HOW TO SPECIFY SOUND MASKING

How to prepare a
performance-based
sound masking specification for
speech privacy and noise control.

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Research conducted by the Center for the Built Environment (CBE) shows that acoustics are an integral part of an effective workplace. Employees are more satisfied and organizations more profitable when their facility provides the requisite level of speech privacy and noise control.

Many organizations use a sound masking system to maintain an appropriate ambient level in their facilities, which is usually between 40 and 48 dBA in commercial interiors. This technology consists of a series of loudspeakers, which are typically installed in a grid-like pattern in or above the ceiling, and a method of controlling their output. The sound the loudspeakers distribute has been specifically engineered to increase speech privacy; however, it also covers up intermittent noises or reduces their impact by decreasing the change between baseline and peak volumes. Although the background sound level is technically higher, occupants perceive the space as quieter. Many systems also provide paging and music distribution, eliminating the need for a separate system.

Sound masking systems have been used in various applications for decades, including offices, call centers, banks, courthouses, libraries, military facilities, hospitals and other healthcare environments. In recent years, they have gained even more popularity because of the increased use of open plan space and demountable partitions, rising densities and sustainable design practices, all of which have a significant impact on acoustics.

The field has also changed with the introduction of new types of sound masking systems. Users are no longer limited to a choice between centralized and decentralized products, but can now select a digital or networked technology. However, what often gets lost in the shuffle are the key design and performance features that can have a substantial impact on the outcome within each space.

The Specification Gap

Sound masking is a critical design choice for which one does not want to leave a lot of room for interpretation. After all, when purchasing a system, the user is not seeking the mere pleasure of owning the equipment. Without a set of performance standards, poor procurement decisions can be made. The desired level of speech privacy, noise control and occupant comfort may be sacrificed, as well as the user's ability to easily and cost-effectively adjust their system in the future.

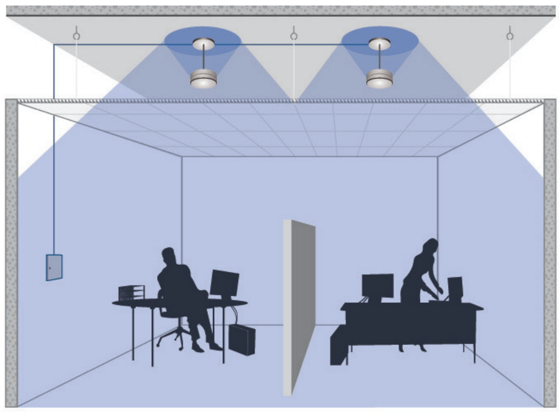

Figure 1: A sound masking system consists of a series of loudspeakers installed above the ceiling, and a method of control.

In order to keep the focus on design and performance, the manner in which sound masking systems are specified needs to be updated. Currently, they are often specified according to the above noted types, limiting the number of vendors that can bid on a given project. Bidding opportunities are further restricted when the specification incorporates propriety elements such as the dimensions of components, types of inputs/outputs and other trivial details. At the other end of this spectrum are specifications that merely state "provide a sound masking system." The contrast to the manner in which most other building systems such a HVAC or fire alarms are specified is striking.

The best-practice approach for sound masking is to write a performance-based specification focusing on the qualities that are critical to the system's effectiveness and occupant comfort.

Key Performance Criteria

A sound masking system's performance is determined by the following criteria:

- Adjustment zone size
- Masking sound generation
- Volume adjustment capabilities
- Frequency adjustment capabilities
- Loudspeaker requirements
- Measured results

These six elements are vital to every project's success. Clear requirements can be set for each one and various masking technologies are available that can meet those standards. In other words, a specification focusing on these elements allows competitive bids and, providing the terms of the spec are upheld, also ensures a high level of performance from the system ultimately selected.

Adjustment Zone Size

Acoustic conditions and user needs vary between private offices, meeting rooms, corridors and reception areas, as well as across open plans. Sound masking designs with small adjustment zones (i.e. individually controllable groups of loudspeakers) enable the user to adjust their frequency and volume to meet these diverse needs.

Conversely, designs using large adjustment zones – from eight to dozens or even hundreds of loudspeakers – require the user to make compromises that may increase the system's effectiveness in some areas while diminishing occupant comfort in others or vice versa.

The impact of these compromises is far from minimal. A few decibels of variation in masking volume can dramatically impact the system's effectiveness, even without taking into consideration the consistency of frequency levels. In many situations, users can expect a 10 percent reduction in performance for each decibel variation below the target masking volume. A poorly designed system can allow as much as 4 to 6 dB variation (i.e. ±2 dB or ±3 dB), meaning the system's effectiveness will be halved in some areas of the user's space.

