Creating and Using Accurate Terrain Based Assessments

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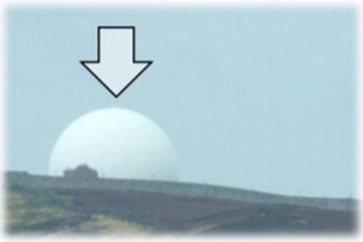
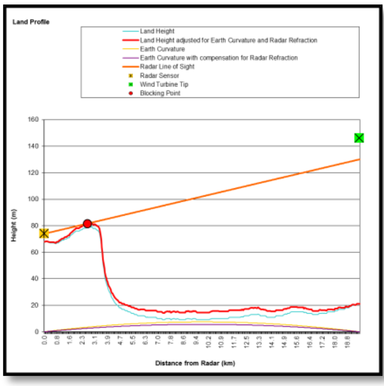
WHITE PAPER

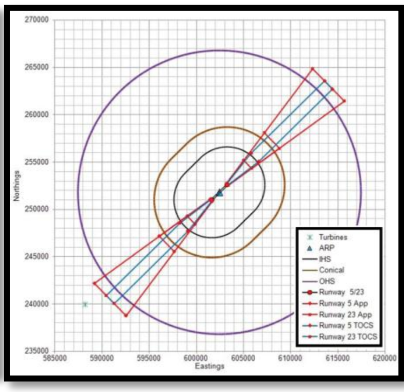
Accurate terrain based assessments answer important questions for people developing communications, transport, property and energy infrastructure.

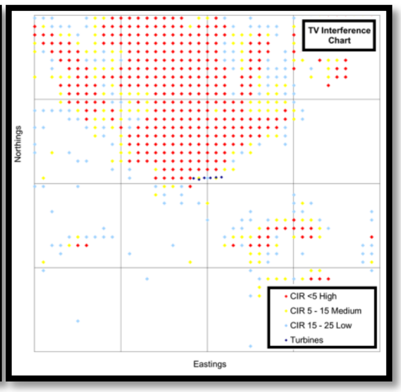
Radio transmission planners can establish whether one radio site can reliably connect to another; Wind farm developers can be certain that their turbines will not affect military radar and airport operators can ensure that new property developments fully comply with national or international safeguarding rules.



There are many tools and software packages that may be used to undertake terrain based assessments such as radar line of sight profile charts; radio coverage charts; physical safeguarding charts and radio interference predictions.



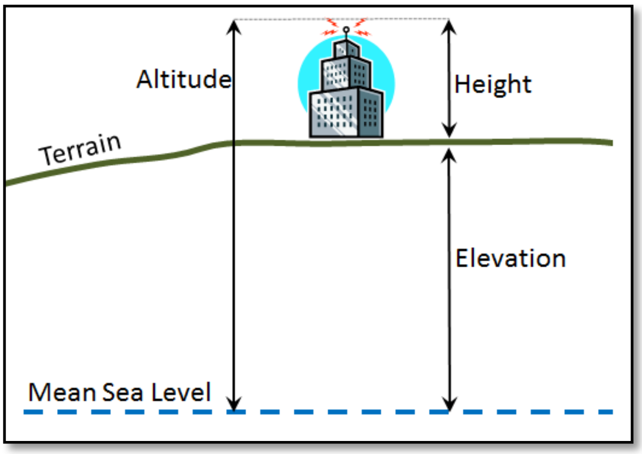




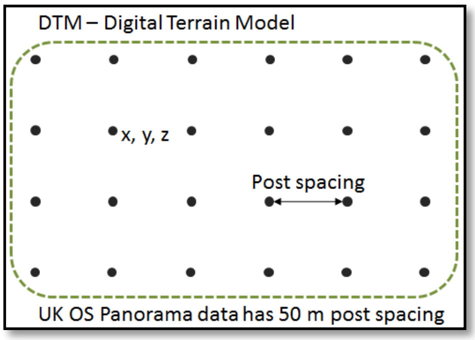
The overall accuracy of any terrain based assessment is dependent on the following factors:

- Accuracy of coordinates and height data for the infrastructure being assessed
- Resolution and quality of digital terrain or surface data
- Choice of algorithm for determining land height from terrain data

Coordinates and height of existing infrastructure may be obtained from the infrastructure owner, custom databases, various forms of mapping or via a site survey.

