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Different Noise Contribution at 0/90 Degree Direction use of Noise Level meter

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1. Introduction

For sound level measurements performed in accordance with IEC 61672, the sound level meter is supposed to be pointed towards the source (0° incidence).

For unattended measurements, the direction from the source is generally unknown. Except for aircraft noise measurements, the sources are located on the ground, therefore the optimal position for unattended noise measurements is to set up the measurement device vertically and to design it in such a way that it fulfills the IEC61672-1 standard for ground sources(90°incidence):

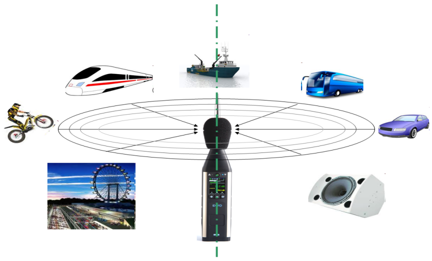

Fig. 1 Ground sources and SLM orientation for 90° incidence

Our goal was to achieve a sound level meter design able to fulfill both 0° (for aircraft noise and measurement pointing at the source) and 90° reference directions (for unattended ground measurements).

2. Design Constraints

2.1 IEC 61672-1: directional response limits

Table 1 gives directional response requirements for the configuration of a sound level meter as stated in the instruction manual for the normal mode of operation or for those components of a sound level meter that are intended to be located in a sound field. The specifications in table 1 apply for plane progressive sound waves at any sound-incidence angle within the indicated ranges, including the reference direction. At any frequency, the design goal is equal response to sounds from all directions of sound incidence.

Table 1 Max. absolute difference in displayed sound levels for class 1 at any 2 sound-incidence angles within ±Θ degrees from the reference direction(incl.expanded uncertainty of measurement for demonstration of compliance to the limits above)

Frequency [kHz]	Expanded uncertainty	θ = 30°	θ = 90°	θ = 150°
0.25 to 1	0.3 dB	1.3 dB	1.8 dB	2.3 dB
> 1 to 2	0.5 dB	1.5 dB	2.5 dB	4.5 dB
>2 to 4	0.5 dB	2.0 dB	4.5 dB	6.5 dB
>4 to 8	1 dB	3.5 dB	8.0 dB	11.0 dB
>8 to 12.5	1.5 dB	5.5 dB	11.5 dB	15.5 dB

2.2 1/2' microphones

$\frac{1}{2}$' microphones are usually selected, as being the best compromise between costs, frequency response and background noise for general environmental noise assessment.

Unfortunately standard $\frac{1}{2}$' microphones do not fulfill the IEC standard for the reference direction 90° configuration, as far as directional response (maximum absolute difference in displayed sound levels for class 1 at any two sound-incidence angles within ±30) is concerned: it is out of tolerance as shown on Fig. 2 below.

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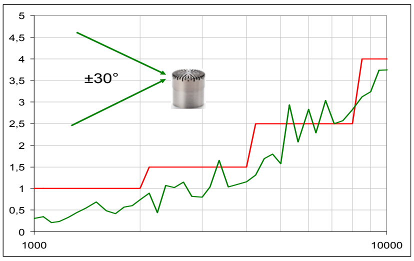

Fig. 2 In green directional response of a 1/2' microphone for Θ = 30°(reference direction 90°); in red, tolerance values of IEC 61672-1 without expanded uncertainty

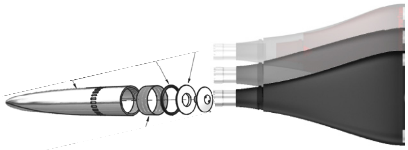

Fig. 3 Different shapes for the upper part of the DUO sound level meter body tested for optimum frequency response and directional response

3. Solution: Acoustic cone

3.1 Shape of the sound level meter body and distance of the microphone to the body

Various shapes of the mechanical design of DUO at the early stage, as well as several distances between the microphone and the body were tested using 3D prints, as shown below.

3.2 Directional response results

Θ = 30° directional response is displayed in fig. 4, as an example of requirement to achieve. The benefit of the cone corresponds to the difference between the green dot curve and the blue curve.

3.3 Influence of the cone on the frequency response

When the cone is mounted on top of the microphone, its influence depends on the incident wave. Fig. 5 has been obtained by subtracting the frequency response of the microphone *with* con and the frequency response of the microphone *without* cone.

3.4 Overall results

The final frequency responses taking into account the influence of all factors(cone, shape of the body, type of windscreen) are displayed on Fig 6. below, resulting from measurements performed at LNE

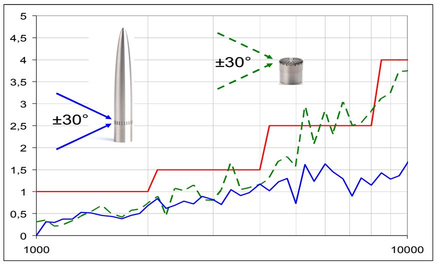

Fig. 4 In blue, directional response of DUO [3] with acoustic cone for Θ = 30°(reference direction 90°); in red, tolerance values of IEC 61672-1 without expanded uncertainty

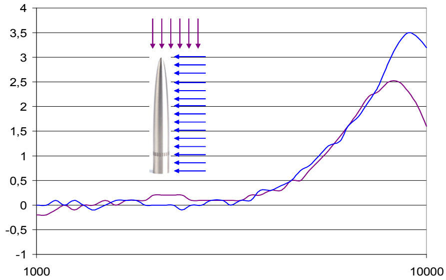

Fig. 5 In blue influence of the cone for 90° incidence; in violet influence of the cone for 0° incidence

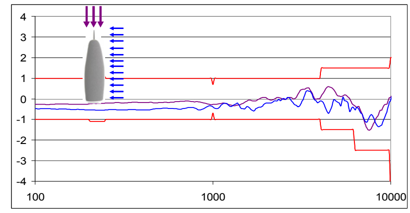

Fig. 6 In blue influence of the cone for 90° incidence; in violet influence of the cone for 0° incidence

(Laboratoire National d'Essais) in France.

4. Conclusion

The requirement for DUO smart noise monitor made mandatory the possibility to setup both configurations: 0° and 90° reference directions. A key to success has been the close cooperation between development teams at 01dB and G.R.A.S. companies. DUO is the first and single sound level meter approved in France, in Germany and in Switzerland with both reference directions 0° and 90°.