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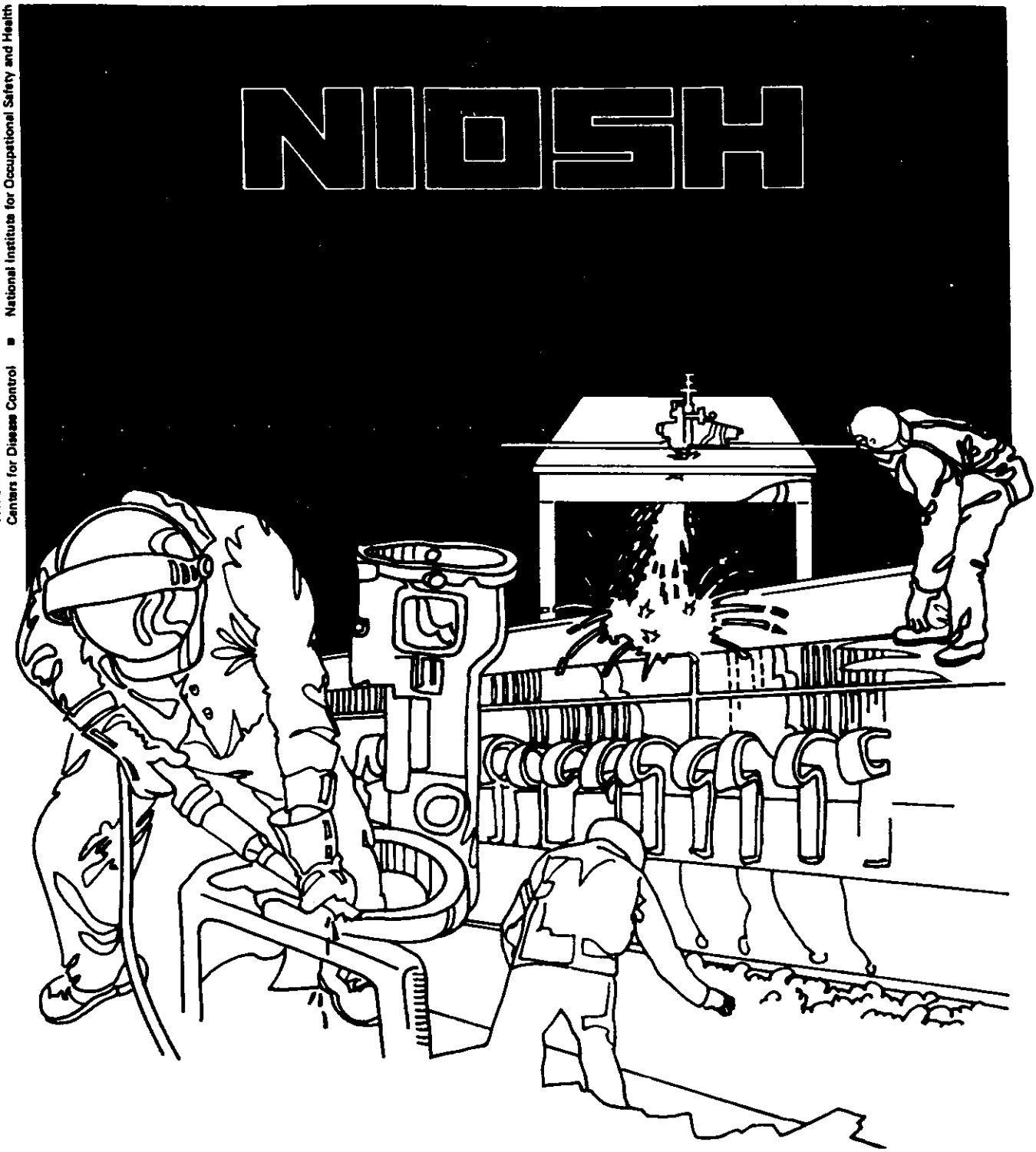

Health Hazard Evaluation Report

HETA 87-159-1962
HARLEY DAVIDSON MOTOR COMPANY
TOMOHAWK, WISCONSIN

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 87-159-1962
APRIL 1989
HARLEY DAVIDSON MOTOR COMPANY
TOMAHAWK, WISCONSIN

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I. SUMMARY

In February 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate potential employee exposures to styrene and fibrous glass and reported respiratory symptoms coincident with the manufacture of various fibrous glass and plastic accessories and equipment for motorcycles at the Harley Davidson Motor Company in Tomahawk, Wisconsin. There was a specific concern about employee exposures during sanding, grinding, polishing, and cutting of the finished fibrous glass or plastic products and during manual fibrous glass/styrene-resin lamination procedures in the side-car area.

On May 14, 1987, an initial NIOSH environmental/medical survey was conducted at the plant. During this survey, industrial hygiene and medical records were reviewed, employees were interviewed, and other pertinent information was obtained. Two sanding employees were noted to have developed respiratory distress at work that resolved when away from work and may have been work-related. This condition in one worker was characterized by rapid onset of wheezing. The second worker appeared to have had multiple episodes of bronchitis accompanied by acute abdominal pain. Agents with a potential to cause respiratory illness were present in the work area. One of the epoxy compounds used in the rough sanding area can cause respiratory irritation, and two chemical compounds known to cause respiratory sensitization were used in the area adjacent to the sanders. However, there was no obvious exposure to these compounds during this investigation.

During a NIOSH follow-up environmental survey on August 25, 1987, long and short-term personal breathing zone (PBZ) samples were collected for measurement of exposure to acetone and styrene in the side-car hand lay-up operation. Full-shift PBZ samples taken on the laminator in the side car operation and the gel coat sprayer adjacent to the hand lay-up process, measured exposures to acetone at 49.7 mg/m^3 and 172 mg/m^3, and to styrene at 12.8 mg/m^3 and 21.1 mg/m^3, respectively. A short-term PBZ sample collected during the side-car lay-up process measured exposures to acetone at 113 mg/m^3 and to styrene at 78.7 mg/m^3. All the acetone and styrene concentrations were well below the NIOSH criterions of 590 mg/m^3 and 215 mg/m^3, respectively.

On August 25, 1987, nine employees wore personal noise dosimeters to assess their noise exposures. Two-thirds of the full shift noise exposures were in excess of the NIOSH recommended exposure level (REL) for noise [85dB(A)] and the OSHA action level for implementation of a hearing conservation program [85dB(A)].

On the basis of the data obtained, we concluded that acetone or styrene overexposures were not occurring during the time of the surveys at the Harley Davidson Motorcycle Company. Personal monitoring for noise exposures indicated workers were overexposed according to the NIOSH recommended standard. Respiratory symptoms, which may have been occupational induced, were noted in two sanding employees. Measures to reduce noise exposures and improve workers safety and health are recommended in Section VIII of this report.

KEYWORKDS: SIC 3751 (Motorcycles), acetone, styrene, noise

II. INTRODUCTION

On February 20, 1987, NIOSH received a request for a health hazard evaluation (HHE) from a Regional Representative of the Allied Industrial Workers of America. The initial request was for evaluation of worker exposures to styrene and fibrous glass. However, there was a specific concern that employees engaged in grinding, sanding, polishing and cutting of the finished fibrous glass or plastic products were experiencing respiratory symptoms as a result of their occupational exposures. The requestor indicated that the Harley-Davidson Motor Company was aware of the HHE request and was joining in requesting the evaluation. An initial survey was conducted at the facility on May 14, 1987; a letter summarizing the results of this survey was distributed on June 11, 1987. A follow-up environmental evaluation was conducted on August 25-26, 1987.

III. BACKGROUND AND PROCESS DESCRIPTION

The Harley-Davidson Motor Company has been in operation in Tomahawk, Wisconsin since 1962. Various fibrous glass and plastic reinforced motorcycle components are manufactured at this facility including, but not limited to, fairings, tour packs, windshields, side cars, and saddle bags. Finished parts are shipped to the Harley Davidson assembly plant in York, Pennsylvania.

At the time of the NIOSH follow-up survey in July 1987, there were 82 production employees, 7 administrative officials, and 2 maintenance workers employed at the plant. The 82 hourly employees worked on a three-shift, five to six-day per week schedule, with 60 on the first shift, 12 on the second shift, and 10 on the third shift. Some of the job titles include routers, grinders, sanders, maskers, painters, pin stripers, assemblers, and shippers.

In early 1986 the Press Department began changing their production methods for making fibrous glass reinforced plastic products. The traditional or "old" molding process (a two person job), which was still in limited use during the NIOSH follow-up survey, was a fibrous glass chopper spray-on application for making saddle bags, fairings, and tour packs. The newer molding technique (single worker job) uses fibrous glass sheets impregnated with resin to mold motorcycle components in three hydraulic presses, none of which are equipped with local exhaust ventilation.

Sanding operations are divided into "rough sanding" and "fine sanding". The Rough Sanding Department, adjacent to the Press Department, employs six rough sanders. Five employees work in the Fine Sanding Department including two pin strippers, two maskers, and one parts sorter. All but two of the six work tables in the rough sanding area are equipped with down-draft, water-wash, local exhaust ventilation systems. The remaining two exhaust systems are down-draft

but not water filtration. The Fine Sanding Department, in contrast to the Rough Sanding Area, has no local exhaust ventilation.

The sanders use various grades of sandpaper and pneumatically powered oscillating disc sanders, drills, and some manual tools to sand and deflash (remove excess plastic or fibrous glass edges) and obtain a finished surface on the parts prior to painting. Besides the fibrous glass motorcycle parts made at Harley, the company also receives some parts, made of acrylonitrile butadiene styrene (ABS) plastic, which they sand, drill, paint, etc., into finished pieces for motorcycles. Some of the parts are patched with an epoxy adhesive resin or an epoxy carvable paste [both diglycidyl ether of bisphenol-a types, which are used with a mercaptan adhesive hardener that contains 2,4,6-tris(dimethylaminomethyl) phenol]. The material safety data sheets for these substances indicate that allergic skin reactions (sensitization) may occur in susceptible individuals. Also a few of the sanders wear gloves (Edmont model #22-515: Polyvinyl chloride coated with a knit lining) and disposable respirators for dusts (American Optical Company TC #21C-264 filter masks). Fine sanding is conducted immediately prior to painting in an area adjacent to the Rough Sanding Department.

