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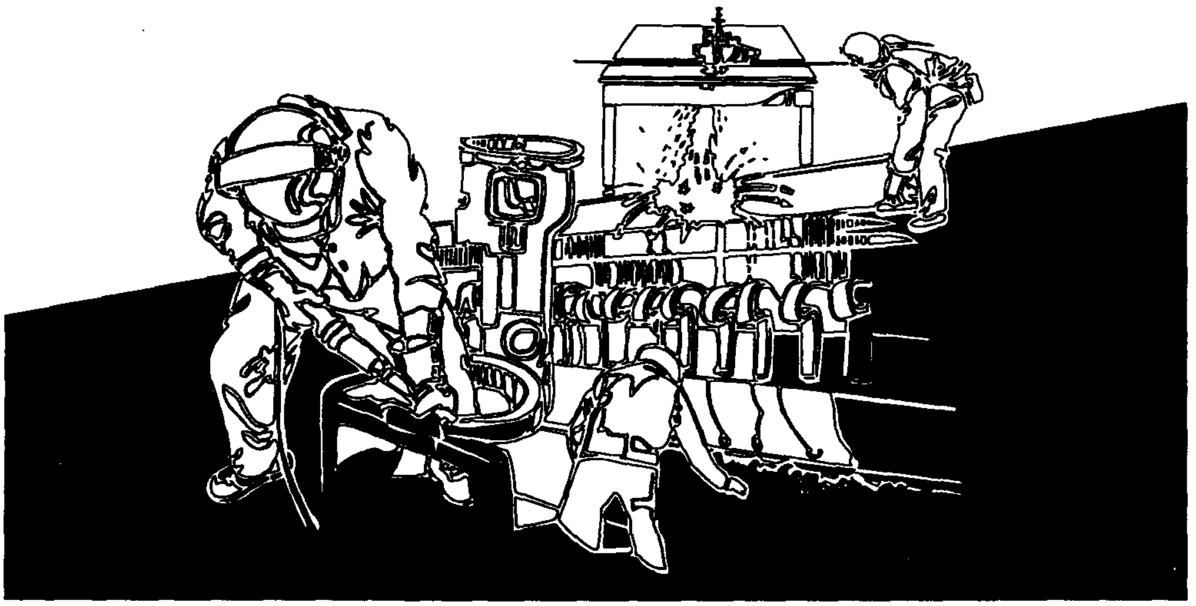
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 91-305-2267
SIEMENS ENERGY AND AUTOMATION, INC.
NORWOOD, OHIO



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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 and 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 91-305-2267
NOVEMBER 1992
SIEMENS ENERGY AND AUTOMATION, INC.
NORWOOD, OHIO

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SUMMARY

In July 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Union of Electricians (IUE), Local 765, to conduct a health hazard evaluation (HHE) at the Siemens Energy and Automation Plant in Norwood, Ohio. The union representatives requested NIOSH to evaluate potential exposures to several commercial products used at the Siemens Energy and Automation Plant in Norwood, Ohio.

On August 20, 1991, NIOSH investigators toured the facility with representatives of IUE and management. Employee interviews and an area noise survey were conducted during a follow-up visit on October 8. This survey identified several areas of the plant where workers may have been overexposed to noise. A full-shift noise survey was conducted on February 27, 1992, to document employees' personal noise exposures in the welding, punch press, and machine taping areas. Workers' exposures to trace metals, phosgene, ozone, and hydrogen chloride (HCl) were also evaluated on February 27.

Personal noise exposures measured for two welders {87.9 and 92.4 (decibels on an A-weighted scale [dB(A)]} were above the NIOSH recommended exposure limit (REL) of 85 dB(A) as an 8-hour time-weighted average (TWA). Personal noise exposures for two of the three press operators monitored {range: 83.5 to 87.6 dB(A)} were also above 85 db(A). Personal noise exposures for two machine taping operators {78.4 and 82.2 dB(A)} were less than 85 dB(A) as an 8-hour TWA.

Personal exposures to specific trace metals ranged up to 1.4 milligrams per cubic meter (mg/m^3) as 8-hour TWAs. With the exception of nickel, these concentrations were well within NIOSH RELs. NIOSH recommends that exposures to nickel be reduced to the lowest feasible level because the carcinogenic risk from exposure to low levels of nickel is not known. Personal exposures to phosgene, ozone, and HCl were not detected.

Results of the environmental monitoring indicate that a health hazard existed for welders and press operators from overexposures to noise. Recommendations are provided to reduce noise exposures, reduce the potential for overexposures to other physical and chemical agents, and improve the hazard communication program.

KEYWORDS: SIC 3621 (Motors and Generators); motor manufacturing; trace metals; noise; welding; brazing; soldering.

INTRODUCTION

In July 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Union of Electricians (IUE), Local 765, to conduct a health hazard evaluation (HHE) at the Siemens Energy and Automation Plant in Norwood, Ohio. The union requested information on the potential hazards of working with several products at the plant. The tradenames and hazardous ingredients (according to the manufacturers) for these products are listed in Table 1.

On August 20, 1991, NIOSH investigators visited the plant to meet with representatives of labor and management and conduct a walk-through inspection of the facility. The welding areas in departments 2022 and 2025, and the winding area of department 2016, were the focus of this inspection.

During the walk-through inspection, employees voiced concerns regarding perceived deficiencies in plant ventilation, hazard communication (HAZCOM) training, and the availability of personal protective equipment (PPE). To evaluate these concerns, confidential employee interviews were conducted on October 8, 1991.

An area noise survey was also conducted on October 8 to determine if noise levels, perceived as high by NIOSH investigators during the August site visit, presented a health hazard to employees. This survey suggested that employees in several areas of the plant were potentially overexposed to noise. A full-shift noise survey was conducted on February 27, 1992, to document personal noise exposures. Personal air monitoring was also conducted on February 27 to evaluate: 1) metal exposures for welders and open slot winders, 2) phosgene and ozone exposures for welders, and 3) hydrogen chloride (HCl) exposures for open slot winders.

BACKGROUND

The facility was originally built by the Bullock company in 1905 to manufacture electric motors. The plant was sold to Allis Chalmers in 1910. In 1980, Siemens Energy and Automation merged with Allis Chalmers to produce high-power electric motors (up to 10,000 horsepower) at the plant.

Of the 495 workers employed at the plant at the time of the August site visit, 380 were production personnel. The production process consisted of manufacturing motor stators and rotor shafts, motor assembly, load testing the motor, and painting the motor. (The HHE focused on stator manufacturing and welding operations.)

