U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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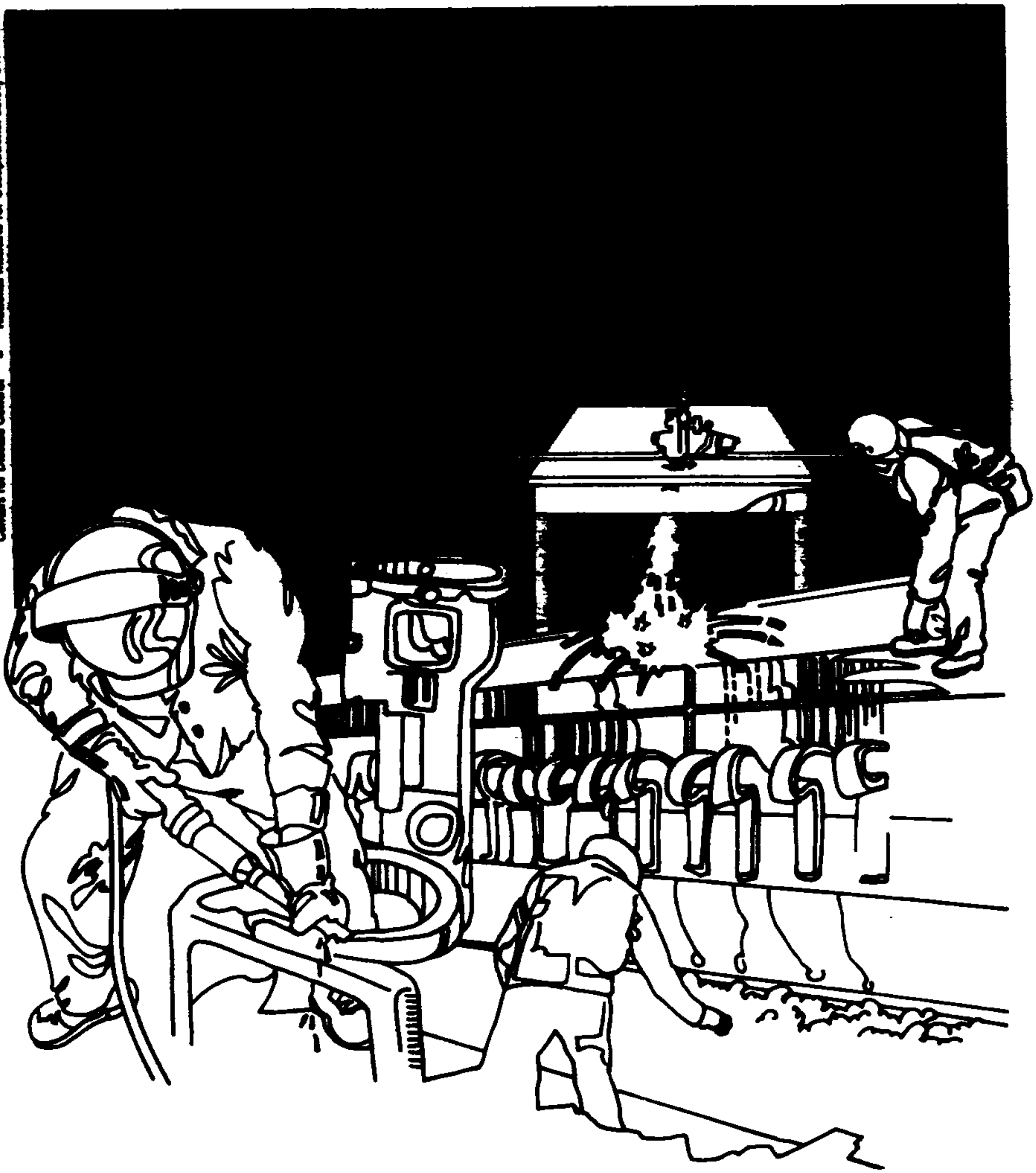

Health Hazard Evaluation Report

MHETA 86-191-1836
WEST VIRGINIA
DEPARTMENT OF HIGHWAYS
CHARLESTON, WV

PREFACE

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

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

MHETA 86-191-1836
FEBRUARY, 1987
WEST VIRGINIA
DEPARTMENT OF HIGHWAYS
CHARLESTON, WV

NIOSH INVESTIGATOR
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I. Summary

On March 18-20, 1986 a NIOSH investigator conducted a Health Hazard Evaluation at the West Virginia Department of Highways (WV-DOH) Sign Shop in Charleston, West Virginia (MHETA 86-191). This evaluation was done in response to a 2/10/86 technical assistance request from the WV-DOH. Potential health hazards cited in this request included solvent exposures from the silkscreening process and noise exposures from the sign fabrication process.

Personal and area organic vapor samples were collected from the silkscreening operation using activated charcoal media and portable sampling pumps. The samples were analyzed by gas chromatography (GC) in conjunction with mass spectrometry (MS) according to NIOSH analytical methods. Dibutyl phthalate samples were also collected from the silkscreening area using cellulose ester filter media and portable sampling pumps. These samples were analyzed by GC.

Personal noise exposure measurements were taken using a noise dosimeter. Noise measurements were also taken using a portable sound level meter with an octave band analyzer.

Organic vapor samples and dibutyl phthalate samples from the silkscreening operation were well below the existing standards/exposure recommendations of the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH),and NIOSH. However, some aspects of silkscreening shop operation were suboptimal from an occupational health standpoint; these aspects could possibly act in combination with increased work volume or variable ink/solvent use to cause potential health/discomfort problems at certain times.

Personal, time-weighted average noise exposures from the sign fabrication shop did not exceed allowable exposure levels as averaged over the entire workshift; however, some workers received brief exposures to hazardous sound levels above the maximum allowable limit (115 dBA) according to the OSHA PEL and ACGIH/NIOSH recommendations. These overexposures resulted from operation of the metal saw.

