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I. SUMMARY

In April 1993, the National Institute for Occupational Safety and Health (NIOSH) received a management request to evaluate worker exposures to noise in the print shop of the Federal Emergency Management Agency (FEMA) in Washington, DC. On July 27-28, 1993, NIOSH investigators conducted an industrial hygiene survey at the agency's print shop. Personal noise dosimeter measurements were collected for the four employees in the print shop and one employee working in an adjacent office, and area noise measurements were made while the print shop equipment was operating. During the site visit, employees in the print shop and surrounding areas expressed concern over the chemicals used in the print shop and their associated odors. In response to these concerns, work practices and engineering control measures were evaluated and a sample of shrink wrap plastic (polyethylene) was analyzed for volatile organic compound content.

All five full-shift samples (range: 56.7 - 78 decibels, A-weighted levels dB[A]) were below the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 90 dB(A) for noise and the 85 dB(A) criteria used by NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH) for noise. In terms of equipment, the folding machine had the highest instantaneous noise levels (89-96 dB[A]), followed by the off-set presses (81-86 dB[A]).

The sample of polyethylene shrink wrap gave off a variety of compounds when heated, mostly acetic acid, which could lead to irritation of mucous membranes. Several additional potential safety hazards were observed, such as open doors on the safety cabinet for flammable compounds and no eye wash station. The print shop was on a recirculating ventilation system and, as a result, any vapors generated in the shop had the potential to circulate throughout that area of the building.

The industrial hygiene sampling data indicate that workers were not over-exposed to noise in the print shop. Recommendations to improve ventilation and employee safety can be found in Section VIII of this report.

KEYWORDS: SIC 2759 (Commercial Printing, not elsewhere classified), noise exposure, shrink wrap.

II. INTRODUCTION

On July 27-28, 1993, National Institute for Occupational Safety and Health (NIOSH) investigators conducted a site visit at the print shop of the Federal Emergency Management Agency (FEMA) in Washington, DC. The management request asked for assistance in assessing noise exposures in the print shop. The request stated that an employee, who worked in an office adjacent to the print shop and entered the print shop on a regular basis, had hearing loss in one ear, which had been diagnosed by their personal physician as potentially due to occupational exposures.

III. BACKGROUND

The print shop of FEMA is located on the third floor of an eleven-story building (eight floors above and three floors below ground). The print shop employs four people who work during the day. It has been in its present location between two office areas and adjacent to a main hallway since 1981. A diagram of the print shop (not to scale) is included as Figure 1.

Several pieces of equipment are used in the production of printed material for the agency. This equipment includes two off-set presses, a camera with automatic developer to create master plates, a paper folding machine, a collator/stapler, a shrink wrap machine with hot wire cutter, a hole punch, a stapler, a paper cutter, and three photocopiers. The print shop has acoustical ceiling panels, and the machines sit on vibration isolators. Employees are provided ear plugs or ear muffs, depending upon their preference.

The shop is supplied air by a recirculating ventilation system, which serves other areas of the building as well. Propeller fans are used to supply additional air movement. There were three separate exhausts located in the ceiling over the off-set presses and photocopiers.

IV. METHODS

Area noise levels were measured throughout the print shop with a Quest Electronics Model 2400 Sound Level Meter. Five personal noise dosimeters (Quest Electronics M-27 Noise Logging Dosimeters) were also used during this survey. The dosimeter consists of a small noise recording device which is worn on the worker's shoulder area during the workshift. The device measures noise in decibels, A-weighted levels (dB[A]), integrates the data according to Occupational Safety and Health Administration (OSHA) noise regulations, and stores it for later analysis.

During the site visit, employees in the print shop and surrounding areas expressed concern over the chemicals used in the print shop and associated odors. In response to these concerns, the facility's Material Safety Data Sheets (MSDSs) and work practices were reviewed and the exhaust systems for the off-set presses and copiers were evaluated. A sample of shrink wrap (polyethylene) was qualitatively analyzed by thermal desorption for volatile organic compounds (VOCs).

