NOISE MEASUREMENTS IN AIRFLOWS

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1 INTRODUCTION

Acoustic measurements in outdoor situations where wind has the potential to affect the results of the measurements are carried out by many practitioners. This paper will look at the effects that wind noise has on acoustic measurements and the practical methods for reducing it. It will also go into details of the situations where airflow from sources other than wind may affect measurements. In these situations, there may be other methods of microphone protection more suitable that the traditional methods and the paper will discuss these in detail, giving practitioners the information to guide decisions on the best method for a specific application. This paper first appeared in the Instrumentation Corner section of the Acoustics Bulletin for March/April 2019.

2 NOISE MEASUREMENTS IN OUTDOOR WIND CONDITIONS

Virtually all acoustics practitioners are aware of the importance of providing protection to microphones to guard against wind induced noise. The use of the ubiquitous 90mm foam windscreen as a minimum for all outdoor measurements is common practice. The increasing use of windfarms has led to the extension of these types of windscreens to include secondary windscreens, which are larger and provide greater protection from wind induced noise on the microphone diaphragm. While these types of windscreens are now mandated for baseline surveys for windfarms, they are not practical for handheld measurements, where the 90mm windscreen is most often used.

Most sources of guidance will advise that a 90mm windscreen will only provide suitable protection up to wind speeds of 5m/s. Any airflows above this velocity may lead to noise measurements being affected by the noise induced by the air movement across the microphone diaphragm. An example of measured wind induced noise at different flow velocities is shown in the figure below.

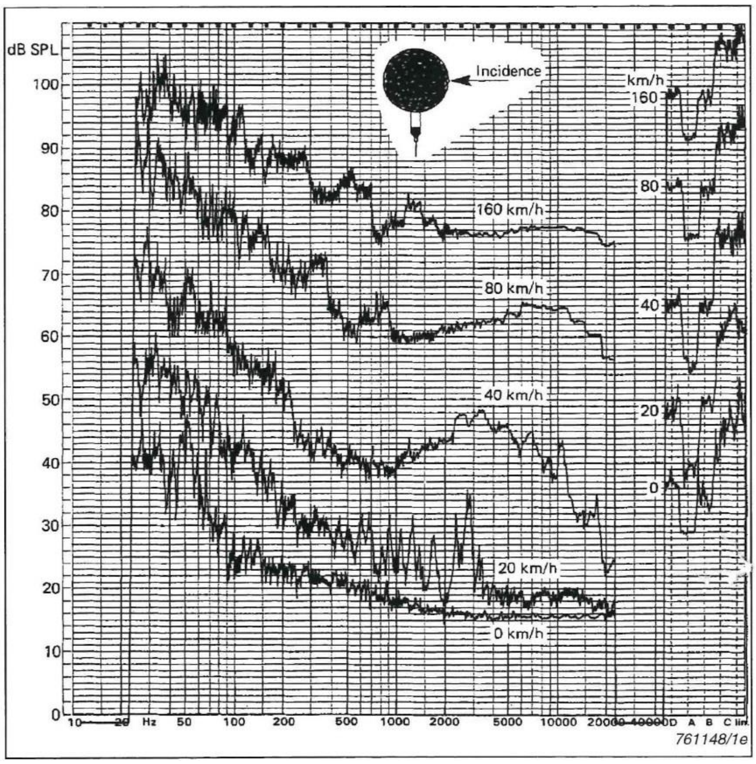

Figure 1: wind induced noise on microphone fitted with 90mm windscreen (source: Brüel & Kjær)

For windspeeds of 20 km/h (5.5 m/s), it is likely that wind induced noise is adversely affecting the measurement, particularly at high frequencies. Increasing the wind speed to 40km/h (11m/s) causes a significant increase in wind induced noise. In many instances, winds in excess of these speeds will lead to environmental noise survey data being discarded, and surveys being rescheduled for more favourable weather conditions. However, there are instances when measurements must be carried out with airflows of this magnitude.

One notable application is when commissioning ventilation installations. If the ventilation system has been designed to produce noise levels below the background noise at the closest receptors, demonstrating noise levels meet the required targets can only be reliably undertaken by measuring close to ventilation intake/discharge. If the air velocities of these systems exceed 5m/s, which is possible in high-duty ducted systems, the use of a standard 90mm windscreen begins to limit the effectiveness of the noise measurement and may add uncertainty to the measured data.

Fortunately, there are methods that can be used to reduce the wind induced noise in such situations. The standard 90mm foam windscreen provides protection from air movement in all directions, but if the airflow from one specific direction, such as you would experience in a ventilation system, many microphones can be fitted with different accessories to protect the reduce the amount of airflow induced noise detected by the diaphragm.

The first of these accessories is the nose cone, which is a replacement for the microphone protection grid and is aerodynamically designed to provide the lowest resistance to airflow possible. A typical nose cone and the associated performance when subjected to airflow are shown in the figure below. A comparison with figure 1 shows the reduction in wind noise that can be achieved by using such a device.

