

Directional Sounders
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Introduction

Directional sound technology was developed at School of Biomedical Sciences of Leeds University during the mid 1990's. The research work was conducted under the direction of Deborah Withington professor of auditory neuroscience. Since the development of the technology numerous studies have been conducted that compare occupancy egress time assisted by directional sounders to egress time based on conventional visual signals and signage ^{1, 2, 3, 4, 5, 6}. These studies have yielded a large body of data that indicates that the use of directional sounders consistently results in a significant reduction of egress time.

The recent NIST study "Performance of Home Smoke Alarms Analysis of the Response of Several Available Technologies in Residential Fire Settings" ⁷ also known as Indiana dunes II, included a comparative analysis if the burning characteristics of interior furnishings commonly in use during the 1960's and early 1970's with modern furnishings. The data generated clearly indicated that modern furnishings burn faster and therefore escape times are reduced. Clearly technology that can reduce escape time would reduce injuries and save lives.

Benefits of directional sound

- Directional sounders are not intended to be replacements for conventional alarms and signage. Rather, they provide additional information that facilitates a significantly faster evacuation in the event of an emergency.
- Directional sounders are intended to be connected to the Notification appliance circuit, NAC, of compatible fire alarm panels. The sounders are only active during an alarm condition. Therefore the attention capturing capability overcomes the issue that people rarely consider the information conveyed via exit signs or evacuation maps/floor plans as these do not relate to their normal routine. (Learned irrelevance)⁸.
- Directional sounders provide additional sound cues to assist occupants in locating the nearest exit rather than their instinctive urge to exit by the route they entered which may not be the fastest route.
- Sound travels around corners therefore avoids issues of line-of-sight methods (e.g. exit signs)
- Directional sound is independent of language. It is simply an auditory cue that directs occupants to an exit.
- Provides cues in adverse conditions of smoke or other low visibility condition
- Significant benefit to the visually impaired
- Reduces evacuation times by up to 75% in smoke obscured and 35% in clear visibility environment^{1, 2, 3, 4, 5, 6}.

Table 1 provides a summary of some of the referenced testing. In each test scenario a significant time reduction was achieved when directional sounders were utilized. Of particular note, the more complex the escape route, the greater the time reduction.

Test scenario	Time without Directional Sounder	Time with Directional Sounder	Improvement %
Leeds University television studio (smoke filled)	04:23	0:15	96
School building (smoke filled, with signage, complex route)	01:08	0:07	89
Marine trial (Smoke filled with low location lighting three exits available)	01:06	0:55	17
Marine trial (Smoke filled with low location lighting one exit available)	05:17	01:49	62
Complex maze trial – Leeds University (smoke filled)	01:38	0:51	48

Table 1 Comparison of escape Time with and without directional sound

Bringing the technology to North America

Directional sound technology probably because it was developed in the UK is further along in Europe. British Standards Institute published PAS 41:2003 Directional Sounders – Requirements and tests in February 2003. ISO has published ISO abcde:2002 “Ships and marine technology – Directional sound evacuation on passenger ships – Arrangement” Draft edition 2. North America interest has resulted in proposed language for directional sounders in the Protected Premises chapter 6, Notification Appliances Chapter 7 and Testing and Maintenance Chapter 10 of the 2006 edition of the National Fire Alarm Code, NFPA 72. There is strong support for the technology. But there are a number of important questions that are repeatedly asked.

Will the directional sound interfere with the alarm signal?

Directional sounders are intended to be connected to the notification appliance circuit, NAC of compatible fire alarm control panels. As such they are powered by the NAC. Therefore, when calculating the load on the NAC circuit, the load of the directional sounders must be included along with the other notification devices connected to the circuit.

Figure 1 is a graphical representation of the human frequency hearing range. Note that the frequency of alarm sounders resides in a narrow portion of this range that is most sensitive to human hearing. Directional sound is a broad band signal that occupies the entire band.