V. EVALUATION CRITERIA

A. 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 excessive noise levels 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.[1] 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 hertz (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.[2]

The A-weighted decibel (dB[A]) is the preferred unit for measuring sound levels to assess worker noise exposures. 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 1,000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies. Because the dB(A) scale is logarithmic, increases of 3 dB(A), 10 dB(A),

and 20 dB(A) represent a doubling, tenfold, and 100-fold increase of sound levels, 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)[3] specifies a maximum permissible exposure limit (PEL) of 90 dB(A)-slow response for a duration of eight 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,[4] and American Conference of Governmental Industrial Hygienists (ACGIH), in their threshold limit values (TLVs),[5] propose an exposure limit of 85 dB(A) for eight hours, 5 dB less than the OSHA standard. Both of these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

Time-weighted average (TWA) noise limits as a function of exposure duration are shown as follows:

Duration of Exposure (hrs/day)	Sound Level dB(A)	
	NIOSH/ACGIH	OSHA
16	80	85
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115*
1/8	115*	---
		**

* 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(A) which stipulates that 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, 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 reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

B. Hot Wire Cutting of Shrink Wrap Plastic (Polyvinyl Chloride and Polyethylene)

There are several documented cases of acute respiratory symptoms as well as pulmonary function changes associated with "hot wire" cutting of meat wrapping film containing polyvinyl chloride.[6-9] These symptoms were more prevalent with individuals with a history of allergies and/or asthma.

According to one case report, a paper packer with pre-existing asthma, which was controlled with medications, worked with a shrink wrap machine which used polyethylene sheeting.[10] The machine heated the paper and plastic to 166°C (331°F) to partially shrink the wrapping. After two weeks of this exposure, the individual experienced asthma attacks six to seven hours after starting work. Symptoms improved when he was away from the workplace. He had several attacks and required hospital admission. He was diagnosed with occupational asthma and recovered after removal from that position. Occupational asthma caused by the pyrolysis products of polyethylene has been suggested by another study.[11]

VI. RESULTS

A. Noise

To determine some of the potentially high noise activities related to specific equipment in the print shop, a sound level meter, in the maximum hold position, was used to take readings in the slow dB(A) mode during a walk-through survey (Table 1). The folding machine had the highest measurements (89-96 dB[A]), followed by the off-set presses (81-86 dB[A]), collating machine (approximately 82 dB[A]), paper cutter (approximately 77 dB[A]), and the photocopiers (approximately 76 dB[A]).

A summary of the five personal noise dosimeter measurements is given in Table 2. All five full-shift samples (56.7 - 78 dB[A]) were below the OSHA PEL of 90 dB(A) for noise and the 85 dB(A) criteria used by NIOSH and ACGIH for noise. The personal noise dosimeter printouts are presented in Figures 2-6. The dosimeter printouts show how variable noise levels affect an employee's noise exposure for an entire shift. Personal noise exposures varied with machine work, break periods when the workers left the area, and clean-up at the end of the day.

B. Polyethylene Shrink Wrap

Samples of shrink wrap plastic were heated, and thermal decomposition products were qualitatively analyzed for VOC content using thermal desorption. The MSDS for the product indicated that it consisted of an ethylene vinyl acetate copolymer, polyethylene material. A sample of shrink wrap was heated to 350°C (662°F) - similar to temperatures used for hot wire-cutting. The major components of emissions identified at this temperature included acetic acid, various alkyl substituted phenols, paraffins, numerous aliphatic compounds, furfural, alcohols, and ketones. Traces of formaldehyde and phenol were also found. These compounds (especially acetic acid) are irritants to the respiratory tract.

Visible vapors generated by the "hot-wire" were carried into the breathing zone of the operator and, as a result, the worker is exposed to the potentially irritating compounds. The shrink wrap machine was located directly under a ceiling luminary air return into the ceiling plenum for the recirculating ventilation system. With this design, vapors can potentially be carried into the ventilation system.

C. Observations

The facility did not have a formal hearing conservation program, and such a program would not be required for the noise levels measured. Hearing protection was provided to the employees, but was not always worn, or used properly. One worker wore ear muffs which were missing the cushion on one muff. Employees were observed plugging one ear with a finger while talking on the telephone on the print shop floor, indicating that they had difficulty in hearing the conversation on the telephone.

