INDUSTRYWIDE STUDIES REPORT OF AN INDUSTRIAL HYGIENE SURVEY AT THE

Clermont Sun
45 North Market
Batavia, Ohio 45103

SURVEY CONDUCTED BY:
Bruce Hills
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DATES OF SURVEY:
September 26, 1984
January 17, 1986

REPORT WRITTEN BY:
Bruce Hills

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Industrial Hygiene Section
Industrywide Studies Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
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A walk through survey was conducted at Clermont Sun (SIC-2752), Batavia, Ohio, a typical small scale newspaper company employing less than 30 persons, to determine if pressroom employees are exposed to polycyclic aromatic hydrocarbons (PAHs), alkylated PAHs, and nitrated PAHs. The black newsprint ink was suspected of containing these compounds. The publishing company prints by the lithographic process. Air samples collected in the pressroom revealed no detectable levels of PAHs. The lithographic or offset press does not achieve the printing speed required to generate an ink aerosol. The black newsprint ink did contain PAHs and alkylated PAHs, which were all below 30.5 nanograms per microliter of ink. The author concludes that there appears to be no inhalation hazard to the employees. Any health hazards to employees from skin contact to inks is unknown. Airborne dust and filings samples from the brake pads used to create tension between the web and press rollers did not contain asbestos. Noise levels during press operation ranged from 90 decibels-A (dBA) to 108 dBA in the work area. The author recommends that a comprehensive noise monitoring system be established.

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PURPOSE OF SURVEY:	To conduct a walk-through survey at a typical small scale newspaper company (less than 30 employees), to determine if pressroom employees are exposed to polycyclic aromatic hydrocarbons (PAHs), alkylated-PAHs, and nitrated-PAHs. The black newsprint ink, used at the Clermont Sun was suspected of containing these compounds. If airborne PAHs are present, then additional surveys at other newspaper facilities will be necessary.
EMPLOYER REPRESENTATIVES CONTACTED:	William Latham, President Clermont Sun Charles Heidelberg, Production Manager Clermont Sun
EMPLOYEE REPRESENTATIVES CONTACTED:	No labor unions are represented at this company.
STANDARD INDUSTRIAL CLASSIFICATION (SIC):	2752

Abstract

Industrial hygiene surveys were conducted on September 26, 1984 and on January 15, 1986 at the Clermont Sun in Batavia, Ohio, a newspaper publishing company which prints by the lithographic process. The purpose of the survey was to determine if pressmen were exposed to polycyclic aromatic hydrocarbons (PAHs) and the alkylated or nitrated forms of these compounds. Air samples collected in the pressroom revealed no detectable levels of PAHs. The lithographic or offset press used at this facility does not obtain the printing speed required to generate an ink aerosol. The black newsprint ink did contain PAHs and alkylated-PAHs, which were all below 30.5 nanograms per microliter (ng/uL) of ink. However, there appears to be no inhalation hazard to the employees from airborne PAHs. Any health hazards to employees from skin contact to inks is unknown. Samples of airborne dust and filings from the brake pads used to create tension between the web and press rollers did not contain asbestos. Noise levels measured during the operation of the press, ranged from 90 dBA to 108 dBA in the work area. A comprehensive noise monitoring program needs to be established because of the high noise levels.

Introduction

Numerous epidemiological studies have demonstrated an increased risk of cancer of the respiratory tract in newspaper pressmen. A mortality study of newspaper pressmen sponsored by NIOSH demonstrated a 200% increase in cancer of the buccal cavity and pharynx and a 50% increase in lung cancer within this occupation (1). Earlier, an increased proportion of upper respiratory cancer deaths was found among U.S. newspaper pressmen (2). Two British reports documented excess deaths from cancer of the lung and bronchus in newspaper pressmen (3,4). While a number of other studies in the printing trades tend to support these findings (5-13), three investigations have found no increase in cancer mortality among printers (14-16).

An explanation of this cancer excess may be found by examining the composition of the news printing inks. Most black newsprint inks contain carbon black and petroleum pitch which is carcinogenic in laboratory animals (17). The carcinogenicity of petroleum pitch is likely due to the content of various polycyclic aromatic hydrocarbons (PAHs) (18-20).

Worker exposure to the newsprint ink occurs in the pressroom by inhalation of ink mist created by the high speed presses used in major newsprinting facilities. A literature review on air concentration of ink mist from six different newsprint facilities ranged from less than 1 to over 40 milligrams per cubic meter air (mg/m^3) (21). Moreover an industrial hygiene survey sponsored by NIOSH, reported that in one newspaper pressroom at least 66% of the mass of the ink mist aerosol was of respirable size of 10 microns (um) in diameter (22). Dermal exposure to ink is common and unavoidable in the printing operations because ink is present on most of the equipment.

A soon to be published study, has found an elevated number of malignant melanoma cases among white males in the printing industry (23). The results of other epidemiology studies provide support for this finding (4,7,8,16,24-30). The cause of this disease is not known except that ultraviolet light and dimethylbenzanthracene are thought to be important factors in the etiology of malignant melanomas. Potential exposure to ultraviolet radiation can occur during printing processes such as photoengraving, lithographic plate making, and the curing of ink. In addition, exposures to inks which contain dimethylbenzanthracene may also contribute to excess risk for malignant melanomas.

The purpose of this survey was to determine if pressroom air and the black printing inks, used in this facility, contained polycyclic aromatic hydrocarbons (PAH), nitrated-PAHs (nitro-PAHs), and alkylated-PAHs. The Clermont Sun was selected for this survey because it is representative of a typical small scale newspaper printing company. The results of this survey will determine if further surveys at similar companies will be conducted.

Plant and Process Description

The company is located in a residential-business area of Batavia, Ohio. The company occupies one building with offices and the layout department on the first floor. The plate making, printing, and mailing is performed in the

basement. Figure 1 is the floor plan of the basement. The single press, a Cottrell Model V-15A, occupies most of the floor space in the basement with photo processing being performed in two adjacent rooms. Printing is done by a typical lithographic offset process, using one black offset ink and several colors. The lithographic process begins with the creation of a printing plate from a photograph which has been chemically pretreated to form ink receptive and ink repellent areas. The printing plate is a thin aluminum sheet which is coated with a photosensitive medium by the supplier of this equipment. The treatment of this medium is done in a sink by a worker who wears rubber gloves and uses tongs to handle the plates. A photographic image is transferred by "burning" an image on to the plate with an ultraviolet light source. The plate is exposed for 5 minutes but is well covered to prevent ultraviolet light from escaping into the work area. The plate is then mounted onto the plate cylinder of the press and rotates on the cylinder coming into contact with water and ink. The ink adheres to the receptive areas of the plate, the image is then transferred from the plate to an intermediate roller or blanket, and finally the ink is transferred to the paper. A continuous roll of newsprint paper is fed onto the press. The roll of paper that passes continuously through the press is termed a web. The web moves over the press rollers while an ink image is transferred to the paper. The paper is automatically cut, folded, and stacked after printing. The press is cleaned daily with isopropyl alcohol and rags.

The black offset ink contains carbon black for pigment and petroleum oils as the vehicle. Once the print is transferred to the paper, the oil is absorbed into the paper leaving the carbon on the surface of the paper. Since there is little binding to the paper, the ink can be smudged and rubbed off during handling.

The company prints 12 weekly newspapers, totaling approximately 300,000 impressions per week. During the survey on September 26, 1984, the presses were operating at approximately 20,000 impressions per shift. On January 17, 1986 the press was operated at a speed of 17,000 impressions per hour (iph) for 51 minutes. The press operator then increased the speed of the press to its maximum speed of 22,000 iph for 10 minutes to demonstrate the highest noise level that the press can generate.

