WELL V2:

EVIDENCE BEHIND THE **SOUND** CONCEPT

FEATURE S01: SOUND MAPPING

OVERVIEW

Part 1: Floor plans or architectural layouts are annotated with Quiet, Loud, Mixed and Circulation zones labeled and a plan to separate Quiet zones from Loud zones is provided.
Part 2: Require projects to strategize an acoustical plan that identifies and labels sources of noise that can negatively impact acoustical conditions within a space.

SCIENTIFIC BACKGROUND

- Sound is the result of pressure fluctuations between particles that make up media, such as gases, liquids or solids.[1]
- When these pressure fluctuations reach the ear, they travel to the cochlea, where they are converted to electrical impulses before traveling to the brain to be interpreted as sound.[2]
- Sound waves are made up of a pattern of air pressure disturbances that move through a medium in mechanical waves that allow energy to transfer from one particle to another.[1] Sound travels in two types of patterns – longitudinal (liquids and gases) and transverse (solids).[3]
    - The way humans interpret sound depends on the properties of sound waves. The frequency of wavelengths (or the amount of time it takes a sound wave to complete one cycle) is interpreted as 'pitch' and measured in Hertz (Hz). 'Loudness' is the amplitude or change in atmospheric pressure created as energy travels from one particle to another in a sound wave. Acoustic pressure is the difference between the pressure produced by emanating sounds and the average ambient or atmospheric pressure, measured in decibels (dB). Sound is most often reported in decibels.[3]
- The human ear is sensitive to sound through a range of frequencies, amplitudes and pressure. Humans respond best to frequencies most similar to the human voice and are most sensitive between 1,000-6,000 Hz but can perceive between 20-20,000 Hz.[4] Humans can perceive sound pressure or decibel levels between 10dB (near silence) and 130dB (pain) with individual variations.[5] For amplitude or pressure, humans can perceive short, sharp increases in sound pressure, long sustained pressure or low-frequency pressure perceived as vibration.[4,6]
- Typical sound transmission in buildings may include conversations, appliances and mechanical, electrical and plumbing systems (airborne, structure-borne, room-to-room or duct-borne), while sound transmission from outside to inside buildings may include sources such as traffic, recreation and industry.[7,8]

KEY HEALTH AND WELL-BEING EFFECTS

- Sound can impact human health and well-being. A cross-national review study on children, traffic and aircraft noise has shown modest negative health impacts at decibel levels of 40dB(A), while levels between 40dB(A) and 50dB(A) have been associated with sustained concentration and impaired memory.[9,10] Levels of 55dB(A) and above have been associated with an increased risk of more severe health impacts, such as ischemic heart disease.[11]
- Architectural trends such as open workspaces, lightweight construction, exposed concrete finishes or HVAC systems can have detrimental effects on acoustic comfort and quality of a space if not intentionally designed.[12-15]
- Environmental stress (ES) encompasses workplace features such as thermal and visual discomfort and sound stress, which reduces self-reported work productivity and job satisfaction.[16,17]
- Noise sensitivity appears to be cumulative. In one study from the United Kingdom, a positive correlation was observed between longer time spent in an office space and perceived disturbance from keyboard and ambient noise.[18]
    - Noise stressors that have been found to negatively influence productivity include in-person conversations, phone conversations, machines, non-specified noises inside the building and non-specified noises outside the building.[19]
- Open workspaces are often utilized to encourage social relations, communication, knowledge-sharing and cooperation.[20]
    - However, the reduced privacy of open workspaces, both acoustically and visually, can cause auditory distractions and interruptions.[20,21] Some reports have shown that occupants are less likely to help others under high noise conditions, reducing collaboration in the workplace.[22]
- Global workplace productivity studies consistently have found a link between lack of concentration and noisy open-plan offices. [20,23-26]

- Figures range from 99% of employees reporting that concentration was impaired by poor acoustical comfort in the workplace to 26.1-28.4% of employees reporting frequent unintended interruptions while completing an important task, impacting productivity and concentration.[13,18]
- Distractions can lead an employee to engage in avoidant behaviors, with one-fifth of staff reporting either arriving early or staying late to complete tasks or choosing methods of self-isolation, such as headphones or email.[13,27]

