I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) contacted by an employee at the Collins Road Station of the U.S. Service (USPS) in Lansing, Michigan on November 14, 1991. The employee, a letter carrier for the USPS, was concerned about the noise at his work station from an automated Small Parcel and Bundle Sorter (SPABS) that had been located adjacent to the letter carriers' cages approximately two years ago. The employees in the sorting view the additional noise from the SPABS as a source of mental stress. The USPS purchased a 30-foot x 8-foot canvas curtain in February and hung it near the ceiling between the sorting area and the SPABS in an attempt to control the noise.

An investigator from NIOSH conducted noise surveys at the Collins Road location on December 17-18, 1991, and January 21, 1992, to document noise exposures experienced by employees in the letter sorting and SPABS areas. Personal noise dosimetry was conducted on letter carriers in the sorting area and on postal clerks and mail handlers servicing the SPABS. Additionally, octave-band analyses were carried out in these areas with an integrating, precision sound level meter.

The employee noise exposures were found to range between 70 and 80 decibels on an A-weighting scale [dB(A)], values which are below exposure levels associated with hearing loss. The pattern seen in employees' noise exposures was variable throughout the work day. Area octave band measurements revealed that a warning signal on the SPABS emitted noise levels up to 103 dB(A), a value 30-40 dB(A) higher than the ambient noise levels measured in the area while the SPABS was operating.

Although no noise levels were measured that exceed current evaluation criteria for noise exposure and occupational hearing loss, the letter carriers do perceive that the noise emitted by the SPABS is stressful and interferes with their work. The noise from the automated sorting machine measured by the NIOSH investigator is clearly audible above the ambient noise in the letter sorting area, with the stop/start warning device being much louder than background noises. The type of noise emitted by the warning device, measured in the evaluation, meets several researchers' definition of noise as an occupational stressor because of its unpredictability and lack of controllability. Therefore, recommendations are made to reduce the noise in the SPABS and letter sorting areas. However, there are no current evaluation criteria to cite specific noise levels that must be reached in order to eliminate the non-auditory effects of the noise exposure.

KEYWORDS: SIC 4311 (United States Postal Service), noise, automated sorting machines, letter carriers.
II. INTRODUCTION

On November 14, 1991, employee representatives from the U.S. Post Office (USPS) in Lansing, Michigan, requested that the National Institute for Occupational Safety and Health (NIOSH) conduct a Health Hazard Evaluation (HHE) at the Collins Road facility of the USPS. Employees were concerned about the noise from an automated Small and Bundle Sorter (SPABS) that had been installed approximately two years ago in a location adjacent to the sorting cages used by letter carriers to sort the mail for their daily route. The employees stated that they were concerned about the mental stress created by the additional noise from the SPABS and how it might affect their health after years of exposure to the noise. An evaluation of a canvas curtain which was installed as a noise control was also requested by the employees.

A noise survey was conducted by a NIOSH investigator on December 17-18, 1991, to document employees' noise exposures in the area of the cages and the SPABS. However, because the large volume of First Class mail for the holiday period reduced the volume of bulk mail (2nd and 3rd Class mail) at the facility, the SPABS operated for only a portion of the work shift on the day of the noise survey. It was decided that a return visit was necessary during January when the volume of mail sorted by the SPABS would be more representative of typical conditions. A second survey was conducted on January 21, 1992, a day when the SPABS was operational for the entire time that the letter carriers were in their sorting cages. An interim letter reporting the results of the first noise survey was sent to union and management representatives on January 14, 1992.

III. BACKGROUND

The Collins Road location of the USPS is a general mail facility that sorts and delivers mail to Lansing, Michigan residents and sorts for smaller post offices in the Lansing area. A new SPABS machine was located in the facility adjacent to the area where letter carriers sort the mail for their daily routes. The carriers reported that they immediately noticed discomfort in their working environment from additional noise produced by the SPABS. The letter carriers' concerns were brought to the attention of USPS management through the union grievance mechanism. The union was told that the noise levels from the SPABS did not exceed the Department of Labor's Occupational Safety and Health Administration (OSHA) noise regulation and therefore there were no reasonable grounds to determine that a hazard existed in the area. Continued concern by the letter carriers resulted in a 30-foot x 8-foot canvas curtain being purchased in February 1990. The curtain was hung between the carrier sorting cages and the SPABS. The location where it was hung allowed for openings above and below the curtain to allow for air flow and to prevent hampers for the area. In June 1990, letter carriers were told that management would furnish ear plugs to carriers who still had problems from the noise emitted by the SPABS.
The USPS Regional Safety Engineer was brought into the Lansing facility in November 1991, to make noise measurements in the area. He found that the area noise levels around the SPABS ranged from 82 to 89 decibels on the A-weighting scale [dB(A)]. Noise levels near the carrier sorting cages ranged from 70 to 71 dB(A). During the noise survey, the stop/start alarms were identified as a potential problem. Six inches of cellular foam packing material was placed over the speakers of the alarm to reduce the amount of noise emitted by the alarms. Area measurements made with the foam in place were found from 75-77 dB(A), a reduction of 5 to 12 decibels. The Lansing Safety Specialist was directed to locate foam with the proper acoustical attenuation characteristics and place it on all four sides of each alarm. The acoustical foam control measure, however, was left in place for only a short time period before it was removed by management. The alarm boxes were uncovered during both NIOSH noise surveys.