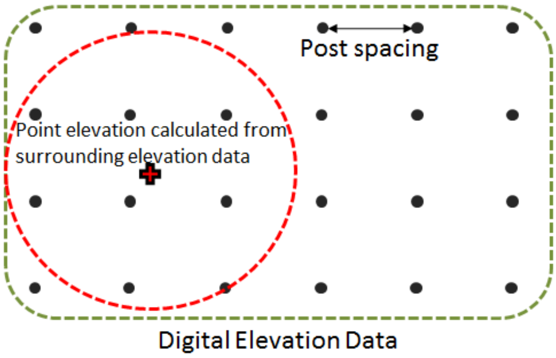


Sometimes the coordinate and height data used may be inaccurate because of coordinate rounding or confusion between height and altitude. Verification of infrastructure position data makes the results of terrain based assessments more reliable.

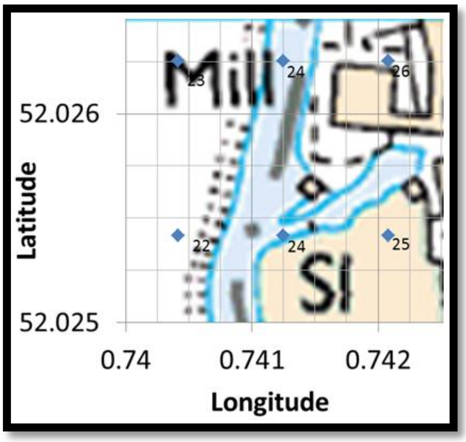


The resolution of digital data is described by its post spacing – a typical resolution being 50 metres.

Digital terrain and surface data has a vertical accuracy described by a statistical relationship between database and actual vertical values – a typical rms[1] vertical accuracy being 2 metres.



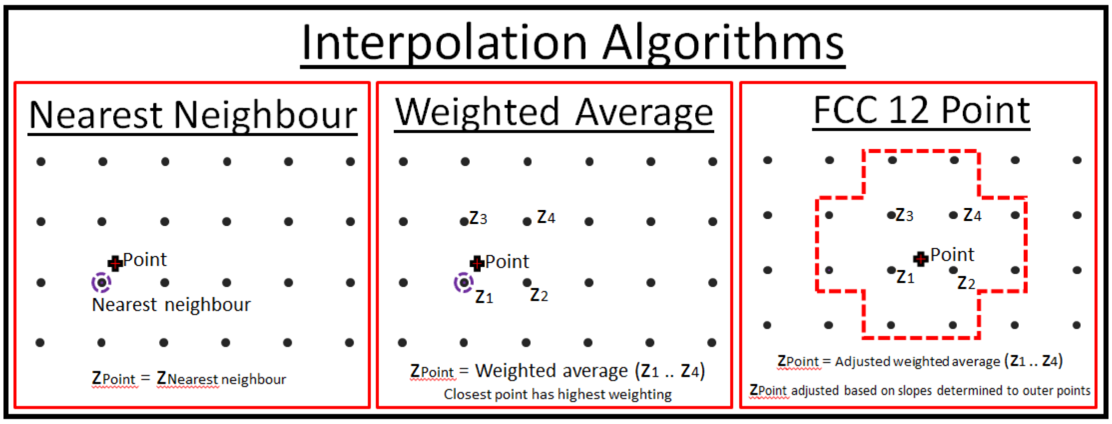
Terrain data relates to the elevation (height above mean sea level) of the ground whereas surface data relates to the altitude (also height above mean sea level) of tree cover or buildings.
Where there are no trees or structures terrain and surface data should match.