- When noise from internal or external sources is increased within a space, occupants are easily distracted, less productive and susceptible to burnout.[18,20,22,23,28]
  - Burnout is categorized as an occupational phenomenon that is a result of chronic work-related stress and includes exhaustion, increased feelings of negativism towards one's job and overall reduced professional efficacy.[29]
  - Burnout correlates with reduced productivity, as symptoms include psychosomatic disorders, employee turnover, absenteeism and performance.[30]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- Source control for noise is the most effective way to manage indoor acoustical environmental stressors.[31] These should include sound-blocking or absorbing materials for outside and inside noise.
  - A meta-analysis of 61 studies found that urban environments rarely go below 50dB(A) during the day.[32]
- Sound-masking can be an effective strategy to mask human conversation but needs to take into account existing acoustics, layout and workplace activities.[33,34]
- Open-plan offices may also have benefits. One pre- and post-study of a comprehensive thermal, acoustic, lighting, interior and ergonomic office renovation with an open-plan office found an increase in employee job and environmental satisfaction post-renovation.[35]
- Spaces should be designed with intent and use in mind. For example, spaces in a typical office can be categorized into four key types of programming: focus, collaboration, socialization and learning.[36]
- Identifying these different activity types within a space at the onset of the design process helps project designers understand the different tasks, design needs in their space and ensure that acoustical design is considered throughout the design and planning process.[37]
  - Studies have found that occupants in large and medium-sized offices had higher levels of complaints around noise and lack of privacy.[38,39]
- Intentionally locating different loud and quiet zones is important as noise from social or collaborative spaces impacts those intended for focus or learning.[36,40]
  - One study found that the number and availability of quiet rooms influenced environmental satisfaction, perceived levels of collaboration and stress.[41]
  - Strategically locating loud and quiet zones can be implemented in any space type that incorporates spaces of socialization and recreation alongside areas for task-centric work or learning.[36]

ADDITIONAL NOTES

- A person who is unable to hear in both ears at thresholds of 25 dB or better is categorized as having hearing loss.[42] Auditory processing disorders (APD) differ from hearing loss because they are categorized as a decreased ability to analyze and interpret information and are related to how the brain processes information, rather than capabilities of the ear.[43]
  - The U.S. Census estimates 28.6 million households report hearing loss and 17.4 million adults (ages 18-64) of workforce age.[44]
- It is possible to provide space accommodations that take into account background noise for employees who are hearing impaired.
  - Excess background noise can impair accessibility and satisfaction within a space and noise from open-plan offices can negatively impact fatigue, motivation and performance, especially for the hearing impaired.[44,45]
  - Accommodations include work area adjustments as needed, assistive listening devices (ALDs), Communication Access Real-time Translation (CART) and compatible telephones, assignments and meetings.[46]
- Natural soundscaping is a growing area of research, particularly water sounds, and may be considered as a part of a larger acoustical plan.[47,48]

FEATURE S02: MAXIMUM NOISE LEVELS

OVERVIEW

Part 1: Meet maximum and average sound pressure level requirements in specified room types.

SCIENTIFIC BACKGROUND

- Sound is a wave created by vibrating objects that exert pressure through the air, moving air particles as they pass through. The resulting sound that we hear is a measure of a change in air pressure: The greater the disturbance from normal atmospheric pressure, the louder the sound.
- Sound pressure, like all types of pressure, commonly is measured in units of Pascals (Pa).
    - The smallest sound pressure that the human ear can detect is 20 micropascals or 2.0×10^{-5} Pa. This is referred to as the threshold of human hearing.
- Sound pressure level (SPL) is measured in decibels (dB) and converts sound pressure (Pa) into a logarithmic scale that expresses the ratio between the sound pressure of a given sound and a reference sound pressure (typically the threshold of human hearing).
    - 2.0×10^{-5} Pa is equal to 0 dB.
- Decibels that are A-weighted (dBa) refer to when an "A" filter is used and represent decibel scale measurements that are adjusted for the human perception of sound. Decibels that are C-weighted (dBc) refer to when a "C" filter is used and represent decibel scale measurements that capture sounds the typical human ear cannot sense, such as low and high frequency sounds and are typically used for peak measurements.

