

THE HOW AND WHY OF WIND SENSOR MOUNTING



How long should my mounting boom be? I have been given conflicting advice that booms should be 7, or 8, or even 12 tower diameters long.

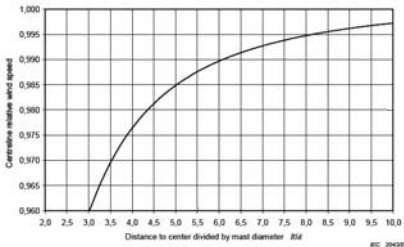


Figure G.6 – Centre-line relative wind speed as a function of distance R from the centre of a tubular mast and mast diameter d

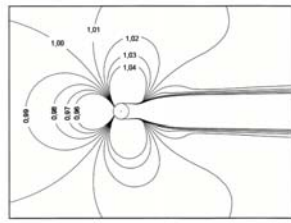
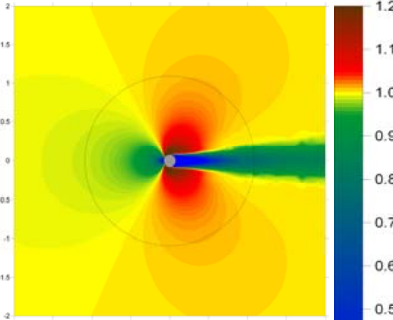
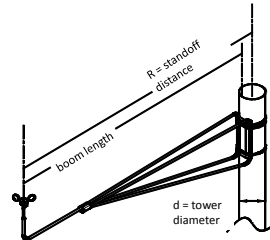


Figure G.5 – Iso-speed plot of local flow speed around a cylindrical mast, normalised by free-field wind speed (from the left); analysis by 2 dimensional Navier-Stokes computations



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In their 2005 paper, Filippelli and Mackiewicz² modeled the flow around a tubular tower, taking into account turbulence and tower roughness, and verifying the model results with field data. This diagram is a top view, with the wind from the left. Their data show that the IEC standard model is optimistic. Even at a standoff distance 7.5 tower diameters straight upwind, this model predicts that flow distortion gives a wind speed only 97% of the true wind. Standoff distances of 12 tower diameters straight upwind are required to obtain less than 1% distortion.

Placing an anemometer too close to the tower, even on the upwind side, places it in distorted flow.

The International Electrotechnical Commission¹ specification IEC 61400-12-1 uses a simple mathematical model of the flow distortion around a tubular tower. This model predicts that straight upwind at a standoff distance $R = 6.1$ tower diameters, the flow distortion gives a measured wind speed 99% of the true wind. Even at $R = 8.2$ times the tower diameter, the model predicts a measured wind speed only 99.5% of the true wind.

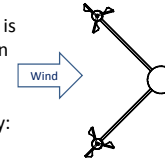
Use the longest booms that are practical. Even 12 tower diameters is not too long. The minimum flow distortion is at 60 degrees into the wind.



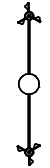
What is the best way to arrange booms for redundant anemometers? I have been given conflicting advice to arrange the booms at the same level 90 degrees apart, or 180 degrees apart.

The models above show that the flow distortion is minimized when the sensors are positioned upwind of the tower about 60 degrees to the wind direction. So, it is very important to find as much information as possible about the range of wind directions of interest before designing your sensor layout. Often, the strongest winds are from a small direction range.

Once the prevailing direction is known, or if only one direction is important for a given study, minimize flow distortion by arranging the sensors this way:



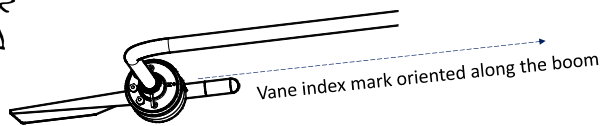
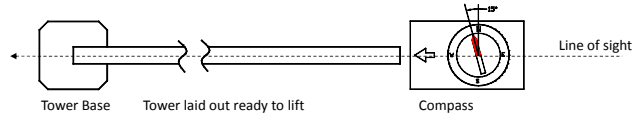
If the prevailing wind is not known, or wind from all directions must be measured, arranging the two sensors this way gives a range of useful directions, but at least one anemometer is always subject to significant flow distortion in the tower wake.



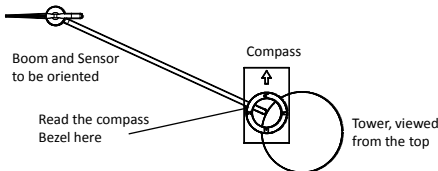
Use information on the wind direction of interest to optimize sensor orientation.



How do I get my direction vanes pointed correctly?

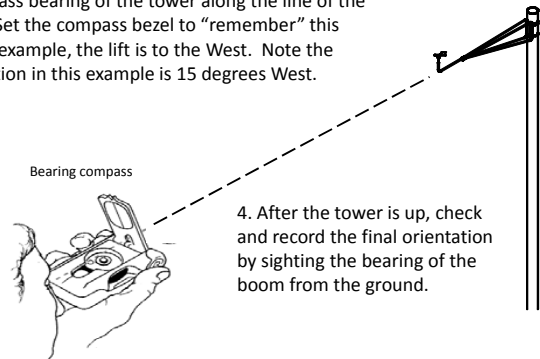


1. Mount the direction vane with the North index oriented along the boom.



3. Set up the boom loosely on the tower. Turn the clear base of the compass to vertical, and sight down the tower. Now, instead of reading the needle, read the compass bezel like a protractor to set the orientation desired. Slide the entire boom around the tower to the desired heading, then tighten the boom's clamps. This example shows the boom oriented heading 195 degrees.

2. Sight the compass bearing of the tower along the line of the lift, top to base. Set the compass bezel to "remember" this direction. In this example, the lift is to the West. Note the magnetic declination in this example is 15 degrees West.



4. After the tower is up, check and record the final orientation by sighting the bearing of the boom from the ground.



Mount your wind direction vane with the index oriented along the mounting boom. Use a compass to orient the boom on the tower. Check the final orientation by sighting the boom from the ground using a bearing compass. Add this measured vane orientation as an offset in your data acquisition system to obtain correctly oriented direction data.

References:

1. IEC 61400-12-1, Wind Turbines ed.1.0 – Part 12-1: Power performance measurements of electricity producing wind turbines, Annex G. Copyright © 2005 IEC Geneva, Switzerland. www.iec.ch
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2. Filippelli, Matthew and Mackiewicz, Pawel: Experimental and Computational Investigation of Flow Distortion Around a Tubular Meteorological Mast (Proc. CanWEA Conference – Toronto, Ontario, October 2005.)
3. Application Note- Aligning Wind Vanes. Revision 2, 2003. (NRG Systems, Hinesburg, Vermont, www.nrgsystems.com)

