



NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2001-0496-2866

**Oklahoma City Community College
Oklahoma City, Oklahoma**

December 2001

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Randy L. Tubbs of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by David Butler. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Noise Levels from Gymnasium Activities and Their Effect on a College Bookstore

A bookstore was temporarily located in the college's gymnasium during a major renovation project. A summer cheerleading camp produced enough noise to result in pain and ringing in one employee's ears. Employees were concerned about these noise exposures and about illnesses possibly related to mold exposure.

What NIOSH Did

- # We measured average noise levels for the employees during their shift.
- # We analyzed the general noise levels to see how well the plywood wall blocked gym noise.
- # We spoke with the employees about their concerns.
- # We did a visual inspection of the bookstore and talked to a representative of the physical plant about ventilation and roof leaks.

What NIOSH Found

- # We found that the average noise levels did not increase the workers' risk of hearing loss.
- # The noise from the gym did interfere with communications in the bookstore.
- # The housekeeping practices in the bookstore were poor.

What Oklahoma City Community College Managers Can Do

- # Build a wall that better blocks out noise from the gym. An example is in the report.
- # Purchase a vacuum cleaner that student workers can use to clean up dust.
- # Remove the stained, yellow wall covering according to EPA guidelines.

What the Oklahoma City Community College Bookstore Employees Can Do

- # Wear hearing protectors furnished by the college when noise is too loud to do your job.
- # Point out dusty areas to the bookstore manager for cleaning.
- # Use a fan to push smoke away from your face when using shrink wrap.



What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report #2001-0496-2866



**Health Hazard Evaluation Report 2001-0496-2866
Oklahoma City Community College
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from employees at the Oklahoma City Community College Bookstore on August 13, 2001. Employees were concerned that the temporary location of the bookstore in the school's gymnasium was exposing them to excessive noise from activities occurring in the gymnasium. Following a cheerleading camp held in the Summer of 2001, one employee experienced pain and ringing in her ears from the yelling and screaming by the participants. The bookstore employees were also concerned about mold and dust in the bookstore that they felt resulted in additional sickness for the workers. A NIOSH investigator visited the campus bookstore on October 17-19, 2001, to make noise measurements in the bookstore while a Fall Break Camp was held in the gymnasium.

Personal and area noise samples were obtained over two full days in the bookstore. The NIOSH investigator also made visual observations of the work area, interviewed bookstore employees, and spoke with representatives of the College's physical plant about the operation of the heating, ventilating, and air conditioning (HVAC) system and the condition of the gymnasium's roof. The results of the personal noise sampling revealed time-weighted average (TWA) noise levels that were 6% or less of the daily allowed noise dose according to the evaluation criteria to prevent occupational hearing loss from noise. The area noise samples showed that the activities in the gymnasium did interfere with communications for the employees of the bookstore, particularly the voices of the children in the day camp. The temporary wall constructed to isolate the bookstore was ineffective in reducing the noises emanating from the gymnasium. Also, the housekeeping conditions observed in the bookstore were poor, with dust located throughout the space.

The personal noise measurements made during the two days of the Fall Break Camp revealed that employees of the bookstore are not at increased risk of occupational hearing loss as a result of their noise exposures. However, the interference with daily activities at the store was confirmed by the area noise samples. Visual observations made during the site visit found large amounts of dust throughout the bookstore and an area on the southeast wall that had visible staining from a previous roof leak. Recommendations are made in the report on the construction of a more efficient, sound-attenuation wall and on improving general housekeeping practices.

Keywords: SIC 8222 (Junior colleges and technical institutes), noise, hearing loss, room acoustics, dust, mold.

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) on August 13, 2001, from employees working at the Oklahoma City (OKC) Community College Bookstore. The bookstore had recently been moved to a temporary location while renovations were occurring at their former site of operation. Employees were concerned that noise from an adjacent gymnasium was having adverse effects on their health. They also noted that high levels of dust and possible mold growth was causing employees to be sick at a greater than normal rate since moving into the gymnasium.

An investigator from NIOSH made a site visit to the OKC Community College campus on October 17-19, 2001. An opening conference with College and employee representatives was held on the afternoon of October 17, followed by a walk-through survey of the bookstore. Noise sampling was conducted from 8 a.m. until 5 p.m. on October 18-19, 2001, while the bookstore conducted normal operations. A Fall Break day camp for elementary students was held in the adjacent gymnasium on both days of sampling.

BACKGROUND

The OKC Community College is located on a 143-acre campus in Oklahoma City. It is the fifth largest college in Oklahoma and offers associate degree programs, transfer credits to other four-year institutions, and adult education programs. It has nine buildings that are all interconnected. In the spring of 2001, a major renovation project began in the main building. The project necessitated that the college bookstore be moved from its location on the first floor of the main building to a temporary location in the gymnasium on June 16-17, 2001. The temporary bookstore is

scheduled to stay in the gymnasium until October - December 2002.