On the basis of the data obtained during this evaluation, NIOSH investigators concluded that some workers receive hazardous noise exposures in the sign fabrication shop. Exposures to substances used in the silkscreening shop did not exceed current standards/exposure guidelines; however, certain aspects of the silkscreening process were suboptimal and may pose the potential for exposure problems under varying work conditions. Recommendations for prevention of these problems are presented in section 8 of this report.

Keywords SIC 2751, 3499 Silkscreening, Organic Solvents, Inks, Noise, Sign Fabrication

II. Introduction

On February 10, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the West Virginia Department of Highways (WV-DOH) to investigate potential occupational health hazards in their sign shop at Charleston, WV (MHETA 86-191). The potential hazards cited in the request included ink/solvent exposures from the silkscreening operation and noise exposures in the sign fabrication shop. On March 18-20, 1986, a NIOSH investigator conducted an environmental evaluation at the WV-DOH to evaluate the health concerns cited in the request. On August 8, 1986, NIOSH investigators received the laboratory results from the samples taken during the survey and on August 29, 1986 the WV-DOH (Mr. Warren Kelly) was contacted by phone and notified of the preliminary results from this evaluation.

III. Background

The WV-DOH Sign Shop makes essentially all the road/traffic signs for state roads and highways in West Virginia. This shop includes both a silkscreening process and a sign fabrication process.

In the fabrication shop, aluminum/metal sign materials are processed and assembled. The six/seven workers from this area operate a variety of fabrication equipment including metal saws, punch machines, shearing machines, drills, bolting equipment, riveting equipment, a roller applicator machine, and a vacuum applicator machine. One gasoline and one electric fork lift are used to transport materials. The sign fabrication equipment in use on any particular day is variable and depends on the orders being processed. (See figure 1 for layout).

The silkscreening operation is in an enclosed area at one end of the sign shop; this area includes a film room, a silkscreening room, and a screen wash room (figure 1). Approximately one to two workers operate the silkscreening operation depending on the work load. The silkscreens are prepared from photo-sensitive dibutyl phthalate emulsion. In the film room, patterned areas of the emulsion-coated screens are exposed to ultraviolet light with the vacuum applicator machine; this fixes the light-exposed emulsion areas to the screen. The unexposed emulsion areas are washed off with water spray and serve as ink-permeable screen surfaces to form the positive sign images. Two screen printers (one large and small) are used to print the signs in the silkscreening room. The inks/cleaning solvents for this printing process are stored in large, wood cabinets and are poured/mixed on an open work bench in the screening room. After printing, the signs are placed in large, open drying racks in the silkscreening room. There is a ventilated drying oven in this room; however, it is not normally used unless there is a rush on the order for the signs. The hardened emulsion materials are removed from the silkscreens with solvents in the screen wash room.

IV. Methods

An industrial hygiene evaluation was done at the WV-DOH Sign Shop to investigate organic vapor exposures from the silkscreening process and noise exposure from the sign fabrication process. This evaluation included organic gas/vapor sampling in the silkscreening/screen washing areas, dibutyl phthalate sampling in the film room, and noise monitoring in the sign fabrication shop. This sampling was done over a two day period, March 19-20, 1986.

The organic gas and vapor samples were collected on a solid charcoal media in a sorbent tube.[1] These samples were collected using portable sampling pumps calibrated at two different flow rates: 20 cubic centimeters per minute (cc/min.) and 100 cc/min. Personal and area samples were taken; this included both partial shift (1-4 hour) and full shift samples (7 hours or longer). Bulk airborne gas/vapor samples were also collected using similar charcoal tubes at a sampling rate of approximately 200 cc/min. Bulk (liquid) samples of the inks/solvents were also obtained. These bulk samples (airborne gas/vapor and liquid) were analyzed qualitatively for hydrocarbon compounds by gas chromatographpy (GC).[1] Charcoal tube samples were analyzed quantitatively for those organic gases and vapors detected in the bulk samples using GC in conjunction with mass spectrometry (MS).[1] The charcoal tube samples were analyzed quantitatively for xylenes, toluene, T900 ink solvent, and T910 ink solvent. The analytical detection limit for these analytes in milligrams per sample (mg/s) includes: xylenes and toluene (0.01 mg/s); T900 solvent (0.1 mg/s); and T910 solvent (2.0 mg/s). (NOTE: Airborne detection concentrations are variable as based on the different sample volumes collected; they can be calculated from Tables 1 and 2 by dividing the analytical detection limit by the individual sampling volume in cubic meters (m^3). One m^3 equals 1000 liters.) Airborne concentrations of the analytes are reported in milligrams per cubic meter of air mg/m^3.

The dibutyl phthalate samples were collected on cellulose ester filter media in a two piece cassette using portable sampling pumps calibrated to 2.0 lpm. Full shift samples were taken. The media was desorbed in carbon disulfide and analyzed by GC according to NIOSH Analytical Method 5020.[1] This analytical method has a detection limit of about 0.01 mg/s; this corresponds to an airborne detection concentration of about 0.01 mg/m^3 for an 8 hour sample.

Noise measurements were taken using a sound-level meter with an octave band analyzer. The sound level meter was used to obtain a direct measure of both continuous and impulse noise levels for the sign fabrication equipment operated during our evaluation. (Impulse [impact] noises are singular noise pulses of approximately one second or less in duration or repetitive noise pulses occurring at intervals of one second or greater.) An A-weighted sound scale was used to assess broadband noise exposure in a manner similar to its injurious effects on the human ear.[2] (Broadband noise refers to sound energy comprised of many different frequencies.) The A-weighted sound level is obtained by electronically filtering or weighting broadband noise to give greater emphasis (weighting) to the sound energy in the frequencies normally used for speech/communications (500-2000 HZ) and lesser emphasis to sound energy in the lower frequencies. The octave band analyzer was used to measure noise energy in the different frequency ranges (octave bands) from the operation of shop equipment (the metal saw). Octave-band filters in the frequency ranges from 31.5 hertz (HZ) to 16,000 HZ are used in this meter to selectively measure the sound energy in the different frequency bands. This instrument was field calibrated each day prior to any survey measurements.