The core unit of a stator consisted of the lamination and the stator housing. Each layer of the lamination was punch pressed from sheet metal. The stator housing was milled to size and then welded together. Following the assembly of the lamination inside the stator housing, the stator core was "wound" with copper wire coils. The wire coils were formed on a machine and then wrapped with insulation tape. The smaller coils were machine wrapped, and the larger coils were wrapped by hand.

The commercial products listed in Table 1 were used during the manufacturing of stators or during welding. Prothin and magnesium silicate were combined to form a pliable substance (protifer) which was applied to stators to prevent moisture from contacting the coils. Blue-Gold Cleaner was used in several departments as an industrial strength cleaner. SP-14 Soldering Paste Flux and the brazing rod were used during the connection of electrical lead wires on the stators. During the initial site visit, NIOSH investigators were informed that two of the products had recently been replaced (sometime in the last couple of months). TRIM SC2000, used as a machine coolant, had been replaced by Trim RD3-42. LP 1009, used as an anti-splatter agent during welding, had been replaced with Weld-Kleen. Another Weld-Kleen product, Weld-Kleen 350, was also used as an anti-splatter agent for welding.

Personal protective equipment available for use by welders included welder's goggles, aprons, gloves, and helmets. It was Siemens' policy that powered air-purifying respirators (PAPRs) be worn by welders when they weld painted surfaces. All personnel were required to wear safety shoes and safety glasses while inside the production area of the plant. Hearing protection devices, including ear muffs and plugs, were available; however, a policy to enforce their use in the plant did not exist.

General exhaust ventilation (GEV) was provided by axial fans mounted along the south wall of the plant near the ceiling. A powered supply of make-up air was not provided for this system. Operations for which there was local exhaust ventilation (LEV) included two paint booths, one aluminum die cast oven, and one mixing machine used to make the protifer.

METHODS

To identify the chemical constituents of the commercial products listed in Table 1, manufacturer material safety data sheets (MSDS) were reviewed.

Environmental Monitoring

Noise Exposures

A full-shift noise survey was conducted to document employees personal noise exposures. Welders, press operators, and machine taper operators were included in the survey. The noise dosimeters used in the survey were Metrosonics Model dB301/26 Metrologgers. Each dosimeter consisted of a small noise level recording device that was worn on the waist of the employee. Wired to this device was a 1/4 inch microphone, which was attached to the worker's shirt collar. This dosimeter was designed to measure noise in decibels {A-weighted levels (dB[A])} four times per second. The noise measurements were integrated according to the Occupational Safety and Health Administration (OSHA) noise regulation (see Evaluation Criteria section of this report) for one minute periods and stored separately in the Metrologger for later analysis and final storage. Each dosimeter was calibrated according to the manufacturer's instructions before being placed on the worker. After the recording period was completed, the dosimeter was removed from the worker and placed in the standby mode of operation. Prior to turning off the dosimeter, it was again calibrated to assure that the calibration had not changed during the sampling period. The data was later transferred to a Metrosonics Model dt-390 Metroreader/Data Collector following the noise sampling. The dosimeter information was finally transferred to a personal computer with supporting Metrosonics Metrosoft computer software for permanent data storage and later analysis.

Chemical Exposures

Workers' exposures to metals, phosgene, ozone, and HCl were measured during the HHE. Metals associated with welding and brazing fumes are listed in Table 2. Eight-hour TWA exposures for those metals were measured using NIOSH Method 7300 (Elements by ICP).[1] Personal breathing zone (PBZ) samples were collected from five welders and four open slot winders. Air was drawn through an 8 micrometer methyl cellulose ester filter at a flow rate of 2.0 liters per minute (lpm) using a battery-operated sampling pump. The average sample volume was 860 liters. One 3-hour PBZ sample for metals was also collected on the aluminum die cast operator. (Collection of this sample was initiated after NIOSH investigators observed fumes escaping from the local exhaust ventilation of the cast oven.) The samples were analyzed by inductively coupled plasma spectroscopy (ICP). In addition to the PBZ measurements of metal exposures, direct-reading air measurements of ozone, phosgene, and HCl were made using Dräger short-term detector tubes. Two measurements for ozone and one measurement for phosgene were made near the breathing zone of welders. Two measurements for HCl were made near the breathing zone of winders during soldering operations.

Employee Interviews

Confidential health interviews of 20 workers, including seven open slot winders, five welders, five utility personnel, two stator processing personnel, and one stator core assembly person were conducted. These workers represented a non-random convenience sample of those employees available for interviews from departments 2016, 2022, and 2025. In addition to collecting health information and discussing workers' concerns, a questionnaire was administered regarding the HAZCOM training they had received and their use of PPE.

EVALUATION CRITERIA

General

As a guide to the evaluation of exposures to physical and chemical agents in the workplace, NIOSH employs criteria which are intended to suggest airborne 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 important to note, however, 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 to the level set by the evaluation criterion. Some substances are absorbed by direct contact with the skin and mucous membranes, or by ingestion, and thus the overall exposure may be greater than airborne concentrations alone. Evaluation criteria typically 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] 2) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs),[3] and 3) the American Conference of Governmental Industrial Hygienists' (ACGIH)

Threshold Limit Values (TLVs).[4] These values are usually based on a time-weighted average (TWA) exposure which refers to the average airborne concentration of a substance over an 8- to 10-hour workshift. Some substances have recommended short-term exposure limits (STELS) or ceiling values (C) which are intended to supplement the TWA where there are toxic effects from high, short-term exposures. Short-term exposure limits are based on 15 minute TWA exposures, and C are limits for instantaneous exposures which should not be exceeded at any time during the day.

Noise

Occupational hearing loss was first documented among metalworkers in the sixteenth century.[5] Since then, it has been shown that workers have experienced excessive hearing loss in many occupations associated with noise. Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear and cannot be treated medically. This contrasts with conductive hearing disorders, some of which can be treated.[6]

While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 hertz (Hz) and spreads to lower and higher frequencies (the frequency range of hearing is 20 Hz to 20000 Hz). Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.[7]

The existing OSHA standard for occupational exposure to noise (29 CFR 1910.95)[8] specifies a 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 of 90 dB(A). 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,[9] and ACGIH, in their TLVs,[10] 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.

TWA noise limits as a function of exposure duration are shown as follows:

Duration of Exposure (hrs/day)	Sound Level (dB(A)) NIOSH/ACGIH	Sound Level (dB(A)) 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 *	---
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* No exposure to continuous or intermittent noise in excess of 115 dB(A).

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

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

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

Metals

The sources of worker exposure to metals during welding and brazing are the work surfaces and the welding wire or brazing rods. The toxicity of exposure to common metals varies. For example, overexposure to iron oxide, (considered to have a relatively low level of toxicity), may cause siderosis,[11] a pneumoconiosis[a] that is generally not associated with health symptoms or abnormal findings upon physical examination. In contrast, nickel may cause allergic dermatitis, and is considered by NIOSH to be a potential occupational carcinogen. Evaluation criteria for metals are provided in Table 2.