The exhaust over the off-set presses was not local exhaust, but instead, it had a booster fan which fed into the return plenum for the recirculating ventilation system. The exhausts over the photocopiers were disconnected above the ceiling tiles but the connecting ductwork also led into the return plenum. As a result, any compounds generated in the print shop could be circulated into the ventilation system for that portion of the building. Black deposits were visible on ceiling tiles around ceiling slot return grilles over the off-set presses, indicating possible inadequate exhaust ventilation. One of the photocopier machines had a crushed ozone filter which might allow ozone to by-pass the filter.

It was observed that stockroom employees manually moved 543 pound rolls of paper to stock the large off-set press. This could lead to back and other muscular skeletal injuries.

The MSDSs for the inks indicated they were water-based. The developing compounds used with the camera system contained small amounts of acids and bases. The off-set presses were cleaned on a regular basis using a chlorinated solvent with a strong odor which entered the surrounding offices whenever it was used. The employees used rubber gloves when handling the solvent to prevent skin contact. The print shop did not have an eye wash station available in case of eye contact as was recommended by several MSDSs. Flammable liquids were kept in a flammable storage cabinet in a corner of the print shop; however, the door to the cabinet was left open at times throughout the day.

VII. DISCUSSION AND CONCLUSIONS

At this facility, NIOSH investigators did not identify noise over-exposures in the print shop. After investigating employee concerns over chemicals used in the print shop, some deficiencies were identified in the ventilation system. There is no local

exhaust ventilation for the off-set presses or shrink wrap machine. The vents over the off-set presses and copiers fed into the recirculating ventilation system. Solvents with strong odors were used to clean the off-set presses and it was observed that the odors permeated into the adjoining offices. The polyethylene shrink wrap used in the hot wire operation has been implicated in cases of occupational asthma and generates potentially irritating compounds during cutting. The MSDS for the shrink wrap plastic also recommended local exhaust ventilation as an engineering control measure.

VIII. RECOMMENDATIONS

Based on the results and observations of this survey, the following recommendations are offered to correct identified deficiencies and optimize employee comfort.

1) If the facility continues to provide hearing protection to employees, a formal hearing conservation program should be implemented with annual audiograms offered to each employee as well as training on how to properly use hearing protection devices. Ear muffs should be replaced when broken and the cushion seals replaced every six months or when damaged. The requirements of the OSHA hearing conservation amendment should be met at a minimum.[3]

2) To prevent compounds generated in the print shop from entering the recirculating ventilation system, separate local exhaust ventilation should be installed, with assistance from a ventilation engineer, for the shrink wrap machine and off-set presses. The connections to the return plenum should be sealed. The print shop should be under negative pressure with respect to the surrounding areas (i.e., air should flow from the office areas into the print shop).

3) To prevent eye damage from accidental exposures to the chemicals used in the print shop, an eye wash station should be installed. Goggles should be worn during the cleaning of the presses when working with the solvents.

4) To help prevent back and muscular skeletal injuries, a mechanical lifting and moving device should be used to move the heavy rolls of paper. Two companies that provide such devices are: Hodge Manufacturing Co., Inc. in Springfield, MA (1-800-262-4634) and American Solving Inc. in Pontiac, MI (1-800-822-2285).*

5) To assist employees in hearing while on the telephone on the work floor of the print shop, a volume amplifier should be added to the telephone.

6) The doors to the flammable cabinets should be kept closed at all times.

7) To prevent ozone generated by the photocopier machine from by-passing the filter and entering the workplace atmosphere, the damaged ozone filter should be replaced.