KEY HEALTH AND WELL-BEING EFFECTS

- One hypothesis suggests that environmental noise exposure may be associated with negative health effects by acting as a stressor that chronically prolongs physiological arousal, leading to adverse effects on the endocrine and nervous system.[49]
- Structures that mitigate and reduce environmental noise exposure (e.g., noise from nearby traffic, rail or aircraft noise) may help shield against some observed negative health effects, such as elevated stress responses, increased levels of adrenaline and noradrenaline in children, increased risk of cardiovascular health problems, hypertension, tinnitus and sleep disturbances.[49-56]
- Studies in environments with low-intensity noise (such as that found in open-plan offices) indicate that such noise may contribute negatively to fatigue, annoyance, motivation, focus and performance.[57-62]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- At the extreme, ensuring that daily noise exposure levels do not reach or exceed 75-85 dBA can protect workers chronically exposed to such levels from irreversible hearing loss and potentially increased risk of hypertension.[63,64]
- Keeping L_{max} levels below 42 dBA indoors can help to prevent waking in the middle of the night or too early in the morning, while keeping levels below 35 dBA can help to prevent more subtle sleep disturbances, such as changes in the duration of different stages of sleep and sleep fragmentation.[64,65]
- To minimize annoyance and distraction from work, it is recommended that sound levels are maintained below 55 dBA for routine work and below 45 dBA for tasks involving deep concentration or in enclosed spaces such as meeting rooms.[63,64]

ADDITIONAL NOTES

- Different health and well-being effects may be associated with different specific sources of noise, wherein noise from road traffic compared to railroads, aircraft noise or speech annoy or otherwise create adverse well-being outcomes for people.[66] Therefore, practitioners should consider the specific sources of noise in the environment in question when identifying appropriate interventions.
- In terms of effects related to sleep disturbances, the threshold for awakening is higher in children than adults, meaning adults may be more sensitive to noise at night. However, the duration of exposure is typically longer for children given that they tend to sleep longer than adults. On the whole, sleep structure becomes more fragmented with age, pregnancy and illness.[67-69] Therefore, seniors, pregnant women and sick individuals are more vulnerable to sleep disturbances from noise. Similarly, shift workers, whose sleep structures may already be under stress due to

their work schedules, may likewise be at greater risk of sleep disturbances and adverse effects on their circadian rhythms.[51,65]

FEATURE S03: SOUND BARRIERS

OVERVIEW

Part 1: Walls and doors are designed to meet specification thresholds for speech privacy and sound transmission coefficient ratings.
Part 2: Walls are designed and measured to meet specification thresholds for speech privacy and sound isolation.

SCIENTIFIC BACKGROUND

- The Sound Transmission Coefficient (STC) is a single-number rating given to a material or structure based on laboratory testing that represents the sound insulating properties of the partition/barrier or the effectiveness of the partition in reducing sound transmission. Higher STC ratings correspond to better sound insulation.
- The degree of privacy between two rooms or spaces can also be quantified by using Speech Privacy Potential (SPP), Speech Privacy Class (SPC) or a similar metric.[70] These metrics are the function of the background noise level in the receiving space combined with the sound insulating performance of the partition separating the spaces (e.g., STC, R'w, NIC).

KEY HEALTH AND WELL-BEING EFFECTS

- One of the most prevalent sources of annoyance in offices is noise.[71] Studies suggest the specific cause of acoustic dissatisfaction relates most often to speech privacy.[71,72]
- Noise can have a negative impact on both physical and mental work performance in both occupational and educational settings and can lead to increased stress for occupants, particularly for work that requires a high level of concentration.[59,73,74]
- Partitions separating different units in residences that allow greater sound transmission between units is associated with difficulty initiating sleep, sleep disturbances throughout the night and negative effects on social variables, such as increased perceptions of neighbors as less considerate.[74,75]
- A review of surveys across several countries found that noises from neighbors in residences often is reported as a prominent, 'highly annoying' concern for occupants that has the potential to cause social conflicts.[76]
    - The degree of annoyance also is mediated by personal factors that do not have to do with building design or construction, such as occupant stress levels, the value of the residence and the duration of time the occupant has lived in the residence.[76]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- In general with building acoustics, low speech intelligibility between adjacent rooms is desired for adequate speech privacy.[77]
- Case studies in open plan offices, private offices and conference rooms have demonstrated that the level of satisfaction with speech privacy predicted by SPP values corresponds well to subjective occupant reports of acoustic satisfaction.[78]
- Industry best practices suggest that SPP values approximately between 60 and 90 represent the practical range for buildings, wherein 60 represents a complete lack of speech privacy and 85 or 90 represents exemplary privacy.[79,80] Therefore, occupant satisfaction with acoustical privacy is most commonly reported when SPP is 60 or greater.[81,82]
    - SPP 70 corresponds to normal voices being audible but largely unintelligible.[83] SPP 75 corresponds to normal voices being barely audible and raised voices being largely unintelligible.[83] SPP 80 corresponds to inaudible normal voices and barely audible raised voices.[83] SPP 85 corresponds to barely audible shouting.[83]
- Building standards and guidelines typically require STC ratings between 40 to 50 for walls separating enclosed spaces.[84,85] The U.S. General Services Administration recommends a minimum STC rating of 53 to isolate sounds in video conference rooms, 45 to separate conference rooms from rooms requiring confidential speech privacy and 40 to separate private offices for normal speech privacy.[86,87]
    - The sound transmission across a door varies considerably depending on door material, construction and sealing between the door and the frame or jamb.[86,88] Improved sealing though enhanced gaskets, adding more gaskets or using different gasket materials all can help to achieve improved acoustical performance and maximize the STC of the door.[88] Heavier doors are also typically better at sound attenuation, with data suggesting that doubling the weight of a door can lead to an increase of up to 9 dB in STC.[88]