The temporary bookstore occupies approximately one-third of the gymnasium space and employs approximately 15 people. A 97 ft. by 56 ft. area was separated from the rest of the gymnasium by a plywood sheet wall that extends up 14 ft. toward a 25 ft. ceiling. The remaining 11 ft. of the wall is constructed of netting and plastic to keep stray gym equipment from flying over the wall into the bookstore. Two doors are on either end of the plywood wall for emergency exits. Bookshelves, display cases, cash registers, and temporary office space and storage were set up allowing for bookstore operations.

Because of the community nature of the college, several outreach programs are offered to the people of Oklahoma City, including sports camps. A cheerleading camp was held in the gymnasium at the end of June 2001. A computerized video that was sent to the NIOSH investigator documented loud screaming coming from the gymnasium, impacting the employees and customers of the bookstore. One employee experienced ear pain and tinnitus immediately following exposure to the camp noise. These symptoms were confirmed by the employee's physician and an otologist to which the patient was referred. The college contracted with an environmental consultant to measure noise levels in the bookstore on July 9, 2001, with noise dosimeters that collect a daily noise dose. The consultant concluded that the noise time-weighted average (TWA) levels were below the Occupational Safety and Health Administration's regulation for occupational hearing conservation. However, the consultant's report only stated that the bookstore was operating normally and did not state what activities, if any, were occurring in the gymnasium while the measurements were made. A subsequent site visit by a NIOSH investigator was scheduled to coincide with a two-day camp for elementary school children who were on

vacation from school to document the noise impact from this type of program.

The environmental consulting firm also conducted a limited evaluation of possible mold growth in the gymnasium. The consultant's report acknowledged visible staining on the southeast wall of the bookstore that may be mold contamination. The consultant conducted air sampling in the bookstore and found airborne mold levels that were not elevated above ambient levels. The consultant concluded that health problems should not be expected and, therefore, no further action was warranted.

METHODS

Quest® Electronics Model Q-300 Noise Dosimeters were worn by the employees during their work day to measure the TWA noise levels. The chosen employees worked in various locations that were staffed during the site visit, including office, checkout, stocking, and front desk employees. The dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point midway between the ear and the outside of the employee's shoulder. The dosimeters were taken off during lunch periods and paused. At the end of the shift, the dosimeters were removed and turned off. The information was downloaded to a personal computer for interpretation with QuestSuite for Windows® computer software. The dosimeters were calibrated before and after the work shift according to the manufacturer's instructions.

Real-time area noise sampling was conducted with a Larson-Davis Laboratory Model 2800 Real-Time Analyzer and a Larson-Davis Laboratory Model 2559 ½" random incidence response microphone. The analyzer allows for the analysis of noise into its spectral components in a real-time mode. The ½" diameter microphone has a frequency response range (± 2 decibels [dB]) from 4 Hertz (Hz) to 21 kilohertz (kHz) that

allows for the analysis of sounds in the region of concern. One-third octave-bands consisting of center frequencies from 20 Hz to 20 kHz were integrated and stored in the analyzer. The analyzer was mounted on a tripod and placed at various locations while the sound was integrated for 30 seconds.

The NIOSH investigator interviewed employees of the bookstore during the two days of the site visit while he visually inspected the conditions in the work space. An individual from the college's physical plant provided information on the heating, ventilating, and air conditioning (HVAC) system in the gymnasium. Finally, discussions were held with a coordinator of Recreation and Community Services to learn about the camps and other activities that used the gymnasium.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Finally, evaluation criteria may change

over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),¹ (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),² and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).³ Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

NOISE

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.⁴ While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20000 Hz) and

spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.⁵

The A-weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dB(A) scale is logarithmic, increases of 3 dBA, 10 dBA, and 20 dBA represent a doubling, tenfold increase, and 100-fold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)⁶ specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate. The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \times (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n)$$

where C_n indicates the total time of exposure at a specific noise level and T_n indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% are in excess of the OSHA PEL.

NIOSH, in its Criteria for a Recommended Standard,⁷ and the ACGIH² propose exposure criteria of 85 dB(A) as a TWA for 8 hours, 5 dB less than the OSHA standard. The criteria also use a more conservative 3 dB time/intensity trading relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

The OSHA regulation has an additional action level (AL) of 85 dB(A); an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels.

The OSHA noise regulation, as well as the limits published by NIOSH and ACGIH are designed to prevent hearing losses from occupational 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 interruption 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, health, and sense of well-being. One set of noise criteria for occupied interior spaces, the balanced noise criteria (NCB) curves, has been devised to limit noise to levels where satisfactory speech intelligibility is achieved.^{8,9,10} The noise 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 communications difficult. The recommended space classifications and suggested noise criteria range for steady background noise heard in various indoor occupied activity areas are shown in Table 1.

