MNS Requires Intelligible Public Address

Mass Notification Systems are coming to Canada and the code requirements are now being determined. One area that will require close attention to detail will be the intelligibility of the installed speaker systems. Speech and alert signaling into large reverberant spaces, small areas and outdoor locations must deliver the message that is clearly understood above any difficult acoustic environments and ambient noise levels. Knowing the characteristics of the spaces and the expected or anticipated ambient noise will be critical in designing an intelligible system. These environment characteristics will determine the type of speaker and it's characteristics that will allow for this intelligibility. The relationship between the message delivered and room acoustics plus ambient noise is called the Signal to Noise Ratio (SNR). There must be more signal than noise.

Noise

- Large spaces that support reverberant fields, delayed reflections, the difficult ability to focus the sound plus any ambient noise can all contribute to the degrading of the intelligibility of the message. These types of influences tend to mask the speech consonants which impart the meaning to many words in the English language. Noise is considered any signal that is not part of the original message.

- It is often stated that for a good system response the signal must be up to 25dB louder than the noise. This requires a good focused sound field and high levels of speaker handling power. Levels of this magnitude would probably require some sort of Ambient Noise Control (DP-L2, AN-9001) to adjust the sound pressure levels (SPL) to the changing ambient noise.

- For areas that have well behaved acoustics, reverberation of less than 1.5 seconds, consideration is mostly given to ambient noise.

Speaker Specifications and Considerations

There are several specifications and conventions that one should be paying attention to when designing for speech intelligibility with the above considerations.

- *Dispersion Angle:* Focused sound requires a speaker that has narrow dispersion angles defined by the -6dB attenuation point of the speaker when measured from the on axis response to the point off axis where the sound drops 6dB. This point determines the actual coverage pattern of the speaker in the horizontal and vertical axis. With narrow dispersion angles, the sound is directed to the audience plane and very little energy is directed towards the walls and ceilings. This helps reduce the excitation of the reverberant field and reduces the delayed reflections. Knowing this dispersion angle allows for proper placement of the speakers because we will match or overlap at these points.

- *Sensitivity:* This figure expressed as 1 watt at 1 meter, (1W/1M) basically states that if the speaker receives one watt of power that the speaker will produce a certain amount of Sound Pressure (expressed in dB) at one meter away from the speaker on axis. The higher this figure, the less total wattage required in the total speaker load. Figures such as 90 dB and higher are the desirable values for this specification.

- *Max Power:* How much final SPL (sound pressure level) is the speaker capable of? Determine the final SPL required at the audience plane and then check the Max Power Handling to see if after distance calculations, the required SPL can be achieved.

- *Doubling Power and Distance:* As power is increased by a factor of two (double, 3 watts to 6 watts etc.) the SPL will increase by 3dB for every doubling. When doubling the distance from the one meter reference point, conventional single cone speakers will lose 6dB for every doubling. For line arrays this loss is less and can be approximately 3dB.

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- *Frequency Response:* Specific frequencies are critical to the speech band pass and thus intelligibility, 500Hz (16%) (Hertz, cycles per second), 1000Hz (25%), and 2000Hz. The most critical is the 2000Hz as it provides 34% of the intelligibility. Information outside of these frequencies add mainly body and sizzle.

Speaker Choices

- In large reverberant spaces such as transportation facilities, line array technology should be considered. This technology will focus the sound where it is needed and as such will not excite the reverberant field that adds to the noise factor. Also these types of speakers will have a very good band pass for speech and a high sensitivity to produce the needed SPL. Line arrays such as the TOA SR-S4 and SR-H series provide these capabilities.
- For warehousing, a focused and high SPL speaker would be one that is horn driven such as the TOA SC series.
- Smaller spaces with low reverberation time are often covered using distributed 70 volt high impedance ceiling speakers (TOA F series ceiling) or wall mount type box speakers (TOA F series box).
- High ceilings require narrow dispersion speakers that will also have higher maximum power ratings (F-2852C) and for lower ceilings, a wider dispersion type is desirable (F-122C). These speakers have the power and intelligibility (frequency response) well suited for message and in some cases, signal handling.

Speaker Installation

- Ceiling height has a large impact on the placement and quantities of speakers. As a rule, the higher the ceiling the fewer speakers that are required. However more power to account for the loss over distance is needed.
- Taking into consideration the acoustics, noise, and impact different speakers have providing intelligible messaging, the need to determine how the SPL varies over the audience plane will determine how the speakers are installed.
- This specification of SPL deviation should be considered depending on the critical nature of the messaging. Generally speaking, this deviation is expressed as so many dB above and below the required SPL calculated by the above considerations. This is expressed as an example, ±3dB. This means that the total SPL varies by 6dB. A good specification writer will include this in the spec for the project. If this is not included it should be asked what the requirements are because this will dictate the speaker spacing. The ideal sound level is one that does not vary across the audience plane however this is generally not practical do to the required number of speakers. Most persons can just begin to detect a change of sound level at 3dB so for a really critical application, ±1.5dB may be appropriate (3dB variance). Note that a 10dB change is perceived my most people as twice as loud.
- Talk to the architect. Often there is objection to placing speakers where they are needed. A discussion with the architect to explain why speakers need to be installed as required, may help ease the decision to place the speakers where required.
- Depending on the SPL deviation required, different installation patterns for ceiling speakers are available. These patterns dictate the row and column spacing and thus affect the change of SPL over the audience plane. To make this easier, TOA offers our SPV program, Speaker Placement Viewer. Automated and manual placement for ceiling speakers and manual placement for wall speakers is possible. This program will show direct SPL only and does not take into consideration room acoustics and ambient noise. However knowing the direct SPL and where the speakers are placed goes a long way to providing the right solution and its free. Other programs such as EASE Focus© and EASE© are also available with TOA speaker definitions to help determine correct placement.

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- Wall speakers install in a similar fashion, that is, they are placed based on the dispersion angles and coverage required. Height of the speaker will be determined by the 6dB down point so that although the SPL at this point is 6dB down, the audience plane is 6dB physically closer compared to the on axis level. Horizontal spacing will determine the distance between each speaker once again using the 6dB down angle as the overlapping point (this overlapping point whether ceiling or wall speakers determines the SPL deviation as discussed.)

This discussion dealt with only some of the requirements for achieving speech intelligibility and there are certainly other influencing factors besides these such as, system stability when using open microphones, frequency adjustment using DSP, SNR as related to the total electronic signal chain, zoning of the various speaker groups, types of messages/signals, signal chain redundancy, wiring size, speaker line supervision and proper selection of amplifiers to name a few. All of these parts of the signal chain must be considered when designing for Mass Notification Systems. Accountability will soon be required to prove that the PA system is capable of providing the designed intelligible requirements. I urge everyone to start their research on Mass Notification Systems and how it will impact our industry.

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