Zone size also affects the ease with which the user can make changes to the system in the future. Churn rates and renovations require building systems that can be quickly, easily and cost-effectively readjusted. Large zones limit the user's ability to reconfigure the sound masking system without first physically changing its design, moving loudspeakers and/or re-wiring parts of the system.

In other words, the single most important factor within a sound masking specification is to place an upper limit on adjustment zone size. In this case, less truly is more: one to three loudspeakers in each zone provides a high degree of flexibility.

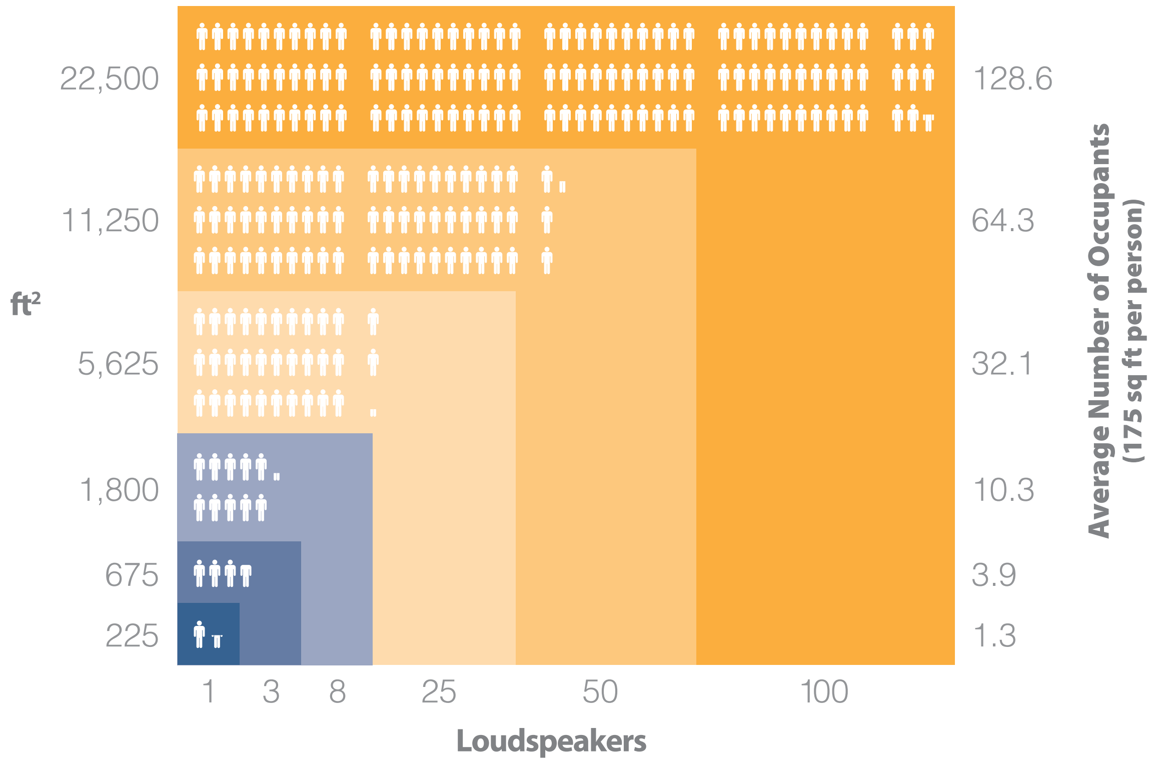

Figure 2: The greater the number of loudspeakers within each adjustment zone, the larger the area of compromise and the greater the number of people affected by it.

Masking Sound Generation

Each small adjustment zone should feature a dedicated masking sound generator in order to avoid a phenomenon called phasing (i.e. uncontrollable variations in the masking levels), which occurs when a number of loudspeakers adjacent to each other emit the same masking signal. This problem is circumvented in this case because each loudspeaker is typically adjacent to another that is supplied by a different generator.

To maximize unobtrusiveness, each masking generator should also provide a sound that occupants perceive as being random (i.e. with no noticeable repeat cycle). Its actual generation can be pseudo-random but, in this case, the repeat cycle should be as long as possible. If there is no noticeable loop, and the masking is also finely tuned to suit the needs found throughout the space, occupants will not focus on the sound.

The sound produced by the generator should cover the entire masking spectrum of 100 to 5,000 Hz (or as high as 10,000 Hz).

Volume Adjustment Capabilities

The masking sound is greatly affected by the overall workplace design, including the materials used, location on the floor, items above the ceiling and furnishings. These elements have an impact no matter how the loudspeakers are installed (i.e. upward-facing above a suspended ceiling or direct-facing cut through a ceiling). For this reason, the ASTM standard for measuring and evaluating masking performance in open offices (i.e. ASTM E1573-09, *Standard Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels*) requires measurements to be taken in areas representative of all workspace types.