Following sanding, the items are painted in either of two manually operated spray paint booths and are then pin striped. Once painted, final assembly is conducted by attaching any necessary items such as hinges, lights, or other fixtures.

Three employees work in the side-car hand lay-up department making fibrous glass reinforced plastic side-cars for motorcycles. Lay-up is performed manually by two workers, one on each side of the side-car. Strips of fibrous glass sheets are layed on the bottom shell and sides of a mold shaped like a side car. A resin containing styrene and 2-butanone peroxide is then brushed on the fibrous glass. Workers performing this task must stand directly over the side car. Resin vapors are emitted both from the drying side car and the open containers of resin. The shell of the side-car is approximately 80 inches long, 30 inches wide and 12 inches deep. One small area of the hand lay up process is enclosed on four sides with yellow see-through plastic strip curtains. Reportedly, the curtains were installed with the idea of confining styrene exposures to a small area or to only a few workers. The exhaust ventilation for this enclosed system, which was in place during the initial HHE visit, consisted of a large canopy hood positioned 40 inches directly above the side car work station. Any emissions generated from the process would theoretically be drawn through the worker's breathing zone and up into the canopy hood. According to management representatives, the canopy hood was installed sometime in late 1985 or early 1986. Prior to the NIOSH follow-up survey, the side-car ventilation system was modified by closing the canopy hood to form a plenum and extending a rectangular duct to a

rectangular 6 x 32 inch side draft hood at each end of the sidecar (see Figure 1 attached).

When ambient temperatures were elevated, workers in the area reportedly used a portable pedestal fan positioned outside the enclosed curtained area. The fan was situated such that when it was in operation air moved across the face of the canopy hood and created a cross draft problem.

Adjacent to the sanding area adhesives are sometimes used to complete the finished fairing or saddlebag or to attach one item to another as necessary. This area was of concern because of its proximity to the down-draft tables and the presence of compounds known to cause respiratory sensitization. An acrylic adhesive (adhesive A) used in this area contains methyl methacrylate (50%), methacrylic acid (less than 5%), and an aromatic amine (less than 5%). The accelerator for adhesive A contains dibenzoyl peroxide (20%), dibutyl phthalate (20%), and a trade secret polymeric resin (50%). According to plant management, adhesive A was first used in the plant in June 1986. Methyl methacrylate has been documented to induce occupational asthma and is known to cause respiratory sensitization[1-3]. A urethane adhesive (adhesive B) is also used in this area of the plant. One part of adhesive B contains isocyanate prepolymer (48%), with 50% free methyl diisocyanate (MDI) and magnesium and aluminum silicates (52%). The second part of adhesive B contains a blend of polyester resins, polyol and triol (74%), and talc and calcium aluminosilicate (24%). An organotin compound (dialkyl tin salt), unspecified modifiers, and a substituted aromatic amine are each present in part 2 of adhesive B in less than 1% by weight. MDI is known to be a respiratory sensitizer and may cause asthma in sensitized individuals[4-6]. Adhesive B was used prior to adhesive A in this area and for the same application. The two parts of adhesive B have always been mixed inside a dispensing tube (in equal parts) just prior to application (using an airless pump system). However, prior to June 1986, the two adhesive B components were purchased in bulk quantities rather than the current system of 5-gallon pails.

Adjacent to the side-car hand lay-up operation is a small enclosed booth where one employee on first shift works at grinding/finishing side cars, fairings, tour packs and musician stands (used to hold sheet music). This employee wears a disposable dust respirator (American Optical F 90 N dust/mist TC #21C-166 with filter 51460), goggles, and ear muffs (North Health Care).

IV. EVALUATION DESIGN AND METHODS

A. Environmental

During the NIOSH survey on August 25, 1987 long and short-term PBZ and area air samples were collected for measurement of exposure to

acetone and styrene in the side-car hand lay-up operation. The samples were collected on activated charcoal tubes connected via tygon tubing to Sipin (low flow) air sampling pumps calibrated at a flow rate of 30-40 cc/minute for the full-shift samples and 500 cc/minute for the short-term 15-minute samples. The charcoal tubes used to collect the acetone and styrene samples were analyzed by gas chromatography according to NIOSH methods 1300 and 1501[7] respectively, with the following modifications. The charcoal tubes were desorbed for 30 minutes in 1.0 milliliter of carbon disulfide containing 1 microliter/milliliter of toluene as an internal standard. The gas chromatograph (GC), a Hewlett-Packard model 5711A, was equipped with a flame ionization detector. A fused silica capillary column, 30 meter x 0.32 millimeter, which was coated internally with 0.50 micrometer of DB Wax was used with the GC. Oven temperatures were programmed from 60 ^{o}C to 120 ^{o}C at a rate of 16 ^{o}C per minute.

Nine employees of the Tomahawk facility were chosen to wear personal noise dosimeters during the day shift of August 25, 1987. These employees had been identified by the management as working in noisy areas. The workers wore the Type I dosimeter for the entire shift so that 7 - 8 hours of noise measurements were taken for each individual. Additionally, spot surveys (in the same areas where the employees wore the dosimeters) were conducted with a hand-held sound level meter and octave band analyzer. Specifically, the following areas were chosen for noise dosimetry: the rough grinding area, the rough sanding area, the press area, the lexan cutting area; and the two paint booth lines.

The personal noise measurements were taken with Metrosonics Model 301-db Metrologgers with 1/8" remote microphones which were clipped to the shirt collars of the tested workers. These noise samples were collected over the entire eight-hour work shift, or as long as the worker was at his/her work station. The dosimeters were not taken off during the lunch period. Noise data collected with the Metrologgers were analyzed with a Metrosonics Model 653 Metroreader. The Metroreader also allowed for the storage of the data on magnetic tape.

Additional area noise measurements were obtained with a GenRad Model 1982 Type I Precision Sound Level Meter. This sound level meter has octave band measurement capabilities as well as the A, B, C, and "flat" weighting networks. Octave band analysis was performed for the jobs which had steady-state noise levels. Only dB(A)-slow or dB peak measurements were taken for jobs whose noise was intermittent or impulsive in nature. Before and after samples were taken, all sound survey equipment was calibrated according to manufacturers' instructions with traceable calibration sources from the National Bureau of Standards.

B. Medical

All employees from the side car and sanding areas of the plant were interviewed by the NIOSH medical officer. The company medical records were reviewed, and information was collected on illnesses and symptoms among workers in these areas. Literature reviews were conducted to identify compounds used in or near the sanding area with the potential to cause respiratory tract sensitization.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommended exposure limits (RELs), 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH RELs and ACGIH TLVs usually are based on more recent information than are the OSHA permissible exposure limits (PELs). The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on

concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

B. Acetone

Acetone has been considered to be a low hazard to health, since few adverse effects have been reported, despite widespread use for many years. In one study, awareness of mild eye irritation occurred at concentrations above 2,375 mg/m^3. Much higher concentrations (28,500 mg/m^3) depress the central nervous system, causing headache, drowsiness, weakness, and nausea. Repeated skin contact with the liquid may cause redness and dryness.[8]

The NIOSH recommended standard for occupational exposure to acetone[9] is 590 mg/m^3 (250 ppm) for up to a 10-hour workshift, 40-hour workweek. The current OSHA[10] PEL is 2,400 mg/m^3 (1000 ppm), whereas the ACGIH TLV[11] is 1,780 mg/m^3 (750 ppm), both 8-hour TWAs. The ACGIH short-term (15-minute) exposure limit is 2,375 mg/m^3 (1000 ppm).

C. Styrene

Exposure to styrene may be irritating to the eyes, nose, throat, and skin. Respiratory tract irritation has been reported in persons exposed to vapor concentrations in excess of about 800 mg/m^3. Higher exposures depress the central nervous system. Prolonged or repeated skin contact may cause dermatitis due to defatting action.[12]

The current ACGIH 8-hour TWA/TLV for styrene[4] is 215 mg/m^3 (50 ppm) and the federal OSHA PEL[10] is 420 mg/m^3 (100 ppm) for an 8-hour TWA. The NIOSH REL for occupational exposure to styrene[13] is 215 mg/m^3 for up to a 10-hour TWA. In addition, NIOSH recommends a ceiling concentration of 100 ppm for styrene, as measured during any 15-minute sampling period.

D. Noise

Exposure to high levels of noise may cause temporary or permanent hearing loss. The extent of damage depends primarily upon the

intensity of the noise and the duration of the exposure. There is abundant epidemiological and laboratory evidence that protracted noise exposure above 90 dB(A) causes hearing loss in a portion of the exposed population.

The Occupational Safety and Health Administration's existing standard for occupational exposure to noise (29 CFR 1910.95)[14] specifies a maximum PEL of 90 dB(A)-slow response for a duration of 8-hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) and is within his daily PEL. Both NIOSH, in its Criteria for a Recommended Standard[15], and ACGIH in its TLVs[11], propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both of these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

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

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

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

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

The OSHA regulation has an additional action level (AL) of 85 dB(A), which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

When workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

VI. RESULTS

A. Medical

Review of the company medical records for the three workers employed in the side-car hand lay-up area indicated that two have an underlying cardiac or pulmonary disease. Neither condition was reported to be of an occupational etiology. Certain cardiac and pulmonary conditions, however, can interfere with safe use of proper respiratory protection.