- An STC of 60 in residences corresponded to not being able to hear neighbor noises “at all” according to survey responses. This also corresponded with residents being “not at all annoyed” by neighbors.[89]
    - One study found that for lower STC ratings in residential partitions, sound insulation mattered less and disturbances were related more strongly to neighbor behaviors.[75] However, the importance of neighbor behaviors waned as sound insulation increased and STC-50 appeared to be a minimum threshold to reduce disturbances from neighbors’ noises.[75] This threshold increased to STC-55 for music-related sounds.[75]
- Occupant satisfaction in residences is influenced by a number of factors. One study found that out of several common building-related issues, poor sound insulation was ranked as the number one concern.[90] Survey data suggests that improving the sound insulation of partition walls between dwelling units (i.e., achieving higher STC values) is a critical way to improve overall satisfaction with the building.

FEATURE S04: REVERBERATION TIME

OVERVIEW

Part 1: Design to meet thresholds for reverberation time as specified by space type.
Part 2: Achieve thresholds for reverberation time as specified by space type.

SCIENTIFIC BACKGROUND

- Reverberation time (RT60) is the length of time (in seconds) required for the average sound pressure level in a space to decay 60 decibels (dB) from its initial level once its source has stopped producing sound.[91]
    - Reverberation is frequency-dependent and can either be measured in frequency bands or as an averaged value. It can be approximated based on the room volume and known properties of the room's contents (absorptive and reflective surfaces) or measured directly in the field.
- Designing to meet specific reverberation time targets for enhancing speech intelligibility is also a function of ambient sound pressure level (dBA) and background noise.
    - The relationship between reverberation and background noise is measured through the signal-to-noise ratio, which accounts for a signal (e.g., a person speaking, a PA system) and the noise level experienced at the listener. This noise level can be influenced not only by a sources' ambient sound pressure levels (e.g., HVAC, building services, external noise) but also by room dimensions and surface finishes, which foster longer reverberation decay times.[92]