If the adjustment zones are large, numerous loudspeakers are set to the same output level, but after interacting with the variables in the space as noted above, the masking volume fluctuates. Variations of 2 dB or more call attention to the masking sound, reveal its source to occupants and diminish results.

Large-zoned designs attempt to mitigate these volume variations by including audio transformers as volume controls on each loudspeaker. However, they only provide rough adjustments of 3 dBA each. When the volume cannot be finely adjusted in small areas, the user needs to set a volume that is best 'on average,' compromising comfort or effectiveness at various, unpredictable points across their space. In other words, if they require a particular performance level in one area, other areas may have to endure louder volumes. If comfort is desired, the masking's effectiveness may be diminished in some areas.

Therefore, the specification should call for fine volume controls for each small zone. Increments of 0.5 dB enable the user to adjust the volume wherever needed in order to accommodate variable acoustic conditions.

The specification should also require the final masking volume be consistent, a range of 1 dBA (±0.5 dBA) of the desired volume at each test location. Again, the benefits are comfort and consistent performance across the space.

Frequency Adjustment Capabilities

The sound masking system should also provide fine frequency control within each small adjustment zone.

The range of masking sound is generally specified to be between 100 to 5,000 Hz (or as high as 10,000 Hz). The system should provide control over these frequencies via third-octave adjustment, because it is both the industry standard and the basis for masking targets set by acousticians.

However, simply providing third-octave adjustment is not sufficient if these controls are paired to large adjustment zones. A well-designed system provides equalization for each group of one to three loudspeakers.

Loudspeaker Requirements

As long as the masking system can meet the volume and frequency targets established by the specification, it is not essential to specify the loudspeaker's size, wattage rating or other parameters. However, it is worth noting that very small loudspeaker drivers (less than 3 inches or 76 mm) are not likely to generate sufficient levels below several hundred hertz (i.e. down to the required 100 Hz). These low frequencies are necessary to create the full masking spectrum. While they play a relatively small role in reducing speech intelligibility, they are vital to occupant comfort and to mask a wider range of noises. Most masking loudspeakers are 4 to 8 inches (100 to 200 mm) in diameter and rated from 10 to 25 watts.

It is also useful to specify a loudspeaker that can be converted and installed in either an upward- or downward-facing orientation on site. For example, certain situations that are not always evident during the design stage may force the use of downward-facing loudspeakers in some areas.

Measured Results

The true gauge of whether the sound masking system ultimately selected is performing as required is gained from post-adjustment measurements.

Figure 3: Requirements vary between different facility areas, as well as across open plans. If the sound masking cannot be finely adjusted to accommodate these differences, a trade off between effectiveness and comfort will be required.

The specification should require specific results that are measured and documented. Best practice is to require a test in each 1000 ft^2 (90 m^2) area, and that the vendor adjust the sound masking system within that area as needs dictate. Some systems may be able to outperform this requirement, but it is a good baseline.

Measurements should include:

Overall volume and variation tolerances

Masking volumes typically range between 40 and 48 dBA, depending on the type of space and the user's performance requirements. 48 dBA is usually the maximum for comfort; therefore, that level should not be exceeded, except in special cases. As previously mentioned, the results should be consistent within a range of 1 dBA (±0.5 dBA).

Masking frequency curve

There is a general curve that the acoustical community considers effective and comfortable. It is defined in third-octave bands. The specification should set maximum variations for each frequency band. Plus or minus 2 dB variation is a reasonable expectation.

Temporal uniformity

This term refers to the consistency of the masking volume over time. While this attribute can be assessed, it is usually not an issue and is less frequently specified and evaluated.

Note that there are no independent standards for masking performance, only standards relating to measurement such as ASTM E1573-09, *Standard Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels*. A specification stating that the sound masking system is or should be 'compliant' with – or 'meet' – any ASTM standard is misleading. Instead, it is essential that it outlines all of the above requirements for masking output.

Additional Considerations

Timer functions

Timers automatically adjust the masking volume to vary in anticipation of noise levels throughout the day, balancing effectiveness and comfort. For example, the user may want the masking volume to lower at a certain time of day when there are fewer occupants in the facility.

Considerations for the specification include whether the timer provides variable rates of volume change, the number of independent timer zones, whether daily schedules can be independent and if unique schedules can be programmed for specific days of the year (i.e. holidays and special events).

Masking systems may also offer a ramp-up feature. It is best to specify this in retrofit situations because it is used to gradually introduce the masking sound, allowing occupants to easily acclimatize to the change in their acoustical conditions.