Two sanders, one retired worker and one current worker, had respiratory problems which may have been work-related. The rapid onset of illness and temporal relationship with work suggest some form of acute respiratory illness. This may have been occupational asthma in one of the two workers as it was characterized by rapid onset of wheezing. Physical examination by a private physician at the time of the illness revealed bilateral rales. The first documented occurrence of illness in this worker was November, 1985. The second worker appears to have had a number of episodes of pulmonary obstruction, possibly chronic bronchitis, accompanied by acute abdominal pain. This worker's symptoms began to occur prior to 1985. Both employees worked for more than 7 years at Harley-Davidson before the onset of their symptoms and their conditions appeared to improve when away from work. The symptoms of the first worker were reported to have improved at around the time of the initial site visit in May 1987. The second worker had retired and was no longer working at the plant.

B. Environmental

1. Air Sampling Results

In March 1985 an industrial hygienist from the insurance carrier for Harley Davidson Company collected personal samples to characterize exposures to two workers in the side-car hand lay-up operation. The samples were collected using Dupont Pro Tek organic vapor GAA monitoring badges for a four-hour time period. The samples indicated worker exposures to styrene at 97 ppm and 169 ppm and to methyl ethyl ketone (MEK) at 3.8 ppm and 2.3 ppm, respectively. As mentioned earlier in this report, the NIOSH REL and the ACGIH TLV for styrene are both 50 ppm or 215 mg/m^3 and the OSHA PEL is 100 ppm or 420

mg/m^3. The ACGIH TLV and OSHA PEL for methyl ethyl ketone is 200 ppm (590 mg/m^3) for an 8-hour TWA. According to Harley management representatives, MEK has never been used in the side-car area as a clean-up solvent and it is not known to be a component of the compounds used in this department. Since it was found in such low concentrations on the organic vapor badge samples, it is possible that the chromatographic peaks were misidentified as being MEK. The reason for the excessive exposure to styrene may have been due in part to the lack of an adequate exhaust ventilation system in place at that time in the side-car area.

An air sample collected by the insurance carrier in June 1986, on a sander measured a methyl methacrylate exposure of 0.44 ppm TWA. The OSHA PEL and ACGIH TLV for methyl methacrylate is 100 ppm (410 mg/m^3) for an 8-hour TWA.

The results of the PBZ and area air samples collected by NIOSH on August 25, 1987 for acetone and styrene are presented in Table I. As shown in the table, full-shift PBZ samples taken on the laminator in the side car operation and the gel coat sprayer adjacent to the hand lay-up process measured acetone exposures of 49.7 mg/m^3 and 172 mg/m^3, and styrene exposures of 12.8 mg/m^3 and 21.1 mg/m^3, respectively. A short-term PBZ sample collected during the side-car lay-up process measured exposures to acetone at 113 mg/m^3 and to styrene at 78.7 mg/m^3. Finally, two stationary area samples taken in the side-car manufacturing area for acetone and styrene revealed acetone levels ranging from 60.8 mg/m^3 to 64.4 mg/m^3 and styrene concentrations of from 15.4 mg/m^3 to 16.7 mg/m^3. All the acetone and styrene air samples were well below the established occupational criteria for these compounds.

When two or more hazardous substances having similar health effects are present, measurement of exposure to the combination, in addition to the assessment of health effects should be considered. That is, the sum of the fraction, actual concentration divided by the exposure limit for each substance ($C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n$) should not exceed unity (must equal 1.0 or less). Using this concept, we concluded that there were no overexposures based on the additive effect of the solvent vapor mixtures (acetone and styrene).

2. <u>Side-car Ventilation Assessment</u>

Measurements of air velocity and hood area obtained during the follow-up NIOSH survey indicated an airflow rate of 1400 cfm

for each side draft hood at the end of the side car (see Figure 1). This resulted in a fluctuating 10-50 ft/min control velocity at the center of the sidecar. Control velocity at the ends of the side car approached the hood face velocity of 1000 ft/min. While the center control velocity is low, smoke tube evaluation indicated fair control at the center (down inside the side car) and good control at the end when the sidecar was centered between the two hoods. We noted several floor fans in the vicinity of the lay up operation, however, these were not operating. The general room air currents were negligible during the second NIOSH survey in August 1987. However, operation of the fans will cause disruptive air currents, which could easily over power the local exhaust system.

3. Noise

The survey results from the noise dosimetry are given in Table 2. The table shows the areas which were sampled, the elapsed time of the sampling period (in hours and minutes), the 8-hour TWA Level (L_{OSHA}), calculated according to current OSHA regulations, and the corresponding percentage of the daily noise dose. The other column, "Max Period Level" is the highest one-minute noise sample which was stored in the dosimeter. Review of the table reveals that the TWA noise exposures in the Harley-Davidson facility are between 80 and 90 dB(A), with two thirds of the samples in excess of 85 dB(A). The maximum one minute levels were found to be between 92 and 99 dB(A).

Each of the dosimeter readouts are graphically presented in Figures 2 - 10. These figures show how the work schedule will dictate the person's noise exposure. For example, the two workers in the new paint booth (Figures 4 and 5) are exposed to a fairly constant noise level when they are in the spray booth. The times when they leave the booth for breaks or to mix paint are characterized by lower noise exposures. The rough grinding operator (Figure 7) has a more variable noise exposure pattern, which is dictated by the type of activity in which he is engaged, i.e., grinding, cutting, or polishing.

Shorter-term noise samples were also taken in various parts of the Harley-Davidson plant. The activities which were continuous enough to obtain an octave-band analysis are described in Table 3. This table shows the overall dB(A) level and the individual octave band levels from 63 to 8000 Hertz (Hz) for different areas and operations in the facility. The areas labeled "ventilation" were surveyed during break times to show the effects of the ventilation systems on the noise levels in the work area.

Additional short-term noise levels were measured for those jobs which were intermittent in nature and thus would not allow a complete octave-band analysis to be done. For these jobs, either a dB(A) "slow" or dB "peak" value is reported. The surveyed noise levels are presented in Table 4.

With the exception of the punch press operation, most of these intermittent noise exposures are in the same range as the other surveyed areas. This operation produces an impact noise exposure with peak levels in excess of 120 dB peak. Current OSHA regulation stipulates a ceiling of 140 dB peak for impact noise. It was reported that this operation is run about twice a month and then only for a short time period during each operation.

4. Other findings

There were some operations in the plant which were noted during the survey to be potentially hazardous. One such situation is in the "old" paint booth area. One employee works on each of the first and second shifts in the old paint booth. This booth, built in the early 1960's, has a water-wash ventilation system and a compressed air spray gun paint application system. One worker reportedly has had symptoms of tendonitis in the wrist and has undergone carpal tunnel surgery to relieve compression of the median nerve. Another operation in the plant which is thought to have potential ergonomic type problems is the tour pak cover drilling process. Workers employed to complete this task could experience wrist and/or forearm/shoulder problems due to the unnatural work postures and hand/arm deviations observed as the job was performed. Lastly, some of the workers in the plant were observed blowing dust off their cloths with compressed air. A vacuuming system designed to clean dust from the workers clothing is preferred rather than blowing particulates and possibly increasing airborne dust exposures.

VII. DISCUSSION

A. Medical

Two sanders developed respiratory distress which, based on a temporal relationship, may have been work-related. Both workers were employed by Harley-Davidson for at least 7 years before experiencing their symptoms and reported that their symptoms did not occur when away from work. The onset of these workers' symptoms occurred prior to 1986. The agents responsible for this

condition could not be identified or confirmed. One of the epoxy compounds used in the rough sanding area can cause respiratory irritation, and two chemical compounds known to cause respiratory sensitization were used in the area adjacent to the sanders. Epoxy compounds may produce a range of toxic effects. Those effects seen with greatest frequency are dermatitis, eye irritation, and pulmonary irritation.[16,17] Sensitization reactions caused by repeated exposures to epoxy compounds may be manifested by skin reactions or by asthma-like reactions of the respiratory tract.[17] The June 1986 report by the insurance carrier showed that one sander was exposed to detectable levels of methyl methacrylate. However, to our knowledge, methyl methacrylate, was not present in the plant before June 1986. If true, it could not have been responsible for the condition of one sander who was not employed by Harley-Davidson after March 1986. Adhesive B, the urethane adhesive described previously, contains MDI and was present before this date and had been used in the same process as Adhesive A (the acrylic adhesive mentioned earlier in this report). The symptoms of these workers may have been the result of exposure to MDI. Since 1984, and possibly earlier, this material has been mixed in a contained system. Currently, the two components of adhesive B are obtained in 5-gallon pails, whereas in past years the two components were purchased in bulk quantities. It is possible that MDI exposures may have decreased. This could explain why the symptoms of the second worker have improved.

Because two sanders had respiratory symptoms, it would seem prudent to take measures to prevent any further problems of this nature. The private physician of one worker has recommended that exposures be decreased by using a dust mask or relocation to another area of the plant.

B. Environmental

The revisions to the side-car ventilation system are satisfactory and offer good control consistent with the need to keep the side of the side car clear for the workers. However, if the workers in this area begin to develop symptoms consistent with exposure to excessive levels of styrene, there are two additional steps that could be taken.

The first step would be to drop a flexible duct from the plenum. The end of the duct should be level with the top and at the center of the sidecar. This would redistribute the airflow and provide additional control at the center, where the side draft hoods cannot achieve a high control velocity. The flexible duct end must be level with or lower than the top of the sidecar to assure that the airflow into the duct comes through the interior. The overall system airflow rate will increase somewhat due to a lowering of the system resistance.

Following installation of the flexible duct, the total airflow could be increased by installing a larger fan. The current airflow is 2400 cfm. The system design is such that the airflow could be doubled without problem.

VIII. RECOMMENDATIONS

In view of the findings of this investigation, the following recommendations are made to ameliorate existing or potential occupational health hazards. Some of the recommendations outlined below were either listed in the June 1987 letter to management and union officials or were offered during the closing conference held at the end of the NIOSH survey in August 1987.