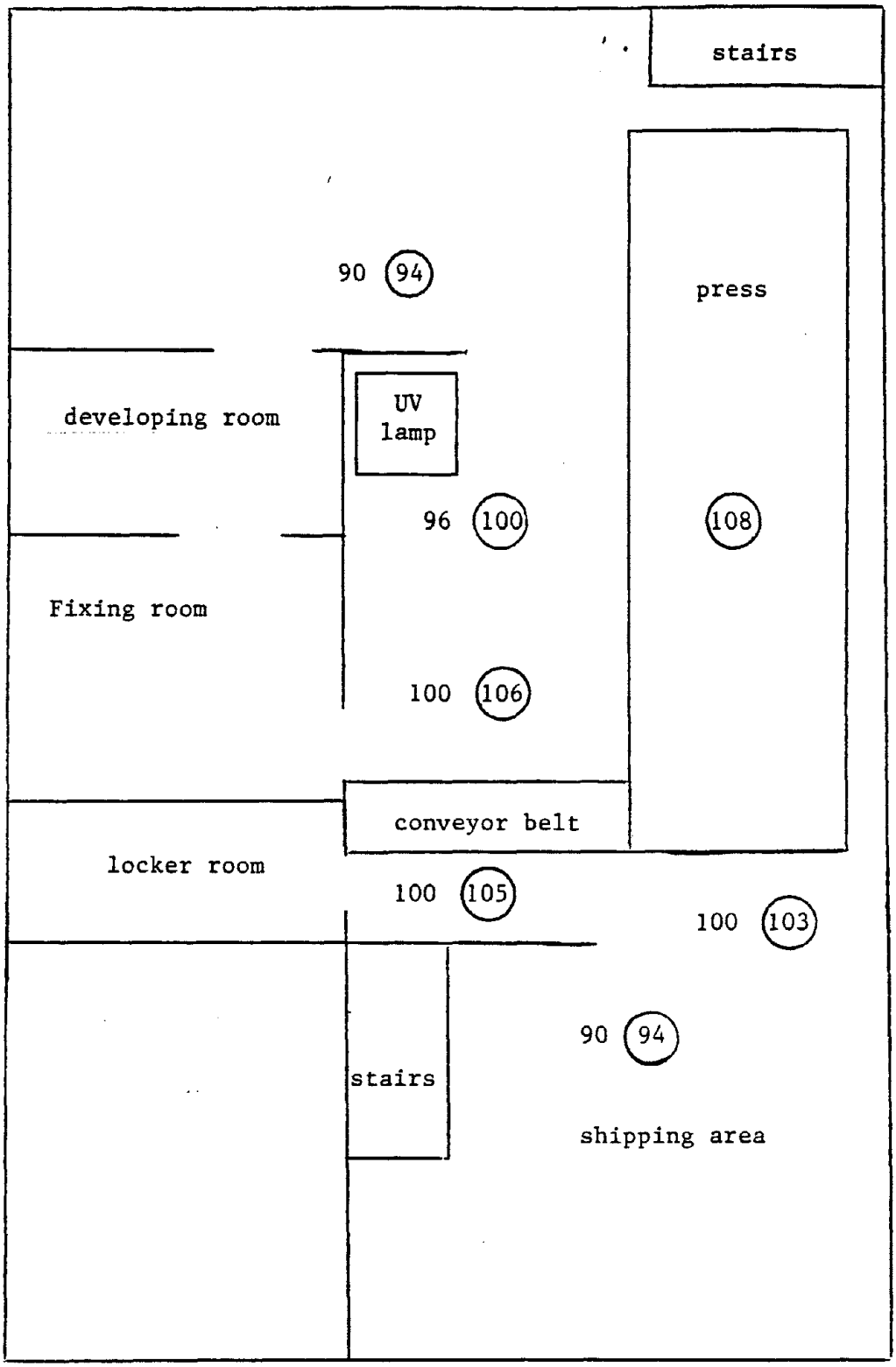
The company was concerned that the brake pads which are used to control the flow of paper between the paper roll and the press rollers contained asbestos. When the brake pads were first installed, they generated a strong sulfur smelling smoke through out the building. After several days of operation, the smoke and odor subsided. The smoke was further reduced by applying oil to the pads. The manufacturer of the brake pads claimed that the pads were free of asbestos. However, to insure that no asbestos was present, dust and filing samples were collected for analysis.

Description of Past Exposures

The company was started in 1971 and began printing that same year with a small offset press. In 1975 the present press was installed. No monitoring of any kind has been conducted at the company. However, since there has been no changes in production it can be assumed that there has been no

Figure 1.

Clermont Sun Lower Level



Numbers are sound level measurements in decibels (A-scale, slow response time for 1 minute) at press speed of 17,000 impressions per hour.
Numbers inclosed in circles are measurements at press speed of 22,000 impressions per hour.

changes in exposures. The only exception is that before September, 1984 the employees did not have hearing protection equipment. Now the pressmen each have ear muffs.

Description of Medical, Industrial Hygiene and Safety Programs

No medical, industrial hygiene or safety programs are currently being offered by the company.

Description of Workforce

The company operates on 2 shifts employing 2 full-time and 2 part-time pressmen per shift. Employees are responsible for loading the paper rolls on the press, supplying ink and fountain solution (a mixture of water, acid, buffer, and a gum to prevent the non-printing areas of the plate from receiving ink), monitoring the operation of the press, and the cleaning of the press. Isopropyl alcohol is used to remove ink from the rollers and equipment. Five women work in a room adjacent to the pressroom, bundling the papers for shipping.

Sampling Method

The air sampling and analysis of PAHs were done according to the NIOSH Technical Bulletin TB001, issued December 1, 1982 (32).

Area air samples were collected in the pressroom next to the press. Two sampling trains were located near the top of the press. The collection media was a 37-mm Zefluor filter, 2.0 um pore size, followed by an XAD-2, 100/50 mg sorbent resin tube. The flow rate was 1 liter per minute and the collection time was for 382 minutes. A third area sample was collected adjacent to the press against a side wall with a Zefluor filter at a flow rate of 23 liters per minute for 267 minutes. The fourth sample was also collected along the same wall. This sampling train contained 2 Zefluor filters in parallel, each with a flow rate of 12.1 liters per minute for 395 minutes. Sampling was performed during the operation of the press.

The area sound levels from the operation of the press were recorded with the Quest Model 215 Sound Level Meter. The meter was set on the A weighted scale, which most closely follows the human range of hearing, with a slow meter response time. Thirteen measurements were recorded at 7 locations in the work area (Diagram 1). The monitoring was conducted during normal press operating speed of 17,000 iph which lasted for 51 minutes and for 10 minutes during maximum operating speed of 22,000 iph.

Two bulk samples were collected from the brake pads for asbestos analysis. One sample was collected by wiping the dust and oil mixture off the edges of the pad. The second sample was collected by filing particles directly from the pad. Four other samples were collected on 25-mm cellulose ester membrane filters inside a closed face cassette by drawing air through the filter using a battery powered pump. Two filters were used to vacuum dust

from surfaces in the building. The other two filters were used to collect airborne particulates for 1 hour during the operating of the press.

Analytical Method

The filters, sorbent tubes, and one ink sample were analyzed by High Performance Liquid Chromatography (HPLC)/Ultraviolet/Florescence for the following PAHs:

Naphthalene
Acenaphthylene
Acenaphthylene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benz(a)anthracene
Chrysene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene

The filter samples were microextracted with 25 ml of toluene for a period totaling 48 hours then concentrated to 5 ml. The concentrate was then solvent exchanged with equal volumes of acetonitrile for HPLC analysis. The sorbent tubes were desorbed with 5.0 ml methylene chloride for 30 minutes and solvent exchanged with equal volumes of acetonitrile.

The same samples were also analyzed by gas chromatography with an electron capture detector (GC/ECD) for the following nitro-PAHs:

2-Nitrofluorene
3-Nitro-9-fluorenone
9-Nitroanthracene
3-Nitrofluoranthene
3-Nitropyrene
2,7-Dinitrofluorene
6-Nitrobenzo(a)pyrene

Filters and the bulk ink sample were prepared for analysis by Soxhlet extraction with toluene for a period of 48 hours then concentrated for GC/ECD analysis. The sorbent tubes were desorbed for 30 minutes in methylene chloride and solvent exchanged into hexane for analysis. The analytical method development and analysis was done at Arthur D. Little, Inc. under a NIOSH contract.

In addition, the bulk ink sample was analyzed by Gas Chromatography/Mass Spectrometry for determination of the alkyl derivatives of the following analytes:

Naphthalene
Acenaphthylene
Anthracene
Fluoranthene
Benzanthracene
Acenaphthylene
Fluorene
Phenanthrene
Pyrene
Chrysene

Benzo(b and k)fluoranthenes 1,2,5,6-Dibenzanthracene
Benzo(ghi)perylene

This portion of the analysis was performed by Southern Research Institute.

The two bulk samples from the break pads were analyzed for asbestos by polarized light microscopy. The four samples collected on cellulose ester membrane filters were analyzed according to NIOSH method 7400 Set B utilizing phase contrast microscopy (33). The limit of detection has been determined to be 0.03 fibers per field or 1500 fibers per filter for a 25-mm diameter filter.

Applicable Standards and Recommended Limits

At present, the only standard and recommended exposure limit for PAHs is the coal tar pitch volatiles standards and recommendations. The Occupational Safety and Health Administration (OSHA) defines coal tar pitch volatiles as fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum, wood, and other organic matter. NIOSH defines coal tar pitch volatiles as the destructive distillates of bituminous coal. The OSHA standards and recommended levels from NIOSH and the American Conference of Governmental Industrial Hygienist (ACGIH) on exposure limits for compounds contained in inks and other exposures present in the newsprint pressroom are listed below.