MOLD

Employees working in buildings may experience a wide range of health symptoms. Many symptoms are thought to be associated with the building since they improve or disappear completely when the employees are away from the workplace. These building-associated health symptoms may include mucous membrane discomfort (eye, nose, and throat irritation), headache, and fatigue. This cluster of symptoms is often referred to as "sick building syndrome." Potential causes of these types of symptoms have been extensively researched, but in most cases no identifiable cause in the workplace can be found. Distinct from these non-specific symptoms of unknown cause are "building-related illnesses." These are illnesses which have a specific medical diagnosis and can be determined by a physician through a medical evaluation and an assessment of work-relatedness. Building-related illnesses can often be associated with specific indoor exposures (such as molds).

Concern about IEQ problems related to molds in the workplace has been increasing with heightened public awareness, primarily through the

popular media. Although this may appear to be a recent problem, exposure to molds has occurred throughout history. In fact, the types of molds found in buildings are not rare or even unique to the building environment.

Molds are a type of fungi and, unlike plants, lack chlorophyll. They survive by using plants and decaying organic matter for food. Molds reproduce by releasing tiny spores that are carried by air currents to other locations. Mold spores are so small that magnification is usually required to see them. Molds are widely distributed in nature and human exposure to mold spores occurs commonly, both indoors and outdoors, at home and at work. It is important to understand that no environment is completely free from mold spores, not even a surgical operating room.

Medical Issues:

A small percentage of people may experience symptoms such as mucous membrane irritation, runny nose, and upper airway congestion when exposed to excessive mold growth in a building. Less common symptoms such as breathing difficulties may also occur. The types and severity of symptoms depend in part on the types and extent of the mold present, the extent of the individual's exposure, and the susceptibility of the individual (for example, whether they have pre-existing allergies or asthma). In general, excessive exposure to mold may produce health problems by several primary mechanisms, including: (1) allergy or hypersensitivity, (2) irritant effects, (3) infection, and (4) toxic effects. Each of these is discussed below.

Allergy or Hypersensitivity

Inhaling or touching mold or mold spores may cause allergic reactions in sensitized (allergic) individuals. Allergic responses are usually characterized by sneezing; itching of the nose, eyes, mouth, or throat; nasal stuffiness and runny nose; and red, itchy eyes. Repeated or single

exposure to mold or mold spores may cause previously non-sensitized individuals to become sensitized.

Asthma – Molds can trigger asthma symptoms (shortness of breath, wheezing, cough) in persons who are allergic to mold. A recent review of the scientific literature concluded that exposure to molds in the indoor environment may make pre-existing asthma worse, but also concluded that there was not enough evidence to determine whether exposure to mold in the indoor environment could cause asthma.

Hypersensitivity pneumonitis – Hypersensitivity pneumonitis, which can result when the immune system reacts to certain types of inhaled substances (such as mold spores), is a rare illness which may resemble bacterial pneumonia. Typically this condition involves respiratory symptoms (such as cough, wheezing, or shortness of breath) as well as other symptoms (such as extreme fatigue and low-grade fever). It has developed in people following both short-term (acute) and long-term (chronic) exposure to molds.

Irritant Effects

Exposure to excessive concentrations of molds in airborne dust can cause irritation of the eyes, skin, nose, throat, and lungs. Irritation of the upper and lower airways may possibly cause a worsening of pre-existing conditions such as allergic symptoms or asthma. Molds produce a variety of volatile organic compounds, the most common of which is ethanol, that may also cause upper airway irritation.

Infection

People with weakened immune systems (immune-compromised or immune suppressed individuals) may be more vulnerable to infections by molds. For example, *Aspergillus fumigatus*, a

mold that has been found almost everywhere on every conceivable type of substrate, has been known to infect the lungs of immune-compromised individuals after inhalation of the airborne spores. Healthy individuals are usually not vulnerable to infections from airborne mold exposure.

Toxic Effects

Recently, there has been increased concern related to exposure to specific molds which produce toxic substances called mycotoxins. Illness associated with exposures (from inhalation and/or skin contact) to mycotoxins in agricultural or industrial environments has been reported. However, there is currently no conclusive evidence of a link between mycotoxin exposure in the indoor environment and human illness. Some of the molds that are known to produce mycotoxins have been commonly found in moisture-damaged buildings; research is ongoing related to the importance of these findings.