IV. METHODS AND EQUIPMENT

The noise dosimeters used in the survey were Metrosonics Model dB-301/26 Metrologgers. The Metrologger is a small noise level recording device which is worn on the waist of the employee, with a 1/4 inch microphone attached to the worker's shirt collar, or the shoulder area if the shirt has no collar. This dosimeter is designed to measure noise in dB[A] levels four times per second. The noise measurements are integrated according to the Occupational Safety and Health Administration (OSHA) noise regulation (see Evaluation Criteria section of this report) for an entire minute and stored separately in the Metrologger for later analysis and final storage. Each dosimeter successfully calibrated according to the manufacturer's instructions before being placed on the worker. After the recording period was completed, the dosimeter was removed from the worker and placed in standby mode of operation. The data was later transferred to a Metrologics Model dt-390 Metroreader/Data Collector following the noise sampling. Prior to turning off the dosimeter, it was again calibrated to assure that the device had not changed during the sampling period. The dosimeter information was finally transferred to a personal computer with supporting Metrosonics Metrosoft computer software for permanent data storage and later analysis.

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 Hertz (Hz) to 16 kilohertz (kHz) along with A-weighted and C-weighted scales were made at several locations around the SPABS and the letter carriers' sorting cage. Noise measurements were made with the sound level meter integrating the sound energy over a 1-minute period with a 3 dB exchange rate. Values were reported as 1-minute equivalent levels ($L_{eq}$) at each measurement or scale.
V. EVALUATION CRITERIA

Occupational deafness was first documented among metalworkers in the sixteenth century. Since then, it has been shown that workers have experienced excessive hearing loss in many occupations associated with 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 cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.

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 "fi", have still higher frequency components.

The existing OSHA standard for occupational exposure to noise (29 CFR 1910.95) specifies a maximum permissible exposure level (PEL) of 90 dB(A) - slow response for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) and is within his daily PEL. Both NIOSH, in its Criteria for a Recommended Standard, and the American Conference of Governmental Industrial Hygienists (ACGIH), in their Threshold Limit Values (TLVs), propose an exposure limit of 85 dB(A) for 8 hours, less than the OSHA standard. Both of these latter two criteria use a 5 dB time/intensity trading relationship in calculating exposure limits.
TABLE 1

Time-Weighted Average (TWA) Noise Limits as a Function of Exposure Duration

<table>
<thead>
<tr>
<th>Duration of Exposure (hrs/day)</th>
<th>NIOSH/ACGIH</th>
<th>OSHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>80</td>
<td>85</td>
</tr>
<tr>
<td>8</td>
<td>85</td>
<td>90</td>
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<td>105</td>
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<td>1/2</td>
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<td>110</td>
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<tr>
<td>1/4</td>
<td>110</td>
<td>115 *</td>
</tr>
<tr>
<td>1/8</td>
<td>115 *</td>
<td>-</td>
</tr>
</tbody>
</table>

* No exposure to continuous or intermittent noise in excess of 115 dB(A).

** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.
The OSHA regulation has an additional action level (AL) of 85 dB which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o). The OSHA noise standard also 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 control the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

There exists a large body of research that has investigated the noise and its effect on peoples' health.\textsuperscript{,7,8} Two major research areas into the non-auditory effects of noise have been on the cardiovascular system\textsuperscript{9} and on the gastrointestinal system.\textsuperscript{10} Overall, there are inconsistencies in the results reported on the non-auditory effects from noise. There is no clear dose-response relationship between single noise variable (intensity, frequency, duration) and a health outcome. However, the degree of perceived control over the noise and the predictability of its occurrence may be an important factor determining the health effect which results from the exposure.\textsuperscript{11} There are currently no evaluation criteria available which attempt to limit noise to a point where the non-auditory effects of the noise exposure are eradicated.