KEY HEALTH AND WELL-BEING EFFECTS

- Learning and other cognitive processes are impeded when speech is disrupted or overwhelmed by other background noise (i.e., a poor signal-to-noise ratio), which is exacerbated by high reverberation time. This can be particularly burdensome for people with imperfect hearing or suboptimal working memory capacity (such as young children or older adults) or when speech is difficult to comprehend, such as if the listener's primary, native language may be different than the speech language.[93-98]
- High reverberation time and background noise levels can lead to increased vocal effort and fatigue in primary school teachers.[99] Classroom conditions that warrant higher reverberation time and background noise require additional audible workload from students and is linked to a reduction in memory retention, productivity and increased distraction.[100-102]
- Longer reverberation time may have a stronger, negative effect on speech perception when background noise levels are higher.[103]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- Optimal reverberation time varies depending on room volume, intended use of the space and the frequency of the transmitted sound.[104] In the case of emergency communications systems, notification zones are denoted by Acoustically Distinguishable Spaces (ADS), which require necessary control of ambient sound pressure level and reverberation time to allow for announcements to be more clearly discernable.[105]
- Public spaces with public address systems rely on acoustical surface finishes that support optimal reverberation times and stronger direct sound signals. The ear is capable of discerning and fixating on the first sound received (line-of-sight direct signal) and disregarding later signals (reflected sound). This occurs up to about 40 milliseconds between direct and reflected sound.[105] A person's ability to localize sound decreases in spaces with longer reverberation (i.e., beyond 40 milliseconds).[106]
- Spaces designed for a shorter reverberation time can help with comprehension and memory recall of spoken information.[103,107] Excessive reverberation "smears" the temporal properties of speech signals. Instead of individual, distinct speech sounds following one after another in words, the reverberation makes the sounds overlap each other, which may make speech harder to comprehend as a listener.[108]
- Both reverberation and background noise can negatively affect speech intelligibility independently, but the negative effects may work synergistically and are further exacerbated together.[109,110] This suggests that to meaningfully improve speech recognition, efforts must be made to address both reverberation and ambient sound pressure levels together.
- Hard surfaces provide poor absorption and contribute to the reflection of noise. Softer surfaces are more effective in absorbing direct sound and reducing reverberation time. Sound-absorptive materials are usually porous, such as

fiberglass, mineral wool, felt or polyurethane foam.[111] Textured surfaces, such as thick grass, can reduce sound levels by up to 10 dB per 100 meters at 2,000 Hz.[112] Overall, low-density, fibrous materials (e.g., nonwoven fabrics) may be ideal for sound absorbing.[113]

FEATURE S05: SOUND ABSORPTION

OVERVIEW

Part 1: Meet noise reduction coefficient (NRC/α_w) threshold values for treating ceilings, walls and partial height barriers as specified by room type and percent area.

SCIENTIFIC BACKGROUND

- The Noise Reduction Coefficient (NRC) is a single-number laboratory rating that expresses the sound-absorption/insulation properties of a given material.[114]
- NRC is calculated by taking the arithmetic average of a material's sound absorption coefficients at four different mid-frequencies (the frequency bands most critical to speech), rounded to the nearest 0.05. The higher the NRC, the better the absorption.[115]

KEY HEALTH AND WELL-BEING EFFECTS

- Learning and other cognitive processes also are impeded when speech is disrupted or overwhelmed by other background noise (e.g., a poor signal-to-noise ratio). This can be particularly impairing in the case of people with imperfect hearing or suboptimal working memory capacity (likely with young children or older adults) or when speech is difficult comprehend, such as if the listener's primary, native language may be different than the speech language.[93-98]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- Sound-absorbing materials applied to floors, walls and ceiling surfaces can absorb sound before it can be reflected or can reduce sound that already has been reflected.[111] Absorptive materials can be used to decrease reverberation time, which in turn can decrease sound level within a space.
- NRC helps to describe the effectiveness of a material in reducing reverberation and echo. It is particularly useful for addressing sounds that fall within the frequency of speech, but not for sounds of lower frequency.
    - The frequency of sound is interpreted as "pitch." The ear responds best to frequencies most similar to the human voice and is most sensitive between 1,000 and 6,000 Hz, with perception ranging from approximately 20 to 20,000 Hz.[116]
- Sound absorbing materials can be applied to surfaces like ceilings and walls to reduce the noise reflected off those surfaces or to further reduce noise that already has been reflected.[111] NRC is used to compare sound absorbing materials for noise control and provides a measure of how well a surface will absorb human speech, though the absorptive properties of a material extend to noises beyond speech.[117] For minimizing HVAC noise, for example, the New York City Department of Environmental Protection suggests the use of absorptive materials on the source side of the noise of NRC > 0.7.[118]
    - Sound absorbing materials reduce the energy of a sound wave by converting the motion of air particles into heat, preventing sound build-up and reducing the strength of any reflected noise.[119]
- Hard surfaces provide poor absorption and contribute to reflection of noise. Softer surfaces are more effective in absorbing direct sound and reducing reverberation time. Sound-absorptive materials usually are porous, such as fiberglass, mineral wool, felt or polyurethane foam.[111] Textured surfaces, such as thick grass, can reduce sound levels by up to 10 dB per 100 m [328 ft] at 2,000 Hz.[112] Overall, low-density, fibrous materials (e.g., nonwoven fabrics) may be ideal for sound absorption.[113]

FEATURE S06: MINIMUM BACKGROUND SOUND

OVERVIEW

Part 1: Sound masking levels do not exceed 48 dBA in open areas with Quiet zones and/or Circulations zones and 42 dBA in enclosed rooms labeled as Quiet zones.