<u>Phosgene, Ozone, and Hydrogen Chloride</u>

Phosgene is a severe respiratory irritant. Short exposures to high concentrations (50 parts per million [ppm]), as well as extended exposures to lower concentrations, can be fatal.[10] Phosgene gas is produced during the welding of metals which have been cleaned with chlorinated hydrocarbons.[12] (The MSDS for Weld-Kleen lists methyl chloroform, a chlorinated hydrocarbon as 85% of the product by weight.) The NIOSH REL, OSHA PEL, and ACGIH TLV for phosgene is 0.1 ppm as an 8-hour TWA.

Ozone exposures in welding environments result from the transformation of oxygen to ozone in the presence of ultraviolet (UV) radiation.[11] Ozone is an irritant of the mucous membranes and lungs.[10] Symptoms reported at concentrations of between 0.1 and 0.5 ppm include nose and throat irritation, shortness of breath, and chest pain. Severe exposure may cause fluids to accumulate in the lungs (pulmonary edema), which reduces the lungs ability to transport oxygen. The NIOSH REL, OSHA PEL, and ACGIH TLV for ozone is 0.1 ppm. The TLV and PEL are 8-hour TWAs, the NIOSH REL is a ceiling limit. A STEL of 0.3 ppm is used by both OSHA and ACGIH.

Hydrogen chloride (HCl) was listed as a decomposition product of the soldering flux used in department 2016. HCl is a strong irritant of the eyes, mucous membranes and skin.[10] The NIOSH REL, OSHA PEL, and ACGIH TLV for HCl are all 5 ppm as a ceiling limit.

RESULTS AND DISCUSSION

The product information requested by the union is provided in Table 1. Trim SC 2000, and its replacement, Trim RD3-42, contained petroleum oil. Overexposure to petroleum oil can cause eye, nose and throat irritation; dermatitis; and nervous system effects (dizziness, drowsiness, and headaches). Overexposures to magnesium oxide (talc) can lead to pulmonary fibrosis, the forming of fibrous tissue in the lungs which can impair pulmonary

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[a] Pneumoconiosis refers to the deposition of substantial amounts of particulate matter in the lungs and the reaction of the tissue to its presence.

function. The brazing rod contained tin, antimony, copper, and lead. Overexposures to tin oxides can cause stannosis, a pneumoconiosis for which there are no reported symptoms or abnormal findings upon physical examination. Overexposures to antimony can irritate the mucous membranes, eyes and skin. Overexposures to lead results in damage to the kidneys, gastrointestinal tract, peripheral and central nervous systems, and the blood-forming organs (bone marrow).

The MSDSs for two products, Prothin and the soldering flux, listed hazardous decomposition products. Overexposures to boron trifluoride (BF_3), listed as a decomposition product of Prothin, can cause severe irritation of the lungs, eyes and skin. Because the Prothin is melted on a hot plate during the mixing of protifer, thermal decomposition may occur. This may in turn lead to short-term overexposures of the mixer operator. (The operator did report that fumes emitted during mixing were irritating.) The NIOSH REL, OSHA PEL, and ACGIH TLV for BF_3 is 1 ppm as a ceiling limit for exposure. Unfortunately, a validated NIOSH or OSHA method for measuring exposures to BF_3 does not currently exist. The mixing of protifer did not occur during the NIOSH site visits; therefore, even a visual evaluation of the operator's potential exposures could not be performed. The mixing chamber in which the Prothin and talc are combined was equipped with LEV. However, based on a qualitative evaluation by NIOSH investigators using Dräger air current tubes, the LEV appeared to be ineffective at capturing contaminants. The MSDS for SP-14 soldering flux listed HCl, an irritant of the eyes and mucous membranes, as a decomposition product. (The results from air monitoring for HCl are provided below under "Environmental Monitoring: Chemical Exposures" section of this report.)

The MSDSs for three products: LP 1009, the Weld-Kleen product that replaced LP 1009, and the Blue-Gold Cleaner did not list compounds defined as hazardous under the Hazard Communication Standard [29 CFR 1910.1200(d)(3)].

Environmental Monitoring

Noise Exposures

The two welders who volunteered to wear noise dosimeters reported that the amount of welding and related activities, (*e.g.*, grinding), performed during the survey period was less than normal because necessary parts were not available. The effect of grinding on noise levels is reflected in measurements made before and after lunch. In the morning, hourly noise levels for welders ranged from 85 to 89 dB(A). In contrast, hourly noise levels of over 100 dB(A) were measured in the afternoon when welders were grinding. The 8-hour TWAs for the two welders were 87.9 and 92.4 dB(A). The graphic presentations of these TWA exposures are shown in Figures 1 and 2. (Both welders had the dosimeters removed and placed on standby during the lunch period so that the typical reduction in noise exposure seen in the middle of the day does not show up in their noise records.)

The three press operators who participated in the survey had 8-hour TWAs that ranged from 83.5 to 87.6 dB(A) (Figures 3-5). The slot press operator who worked on machine #4851 in the morning, switched to an enclosed punch press similar to press #5693 in the afternoon. The average noise exposures for this individual were considerably lower [4-5 dB(A)] in the afternoon, when compared to the morning. The spacer machine (#5331) operator reported that the machine was not working properly at the beginning of the work shift. This resulted in lower noise levels during the first two hours of the shift. Average noise levels of approximately 90 dB(A) were recorded for the middle portion of the shift (from hours 2-5 in Figure 5). The recorded levels for the remainder of the shift were less than 85 dB(A). This reduction in noise level at the end of the shift corresponded to a change in product. The product produced during the last two hours of the shift did not require the air-driven material shuttle that was used on the machine from hours 2-5. The shuttle was a major source of noise on the machine as it slammed back and forth between mechanical stops at a high rate of speed.

The TWAs for the machine taper operators were less than 85 dB(A) (Figures 6-7). The 8-hour TWA values for the two operators who wore dosimeters were found to be 78.4 and 82.2 dB(A) for the 7½ hour survey period.

There was not a consistent use of hearing protection devices (HPDs) observed among workers. One of the welders wore ear muffs while welding, yet other welders did not wear any protection. The use of HPDs is similar for punch press operators. One of the operators reported that she did not wear ear plugs because they were uncomfortable and led to ear infections.

Chemical Exposures

Personal exposures to metals (fume and particulate) ranged up to 1.4 milligrams per cubic meter (mg/m^3). With the exception of nickel, TWA exposures for metals were well within the respective occupational guidelines (see Table 2).

