WINDSCREEN INSERTION LOSS IN STILL AIR

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ABSTRACT

Microphone windscreens are used to attenuate wind noise. However, even in still air, windscreens have an impact due to the added impedance between the source and microphone. This impedance is not accounted for when the system is checked by the use of an acoustical calibrator or when used in the field. The procedure for the characterization of the attenuation in still air has recently been addressed in ANSI S1.17-2000 part 1. But to date, no commercial windscreens have been tested in accordance with that standard. One of the reasons may be because the precision of the procedure has not been determined, even though the results of a round robin and the results of the uncertainty determination are available. Some of the commonly used windscreens were tested in a small chamber approaching free-field conditions. The results of the tests of insertion loss from the non-standard method and those based on S1.17 are presented here. It is shown that in some cases, the use of a windscreen can easily change the measurements using Type 1 instruments to Type 2 or worse. Without knowing information about a particular windscreen, the use of a windscreen in still air, can drastically change uncertainty of measurement. In moving air conditions can be expected to be even more severe.

SOMMAIRE

Les écrans de protections des microphones sont employés pour atténuer le bruit de vent. Mais même en condition de vent faible, ces derniers ajoutent une impédance entre la source et le microphone qui n'est pas prise en compte lors de l'étalonnage ou lors de l'utilisation sur le terrain. La procédure pour la caractérisation de l'atténuation sous condition de vent faible a été récemment adressé dans la partie 1 de la norme ANSI S1.17-2000. Mais jusqu'ici, aucun écran de protection commercial n'a été vérifié selon les recommandations du standard. En partie à cause du fait que la précision de la procédure n'a pas encore été déterminée. Les résultats d'un round robin et de la détermination des incertitudes sont disponibles. En attendant, nous avons testé quelques modèles d'utilisation courante et d'autres dans une petite chambre dont les caractéristiques acoustiques approchent celles du champ libre. Nous présentons les résultats des deux méthodes: pertes par insertion obtenues par notre méthode non standard, et ceux obtenues par la méthode standard AINSI S1.17. Nous prouvons que, dans certains cas, l'utilisation d'un écran protecteur peut facilement changer la précision de la mesure avec l'emploi d'instruments de type 1 en type 2 ou plus mauvais. L'emploi d'un écran protecteur en condition de faible vent sans la connaissance préalable des caractéristique peut rigoureusement affecter l'incertitude de la mesure. Dans des condition de vent modéré à élevé, nous anticipons des problèmes encore plus graves.

1. INTRODUCTION

Microphone windscreens are used to attenuate wind noise. However, even in still air, they can have an impact not accounted for when the system is checked by use of an acoustical calibrator or when used in the field. The procedure for the characterization of the attenuation in still air has recently been addressed in ANSI S1.17-2000 part 1 (Microphone Windscreens-Part 1 Measurements and specifications of insertion loss in still air). But to date, no commercial windscreens have been tested in accordance with that standard. Partially, the reason is the precision of the procedure was not determined. The results of a round robin and the results of the uncertainty determination are now available but still no manufacturers have tested to the method.

Some of the samples used were tested in a small chamber approaching free-field conditions. The results of the tests of insertion loss from the non-standard, but well-controlled, method are presented in this paper. We show that, in some cases, the use of a windscreen can easily change a

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measurement using Type 1 instruments to Type 2 or worse. Without knowing information about a particular windscreen, the use of a windscreen in still air, can drastically change uncertainty of measurement. In moving air conditions can be expected to be worse.

Since wind turbulence and its interaction with the surface of the microphone produces a noise that becomes part of the signal detected, it is useful to somehow reduce wind turbulence. But the reduction of turbulence and associated noise comes at a cost: The artefact used to reduce noise (windscreen) may interfere with the sound field in some respect. So the windscreens, used primarily to reduce noise generated by wind, should minimally affect measurements and should reduce all noise from wind. However, windscreens are also used in still air to protect microphones from damage and as general protection against wind gusts.