Personal, time-weighted noise exposure measurements were taken from workers in the shop using a noise dosimeter. This noise dosimeter was attached to the worker and operated throughout the shift to take a full shift noise exposure measurement. An A-weighted sound scale was also used with this sampling instrument.

The decibel (dB) scale is used to report the sound levels measured during this evaluation; this is a logarithmic scale. The dB is a dimensionless unit used to express the logarithm of the ratio of the measured sound energy (P_1) to a reference sound energy (P_0=0.00002 newtons per square meter):[2]

$$dB = 10 \, Log_{10} \, {}^{P_1}/_{P_0}$$

V. Evaluation Criteria

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria consist of exposure levels for substances and conditions to which most workers can be exposed day after day for a working lifetime without adverse health effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure.

Several sources of evaluation criteria exist and are commonly used by NIOSH investigators to assess occupational exposures. These include:

1. The U.S.Department of Labor (OSHA) permissible exposure limits (PEL's);[3]

2. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit (Exposure) Values (TLV's);[4]

3. NIOSH recommended exposure limits.

These criteria have been derived from industrial experience, from human and animal studies, and, when possible, from a combination of the three. Consequently, due to differences in scientific interpretation of these data, there is some variability in exposure recommendations for certain substances. Additionally, OSHA considers economic feasibility in establishing occupational exposure standards; NIOSH and ACGIH place less emphasis on economic feasibility in development of their criteria.

The exposure criteria described below are reported as: time-weighted average (TWA) exposure recommendations averaged over the full work shift; short term exposure limit (STEL) recommendations for a 10-15 minute exposure period; and ceiling levels (C) not to be exceeded for any amount of time. These exposure criteria and standards are commonly reported as parts contaminant per million parts air (ppm), or milligrams of contaminant per cubic meter of air (mg/m^3). Occupational criteria for the air contaminants measured during this study are as follows:(3,4,5,6)

SUBSTANCES	NIOSH (REC)	ACGIH (TLV)	OSHA (PEL)
Dibutyl phthalate	No REC.	5 mg/m^3 - TWA	5 mg/m^3 - TWA
Xylenes	435 mg/m^3-10 hr. TWA 870 mg/m^3-10 min. C	435 mg/m^3 - TWA 655 mg/m^3 - STEL	435 mg/m^3 - TWA
Toluene	375 mg/m^3-10 hr. TWA 750 mg/m^3-10 min. C	375 mg/m^3 - TWA 560 mg/m^3 - STEL	750 mg/m^3 - TWA 1125 mg/m^3 C
T900 Solvent	No standard for the solvent but there are standards/health guidelines for some of the chemical components in the solvent mixture.		
Components:			
xylenes (see above)			
High boiling aromatic napthas	No REC.	No TLV	400 mg/m^3 - TWA
T910 Solvent	No standard for the solvent but there are standards/health guidelines for some of the chemical components in the solvent mixture.		
Components:			
cyclohexanone	100mg/m^3 10 hr. TWA	100 mg/m^3 - TWA	200 mg/m^3 - TWA
high boiling aromatic napthas 400 mg/m^3 - TWA	No REC		No TLV
napthalene	No REC.	50 mg/m^3 - TWA 75 mg/m^3 - STEL	50 mg/m^3 - TWA

The occupational health criteria/standards for continuous or intermittent noise exposure, based on an A-scale weighting, are as follows:(3,4,7)

Exposure Levels (dBA[1])

Hours of Exposure	ACGIH TLV	NIOSH REC.	OSHA PEL
16	80	80	85
8	85	85	90
4	90	90	95
2	95	95	100
1	100	100	105
1/2	105	105	110
1/4	110	110	115
1/8	115	115	-

[1]dBA - Decibel Level, A-scale Weighted.

As indicated above, continuous noise exposures should not exceed 115 dBA for any amount of time according to the OSHA PEL, ACGIH TLV, or NIOSH recommended standard.(3,4,7)

ACGIH provides the following TLV exposure guidelines for impulse noise:(4)

Sound Level (dB)[1]	Permitted Number of Impulses or Impacts Per Day
140	100
130	1000
120	10,000

[1]Decibels peak sound pressure level, no frequency weighting scheme.

For impulse noise, the OSHA PEL requires that impulse sound levels from 80-130 Decibels be integrated into the total noise measurement and regulated according to the OSHA PEL for continuous noise.(3)

VI. Results/Discussion

A. Silkscreening Operation

Material Safety Data Sheets (MSDS) were obtained initially for the different inks and solvents used in the silkscreening area. These MSDS's indicated that there was potential exposure to several different chemical compounds. Some of these included aromatic napthas, mineral spirits, toluene, acetone, cyclohexanone, petroleum distillates, pine oil, xylene, stoddard solvent, and dibutyl phthalate. Bulk air samples taken from the silkscreening area indicated the presence of toluene, xylenes, and a variety of aromatic naptha compounds (largely (C_9H_{12} alkylbenzenes and $C_{10}H_{14}$ alkylbenzenes).

These alkylbenzene compounds included: (C_9H_{12}) - propyl benzenes, trimethylbenzenes, and methylethylbenzenes; ($C_{10}H_{14}$) - tetramethylbenzenes, butylbenzenes, dimethylethylbenzenes, and diethylbenzenes.

These aromatic naptha patterns from the airborne samples matched those from the bulk liquid samples of T900 solvent and T910 solvent; consequently, the airborne charcoal tube samples were quantified for xylene, toluene, T900 solvent and T910 solvent. These airborne gas/vapor concentrations are reported in Tables 1 and 2.