1. If the old paint booth continues to be used, the spray paint gun should be suspended from the ceiling so that the worker does not have to hold up the combined weight of the gun, compressed air hose, and paint supply hose. Suspending the gun and air/paint lines will help relieve the tension on both the wrist and the forearm. Second, the items to be painted should be suspended such that painters can easily move the piece to be painted rather than placing their hands, wrists, or forearms in awkward, ergonomically stressful positions. Lastly, management representatives should inquire as to the availability of obtaining a lighter weight spray gun. Attempts to eliminate or reduce the ergonomic problems in the old paint booth should also be explored in the tour pack cover drilling operations.

2. A total of two-thirds of the full shift noise exposures were in excess of the NIOSH REL for noise and the OSHA action level for implementation of a hearing conservation program. Because of this finding, attempts to implement engineering controls in some of the noisier operations should be investigated. Several of the major noise sources are the result of two rigid surfaces vibrating against each other. This was observed in the rough grinding and ABS areas. Damping the vibration with vibration absorbing materials should help to reduce the noise levels in these areas. For example, there are numerous fibrous glass and/or plastic drilling operations conducted in the plant, and changing drill bits more often or using sharpened drill bits more frequently might lower the drilling time, thus lowering noise exposures. In addition, the use of sharp bits would require less pressure on the drill handle to perform the same amount of work, meaning that lower forearm force is needed. In the rough sanding area, the fan motors situated atop the ventilation ducts could be mounted on rubber anti-vibration mounts, which would help reduce noise levels in the low frequency range. The exhaust ventilation fan in the press area located on the outside wall of the building is a major noise source. This fan should be replaced with a quieter model. The

area of the lexan punch press located adjacent to the ABS area should be posted as a noise hazard location. The operator of this machine, as well as anyone in the area of a posted noisy operation, should be required to wear hearing protection during the operation of noise-producing equipment. Lastly, the Harley Davidson Company should continue the hearing conservation program which has been set up for the Tomahawk, Wisconsin facilities. If the program does not currently involve all employees, it should be expanded to include all employees working in the production areas.

3. When the side car is being laminated with fibrous glass and resin, attempts should be made to keep the side-car directly below and in the center of the exhaust hood. The lay-up operation should not use a floor fan, and if one is used in the vicinity, the plastic curtains should be used to protect the area from any disruptive air currents. Those side cars which have been laminated should be moved (if operations permit) to the paint booth adjacent to the lay-up operation for air curing/drying and to off gas within the booth.

4. Some workers reported that the water used in the down draft water-wash booth for the rough sanding area is changed infrequently and that on Monday mornings there often is an odor problem since the ventilation system had been turned off for a couple of days. To help remedy this situation, plant management representatives should consider either changing the water in this system more often and/or adding bactericide to the water to combat the occasional offensive odors.

5. A surveillance program for obstructive respiratory disease should be initiated and all rough sanders included. This program should include, at a minimum, a respiratory history, physical examination and pulmonary function tests. Furthermore, these workers should be encouraged to stop smoking and to use respirators when warranted.

6. If plant management continues to provide respiratory protection for the workers, then a respiratory program consistent with the requirements of the General Industry Occupational Safety and Health Standards (29 CFR 1910.134) should be implemented. If a worker's symptoms persist despite wearing a suitable respirator, or if a symptomatic worker is not physically capable of safely using a respirator, he or she should be relocated to another area in the plant.

7. Exposures to styrene or to 2-butanone peroxide (methyl ethyl ketone peroxide) are not thought to compromise the cardiopulmonary system. However, employees with underlying medical conditions should be protected from exposures that could further compromise

their health. For example, carbon monoxide and methylene chloride should be avoided by workers with a significant cardiac disease, and heavy dust exposure avoided by workers with respiratory disease. If a respirator is necessary to protect these workers, then each worker should be medically evaluated for his or her ability to safely use a respirator.

8. Exposures to the adhesives used in the plant should be carefully controlled. Some of these compounds contain chemicals which are capable of respiratory sensitization in susceptible workers. NIOSH, OSHA, and ACGIH exposure limits for these compounds are not necessarily adequate to protect a worker who has been sensitized. Such a worker may need additional respiratory protection or transfer to an area without potential exposures to adhesives.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT:

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Harley Davidson Motor Company, Tomahawk, Wisconsin
2. Allied Industrial Workers of America International Union
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