VI. RESULTS AND DISCUSSION

A total of 14 noise dosimeter measurements were made on postal employees working in the vicinity of the SPABS during the December and January evaluations. All of the TWA noise levels were below the evaluation criteria used in determining the risk of hearing loss from occupational noise exposures. The TWA levels ranged from 70 dB to 80 dB(A), with a median value of 77 dB(A). The individual noise dosimeter results are given in Tables 2 and 3.

Area noise measurements were made at letter carriers' sorting cages in aisles around the sorting cages in order to determine the level of noise that the carriers work in while the SPABS operates in the background. The octave band results from these measurements are shown in Figure 1. The SPABS - at bend measurements were made in the aisle that separates the end of the SPABS delivery line from the first letter carriers' sorting cages. It also was the location in front of the canvas curtain hung by the Safety and Health Service Department for noise control. Route 1132 Cage is in the first row of cages and behind the canvas curtain. An aisle separates row one from row
the letter carriers' sorting cages (Route 1132 Aisle). Row two three of the cages are located back-to-back to each other. **Route Cage** is in the third row of sorting cages. The measurements rev that the sound energy emitted by the SPABS is predominately made lower frequencies with the octave band center frequencies from 3 to 1000 Hz having about equal sound pressure levels with decreas sound pressure levels at the frequencies above 1000 Hz. The ove sound levels measured at the four locations ranged from 78 to 68 decreasing in intensity as one moves farther from the SPABS. Th overall decrease for the noise from the SPABS falls from 77.6 dB the aisle next to the SPABS to 72.5 dB(A) at Route 1132's sortin located in the first row of cages. This drop in sound level is partially the result of the combination of the canvas curtain, t metal walls of the sorting cage, and the increased distance from noise source. It cannot be determined from these data the absol contribution of the canvas curtain in the overall 5 dB reduction.

During the evaluation, the NIOSH investigator noticed that the a alarm on the SPABS, which warns employees that the machine is ab start operating, was a major noise source. The alarm is program sound ten separate blasts before the machine starts. These alarm blasts were clearly audible throughout the entire postal facilit just the immediate area of the SPABS. The Postal Service had pi packing foam over the speakers of the three alarms on the SPABS order to reduce the noise levels produced by the warning. Howev foam was removed as a possible safety hazard. A **a-octave band** analysis of the ten blasts of the alarm, measured 3 feet from th speaker, revealed that the sound energy was concentrated in 2.5 3.15 kHz bands, with maximum root-mean-squared (rms) intensities 99.8 dB. The overall A-scale value of the alarm noise was 102.6 A 3-inch thick piece of acoustical foam temporarily placed over speaker of the alarm reduced noise levels emitted by the alarm t dB at the peak frequency of 2.5 kHz and to a overall value of 86 dB(A). The sound spectrum of the warning signal was overlaid on spectrum of the SPABS during its operation at two measurement lo (Figures 2 and 3). These figures clearly show that the warning is 30 to 40 dB above the ambient sound produced by the SPAB it is in operation.

**VII. CONCLUSIONS**

The noise from the SPABS is perceived by the letter carriers as stressor that interferes with their work. The noise levels meas during the carriers' work shift on two separate occasions are, h well below the evaluation criteria used to assess the risk of he loss from occupational noise exposures. The results of the nois survey in the area show that the warning signal from the SPABS i clearly audible in the work area of the carriers. The sounding
alarm is outside of the control of the letter carriers, making it unpredictable and variable in nature.

The variable and unpredictable nature of the loud warning alarm on the SPABS meets researchers' criteria of a stressor that could lead to adverse health effects discussed earlier in the report. Because the warning alarm is 30-40 dB above the facility's background sound, the initial sounding of the alarm could startle a carrier as he or she sorts their daily mail. Previous research has shown that over a wide range of intensities and frequencies, signals need to be only 5-15 dB greater than background noise in order to be heard. This finding of warning signals that are excessively loud in the Postal Service has also been documented in another NIOSH Health Hazard Evaluation at a different U.S. Post Office facility.

The canvas curtain purchased by the Postal Service is not very efficient in blocking the noise from the SPABS. The procurement process did not take into account any measurement standards or performance data on the sound attenuating characteristics of the curtain. If these characteristics had been investigated, it would have been discovered that the canvas curtain, as installed, would provide little noise protection for the letter carriers. The American Society for Testing and Materials (ASTM) is one source of consensus standards that deal with the classification of materials and systems for their acoustical properties. Information of this nature should be investigated prior to installing any noise reduction system.