Toluene concentrations were all below detectable levels in both personal and area charcoal tube samples as indicated on Tables 1 and 2. (Note: the bulk charcoal tubes taken for qualitative analysis had a much larger sample volume than the charcoal tube samples taken for quantitative analysis and thereby only the bulk samples contained detectable concentrations of toluene). Toluene is a solvent for many inks, paints, and coatings. Toluene's toxic effects can be confounded by the presence of small quantities of benzene; however, benzene was not detected in our samples. Exposure to toluene can be irritating to the eyes, respiratory tract, and skin. Prolonged or repeated skin contact with toluene can cause a dry, fissured dermatitis. Toluene is also a central nervous system (CNS) depressant producing symptoms of exhilaration, verbosity, inebriation, headache, and (in high concentrations around 7500 mg/m^3), collapse, coma, and death.[5,8] However, toluene concentrations in the silkscreening areas were below the detection limit and posed no substantial health risk.

Xylene was detected in only one of fourteen area samples at a concentration of 0.6 mg/m^3 (Table 1). Xylene was detected in two of the four personal samples taken from workers in the screening area (Table 2). One exposure measurement had a xylene concentration of 1.1 mg/m^3 while the second exposure measurement (about 0.7 mg/m^3) was between the detection limit and the quantification limit for this analytical method. Xylene is also a common solvent for many paints, inks, lacquers, and varnishes. The toxic effects of xylene can include irritation of the eyes, nose, and throat. Xylene exposure, like toluene, causes CNS depression; symptoms can include headache, feeling of inebriation, dizziness, gastric discomfort, and dryness of the throat. Repeated or prolonged exposure to xylene (above existing health standards) can cause a skin rash. Exposure to high concentrations of xylene (above existing health standards) can also cause damage to the kidneys and liver.[5,8] The OSHA PEL for xylene is 435 mg/m^3 as a TWA; NIOSH and ACGIH also have an exposure recommendation of 435 mg/m^3 for xylene.[3,4,5] The xylene exposures/area concentrations measured during this evaluation were below existing health standards and posed no substantial health hazard for the workers.[5,8]

Bulk airborne samples also indicated the presence of two of the solvents used in the screening area: T900 and T910; however, only solvent T900 was detected in those samples submitted for quantification. (As discussed earlier, the bulk samples had larger sample volumes and increased potential to detect low level air contaminants.) The T900 solvent compounds were detected in four of the fourteen area samples but concentrations were below quantifiable levels (Table 1). The T900 solvent compounds were detected in one of the four personal exposure measurements at a concentration of 10.6 mg/m^3 (Table 2). Bulk liquid samples of the T900 solvent indicated predominately xylene and the aromatic naptha compounds (alkylbenzenes) discussed earlier. The acute toxicity of the alkylbenzenes is CNS depression. Exposure to these alkylbenzene compounds can also be irritating to the eyes, skin, and respiratory tract. No serious residual health effects of alkylbenzenes are known with long term exposures at low to moderate airborne concentrations.(9) The exposure levels measured during our evaluation were below the existing OSHA PEL (400 mg/m^3) and posed no substantial health hazard for the workers.(3,9)

The two dibutyl phthalate samples taken from the film room were below the lower analytical detection limit (LOD) of 0.01 milligrams per sample. Consequently, dibutyl phthalate concentrations in air were less than 0.02 mg/m^3 -- below existing health standards/exposure criteria.(3,4,5)

The occupational solvent exposures measured during our evaluation were below the existing health standards and exposure criteria. However, these solvent exposure levels could be quite variable as influenced by several factors including: the volume of work; the different inks/solvents used; and work/ventilation practices. During our evaluation, the work volume was moderate and the REX series inks were used. Personal protective goggles and gloves were not used consistently when handling inks/solvents. The ventilation practices and equipment used during our evaluation were suboptimal. The silkscreening area has two axial fans that exhausted air from this process; one fan is located in the screening room and the second is located in the screen wash room (see figure 1). The fan in the screen wash room was run continuously during our evaluation, but the larger fan in the silkscreening room was run less frequently. The larger (silkscreening room) fan had a design volumetric flow rate of 12,650 cubic feet per minute, while there was no design data available for the fan in the screen wash room. The only supply air source for these two fans was the doorway between the fabrication shop and the screening area (see figure 1). Often, the door was kept closed during screening operations (to prevent dust contamination of the wet signs); this reduced air flow through the silkscreening areas as well as the exhaust/dilution of vapors from the screening operation. Additionally, the racks for drying the silkscreened signs were located across the room from both the workers and the fan. Consequently, solvent vapors would normally be drawn through the workers breathing zone prior to the dilution and exhaust of these vapors. This would increase worker exposure.

B. Sign Fabrication Operation

Workers in the sign fabrication shop are exposed to noise through the operation of a variety of different equipment/machines. The machines/equipment operated on any day can be variable (both in terms of equipment use and the duration of use) and is dependent on the nature of the orders being processed. Personal, time-weighted average (TWA) noise exposure measurements taken over a two day period in the sign shop ranged from below 70 dBA to a high of 85 dBA (Table 3).

Exposure to high noise levels can cause permanent damage to hearing ability. When an individual is first exposed to hazardous noise levels, the initial change usually observed is a temporary loss of hearing ability (threshold shift) in the higher sound frequency ranges. After a rest period away from the noise, hearing ability usually returns to its former level. The long-term (cumulative) effects of repeated, prolonged exposure to high noise levels can result in permanent pathologic changes in the inner ear (the cochlea) and irreversible (permanent) threshold shifts in hearing ability. This hearing damage is generally classified as noise induced hearing loss. Exposure to a very brief but very loud noise can also cause a form of permanent (noise induced) hearing loss called acoustic trauma. When any hearing loss involves the sound frequency ranges commonly used for speech (500-2000 Hz), considerable difficulty in communication (hearing conversational speech) develops.

