

A Test Procedure for Sound Level Limiters in Toys

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1 Introduction

The publication of the revised International Standard EN 71 on 'Safety of toys' [1] in the year 1998 represented an important milestone in the hearing conservation efforts within the European Community. Besides the Directive 92/59/EEC on General Product Safety [2] and the respective laws in the member countries, this standard provides a powerful legal mean to prevent hearing damage caused by noisy toys.

According to part 1 of this standard: 'Mechanical and physical properties' the sound pressure level of toys which were 'obviously designed for generating sound' has to be limited in order to protect the hearing of the users - the children.

If the acoustic output signal of the toy is, as in most cases, generated by means of built-in program material, the maximum output level can be measured with test signals while the toy is working with full-on gain. If, however, the output signal depends on an acoustic input, e.g. a microphone, the performance of the level limitation has to be tested with suitable acoustic input signals and input levels.

2 Sound immission by toys - measurement procedures

EN 71-1 describes the operation, conditioning, positioning, power supply etc. for the acoustical testing of different types of toys. Toys intended *for the use close to the ear (as defined in EN 71-1)* have to be tested under free-field conditions in a measuring distance of $(2,5 \pm 0,5)$ cm from the surface of the toy. This definition differs from that of *sound sources placed close to the ear*, see clause 3. Toys equipped with headphones, however, need to be measured as sound sources placed close to the ear.

The permitted A-weighted emission sound pressure level for toys intended for the use close to the ear stated in the standard EN 71-1 is $L_{pA} = 80$ dB under free-field conditions. For toys with headphones, a limit for the A-weighted coupler level of $L_{pA} = 90$ dB applies.

3 Sound sources placed close to the ear - coupling problems

Sound sources placed close to the ear are characterised by the fact that the interaction between the source and the human ear has a considerable effect on the source-to-eardrum transfer function and thus the immission level depends on this interaction. Well-known examples are headphones and earphones of many types, e.g. in telephone handsets, headsets and hearing aids, but hearing protecting

devices and other units operated in close vicinity of the ear belong to this category as well.

Many level limits for hearing conservation purposes are based on free-field measurements; therefore a transformation of the eardrum levels to free-field equivalent levels is required in order to check whether the immission is within the limits. Procedures for the determination of free-field equivalent levels are standardised [3-4].

EN 71-1 prescribes the use of couplers according to IEC 60126 or, for supra-aural headphones, an artificial ear according to IEC 60318 with a special adapter, for the measurement of the eardrum levels. The vast majority of toys, however, is equipped with concha-earphones, which cannot be adequately connected to those couplers.



Figure 1: Use of a head and torso simulator for the measurement of eardrum levels.

The only alternative for those types of earphones is the use of a head and torso simulator with suitable pinna simulation and ear simulator, see Figure 1. This procedure had been introduced and standardised for the measurement of portable audio equipment [5].

4 External acoustic input and sound level limiters

Most toys produce their acoustic output signal dependent on their volume setting, the program material or their mode of operation. In special cases, however, the output depends on an acoustic input signal. An example for such a toy is a telescope equipped with a directional microphone, an amplifier and earphones in order to enable the user (the playing child) to acoustically spot the object he/she is targeting at, see Figure 2.

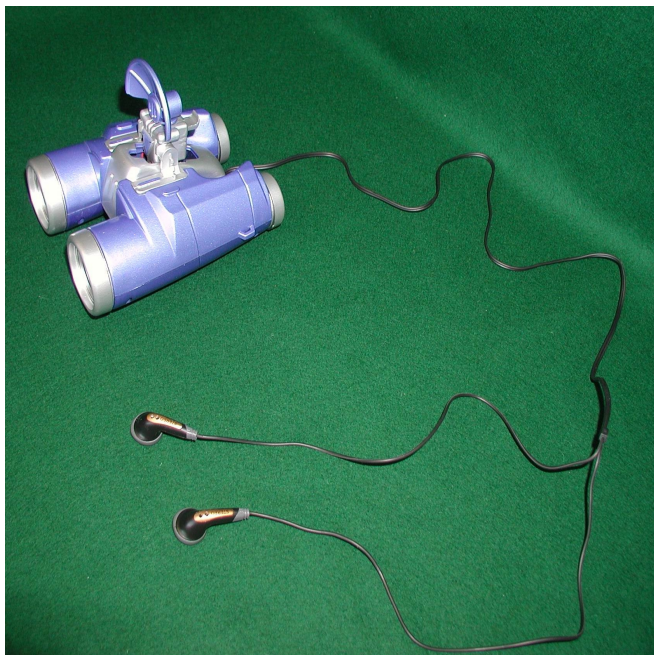


Figure 2: Agent-set. Sample of a toy equipped with earphones and acoustic input.

In this case the output level of the headphones will strongly depend on the sound emitted by the target and the background noise. Even a scene where another person shouts with high level near the input microphone, the signal of which is highly amplified, is quite likely to happen with playing children. Thus, a level limiter is urgently needed for the protection of the user.

A test of such a device according to EN 71-1 provides the following difficulties:

- (a) under normal operation conditions, the sound emission of the earphones will be superposed with the sound of the environment
- (b) the acoustical input signal is not known

Problem (a) can be solved by placing the device in an anechoic chamber, while the measurement of the sound emission of the earphones is performed at a different location. Care has to be taken that the extension of the headphone cable, which will be obviously necessary, does not provide a significant loss of output level.

A test signal for the acoustic input shall allow reproducible measurements to be performed, and it should provide the frequency spectrum and the temporal structure of an average

sound. Therefore, a programme simulating noise according to IEC 268-1 [6] had been chosen. The signal was presented in the anechoic room in a way that the requirements of this standard were met in the measurement point, checked by a free-field microphone.

The eardrum sound immission was measured as described above by means of a suitable head and torso simulator.

After an initial measurement for the determination of a suitable start level which depends on the overall gain of the device under test, the input level was increased in steps of 5 dB, while the eardrum level produced by the earphones was recorded and monitored. This procedure was continued until either the level limit had been reached or some saturation of the limiting circuit was detected. In the case of reaching the limit level one additional increase by 5 dB was performed to demonstrate clearly that there was no limiting with respect to this level. In the other case, the step size was reduced to 1 dB in order to be able to determine the slope of the output-input characteristic with a better resolution.

By now, none of the devices tested by the PTB, showed an output level limitation which meets the requirements of EN 71-1.

5 Conclusions

The sound emission of toys equipped with a sound pick-up, amplification and earphones can be measured and tested according to the requirements of the standard EN 71. Programme simulating noise as input signal and the determination of the output-input-characteristic under well-defined conditions enable this test.

References

- [1] EN 71-1:1998 - Safety of toys - Part 1: Mechanical and physical properties.
- [2] Council Directive 92/59/EEC of 29 June 1992 on general product safety. URL: http://www.view-berlin.de/dokument/sicherheit/ps02_en.pdf
- [3] ISO 11904-1:2002, Acoustics - Determination of sound immissions from sound sources placed close to the ears - Part 1: Technique using microphones in real ears (MIRE-technique)
- [4] ISO/FDIS 11904-2:2003, Acoustics - Determination of sound immissions from sound sources placed close to the ears - Part 2: Technique using a manikin (manikin-technique)
- [5] EN 50332-1:2000, Sound system equipment: Headphones and earphones associated with portable audio equipment - Maximum sound pressure level measurement methodology and limit considerations, Part 1: General methods for "one package equipment".
- [6] IEC 268-1, Sound system equipment, Part 1: General.