EFFECTIVE USE & DESIGN OF LARGE OUTDOOR SOUND SYSTEMS

KEEP TIME & DISTANCE IN MIND

A Daktronics Audio large venue outdoor sound system is based on "Point Source" technology, meaning the system generates sound to cover the majority of the venue from one location (typically at the scoreboard/display). Since the speed of sound is 1130' (344.4 m) per second under controlled conditions, it takes approximately one half second for sound to arrive at a spectator seat that is 550' (167.6 m) from the speaker system. This is not a problem if there are no other significant sound sources playing the same program material as the main speaker system.

A portable sound system on the playing field that has been interfaced into the main system can cause sound problems. Let's say the portable sound system is located midfield, 300' (91.4 m) away from the main sound system. Sound is leaving both speaker systems at the same time but arriving at the listener position at different times. This delay greatly diminishes the speech intelligibility and overall performance of both sound systems. The solution? Do not interface the systems together.

Large sports venues often feature special rooms for spectators in the press box or some other enclosed space. These rooms typically have a speaker system that provides game audio to the spectators. If the audio played in the room is the same audio that is being played through the main speaker system, an electronic audio delay must be incorporated into the room speaker system for "Time Aligning". Without this time alignment, an annoying "slap back" echo will be heard.

A similar situation can occur if a sports venue has a distributed speaker system in the concourses under the seating area. When the audio playing through the concourse speaker system is the same audio as the main speaker system, audio delays must be incorporated into the concourse speaker system as well.

Audio played through a concourse or spectator suite speaker system is not usually the same as the audio heard from public address system. The team's sports radio broadcast is the most common program material played through the concourse and suite systems, avoiding the issues described above.

GARBAGE IN, GARBAGE OUT

Referred to as "GIGO" in computer circles, the expression Garbage In, Garbage Out also applies when choosing the best program material for a sound system. An effective "Full Range" large venue sound system can cover a vast seating area with audio frequencies from 120 Hertz (bass) to 14,000 Hertz (treble). This frequency range is very appropriate for quality music reproduction and excellent speech intelligibility, precisely what Daktronics sound systems are designed for.

Much of the popular music produced today is mixed with heavy emphasis on bass. The frequencies that are emphasized can rattle car windows, but are lost when played over a large venue sound system. It is not unusual for program material that sounds powerful at home or in the car to sound thin on a full range system without subwoofers. Choosing program material carefully and auditioning the material over the sound system prior to performance will ensure a predictable result.

It is possible to format popular music cuts to perform well on large venue sound systems. Many athletic programs do not have funds available to pay the royalties and licensing fees required by law when using popular music cuts. A prepared sports music package can provide musical excitement and continuity while remaining cost effective. Some organizations choose to have custom themes and sound bytes produced to provide a unique impact.

Many times a team has a favorite music cut that simply needs to be reformatted or "de-noised". The quality of the cut can be greatly improved through a digital re-mastering process. The newly formatted cut is then recorded onto a CD for repeated playback. Keep in mind the performance of the sound system is directly related to the quality of the program material.

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Additionally, only high quality music should be chosen for the system. Low quality music tracks from sources such as YouTube will be very apparent in a high performance sound system. High quality tracks from iTunes or store-bought CDs are recommended. To evaluate content, always listen to the tracks through high quality headphones first as this will emphasize both the good and the bad in the music, just like an effective sound system.

HOW **LOUD** WILL THE SYSTEM GET?

An effective sports venue sound system will get loud enough to produce intelligible speech over a stadium full of cheering fans. Daktronics Audio systems are designed to produce ample sound pressure level (SPL) to cut through the ambient noise. Our systems are also configured to produce a fixed maximum volume level and calibrated to not exceed this level.

Audio limiters are set to engage when the audio mixer is pushed beyond normal operating parameters. It is critical that the limiting equipment and program presets are not tampered with. Typically, limiting equipment is installed with security covers in place or program presets locked to discourage unauthorized adjustments. If a system is operating out of calibration, equipment damage is highly possible.

The audio control system in many sports venues is located in a less than ideal space, often inside a room with little access to the outdoors. It becomes necessary for the sound engineer to adapt to the surroundings and find a point of reference to judge the actual volume level of the system in the seats. It is very easy to overpower the crowd with the sound, even to the point of pain. The sound engineer must have a very good grasp of the volume level the system is producing in the seats.

ECHO MAKES TALKING DIFFICULT DIFFICULT DIFFICULT

In the first section, we addressed the issue of audio time delay with regards to different speaker systems. With significant distance between the announcer and the speaker cluster, the announcer's words come back at the press box sounding like a quick echo. Daktronics Audio offers a headphone monitoring option for the announcer to reduce the distraction caused by this echo effect. Game announcers tend to prefer using headphones for isolation from echoes and other ambient noise.