It is currently believed that noise exposure in excess of 115 dBA is hazardous and should be avoided. Exposure to sound levels below 70 dBA are regarded as safe and will not cause any permanent hearing loss.(2) The hazard of A-weighted noise levels between 70-115 dBA is a function of the duration of exposure. The OSHA PEL for eight hours of noise exposure is 90 dBA as a TWA.(3) Both NIOSH and ACGIH recommend an eight hour TWA noise exposure level of 85 dBA to prevent noise induced hearing loss.(4,7) The OSHA PEL and NIOSH/ACGIH recommendation for the maximum allowable noise exposure limit is 115 dBA.(3,4,7) Workers should not be exposed to sound levels above 115 dBA for any amount of time. None of the sign fabrication shop workers received a full shift, TWA noise exposure in excess of the OSHA PEL or the NIOSH/ACGIH recommendations; however, one worker had a TWA noise exposure at the NIOSH/ACGIH recommended exposure limit of 85 dBA. Eight of the ten personal samples exceeded the maximum allowable noise exposure limit (115 dBA) for a brief period of time at some point during the work shift. These noise exposures in excess of 115 dBA were of a short duration and did not result in full shift, TWA overexposures by OSHA standards or NIOSH/ACGIH criteria. But, noise exposure in excess of 115 dBA is hazardous and can result in permanent hearing loss.

Two of the workers wore enclosure-type hearing protection devices (earmuffs) part of the workday while operating certain equipment (the metal saw); however, hearing protection devices were not observed on most of the workers, even though they may have been in the general area of the metal saw when it was operating.

Table 4 lists the A-weighted sound level measurements from the equipment operated during our evaluation. These are short term sound level measurements taken over a 1-5 minute sampling period. Several of the sign shop equipment/operations produced high sound levels (impulse or continuous) that could cause exposures in excess of the OSHA PEL if operated for a full (8 hour) shift. These included: the punch machine (108 dBA-impulse); the shearing machine (94 dBA); the metal saw (110-117 dBA); the bolting operation (94 dBA); the hammering operation (100 dBA); the drilling operation (95 dBA); and the huck fastening (riveting) operation (100-102 dBA). During our evaluation, most of the equipment in the sign shop was used intermittently for only part of the work shift; consequently, the TWA noise exposures averaged over the entire work shift were within acceptable levels even though the workers operated some machines that produced high sound levels.

The metal saw was the only piece of shop equipment that produced sound levels in excess of the 115 dBA OSHA, NIOSH, and ACGIH standard/exposure criteria. The saw has a radial-arm design and is used to cut aluminum for sign materials. The saw blade is comprised of 90 tungsten-carbide teeth with five side cuts to allow the blade to flex when cutting metal materials.

As discussed earlier, this saw had an A-weighted sound level of 110-117 dBA at a distance of three feet (Table 4). Most of the sound energy from operation of this saw was in the higher frequency ranges above 500 Hz (Table 5). A large portion of the sound energy was in the frequency ranges used for normal speech/communications (e.g. 500-2000 Hz). Consequently, noise exposures from this saw would be particularly dangerous to workers without hearing protection.

During the evaluation, this saw was used for only about five minutes or less each day. Two workers operated the saw. Both of these workers used the enclosure type hearing protectors while operating the saw; however, other workers in the area of the saw wore no hearing protection. Properly worn enclosure-type hearing protection devices can reduce noise exposures by about 35 dB at frequencies of about 250 Hz, and up to about 50 dBA at higher frequencies. Consequently, the workers operating the metal saw were protected from excessive noise exposures by the hearing protection devices; however, other workers in the areas around the saw were not.

VII. Conclusion

1. The organic vapor exposures measured during the silkscreening operations were below the existing health standards/exposure guidelines of OSHA, ACGIH, and NIOSH.[3,4,5,6] However, some aspects of the silkscreening shop operation were suboptimal from an occupational health perspective:

- The general exhaust fan in the main screening room was not run continuously during silkscreening operations.

- There was no mechanical supply air source for the general exhaust fans in the silkscreening areas. The door to this area was generally closed when the exhaust fans were operated.

-After screening, the wet signs were placed on drying racks across the room from the exhaust fans and the workers. Accordingly, vapors from the drying signs would be drawn through the workers breathing zone increasing their potential for exposure.

-Personal protective goggles and gloves were used infrequently when handling the solvents/inks.

These suboptimal aspects of the screening operation, in combination with increased work loads and variable ink/solvent use, could result in the buildup of ink/solvent vapors and the related health/comfort complaints reported by workers in this shop area.

2. All personal, time-weighted average (TWA) noise exposures were below the existing standards/health guidelines of OSHA, ACGIH, and NIOSH. However, some workers received brief exposures to hazardous noise levels above the maximum allowable limit (115 dBA) of existing standards/health guidelines.[2,4] These overexposures are a result of brief operation of a metal saw (about five minutes). Increased use of this saw for periods of about ten minutes or longer would likely result in TWA exposures in excess of the OSHA PEL and the ACGIH/NIOSH recommendations.[2,3,4,7]

3. The operation of sign fabrication shop equipment is variable depending on the number/nature of the sign orders. Consequently, there is potential for noise overexposures on any day depending on the shop equipment used and the duration of equipment use, and corresponding exposure to the noise levels generated by this equipment.

4. Enclosure type hearing protectors were available for the workers but their use was infrequent; the workers operating the metal saw were observed using hearing protection only during saw operation.

VIII. Recommendations

1. The general room exhaust fans in the silkscreening shop should be operated continuously during all screening operations (including any drying of the signs in the screening area).