There are two types of windscreens: 1) general purpose, used for most outdoor measurements and 2) all-weather types for long term community noise. The general purpose type are usually spherical while the all-weather types are often ellipsoidal. The IL differences between the various types are available, but these results are not discussed here.

Windscreens are made of various materials that include:

- Fabric, with almost no acoustical influence - has durability problems
- Perforated metal, durable - but hole size effects measurements
- Metal screens - not common because they are hard to manufacture
- Polyurethane foam - open cell, the most common. Some manufacturers 'seal' the outside to make them waterproof. This affects IL.

Foam windscreens are the most popular and least expensive. The foam windscreens are produced by chemical activity that removes cell walls between adjacent cells. As the density of the foam increases, the insertion loss (IL) increases. Most cell density is between 70 to 150 cells per 10 cm.

2. DISCUSSION

When one places a windscreen on a microphone, the material properties and the size of the windscreen can alter the measured characteristics of the sound, usually in an unknown manner. The windscreen is affected by:

- Directivity effects: Sound coming from one direction compared to another may be altered by properties of the windscreen
- Non-homogenity: Windscreen characteristics may be different in different directions (especially for the non-spherical type.)
- Attenuation characteristics
- Moisture characteristics
- Wind effects on attenuation, on noise generation

The bare microphone has characterized directional properties, determined in controlled conditions: Random, Diffuse, Pressure, and Free field. These conditions hardly ever represent actual spaces. In general the description of the usual measurement field is unknown. So, the real directional characteristics of the microphone are unknown. Now a windscreen is added to the bare microphone, which further complicates the issue.

Sound pressure is measured at a point and is temporally varying. The measurements usually result in a signature of pressure level against frequency or against time. This pressure is unknown until it is measured. So the measurement ***IS*** the defined sound. And any error in measurement is usually not detected if systematic.

The effects of windscreens and wind are not discussed here, even though it is important. However, the basics of the effects of the windscreen on sound is as important. The reality of the uncertainty of the measurement chain is disturbing: 1) the level or frequency of the sound produced is not known; 2) the microphone characteristics are not known; 3) sound level meter (Type 1 or Type 2) that has a variability from ±1 dB to +3dB, is used; 4) windscreen with unknown characteristics is added; and finally 5) the reading is compared with some criterion: ordinance, guideline, etc.

3. WINDSCREEN CHARACTERISTICS

Since they introduce added impedance between sound and microphone, windscreens can affect the measured sound by insertion loss, by angle of sound, and perhaps by condition (old, damp, frozen)

Until now, there was no recognized standard for measuring windscreen insertion loss in still or moving air. Recently a standard was developed, ANSI S1.17-2000 Part 1 which requires hemi-anechoic space or reverberant space. This is a still-air standard; the moving air version has yet to be developed.

This paper discusses preliminary results of a series of insertion loss tests on the windscreens used for the round-robin of ASNI S1.17. The IL was measured in an ordinary space (an office with a loudspeaker sound source, measured with and without windscreen) and in a controlled space (a small anechoic box - 43.5" x 26" x 26," 1/2" walls, 9" wedges on each wall, with a windscreen-microphone-preamplifier at one end, and a loudspeaker at the others, excited by broadband or sine waves)

Windscreens were solicited from all major manufacturers but the following submitted their samples for testing: Scantek, Quest, Castle Group, ACO, Norsonic. A description of each of the windscreens is shown in Table 1.