Medical Treatment

Those persons experiencing symptoms potentially related to exposure to excessive mold in the indoor environment should minimize that exposure. This will likely require effective communication between employees (or employee representatives) and those persons responsible for maintaining the building environment, as well as effective actions by the building maintenance staff should a problem be found. Individuals concerned about their symptoms are encouraged to seek medical attention to ensure the proper diagnosis and treatment. **A systematic clinical approach for evaluating persons with suspected building-related symptoms or illness is recommended.** Recognizing and treating workers with serious building-related illness, if present, is important to prevent chronic disease.

Environmental Issues:

There are no exposure guidelines for mold in air. Therefore, it is not possible to distinguish between "safe" and "unsafe" levels of exposure. We do know, however, that moisture intrusion along with nutrient sources such as building materials or furnishings allows mold to grow indoors. It is extremely important, therefore, to keep the building interior and furnishings dry to prevent unwanted mold growth.

RESULTS

The OKC Community College Fall Break Camp was held on October 18-19, 2001. The boys and girls who attended the camp were in the elementary school grades kindergarten through sixth. A total of 65 children were in attendance on October 18 and 57 children on October 19. They began to arrive at 7:30 a.m. and left at 5:30 p.m. The bookstore opened at 8:00 a.m. each day. The camp students were scheduled in the gymnasium for the majority of the day with the exception of swimming in the natatorium from 12:45 - 3:00 p.m. The bookstore employees wore noise dosimeters from 8:00 a.m. until 5:00 p.m. each day. Area noise measurements were made throughout the two days while the camp students were in and out of the gymnasium.

Visual inspection of the bookstore area revealed that it is constructed of solid concrete on two walls and concrete blocks on the third wall and a solid concrete ceiling. The fourth wall is a temporary plywood sheeting and plastic structure the college put in place to separate the bookstore from the remainder of the gymnasium. The floor has a soft, flexible plastic or rubberized material on it. The bookstore area is serviced by a single HVAC system with chilled water and heating pipes. The unit is hung from the ceiling at one end of the bookstore and air is supplied into the space through six supply diffusers that branch off of sheet metal ductwork running the length of the room. There are two return air ducts at the HVAC unit. The physical plant representative

stated that the HVAC unit mixes the return air with 30% fresh air that is filtered through 80% efficient filters. The filters are on a routine maintenance schedule that calls for changing the filters every 6 months. The bookstore is under negative pressure with respect to the rest of the building. The two front entrance doors to the bookstore were open during operations and a noticeable influx of air was felt entering the store. The housekeeping in the bookstore was poor with large clumps of dust found on the floor, on shelves, and on the louvers of the HVAC's return air ducts. A noticeable black/brown growth was observed on the southeast wall of the bookstore under a piece of torn, yellow wall covering. A staining pattern on the wall was indicative of a water leak from the roof. The physical plant representative acknowledged that there was a past roof leak in this location but that a new roof over the gymnasium solved this problem.

Noise dosimeters were worn by three different bookstore employees each of the two survey days for their entire work shift. The exception to this was that the meters were taken off the workers while they were at lunch and the units placed in a paused mode so that no noise was measured for this period. The measured noise doses were very low for all six samples. None of the employees exceeded a 6% noise dose on the NIOSH REL, the most conservative criterion used in this evaluation. A 6% dose equates to an 8-hour TWA level of 73 dB(A), a value below the NIOSH recommended limit of 85 dB(A). One advantage of recording noise levels with dosimeters is that a minute-by-minute record of different noise metrics are stored in the unit. One metric appropriate for this evaluation is the maximum dB(A) level measured on the meter's fast scale [Fast MAX dB(A)] during every 1-minute period. This metric quantifies the very transient nature of sound levels produced by voices and activities in the gymnasium and, when plotted in real time, can give an indication of the impact of the sounds produced by the day camp's participants. These values are not the same as an

instantaneous peak noise measurement, but rather are the root-mean square values collected on the meter's fast scale. The noise levels expressed as Fast MAX dB(A) collected the second day of the survey for the employee who sat at the front desk of the bookstore are shown in Figure 1. The lower limit of the meter was set at 70 dB(A), so that no values would be less than this number. The lunch period was artificially set at 0 dB(A) to clearly show the time that the meter was paused during the employee's lunch. Each point is the highest sound level measured on the fast scale for that 1-minute period. The time scale can then be compared to the activities scheduled in the gymnasium. Recall that swimming in the natatorium was from 12:45 - 3:00 p.m. and little or no activity occurred in the gymnasium. The noise levels in Figure 1 during the swimming period exhibit several instances where the floor value of 70 dB(A) was not exceeded. However, once the children reentered the gymnasium after 3:00 p.m., the maximum noise levels routinely exceeded 70 dB(A) and, as a general trend, seem to be at a greater magnitude than the values recorded while the children were swimming. Several of the Fast MAX dB(A) levels exceed 90 dB(A) while the children are in the gymnasium.

