inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 7.1

NEW WIND SCREEN DEVELOPED FOR UNATTENDED LOW FREQUENCY NOISE MEASUREMENT

K. Fukushima*, H. Ochiai, K. Makino**, A. Yokota**, I. Yamada**, H. Tsukioka*****

* RION Co., Ltd, 3-20-41, Higashimotomachi Kokubunji, 185-8533, Tokyo, Japan

** Kobayasi Institute of Physical Research, 3-20-41, Higashimotomachi Kokubunji, 185-0022, Tokyo, Japan

*** Defense Facilities Environment Improvement Association, 3-41-8Minatoku Shiba, 105-0014, Tokyo, Japan

Tel.: +81-42-359-7844 / Fax: +81-42-359-7461 / Email: fukuken@rion.co.jp

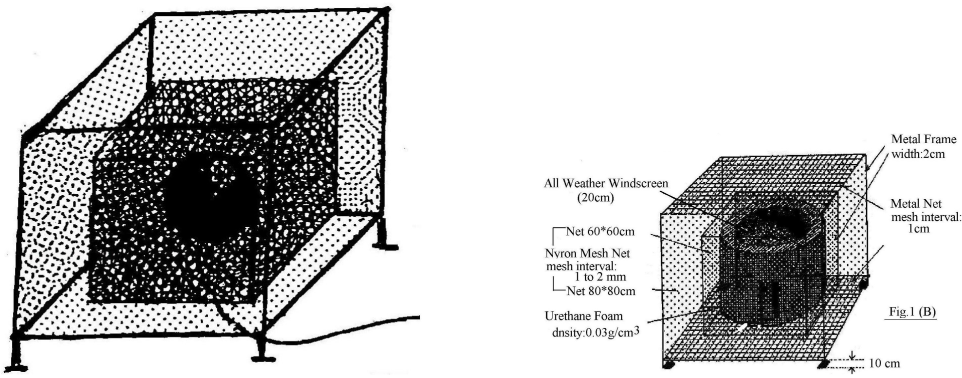
Keywords:
WINDSCREEN, WIND NOISE, DOUBLE LAYERED NYLON NET, UNATTENDED NOISE MONITORING

ABSTRACT
This paper describes a newly developed windscreen that effectively decreases low frequency noise induced by the wind. The basic idea of the new windscreen is to use a double layered nylon net (mesh interval: 1~2 mm). The two layers of the net are several centimeters distant each other. Field experiments suggest that the new windscreen is effective in decreasing wind noise if the wind blows at a maximum speed of 20 m/s.

1 - INTRODUCTION
In field measurements wind noise inevitably occurs and it disturbs or deteriorates the quality of the measurements. Especially, in long-term unattended monitoring of low frequency sound using C or Flat frequency weighting, wind noise sometimes makes the measurement impossible. Conventional windscreens are, however, not effective when the wind blows at a speed exceeding several meters per second. If the wind blows at a speed of 10~20 m/s, the sound pressure level of wind noise may grow up to 100 dB. The authors developed a new windscreen applicable to long-term unattended monitoring devices of low frequency noise such as artillery sound. The effectiveness of the screen was examined through outdoor experiments using a prototype unattended device installed temporarily on the rooftop of a building several kilometers distant from an artillery field.

2 - STRUCTURE OF NEWLY DEVELOPED WINDSCREENS
Two trial products of windscreens WS-1 and WS-2 were in turn manufactured in the shape of a cubic net structure, using metal framework and nylon nets with urethane foam material. Wind-breaking nets, which fruit farms use, reminded us of applying the net structure to windscreens. Note that the porosity of the foam material used was about 97 % (density: 0.03 g/cm^3). The porosity seems to correspond to 400 pores per meter (ppm).
The structure of WS-1 is shown in Fig. 1a. The four sides of a cubic metal framework 100 by 100 by 100 cm were put up with square nylon nets (mesh interval: 1~2 mm). Inside the framework was placed a cube made of urethane foam material 60 by 60 by 60 cm. A microphone covered with a conventional round all-weather windscreen having a diameter of 20 cm was installed in a round hollow (inner diameter: 20 cm) carved in the center of the cubic foam material. WS-1 worked well for rejecting wind noise as is shown later, but the drainage of the cubic foam material was very poor after a heavy rainfall. It might affect acoustical characteristics of the microphone.
WS-2 has a nesting structure of two cubic metal frameworks (respectively, 80 by 80 by 80 cm and 60 by 60 by 60 cm) as is shown in Fig. 1b. The entire size of WS-2 was made to a little smaller than WS-1

for the sake of better portability. The four sides of both the two frameworks were put up with the same square nylon nets as in (A). The interval between the double layered nets was 10 cm. A microphone covered with the same conventional windscreen as WS-1 was installed inside the inner cubic framework. A hollow cylinder made of urethane foam (thickness: 10 cm, inner diameter: 40 cm) was placed inside the inner cube so as to surround the conventional windscreen. The top and bottom sides of WS-2 were covered with lids made of metal nets in order to avoid troubles such as bird invasion. Four legs 10 cm high were attached on the underside of WS-2 to avoid 'flooded with rain'. It was confirmed in an anechoic chamber that WS-1 and WS-2 had no significant effect on the acoustical characteristics of the microphone in a frequency range of 20∼1 kHz.



