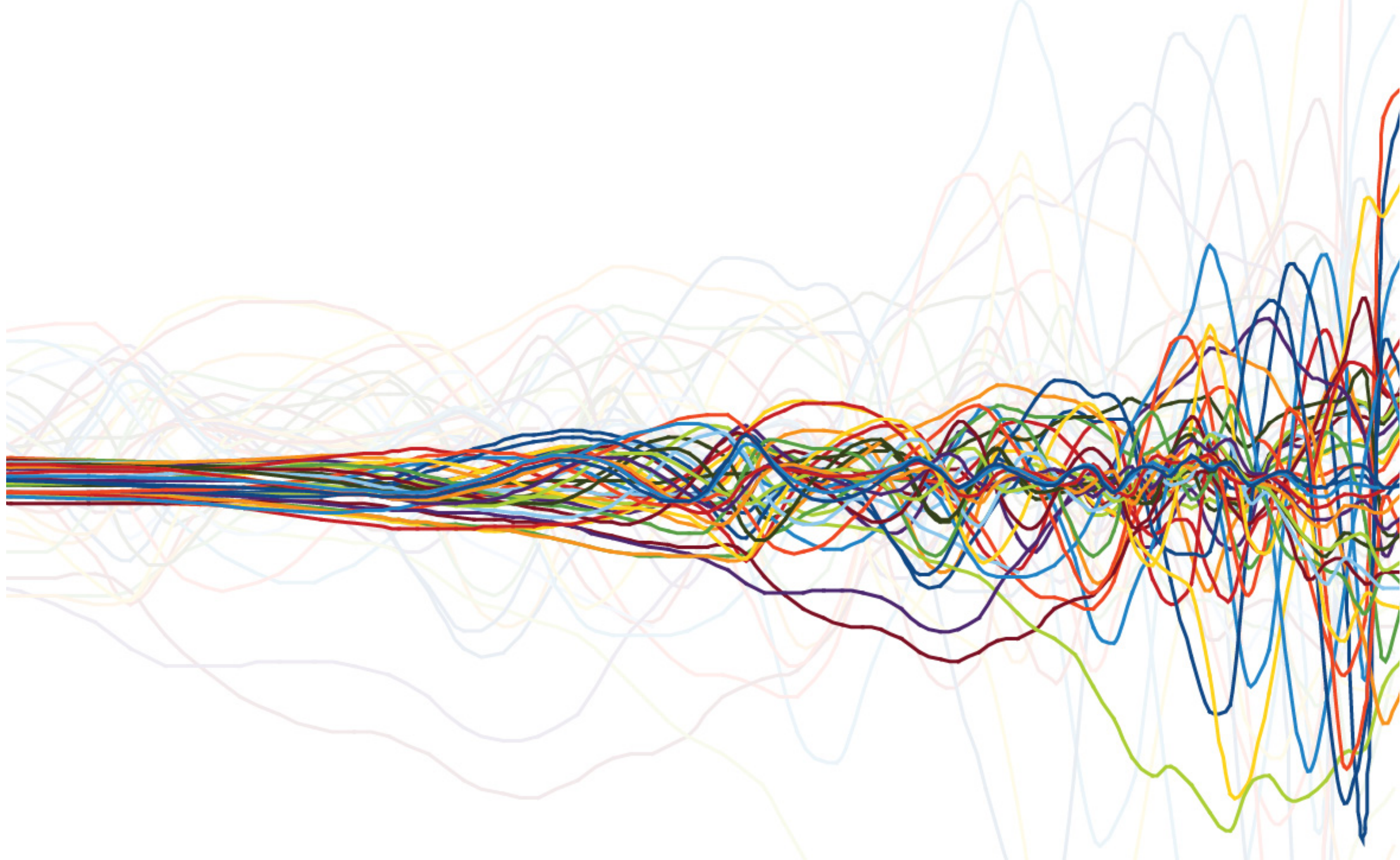
Influences of weather, damage and ageing on the performance of outdoor microphone windshields



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ABSTRACT

Windshields fitted to outdoor measuring microphones serve a dual purpose - to reduce wind-generated noise, and to protect the delicate microphone from damage by environmental factors such as rain, ice and dust. However, the presence of a windshield inevitably affects the directional and frequency responses of the measuring system.