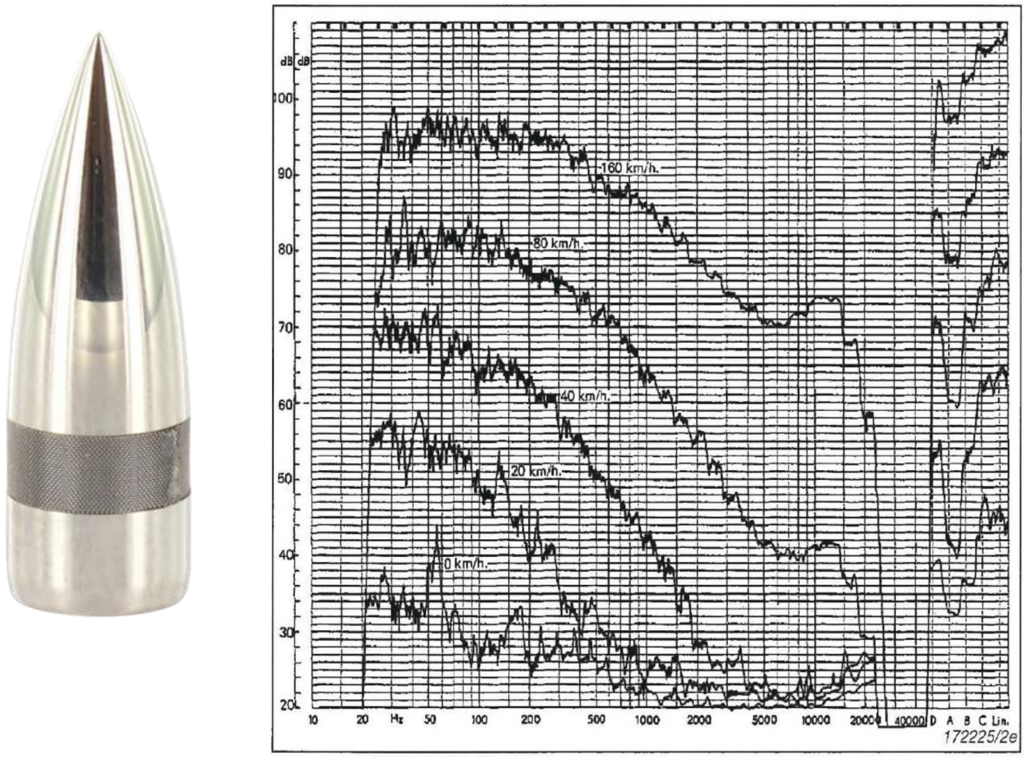

Figure 2: microphone nose cone and wind induced noise when microphone fitted with nose cone (source: Brüel & Kjær)

The main disadvantage of using a nose cone is that it replaces the microphone protection grid, which requires the grid to be removed and the diaphragm to be exposed while installing the nose cone, which can increase the likelihood of causing damage to the diaphragm.

If the noise measurements are required to be carried out within the ductwork of the system, a higher level of protection may be necessary to prevent noise from turbulence in the airflow. In these circumstances, it is possible to use a turbulence screen, which provides even better levels of protection than a nose cone. An example of a turbulence screen is shown in figure 3.