(a): WS-1. **(b):** WS-2.

Figure 1: The structure of newly developed windscreens.

Schomer et al. [1] proposed two methods for reducing wind-induced noise in a low frequency region: 'cross product' signal processing and a specially layered windscreen. They set up a microphone covered with a 17 cm round windscreen made of solid foam material (porosity: 1200 ppm) inside a hollow cylinder made of 400 ppm foam material (thickness: 2.5 cm, diameter: 40 cm). They say that a combined use of the two methods brings about 33 dB reduction of the C-weighted wind noise at a wind speed of about 10 m/s in average, compared to the result of a bare microphone. The layered windscreen alone is said to reduce wind noise by 30 dB. Note that their windscreen seems to be similar to the inner structure of WS-2 described in this paper, but that the most distinctive feature of WS-2 is its double layered cubic net structure.

3 - FIELD EXPERIMENT AND THE RESULT

The effectiveness of the new windscreens WS-1 and WS-2 was examined through outdoor experiments using a prototype unattended device based on NA-36/RION. The device was installed temporarily on the rooftop of a five-storied building several kilometers distant from an artillery field. The experiments were carried out three times (preliminary exp. / January, WS-1 / March and WS-2 / July in 1999). The wind blew at a maximum speed around 20 m/s in January and March experiments, but it was only about 10 m/s in July.

At the first experiment in January, we examined the effectiveness of usual foam windscreens having diameters of 9, 20 and 40 cm. Wind noise, however, could not be reduced with these windscreens when the wind blew stronger than 10 m/s.

At the second experiment in March, WS-1 was examined. Figure 2 shows the result of the second experiment, i.e. the relationship between wind speed and the C-weighted and F time-weighted sound pressure level of wind-induced noise. The wind noise went up to about 90 dB for the 9-cm windscreen, while it remained below 76 dB for WS-1 even if the wind blew at a maximum speed of about 20 m/s.

At the last experiment in July, WS-2 was examined, but we could obtain no data at wind speeds above 10 m/s. This time, sound level and wind speed were measured at the same time both inside and outside of the WS. The sound level meters and anemometers were placed closely together within 10 cm at both sides. The meters outside were located 50 cm apart from the WS. The instantaneous signals of C-weighted sound pressure and wind speed were recorded on a DAT simultaneously. Figure 3 shows the relationship of wind speed every 0.1 s between inside and outside of WS-2 with and without the urethane foam hollow cylinder. The wind speed inside the WS was reduced to at most 2 m/s without cylindrical urethane foam and was reduced to below 1 m/s with the cylinder. The result suggests that the combination of double nets and cylindrical urethane foam can effectively decrease the wind speed.

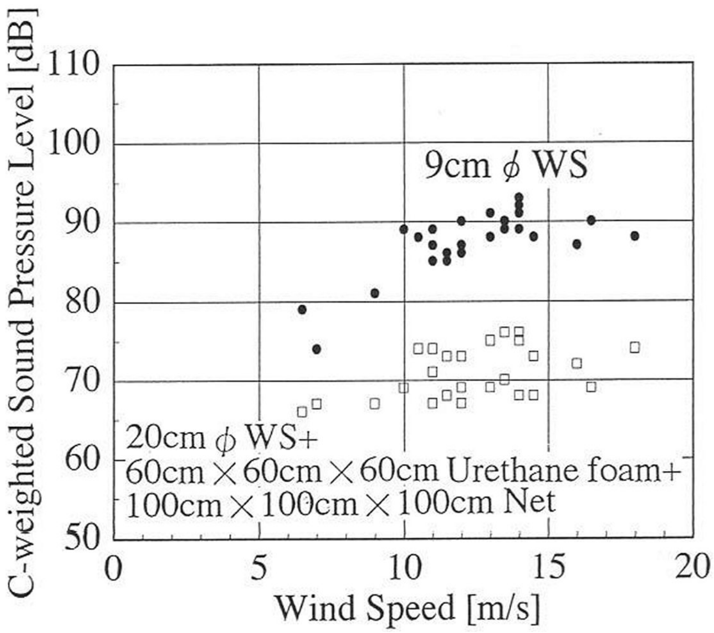


Figure 2: Relationship between the wind-induced noise level and the wind speed.

The wind speed outside WS-2 remained below 10 m/s during the experiment. But, Fig. 2 for WS-1 suggests that the wind speed inside WS-2 may not go up so high, as far as the wind outside stays at a speed below 20 m/s.