This paper presents results of measurements on the directional and frequency responses of a selection of windshield types under a variety of climate conditions such as rain and ice, and after typical wear such as bird damage and sunlight degradation.

The paper concludes with remarks on the potential for deviations in measurement performance due to the windshield when carrying out real-world environmental noise measurements.

1. INTRODUCTION

Microphone systems used for long-term outdoor noise monitoring are exposed to constant risk of damage from rain, corrosion and mechanical damage [1]. Such systems are generally required to fulfil the specifications in IEC 61672-1 [2] and are periodically verified to IEC 61672-3 [3].

However, due to practical limitations of test laboratories, such periodic verification does not typically include free-field testing of the entire microphone system including windshield. Instead, a standard procedure is to visually inspect the components and replace any that show clear signs of wear.

The advent of modern digital methods for free-field testing [4-5] enables free-field testing to be carried out rapidly and in a cost-effective manner, and thus demonstrate the influences of climate, damage and ageing on the performance of real-world outdoor measuring systems.

2. EXPERIMENTAL METHOD

2.1 Test system

The simulated free-field test system uses swept sine signals and the time-selective technique [4-5], [7]. A software-controlled automated turntable is employed for directional testing. Using this system a complete 360° series of frequency response measurements at 10° intervals can be carried out in less than 20 minutes – compared to about 4 hours in the older method using fixed frequency measurements under manual control.

All tests were carried out with the devices-under-test fitted to a B&K 4191 microphone capsule on a vertically-mounted preamplifier and rod. All mounting hardware for the windshields, such as retaining clips, wire cages, birdspikes and turned parts, were deliberately omitted. This simple mounting method was employed so that the performance of the windshields could be characterised without influences from other parts of the outdoor microphone measurement system.

2.2 Simulated weather conditions

Experiments with wet windshields were carried out by spraying water from above in an approximation of rainfall. After testing when fully wet, the devices were left to drain naturally at room temperature for several hours, to achieve the 'damp' state.

Experiments with weathered windshields were carried out using devices that had been used in long-term outdoor monitoring in the United Kingdom for up to 5 years.

Frozen windshields were achieved using a climate chamber to cool the devices rapidly to -30°C immediately prior to testing.

2.3 Devices under test

Two types of outdoor windshield were tested:

Type 'A' - 'conventional' cylindrical type, comprising 40 dpi foam in an open cavity shape with wall thickness 7mm.

Type 'B' - spherical type of diameter 80mm, comprising solid 80 dpi foam with ultra-violet resistant and hydrophobic (water-repellant) treatments.

3. RESULTS

3.1 Effects of water

When sprayed with water to simulate rain, type 'A' absorbed up to 70g of water, whereas the hydrophobically treated type 'B' absorbed 4g.

Frequency responses for windshield 'A' are shown in Figure 1. It can be seen that the wet and damp effects are similar up to 10kHz, but at higher frequencies they are markedly different.