2. A mechanical source of supply air should be provided for the general room exhaust fans in the silkscreening area. This supply air source should be located across the room from the exhaust fans to insure adequate mixing/dilution of the shop generated vapors and to prevent any short circuit of the fresh supply air. (Appendix A provides a description of proper location of supply and exhaust air inlet locations for proper dilution/exhaust of vapors).[10]

3. The drying racks with wet signs should be dried in the oven (with or without heat) with the oven exhaust fans operating and the oven door

closed. If the volume of signs exceeds the holding capacity of the oven, the additional drying racks should be positioned "down wind" from the workers as close to one of the general room exhaust fans as possible.

4. Personal protective goggles and gloves should be used at all times when handling all inks/solvents in the shop.

5. Workers in the sign fabrication shop should wear hearing protection devices when operating the shop equipment or when working in an area where shop equipment is being operated.

6. As discussed with officials at the sign shop, it would be ideal to enclose the metal saw in a sound room to reduce noise levels in the shop; however, this would not be a feasible alternative due to the size and bulk of some sign materials cut with this saw. As an alternative, administrative control measures scheduling major use of the metal saw after work hours would reduce shop noise levels and exposures (NOTE: shop officials report that this action was taken following the NIOSH survey.) All workers in the shop should be required to wear hearing protection when the metal saw is operated; a warning signal should be used to alert nearby workers prior to operation of the saw. Additionally, plugging the side-cut in the saw with a durable, flexible material (that would still allow the saw blade to flex) should reduce the noise levels of the saw.

7. Establish a hearing conservation program for workers in the sign fabrication shop to prevent permanent, noise induced hearing loss. This program should be structured according to the OSHA final rule on hearing conservation as detailed in the Federal Register, Vol. 48, No. 46, Tuesday, March 8, 1983. All sign fabrication shop workers should receive periodic audiometric testing and counseling. New workers should be given a base-line audiometric test prior to work in the shop.

IX. References

1. National Institute for Occupational Safety and Health (NIOSH). NIOSH Manual of Analytical Methods, 3rd Ed. , NIOSH Pub. No. 84-1000, 1986.

2. Olishifski PE and ER Harford. Industrial Noise and Hearing Conservation, National Safety Council: Chicago, 1985.

3. Code of Federal Regulations. Occupational Safety and Health Administration Standards, 29CFR,1910, 1986.

4. American Conference of Governmental Industrial Hygienists (ACGIH). Threshold limit values for chemical substances and physical agents in the work environment with intended changes for 1986-1987. (ACGIH), Cincinnati, OH, 1986.

5. National Institute for Occupational Safety and Health. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Pub. No. 81-123, 1981.

6. National Institute for Occupational Safety and Health. Pocket Guide to Chemical Hazards. DHHS(NIOSH) Pub.No. 78-210, September 1985.

7. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard - Occupational Exposure to Noise, DHEW(NIOSH) Pub.HSM 73-11001, 1972.

8. Rom WN. Environmental and Occupational Medicine, Little Brown and Company: Boston, 1983, (511-533).

9. Klassen CD, MO Amdor, and J Doull. Casarett and Doull's Toxicology - The Basic Science of Poisons, 3rd Ed., Macmillan Publishing Cc.: New York, 1986, (636-668).

10. American Conference of Governmental Industrial Hygienists (ACGIH). Industrial Ventilation: A Manual of Recommended Practice. (ACGIH) 15th Ed., Cincinnati, OH, 1978.

