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Case Studies

"Elevator Music" in the Open Office Environment

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Reported by Randy L. Tubbs

Introduction

The National Institute for Occupational Safety and Health (NIOSH) was contacted by an employer representative of a federal government agency to request a health hazard evaluation of a portion of office space in a high rise building. The request concerned the use of recorded instrumental music, sometimes referred to as "elevator music," in an open office environment and its interference with employees' ability to concentrate on their job functions.

Octave band noise measurements and overall A-weighted and C-weighted measurements were made in open and private offices while the music was on at its preset level and while the music was turned off. These measurements were compared with the balanced noise criteria (NCB) proposed by Beranek.[1] The NCB criterion curves apply to occupied spaces where satisfactory speech communication is required. The measurements revealed little differences in the acoustic energy in the office spaces regardless of whether the music was on or off. When compared with the occupied room noise criteria, it was found that the levels approached the upper limits of ambient noise where good listening conditions are required. It was also observed that design characteristics for open office environments were deficient or missing. Based on the noise levels found in the offices and the job requirements needed for the employees to efficiently perform their duties, NIOSH recommended that the music be eliminated from the office environment and that the requirements for an open office environment be reevaluated.

Background

The high rise office building that was investigated houses several federal government agencies. It had recently undergone extensive asbestos rededication and renovation, and the employees had just recently returned to this work area. Employees on the floor of the survey were required to review grant applications for funding of infant and child nutrition programs from public health agencies throughout the country. There was a complaint that the use of instrumental music played through speakers throughout the open office area interfered with employees' ability to concentrate on their reviews. One employee sought relief from the music by having the music turned off in the work area or through a move to private office space.

The evaluated portion of the office space was a combination of private offices and open office cubicles. The open cubicles are separated from other work areas with modular furniture and approximately 4-ft high partitions. The private offices are arranged along the perimeter of the office space, while the open cubicles are generally located in the interior of the floor space. However, the office where complaints about the music originated is located along the perimeter and is of an open office design. Volume controls for the ceiling-mounted speakers that deliver the music were located throughout the work space and could be changed by the employees. The exception was found in the complaint area, where the control knob had been replaced with a keyed lock and the speaker closest to the complainant had been removed from the ceiling. The playing of instrumental music in the office has been a practice of the employer for many years.

Methods

To evaluate the acoustical environment of the office, area noise samples were made with a Larson-Davis Laboratories model 800B precision integrating sound level meter. Octave band measurements at consecutive center frequencies of 31.5 Hz to 16 kHz along with A- and C-weighted measurements were made in the various open and private office locations. Octave measurements were made with the sound level meter integrating the sound energy over 1-minute periods with a 3-dB exchange rate. Three open office cubicles and one private office were acoustically measured when the music system was turned on and when the system was turned off. The three open spaces included the complainant's work area, an adjacent vacant cubicle, and a vacant cubicle on the opposite side of the floor. The private office was measured separately with the door open and with the door closed.

Evaluation Criteria

The occupational noise regulation promulgated by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)[2] is not appropriate for the situation at the office building. The OSHA regulation is designed to prevent hearing losses from exposures to intense noise levels. However, noise of intensities lower than that which may cause a loss of hearing can be disruptive in the workplace. Interference with speech and disruption of office activities are possible results of unwanted noise. The noise can interfere with the efficiency and productivity of the office staff and can be detrimental to the occupants' comfort and sense of well-being. Noise criteria for occupied interior spaces (NCB curves) have been devised to limit noise to levels where satisfactory speech intelligibility is obtained.[1,3,4] These criteria were devised through the use of extensive interviews with personnel in offices, factories, and public places along with simultaneously measured octave band sound levels. The interviews consistently showed that people rate noise as troublesome when its speech interference level is high enough to make voice communication difficult. The recommended space classification and suggested noise criteria range for steady background noise heard in various indoor occupied activity areas are shown in Table 1.

Results

The octave band measurements for the morning measurement periods with the instrumental music turned on and off are presented in Figures 1 through 5. The

TABLE 1. Recommended Space Usage for Balance Noise Criteria Range in Occupied Indoor Areas

Type of Space and Acoustical Requirements	NCB Curve
Concert halls, opera houses, and recital halls	10–15
Large auditoriums, large drama theaters, and large churches	Not to exceed 20
Small auditoriums, small theaters, small churches, music rehearsal rooms, large meeting and conference rooms, or executive offices	Not to exceed 30
Bedrooms, hospitals, residences, apartments, hotels	25–40
Private or semiprivate offices, small conference rooms, classrooms, libraries	30–40
Large offices, reception areas, retail shops and stores, cafeterias, restaurants	35–45
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas	40–50
Light mainteannce shops, industrial plant control rooms, office and computer equipment rooms, kitchens, and laundries	45–55
Shops, garages	50–60*
Work spaces where speech or telephone communication is not required	55–70

*Levels above NCB-60 are not recommended for any office or communication situation.