Subsequent to the tests reported here, an extensive round robin was done to determine uncertainty of test method (not to characterize windscreens). The Labs that par-

Letter	Description
A	2 1/2", black, small hole
B	3 1/4", blue-green, small hole
C	3 1/2", blue-green, foam missing, small hole
D	3 3/4", black, larger hole
E	3 3/4", black, larger hole
F	2 3/8", black, small hole
G	2 3/8", black, small hole
H	2 3/8", black, small hole
I	3/4"width/1 1/4" length, black, small hole
J	3/4"width/1 1/4" length, black, small hole
K	3 1/2", black, small hole L 3 3/4", black, larger hole
M	3 1/2", black, small hole
N	3/4"width/1 1/4" length, black, small hole
O	3 1/2", black, small hole
P	3", grey, small hole
Q	7", grey, small hole
R	3", grey and dirty, smooth surface, medium hole
S	3", grey and smooth, medium hole
T	3", grey, small hole
U	3", grey, small hole
V	3", grey and smooth, medium hole
W	7", grey, small hole
X	7", grey, small hole
Y	2 1/2", grey, small hole
Z	2 1/2", black, small hole
AA	2 1/2", black, small hole
BB	2 1/2", black, small hole
CC	3", light grey, large hole, flat bottom
DD	3", light grey, large hole, flat bottom
EE	3", light grey, large hole, flat bottom
FF	3/8"width/1"length, grey cylinder
GG	3/8"width/1"length, grey cylinder
HH	3/8"width/1"length, grey cylinder
II	1"width/1 5/8"length, grey cylinder
JJ	1"width/1 5/8"length, grey cylinder
KK	1"width/1 5/8"length, grey cylinder
LL	7/8"width/2 1/2"length, grey
MM	7/8"width/2 1/2"length, grey
NN	7/8"width/2 1/2"length, grey
OO	8 1/2", grey, football shaped
PP	3 1/2", black, small hole
QQ	3 1/2", black, small hole
RR	3 1/2", black, small hole
SS	2 1/4", black, small hole
TT	2 1/4", black, small hole
UU	2 1/4", black, small hole

Table 1 Windscreen Description

ticipated were: NRC, Ontario, Canada; IAC, New York, USA; Manville, Colorado, USA; ATI, Pennsylvania, USA; WEAL, California, USA; Vibroacoustics, Ontario, Canada; and National Gypsum, New York, USA. The results of the round-robin are not discussed here. Samples of windscreen are shown in Figures 1 and 2.

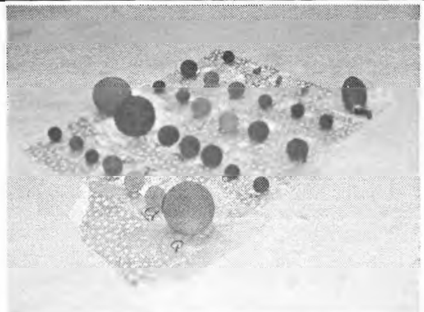

Figure 1. Standard Winscreens

Figure 2. Standard Winscreens

4. RESULTS

Only a few results of the preliminary tests can be discussed here. The tests were done in very controlled conditions: in the ordinary office, distances and sound levels were held very constant, although reflecting surfaces and background noise were rather not well defined. In the anechoic box, the background noise and reflecting surfaces were well characterized. Figure 3 shows the insertion loss and standard deviation for a single windscreen tested by one engi-