Potential Hazard	OSHA Standard (34)	NIOSH Recommended Exposure Limit (35)	ACGIH TLV (36)
Coal Tar Pitch Volatiles	0.2 mg/m^3 8-hr TWA benzene-soluble fraction	0.1 mg/m^3 10-hr TWA cyclohexane-extractable fraction	0.2 mg/m^3 as benzene-soluble-human carcinogen
Chrysene	None	To be controlled as an occupational carcinogen	Suspect carcinogen
Carbon Black	3.5 mg/m^3 8-hr TWA	3.5 mg/m^3 TWA, 0.1 mg/m^3 TWA in presence of PAHs	3.5 mg/m^3 TWA
Oil Mist, Mineral	5 mg/m^3 8-hr TWA	None	5 mg/m^3 TWA 10 mg/m^3 STEL
Asbestos	2 million fibers/ m^3 over 5 um in length 8-hr TWA 10 million fiber /m^3 ceiling	100,000 fibers/m^3 over 5 um in length 8-hr TWA in a 400 liter air sample	Amosite=500,000 fibers/m^3; Chrysotile=2 million fibers/m^3; Crocidolite= 200,000 fibers/m^3
Isopropyl Alcohol	980 mg/m^3 8-hr TWA	984 mg/m^3 10-hr TWA, 1,968 mg/m^3 ceiling STEL	980 mg/m^3, 1,225 mg/m^3 STEL
Noise	90 dBA 8-hr TWA, 85 dBA 8-hr TWA Action Level	85 dBA TWA, 115 dBA ceiling	85 dBA 8-hr TWA

STEL = Short Term Exposure Limit, a 15 minute TWA exposure which should not be exceeded at any time during a work day.

Results

The samples analyzed by HPLC for PAHs, and the samples analyzed by GC/ECD for Nitro-PAHs were all below the analytical limit of detection. The limit of detection varied for each compound tested.

The analysis of the bulk ink samples by GC/MS detected methylated and nonmethylated PAHs. Table 2 summarizes the arithmetic mean levels detected. The detection limit was estimated to be 1 ng/uL of ink. No methlylated nor nonmethylated PAHs were detected in the air samples, at a detection limit of 0.83 microgram of total PAHs per cubic meter of air. Unfortunately, the contracting laboratory failed to analyze the samples for Benzo(a)pyrene as requested.

The six sound level measurements recorded at normal press operating speed of 17,000 iph ranged from 90 dBA to 100 dBA. Most of the noise was generated by the paper folder at the end of the press. Four employees were working adjacent to the folder to observe the press and to collect and stack the papers as they were folded and moved by conveyor belt. Three measurements in this area were each 100 dBA. When the speed of the press was increased to 22,000 iph the sound levels in the vicinity of the folder ranged from 103 to 106 dBA. Two of the four press workers wore ear muff hearing protection. The other two employees were provided the same protective equipment by the company, but they failed to wear their equipment. A measurement in the press, on a walk way, between the rollers was 108 dBA. Occasionally an employee would step into this area to wipe up excess ink from the equipment. Once the papers are removed from the conveyor belt and stacked, they are then carried to an adjacent room for bundling and shipping. Five women perform the task of organizing the papers for shipping. In this room the work station closes to the press the sound level was 90 dBA during normal press speed and 94 dBA during maximum press speed. The women in this room did not have hearing protection.

All the samples collected for asbestos fibers were non-detectable.

Conclusion

Based on observations in the press room and the results of the air sampling, there appears to be no ink mist being generated from the press. The ink that was present on the floor, wall, and equipment originated from the drums of ink and is not due to misting. The air sampling filters were a dark gray in color after sampling but this may be due to paper dust and possibly tobacco smoke. Three of the four employees in the pressroom were smoking at the time of the survey. No PAHs were detected in any of the air samples. The offset black ink that is used does contain low levels of PAHs and alkylated-PAHs, but since the ink does not become airborne there is no apparent health hazard from inhalation of ink mists. We have also concluded from conversations with the company and reports in the literature that the small newspaper companies, which the Clermont Sun is a typical example, operate offset presses that do not generate ink mist. Ink misting is mainly a problem encountered in the large major newspaper companies.

Four PAHs, detected in the ink, benzo(b and k)fluoranthenes, benzanthracene, and methyl chrysene have sufficient evidence for carcinogenicity in experimental animals (22,24). Another compound in the ink, chrysene, has limited evidence for carcinogenicity in experimental animals and activity in short term tests (24). Dimethylbenzanthracene, which has been reported to induce melanomas in laboratory animals, may also be present in the ink. The analytical method detected an average of 7.1 nanogram/microliter of ink for dimethylated benzanthracene and dimethylated chrysene. In other words, the analytical method could not distinguish between the dimethylated forms of benzanthracene and chrysene. The quantity found (7.1 nanogram/microliter) is either entirely dimethylated benzanthracene or dimethylated chrysene or a combination of both. A summary of the carcinogenicity data for the compounds analyzed in this survey have been evaluated by the International

Agency for Research on Cancer, World Health Organization (31). This information is listed in Table 1.

When PAHs are in contact with the skin they have the property of penetrating dermal tissue and being absorbed into the body. Although the PAH levels in the ink are relatively low compared to products such as used motor oils or coal tar pitch, the risk to workers who have a daily skin contact with black inks is unknown, and therefore it would be prudent to avoid dermal exposure to the ink.

The sound level meter used in this survey records sound intensity at a given moment. During this survey measurements were made for approximately 30 seconds at each location. In order to obtain personal noise measurements with a sound level meter, each employee would have to be followed through out the work day and sound intensity recorded. This was not possible because the pressmen had to move about the work area to complete their job duties. A more accurate noise measurement device for mobile workers is a personal noise dosimeter which stores sound level measurements and integrates these measurements over time, providing an average noise exposure reading, such as an 8-hour time-weighted average. The dosimeter is attached to the employees clothes and the exposure measurement is read at the end of the work day.

If the employees were to remain in the vicinity of the folder-press during printing, which is not unlikely, then they would receive the following noise exposure.

51 minutes at 100 dBA
10 minutes at 105 dBA
7 hours at less than 80 dBA

Using Table G-16a from the OSHA regulation on Permissible Noise Exposures, 46 Federal Register 4161 January 16, 1981 (Attachment 1), the noise dose can be computed with the formula:

$$Dose = 100 \left(C1/T1 + C2/T2 + \ldots Cn/Tn \right)$$

C = Total time of exposure at a specific noise level (in decibels)
T = Reference duration for that level as given by Table G-16a

$$Dose = \left(0.85 \text{ hours}/2 \text{ hours} + 0.167 \text{ hours}/1 \text{ hour} + 7 \text{ hours}/ \right)$$

$$Dose = 59.2\%$$

The 8-hour time-weighted average (TWA) sound level in decibels is then computed by the formula:

$$TWA = 16.61 \log(Dose/100) + 90$$

$$TWA = 86 \text{ dBA}$$

This value indicates that the pressmen's noise exposure may be exceeding the OSHA Action Level for noise exposure which is 85 dBA as an 8-hour TWA. The details of the OSHA regulation can be found in Attachment 1. Likewise, the pressmen's noise exposure may also be approaching the NIOSH recommended noise standard of 85 dBA as a 10-hour TWA.

Recommendations

When cleaning equipment with solvents and during platemaking, the employees should always wear gloves to protect against chemicals that can enter the body through the skin. Wearing gloves during platemaking is especially important because the process uses the caustic chemicals sulfuric acid and potassium hydroxide. Solvents remove body oils allowing many toxic chemicals to easily penetrate the skin. Employees should also wear a face shield or splash goggles when using solvents or platemaking chemicals.

Another good practice is to provide adequate ventilation during the use of cleaning solvents.

Since the noise levels in the pressroom were above 85 dBA during printing the following procedures are recommended to control employee noise exposures (see Attachment 1).

1. Establish a comprehensive noise monitoring program. Periodic monitoring of personal exposures can best be accomplished by providing employees with noise dosimeters to be worn during the work day.

2. Establish a hearing conservation program with audiometric testing to determine if employees are experiencing a hearing loss.

3. Reduce noise exposures by administrative and engineering controls. Administrative controls may include restricting the amount of time that employees can be in the vicinity of the noise source (folder). Engineering controls may include reducing the speed of the press which lowers the sound levels, installing noise absorption materials on the walls, floor, and ceiling, and enclosing the folder or erecting a barrier wall. A barrier wall or door between the press and the shipping room would greatly reduce the noise levels in that area.

4. If the administrative and engineering controls are not sufficient in reducing sound levels within the levels of Table G-16a, then personal protective equipment should be provided to the effected employees.

5. Employees should also be educated on the need for hearing conservation and on the use and care of personal hearing protection. Typical hearing protection equipment are ear plugs and ear muffs. Since the comfort of the equipment is important factor on how often the equipment is worn, the employees should be allowed to chose the equipment that best suits them.