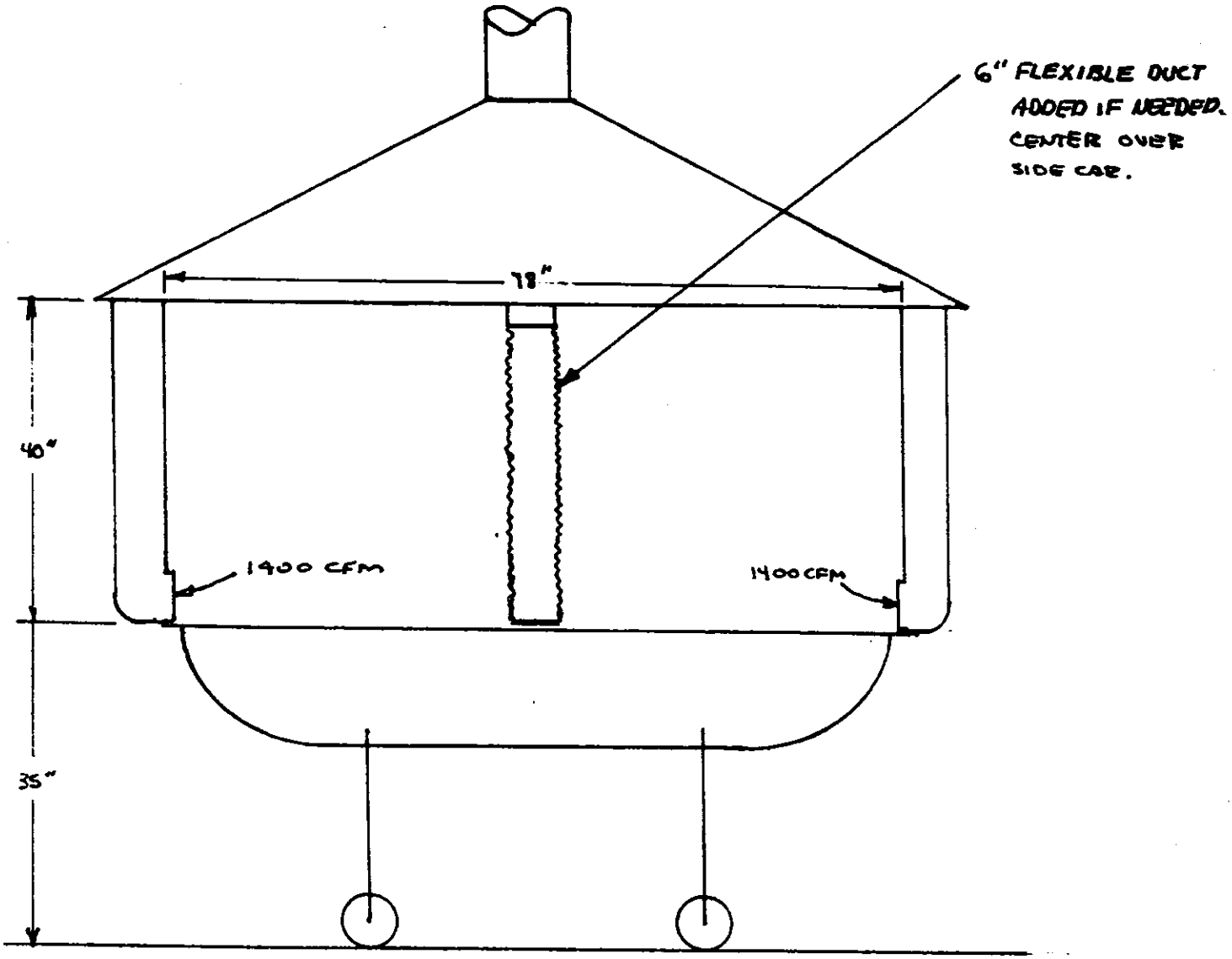


FIGURE 1

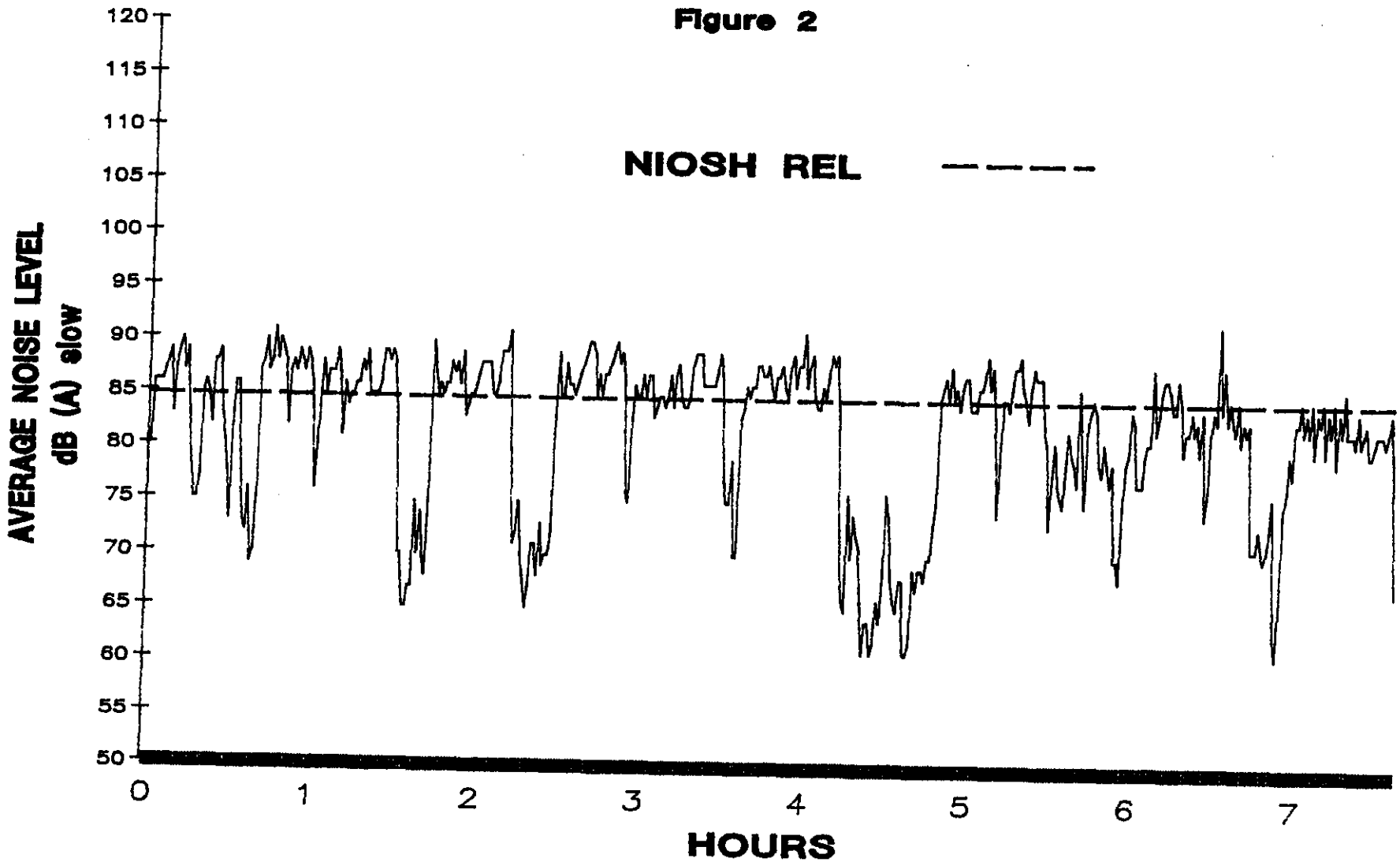
SIDECAR FIBERGLASS
LAYUP VENTILATION

RH 9/1/87

HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Rough Sanding Area
Drilling Operation