VIII. RECOMMENDATIONS

The area adjacent to the SPABS is affected by the noise emitted from the operation of the automated sorter and its warning signals. The noise reduction control installed by the Postal Service does little to decrease exposures to the variable and unpredictable noise on letter carriers in the sorting cage area. Because the employees in this area feel that the noise from the SPABS is stressful and interferes with their work, the following recommendations are offered to the Postal Service to reduce noise exposures to the employees in the SPABS letter sorting area. The recommendations are given in a similar to the methods that are typical used to control noise exposures; (1) reduce the noise at the source, (2) alter the pathway of the noise, or (3) reduce the noise at the receiver (worker).

1. The noise emitted by the three warning signals on the SPABS should be reduced to a level 5-15 dB above the ambient noise of the workplace. This reduction in sound level can be achieved by placing acoustical material over the speakers of the signal box or electronically lowering the signal with a variable resistance potentiometer placed in the circuitry of the warning signal.
latter change will act as a volume control for the signal and be changed at a later time if the sound conditions in the building change as a result of the introduction of new equipment or the relocation of personnel.

2. The warning signal on the SPABS is composed of both an auditory alarm and a flashing light on all three alarm locations. The light used by the alarm system is enclosed in an amber-colored fixture and is cycled on and off along with the audible alarm during warning period. The NIOSH investigator observed that the visual signal was not very perceptible unless one looked directly at the light fixture. Perhaps a blue or red light that is larger and has a rotating mirror inside the fixture would be more readily perceptible by employees in areas adjacent to the SPABS. Also, it would be beneficial to change the pattern of the warning system such that the light would be cycled on for several seconds before the audible signal sounds. The number of blasts from the audible signal could be reduced if the rotating light focused employee attention toward the SPABS machine. This recommendation would eliminate the unpredictability of the warning signal and reduce potential as an occupational stressor.

3. If a barrier is the desired noise control, it should be installed as a rigid structure connected to the floor and reaching to near the ceiling. It should also extend from the outside wall all the way to the end of the row of sorting cages. A rigid structure is preferred because of its additional sound reduction performance and the fact that it will provide a solid barrier in case the pallets of mail which were observed stacked along the back side of the sorting cages would tip and fall into the cages. If a barrier is to be built, it would be beneficial to seek the advice of an acoustical engineer in the selection of construction material needed to maximize the sound reduction to the letter carriers without interfering with ventilation in the area. It must be noted that this method of noise reduction will not reduce the noise exposures experienced by the postal clerks and mail handlers operating the SPABS. The reduction of the intensity of the warning signals would, however, lower noise exposures for all employees in the area.

4. The canvas curtain installed by the Postal Service should be removed. Because the curtain has a low sound transmission loss value, particularly at low frequency sounds, and has been installed as a partial barrier with openings above, below, and to one side, it provides little protection from the noise emitted by the SPABS. It has also become a focal point in the discussion of the Postal Service's handling of the noise complaint in the area.
5. The issuance of ear plugs to employees bothered by the noise the SPABS is not recommended. Most hearing protection devices (HPDs) are designed to reduce the risk of hearing losses from occupational noise, not to reduce annoyance from noise. If HPDs are distributed by the Postal Service, NIOSH recommends that individuals who are given the devices be included in a period audiometric testing program to ensure that the employees are properly protected.\textsuperscript{5}

IX. REFERENCES


X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Division of Surveillance, Hazard Evaluations, and Field Studies

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Office Automation Clerk
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   Letter Carriers, Lansing, MI
4. NIOSH Cincinnati Office
5. U.S. Department of Labor\OSHA, Region V

For the purpose of informing affected employees, copies of this
shall be posted by the employer in a prominent place accessible
employees for a period of 30 calendar days.
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<th>Measurement Location</th>
<th>Sample Period (hh:mm)</th>
<th>Time-Weighted Average [dB(A)]</th>
<th>Maximum 1-min Average [dB(A)]</th>
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<td>88</td>
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<td>81</td>
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TABLE 3
Noise Dosimeter Results from January 21, 1992 Survey
U.S. Postal Service
Lansing, Michigan General Mail Facility
HETA 92-056

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<th>Measurement Location</th>
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<td>Mail Handler (Sweeper) - SPABS</td>
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