NIOSH considers nickel (measured at concentrations of up to 1 micrograms per cubic meter ($\mu g/m^3$) to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible level.

Neither phosgene, ozone, nor HCl were detected in the air. The limits of detection were 0.04, 0.05, and 1 ppm for phosgene, ozone, and HCl respectively.[13]

Employee interviews

During confidential health interviews with 20 workers, several issues of concern became evident. These included a lack of adequate eye protection, a perception of inadequate ventilation and inadequate respiratory protection, potential electrical shock hazards, and a general lack of understanding regarding the hazards to which workers were exposed.

Inadequate eye protection was reported by both welders and brazers. All five welders reported a history of flash burns to the eyes (keratoconjunctivitis). The reported frequency ranged from twice weekly to "rarely." Two welders reported frequent occurrence while tack welding, a procedure they perform without eye protection. Another welder believed that his flash burns occurred when entering other booths to get tools during welding operations. Because their symptoms usually began after completion of the work day, and then largely resolved prior to returning to work, none of the welders had reported the symptoms as a work-related injury. Due to this, there is no substantiating OSHA 200 log record. Welders reportedly used over-the-counter products such as eye-drops to self treat their symptoms. Open-slot winders reported that brazing glasses were not always available, but they did not report any symptoms related to this inadequacy.

Both acute and chronic effects from exposures to UV and infrared (IR) radiation during welding have been recognized. Exposure of a few seconds duration to UV radiation from a welding arc can cause acute keratoconjunctivitis, also known as welder's flash and actinic ray photokeratitis. Symptoms include foreign-body sensation, burning pain, photophobia, lacrimation, and headache. Symptoms begin four to 12 hours after exposure and may last up to 48 hours.[14,15] Multiple acute exposures to welding arcs over a long period of time may also cause cataract formation.[14] Additionally, welders have been shown to have an increase in damage to the corneal epithelium and endothelium when compared to non-welders. This damage was also attributed to UV radiation exposure.[14] IR radiation exposure has been associated with the formation of cataracts and thermal damage to the eye.[14]

Eye injury to welders may also occur from metal splatter entering the eye. In one study of welders, the most common reported eye injury was imbedded objects. In the same study, serious visual impairment was observed in 20% of welders, and substandard visual acuity (20/60 or less) was found in 59%.[14] These impairments may have been due to the combined effects of mechanical trauma and radiation induced injuries. In addition to metal splatter, welders at Siemens were potentially exposed to airborne metal particulate while grinding.

Employees from several departments were concerned that there was inadequate ventilation in the building. Several welders and open slot winders perceived the ventilation in their respective work areas to be ineffective at protecting them from the irritants contained in the fume and vapors emitted during welding, brazing, and soldering.

With the exception of a few processes (e.g., painting and aluminum die casting) which have LEV, the control of contaminant levels at the plant relies on GEV. The effectiveness of GEV to reduce contaminant levels is dependent on several factors.[16] These include the physical properties, generation rate, and target air concentrations of the contaminants; the location of exhaust fans and supply air relative to points of contaminant generation; and other sources of ventilation such as LEV and natural ventilation (open doors and windows). The GEV system at Siemens uses propeller fans along the south wall of the building to exhaust contaminated air from the plant. Although propeller fans are capable of moving large amounts of air, they do not perform well against static pressures. Static pressures across the fan might develop, for example, when the bay doors along the east wall of the plant are closed, which may cause the building to be under negative pressure relative to the outside. In order to prevent such conditions, it is necessary to provide an adequate amount of clean make-up air for the fans. A powered source of tempered outside air, is the best way of assuring this.

In general, LEV is more effective than GEV at controlling emissions from contaminant-producing processes such as welding. This is because LEV, if designed and maintained properly, captures and removes contaminants at their source. Furthermore, although the initial cost of a LEV system may be greater than a GEV system, the operating costs are generally less; this is particularly true if the GEV requires large airflow rates to be effective. A LEV system, therefore, may be more productive as a long-term investment.

Ten of the 20 workers interviewed reported that they had been issued cartridge respirators. Seven of the 10 had been fit-tested, but the other three had chosen respirators without assistance from health and safety personnel. None of the ten workers underwent pulmonary function testing or physician evaluation prior to obtaining a respirator. Each employee was responsible for the care of their own respirator. The respirator was stored either in a locker or in a tool box. Reported respirator cleaning procedures varied from wiping the face-piece out with a dry cloth or towelette to placing the entire face-piece under running water. Welders reported that the PAPRs, required by management to be worn when welding on painted surfaces, were sometimes not available.

If respirators are used to control airborne exposures, they should be selected based on criteria similar to that found in the NIOSH Respirator Decision Logic publication.[17] A complete respirator program that meets the requirements of the OSHA respiratory protection standard (29 CFR 1910.134),[18] should be implemented. Guidelines for such a program are provided in the NIOSH guide to <u>Industrial Respiratory Protection</u>.[19] A partial list of program requirements are provided as Appendix I of this report.

Open slot winders voiced concerned that potential safety hazards were presented by: 1) electrical shocks that occurred periodically during the testing of the motor stators, and 2) the overhead cranes. Information regarding these concerns should be obtainable from management upon request. (The OSHA inspection requirements of overhead cranes {29 CFR 1910.179 [j]} outlines intervals for which items of the crane and its function must be inspected. The OSHA safety guidelines for working with electrical equipment are provided in 29 CFR 1910.333.)

Only one worker reported that he was aware of the hazards associated with the commercial products he used. Several workers commented that the HAZCOM training provided by the company does not address the specific hazards that they encounter on the job. For example, workers mentioned that training films covered information on lifting hazards, but not those hazards specific to the processes which they are involved in. Six workers reported inadequate or mislabeling of chemical products. Several mentioned that xylene was at their workstations in unmarked containers.

NIOSH investigators did observe that xylene used by stator winders, was stored in containers labelled for other chemical products. This practice could potentially create a health hazard from the incorrect use of xylene, or by not having the information available to respond correctly to an emergency situation such as a fire or personal injury.

Work Practices

Two additional exposure concerns noted by NIOSH investigators were: 1) the practice of smoking, eating, and drinking by employees in production areas of the shop, and 2) the potential for employees in the tape room to suffer from repetitive trauma disorders. Smoking, eating, and drinking in areas where surfaces are likely to be contaminated with chemical products increases the potential for hand-to-mouth contact, and ingestion of contaminants.

Work practices and conditions were observed in the tape room which may produce repetitive trauma injuries. These included the repetitive use of pinch grips, repeated supination-pronation movements of the wrist, and exposure to vibrating machinery. These exposures can lead to painful and debilitating conditions such as carpal tunnel syndrome and hand-arm vibration syndrome.