Table 1

Evaluation of PAHs by the Internation Agency for Research on Cancer, WHO
IARC Monographs volumes 32 and 33 (31)

Fluorene	Data inadequate to permit an evaluation of carcinogenicity in experimental animals. Inadequated evidence for activity in short-term tests. IARC 32:365
Phenanthrene	Data inadequate to permit an evaluation for carcinogenicity in experimental animals. Limited evidence that it is active in short-term tests. IARC 32:419
Anthracene	No evidence for carcinogenicity in experimental animals or activity in short term tests. IRAC 32:105
Fluoranthene	No evidence for carcinogenicity in experimental animals. Limited evidence that it is active in short term tests. IRAC 32:355
Pyrene	No evidence for carcinogenicity in experimental animals. Limited evidence that it is active in short term tests. IARC 32:431
Benz(a)anthracene	Sufficient evidence for carcinogenicity in experimental animals. IARC 32:135
Chrysene	Limited evidence for carcinogenicity in experimental animals and activity in short term tests. IARC 32:247
Benzo(b)fluoranthene	Sufficient evidence for carcinogenicity in experimental animals. IARC 32:147
Benzo(k)fluoranthene	Sufficient evidence for carcinogenicity in experimental animals. IARC 32:163
Benzo(a)pyrene	Sufficient evidence for carcinogenicity in experimental animals. IARC 32:211

Table 1 (continued)

Evaluation of PAHs by the Internation Agency for Research on Cancer, WHO
IARC Monographs volumes 32 and 33 (31)

9-Nitroanthracene	Inadequate evidence for activity in short-term tests. IARC 33:179
3-Nitrofluoranthene	Data inadequate to permit an evaluation of carcinogenicity in experimental animals. Limited evidence of activity in short-term tests. IARC 33:201
3-Nitropyrene	Limited evidence for carcinogenicity in experimental animals. Sufficient evidence of activity in short-term tests. IRAC 33:209
Methyl phenanthrene	Data inadequate to permit an evaluation of carcinogenicity in experimental animals. Sufficient evidence of activity in short-term tests. IARC 32:405
Methyl chrysene	Sufficient evidence for carcinogenicity in experimental animals. IARC 32:379

Table 2

PAHs and Alkylated-PAHs in Ink Sample No. BSWO, ng/uL of ink

PAH	Non-methylated	Mono-methyl	Di-methyl	Tri-methyl
Naphthalene	1.2	1.1	4.8	7.6
Acenaphthylene	ND	1.0a	2.7b	6.5c
Acenaphthylene	1.0	1.8	4.7	4.5
Fluorene	1.0a	2.8b	6.6c	10.0
Anthracene/ Phenanthrene	8.7	20.0	30.5	28.0
Fluoranthene/ Pyrene	4.9	10.0	15.3	19.0
Benz(a)anthracene/ Chrysene	3.7	5.1	7.1	5.6
Benzo(b and k)- fluoranthenes	1.6	1.5	1.2	ND
1,2,5,6- Dibenzanthracene	ND	ND	ND	ND
Benzo(ghi)perylene	ND	ND	ND	ND

ND = not detected; less than 1 ng/uL

a The retention times and quantitation ion for mono-methylated acenaphthylenes and nonmethylated fluorene are the same. The results given are based on the assumption that the quantity found is entirely mono-methylated acenaphthylene or entirely nonmethylated fluorene.

b The retention times and quantitation ion for di-methylated acenaphthylenes and mono-methylated fluorenes are the same. The results given are based on the assumption that the quantity found is entirely di-methylated acenaphthylenes or entirely mono-methylated fluorenes.

c The retention times and quantitation ion for tri-methylated acenaphthylenes and di-methylated fluorenes are the same. The results given are based on the assumption that the quantity found is entirely tri-methylated acenaphthylenes or entirely di-methylated fluorenes.

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Attachment 1.

Occupational Safety and Health Administration

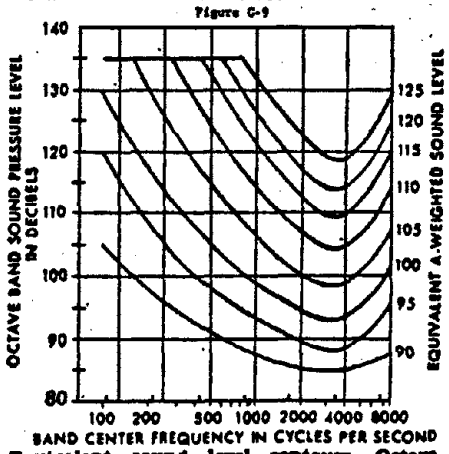
Safety and Health Standards 29 Code of Federal Register

1910.95

§ 1910.95 Occupational noise exposure.

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G–16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

Figure G-9



Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table G–16.

[Sec. 1910.95 amended at 39 FR 19468, June 3, 1974]

(b)(1) When employees are subjected to sound exceeding those listed in Table

G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

(3) (Deleted)

[Section 1910.95(b)(3) deleted by 46 FR 4161, January 16, 1981]

TABLE G-16—PERMISSIBLE NOISE EXPOSURES[1]

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1+C_2/T_2+\cdots C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. *Cn* indicates the total time of exposure at a specified noise level, and *Tn* indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

[1910.95 Table G16 amended at 39 FR 19468, June 3, 1974]

[Section 1910.95(c)—(s) and Appendix A—I added by 46 FR 4161, January 16, 1981]

(c) *Hearing conservation program.* (1) The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with Appendix A and Table G-16a, and without regard to any attenuation provided by the use of personal protective equipment.

(2) For purposes of paragraphs (c) through (n) of this section, an 8-hour time-weighted average of 85 decibels or a dose of fifty percent shall also be referred to as the action level.

(d) *Monitoring.* (1) When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program. (i) The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors.

(ii) Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this paragraph unless the employer can show that area sampling produces equivalent results.

(2)(i) All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels shall be integrated into the noise measurements.

(ii) Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

(3) Monitoring shall be repeated whenever a change in production, process, equipment or controls increases noise exposures to the extent that:

(i) Additional employees may be exposed at or above the action level; or

(ii) The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of paragraph (j) of this section.

(e) *Employee notification.* The employer shall notify each employee exposed at or above an 8-hour time-weighted average of 85 decibels of the results of the monitoring.

(f) *Observation of monitoring.* The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section.

(g) *Audiometric testing program.* (1) The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels.

(2) The program shall be provided at no cost to employees.

(3) Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

(4) All audiograms obtained pursuant to this section shall meet the requirements of Appendix C: *Audiometric Measuring Instruments.*

(5) *Baseline audiogram.* (i) Within 6 months of an employee's first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared.

(ii) *Mobile test van exception.* Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within 1 year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee's first exposure at or above the action level, employees shall wearing hearing protectors for any period exceeding six months after first exposure until the baseline audiogram is obtained.

(iii) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise.

(iv) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(6) *Annual audiogram.* At least annually after obtaining the baseline audiogram, the employer shall obtain a

new audiogram for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

(7) *Evaluation of audiogram.* (i) Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in paragraph (g)(10) of this section has occurred. This comparison may be done by a technician.

(ii) If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

(iii) The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

(A) A copy of the requirements for hearing conservation as set forth in paragraphs (c) through (n) of this section;

(B) The baseline audiogram and most recent audiogram of the employee to be evaluated;

(C) Measurements of background sound pressure levels in the audiometric test room as required in Appendix D: Audiometric Test Rooms.

(D) Records of audiometer calibrations required by paragraph (h)(5) of this section.

(8) *Follow-up procedures.* (i) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

(ii) Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

(A) Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

(B) Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

(C) The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

(D) The employee is informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

(iii) If subsequent audiometric testing of an employee whose exposure to noise is less than an 8-hour TWA of 90 decibels indicates that a standard threshold shift is not persistent, the employer:

(A) Shall inform the employee of the new audiometric interpretation; and

(B) May discontinue the required use of hearing protectors for that employee.

(9) *Revised baseline.* An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist or physician who is evaluating the audiogram:

(i) The standard threshold shift revealed by the audiogram is persistent; or

(ii) The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

(10) *Standard threshold shift.* (i) As used in this section, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

(ii) In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in Appendix F: *Calculation and Application of Age Correction to Audiograms.*

(h) *Audiometric test requirements.* (1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audiometers, S3.6–1969.

(3) Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix C: *Audiometric Measuring Instruments.*

(4) Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix D: *Audiometric Test Rooms.*

(5) *Audiometer calibration.* (i) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

(ii) Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix E: *Acoustic Calibration of Audiometers.* Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 decibels or greater require an exhaustive calibration.

(iii) An exhaustive calibration shall be performed at least every two years in accordance with sections 4.1.2; 4.1.3.; 4.1.4.3; 4.2; 4.4.1; 4.4.2; 4.4.3; and 4.5 of the American National Standard Specification for Audiometers, S3.6–1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(i) *Hearing protectors.* (1) Employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary.

(2) Employers shall ensure that hearing protectors are worn:

(i) By an employee who is required by paragraph (b)(1) of this section to wear personal protective equipment; and

(ii) By any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:

(A) Has not yet had a baseline audiogram established pursuant to paragraph (g)(5)(ii); or

[B] Has experienced a standard threshold shift.

(3)Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer.

(4) The employer shall provide training in the use and care of all hearing protectors provided to employees.

(5) The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

(j) *Hearing protector attenuation.* (1) The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the evaluation methods described in Appendix B: *Methods for Estimating the Adequacy of Hearing Protection Attenuation.*

(2) Hearing protectors must attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by paragraph (b) of this section.

(3) For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.

(4) The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

(k) *Training program.* (1) The employer shall institute a training program for all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels, and shall ensure employee participation in such program.