NCB curves have been overlaid onto each figure to show the range of the space and acoustical requirements from Table 1. The curves are read by finding the highest octave band level measured for the "music on" and "music off" conditions in the office space. The curve closest to the highest octave band is the criterion for the office space. Thus, in the complaint area open cubicle, the NCB-45 curve describes the music on situation and the NCB-40 curve best describes the music off condition (Figure 1). For the adjacent open cubicle, the NCB-40 curve best describes both the music on and music off situations, with the criterion slightly exceeded when the music was off (Figure 2). The minimum octave band intensities were observed in the private office when the door to the corridor was closed. The octave band levels fell to the NCB-35 curve under these conditions (Figure 5).

With the exception of the sound levels measured in the open cubicle complaint area, it was observed that the average octave band levels were higher when the music was turned off. This curious finding is probably the result of increased ventilation necessitated by the rising outdoor temperature throughout the day. The order of measurements was to do all office spaces initially with the music on, followed by the condition where the music was turned off. This finding was substantiated by the fact that all of the afternoon measurements made with the music on were higher than the corresponding measurements made in the morning. The range of noise levels from the morning measurements was 41 to 50 dB(A), while the afternoon levels ranged from 45 to 56 dB(A).

The octave band levels show that the evaluated office spaces were generally found to be near the NCB-40 curve, regardless of whether the sound system was operating or not. This criterion of NCB-40 is the upper limit for private and semiprivate offices where good listening conditions are required.

Discussion

Even though the noise levels measured in the evaluated space seem appropriate for the type of office usage, the annoyance and interference from unwanted acoustical signals in the offices are readily appar-

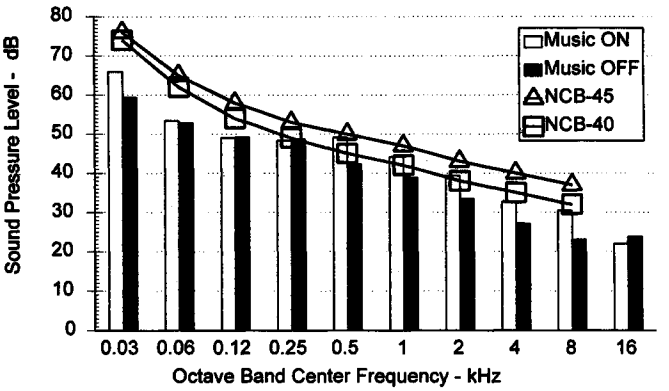

FIGURE 1. Open office: complaint area.

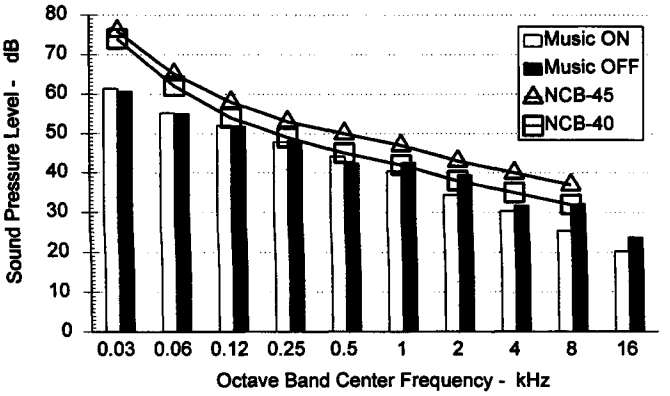

FIGURE 2. Open office: adjacent to complaint area.

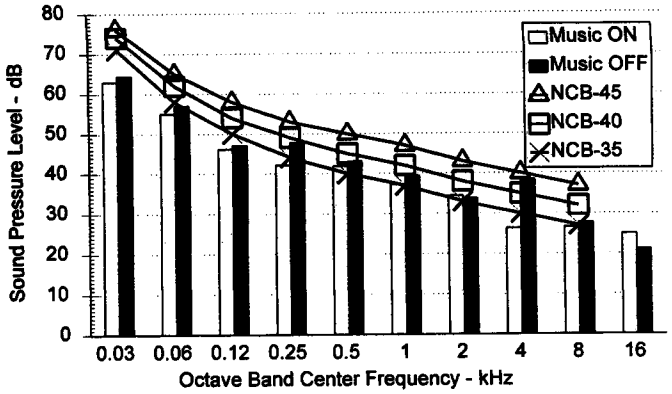

FIGURE 3. Open office: opposite side of floor.