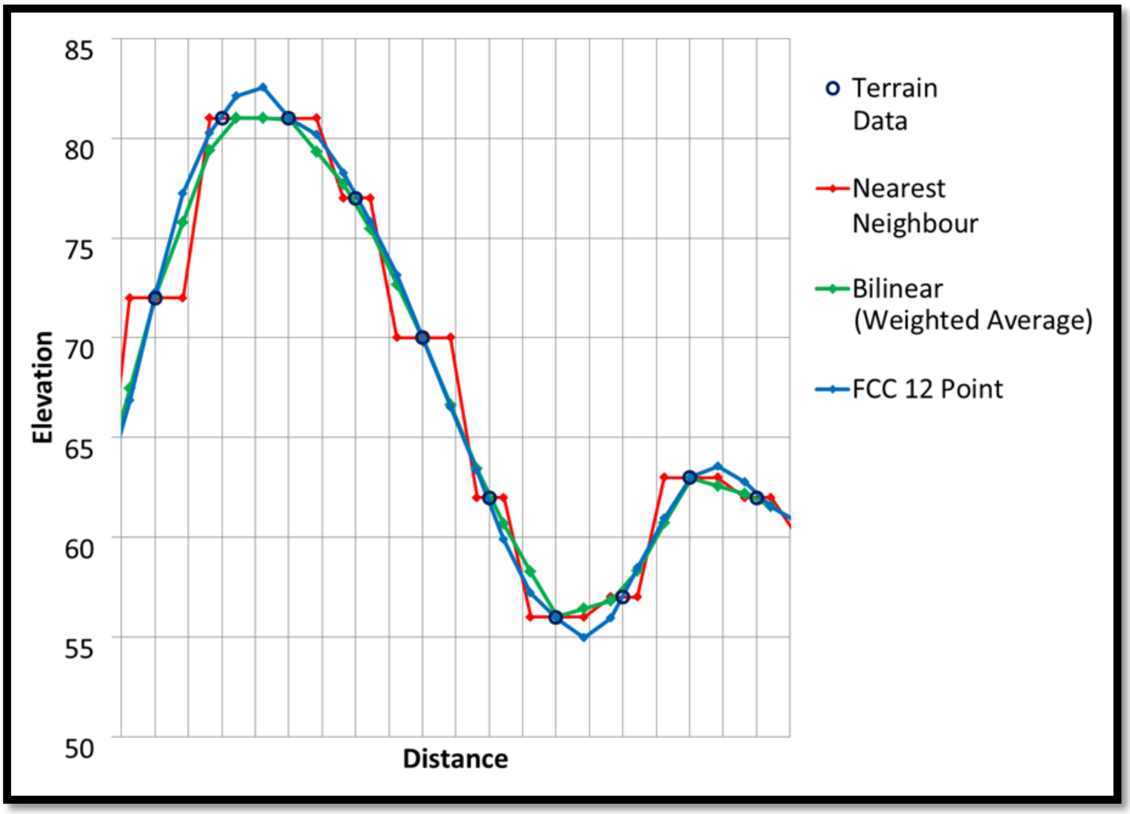
Typically surface data is higher than terrain data because it includes features above the terrain. It is important that an appropriate terrain data set is selected and that its quality and accuracy are fully understood.

[1] Root mean square

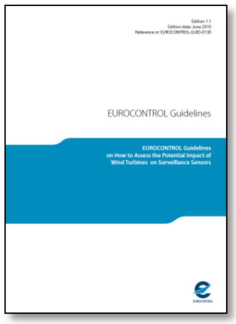
Digital terrain data is used to calculate the terrain or surface height at specific locations. There are many processing algorithms for achieving this. These algorithms vary in accuracy and some are more appropriate for certain types of calculations than others. The nearest neighbour algorithm runs quickly and is effective for some applications. A weighted average algorithm is more accurate and generally gives conservative results for wind farm radar calculations. A more advanced algorithm using twelve data points is more accurate yet less conservative when determining the likelihood of a radar detecting a wind turbine.



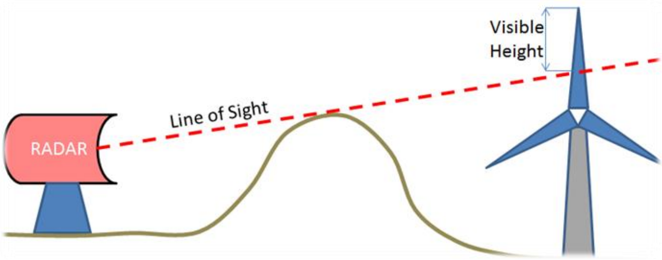
Comparison of Interpolation Algorithms – (Simplified 2D)



