What about standards concerning speech intelligibility in large public areas?

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Introduction

Intelligibility is quite complex to estimate, and especially when the situation is complex rooms: large, noisy and crowded. Nevertheless, it is needed for public address systems (PAS) to be as efficient as possible, especially in emergency situations. Many studies have been performed on this topic for tens years. However, standards arose very much recently, always in a security point of view. The question is to discuss the validity of standards and more precisely their application in situ. Are they usable and detailed enough

Intelligibility estimation methods

Since the beginning of the 19' a lot of estimators or methods have been developed in order to have an idea of the intelligibility in rooms. Probably the first index has been the Articulation index (AI) which has been used for a long time (and is still used here and there as a reference). Further, other indexes have been developed, some of them on an acoustical point of view (building acoustic and speech characteristics). Others were based on listeners' tests.

Both of them have advantages and difficulties: acoustic methods are quite easy to use, but need to be confirmed by trusty methods such like tests. On another hand, these last method although representing correctly the reality of the situation, are very complex to set up correctly.

Several standards deal with intelligibility, in a security purpose. EN 60849, CEI 60268-16, ISO 9921, ISO 7731

One of them, the EN 60849 is very interesting to examine, taking into account all these remarks.

The case of the EN 60849 standard

This standard was set up in 1998 and refers to some other standards, such as: CEI 60268-16 (1998). The main part concerns the technically reliability of the electronic features., such as: power supply of amplifiers, environmental conditions of temperature, atmospheric pressure or, hygrometry of air. Another part is dealing with the good working of the system, such as the correct functioning of the loudspeakers, the records to be kept up and the measure of intelligibility. There is also an item on the maintenance of the whole system.

Therefore, this seems to be a quite complete standard.

Nevertheless, little by little, the correct application of the standard for in situ measurements appears as difficult, especially for the intelligibility measurements. Yet, in security contexts the intelligibility of the message diffused by the PA system is of a great importance.

Intelligibility requirements.

For security purposes, the intelligibility needs to be at the best level, whatever the method used to check it in the rooms equipped with PA. Two main methods are usually used to do so. One using acoustic measurements, and the other performing tests with people. Both need to be defined very clearly, in order to get the same results in the same conditions. By the way, one of the main goals of standards is to detail all these procedures. The European standard 60849 contains a very interesting chart where one can find the relationship between intelligibility scales: it is named "common intelligibility scale", or CIS. (See figure 1). Whatever the method used, one can reach the requirement of the standard, which is a 0.7 CIS. As an example, one can see that a 0.7 CIS means a 0.5 STI or AI, or a 90% Alcons, or a 95% with phonetically balanced words. Therefore, it means a very good intelligibility score, which could be difficult to reach in severe conditions, for example.

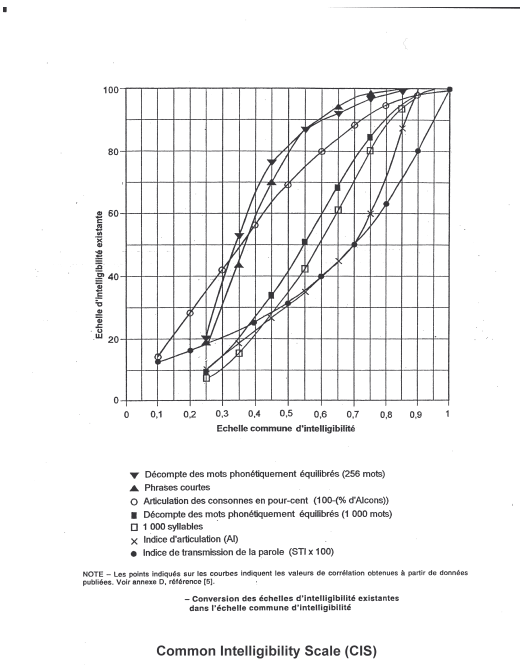

Figure 1: Intelligibility scales

Some other standards give also requirements for speech communication in specific environments. They concern the ergonomics domain. Let us cite the ISO 9921: *Assessment of speech communication*, and ISO 7731: *Danger signals for public and work areas - Auditory danger signals*.

The first one (9921) applies with the performance of the different situations: alert, person to person, sound systems, etc…A table gives the minimum intelligibility requirements for each situation, but only on a qualitative way: poor, correct, good. Nevertheless, this standard also gives the methods to be used in order to estimate or measure the intelligibility, referring to other well-known standards such as ISO/TR 4870 for listening tests, or CEI 60268-16 for the measurement of STI. As examples, this standard gives relationship between several intelligibility parameters. (See Table 1)

Table 1 — Intelligibility rating and relations between various intelligibility indices

Intelligibility rating [a]	Sentence score [b] %	Meaningful PB-word [c] score %	CVC_{EQB} -non-sensical word score %	STI [d]	SIL [d] dB	SII [e]
Excellent	100	> 98	> 81	> 0,75	21	—
Good	100	93 to 98	70 to 81	0,60 to 0,75	15 to 21	> 0,75
Fair	100	80 to 93	53 to 70	0,45 to 0,60	10 to 15	—
Poor	70 to 100	60 to 80	31 to 53	0,30 to 0,45	3 to 10	< 0,45
Bad	< 70	< 60	< 31	< 0,30	< 3	—

[a] Qualification according a five-point scale, see [7] [8] [14].

[b] The sentence score refers to simple sentences [10], CVC_{EQB}-nonsensical words with an equally balanced phoneme distribution [12, 13], and the PB-word score (related to the phonetically balanced Harvard list) [2].

[c] According to Anderson and Kalb (1987) [2].

[d] The SIL (Annex E) and SII (Annex C) only refer to noise conditions.

[e] The SII procedure does not provide qualification intervals. The ANSI standard [1] does provide two benchmarks: good > 0,75, poor < 0,45.

This table, although included in an informative annex of the standard is very useful for in situ features. In the same standard, another chart gives the correlation between these intelligibility ratings (table 1) and a numerical estimation parameter, the STI. Obviously, the quality of the intelligibility needed depends strongly upon the situation. This is the topic of the standard ISO 7731. The table hereunder shows the different types of danger signal, and the corresponding response expected.

Table 1 — Various types of danger signals

Type of danger signal	Response
Auditory emergency signal	Take urgent action for rescue or protection
Auditory emergency evacuation signal	Leave the danger zone immediately
Auditory warning signal	Take preventative or preparatory action

This standard does not cover verbal signals but is used to characterise warning signals preceding verbal signals described in standard 9921. This is the reason why it figures here.

How to use standards?

The security of public areas becomes increasingly critical. In the same time, even without any danger, people need to be informed of many different things: timetables, cancellations, danger, personal messages, and so on. Therefore, sound security systems have to be developed and, their efficiency too. Some signals can be quite easily defined by their physical and electrical parameters. However, intelligibility of speech is much more difficult to evaluate, and there is a strong need to develop everywhere the same efficiency. Standards can be of great interest in such a goal. Nevertheless, a standard is not always enough to perform estimations or measurements in a correct way.

So, one can say that in this specific topic, a practical guide would be very useful for in situ applications.

Such a guide is going to be elaborated.

Conclusion

Standards dealing with intelligibility have been strongly developed since several years and they appear to participate in the security of people in public areas. They remain a bit complicated to be applied in building, notably when final acceptance of installation is needed.

References

ISO 7731: Ergonomics- Danger signals for public and work areas - Auditory danger signals. 2003

ISO 9921: Ergonomics - Assessment of speech communication. 2003

NF EN 60849: Sound systems for emergency purposes. 1998.