* Mention of company names does not constitute endorsement by NIOSH

IX. REFERENCES

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X.AUTHORSHIP AND ACKNOWLEDGEMENTS

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3. General Services Administration, National Capital Region
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Table 1

Area Sound Level Measurements
Federal Emergency Management Agency
Washington, DC
HETA 93-0863

July 28, 1993

Location/Activity	Sound Level [dB(A)]
Off-set Presses Operating	81-86
Copier	76
Folding Machine	89-96
Collating Machine	82
Paper Cutter	77

Table 2

Personal Noise Dosimeter Survey
Federal Emergency Management Agency
Washington, DC
HETA 93-0863

July 28, 1993

Job Category	Sample Period [minutes]	Time-Weighted Avg. [dB(A)]
Small Off-set Press Operator	551	71
Supervisor	546	75.2
Office Worker	547	56.7
Xerox® Operator	515	66.4
Large Off-set Press Operator	510	78
NIOSH Recommended Exposure Limit (REL):		85
OSHA Permissible Exposure Limit (PEL):		90
ACGIH Threshold Limit Value (TLV):		85

Figure 1
Fa ity Diagram Print hop
Federal mergency Management Agency
HETA 93-0863

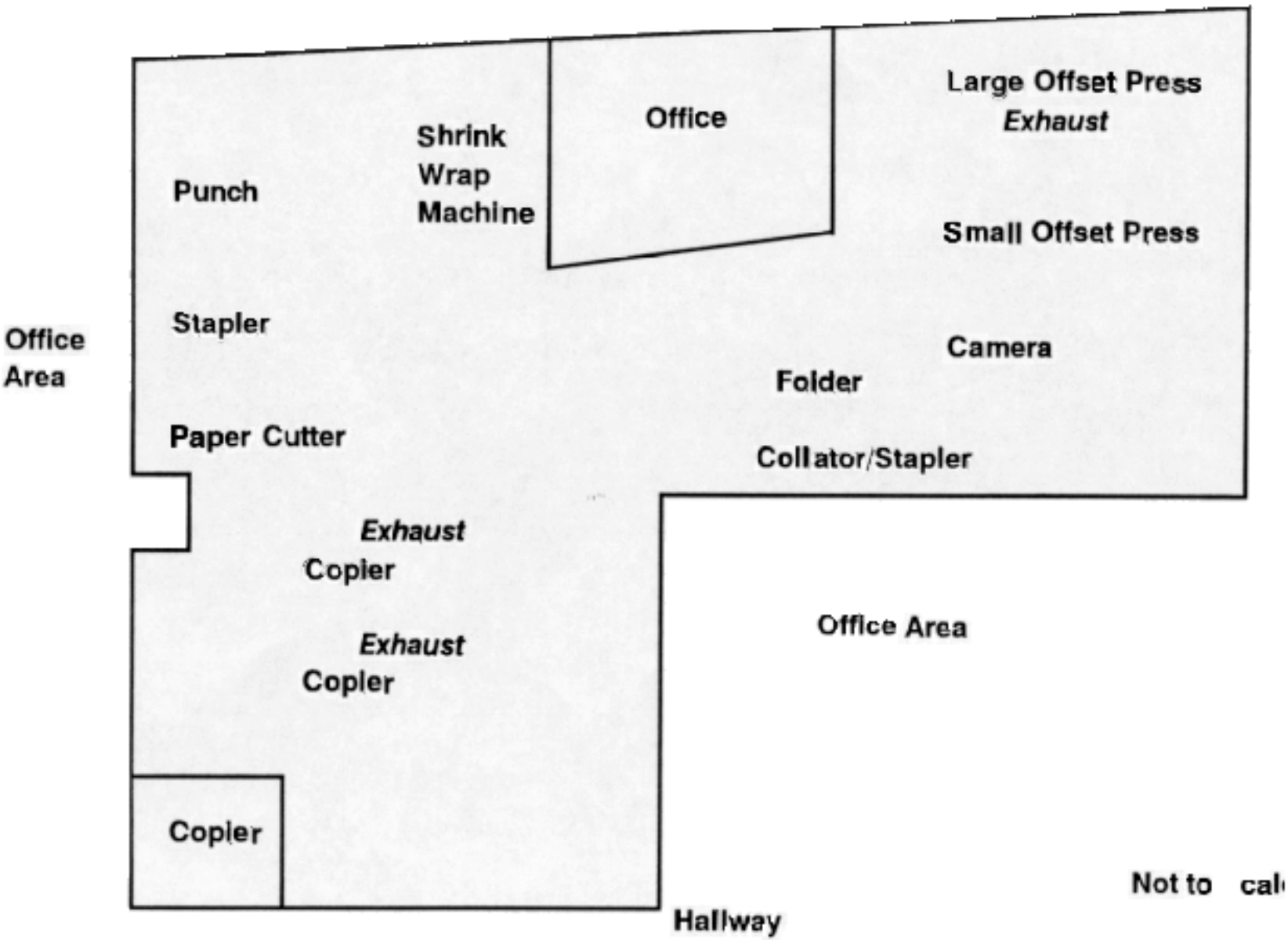
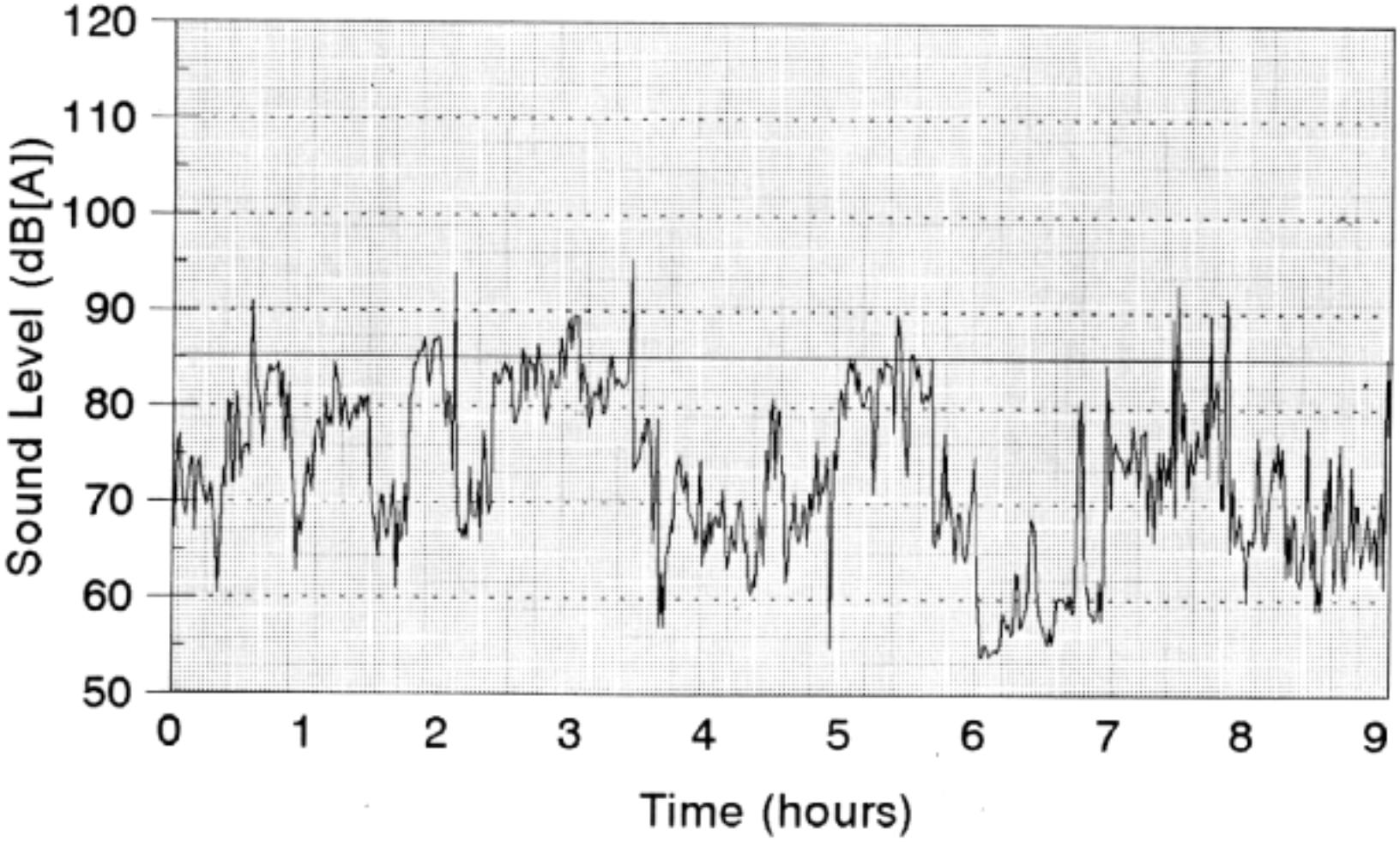