The one-third octave area noise samples obtained in the bookstore at various times of the day confirm the finding that the activities in the gymnasium are impacting operations in the bookstore. Measurements were made in the center of the bookstore while the day camp participants were in or out of the gymnasium. The audible activities of the camp participants were noted during the 30-sec. measurements. Generally, these activities included the bouncing of balls and the shouting of children. Figure 2 shows a sound spectrum for a 30-sec. period where no activity occurred (ambient) compared to a period where the campers were shouting while bouncing balls. The largest sound level increases are at the 500 Hz to 2.5 kHz bands. Inspection of Figures 3 (voices only) and 4 (bouncing balls only) show that

the children's voices are the greatest contributor to the increase in these frequencies.

The octave band sound pressure levels for the combined shouting and bouncing ball scenario were calculated from the one-third octave data and plotted in Figure 5. Two NCB curves are also shown in the figure. The NCB-45 curve is the highest recommended level for retail shops and stores (Table 1). The NCB-60 curve represents the maximum octave band levels for situations where communications are necessary in the work space. The measured sound levels in the bookstore exceed each of these recommended criteria.

DISCUSSION

The noise measurements made during the 2-day NIOSH evaluation showed that the sound levels produced by the day camp were not sufficient to put the bookstore employees at an increased risk for hearing loss as a result of their work environment. The 8-hour TWA values were less than 6% of the NIOSH REL for occupational noise. However, the annoyance, disruption of work, and interference with communications in the bookstore resulting from activities in the gymnasium were confirmed. During the survey, the NIOSH investigator asked six of the bookstore employees if they had a choice, would they rather listen to balls bouncing in the gymnasium or children shouting, they all independently stated that they would choose to hear the bouncing balls. Therefore, any design change made in the temporary location of the bookstore should consider a reduction in the transmission of higher frequency voice sounds across the barrier between the gymnasium and bookstore.

The temporary wall that was constructed to separate the bookstore from the rest of the gymnasium does a poor job of acoustically isolating the two areas from each other for two reasons. First, the wall only extends 3/5 of the

way up towards the ceiling with netting and plastic covering the remaining 2/5 of the area. Second, the single wall construction (plywood on only one side of the 2" x 4" studs) offers minimal sound transmission loss.¹¹ A better construction design for a wall would be to continue the temporary wall up to the ceiling, plugging as many openings between the two areas as is possible. Additional sound blocking would be obtained by adding a second wall on the gymnasium side of the wooded studs, changing the material of the wall from plywood to gypsum board, and adding R-11 Fiberglas® insulation between the two walls. Gypsum board, a heavier material, is more effective than plywood in reducing sound transmission. The surface weight of ½" gypsum board is 1.80 lb/sq. ft. while ½" plywood is 1.33 lb/sq. ft.¹² If durability of the wall is a concern, then plywood could be substituted for gypsum board as long as it is realized that the transmission loss would be slightly less. The expected sound transmission loss from a double-sided gypsum wall on 2" x 4" wood studs, 16" centers with and without a 3 ½" Fiberglas insulation filler between the two walls is shown in Table 2. As can be seen in the table, the greatest sound loss is at the 500, 1k, and 2k Hz octave bands, the frequencies most influenced by the campers' shouts and the octave bands that exceed the room acoustics NCB-60 criterion. It must be noted that the values reported in Table 2 are based on laboratory tests conducted in controlled environments. Sound transmission losses in the real world will be less than these reported values. However, a well constructed barrier will begin to approach the values reported in the table. The goals of the barrier are reductions on the order of 2-5 dB to meet the NCB-60 criterion and on the order of 12-22 dB to reach the NCB-45 criterion.

The environmental consultant and the requester's physician both recommended that some type of hearing protection be offered to employees of the bookstore. Because the measured noise levels are not hazardous to the workers' hearing, the type of hearing protection device (HPD) should be

designed for this particular situation. The HPD does not have to be worn at all times, only when the activities in the gymnasium are intense enough to interfere with the workers' tasks. Also, the HPDs do not have to have large attenuation or noise reduction rating (NRR) values. Some of the moderate attenuation, flat-response HPDs that are available should be considered if hearing protection is to be issued to the employees. Examples of these HPDs were left with the bookstore manager and their functions were discussed with several of the employees. However, it is preferable to reduce the overall levels of noise in the bookstore through engineering controls rather than to place the responsibility of noise reduction on the employees through the use of HPDs.

The poor housekeeping practices in the bookstore need to be addressed. Clumps of dust on the floor and on the bookshelves and display cases were evident throughout the space. The return air intakes on the HVAC unit were also visibly dirty. The entire bookstore should be thoroughly vacuumed with a high efficiency particulate air (HEPA) filtered vacuum cleaner and then a periodic vacuuming schedule needs to be put into place to keep the dust out of the area.