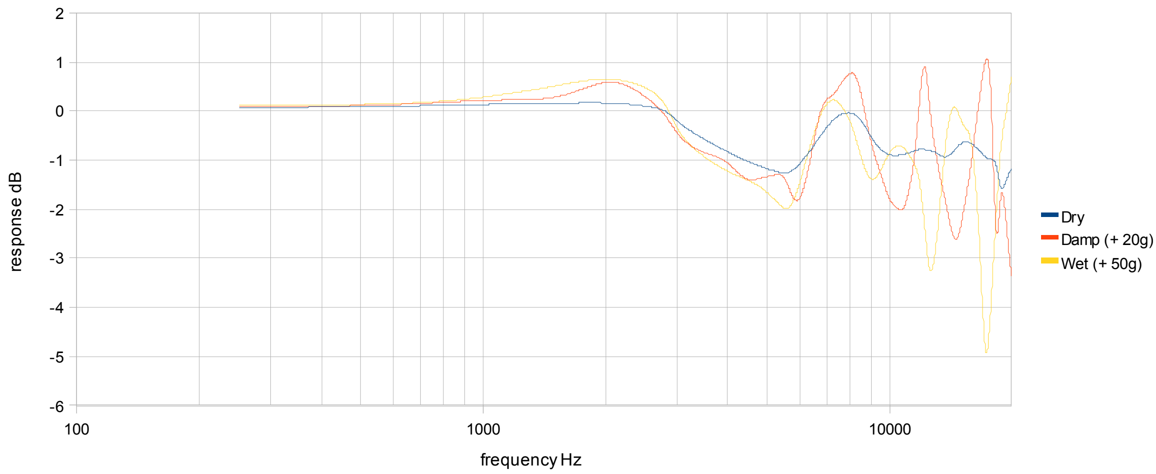

Figure 1: influence of rainwater, windshield 'A'

Frequency responses for windshield 'B' are shown in Figure 2. It can be seen that this type shows a steadily increasing attenuation at higher frequencies when dry, but this characteristic can be corrected using a digital filter in the Sound Level Meter.

The deviations due to rain are within approximately 3dB in the worst cases – at frequencies above 10kHz.

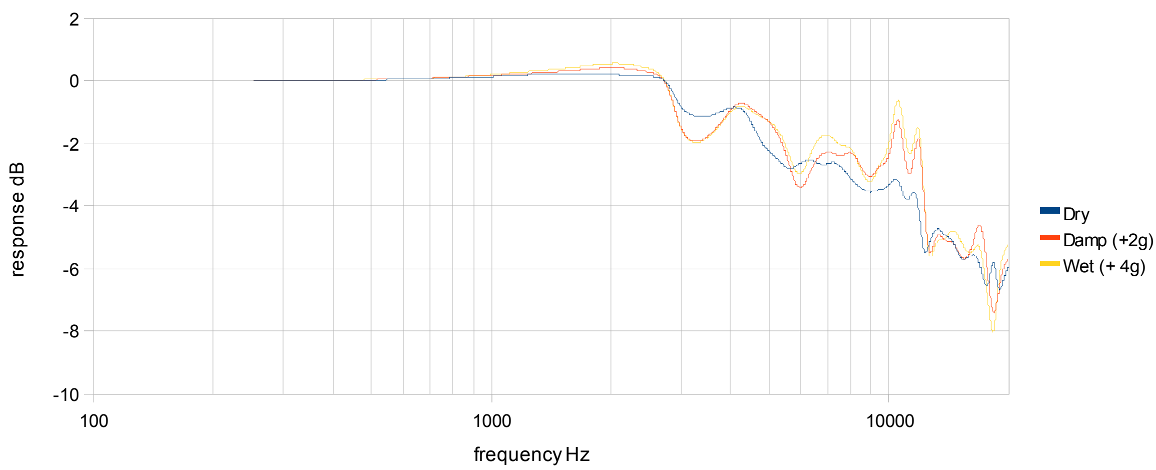

Figure 2: influence of rainwater, windshield 'B'

3.2 Effects of ice

Two weather scenarios were considered: firstly that the windshield is soaked in rain, then frozen – a situation common in rainy climates where the night-time temperature drops below 0°C; and secondly that the side of the windshield builds up a coating of hard snow due to deposition in blizzards with strong winds.