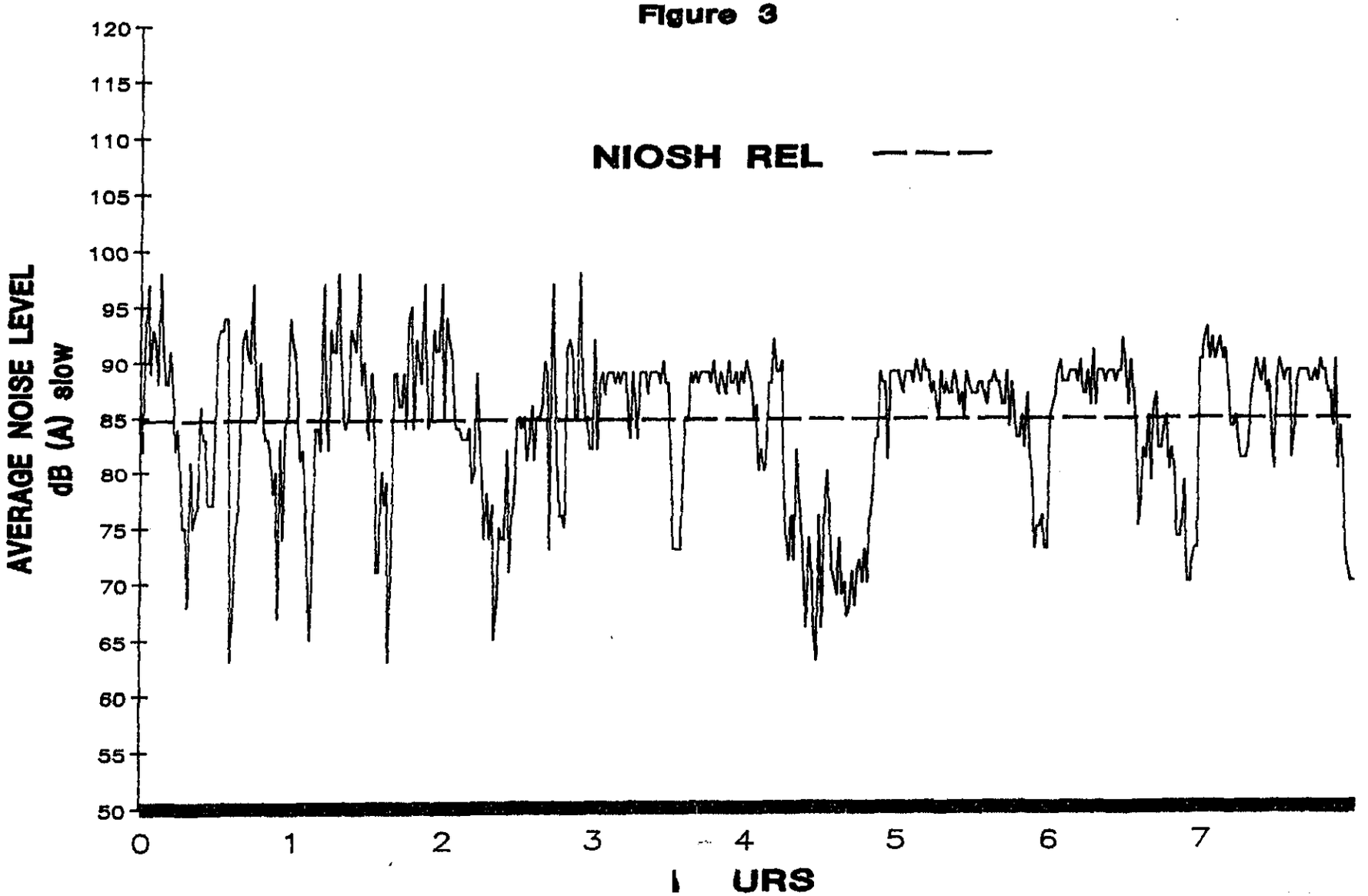
Figure 2



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Rough Sanding Area

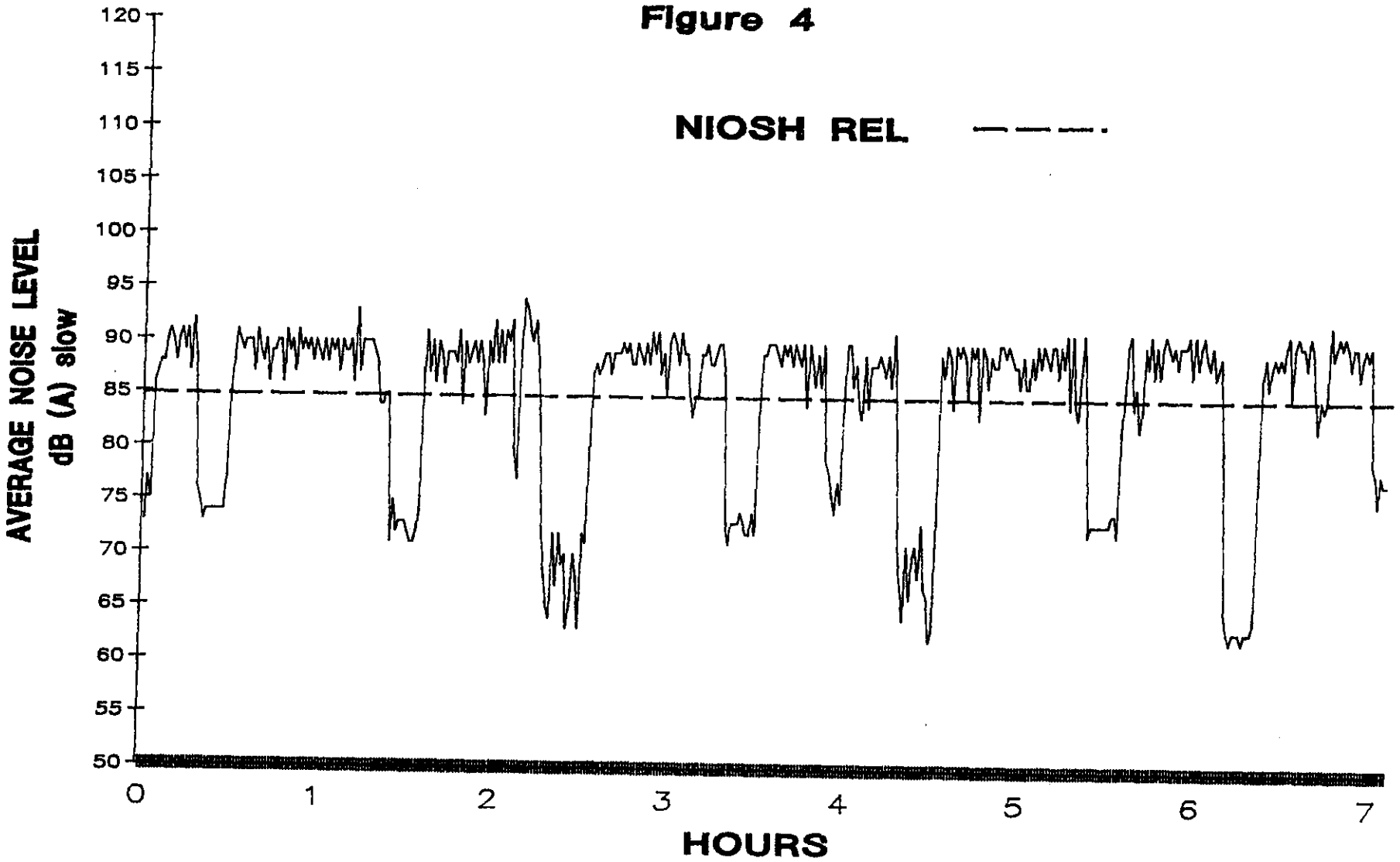
Figure 3



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
New Paint Booth Line

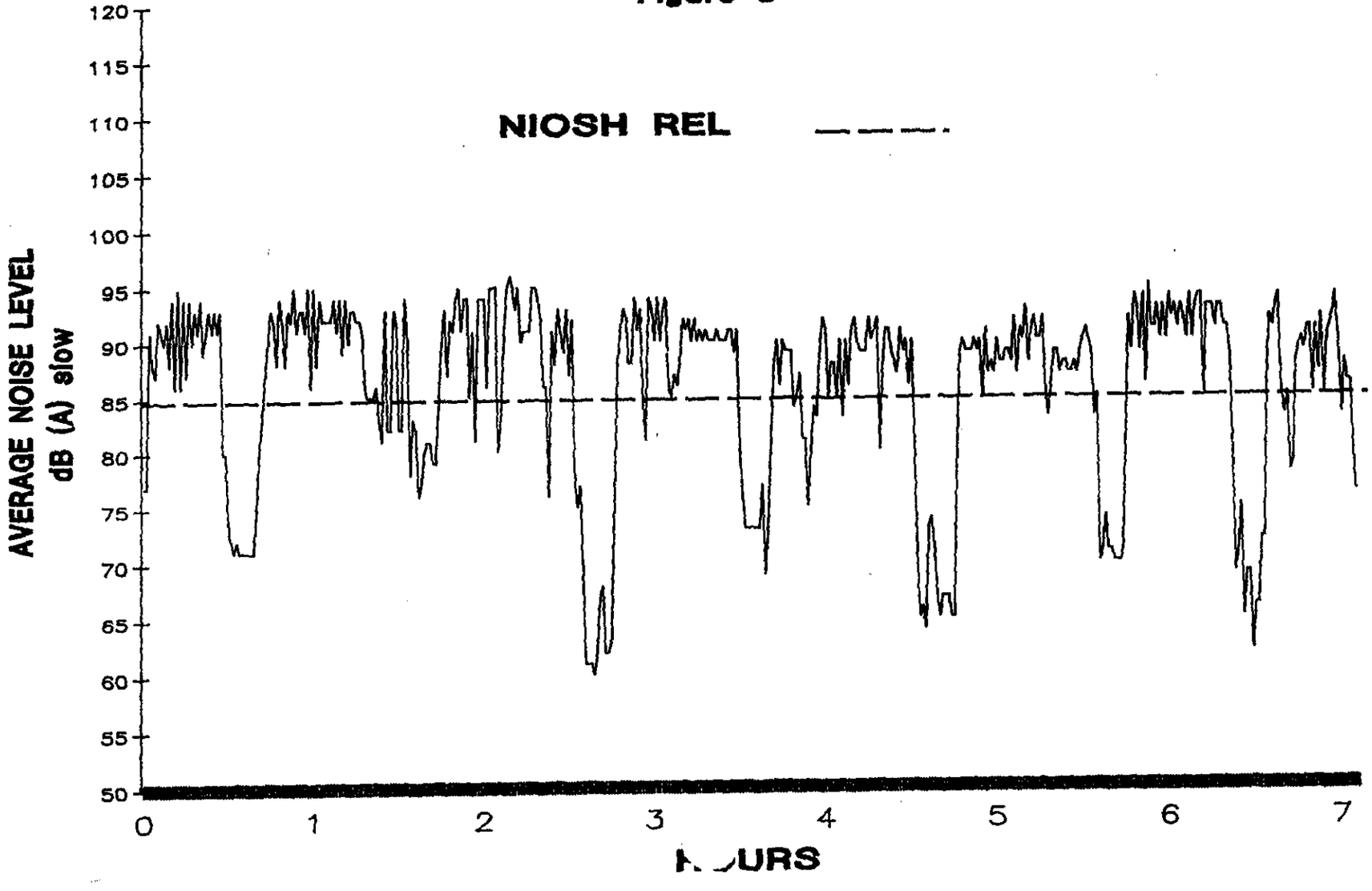
Figure 4



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
New Paint Booth Line

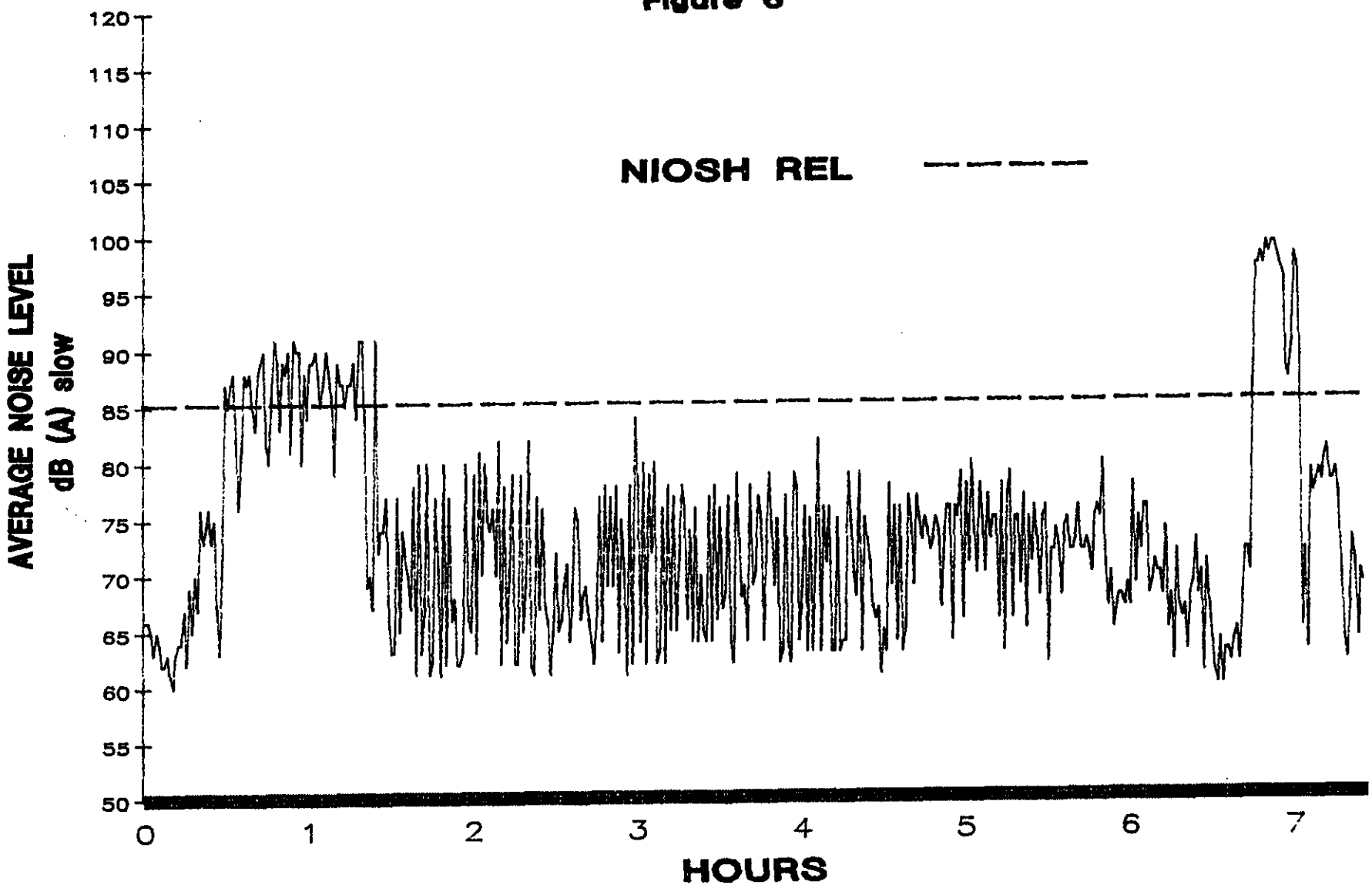
Figure 5



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Lexan Windshield Cutting Area

