASE C) THE WIRES SNAP AT THE ANCHOR, AND THE TOWER FALLS.

The falling tower causes the guy wires to whip out in the direction of its fall. The longest wire is connected at 90% of the tower's height. Hence, the calculations have the same numbers and the result as in case B.

The distance of danger is $2 \times h$ from the center of the tower. The radius of danger is given by this distance = $2h$. The area is a circle with $4h$ in diameter

Again here, only a square with a side of 4 times the height of the tower encloses the danger zone.

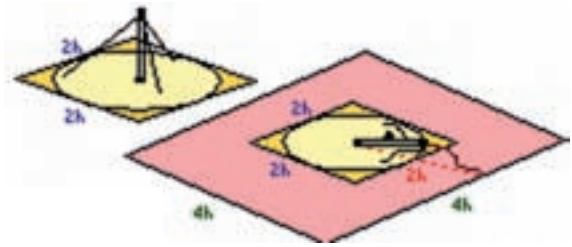


Figure 3 – Case C

CASE D) THE TOP WIRE SNAPS AT ONE ANCHOR, THE TOP CAGE ELEMENT BREAKS OFF AND LASHES OUT TIED TO A REMAINING ANCHOR.

The total mechanical length is $2 \times$ wire length plus anchor distance from center that calculates to $(0.9 + 2.54)h = 3.44h$. Applying bend and drag reduction, the safe distance in this case easily calculates to $0.9h + 0.9 \times 1.27h + 0.4 \times 1.27h = (0.9 + 1.143 + 0.508)h = 2.551h$. The safety zone is a circle with about $5h$ in diameter requiring a square of this side length.

The 40% drag-lash length is a favourable assumption - applying the full length of this "debris" $3.44h$ from center would require a square of about $7h$ to ensure 100% safety.

The fenced area may be smaller, depending on regulations, but the tower must then be removed from a neighbouring property by the above calculated lengths to be at a safe distance.

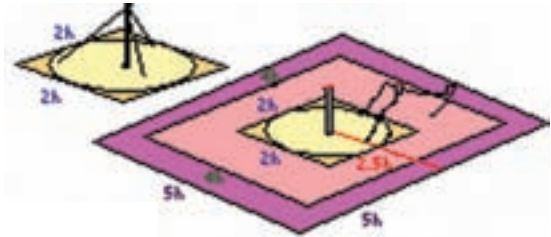


Figure 4 – Case D

Therefore, it is best that any such tower should be distanced at least twice the height (better two and a half times) the tower's height from any neighbouring property line.

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