Figure 3: ice on top


Figure 4: ice on side

The first scenario is shown in Figure 3. The frequency response for the horizontal plane (90° incidence) is shown in Figure 5. Even after correction of the dry response of the windshield, the effect of ice is to exceed the tolerances in IEC 61672-1 [1], particularly at around 4kHz.

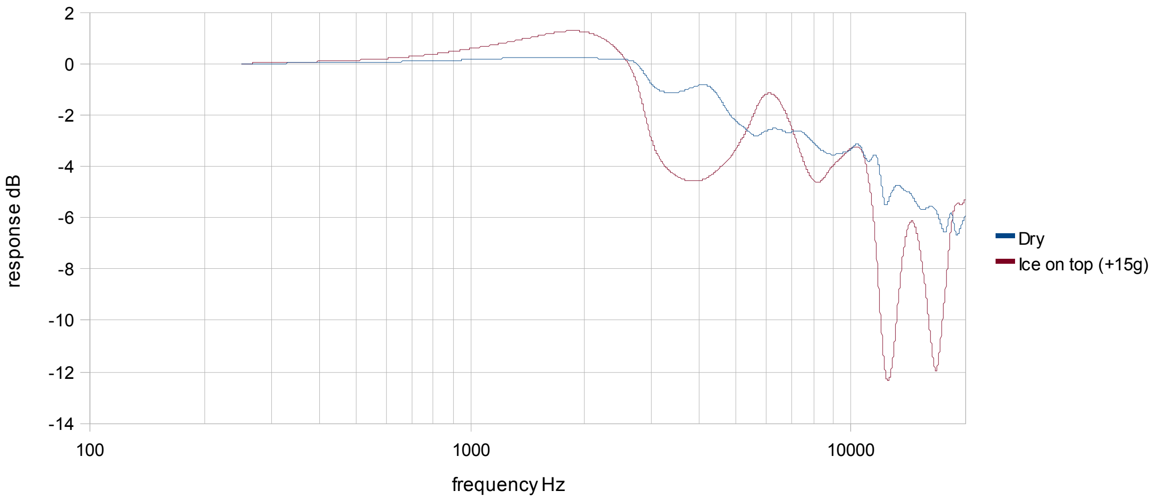

Figure 5: influence of ice on top, windshield 'B'

The second scenario – ice buildup on one side of the windshield due to wind-blown snow – is shown in Figure 4.

Frequency responses at selected angles on the horizontal plane are shown in Figure 6, and the polar responses at selected frequencies shown in Figure 7. Note that the ice patch was oriented such that it was directly facing the loudspeaker near the 180° position.