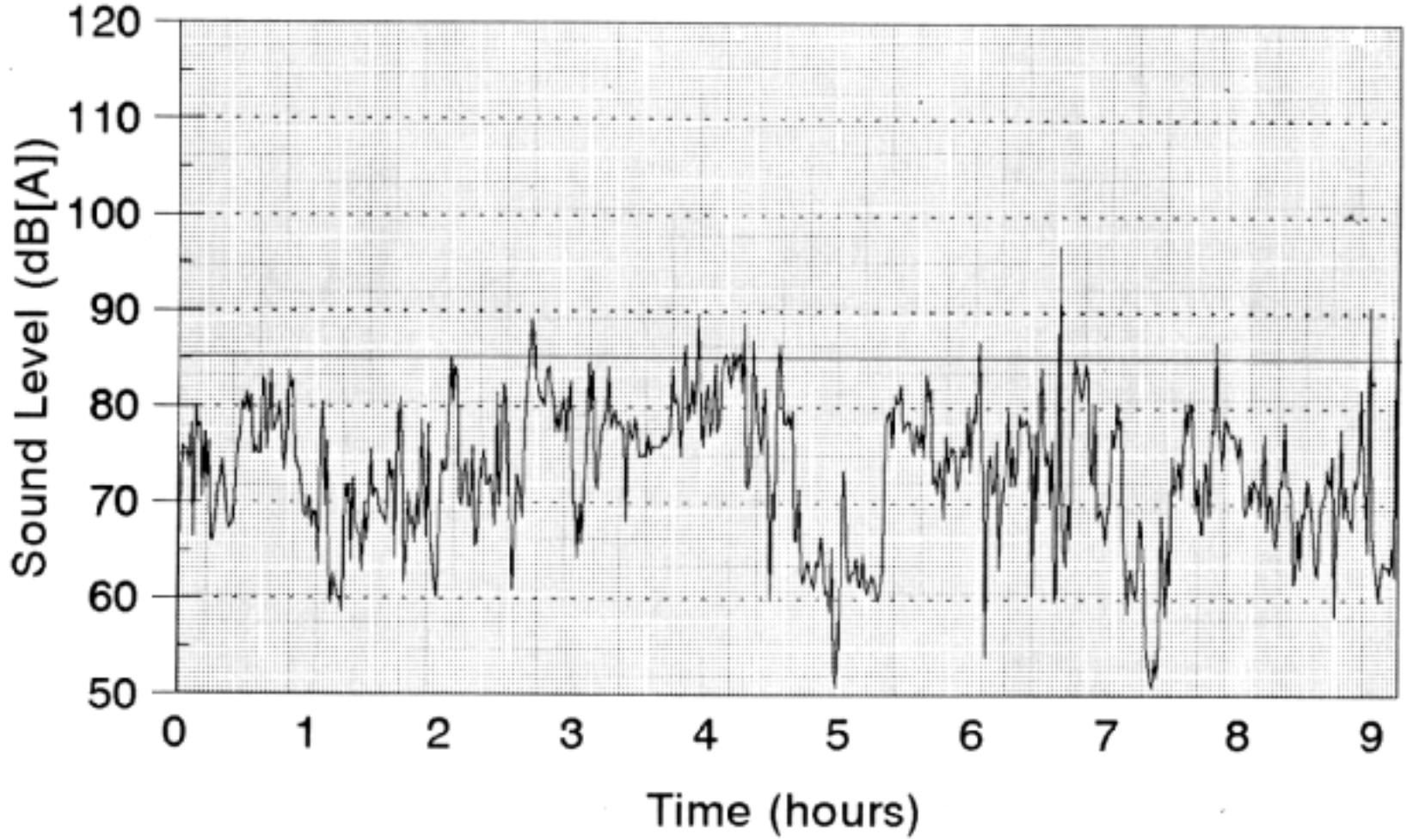
Figure 2

Small Offset Press Operator
July 28, 1993 - HETA 93-0863



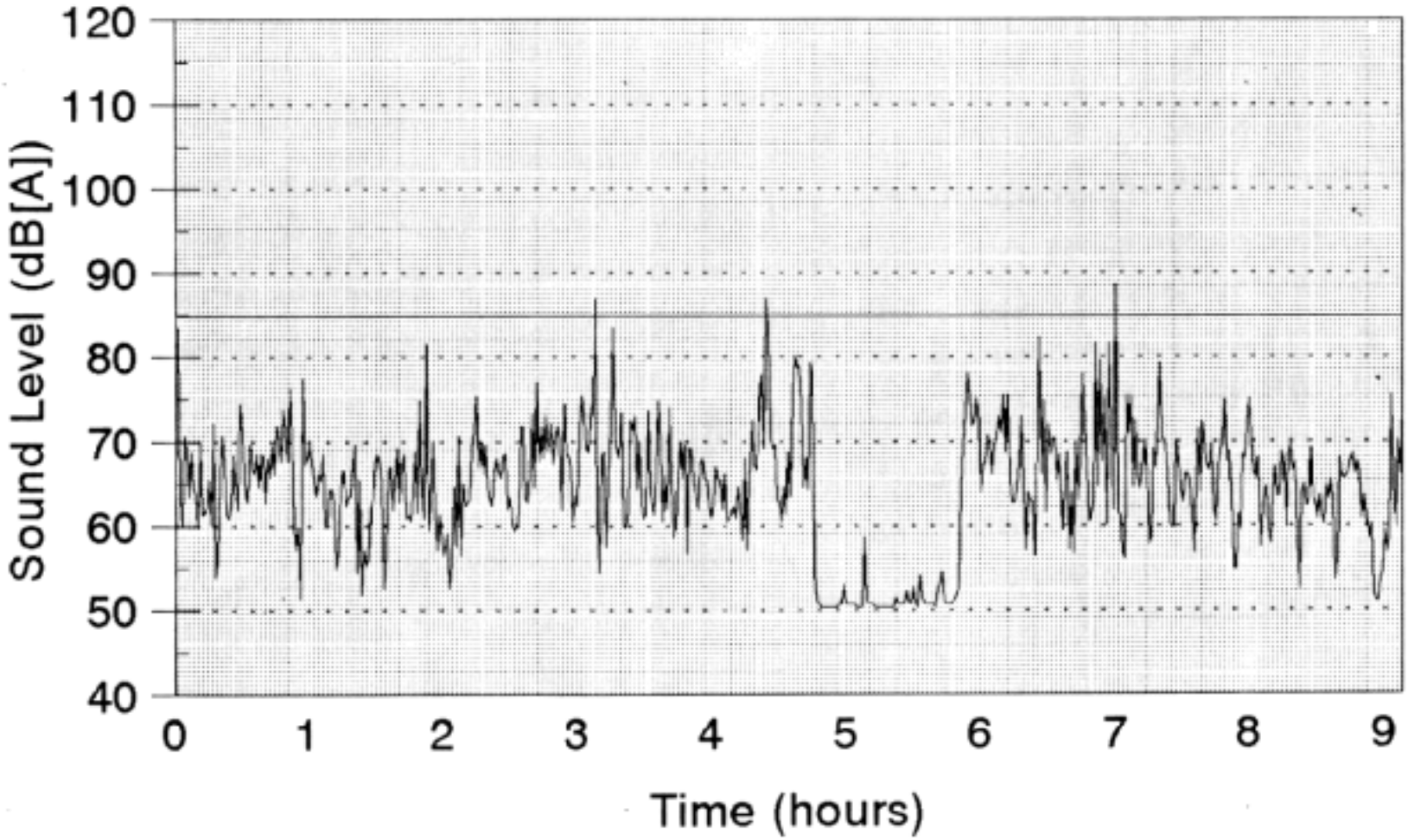
8-Hour Time-Weighted Average: 75 dB[A]

Figure 3
Supervisor
July 28, 1993 - HETA 93-0863



8-Hour Time-Weighted Average: 70.9 dB[A]

Figure 4
Office Worker
July 28, 1993 - HETA 93-0863



8-Hour Time-Weighted Average: 56.6 dB[A]