When using a remote wireless microphone on the field, be conscious of the time delay issue. Try to make anyone unfamiliar with speaking over this type of system aware of the delayed audio. Experienced announcers and coaches work with the time delay and pattern their speech pace and rhythm accordingly.

For example:

> "Number 12 Brian Lawson – [pause] – Quarterback Keeper – [pause] –
> tackled by Scott Yates – [pause] – 10 yard gain – [pause] – First Down."

Daktronics can also provide a Wireless In-Ear monitor system for on-field talent. This will allow the sound engineer to selectively send audio to earphones of the person using the remote wireless microphone on the field. This includes their own voice and additional cues as required to help reduce the effect of echoing on their performance.

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THE REALITIES OF WIRELESS MICROPHONES

The best way to connect a microphone to an audio mixer is with a hardwired cable. The alternative is linking the microphone to the audio mixer via wireless transmission and reception. With convenience and portability also comes potential for interruptions and interference in the wireless audio link. Therefore, proper understanding and operation of the wireless microphone system is crucial for success.

Wireless microphone systems consist of a microphone interfaced to a battery-powered transmitter. The transmitter is housed in the body of a hand-held microphone or in a body pack when attached to a lapel microphone or headset. The audio information is transmitted on a specific frequency to a receiving unit connected to the audio mixer. The receiver will usually be AC powered and feature two antenna inputs.

The FCC has allocated frequencies in UHF spectrum areas for wireless microphone systems. If multiple wireless systems are operating in the same venue, all systems must be frequency compatible. The fact that wireless systems operate on different frequencies does not ensure compatibility. Frequency compatibility is determined by mathematical calculations, typically performed by a computer. A qualified wireless systems technician can easily access compatibility information.

There are several causes for transmission interruption:

Competing Frequencies – The most common cause of wireless microphone interruption is competing wireless transmissions. In today's world, the demand for wireless communication is so high that it has created very few available frequencies in which current wireless microphone systems may operate. Typically, the available frequency selection is the same that Digital Television stations operate on as well as many other wireless camera and intercom equipment.

Outside of a dedicated frequency coordinator for the event, the next best solution is to set your equipment to an available frequency after performing a wireless spectrum scan. Most quality wireless microphone systems have this scan function built in. It is fast and effective as long as the process is performed after all other competing wireless equipment has already been set up and is in operation.

Low Battery – This is the most common problem associated with transmission interruption. Many newer model wireless transmitters provide a battery life indicator on the unit. Monitor this closely and change batteries when the power begins to drop. Always use Alkaline Batteries (Duracell, Energizer, etc.) or battery packs provided by the manufacturer. Keep in mind that it is possible to have a bad battery out of the box. Keeping a volt meter handy and checking batteries prior to installation is a good practice. Insert new batteries prior to each use as well as at half time, and always have spares on hand.

Transmitter Antenna Position – Many belt pack transmitters have an antenna wire that hangs from the unit. If this wire is not in an extended position, the transmission is compromised. Make sure the antenna wire is not crumpled.

Broken Wires – Sometimes there is an interruption in the audio signal that is not caused by the transmission link. The tiny microphone cable that attaches a lapel microphone to the belt pack transmitter is the most vulnerable part of the system. This wire is often stressed, especially at the belt pack connection point, and can totally fail or be intermittent. Keeping a spare lapel microphone on hand is recommended.

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ENVIRONMENTAL EFFECTS ON SOUND PROPAGATION

TEMPERATURE

If sound is propagated over large distances outdoors, its behavior may seem erratic. Differences (gradients) in temperature above ground level will affect propagation as shown below. Refraction of sound refers to its changing direction as its velocity increases slightly with elevated temperatures. In **Figure 1**, we observe a situation which often occurs at nightfall, when the ground is still warm. The case shown in **Figure 2** may occur in the morning, and its "skipping" characteristic may give rise to hot spots and dead spots in the listening area.