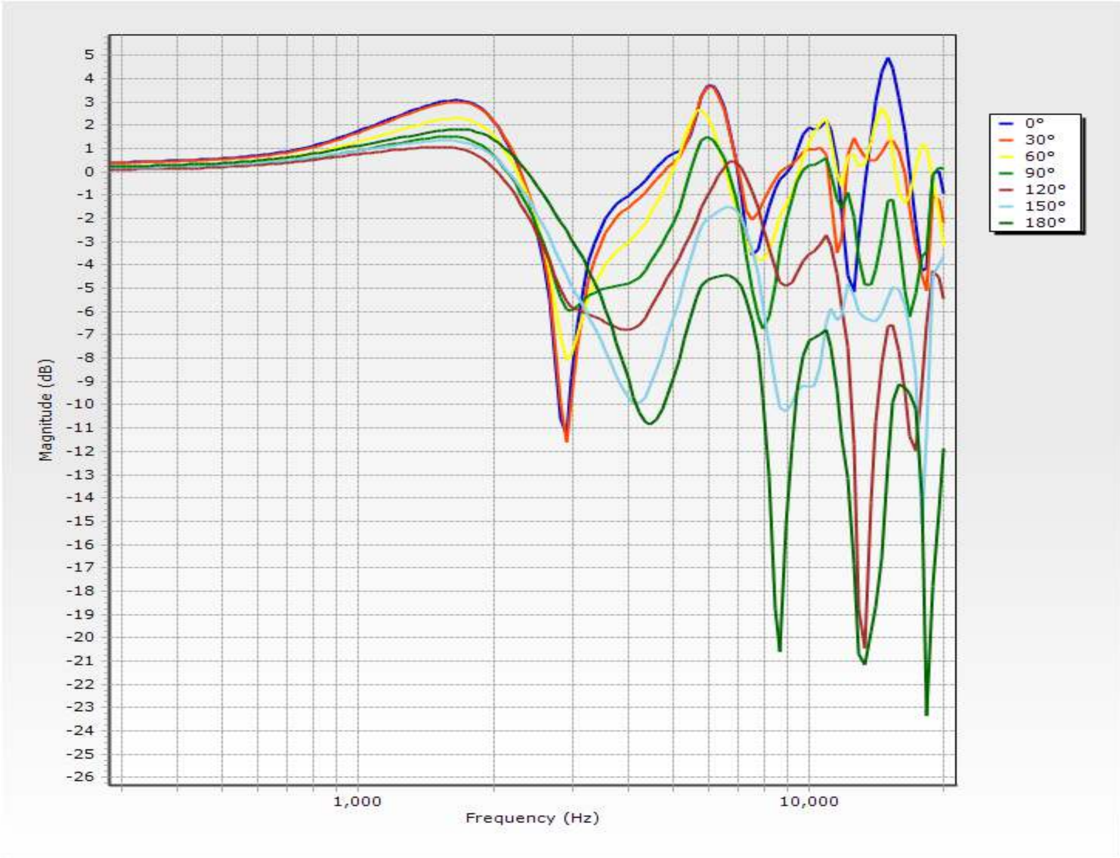

Figure 6: Type 'B', ice on side

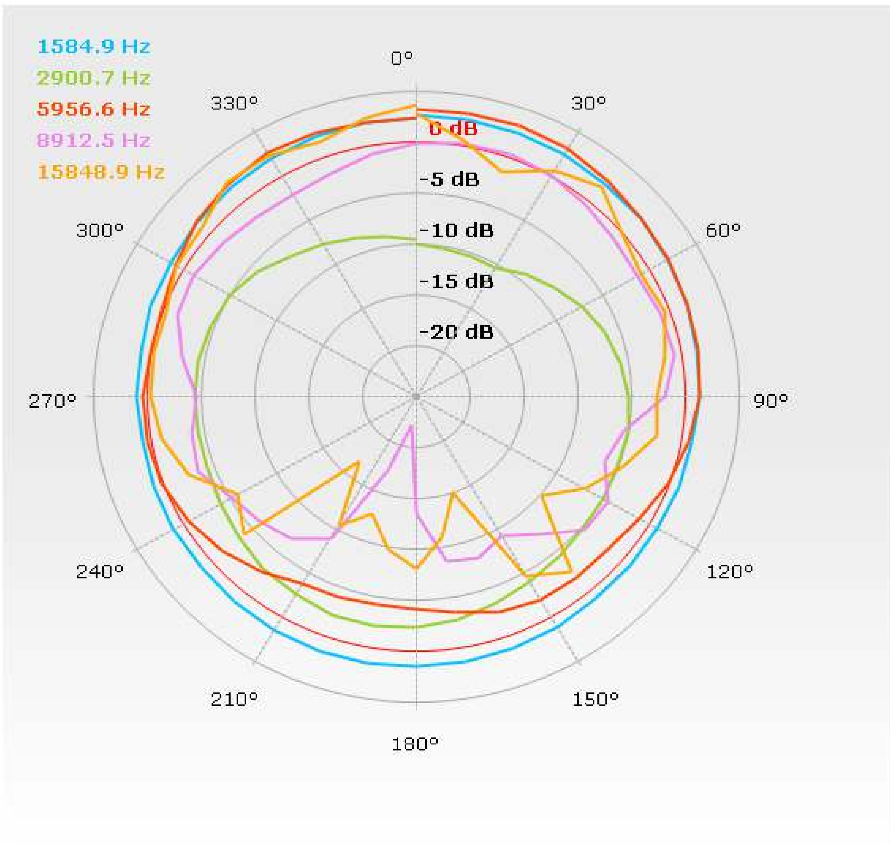

Figure 7: Type 'B', ice on side

These figures show a complicated situation, but it can be seen that the deviations from a flat frequency response are high, between +5dB and -23dB. Deviations of more than 10dB occur at different angles, not simply when the ice patch is facing the direction of incident sound.

The differences between 0° and 360° results may be due to changes between the start and end condition of the ice as it melted slightly during the test.

3.3 Effects of ageing and damage

Two windshields of type 'A' were tested after retrieval from outdoor systems after 5 years service. Both showed deterioration in the foam material, thought to be due to ultraviolet (UV) ageing from sunlight.