(2) The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes.

(3) The employer shall ensure that each employee is informed of the following:

(i) The effects of noise on hearing;

(ii) The purpose of hearing protectors, the advantages, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care; and

(iii) The purpose of audiometric testing, and an explanation of the test procedures.

(l) *Access to information and training materials.* (1) The employer shall make available to affected employees or their representatives copies of this standard and shall also post a copy in the workplace.

(2) The employer shall provide to affected employees any informational materials pertaining to the standard that are supplied to the employer by the Assistant Secretary.

(3) The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to this standard to the Assistant Secretary and the Director

(m) *Recordkeeping.*—(1) *Exposure measurements.* The employer shall maintain an accurate record of all employee exposure measurements required by paragraph (d) of this section.

(2) *Audiometric tests.* (i) The employer shall retain all employee audiometric test records obtained pursuant to paragraph (g) of this section:

(ii) This record shall include:

(A) Name and job classification of the employee;

(B) Date of the audiogram;

(C) The examiner's name;

(D) Date of the last acoustic or exhaustive calibration of the audiometer; and

(E) Employee's most recent noise exposure assessment.

(F) The employer shall maintain accurate records of the measurements of

the background sound pressure levels in audiometric test rooms.

(3) *Record retention.* The employer shall retain records required in this paragraph (m) for at least the following periods.

(i) Noise exposure measurement records shall be retained for two years.

(ii) Audiometric test records shall be retained for the duration of the affected employee's employment.

(4) *Access to records.* All records required by this section shall be provided upon request to employees, former employees, representatives designated by the individual employee, and the Assistant Secretary. The provisions of 29 CFR 1910.20 (a)–(e) and (g)–(i) apply to access to records under this section.

(5) *Transfer of records.* If the employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained by this section, and the successor employer shall retain them for the remainder of the period prescribed in paragraph (m) (3) of this section.

(n) *Appendices.* (1) Appendices A, B, C, D, and E to this section are incorporated as part of this section and the contents of these Appendices are mandatory.

(2) Appendices F and G to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

(o) *Exemptions.* Paragraphs (c) through (n) of this section shall not apply to employers engaged in oil and gas well drilling and servicing operations.

(p) *Startup date.* Baseline audiograms required by paragraph (g) of this section shall be completed by March 1, 1984.

[Section 1910.95(c) — (p) revised by 48 FR 9776, March 8, 1983]

[Section 1910.95(q) — (s) deleted by 48 FR 9776, March 8, 1983]

[Editor's note: The Occupational Safety and Health Administration June 28, 1983 (48 FR 29687) corrected the amendatory language which was published at 48 FR 9776, March 8, 1983, to reflect the Agency's intention to delete paragraphs (q)—(s). The correction was done earlier by editor.]

[Appendices A — I revised by 48 FR 9776, March 8, 1983]

Appendix A: Noise Exposure Computation

This Appendix is Mandatory

I. Computation of Employee Noise Exposure

(1) Noise dose is computed using Table G–16a as follows:

(i) When the sound level, L, is constant over the entire work shift, the noise dose, D, in percent, is given by: $D = 100\ C/T$ where C is the total length of the work day, in hours, and T is the reference duration corresponding to the measured sound level, L, as given in Table G–16a or by the formula shown as a footnote to that table.

(ii) When the workshift noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

$$D = 100\ (C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n),$$

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 by Table G–16a.

(2) The eight-hour time-weighted average sound level (TWA), in decibels, may be computed from the dose, in percent, by means of the formula: $TWA = 16.61 \log_{10} (D/100) + 90$. For an eight-hour workshift with the noise level constant over the entire shift, the TWA is equal to the measured sound level.

(3) A table relating dose and TWA is given in Section II.

TABLE G–16a

A-weighted sound level, L (decibel)	Reference duration, T (hour)
80	32
81	27.9
82	24.3
83	21.1
84	18.4
85	16
86	13.9
87	12.1
88	10.6
89	9.2
90	8
91	7.0
92	6.1
93	5.3
94	4.6
95	4

TABLE G-16a—Continued

A-weighted sound level, L (decibel)	Reference duration, T (hour)
96	3.5
97	3.0
98	2.6
99	2.3
100	2
101	1.7
102	1.5
103	1.3
104	1.1
105	1
106	0.87
107	0.76
108	0.66
109	0.57
110	0.5
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25
116	0.22
117	0.19
118	0.16
119	0.14
120	0.125
121	0.11
122	0.095
123	0.082
124	0.072
125	0.063
126	0.054
127	0.047
128	0.041
129	0.036
130	0.031

In the above table the reference duration, T, is computed by

$$T = \frac{8}{2^{(L-90)/5}}$$

where L is the measured A-weighted sound level.

H. Conversion Between "Dose" and "8-Hour Time-Weighted Average" Sound Level

Compliance with paragraphs (c)–(r) of this regulation is determined by the amount of exposure to noise in the workplace. The amount of such exposure is usually measured with an audiodosimeter which gives a readout in terms of "dose." In order to better understand the requirements of the amendment, dosimeter readings can be converted to an "8-hour time-weighted average sound level." (TWA).

In order to convert the reading of a dosimeter into TWA, see Table A–1, below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table G-16a. So, for example, a dose of 91 percent over an eight hour day results in a TWA of 89.3 dB, and, a dose of 50 percent corresponds to a TWA of 85 dB.

If the dose as read on the dosimeter is less than or greater than the values found in Table A-1, the TWA may be calculated by using the formula: $TWA = 16.61 \log_{10} (D/100) + 90$ where TWA = 8-hour time-weighted average sound level and D = accumulated dose in percent exposure.

TABLE A–1.—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
10	73.4
15	76.3
20	78.4
25	80.0
30	81.3
35	82.4
40	83.4
45	84.2
50	85.0
55	85.7
60	86.3
65	86.9
70	87.4
75	87.9
80	88.4
81	88.5
82	88.6
83	88.7
84	88.7
85	88.8
86	88.9
87	89.0
88	89.1
89	89.2
90	89.2
91	89.3
92	89.4
93	89.5
94	89.6
95	89.6
96	89.7
97	89.8
98	89.9
99	89.9
100	90.0
101	90.1
102	90.1
103	90.2
104	90.3
105	90.4
106	90.4
107	90.5
108	90.6
109	90.6
110	90.7
111	90.8
112	90.8
113	90.9
114	90.9
115	91.1

TABLE A–1.—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
116	91.1
117	91.1
118	91.2
119	91.3
120	91.3
125	91.6
130	91.9
135	92.2
140	92.4
145	92.7
150	92.9
155	93.2
160	93.4
165	93.6
170	93.8
175	94.0
180	94.2
185	94.4
190	94.6
195	94.8
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	103.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4

Table A-1.—*Conversion From "Percent Noise Exposure" or "Dose" to "8-Hour Time-Weighted Average Sound Level" (TWA)*—Continued

Dose or percent noise exposure	TWA
760	104.5
780	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1
820	105.2
830	105.3
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
999	106.6

Appendix B: Methods for Estimating the Adequacy of Hearing Protector Attenuation

This Appendix is Mandatory

For employees who have experienced a significant threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. Employers must select one of the following methods by which to estimate the adequacy of hearing protector attenuation.

The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. This Appendix describes four methods of using the NRR to determine whether a particular hearing protector provides adequate protection within a given exposure environment. Selection among the four procedures is dependent upon the employer's noise measuring instruments.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the "List of Personal Hearing Protectors and Attenuation Data," HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH methods #1, #2 and #3. The NRR described below is a simplification of NIOSH method #2. The most complex method is NIOSH method #1, which is probably the most accurate method since it uses the largest amount of spectral information from the individual employee's noise environment. As in the case of the NRR method described below, if one of the NIOSH methods is used, the selected method must be applied to an individual's noise environment to assess the adequacy of the attenuation. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

Note.—The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

When using the NRR to assess hearing protector adequacy, one of the following methods must be used:

(i) When using a dosimeter that is capable of C-weighted measurements:

(A) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA (see Appendix A, II).

(B) Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(ii) When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:

(A) Convert the A-weighted dose to TWA (see Appendix A).

(B) Subtract 7 dB from the NRR.

(C) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iii) When using a sound level meter set to the A-weighting network:

(A) Obtain the employee's A-weighted TWA.

(B) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iv) When using a sound level meter set on the C-weighting network:

(A) Obtain a representative sample of the C-weighted sound levels in the employee's environment

(B) Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.

(v) When using area monitoring procedures and a sound level meter set to the A-weighing network.

(A) Obtain a representative sound level for the area in question.

(B) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.

(vi) When using area monitoring procedures and a sound level meter set to the C-weighting network:

(A) Obtain a representative sound level for the area in question.

(B) Subtract the NRR from the C-weighted sound level for that area.

Appendix C: Audiometric Measuring Instruments

This Appendix is Mandatory

1. In the event that pulsed-tone audiometers are used, they shall have a tone on-time of at least 200 milliseconds.

2. Self-recording audiometers shall comply with the following requirements:

(A) The chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least ¼ inch. Additional increments are optional. The audiogram pen tracings shall not exceed 2 dB in width.