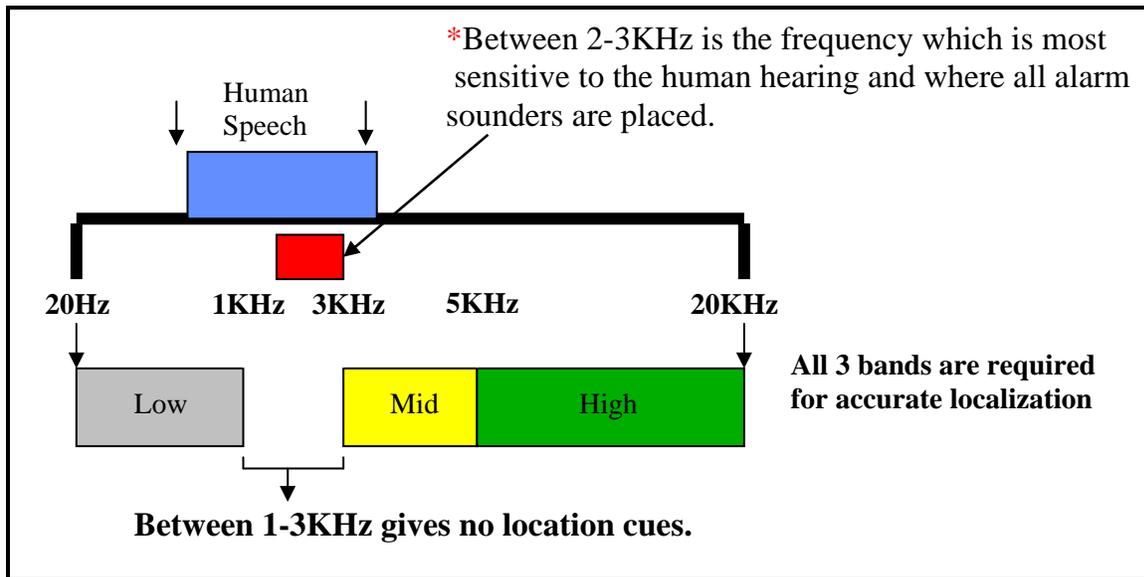


Figure1.

Figure 2 is a frequency domain representation of a typical fire alarm horn and a directional sounder. As in Figure 1 the sound power of the alarm sounder is primarily concentrated around 3KHz. The directional sound signal is relatively flat across the entire band at least 30 dB below the alarm signal concentrated around 3KHz. This signal ratio assures that the directional sound signal will not mask the alarm signal.

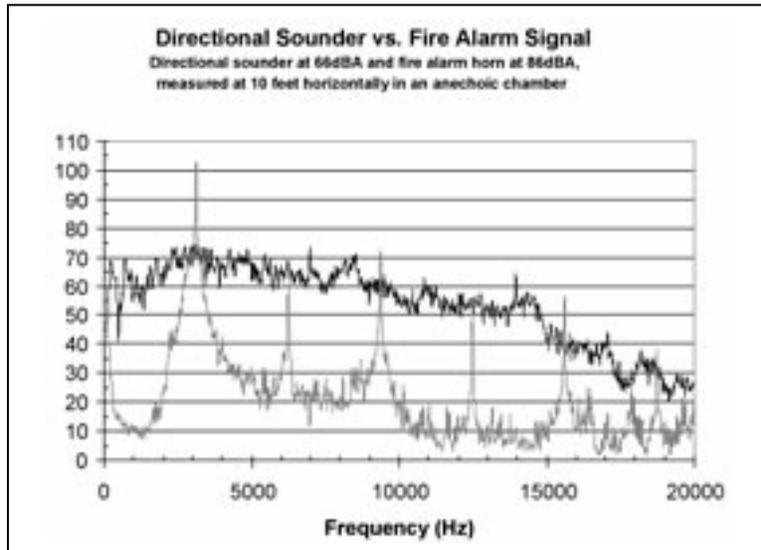


Figure 2.

Will the directional sound be masked by the alarm signal?

As indicated in Figure 2 the alarm signal is concentrated in a narrow band centered around 3 KHz and the directional sound level is relatively flat over the human hearing band. Therefore the only point where the directional signal will be masked by the alarm signal will be the narrow band around 3 KHz. As the directional information is carried outside this narrow band, the alarm signal does not mask the directional sound. The two signals can coexist and fully convey their respective information concurrently.

Conclusion

When fire strikes, fire safety demands rapid and orderly evacuation of the occupancy. The traumatic nature of a fire event can often cause disorientation and confusion resulting in lost moments that can lead to injury and possibly death. Directional sound technology has demonstrated a consistent reduction in evacuation time when added to conventional fire alarm and signage. Clearly incorporating this technology into the National Fire Alarm Code will enhance fire safety.

References

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