FIGURE 1
SHOP LAYOUT
WEST VIRGINIA DEPARTMENT OF HIGHWAYS
MHETA 86-191

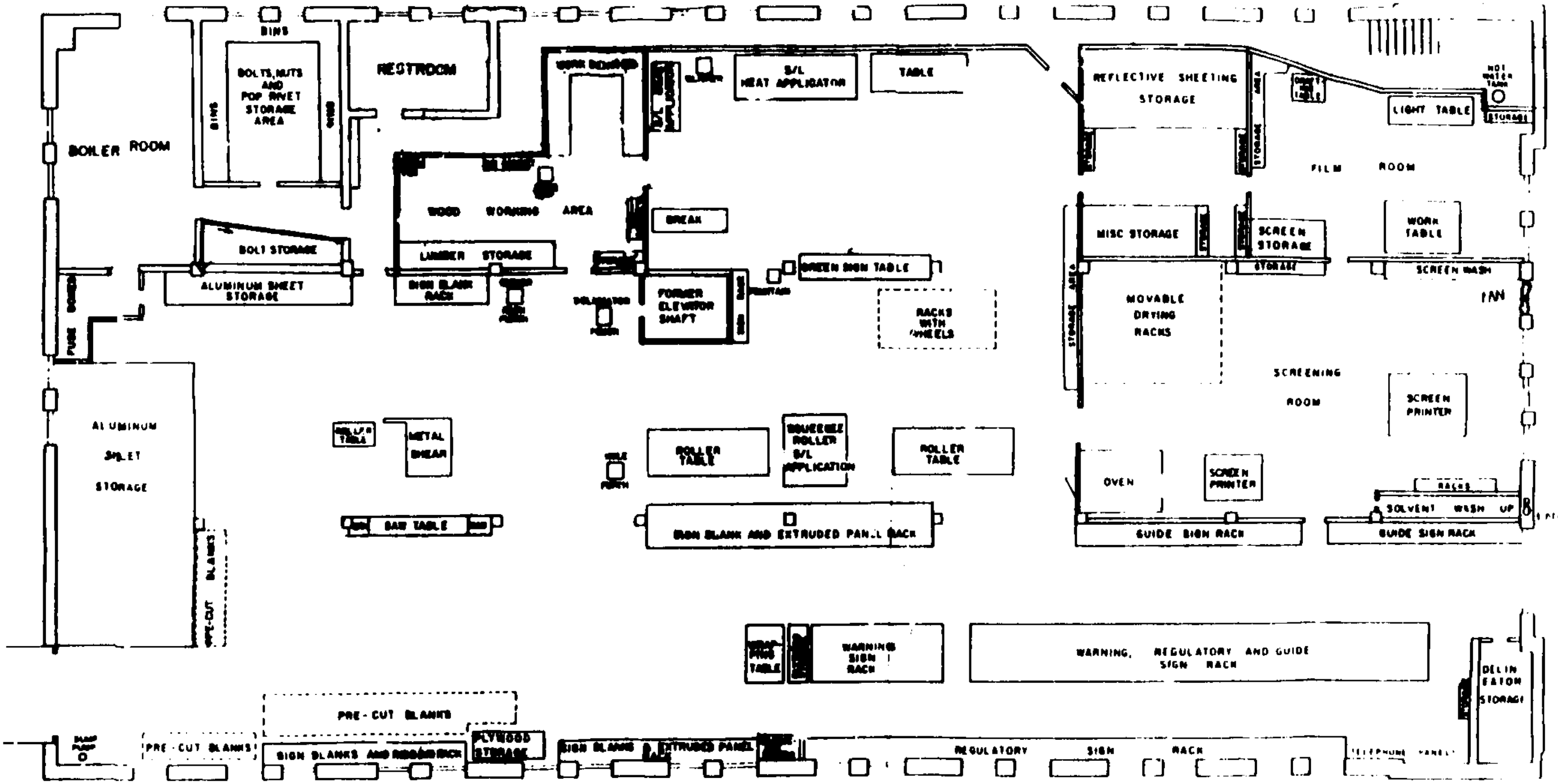


Table 1

Organic Gas and Vapor Concentrations[1] From Area Samples
West Virginia Department of Highways
MHETA 86-191
Concentrations in mg/m^3

Sample	Date	Location	Sampling Vol(1)	Xylenes	Toluene	T900	T910
A-1	3/19/86	Screen Wash Rm	16.5	ND	ND	(6.1)	ND
A-11	3/19/86	Screen Wash Rm	20.3	ND	ND	ND	ND
B-1	3/19/86	Screening Area	17.6	0.6	ND	(5.7)	ND
B-11	3/19/86	Screening Area	19.6	ND	ND	ND	ND
B-12	3/19/86	Screening Area	6.3	ND	ND	ND	ND
B-21	3/19/86	Screening Area	7.0	ND	ND	ND	ND
B-4	3/19/86	Screening Area	8.0	ND	ND	ND	ND
A-13	3/20/86	Screen Wash Rm	17.9	ND	ND	(11.2)	ND
A-14	3/20/86	Screen Wash Rm	18.9	ND	ND	ND	ND
B-13	3/20/86	Screening Area	18.4	ND	ND	(10.6)	ND
B-14	3/20/86	Screening Area	17.2	ND	ND	ND	ND
B-22	3/20/86	Screening Area	8.5	ND	ND	ND	ND
C-25	3/20/86	Film Room	6.8	ND	ND	ND	ND
C-45	3/20/86	Film Room	10.6	ND	ND	ND	ND

Includes both full and partial period area samples; concentrations reported as - milligrams of substance per cubic meter of air (mg/m^3).

ID - Concentrations below the analytical detection limit: 0.01 mg/sample for Toluene and xylene 0.1 mg/sample for T900; and 0.5 mg/sample for T910.

) - Indicates estimated concentrations above the detection limit but below the limit of quantification.

1) - Sampling Volume reported in liters.

Table 2

Personal Organic Vapor Exposures[1]
West Virginia Department of Highways
MHETA 86-191
Concentrations[2] in mg/m^3

Sample	Date	Job	Sampling Vol(1)	Xylenes	Toluene	T900	T910
1	3/19/86	Silkscreener	37.7	1.1	ND	10.6	ND
2	3/19/86	Silkscreener Assistant	6.06	ND	ND	ND	ND
3	3/20/86	Silkscreener	6.78	ND	ND	ND	ND
4	3/20/86	Silkscreener Assistant	14.9	(0.7)	ND	ND	ND

[1]Personal breathing zone exposure measurements time weighted over the employees work shift and reported as milligrams of substance per cubic meter of air (mg/m^3).

(1) The volume of air sampled in liters.

ND - Concentrations below the analytical detection limit: .01 mg/sample for toluene and xylenes 0.1 mg/sample T900; and 0.5 mg/sample for T910.

() - Indicates estimated concentrations above the detecting limit but below the limit of quantification.

Table 3

Personal Noise Dosimeter Exposure Measurements
West Virginia Department of Highways
MHETA 86-191

Sample	Date	Job/Activity	Sound Level[1] (dBA)	Noise Levels Exceeded 115 dBA[2]	Hearing Protection Used
D-1	3/19/86	Punch Machine Metal Saw Oper.(about 5 Min.) Roller Applicator Machine	82	Yes	Yes (part time)
D-2*	3/19/86	Punch Machine Metal Saw Oper.(about 5 Min.) Roller Applicator Machine	81	Yes	Yes (part time)
D-3	3/19/86	Sign Layout Activity	<70	Yes	No
D-4	3/19/86	Loading Trucks Outside	75	Yes	No
D-5	3/19/86	Operated Fork Lift Load Trucks Outside	72	No	No
D-11	3/20/86	Bolting, Punching, Riveting, Drilling, Metal Saw Oper. (about 5 min.) Roller Applicator Machine	85	Yes	Yes (part time)
D-21	3/20/86	Bolting, Punching, Riveting, Drilling, Metal Saw Oper. (about 5 Min.) Roller Applicator Machine	83	Yes	Yes (part time)
D-31	3/20/86	Sign Layout Activity	<70	No	No
D-41	3/20/86	Punch Machine Operation Moving materials	71	Yes	No
D-51	3/20/86	Desk Work in Sign Shop (Near the Metal Saw), Moving Materials	73	Yes	No

[1]Time weighted noise exposure measurements in decibels using an A-scale weighting.
[2]Indicates those workers whose noise dosimeter readings were in excess of the OSHA ceiling limit of 115 dBA.
* This employee worked only part of the day.