(B) It shall be possible to set the stylus manually at the 10-dB increment lines for calibration purposes.

(C) The slewing rate for the audiometer attenuator shall not be more than 6 dB/sec except that an initial slewing rate greater than 6 dB/sec is

permitted at the beginning of each new test frequency, but only until the second subject response.

(D) The audiometer shall remain at each required test frequency for 30 seconds (± 3 seconds). The audiogram shall be clearly marked at each change of frequency and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than ± 3 seconds.

(E) It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

Appendix D: Audiometric Test Rooms

This Appendix is Mandatory

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D-1 when measured by equipment conforming at least to the Type 2 requirements of American National Standard Specification for Sound Level Meters, S1.4-1971 (R1976), and to the Class II requirements of American National Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, S1.11-1971 (R1976).

TABLE D-1.—MAXIMUM ALLOWABLE OCTAVE-BAND SOUND PRESSURE LEVELS FOR AUDIOMETRIC TEST ROOMS

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

Appendix E: Acoustic Calibration of Audiometers

This Appendix is Mandatory

Audiometer calibration shall be checked acoustically, at least annually, according to the procedures described in this Appendix. The equipment necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by American Standard Specification for Audiometers, S3.6-1969.

(1) Sound Pressure Output Check

A. Place the earphone coupler over the microphone of the sound level meter and place the earphone on the coupler.

B. Set the audiometer's hearing threshold level (HTL) dial to 70 dB.

C. Measure the sound pressure level of the tones that each test frequency from 500 Hz through 6000 Hz for each earphone.

D. At each frequency the readout on the sound level meter should correspond to the levels in Table E-1 or Table E-2, as appropriate, for the type of earphone, in the column entitled "sound level meter reading."

(2) Linearity Check

A. With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.

B. Measure the sound levels in the coupler at each 10-dB decrement from 70 dB to 10 dB, noting the sound level meter reading at each setting.

C. For each 10-dB decrement on the audiometer the sound level meter should indicate a corresponding 10 dB decrease.

D. This measurement may be made electrically with a voltmeter connected to the earphone terminals.

(3) Tolerances

When any of the measured sound levels deviate from the levels in Table E-1 or Table E-2 by ± 3 dB at any test frequency between 500 and 3000 Hz, 4 dB at 4000 Hz, or 5 dB at 6000 Hz, an exhaustive calibration is advised. An exhaustive calibration is required if the deviations are greater than 15 dB or greater at any test frequency.

TABLE E-1.—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-39 EARPHONES

Frequency, Hz	Reference threshold level for TDH-39 earphones, dB	Sound level meter reading, dB
500	11.5	81.5
1000	7	77
2000	9	79
3000	10	80
4000	9.5	79.5
6000	15.5	85.5

TABLE E-2.—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-49 EARPHONES

Frequency, Hz	Reference threshold level for TDH-49 earphones, dB	Sound level meter reading, dB
500	13.5	83.5
1000	7.5	77.5
2000	11	81.0
3000	9.5	79.5
4000	10.5	80.5
6000	13.5	83.5

Appendix F: Calculations and Application of Age Corrections to Audiograms

This Appendix Is Non-Mandatory

In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging to the change in hearing level by adjusting the most recent audiogram. If the employer chooses to adjust the audiogram, the employer shall follow the procedure described below. This procedure and the age correction tables were developed by the National Institute for Occupational Safety and Health in the criteria document entitled "Criteria for a Recommended Standard . . . Occupational Exposure to Noise," ((HSM)-11001).

For each audiometric test frequency:

(i) Determine from Tables F-1 or F-2 the age correction values for the employee by:

(A) Finding the age at which the most recent audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz;

(B) Finding the age at which the baseline audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz.

(ii) Subtract the values found in step (i)(B) from the value found in step (i)(A). [Appendix F/B (ii) corrected by 48 FR 29687, June 23, 1983]

(iii) The differences calculated in step (ii) represented that portion of the change in hearing that may be due to aging.

Example: Employee is a 32-year-old male. The audiometric history for his right ear is shown in decibels below.

Employee's age	Audiometric test frequency (Hz)				
	1000	2000	3000	4000	6000
26	10	5	5	10	5
*27	5	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	15	20	10
31	5	10	20	15	15
*32	5	10	10	25	20

The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.

The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25). A retest audiogram has confirmed this shift. The contribution of aging to this change in hearing may be estimated in the following manner:

Go to Table F-1 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	2000	3000	4000	6000
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audiogram hearing threshold at 4000 Hz (22). Thus the age-corrected threshold shift would be 17 dB (as opposed to a threshold shift of 20 dB without age correction).

TABLE F-1.—AGE CORRECTION VALUES IN DECIBELS FOR MALES

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	5	3	4	5	8
21	5	3	4	5	8
22	5	3	4	5	8
23	5	3	4	6	9
24	5	3	5	6	9
25	5	3	5	7	10
26	5	4	5	7	10
27	5	4	6	7	11
28	5	4	6	8	11
29	6	4	6	8	12
30	6	4	6	9	12
31	6	4	7	9	13
32	6	5	7	10	14
33	6	5	7	10	14
34	6	5	8	11	15
35	7	5	8	11	15
36	7	5	9	12	16
37	7	6	9	12	17
38	7	6	9	13	17
39	7	6	10	14	18
40	7	6	10	14	19
41	7	6	10	14	20
42	8	7	11	16	20
43	8	7	12	16	21
44	8	7	12	17	22
45	8	7	13	18	23
46	8	8	13	19	24
47	9	8	14	19	24
48	9	8	14	20	25
49	9	9	15	21	26
50	9	9	16	22	27
51	9	9	16	23	28
52	9	10	17	24	29
53	9	10	18	25	30
54	10	10	18	26	31
55	10	11	19	27	32
56	10	11	20	28	34
57	10	11	21	29	35
58	10	12	22	31	36
59	11	12	22	32	37
60 or older	11	13	23	33	38

TABLE F-2.—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	7	4	3	3	6
21	7	4	4	3	6
22	7	4	4	4	6
23	7	5	4	4	7
24	7	5	4	4	7
25	8	5	4	4	7
26	8	5	5	4	8
27	8	5	5	5	8
28	8	5	5	5	8
29	8	5	5	5	9
30	8	6	5	5	9
31	8	6	6	5	9
32	9	6	6	6	10
33	9	6	6	6	10
34	9	6	6	6	10
35	9	6	7	7	11
36	9	7	7	7	11
37	9	7	7	7	12
38	10	7	7	7	12

TABLE F-2.—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES—Continued

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
39	10	7	8	8	12
40	10	7	8	8	13
41	10	8	8	8	13
42	10	8	8	8	13
43	11	8	8	8	14
44	11	8	9	9	14
45	11	8	10	10	15
46	11	9	10	10	15
47	11	9	10	11	16
48	12	9	11	11	16
49	12	9	11	11	16
50	12	10	11	12	17
51	12	10	12	12	17
52	12	10	12	13	18
53	13	10	13	13	18
54	13	11	13	14	19
55	13	11	14	14	19
56	13	11	14	15	20
57	13	11	15	15	20
58	14	12	15	16	21
59	14	12	16	16	21
60 or older	14	12	16	17	22

Appendix G: Monitoring Noise Levels Non-Mandatory Informational Appendix

This appendix provides information to help employers comply with the noise monitoring obligations that are part of the hearing conservation amendment.

What is the purpose of noise monitoring?

This revised amendment requires that employees be placed in a hearing conservation program if they are exposed to average noise levels of 85 dB or greater during an 8 hour workday. In order to determine if exposures are at or above this level, it may be necessary to measure or monitor the actual noise levels in the workplace and to estimate the noise exposure or "dose" received by employees during the workday.

When is it necessary to implement a noise monitoring program?

It is not necessary for every employer to measure workplace noise. Noise monitoring or measuring must be conducted only when exposures are at or above 85 dB. Factors which suggest that noise exposures in the workplace may be at this level include employee complaints about the loudness of noise, indications that employees are losing their hearing, or noisy conditions which make normal conversation difficult. The employer should also consider any

information available regarding noise emitted from specific machines. In addition, actual workplace noise measurements can suggest whether or not a monitoring program should be initiated.

How is noise measured?

Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter. A sound level meter is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday. If noise levels fluctuate, the amount of time noise remains at each of the various measured levels must be determined.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace. After appropriate sound level meter readings are obtained, people sometimes draw "maps" of the sound levels within different areas of the workplace. By using a sound level "map" and information on employee locations throughout the day, estimates of individual exposure levels can be developed. This measurement method is generally referred to as *area* noise monitoring.