The staining of the wall material on the southeast wall resulted from a past roof leak in the gymnasium. The water leak was solved with the installation of a new roof over the area. The remaining stain and black/brown growth on the yellow wall covering should be removed. The U. S. Environmental Protection Agency (EPA) has issued guidelines for mold remediation.¹³ The minimal amount of contamination found in the OKC bookstore can be treated as a "small" area when determining the amount of containment, disposal of materials, and types of personal protective equipment (PPE) needed by the personnel doing the removal according to these guidelines.

During the site visit, bookstore employees were observed using a shrink-wrap system to bundle books and materials together to be put onto the shelves. The roll of plastic and the hot wire used to cut it are located in the storage area of the bookstore next to the southeast wall. A pedestal comfort fan was located next to the work station. A noticeable plume of smoke was seen rising from the wire whenever the employee cut the plastic wrap. When the fan was turned on during the operation, an odor was noticed permeating the storage area. The fume from polyvinyl chloride (PVC) heated film has been identified as a pulmonary sensitizer that has led to meat wrapper's asthma.¹⁴ Employees' exposure to the plume of smoke should be reduced in the temporary location of the bookstore. Moving the pedestal fan to the left side of the worktable will blow the fume out of the worker's breathing zone and back into the storage area where there are generally no workers. A more permanent solution for removing the plume from the workers' breathing zone in the new, permanent bookstore should be incorporated into the designs. Local exhaust ventilation would be appropriate to remove the plastic film smoke from the area.

CONCLUSIONS

The noise sampling conducted during the 2-day site visit by NIOSH shows that the bookstore employees are not exposed to noise levels that are great enough to increase their risk for occupational hearing loss. The noise levels were generally 6% or less of the daily dose recommended by NIOSH. However, the noise levels measured in the bookstore do confirm that there is interference with communications and disruption of work as a result of the noise from activities in the gymnasium. A recent research study has shown that employees who are exposed to lower levels of noise in an open-office space exhibit elevated urinary epinephrine levels, behavioral changes indicative of motivational deficits, and reduced use of ergonomic features of office furniture as

compared to workers who were in a quiet environment. These findings point to evidence of elevated stress in workers exposed to low-intensity noise.¹⁵

The area noise measurements revealed that the noise from the gymnasium exceeded the recommended guidelines for a retail store and was great enough to interfere with communications in the bookstore. The completion of the original wall up to the ceiling along with the addition of a second wall with Fiberglas insulation between the two appears to be sufficient to lower the impact of voices in the bookstore. Activities in the gymnasium will still be heard in the bookstore after a second wall is installed, but the noise levels should be appropriate for the work that is conducted in the temporary bookstore.

The general housekeeping practices in the bookstore need to be improved. The yellow wall covering on the southeast wall should be removed according to the recommended guidelines of the EPA.¹³ The floor and shelves should be vacuumed with a HEPA vacuum cleaner on a routine basis to remove dust from the work area. Filters on the HVAC system should be changed on a routine schedule to keep dust from being recirculated into the air.

It is recognized that the situation at the OKC Community College Bookstore is temporary; a new location for the store is scheduled to be finished near the end of 2002. However, some relatively inexpensive renovations can reduce the noise impact from activities that occur in the gymnasium. The college administration should set up a mechanism where employees' concerns can be made known and the steps taken to address the concerns are shared with the bookstore employees. It is also recognized that the college needs to continue the community outreach programs that are offered by the Recreation & Community Services Department. But many of the activities could be altered to help reduce the noise impact from their activities. For example, the use of whistles as an attention-getting device

could be eliminated or reduced or the horn on the scoreboard could have the volume reduced while sharing space with the bookstore.

RECOMMENDATIONS

The following recommendations, based on the noise measurements and observations made during the NIOSH evaluation, are offered to improve the working conditions experienced by employees in the OKC Community College Bookstore.

1. The temporary wall between the gymnasium and the bookstore should be changed. The original wall should be extended to the ceiling and the openings closed as best as possible. A second wall should be added with Fiberglas insulation placed between the two walls. The sound transmission loss results presented in Table 2 show that the addition of the wall and insulation will reduce the higher frequency sounds and reduce the impact of voices yelling and screaming on the bookstore employees. A gypsum wall will offer more sound reduction; but if it is determined that a plywood structure would be more stable and less prone to damage from thrown balls, the plywood should also reduce the impact of high frequency sounds.
2. If employees wish to use HPDs during the period while the bookstore is in the gymnasium, the type of protector should be a flat-response, moderate attenuation device. The noise levels are not hazardous to hearing and therefore, the HPDs do not need to offer a lot of attenuation. Particularly for the employees who must converse with the patrons of the store, the HPD should not add to any interference in communication. Examples of this kind of device were

given to the bookstore manager during the site visit.