SCIENTIFIC BACKGROUND

- Sound masking systems provide a continuous, even background sound level to reduce the perception of otherwise intelligible speech.[120]
- Masking systems often are used as a solution to persistent levels of background noise in open offices. They can be centralized or dedicated, providing even, uniform background noise.[121]
- For effective sound masking, the frequency characteristics of the sound of the system must be similar to the frequencies of the sounds being masked.[122]

KEY HEALTH AND WELL-BEING EFFECTS

- Certain sounds are considered by many as particularly annoying or to have adverse effects on mental health. Unwanted intelligible speech — speech where the information content is clearly understood—has been shown to be particularly distracting in places like offices and is often rated by employees as the most annoying noise source in offices.[35,72,123-127]
    - In a study of 31 office workers relocated from private office rooms to open-plan offices, researchers found that the most commonly reported sound that disturbed concentration on work was “voices and laughter from general areas” in open-plan offices.[124]
    - In a field study of 2,391 employees at 58 sites, 54% of employees reported being annoyed or distracted by noise, particularly people talking and phones ringing, with intelligible speech noted as a leading factor in bothering employees.[22,72]
- Background speech, intelligible or not, can be distracting and impair performance on cognitive tasks such as proofreading, reading comprehension and writing.[128-133]
- The “irrelevant sound effect” is a well-evidenced phenomenon showing that short-term memory, in terms of serial recall (i.e., recalling a list of items in order), is impaired by irrelevant sound. Irrelevant sounds include any human speech sounds, whether or not they are intelligible or spoken in a language understood by the person in question.[134,135] The exact degree of impairment is variable depending on the particular sound and the specific cognitive task but irrelevant sound has been shown to degrade accuracy in serial recall by up to 50%.[136,137]
    - Serial recall has been shown to be particularly susceptible to disruption by irrelevant sounds. But studies show that performance on other short-term memory tasks also may be impaired, such as tasks involving mental math, memory for prose, immediate-probe recognition and missing-item tasks.[138-142]
- Dissatisfaction with speech privacy is responsible for low average acoustic ratings. In a survey of nearly 24,000 office workers, about 80% of respondents working in cubical spaces reported that it is dissatisfying when others can overhear private conversations. Acoustic dissatisfaction in the workplace was more often associated with speech privacy conditions than noise levels.[71]
- Shared or open office spaces performed much lower on sound privacy questionnaires compared to more private office spaces.[22]

HEALTH PROMOTION BENEFITS AND STRATEGIES

- Sound masking technology can reduce distraction from human speech and also may help reduce stress.[73,134,143] Sound masking is particularly effective in minimizing the intelligibility of noises like speech, which is a primary way of enhancing privacy.[78,127]
    - Speech privacy is especially important in settings where confidentiality of speech content is a priority, such as in healthcare settings. However, strategies like sound masking also may be inappropriate in these settings if systems are not properly installed to avoid interfering with necessary communication between patients and staff.[144]
- Masking systems that use sound with a spectrum similar to the human speech spectrum are particularly effective at masking conversations.[122]

    - Masking sounds that are spectrally similar to human speech can mask the perception of both intentional and distracting speech sounds. So, the positioning and equalization of sound masking should be carefully considered.
- Sound masking has been shown to have a significant positive effect on patient sleep, particularly for patients in ICUs, and may be more effective in improving sleep than other strategies like sound-absorbing treatment.[145-148]
    - A review of 11 studies on noise and its effect on ICU patients' sleep found that sound masking was able to significantly promote sleep in ICU patients, producing an overall improvement in sleep of 42.7%.[145]
- Studies support that ambient noise levels in open offices should not exceed 48 dBA for occupant comfort and some best-practice recommendations suggest using electronic speech masking, matched to work zones, at 45 to 48 dBA for normal speech privacy in an open plan workspace.[86,126,149-151] Disruption by background noises in places like offices can be reduced by adding a continuous noise signal of 45 to 50 dBA.[137]
- For normal speech privacy in enclosed offices, the U.S. General Services Administration recommends electronic sound masking at 40 to 42 dBA.[86]

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