# Technical Brief

## Radio Line of Sight

Radio transmission requires a clear path between antennas known as radio line of sight. It is necessary to understand the requirements for radio line of sight when designing a network using Solectek equipment.

Line of sight is the direct free-space path that exists between two points. Using binoculars on a clear day, it is easy to determine if visual line of sight exists between two points that are miles apart. To have a clear line of sight there must be no obstructions between the two locations. Often this means that the observation points must be high enough to allow the viewer to see over any ground-based obstructions.

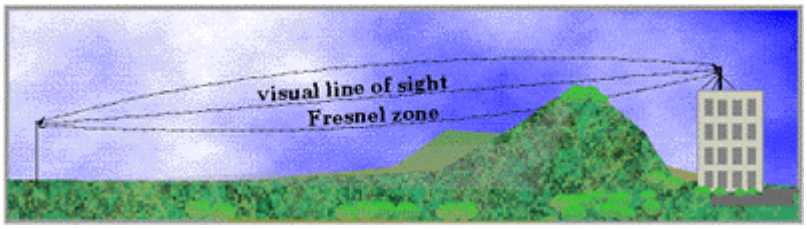
**The following obstructions might obscure a visual link:**

- Topographic features, such as mountains
- The curvature of the Earth
- Buildings and other man-made objects
- Trees

If any of these obstructions rise high enough to block the view from end to end, there is no visual line of sight.


Obstructions that can interfere with visual line of sight can also interfere with radio line of sight. But one must also consider the Fresnel effect. If a hard object, such as a mountain ridge or building, is too close to the signal path, it can damage the radio signal or reduce its strength. This happens even though the obstacle does not obscure the direct, visual line of sight.

The Fresnel zone for a radio beam is an elliptical area immediately surrounding the visual path. It varies in thickness depending on the length of the signal path and the frequency of the signal. The necessary clearance for the Fresnel zone can be calculated, and it must be taken into account when designing a wireless links.




As shown in the picture above, when a hard object protrudes into the signal path within the Fresnel zone, knife-edge diffraction can deflect part of the signal and cause it to reach the receiving antenna slightly later

than the direct signal. Since these deflected signals are out of phase with the direct signal, they can reduce its power or cancel it out altogether. If trees or other 'soft' objects protrude into the Fresnel zone, they can attenuate (reduced the strength of) a passing signal. In short, the fact that you can see a location does not mean that you can establish a quality radio link to that location.

For short links of three miles or less, you can determine radio line of sight by climbing to the proposed antenna mounting point and looking for the other site with the aid of binoculars. If you can see the destination point, you can calculate the Fresnel zone allowance by reference table or with Solectek's help. If any obstacles (buildings, trees, etc.) in the Fresnel zone between the two points could interfere with the signal, the calculation for the antenna height must take these obstructions into account. Where trees or man-made objects obscure one end of the link, Solectek or a third-party specialist can float a large balloon on a calibrated tether. Using binoculars and cell phones or walkie-talkies, the person at one site can tell the person at the other site when the balloon is high enough for visual line of sight. The clearance requirement for the Fresnel zone is added to the visual line of sight height when calculating the antenna heights.

For links of three to twenty-five miles, Solectek uses computerized maps provided by the US Geological Service to make a preliminary assessment concerning the feasibility of a radio link between two points. Where the preliminary finding leaves any doubt, it is the customer's responsibility to engage the proper resources to certify that radio line of sight for the desired frequency is possible and what the antenna heights must be.

Whenever possible, Solectek recommends that the customer establish a test link, using the proposed Solectek equipment between the sites to determine the actual quality of the path. Solectek Technical and Field Support has further information.

**There are several options to establish or improve the line of sight:**

- Raise the antenna mounting point on the existing structure
- Build a new structure, i.e. radio tower, which is tall enough to mount the antenna
- Increase the height of an existing tower
- Locate a different mounting point, i.e. building or tower, for the antenna
- Cut down problem trees