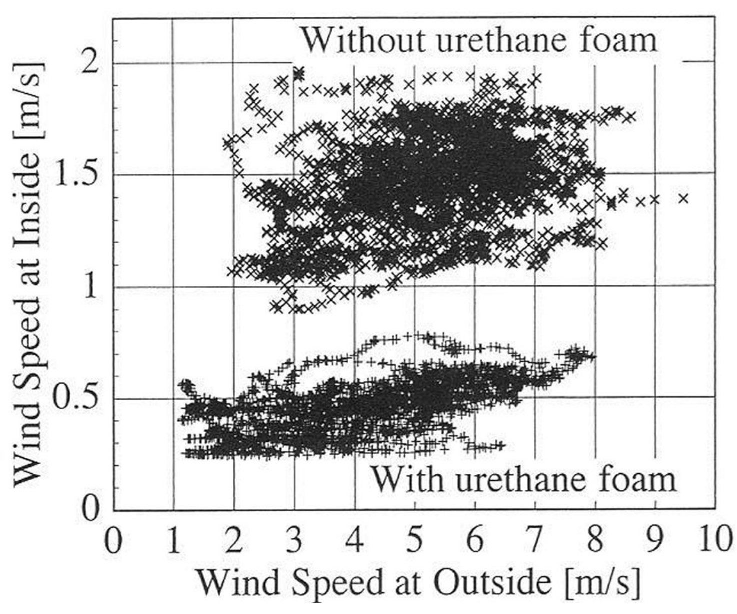


Figure 3: Relationship of the wind speed between inside and outside of WS-2.

Figure 4 shows the relationship between instantaneous wind speed outside WS-2 and the C weighted and F time-weighted sound pressure level measured using both WS-2 (mark: +) and 9-cm ball-shaped windscreen (mark: Δ). The figure also shows regression lines, described in reference 2, of the relationships without windscreen and with a 9-cm windscreen. If we compare C-weighted wind noise levels at a wind speed below 8 m/s, wind noise stays lower than 65 dB by using WS-2, at most 90 dB by using the 9-cm ball-shaped windscreen and about 100 dB without windscreen. In other word, noise reduction effect of WS-2 is 25 dB compared to the 9-cm windscreen. It is 35 dB compared to the bare microphone below 8 m/s. The result of the second experiment using WS-1 suggests us that the effect will be kept even if the wind goes stronger up to 20 m/s.

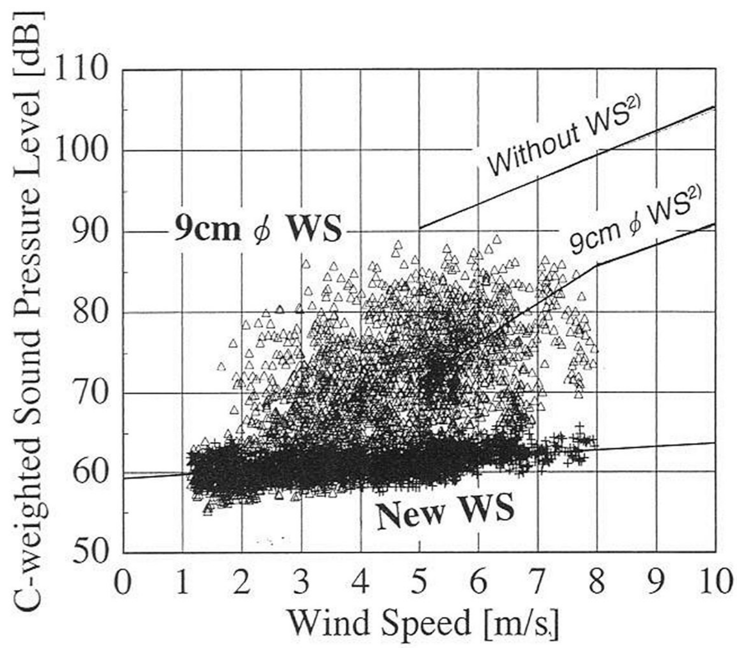


Figure 4: Relationship between the wind-induced noise level and the wind speed.

4 - CONCLUSION

Two new windscreens were manufactured in the shape of a cubic net structure, using metal framework and nylon nets with urethane foam material. It was found that the windscreens effectively decreased low frequency noise induced by the wind up to about 20 m/s.

REFERENCES

1. **P. D. Schomer et al.**, Reduction of Wind Noise for Unattended Blast Noise Monitoring, *Noise Control Eng. J.*, Vol. 34(2), pp. 77-88, 1990

2. **I. Yamada and K. Yoshikawa**, Suggestions for noise measurement using sound level meters, *J. Acoust. Soc. J*, Vol. 55(5), pp. 382-385, 1999