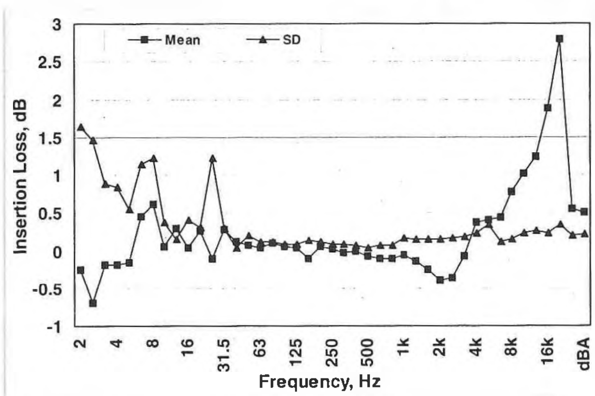

Figure 3. Results of five repeat measurements of Windscreen M

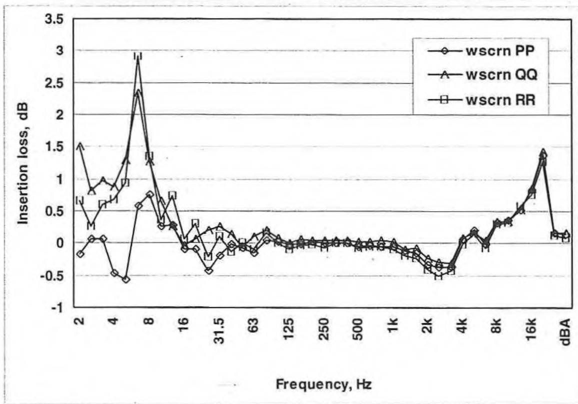

Figure 4. Insertion loss for three of the same type of windscreen

neer. This illustrates that the repeatability of a given test, by a single technician, is reasonably good for the " normal " frequency range of interesrt, from about 100 Hz to 15k or 20k Hz, it is important to note that, idealy, the insertion loss should be near zero which means any uncertainty, especially in an environment with some varying ambient noise, will often be greater than the insertion loss. Repeatability of measurements may be affected by a) position in box: from source to microphone, b) thickness of absorption on walls, c) sizes of windscreens compared to the volume of the box, d) placement of microphone in windscreen hole. Effects of these variables were not reviewed.

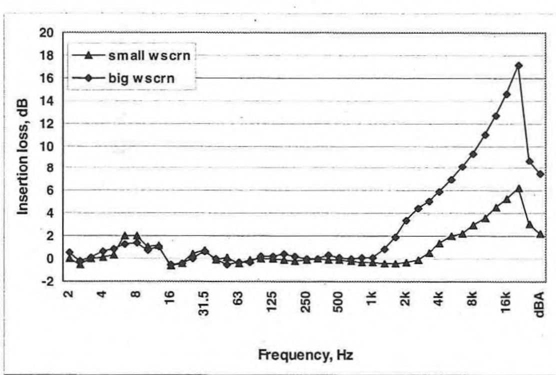

Figure 5. Insertion loss of two outdoor windscreens

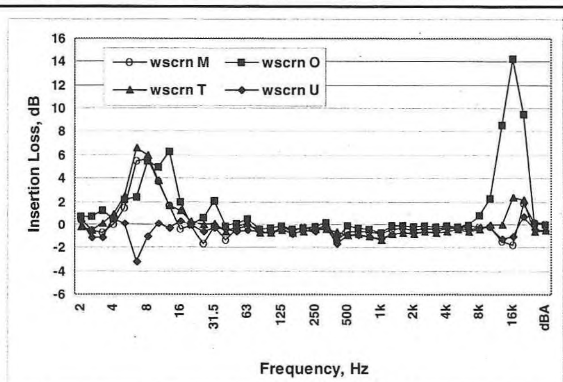

Figure 6. Repeatability in an ordinary room

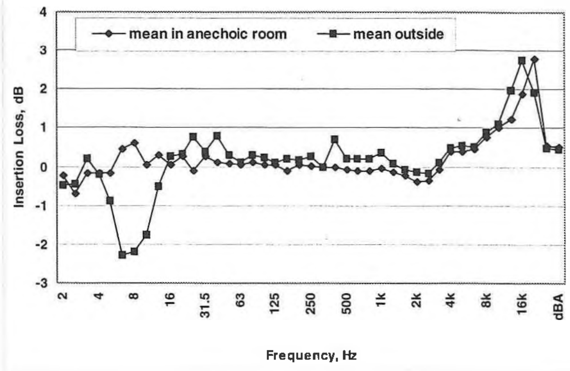

Figure 7. Windscreen IL measured in different spaces

Figure 4 shows test results for three of the same type of windscreen. The windscreens are nominally the same material, same diameter, same porosity, and between the normal frequency range, the repeatability of insertion loss is good. The low frequency spread may be due to space effects.