Frequency responses relative to that of a pristine new windshield, in the horizontal plane, are shown in Figure 8.

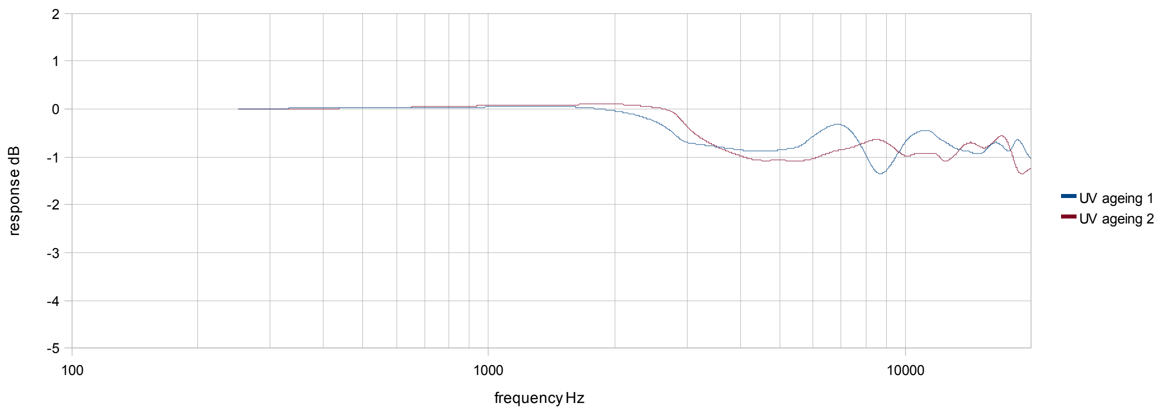

Figure 8: Effects of UV ageing, windshield 'A'

Damage is often encountered from to birds and small animals picking pieces of foam from the windshield, presumably to use for nesting material.

Such damage was simulated by cutting a conical section from a device of type 'B' as shown in Figure 9.

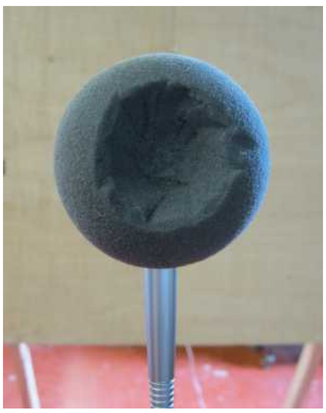

Figure 9: windshield 'B'
with cutout

Note that the cutout was oriented to face the loudspeaker at approximately the 180° position. Polar responses at selected frequencies are shown in Figure 10.

The magnitude of the deviations in this case are within +2.5dB and -2.0dB of the reference level.

