The trouble is, we need to be careful about what we mean by setbacks.

There are safety setbacks, and there are noise setbacks. They are not the same.

I'll try to give an explanation here, with only as much detail as needed. (But probably more than wanted by some who just want a simple number.)

Noise setbacks should be based on the noise where a person is trying to rest, including contributions from all turbines within 3 to 5 km, not just a single turbine. Thus, single turbine setbacks are really not relevant to sound measurements. To understand noise setbacks you need to have a rough idea of what dBA sound measurement means. The dBA scale is based on maximizing contribution of those sound frequencies that are used in speech communication, and minimizing the contribution of frequencies not in normal speech.

Sound is calculated in dBA by looking at 8 octave bands - where the frequency doubles from band to band. The contributions are added together logarithmically.

Sounds below the 63 Hz band are ignored.
Sound in the 63 Hz band is reduced by 26.2 dB (thus low frequency sound - such as 60 Hz transformer hum has a low additive effect)
Sound in the 125 Hz band is reduced by 16.1 dB
Sound in the 250 Hz band is reduced by 8.6 dB
Sound in the 500 Hz band is reduced by 3.2 dB
Sound in the 1000 Hz band is fully included
Sound in the 2000 Hz band is increased by 1.2 dB
Sound in the 4000 Hz band is increased by 1.0 dB
Sound in the 8000 Hz band is decreased by 1.1 dB
Sound above the 8000 Hz band are ignored. (Thus high frequency whistles, are ignored).

This does not say that you cannot hear the lowest or highest frequencies, it says that they are not normally part of communication, and in fact our hearing is most sensitive in the middle range. Different people have different response, some hear further into the low and high range. Particularly as we age, or if exposed to excessive industrial noise, (or even play our iPods too loud) most start to loose the highest frequency response, and gradually our hearing diminishes. We hear lower pitch rumbles, but cannot determine what is being said. Thus, a person with typical age degenerated hearing will still hear low frequency sound, but will have difficulty understanding conversation, particularly conversation of children or women who have higher pitched voices. Wind turbines cover a wise frequency spectrum, but emit sound that is higher in intensity in the lower frequency ranges. The cruelty of this is that wind turbines produce a sound that is more pronounced at a low frequency end, so a person who has difficulty hearing others can still be bothered by wind turbines!

When one calculates a dBA sound measurement for a wind turbine it tends to diminish the contribution from the low frequency end. An alternate "scale" used to measure sound is the dBC scale. It tends to be more level, and not diminish the low frequency contribution as does the dBA scale. For example sounds in the 63 Hz band are reduced by only 0.8 dB on the dBC scale, not 26.2 dB as on the dBA scale. Thus measurement of sound from wind turbines on the dBC scale shows a larger contribution from the lower frequency.

A way to understand the implications the use of different scales has when calculating the sound from different sources is to compare the sounds measured on the dBA or dBC scale for a number of common appliances, and to compare them to the sound from a wind turbine.

We often hear claims that a wind turbine makes no more sound than is issued by a refrigerator in a home. I used a sound level meter with dBA and dBC scales, and sensitive from about 30 dB to 120 dB to measure some common appliances and to compare them to a wind turbine.

At about 1 metre, our refrigerator (a newer machine with several fans) measures 45 dBA and 50 dBC, showing that the sound is emitted mostly in the middle ranges of the octave scales, as the dBC measurement is only somewhat greater than the dBA reading.

Our upright vacuum cleaner measures about 70 dBA and 74 dBC at the user's ears. Considerably louder than the refrigerator, but still mostly in the middle ranges.

However, when I made measurements using the same sound level meter at night about 400 metres from a turbine of the Huron Wind array of 5 Vestas V80 1.8 MW turbines (plus 1 smaller Tacke 600 kw turbine in the distance), with the others within 1000 metres, the measured sound was from 40 to 45 dBA, and 55 to 75 dBC (varying up and down in intensity as the blades rotated). Not only was the sound intensity variation very noticeable (significantly more on the dBC scale than the dBA scale), the difference between the dBA and dBC readings was significantly higher than for the home appliances. This showed two significant differences:

1) the wind turbine has a much larger low frequency component than the household appliances, apparent because of the greater difference between the dBA and dBC readings, and

2) the sound from the wind turbine, particularly the low frequency component, had an apparent cyclical pattern up and down in intensity in step with the blade rotation.

Another way to think about this, is that while the dBA measurement for the wind turbines is comparable to the refrigerator, the dBC readings are closer to the vacuum cleaner. It puts some clarity onto the issue of why the low frequency component of the sound from wind turbines impacts a person.

The Ontario MOE publication NPC-232 "Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)" allows sound levels of 40 dBA overnight between 7 PM and 7 AM. However, MOE Publication NPC-104 "Sound Level Adjustments" requires that for cyclic variations, "If a sound has an audible cyclic variation in sound level such as beating or other amplitude modulation then the observed value shall be increased by 5." In other words, for a sound level measured from wind turbines which show a cyclic measurement, going up and down in intensity, as noted above, then a sound measured as 45 dBA should be increased by 5 to 50 dBA. Clearly this would be above the MOE night time limit of 40 dBA in the case measured. However, the MOE in their October 2008 publication "Noise Guidelines for Wind Farms" specifically states, "It should be noted that the adjustments for special quality of sound described in Publication NPC-104, were not designed to apply to sounds exhibiting such temporal characteristic." This means they are not applying the penalty called for by NPC-104 to wind turbines. We have raised this as an incorrect interpretation consistently with the MOE, and even one of the original authors of the NPC-104 documents has stated that the cyclical sound from wind turbines is the sort of sound variation that the original authors had in mind, but the MOE have refused to respond to any of the criticism. If this cyclical penalty were applied, then wind turbines would need to be nearly twice as far from homes to meet the regulations.