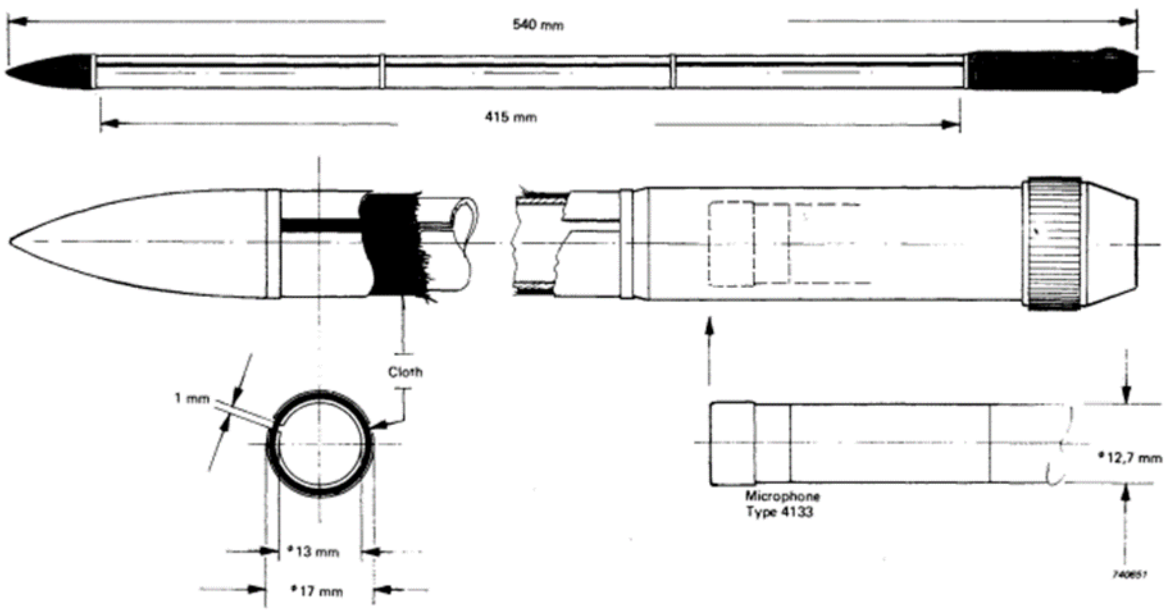

Figure 3: microphone turbulence screen (source: Brüel & Kjær)

In these devices, the microphone is inserted into the cylindrical tube. The tube is equipped with an axial slit which is covered with damping material to control the flow resistance of the slit. It essentially allows the sound to pass through, while restricting the pressure fluctuations of the air turbulence. These devices are generally only needed in specific circumstances; manufacturers' generally quote their performance based on air velocities of 20m/s and it will perform significantly better than a nose cone at those velocities. However, air velocities of this magnitude are generally higher than most practitioners will experience.

If the testing is to be carried out within a solid-walled wind tunnel, there are specialist windscreens available for specifically this purpose. These types of turbulence screen can be flush mounted into a recess in the wall of a duct and are designed to reduce the turbulent component at the microphone by up to 25dB. An example of a turbulence screen for ducts is shown in the figure below.

Figure 4: turbulence screen for use in duct walls (source: GRAS sound and vibration)

Since both nose cones and turbulence screens are aerodynamically shaped, they will only function as intended when the airflow is from a single and constant direction. It should be noted that any device fitted to a microphone to reduce airflow induced noise will affect the frequency response of the microphone. The effect on the frequency response of the microphone for a 90mm windscreen and a nose cone are shown in the figure below.

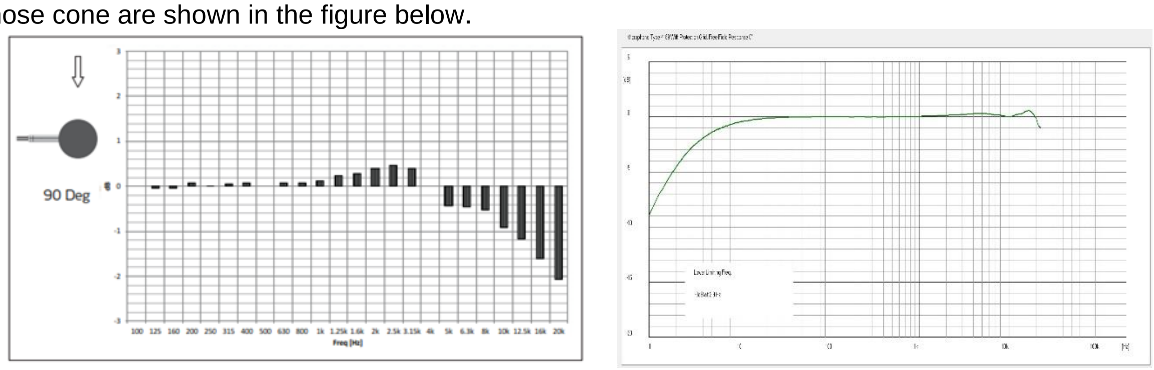

Figure 5: Effect on frequency response of ½" microphone for a 90mm windscreen (left - source: GRAS sound and vibration) and a nose cone (right - source: Brüel & Kjær)

The traditional 90mm windscreen has a small effect on the frequency response for which many modern sound level meters have compensation filters included. These types of sound level meter can automatically correct for the presence of the windscreen. However, if a device such as a nose cone is to be used, the effect of this on the frequency response of the system should be noted and corrected for if necessary. The manufacturer of the device should be able to provide these details if required, as shown in the example above.

Many people will also be aware of the large windscreens used by television broadcast teams to reduce wind noise, where a large fluffy cover is placed on the microphone. There appear to be no manufacturers of instrumentation quality equipment that produce an equivalent product. The use of such products is not recommended unless documentation on the effect on the microphone sensitivity and frequency response can be demonstrated.

This article has covered the options available on the market for minimising wind induced noise on microphones. Each of the options has advantages and disadvantages, which should be considered carefully when carrying out measurements of these types to ensure that measurements reduce the uncertainty as much as possible.

3 REFERENCES

1. Brüel & Kjær, Condenser Microphones and Microphone Preamplifiers for Acoustic Measurements Data Handbook, September 19822. T.J. Cox, F. Li and P. Darlington., 'Extracting room reverberation time from speech using artificial neural networks', J.Audio.Eng.Soc. 49(4) 219-230. (April 2001).
2. https://www.gras.dk/products/product/662-67ts-1-cl.html