Table 4

Sound Level Meter Readings
West Virginia Department of Highways
MHETA 86-191

Operation/Activity	Date	Sampling Location	Sound Level (dBA)[1]
Vacuum Applicator Machine Operation	3/19/86	6' in front of machine 5' to side of machine	75-80 70-80
Punch Machine Adj. To Vacuum Applicator	3/19/86	1' in front of machine	108 - (I)
Shearing Machine Operation	3/19/86	1' in front of machine	94
Metal Saw Operation	3/19/86	3' behind machine operator at near-by desk	110-117 111
Bolting Activity	3/20/86	2' from workers	94
Hammering Activity	3/20/86	2' from workers	100
Drilling Activity	3/20/86	By the workers	95
Huck Fastener Oper.	3/20/86	By the workers	100-102 dBA

[1] Short term (1-5 min.) sound level measurements in decibels using an A-scale weighting

I - Impulse noise = singular noise pulses of about a second or less in duration or repetitive noise pulses occurring at intervals of one second or greater.

Table 5

Octave Band Sound Analysis for the Metal Saw
West Virginia Department of Highways
MHETA 86-191

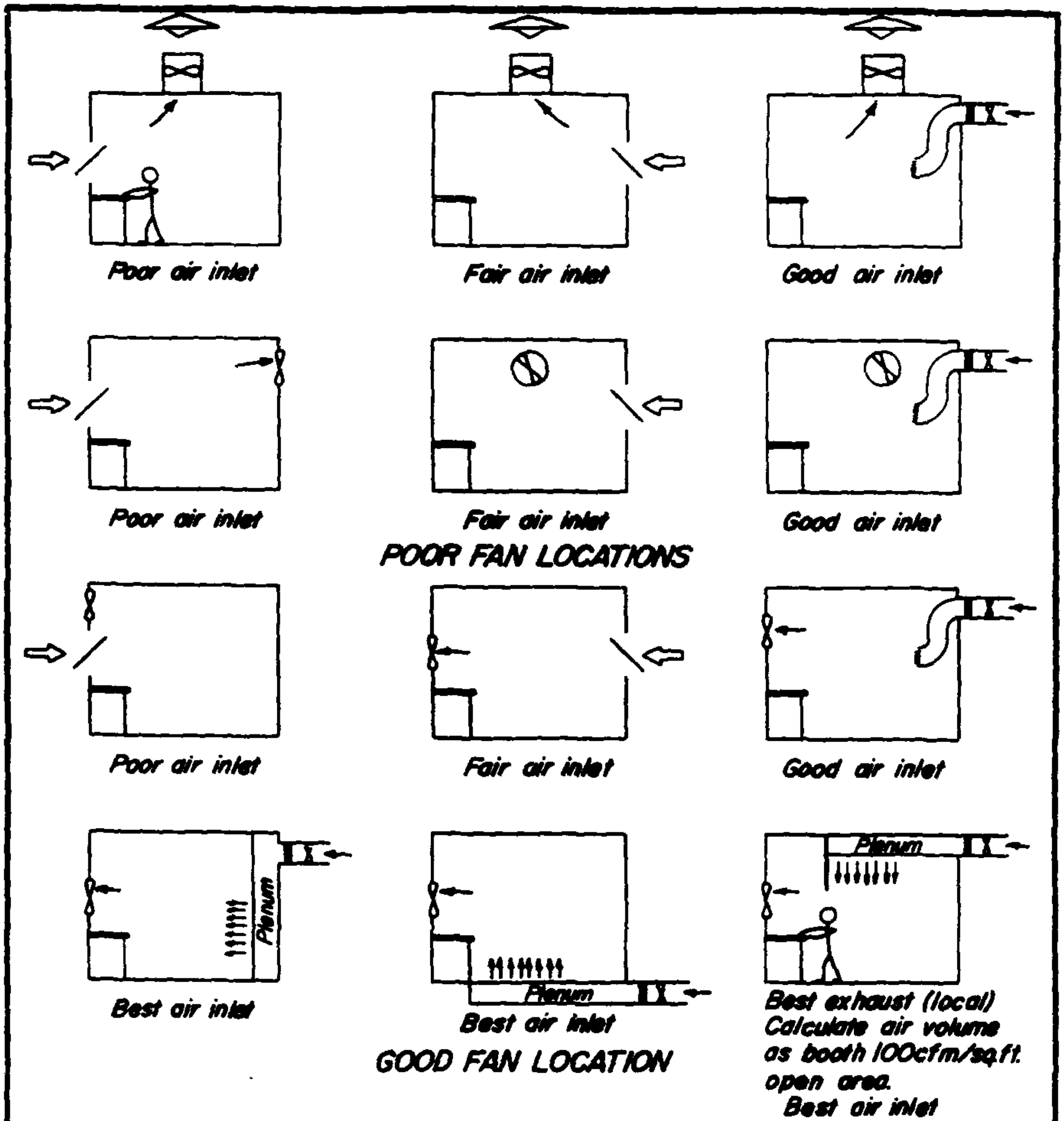
Octave Band Center Frequencies (Hz)[1]	Decibels
31.5	73
63	72
125	72
250	81
500	93
1000	94
2000	103
4000	108
8000	108
16000	103

[1]These are the center frequencies for the different octave bands as analyzed in hertz (cycles per second).
- Sound levels reported as decibels - flat response, no weighting scale.

Appendix A

Principles of Dilution Ventilation

(From ACGIH - Industrial Ventilation Manual)



Note:
Inlet air requires tempering during winter months.
See Section 7

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PRINCIPLES OF DILUTION VENTILATION

DATE 1-66	Fig. 2-1