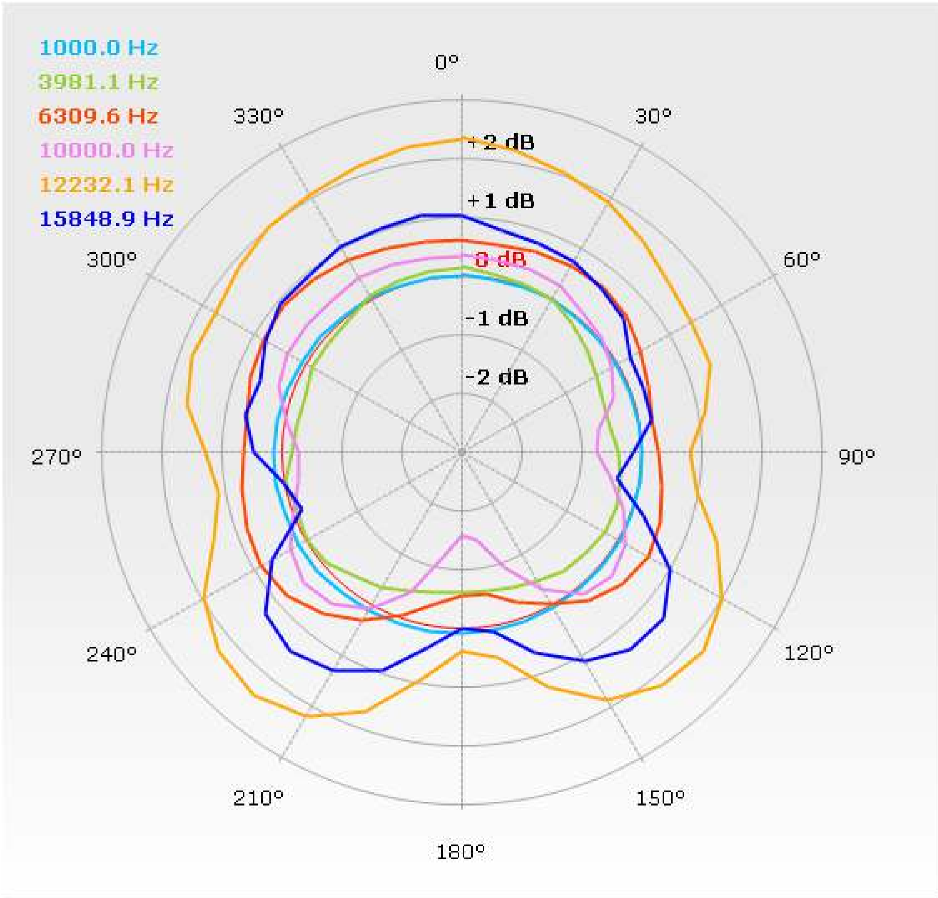

Figure 10: cutout damage, windshield 'B'

4. CONCLUSIONS

Rain soaking into the windshield has a complex effect on the responses, with potential to move the system response outside acceptable limits. These effects are less pronounced on hydrophobically-treated spherical devices than on non-treated open-cavity ones.

Ice crusts on windshields have marked effects on the responses.

In measuring locations that are prone to heavy rainfall and freezing, it is suggested that care be taken to record meteorological conditions and interpret noise measurements accordingly.

The windshield may exhibit significant response deviations that vary over time during the drying process for several hours after rain has stopped.

Damage to and ageing of the foam also affects the responses - with animal-caused damage apparently more severe than gradual deterioration of the material due to sunlight and climate. (Data from a large sample of windshields has been gathered but is outside the scope of this paper).

It has been shown [6] that wind-induced noise is lower with larger windshields. It is possible that weather, damage and ageing effects are also lower on larger devices, and this conjecture will form the basis of future work.

In modern Sound Level Meters it is possible to employ digital filters to compensate for the typical frequency response of the windshield when new.

However, such corrections may not adequately compensate for directional differences in the windshield's response. It is predicted that spherical windshields with the microphone at the centre exhibit more consistent directional responses, and this is to be investigated in future work.

5. REFERENCES

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