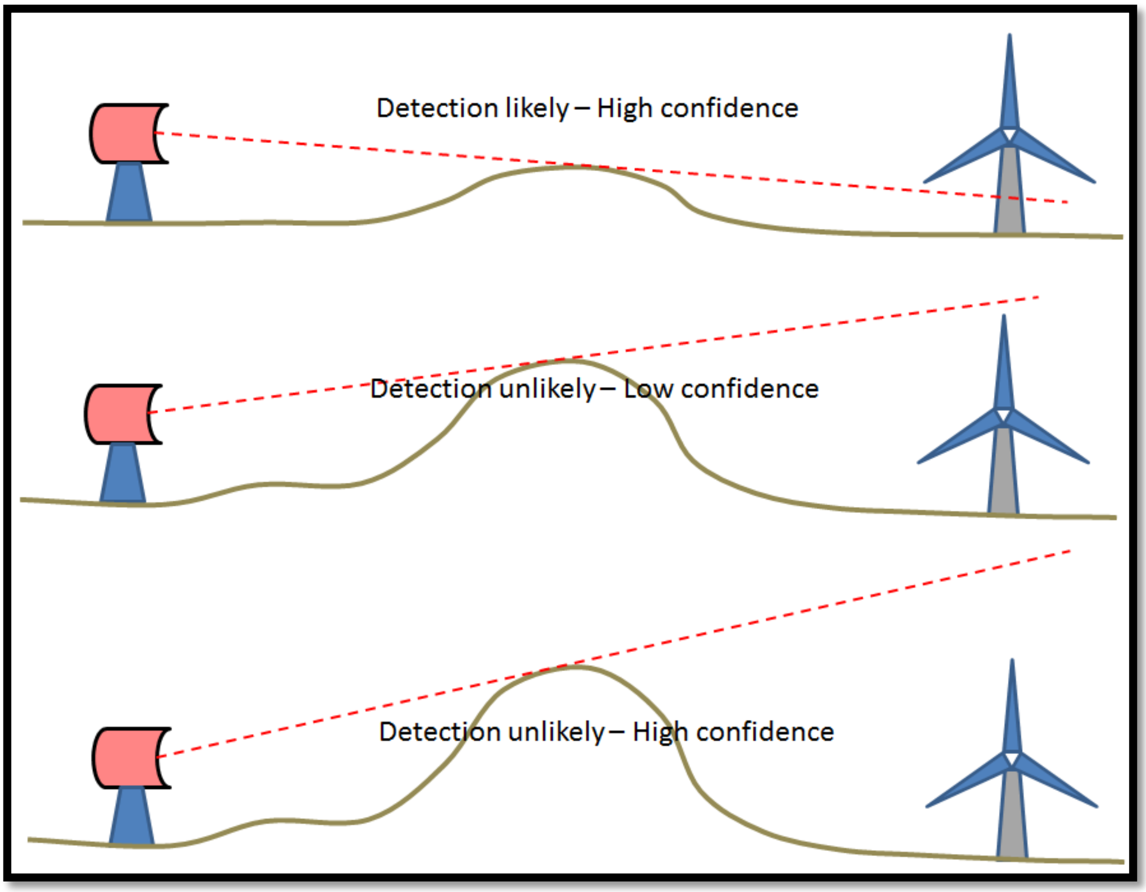
Radar line of sight charts are used to determine whether a wind turbine is likely to affect a radar. Line of sight assessment is specified in standard radar texts as well as in guidance from national and international energy, defence and aviation agencies.



Line of sight analysis shows how much of the turbine is illuminated by the radar beam and takes earth curvature and refraction into account. Whilst the level of refraction can vary it usually results in a downward bending of the radar signal due to the atmosphere and increases the amount of the turbine visible to the radar. The level of confidence in this visibility may be calculated as a percentage for a specific assessment.