Dr. John Harrison has raised an additional concern that he believes the 40 dBA permitted sound level in rural communities is inappropriate as it is a significant intrusion on the typical sound levels in rural communities at night of 25 dBA or so. It makes the wind turbine not just a contributor t the overall sound, it becomes the dominant sound and thus is more annoying.

At any rate, given the limit currently in use of 40 dBA, the case continues to be put forward that the limit is excessive since:

1) the wind turbine sound is greatly influenced by the low frequency component, which is significantly reduced in measured intensity by using the dBA weighting system.

2) the wind turbine sound is cyclical - so a penalty of 5 dBA should apply.

3) the rural background is low, and a 40 dBA limit is a significant intrusion.

Even still, if we consider the sound output of a GE 1.5 sle turbine, then a single turbine would need to be 680 metres from a home to achieve 35 dBA limit and an array of 5 turbines would have to each be 1315 metres from a home for the array of 5 to achieve 35 dBA at a home.

An array of Siemens 2.3 turbine with 93 metre or 101 blades, produce more sound than the GE turbines, and the sound produced would require a further setback, while a single Vestas V82 turbine would require a setback of 1250 metres to achieve 35 dBA, and an array of 5 Vestas V82 turbines would require a setback of over 2200 metres each to achieve a sound level of 35 dBA at homes.

You can see why a single value of setback from turbines is really of little value in determining an acoustical setback, as the effect of all turbines in the array must be considered. As a general rule, if there are any turbines within 2000 metres of a home, they will produce a large enough effect that turbines at distances over 3000 metres likely do not need to be considered.

The acoustical impact of turbines on the interior of a house, depends on the house construction. Generally, Canadian wood frame constructed homes provide less attenuation to lower frequencies than to high frequencies. Again, the low frequency component of wind turbine sound is important. Often standards are written considering that a house provides an attenuation of 15 dB or so, but this is considering the speech sensitive middle frequencies. The attenuation of the lower frequency component of wind turbine sound may well be less. The attenuation also depends upon the house construction (amount of insulation) and to a significant degree upon the construction and opening of windows. A closed - double paned, sealed window provides a much better attenuation, than older double hung windows with single glazed windows and a removable storm window. These may be more prone to rattle, and to pass sound through. However, even newer double insulated casement windows can present their own problems, as if opened, depending on the direction of the sound source, the opened casement window acts rather like "ears" and captures sound coming from the direction the window is opened towards to direct it into the house.

I hope this discussion has not been too complex, but gives an idea of some of the conditions that need to be considered in calculating a sound setback.

The case of a safety setback is relatively simpler. The physical safety depends on factors that put items on the ground around the turbine. This includes:

- ice falling from the blades (relatively the issue with the highest frequency). It is not a trivial issue as pieces of ice up to 12 inches x 12 inches x 2 inches thick have been found at distances of up to 100 metres from the 50 metre hub height Tacke wind turbine at the Bruce Nuclear Information Centre. Ice of a similar size falling from a turbine with an 80 metre hub height can hit the ground with the same impact as a concrete block dropped from a 6 storey window. Simply scaling up the smaller turbine would suggest this ice might impact up to 175 metres from the tower, and GE, a turbine manufacturer recommends an ice safety setback of 1.5 times the sum of the turbine hub height plus the rotor diameter. (For a 95 metre hub with 90 metre rotor diameter, this is a setback of 277 metres.
- tower collapse occurs relatively infrequently, often associated with blade

impact with the tower. While a tower collapse puts a lot of equipment on the ground, the distance is relatively limited.

- probably the accident of the highest significance is the loss of a turbine blade or part of blade. Actual experience has seen turbine blade pieces travel up to 500 metres from turbine towers. For this reason, Hydro One Systems have said they are putting in place a guideline to require wind turbines to be 500 metres from Hydro One critical assets, the 500 kV transmission corridors. To have an idea of the magnitude of the impact that even 10% of a turbine blade would have falling, a calculation shows that this would hit the ground with the same impact as dropping a Ford Crown Victoria (chosen only because it is the largest domestic automobile produced) from the top of the Bluewater bridge in Sarnia onto the water below.

Applying what is called "deterministic safety analysis" what one does is to put in place a barrier effective to protect the member of the public who is not prevented from being within the barrier restricted area. This means putting in place a 500 metre setback to protect the public. Often wind turbine proponents will do calculations suggesting that the risk of actually killing someone in a wind turbine accident is low, as it is unlikely that a person would be in the area around the turbine. However, this is an inappropriate use of probabilistic risk assessment as it does not show that the risk to the person who is within the exclusion area is significant. How high the risk is can be determined by considering the actual blade failure frequency.

Without going into detail here, simply put the effective deterministic safety setback for today's wind turbines is about 500 metres, not the setback of turbine blade length plus 10 metres that is quoted in the Ontario regulations.

Over time, I hope to develop a more comprehensive writeup of the whole issue of setbacks, but this may help to explain the differences between noise setbacks and safety setbacks.

Bottom line is that a 360 metre setback is inadequate for either a safety setback or a noise setback, and it is misunderstanding as noted in the memo below that causes confusion. Some smaller turbines may in the past have been installed with 360 metre setbacks, but that is far from adequate for today's turbines. Claims that Ontario has a restrictive 550 metre setback are similarly flawed. I hope this helps some on an interim basis.

Bill Palmer