RECOMMENDATIONS

The following recommendations are provided to reduce noise exposures, reduce the potential for overexposures to chemical and physical agents, and improve the hazard communication program.

1. Welders' tasks that produce particularly high levels of noise, such as grinding, need to be separated from the rest of the machine shop. The noise levels recorded on the two welders' noise dosimeters were consistently higher than 85 dB(A). These levels were the result of machining operations in their area, coupled with grinding operations of welders at the other end of the shop. Placing all of the welders in an area by themselves with proper isolation would reduce the noise and airborne contaminant exposures of other workers. Also, if individual welding booths were isolated from each other, the effects of one welder's activities on the exposures of other welders would be reduced.

2. The recorded noise exposures for the two welders warrant that a hearing conservation program be offered to welders. At a minimum, the program must meet the requirements set forth by OSHA in the noise regulation for general industry (29 CFR 1910.95).[7] The noise exposures of punch press operators suggest that most, if not all machine shop employees should also be included in this program.

Additional noise monitoring is necessary to determine if other workers should be included.

The hearing conservation program should include periodic noise monitoring, annual audiometric testing of employees in the program, the mandatory use of hearing protection in areas that expose workers to noise levels in excess of a TWA of 85 dB(A), recordkeeping, and employee education programs concerning noise exposures and its effect on hearing. Further guidelines for a hearing conservation program are discussed in the NIOSH technical report: <u>A practical guide to effective hearing conservation programs in the workplace</u>.[20]

3. A design change should be made in the material shuttle on the spacer machine to alleviate the need for high air pressures. The practice of increasing the air pressure of the machine is likely to exacerbate noise exposures by increasing the force of the collision between the moving part and the mechanical stop. A reduction in air pressure to the lowest possible level should also be a goal of maintenance performed on the machine. If a design change is not available from the manufacturer, or cannot be accomplished in-house, retrofit noise controls should be added. In addition, the mechanical stops on the spacer machine should be repaired (one of the nylon/plastic sheaths around the metal stop was missing and the other one, though in place, was split).

4. The practice of replacing old punch presses with enclosed presses should be continued to further reduce noise exposures. If a sufficient number of presses are replaced, ambient noise exposures may be reduced to levels that would alleviate the requirement of a hearing conservation program for machine operators.

5. The HAZCOM program at the facility needs to be improved so that it is consistent with that required by OSHA as of May 1986 (29 CFR 1910.1200). Specific areas which need to be improved include the training of workers in the hazards specific to their jobs and the proper labelling of products.

6. A program for routine environmental monitoring of worker exposures to physical and chemical hazards should be designed and implemented for all workers. Welders, in particular, are exposed to potential chemical and physical hazards which need initial characterization and follow-up monitoring. Guidelines for monitoring welders' exposures can be found in the NIOSH document: <u>Criteria for a</u>

Recommended Standard: Welding, Brazing, and Thermal Cutting.[14]

7. Work practices during welding and brazing should conform to those required by OSHA[21] (29 CFR 1910.251-254) and recommended by NIOSH.[14] As a rule, painted or coated materials that may produce toxic pyrolysis or combustion products should be removed from work surfaces prior to welding. If the practice of welding on painted surfaces is continued at the Siemens facility, exposures to all related hazards should be evaluated to determine what control measures are needed to protect the worker. Engineering controls should be the primary method of reducing exposures. If respirators are used to control airborne exposures, a complete respirator program that meets the requirements of the OSHA respiratory protection standard (29 CFR 1910.134),[18] should be implemented. (A partial list of program requirements are provided as Appendix I of this report.)

8. Proper eye protection should be provided to workers involved in welding and brazing operations. Eye protection consistent with the OSHA standard {1910.252(e)(2)(ii)} should be provided to employees and their use should be mandatory. If existing eye protection hinders certain welding operations such as tacking, manufacturers of protective eyewear should be consulted to provide an effective means of eye protection that also minimizes the hindrance to welding. Workers should be required to wear eye protection and encouraged to report eye symptoms consistent with welders flash, even when they occur after completion of the work day. This will both allow for more complete record-keeping on the OSHA 200 log and will also assist in recognizing particular welding activities which are more problematic than others.

9. Effective local exhaust ventilation should be provided in the mixing room of department 2016. This should be designed to reduce the potential for overexposure of the mixing operator to BF_3 during the making of protifer. Both processes of melting the Prothin and mixing the Prothin with the talc should be provided with LEV. In addition, the LEV for the die-cast oven should be evaluated and repaired to prevent the escape of contaminants into the plant.

10. The general exhaust ventilation at the plant should be evaluated to determine if worker complaints of inadequate ventilation are warranted. To help assure that an

adequate amount of clean make-up air is available, a powered supply for outside air should be provided. Management may also want to investigate the use of LEV for processes such as welding, for which contaminants can effectively be captured and removed at their source.

11. The circumstances associated with the electrical shocks reported by employees to occur during the voltage testing of stators in department 2016 should be investigated by management, with measures taken to prevent any occurrence in the future.

12. Smoking, eating, and drinking in production areas of the plant should be prohibited to reduce accidental ingestion of toxic substances.

13. An ergonomist should be consulted to evaluate the work practices of personnel in the tape room. This is a first step toward preventing repetitive trauma disorders from occurring during the taping of coils.

REFERENCES

1. NIOSH [1984]. Manual of analytical methods, 3rd rev. ed., Volumes 1 & 2. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

2. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. MMWR 37(S-7): 1-29 (1988).

3. Code of Federal Regulations [1989]. OSHA Table Z-1-A. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

4. ACGIH [1991]. 1991-1992 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

5. Alberti [1591 (1970)], cited by Bunch, C.C. Traumatic deafness. In E.P. Fowler, Jr. (Editor), Medicine of the ear, chapter X. Reprinted Translations of the Beltone Institute for Hearing Research, No. 23.

6. Ward WD [1986]. Anatomy & physiology of the ear: normal and damaged hearing. Chapter 5. In: Berger EH, Ward WD, Morrill JC, Royster LH, eds. Noise & hearing conservation manual. 4th ed. Akron, OH: American Industrial Hygiene Association, pp. 177-195.

7. Ward WD, Fleer RE, Glorig A [1961]. Characteristics of hearing loss produced by gunfire and by steady noise. Journal of Auditory Research 1:325-356.

8. Code of Federal Regulations [1989]. OSHA. 29 CFR 1910.95. Washington, DC: U.S. Government Printing Office, Federal Register.

9. NIOSH [1972]. Criteria for a recommended standard: occupational exposure to noise. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-11001.

10. ACGIH [1990]. 1990-1991 threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

11. Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1988]. Chemical hazards in the workplace, 3rd ed. Philadelphia, PA: J.B. Lippincott Company.