3. The employees of the gymnasium programs should be sensitive to the impact that their activities have on the bookstore. Any elimination or reduction of noise will help alleviate the problem of noise levels in the bookstore. Reductions in the use of whistles and the scoreboard horn will help reduce the noise impact on the bookstore employees. Any activities that can be postponed until times the bookstore is not in operation or until the store moves to its new location should be considered.
4. The general housekeeping in the bookstore should be improved. The college should purchase a HEPA vacuum cleaner for use in the store. If security is an issue, perhaps the student staff could be tasked with the job of vacuuming the floors and shelves on a routine basis.
5. The stained and torn wall covering on the wall should be removed. The guidelines for removal, PPE use, and disposal put forth by the U.S. EPA should be followed.¹³ Copies of these guidelines will be provided to the administration representative and the employee requester with this final report.
6. The shrink-wrap operation should be addressed in the design of the new bookstore. Local exhaust ventilation and a ventilation hood should be incorporated into the work area where the operation will take place. In the temporary location, the pedestal fan should be located to the left of the employee and set to blow air across and out of the worker's breathing zone into the unoccupied storage area. It should be noted that none of the employees interviewed by the NIOSH investigator who performed this job had

any health complaints that they felt were associated with the task.

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Table 1
Recommended Space Usage for Balanced Noise
Criteria Range in Occupied Indoor Areas
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496

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, and executive offices	Not to exceed 30
Bedrooms, hospitals, residences, apartments, hotels	25 - 40
Private or semi-private 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 maintenance 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.

Table 2
Sound Transmission Loss in dB for Wall Constructions
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496

Construction	Octave Band Center Frequency, Hz					
	125	250	500	1k	2k	4k
2" x 4" wood studs, 16" centers, ½" gypsum wallboard on both sides	15	27	36	42	47	40
2" x 4" wood studs, 16" centers, ½" gypsum wallboard on both sides plus 3 ½" R-11 Fiberglas insulation between two walls	15	31	40	46	50	42
Gymnasium activities with voices and bouncing balls	63.3	58.9	62.3	64.4	64.4	52.2

Figure 1
Bookstore Front Desk Employee
Noise Levels in Fast MAX dB(A)
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496
October 19, 2001

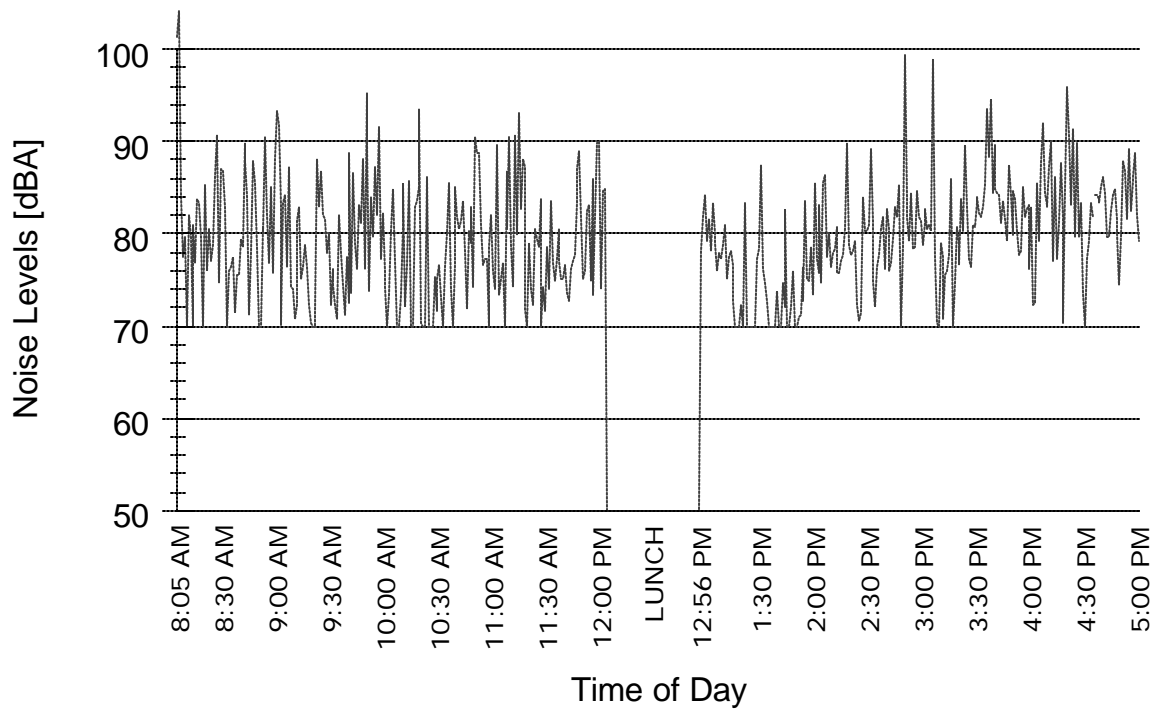


Figure 2
Center of Bookstore
Ambient Noise Levels vs. Gym Voices and Balls Bouncing
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496
October 18-19, 2001