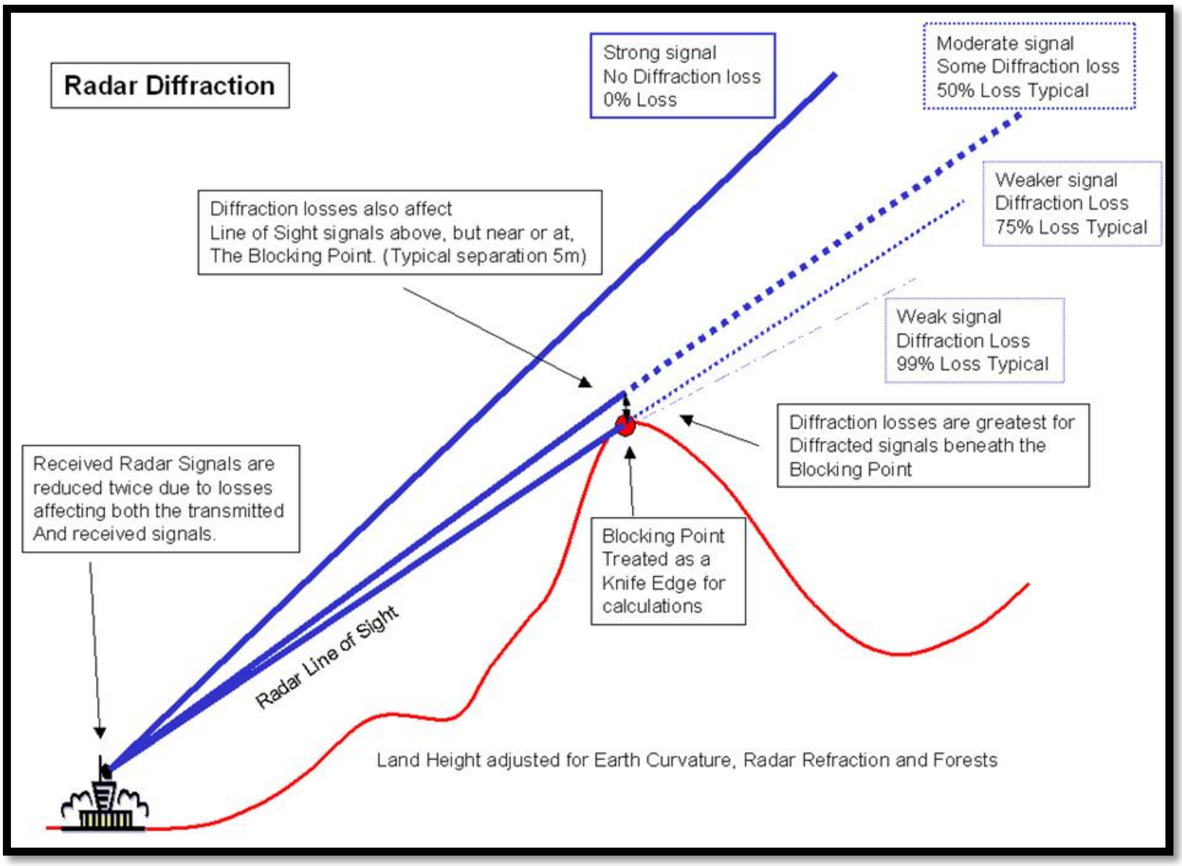
The point between the radar and turbine that limits the radar's view of the turbine is the blocking point. It is important to recognise that the point initially identified as the blocking point may not be the actual blocking point. Detailed analysis of the blocking point increases the certainty and accuracy of assessment results. Comparison of the results of line of sight assessments with real world radar screen observations show that accurate line of sight analysis gives a good conservative indication as to whether a wind turbine will be detected.