12. AWS [1973]. The welding environment: a research report of fumes and gases generated during welding operations. The American Welding Society, Miami, Florida.

13. Leichnitz K [1989]. Detector tube handbook: air investigations and technical gas analysis with Dräger tubes, 7th ed. Graphische Werkstatten GmbH, Lubeck, Germany.

14. NIOSH [1988]. Criteria for a recommended standard: welding, brazing, and thermal cutting. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-110a.

15. APHA [1991]. Preventing occupational diseases and injury. Weeks JL, Levy BS, and Wagner GR eds. American Public Health Association, Washington, D.C., pp. 508-515.

16. ACGIH [1988]. Industrial ventilation: a manual of recommended practice, 20th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

17. NIOSH [1987]. Respirator decision logic. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.

18. Code of Federal Regulations [1989]. OSHA. 29 CFR 1910.134 Washington, DC: U.S. Government Printing Office, Federal Register.

19. NIOSH [1988]. NIOSH guide to industrial respiratory protection. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.

20. NIOSH [1990]. A practical guide to effective hearing conservation programs in the workplace. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS(NIOSH) Publication No. 90-120.

21. Code of Federal Regulations [1989]. OSHA Standard for welding, cutting, and brazing. 29 CFR 1910.252. Washington, DC: U.S. Government Printing Office, Federal Register.

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3) Superintendent of Plant Eng. & Maint. Siemens Energy and Automation Inc.
4) Supervisor, Industrial Relations Siemens Energy and Automation Inc.
5) 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.

Table 1
Product Information
Siemens Energy and Automation
HETA 91-305

PRODUCTS/ DEPARTMENTS USED	**HAZARDOUS INGREDIENTS**[1]	**HEALTH EFFECTS FROM OVEREXPOSURE**[2]
LP 1009[3]/ 2022&2025	NONE	
WELD-KLEEN/ 2022&2025	METHYL CHLOROFORM	SKIN IRRITATION, DEPRESSION OF THE CNS[4]
PROTHIN/2016	BORON TRIFLUORIDE[5]	SEVERE IRRITATION OF THE LUNGS, EYES, AND SKIN.
TRIM SC200[3]/ VARIOUS	PETROLEUM OIL	EYE, NOSE, AND THROAT IRRITATION; DERMATITIS; NERVOUS SYSTEM EFFECTS.
MAGNESIUM SILICATE/2016	TALC	PULMONARY FIBROSIS[6]
BLUE-GOLD CLEANER/ 2022, 2024,& 2028	NONE	
SP-14 SOLDERING PASTE FLUX/2016	HYDROGEN CHLORIDE[5]	IRRITATION OF THE EYES AND MUCOUS MEMBRANES
WHITE METAL ALLOYS BRAZING ROD/ 2016	TIN, ANTIMONY, COPPER, LEAD	<u>TIN OXIDES</u>: STANNOSIS[7] <u>ANTIMONY</u>: IRRITATION OF THE MUCOUS MEMBRANES, EYES, AND SKIN <u>LEAD</u>: DAMAGE TO THE KIDNEYS, GASTROINTESTINAL TRACT, CNS AND PNS[8], AND THE BONE MARROW

1. Hazardous ingredients refer to those compounds reported by the manufacturer that are defined as hazardous under the Hazard Communication Standard (29 CFR 1910.1200(d)(3)).
2. From Hathaway et al.[11]
3. This product is no longer being used.
4. Central nervous system.
5. Listed as a decomposition product.
6. The formation of fibrous tissue in the lung, which generally impairs pulmonary function.
7. Stannosis is a benign, symptomless pneumoconiosis. Pneumoconiosis refers to the deposition of substantial amounts of particulate matter in the lungs and the reaction of the tissue to its presence.
8. Peripheral nervous system.

Table 2
Results of Personal Monitoring for Trace Metals
Siemens Energy and Automation
HETA 91-305

METAL	RANGE FOR WELDERS ($\mu g/m^3$)	RANGE FOR STATOR WINDERS ($\mu g/m^3$)	NIOSH REL (mg/m^3)	OSHA PEL (mg/m^3)	ACGIH TLV (mg/m^3)	MDC[a] ($\mu g/m^3$)
Aluminum	2-21	2-6	5/10[b]	5/15[b]	5/10[b]	2
Arsenic	ND	ND	LFL[c]	0.01	0.2	2
Beryllium	ND	ND	LFL[c]	0.002	0.002	0.6
Cadmium	ND	ND	LFL[c]	0.1/0.2[b]	0.05	0.6
Chromium	0.7-1	ND-0.7	0.5	0.5	0.5	0.6
Cobalt	ND	ND	0.05	0.05	0.05	0.6
Copper	9-24	0.2-15	0.1/1	0.1/1[b]	0.2/1	0.6
Iron	760-1400	0.6-930	5	10	5	0.6
Lead	ND	ND	< 0.1	0.05	0.15	1
Magnesium	2-4	ND-5	n/a	10	10	1
Manganese	46-160	ND-860	1	1	1/5[d]	0.6
Molybdenum	ND	ND	n/a	5/10[d]	5/10[d]	0.6
Nickel	ND-1	ND-0.6	LFL[c]	0.1/1[d]	0.1/1[d]	0.6
Silver	ND	ND	0.01	0.01	0.01/0.1[d]	1
Tin	ND	ND	2	2	2	3
Tungsten	ND	ND	1/5[d]	1/5[d]	1/5[d]	3
Vanadium	ND	ND	0.05[e]	0.05	0.05	0.6
Zinc	3-18	ND-3	5	5/10[b]	5/10[b]	1

ND The analyte was not detected.

n/a NIOSH does not have a REL for this metal.

a. Minimum detectable concentration (MDC) based on an average sample volume of 860 liters.

b. Values are for fume/total dust.

c. NIOSH considers this analyte to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible level.

d. As soluble compound/insoluble compound of the metal.

e. As a ceiling exposure criterion.