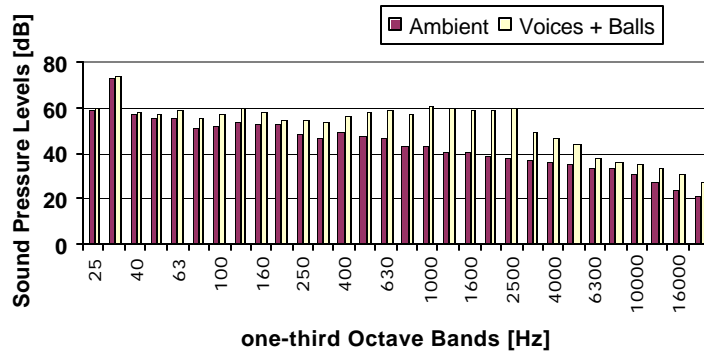


Figure 3
Center of Bookstore
Ambient Noise Levels vs. Gym Voices Only
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496
October 18-19, 2001

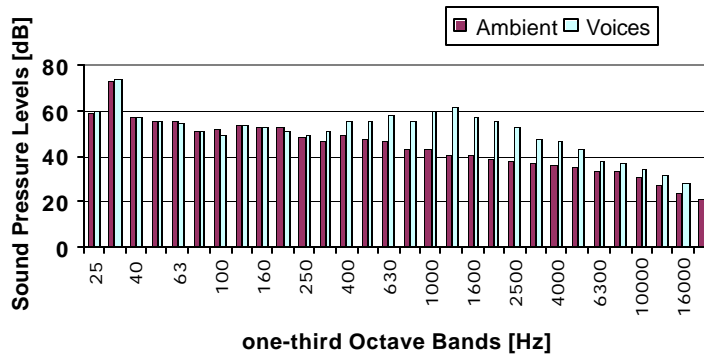


Figure 4
Center of Bookstore
Ambient Noise Levels vs. Gym Balls Bouncing Only
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496
October 18-19, 2001

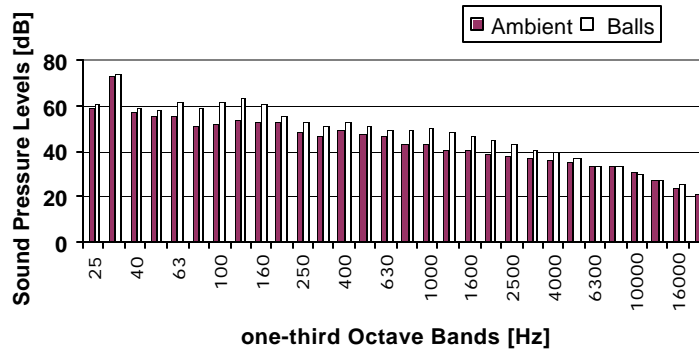
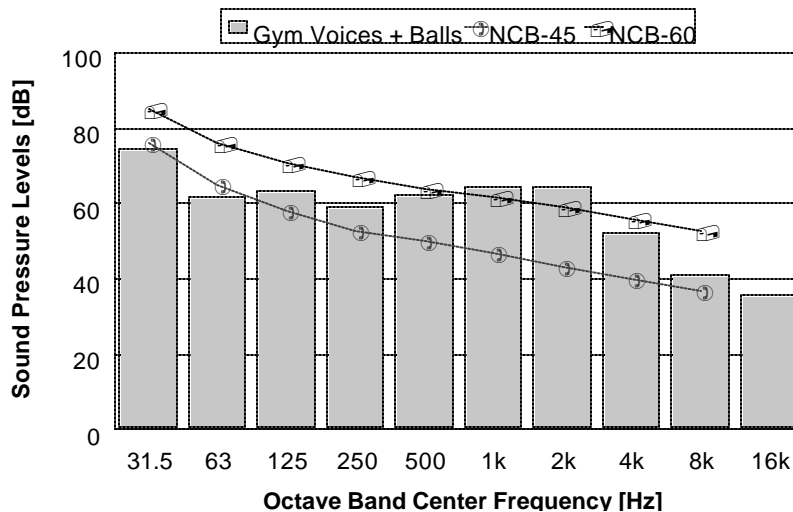


Figure 5
Center of Bookstore
Octave Band Noise Levels vs. Balanced Noise Criteria
Oklahoma City Community College
Oklahoma City, Oklahoma
HETA 2001-0496
October 18-19, 2001



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