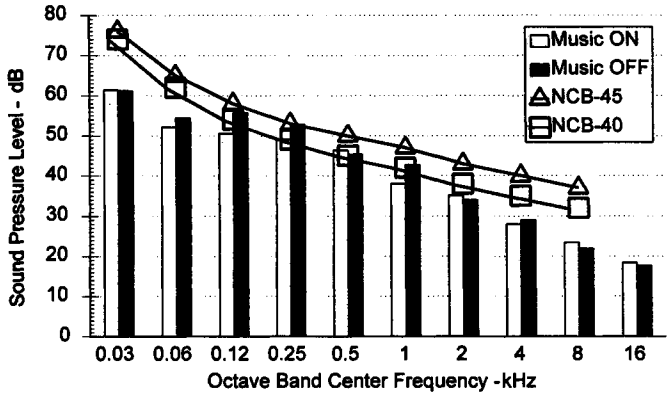

FIGURE 4. Private office: door open.

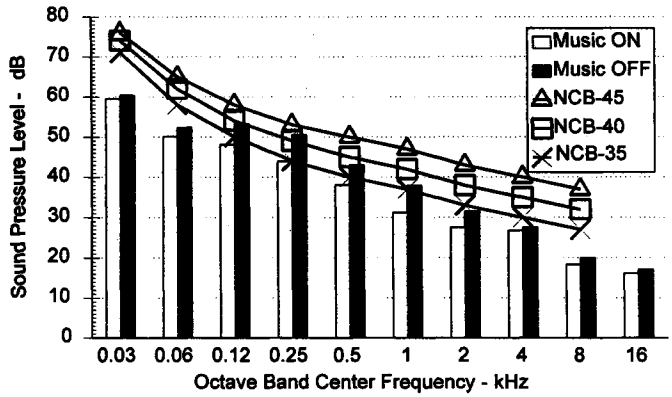

FIGURE 5. Private office: door closed.

ent. During the measurement periods, the NIOSH investigator was able to clearly hear the sounds of laser printers, computer keyboards, music, foot traffic, doors opening and closing, and employee conversations with each other and on the telephone. These concerns fall under the category of acoustical privacy in an office setting. The American Society for Testing and Materials (ASTM), under the jurisdiction of ASTM Committee E-33 on Environmental Acoustics, maintains a Subcommittee E33.02 on Open Plan Spaces. Their guide describes the components for assuring acoustical privacy in the open office setting.[5] The three necessary components are (1) the ceiling system, (2) sound barriers and vertical surfaces, and (3) masking sound. The masking sound, to be effective, should be a random noise generator that produces background noise that has both spatial and temporal uniformity. Because of the time and space uniformity requirement, music cannot be substituted for the masking sound.

Recommendations

Based on the observations and measurements made during the health hazard evaluation, the following recommendations are made to management officials at the office building.

1. The instrumental music played on the floor in both open and private offices should be turned off. It is clearly audible in all locations of the office space and is thus a potentially unwanted acoustic signal. It is one of many such signals that can interfere with employees' ability to concentrate on their work tasks. The use of music as a noise-masking system in an open office environment is contrary to the guidelines set forth by ASTM in E 1374–93. The guidelines do, however, allow music and paging systems to be introduced into the open office setting as secondary sources to the random noise generator. The guidelines specifically address the amplifier, equalizer, and loudspeaker requirements necessary to introduce these various sounds into the office setting.
2. Employees should be allowed to continue to listen to music through the use of their own personal devices (e.g., desk radios and personal radio, tape, or disc headsets) in the office space if they so desire. However, if the sound carries out of their individual spaces, it will become another unwanted acoustical signal. Management will need to monitor the use of these devices and regulate their loudness so that they do not impact adjacent office spaces.
3. The layout of the sound barriers and vertical surfaces should be reevaluated with office noise in mind. Many cubicle openings were found to be in direct line with each other or with the doors of private offices, which offers no attenuation or redirection of sound from one space to another. The openings should be staggered so that direct sight lines from office to office are

eliminated. Before major changes in the office are made, an architect or engineer who is familiar with ASTM open office plan guidelines should be consulted.

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