Figure 1
Welder #1
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992

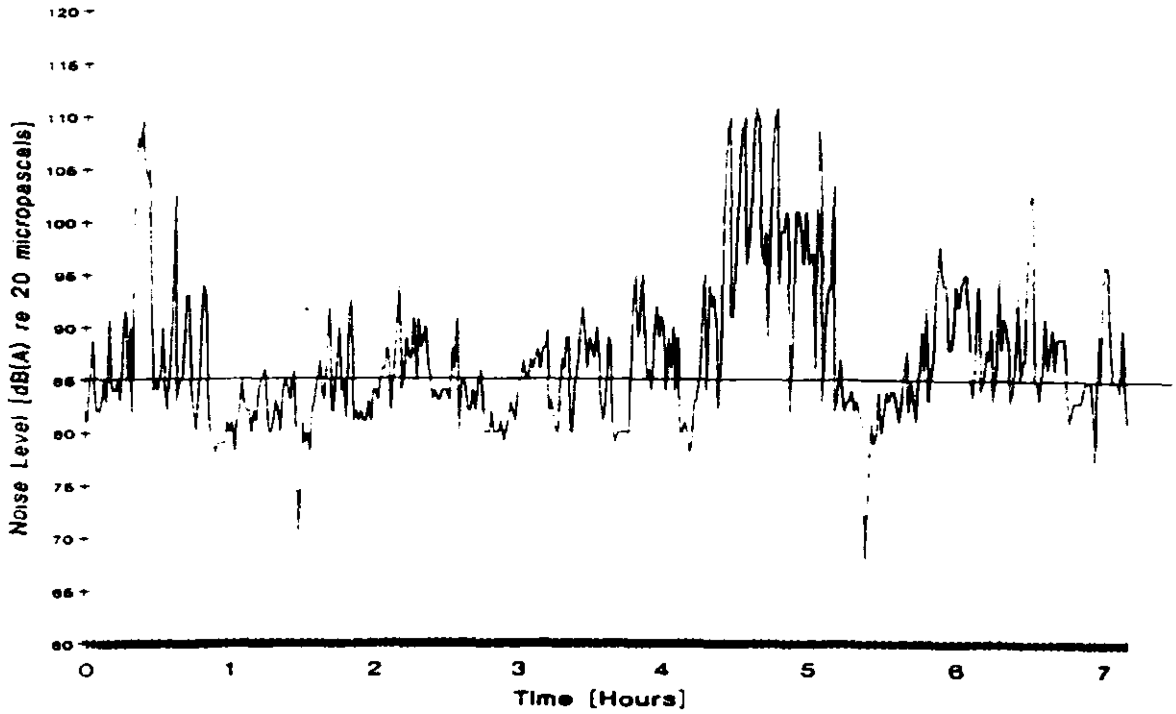

Figure 2
Welder #2
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992

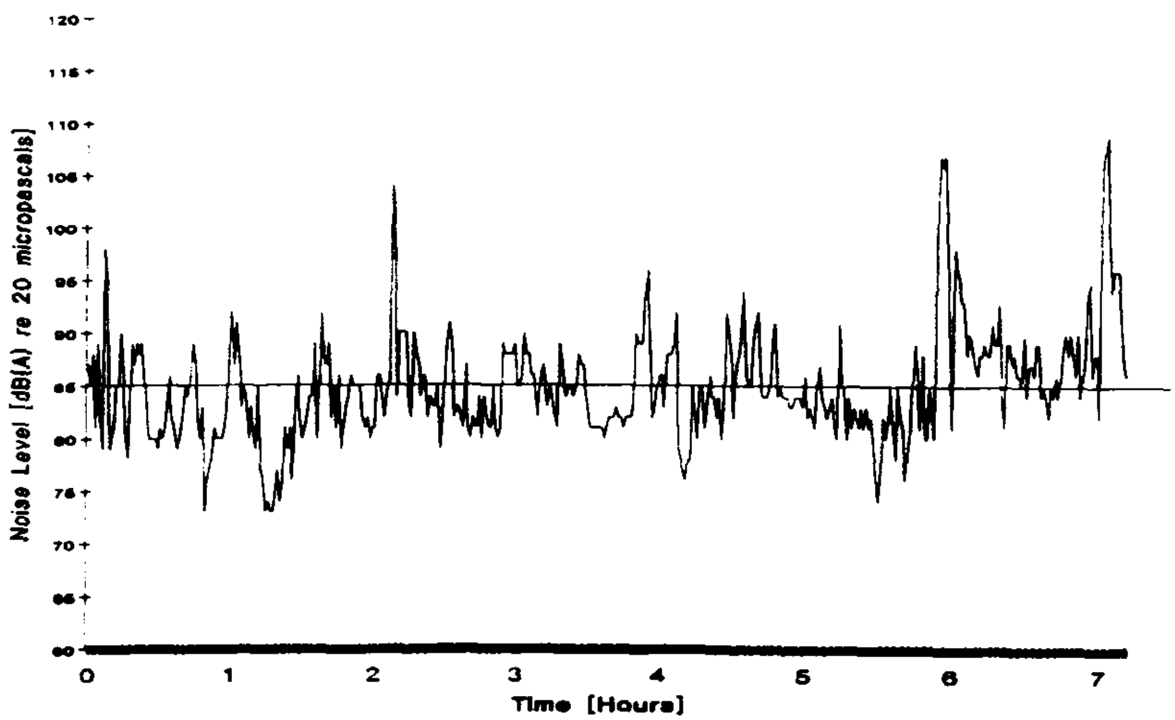

Figure 3

Slot Press #4851 Operator
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992