A dosimeter is like a sound level meter except that it stores sound level measurements and integrates these measurements over time, providing an average noise exposure reading for a given period of time, such as an 8-hour workday. With a dosimeter, a microphone is attached to the employee's clothing and the exposure measurement is simply read at the end of the desired time period. A reader may be used to read-out the dosimeter's measurements. Since the dosimeter is worn by the employee, it measures noise levels in those locations in which the employee travels. A sound level meter can also be positioned within the immediate vicinity of the exposed worker to obtain an individual exposure estimate. Such procedures are generally referred to as *personal* noise monitoring.

Area monitoring can be used to estimate noise exposure when the noise levels are relatively constant and employees are not mobile. In workplaces where employees move about in different areas or where the noise intensity tends to fluctuate over time, noise exposure is generally more accurately estimated by the personal monitoring approach.

In situations where personal monitoring is appropriate, proper positioning of the microphone is necessary to obtain accurate measurements. With a dosimeter, the microphone is generally located on the shoulder and remains in that position for the entire workday. With a sound level meter, the microphone is stationed near the employee's head, and the instrument is usually held by an individual who follows the employee as he or she moves about.

Manufacturer's instructions, contained in dosimeter and sound level meter operating manuals, should be followed for calibration and maintenance. To ensure accurate results, it is considered good professional practice to calibrate instruments before and after each use.

How often is it necessary to monitor noise levels?

The amendment requires that when there are significant changes in machinery or production processes that may result in increased noise levels, remonitoring must be conducted to determine whether additional employees need to be included in the hearing conservation program. Many companies choose to remonitor periodically (once every year or two) to ensure that all exposed employees are included in their hearing conservation programs.

Where can equipment and technical advice be obtained?

Noise monitoring equipment may be either purchased or rented. Sound level meters cost about $500 to $1,000, while dosimeters range in price from about $750 to $1,500. Smaller companies may find it more economical to rent equipment rather than to purchase it. Names of equipment suppliers may be found in the telephone book (Yellow Pages) under headings such as: "Safety Equipment," "Industrial Hygiene," or "Engineers-Acoustical." In addition to providing information on obtaining noise monitoring equipment, many companies and individuals included under such listings can provide professional advice on how to conduct a valid noise monitoring program. Some audiological testing firms and industrial hygiene firms also provide noise monitoring services. Universities with audiology, industrial hygiene, or acoustical engineering departments may also provide information or may be able to help employers meet their obligations under this amendment.

Free, on-site assistance may be obtained from OSHA-supported state and private consultation organizations. These safety and health consultative entities generally give priority to the needs of small businesses. See the attached directory for a listing of organizations to contact for aid.

OSHA ONSITE CONSULTATION PROJECT DIRECTORY

State	Office and address	Contact
Alabama	Alabama Consultation Program, P.O. Box 6005, University, Alabama 35486	(205) 348-7136, Mr. William Weems, Director.
Alaska	State of Alaska, Department of Labor, Occupational Safety & Health, 3301 Eagle St., Pouch 7-022, Anchorage, Alaska 99510.	(907) 276-5013, Mr. Stan Godsoe, Project Manager (Air Mail).
American Samoa	Service not yet available.	
Arizona	Consultation and Training, Arizona Division of Occupational Safety and Health, P.O. Box 19070, 1824 W. Adams, Phoenix, Ariz. 85005.	(602) 255-5795, Mr. Thomas Ramsey, Manager.
Arkansas	OSHA Consultation, Arkansas Department of Labor, 1022 High St., Little Rock, Ark. 72202	(501) 371-2992, Mr. George Smith, Project Director.
California	CAL/OSHA Consultation Service, 2nd Floor, 525 Golden Gate Avenue, San Francisco, Calif. 94102.	(415) 557-2870, Mr. Emmett Jones, Chief.
Colorado	Occupational Safety & Health Section, Colorado State University, Institute of Rural Environmental Health, 110 Veterinary Science Building, Fort Collins, Colo. 80523.	(303) 491-6151, Dr. Roy M. Buchan, Project Director.
Connecticut	Division of Occupational Safety & Health, Connecticut Department of Labor, 200 Folly Brook Boulevard, Wethersfield, Conn. 06109.	(203) 566-4550, Mr. Lee Alix, Director.
Delaware	Delaware Department of Labor, Division of Industrial Affairs, 820 North French Street, 6th Floor, Wilmington, Del. 19801.	(302) 571-3908, Mr. Bruno Salvadori, Director.
District of Columbia	Occupational Safety & Health Division, District of Columbia, Department Employment Services, Office of Labor Standards, 2900 Newton Street NE., Washington, D.C. 20018.	(202) 832-1230, Mr. Lorenzo M. White, Acting Associate Director.
Florida	Department of Labor & Employment Security, Bureau of Industrial Safety and Health, LaFayette Building, Room 204, 2551 Executive Center Circle West, Tallahassee, Fla. 32301.	(904) 488-3044, Mr. John C. Glenn, Administrator.
Georgia	Economic Development Division, Technology and Development Laboratory, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Ga. 30332.	(404) 894-3806, Mr. William C. Howard, Assistant to Director. Mr. James Burson, Project Manager.
Guam	Department of Labor, Government of Guam, 23548 Guam Main Facility, Agana, Guam 96921	(671) 772-8291, Joe R. San Agustin, Director.