The problem is, not all windscreens have similar insertion losses. For an arbitrarily chosen windscreen, the insertion loss vary significantly. Figure 5 shows the IL for two 'all-weather' windscreens. The IL above 3 kHz is rather high. The problem is, unless either there is little high-frequency sound to measure, or the insertion loss is known, one cannot tell what the windscreen does to the measured sound, by

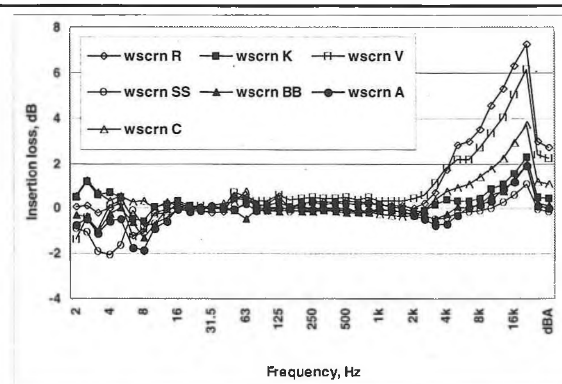

Figure 8. Mean insertion loss for several windscreens

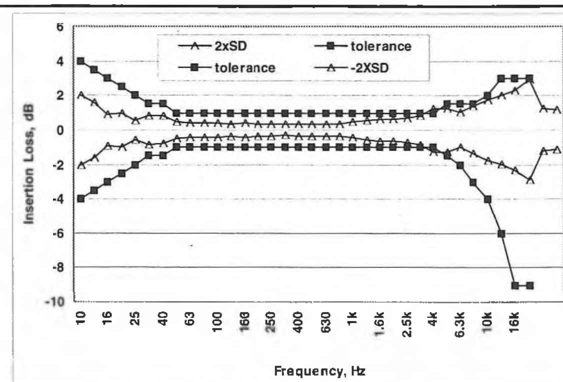

Figure 9. Insertion loss compared to ANSI tolerances

spectrum or even by A-weighted measures.

Figure 6 shows repeatability test for two measurements per windscreen, in an ordinary room. In general, for the frequency range of 20 Hz to 12 kHz, repeatability is less than 1 dB. So, even for a simple test, not necessarily using a controlled space, the insertion loss over normal frequencies is reasonably repeatable. However, it can vary a lot at the upper and lower frequency ranges, suggesting that it is better to use a controlled space for any type of IL tests.

Figure 7 shows the IL for the same windscreen measured in different spaces. Space does not seem to be critical.

Figure 8 shows the average insertion loss for several windscreens. Note that IL is most critical at upper frequencies. Significant here is that windscreens are different. One cannot use any windscreen and expect to obtain the same results with a measurement using another windscreen. And this is for controlled test! It seems critical to know what the windscreen is doing.

Figure 9 shows, for a given windscreen, the uncertainty of the measurements superimposed on the ANSI Type 1 requirements. Given the tolerances are shown w/o any windscreen, this suggests that the addition of a windscreen, albeit randomly chosen, will change Type 1 measurement to a Type 2 measurement. It must be pointed out that the tolerances given for Type 1 specifications are on the overall meter and the uncertainties of a windscreen are over and above those of the sound level meter meeting Type 1 specifications. Often manufacturers are just within Type 1 specifications and hence a windscreen with any insertion loss can change the precision of the measurement.

5. CONCLUSIONS

The following conclusions were the results of the simple insertion loss tests presented in this paper.

- o Windscreen insertion loss can be measured but results may depend on measurement method.
- o For a given test method, windscreens can have an Insertion Loss between 0.1 dB and 10 dB in the frequency range most are interested in.
- o Without a characterization of some sort, insertion loss of windscreens can significantly affect your measurements in some unknown manner..

ACKNOWLEDGEMENTS

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