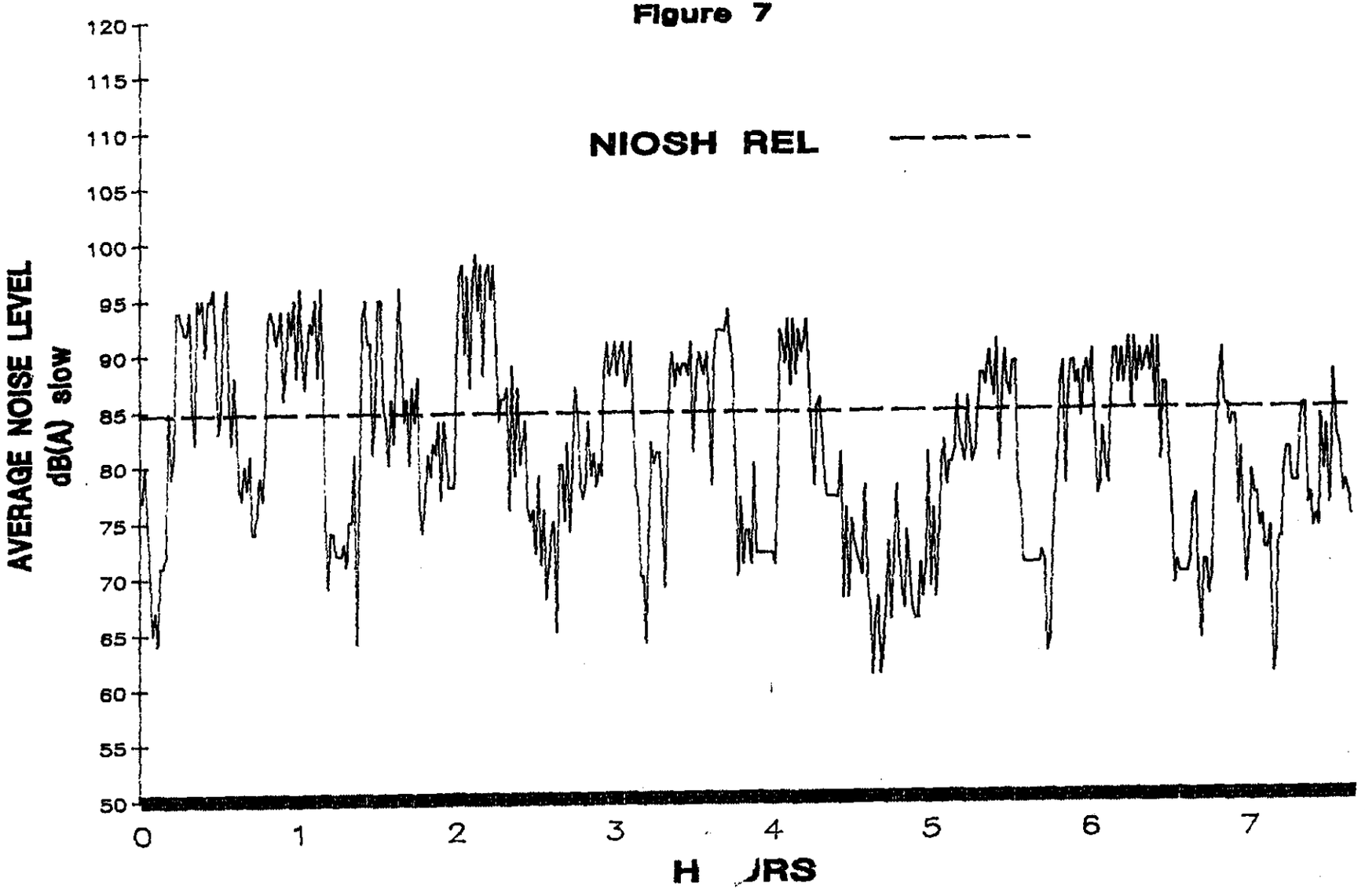
Figure 6



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Rough Grinder Station

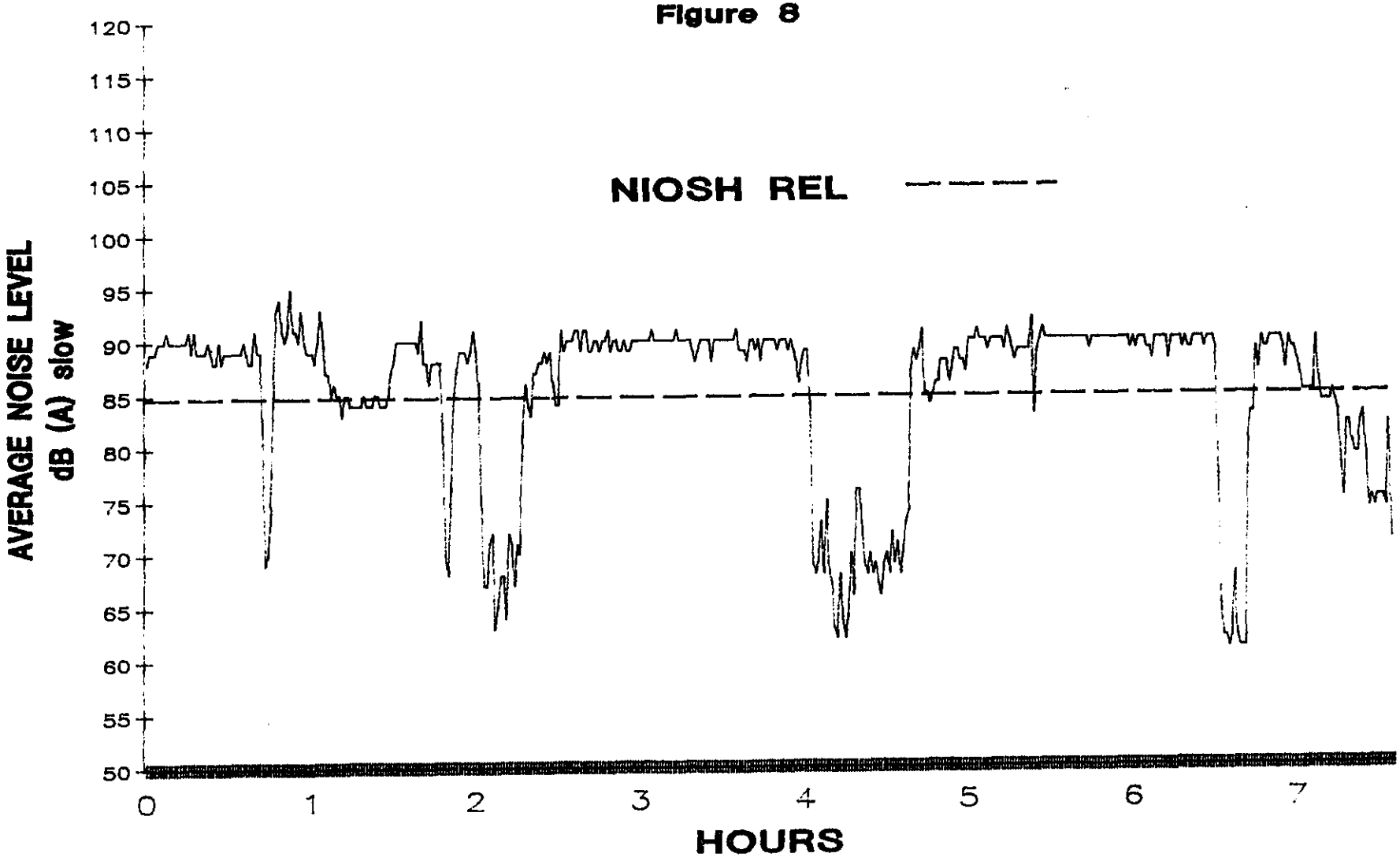
Figure 7



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Press Area
Chopper Gun Operation