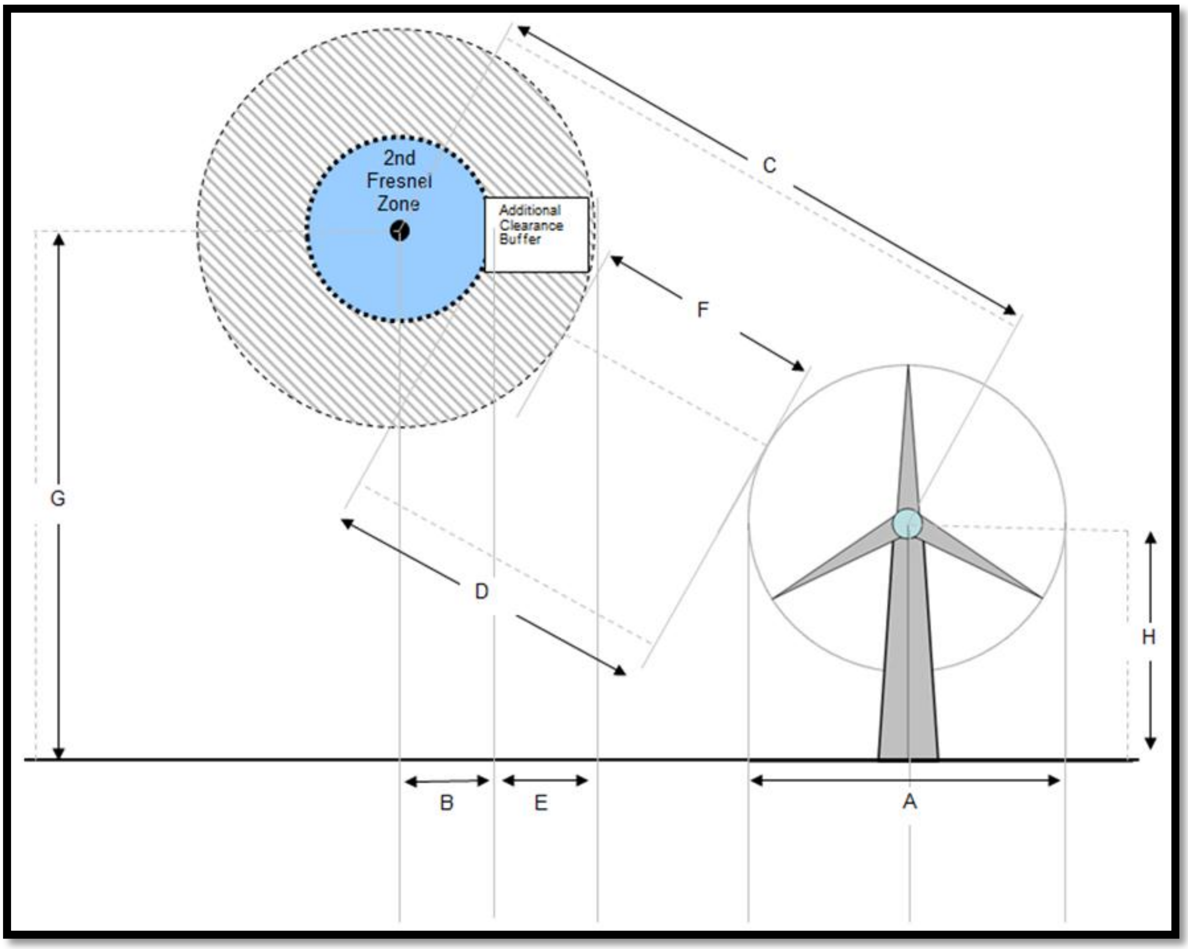
Diffraction is a physical effect that means radio signals passing just above the blocking point are weakened and that weak radio signals radiate below the blocking point. Standard line of sight analysis does not account for diffraction effects. There are a number of assessment methods which account for diffraction – not all are effective for wind farm radar assessments.

Radar detectability calculations for wind turbines account for diffraction losses being underpinned by accurate terrain based assessments. These calculations indicate whether the energy reflected from a wind turbine is sufficient to be detected by the radar.

Diffraction losses between the radar and the top of a wind turbine are typically much less than the diffraction losses between the radar and the bottom of the turbine rotor. It is important that this variation in diffraction loss is modelled accurately for reliable results.



A combination of line of sight analysis; detailed blocking point analysis and radar detectability analysis can accurately and reliably predict whether a radar will detect a wind turbine of specific dimensions at a specific position. More advanced assessments can be undertaken to determine what size of turbine can be accommodated at a specific point without affecting a radar. Assessments can also show areas where turbines of a particular size can be accommodated without affecting a specific radar.



Terrain based assessments can also be used to determine whether a radio communications link between two sites will work reliably by determining whether the link path and the zone around it are clear of terrain and obstructions. The required clearance is dependent on the frequency of the radio link. It is also possible to predict radio coverage from a specific transmitter over a particular area. More complex assessments can predict interference from wind turbines over a specific area.

For further information or assistance with a particular project please visit www.pagerpower.co.uk

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