OSHA ONSITE CONSULTATION PROJECT DIRECTORY—Continued

State	Office and address	Contact
Hawaii	Education and Information Branch, Division of Occupational Safety and Health, Suite 810, 677 Ala Moana, Honolulu, Hawaii 96813.	(808) 548-2511, Mr. Don Alper, Manager (Air Mail).
Idaho	OSHA Onsite Consultation Program, Boise State University, Community and Environmental Health, 1910 University Drive, Boise, Idaho 83725.	(208) 385-3929, Dr. Eldon Edmundson, Director.
Illinois	Division of Industrial Services, Dept. of Commerce and Community Affairs, 310 S. Michigan Avenue, 10 Floor, Chicago, Ill. 60601.	(800) 972-4140/4216 (Toll-free in State), (312) 793-3270, Mr. Stan Czyzniski, Assistant Director.
Iowa	Bureau of Labor, 307 E. Seventh Street, Des Moines, Iowa 50319	(515) 281-3606, Mr. Allen J. Meier, Commissioner.
Indiana	Bureau of Safety, Education and Training, Indiana Division of Labor, 1013 State Office Building, Indianapolis, Indiana 46204.	(317) 633-5845, Mr. Harold Mills, Director.
Kansas	Kansas Dept. of Human Resources, 401 Topeka Ave., Topeka, Kans. 66603	(913) 296-4086, Mr. Jerry Abbott, Secretary.
Kentucky	Education and Training, Occupesonal Safety and Health, Kentucky Department of Labor, 127 Building, 127 South, Frankfort, Ky. 40601.	(502) 564-6895, Mr. Larry Potter, Director.
Louisiana	No services available as yet (Pending FY 83).	
Maine	Division of Industrial Safety, Maine Dept. of Labor, Labor Station 45, State Office Building, Augusta, Maine 04333.	(207) 289-3331, Mr. Lester Wood, Director.
Maryland	Consultation Services, Division of Labor & Industry, 501 St. Paul Place, Baltimore, Maryland 21202	(301) 659-4210, Ms. Ileana O'Brien, Project Manager, 7(c)(1) Agreement.
Massachusetts	Division of Industrial Safety, Massachusetts Department of Labor and Industries, 100 Cambridge Street, Boston, Massachusetts 02202.	(617) 727-3567, Mr. Edward Noseworthy, Project Director.
Michigan (Health)	Special Programs Section, Division of Occupational Health, Michigan Dept. of Public Health, 3500 N. Logan, Lansing, Mich. 48909.	(517) 373-1410, Mr. Irving Davis, Chief.
Michigan (Safety)	Safety Education & Training Division Bureau of Safety and Regulation, Michigan Department of Labor, 7150 Harris Drive, Box 30015, Lansing, Michigan 48909.	(517) 322-1809, Mr. Alan Harvie, Chief.
Minnesota	Training and Education Unit, Department of Labor and Industry, 5th Floor, 444 Lafayette Road, St. Paul, Minn. 55101.	(612) 296-2973, Mr. Timothy Tierney, Project Manager.
Mississippi	Division of Occupational Safety and Health, Mississippi State Board of Health, P.O. Box 1700, Jackson, Mississippi 39205.	(601) 982-6315, Mr. Henry L. Laird, Director.
Missouri	Missouri Department of Labor and Industrial Relations, 722 Jefferson Street, Jefferson City, Missouri 65101.	1-(800) 392-0208, (314) 751-3403, Ms. Paula Smith, Mr. Jim Brake.
Montana	Montana Bureau of Safety & Health, Division of Workers Compensation, 815 Front Street, Helena, Montana 59601.	(406) 449-3402, Mr. Ed Gatzemeier, Chief.
Nebraska	Nebraska Department of Labor, State House Station, State Capitol, P.O. Box 94600, Lincoln, Nebraska 68509.	475-8451 Ext. 258, Mr. Joseph Carroll, Commissioner.
Nevada	Department of Occupational Safety and Health, Nevada Industrial Commission, 515 E. Musser Street, Carson City, Nev. 89714.	(702) 885-5240, Mr. Allen Tzantzner, Director.
New Hampshire	For information contact	Office of Consultation Programs, Room N3472 200 Constitution Avenue, N.W. Washington, D.C. 20210, Phone: (202) 523-8985.
New Jersey	New Jersey Department of Labor and Industry Division of Work Place Standards, CN-054, Trenton, New Jersey 08625.	(609) 292-2313, FTS-8-477-2313, Mr Willard Clark, Assistant Commissioner.
New Mexico	OSHA Consultation, Health and Environment Department, Environmental Improvement Division, Occupational Health & Safety Section, 4215 Montgomery Boulevard, NE., Albuquerque, New Mexico 87109.	(505) 982-3387, Mr. Albert M. Stevens, Project Manager.
New York	Division of Safety and Health, New York State Department of Labor, 2 World Trade Center, Room 6995, New York, New York 10047.	(212) 488-7746/7, Mr. Joseph Allevs, Project Manager, DOSH.
North Carolina	Consultation Services, North Carolina Department of Labor, 4 West Edenton Street, Raleigh, N.C. 27601.	(919) 733-4985, Mr David Pierce, Director.
North Dakota	Division of Environmental Research, Department of Health, Missouri Office Building, 1200 Missouri Avenue, Bismarck, N. Dak. 58505.	(701) 224-2348, Mr. Jay Crawford, Director.
Ohio	Department of Industrial Relations, Division of Onsite Consultation, P.O. Box 825, 2323 5th Avenue, Columbus, Ohio 43216.	(800) 282-1425 (Toll-free in State), (614) 466-7485, Mr. Andrew Dosimal, Project Manager
Oklahoma	OSHA Division, Oklahoma Department of Labor, State Capitol, Suite 118, Oklahoma City, Okla. 73105.	(405) 521-2461, Mr. Charles W. McGlon, Director.
Oregon	Consultative Section, Department of Workers' Compensation, Accident Prevention Division, Room 102, Building 1, 2110 Front Street NE., Salem, Oregon 97310.	(503) 378-3880, Mr. Jack Buckland, Supervisor.
Pennsylvania	For information contact	Office of Consultation Programs, Room N3472, 200 Constitution Avenue NW., Washington, D.C. 20210, Phone: (202) 523-8985.
Puerto Rico	Occupational Safety & Health, Puerto Rico Department of Labor and Human Resources, 505 Munoz Rivera Ave., 21st Floor, Hato Rey, Puerto Rico 00919.	(809) 754-2134, Mr. John Cinque, Assistant Secretary, (Air Mail).
Rhode Island	Division of Occupational Health, Rhode Island Department of Health, The Cannon Building, 206 Health Department Building, Providence, R.I. 02903.	(401) 277-2438, Mr. James E. Hickey, Chief.
South Carolina	Consultation and Monitoring, South Carolina Department of Labor, P.O. Box 11329, Columbia, S.C. 29211.	(803) 758-8921, Mr. Robert Peck, Director, 7(c)(1), Project.
South Dakota	South Dakota Consultation Program, South Dakota State University, S.T.A.T.E.-Engineering Extension, 201 Pugsley Center-SDSO, Brookings, S. Dak. 57007.	(605) 688-4101, Mr. James Ceglian, Director.
Tennessee	OSHA Consultative Services, Tennessee Department of Labor, 2nd Floor, 501 Union Building, Nashville, Tennessee 37219.	(615) 741-2793, Mr. L. H. Craig Director.
Texas	Division of Occupational Safety and State Safety Engineer, Texas Department of Health and Resources, 1100 West 49th Street, Austin, Texas 78756.	(512) 458-7287, Mr. Walter G. Martin, P.E. Director.
Trust Territories	Service not yet available.	
Utah	Utah Job Safety and Health Consultation Service, Suite 4004, Crane Building, 307 West 200 South, Salt Lake City, Utah 84101.	(801) 533-7827/S/S, Mr. H. M. Bergeson, Project Director.
Vermont	Division of Occupational Safety and Health, Vermont Department of Labor and Industry, 118 State Street, Montpelier, Vt. 05602.	(802) 828-2786, Mr. Robert Moleod, Project Director.
Virginia	Department of Labor and Industry, P.O. Box 12064, 205 N. 4th Street, Richmond, Va. 23241	(804) 786-5875, Mr. Robert Beard, Commissioner.
Virgin Islands	Division of Occupational Safety and Health, Virgin Islands Department of Labor, Lagoon Street, Room 207, Frederiksted, Virgin Islands 00840.	(809) 772-1315, Mr. Louis Llanos, Deputy Director-DOSH.
Washington	Department of Labor and Industry, P.O. Box 207, Olympia, Wash. 98504	(206) 753-6500, Mr. James Sullivan, Assistant Director.
West Virginia	West Virginia Department of Labor, Room 4519, State Capitol, 1900 Washington Street, Charleston, W. Va. 25305.	FTS 8-885-7890, Mr. Lawrence Barker, Commissioner.
Wisconsin (Health)	Section of Occupational Health, Department of Health and Social Services, P.O. Box 309, Madison, Wisconsin 53701.	(608) 266-0417, Ms. Patricia Natzke, Acting Chief.
Wisconsin (Safety)	Division of Safety and Buildings, Department of Industry, Labor and Human Relations, 1570 E. Moreland Blvd., Waukesha, Wis. 53186.	(414) 544-6666, Mr. Richard Michalski, Supervisor.
Wyoming	Wyoming Occupational Health and Safety Department, 209 East 8th Avenue, Cheyenne, Wyo. 82002.	(307) 777-7786, Mr. Donald Overley, Health and Safety Administrator.

Appendix H: Availability of Referenced Documents

Paragraphs (c) through (o) of 29 CFR 1910.95 and the accompanying appendices contain provisions which incorporate publications by reference. Generally, the publications provide criteria for instruments to be used in monitoring and audiometric testing. These criteria are intended to be mandatory when so indicated in the applicable paragraphs of Section 1910.95 and appendices.

It should be noted that OSHA does not require that employers purchase a copy of the referenced publications. Employers, however, may desire to obtain a copy of the referenced publications for their own information.

The designation of the paragraph of the standard in which the referenced publications appear, the titles of the publications, and the availability of the publications are as follows:

Paragraph designation	Referenced publication	Available from—
Appendix B	"List of Personal Hearing Protectors and Attenuation Data," HEW Pub. No. 76-120, 1975. NTIS-PB267461.	National Technical Information Service, Port Royal Road, Springfield, VA 22161.
Appendix D	"Specification for Sound Level Meters," S1.4-1971 (R1976).	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
§ 1910.95(k)(2), appendix E	"Specifications for Audiometers," S3.6-1969.	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
Appendix D	"Specification for Octave, Half-Octave and Third-Octave Band Filter Sets," S1.11-1971 (R1976).	Back Numbers Department, Dept. STD, American Institute of Physics, 333 E. 45th St., New York, NY 10017; American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

The referenced publications (or a microfiche of the publications) are available for review at many universities and public libraries throughout the country. These publications may also be examined at the OSHA Technical Data Center, Room N2439, United States Department of Labor, 200 Constitution Avenue, NW., Washington, D.C. 20210, (202) 523-9700 or at any OSHA Regional Office (see telephone directories under United States Government—Labor Department).

Appendix I: Definitions

These definitions apply to the following terms as used in paragraphs (c) through (n) of 29 CFR 1910.95.

Action level—An 8-hour time-weighted average of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of fifty percent.

Audiogram—A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

Audiologist—A professional, specializing in the study and rehabilitation of hearing, who is certified by the American Speech-Language-Hearing Association or licensed by a state board of examiners.

Baseline audiogram—The audiogram against which future audiograms are compared.

Criterion sound level—A sound level of 90 decibels.

Decibel (dB)—Unit of measurement of sound level.

Hertz (Hz)—Unit of measurement of frequency, numerically equal to cycles per second.

Medical pathology—A disorder or disease. For purposes of this regulation, a condition or disease affecting the ear, which should be treated by a physician specialist.

Noise dose—The ratio, expressed as a percentage, of (1) the time integral, over a stated time or event, of the 0.6 power of the measured SLOW exponential time-averaged, squared A-weighted sound pressure and (2) the product of the criterion duration (8 hours) and the 0.6 power of the squared sound pressure corresponding to the criterion sound level (90 dB).

Noise dosimeter—An instrument that integrates a function of sound pressure over a period of time in such a manner that it directly indicates a noise dose.

Otolaryngologist—A physician specializing in diagnosis and treatment of disorders of the ear, nose and throat.

Representative exposure—Measurements of an employee's noise dose or 8-hour time-weighted average sound level that the employers deem to be representative of the exposures of other employees in the workplace.

Sound level—Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of 20 micropascals. Unit: decibels (dB). For use with this regulation, SLOW time response, in accordance with ANSI S1.4-1971 (R1976), is required.

Sound level meter—An instrument for the measurement of sound level.

Time-weighted average sound level—That sound level, which if constant over an 8-hour exposure, would result in the same noise dose as is measured.