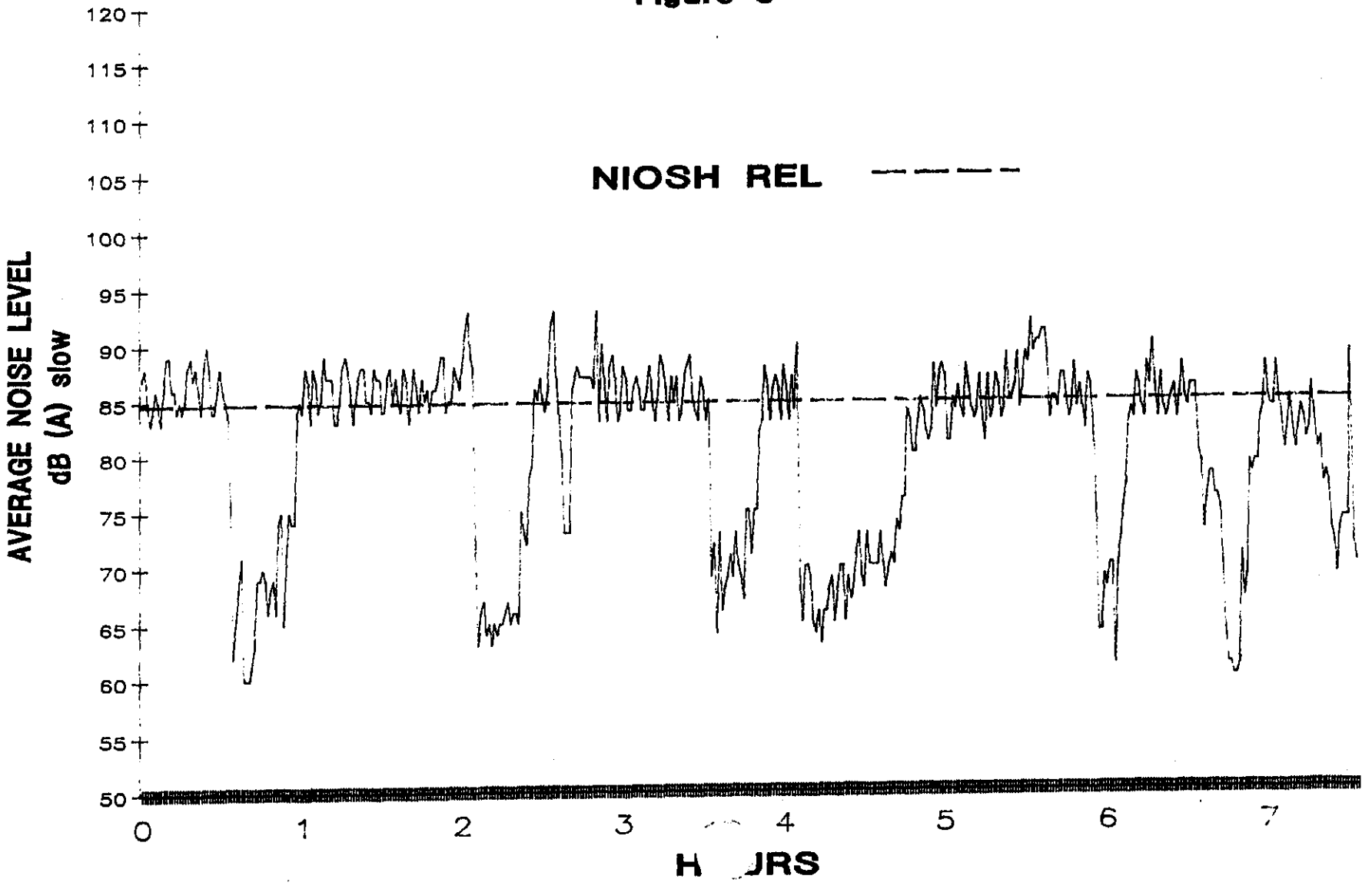
Figure 8



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Press Area

Figure 9



HETA 87-159

HARLEY-DAVIDSON CO.
Tomahawk, WI
Old Paint Booth Line

Figure 10

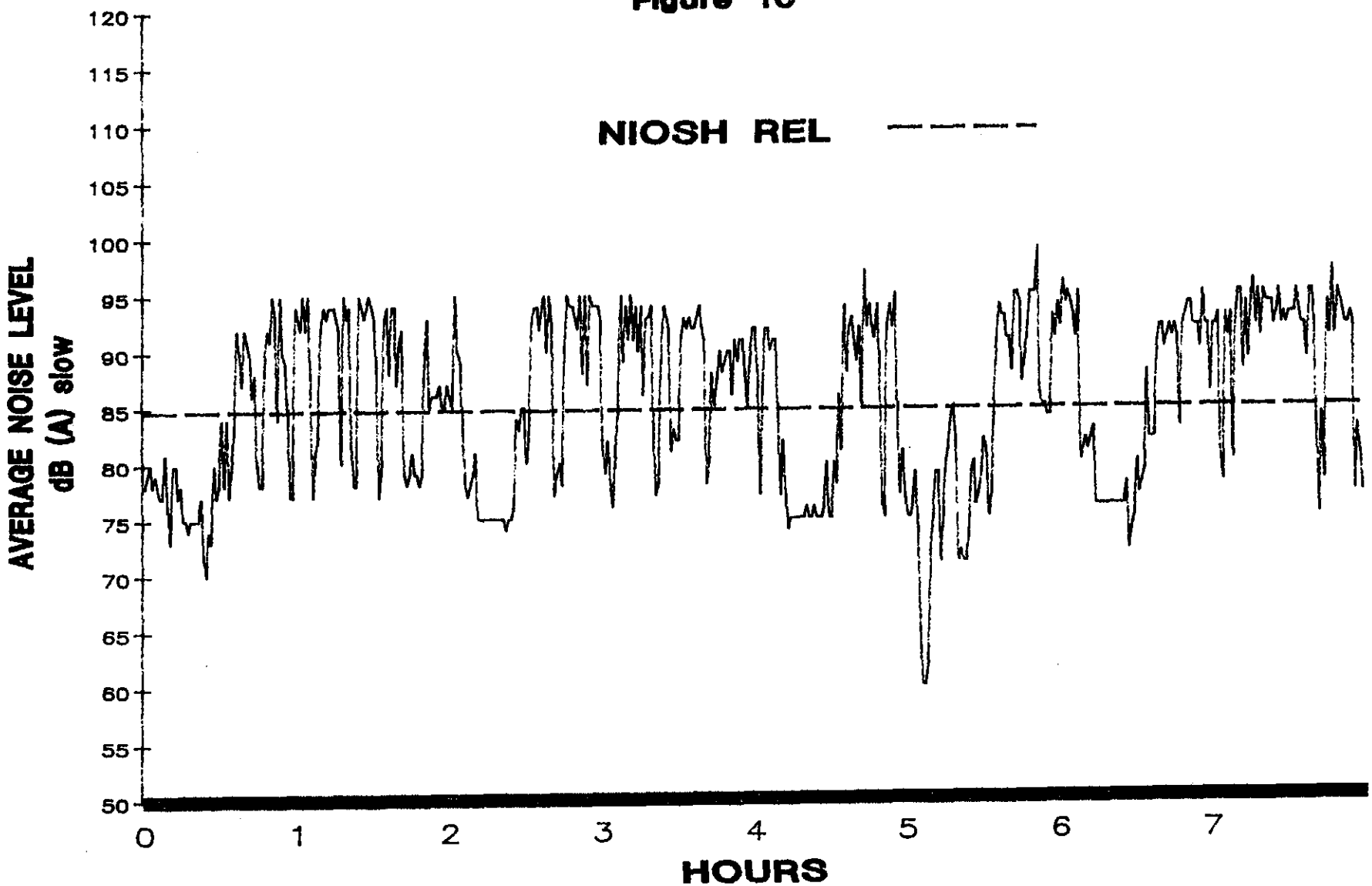


Table 1

RESULTS OF ENVIRONMENTAL AIR SAMPLES FOR ACETONE AND STYRENE

HARLEY DAVIDSON MOTOR COMPANY
TOMAHAWK, WISCONSIN
HETA 87-159
AUGUST 25, 1987

Sample Location	Time	Sample Volume (liters)	mg/m^3 (1) Acetone	Styrene
Personal Sample[2] Laminator, Side-Car Hand Lay-up Operation	0615-1422[3]	15.6	49.7[4]	12.8[4]
Personal Sample Gel Coat Sprayer Adj. to Side-Car Operation	0620-1055 & 1130-1410	18.0	172	21.1
Personal Sample Laminator, Side-Car Lay-up Operation (Short-term Sample)	0757-0812	7.5	113[5]	78.7[6]
Area Sample Side-Car Hand Lay-up Operation Inside Curtained Area On Conduit Along Wall	0723-1433	13.2	64.4	16.7
Area Sample Side-Car Lay-up Operation, Outside Curtained Area, On Top Edge Of Half Of A Side-Car Which Had Recently Been Laminated With Resin and fibrous glass	0725-1433	13.0	60.8	15.4
Evaluation Criteria normal workday, 40 hr/wk time-weighted average			590[7]	213[8]

1. mg/m^3 = milligrams per cubic meter of air.
2. All concentrations are time-weighted averages for the period sampled.
3. Concentrations should be considered as a minimum due to sample pump failure.
4. Laboratory analytical limit of detection (LOD) and limit of quantitation (LOQ) in milligrams/sample for acetone and styrene: LOD = 0.01; LOQ = 0.03. The laboratory analytical method for acetone and styrene was a gas chromatograph equipped with a flame ionization detector.
5. This concentration should be considered as a minimum due to breakthrough (greater than 30% of the total amount) on the backup section of the charcoal tube. The evaluation criterion for this 15 minute acetone sample is 2,375 mg/m^3.
6. This concentration should be considered as a minimum due to breakthrough (greater than 30% of the total amount) on the backup section of the charcoal tube. The evaluation criterion for this 15 minute styrene sample is 426 mg/m^3.
7. One part per million (ppm) of acetone is approximately equal to 2.4 mg/m^3.
8. One ppm of styrene is approximately equal to 4.3 mg/m^3.

Table 2

HETA 87-159
HARLEY-DAVIDSON CO.
TOMAHAWK, WISCONSIN
AUGUST 25, 1987

PERSONAL DOSIMETER RESULTS

JOB SAMPLED	ELAPSED SAMPLING TIME (hours)	$L_{(OSHA)}$	MAX PERIOD LEVEL	PERCENT DOSE
ROUGH GRINDER	7:39	85.7 dBA*	99 dBA	55.3%
ROUGH SANDER	8:00	86.8 dBA*	98 dBA	64.5%
ROUGH SANDER	7:37	84.1 dBA	92 dBA	43.9%
[illegible]N CUTTER	7:26	80.0 dBA	99 dBA	25.0%
PRESS AREA	7:33	83.5 dBA	93 dBA	40.6%
PRESS AREA	7:35	87.6 dBA*	95 dBA	72.0%
OLD PAINT BOOTH	8:00	88.8 dBA*	99 dBA	84.4%
NEW PAINT BOOTH	7:06	87.0 dBA*	94 dBA	66.1%
NEW PAINT BOOTH	7:06	88.9 dBA*	96 dBA	85.5%

NOTE:

The NIOSH REL is 85 dBA-slow for an 8-hour TWA. This level also corresponds to current OSHA regulations for implementing an effective hearing conservation program. Those values marked * are in excess of the NIOSH REL. The column "PERCENT DOSE" is in reference to OSHA's PEL for noise with 100% dose representing a TWA of 90 dBA. Max Period Level is the highest one minute noise sample which was stored in the dosimeter.

Table 3

HETA 87-159
HARLEY-DAVIDSON CO.
TOMAHAWK, WISCONSIN
AUGUST 25, 1987

OCTAVE BAND ANALYSES

AREA SAMPLED	OVERALL LEVEL (dBA)	OCTAVE BAND CENTER FREQUENCIES (Hz)*							
		63	125	250	500	1000	2000	4000	8000
ROUGH GRINDER (Routing)	94-97	77	78	90	91	88	90	82	80
ROUGH SANDER (Ventilation)	86	86	82	83	82	81	80	77	74
LEXAN CUTTING	96-98	82	80	87	94	85	84	91	95
PRESS AREA (Ventilation)	87-88	81	81	81	83	83	80	75	65
PRESS AREA (Chopper Gun)	89	84	98	90	85	81	79	75	
PRESS AREA (Work Station)	82	82	84	82	79	76	74	71	68
OLD PAINT BOOTH	87-90	81	86	84	80	80	79	82	88
NEW PAINT BOOTH	91	82	87	92	82	77	77	83	88

*The individual octave bands are expressed in unweighted sound pressure levels (re. 20 uPa).

Table 4

HETA 87-159
HARLEY-DAVIDSON CO.
TOMAHAWK, WISCONSIN
AUGUST 25, 1987

SHORT-TERM NOISE SAMPLES

Rough Grinding	
ventilation	80 dB(A)
grinding edges	96 dB(A)
polishing	89 dB(A)
compressed air cleaning	87 dB(A)
aisle in front	90 - 92 dB(A)
Rough Sanding	
drilling	85 - 89 dB(A)
drill saw	91 - 92 dB(A)
ABS Area	
cutting headlight section	85 - 94 dB(A)
center station, cutting	94 - 101 dB(A)
center station, drilling	79 - 83 dB(A)
side station, drilling	71 - 75 dB(A)
Lexan Punch Press	
cycle 1	94 dB(A) slow
cycle 2	99 - 100 dB(A) fast
cycle 3	119 - 122 dB peak

All values were obtained using a GenRad Model 1982 Type I Precision Sound Level Meter.