Zoning methods

Beyond masking zones, most systems can be zoned for a variety of functions, including paging and timer functions, as well as local occupant control (i.e. in a meeting room). In this case, the type of zoning is relevant. For example, hardwired zones require advanced planning because a contractor has to re-cable parts of the system when changes need to be made in the future. Digital zones can usually be re-assigned without altering the system's physical design. Less planning is required from the outset because any changes can be made in minutes. Digital zoning should allow for independent zoning of all functions.

Control methods

The method of controlling the system impacts the ease, cost, precision and amount of disruption associated with making initial and future adjustments. Some designs provide central control over a limited range of features. Others provide central control over a few features and local control over others. There are also more flexible designs offering control over all features from a central location.

Most users make significant changes to their space over time – to department location, demountable partition placement or furniture system configuration – and it is important to consider how the corresponding changes will be made to the sound masking system. The specification can include the types of features and settings that need to be controlled and from what kind of access point (i.e. hardware and/or software).

Figure 4: If the sound masking system is installed in an open ceiling, it should blend in with other visible components, such as the lighting.

Security features

Depending on the user, security may be another key consideration. In this case, the specification should describe both the physical and electronic security features for the sound masking system.

Physical features can include housing below-ceiling equipment in locked enclosures and also ensuring enclosed rather than exposed cabling connections. Electronic measures can include monitoring, password-controlled access, encrypted communication and more.

If security is a concern, additional masking generators and longer generation cycles are better because short cycles can easily be filtered out of recorded conversations.

Paging and music functions

Many sound masking systems can provide simultaneous overhead paging and background music functions. If the user requires these features, cover them in the specification.

Aesthetics

When installed in an open ceiling, the system's appearance should be considered, including the look of the loudspeakers (i.e. an industrial aesthetic or similar to a lighting pendant), the cable and cable connections, as well as the loudspeaker suspension methods (i.e. chain or a braided steel cable).

Certifications

Another important aspect of the specification concerns the system's certifications. Though not critical to performance per se, they are essential to meeting regulatory requirements.

Sound masking systems must meet Underwriters Laboratories (UL) or similar standards for electrical safety. In the United States, any components installed in air-handling plenum or via cut-throughs in a suspended ceiling must also be tested to meet UL 2043, *Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*. Cables must be plenum rated. If using low-voltage power supplies, these should conform to the UL1310 standard for Class 2 power sources in order to avoid conduit requirements.

Digital masking systems need to meet electromagnetic interference (EMI) standards.

If sustainability is a goal within their space, users might also voluntarily require *Restriction of Hazardous Substance* (RoHS) compliance, which limits the quantities of hazardous substances used in the system's components. Note that RoHS compliance is now mandatory is some markets (i.e. Europe).

Drawings

Even if the sound masking technology the vendor proposes adheres to a generally worded design guide, they may intend to implement it in a different manner. Therefore, it is important to require drawings as part of the bid submission process.

Drawings can help to identify differences between sound masking proposals, because they show the components, quantities and locations, making it easier to spot design shortcuts and subsequently discuss those deviations with the vendor.

Ideally, of course, the drawings should be included as part of the specification itself, allowing the user to set the adjustment zones for each area. For example, there may be areas where the client wishes to use zones smaller than the three-loudspeaker maximum, such as in private offices and meeting rooms. These drawing should be created by the user in conjunction with an acoustical consultant or trusted vendor.

Compliance form

Another useful document to request in the specification is a compliance form. Vendors should be asked to submit a statement indicating their adherence to each aspect of the specification. They should also be required to note any deviations, describing how their system's design differs.

Own Your Spec

Acoustics are an integral part of a project's long-term success and should be planned from the outset. While every sound masking system introduces a sound into the space, overall performance can vary dramatically. A well-constructed specification is essential to ensuring the technology and the system's design meets the user's current and future requirements. If not, the sound masking system may be ineffectual, underutilized, or become a source of irritation itself and possibly turned off.

However, even with a well-written specification, the user could end up with a non-conforming system unless the specifier, user or another person(s) involved in the design and procurement process is appointed as a guardian whose responsibility it is to ensure bids meet the criteria outlined. Many times the value of a well-designed specification is nullified because no one is asked to ensure all proposals – and, indeed, the system ultimately selected – conform to the desired performance levels.

It is also wise to learn what services are offered in conjunction with each proposal under consideration. The sound masking system should be supported by professionals who can properly design and implement it and provide the user with ongoing support.

For a sample of a performance-based spec visit:
www.soundmaskingspecs.com

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info@logison.com www.logison.com 1.866.LOGISON