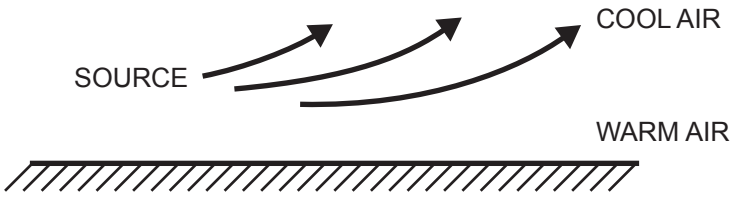

Figure 1

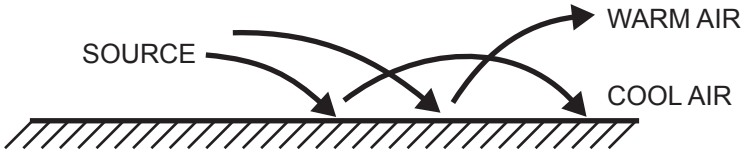

Figure 2

WIND

Figure 3 below shows the effect of wind velocity gradients on sound propagation. The actual velocity of sound in this case is the velocity of sound in still air plus the velocity of the wind itself. **Figure 4** shows the effect of a cross breeze on the apparent direction of a sound source.

The effects shown in these two figures may be evident in your stadium, where the distances covered may be in the 500' (152 m).

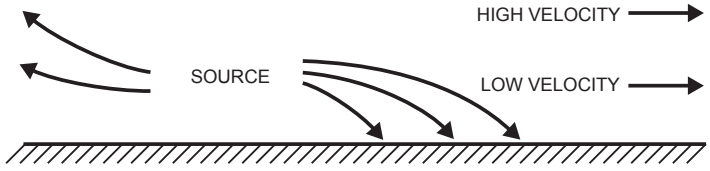

Figure 3

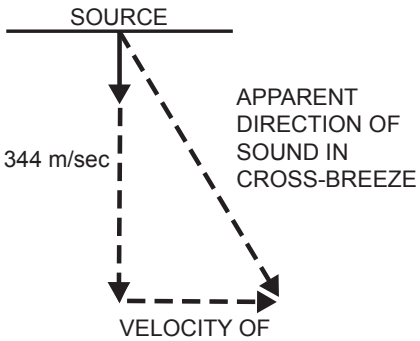

Figure 4

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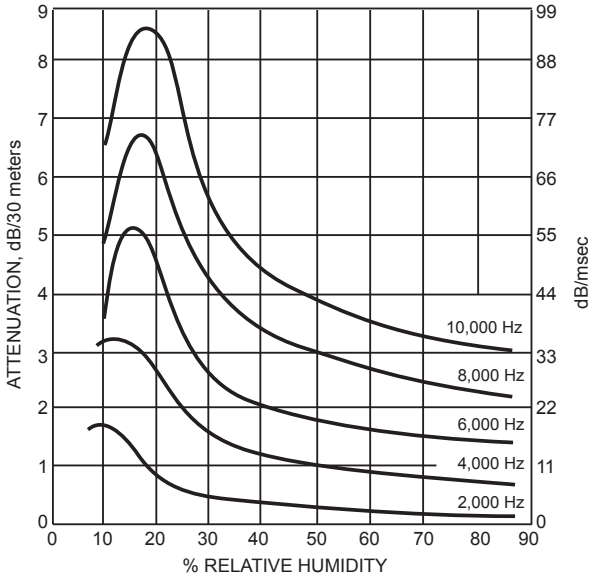
HUMIDITY

Contrary to what most people believe, there is more sound attenuation in dry air than in damp air. The effect is a complex one, and it is shown in **Figure 5**. Note that the effect is significant only at frequencies above 2 kHz. This means that high frequencies will be attenuated more with distance than low frequencies will be, and that the attenuation will be greatest when the relative humidity is 20% or less.

Figure 5



SUMMARY

A sound reinforcement system is made up of several components that must work together for optimum performance. One bad component can adversely affect the entire system. In a perfect world, audio components would never fail or sustain damage. In our real world, however, even the best components can and do fail from time to time. A good working knowledge of the total system can help prevent and resolve problems and is the best preparation for operational difficulties.

An audio system may appear to be "kind of working", but not working properly. A good example of this can be found with something as simple as microphone cable. The conductors in a microphone cable are made up of stranded wire. Several broken strands in a conductor will pass signal, but with diminished audio quality. If a microphone does not sound normal, the first item to check should be the cable.

Testing an audio system well ahead of any performance should be standard practice, especially if the system has not been used for an extended period of time. Don't let the system sit quietly all summer and expect it to work flawlessly at the first football game in the fall. A "test run" should expose problems or inconsistencies before interfering with the event. Be sure to test all components and functions that will be used in the upcoming performance situation. For example, while the system my appear to be working properly from the control point, a wireless microphone may have sustained damage that causes it to fail. Test all wired/wireless microphone inputs and all playback sources such as CD/MP3 players.

Understanding your audio system and routine pre-event testing will eliminate unwanted surprises and reduce the potential for failure.

Portions of this document were reproduced from the *JBL Sound System Design Reference Manual, Third Edition (1999)*

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