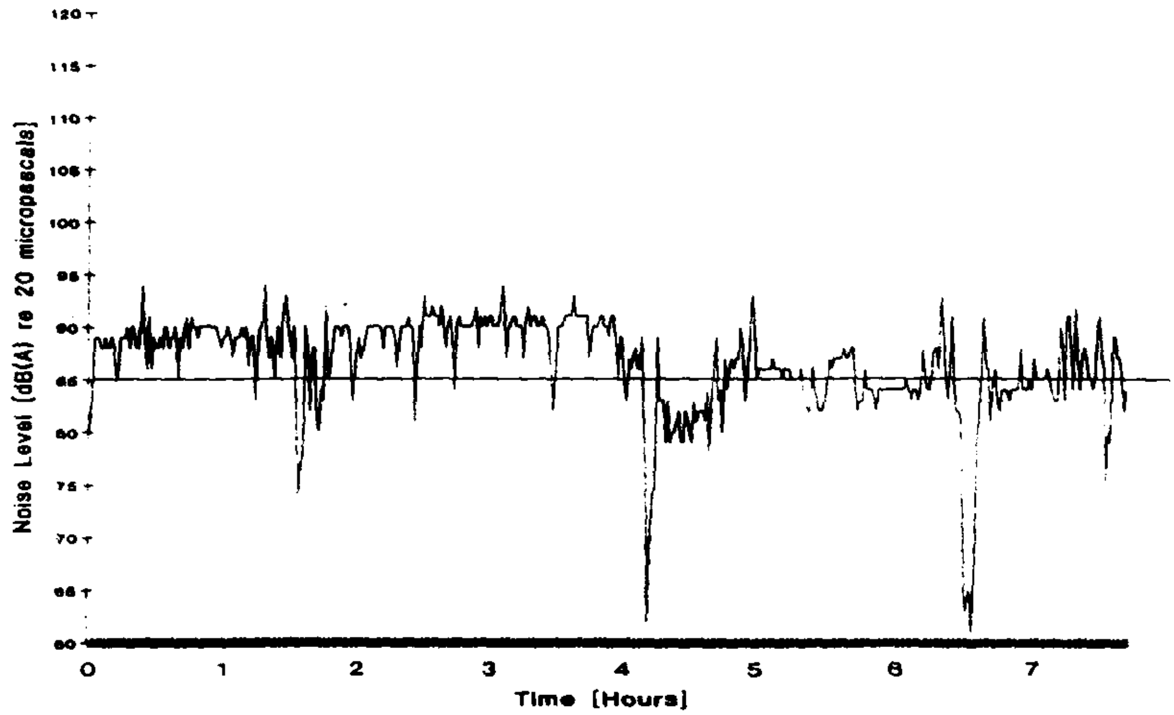

Figure 4

Punch Press #5693 Operator
Siemens E & A - Cincinnati, OH
HETA 91-305
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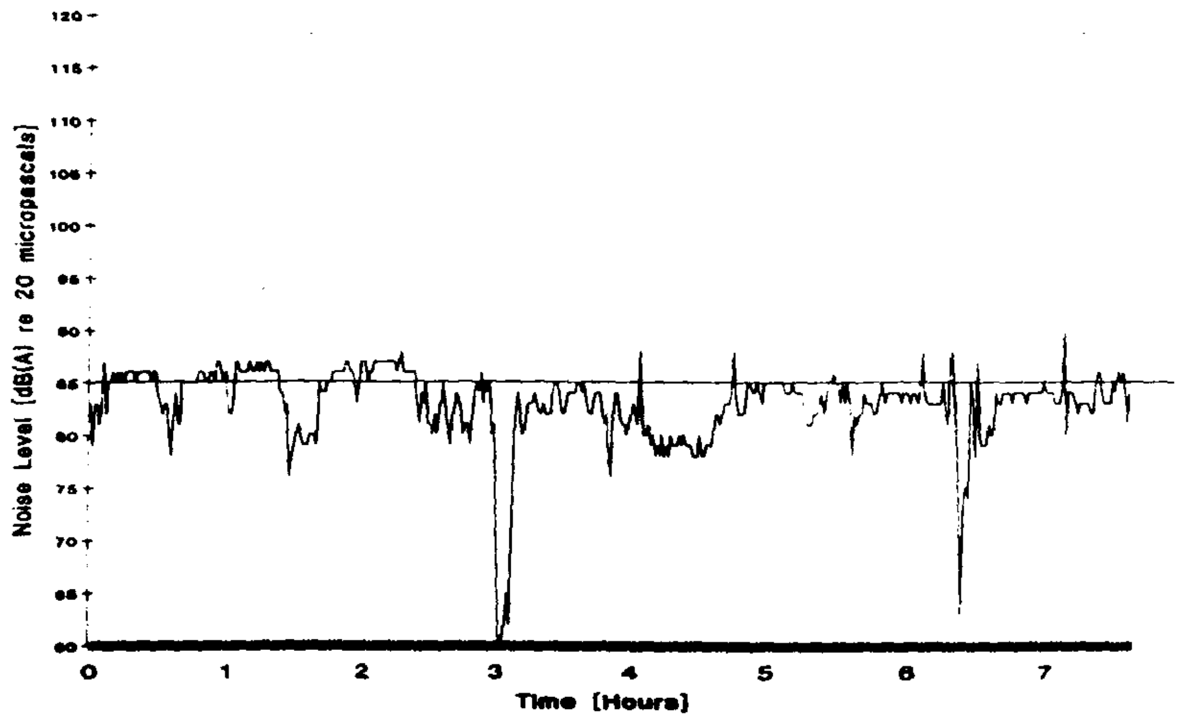


Figure 5

Spacer Machine #5331 Operator
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992

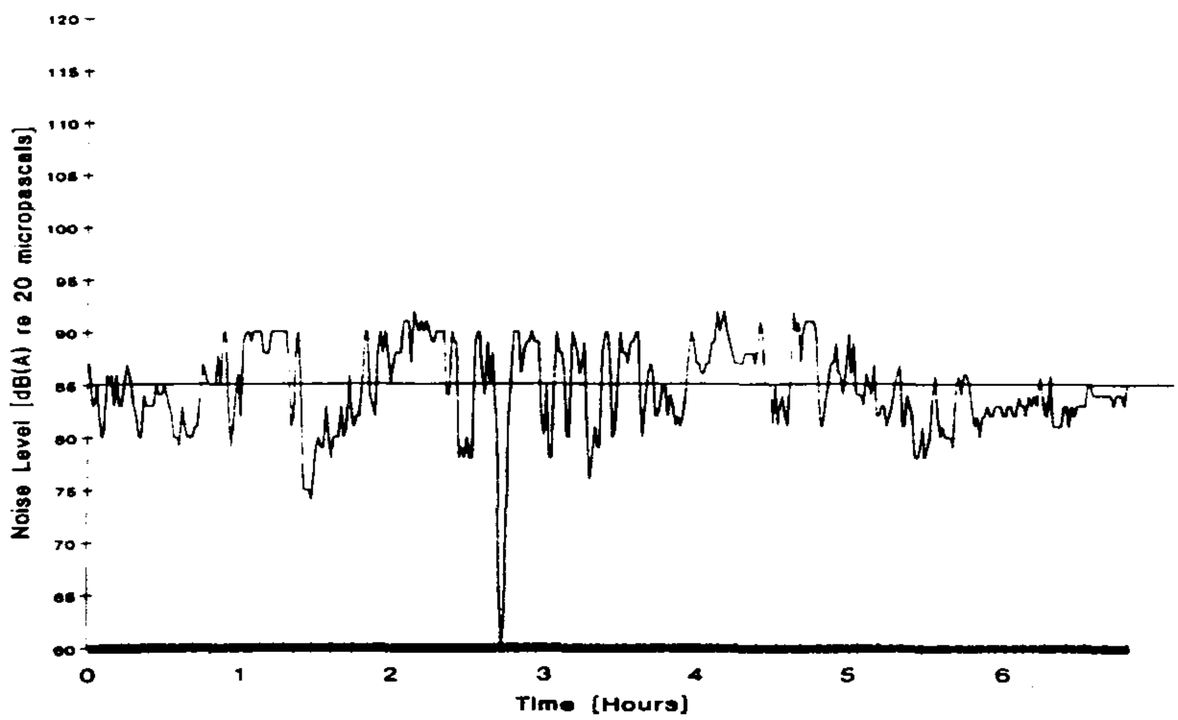


Figure 6

Tape Machine #4391 Operator
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992

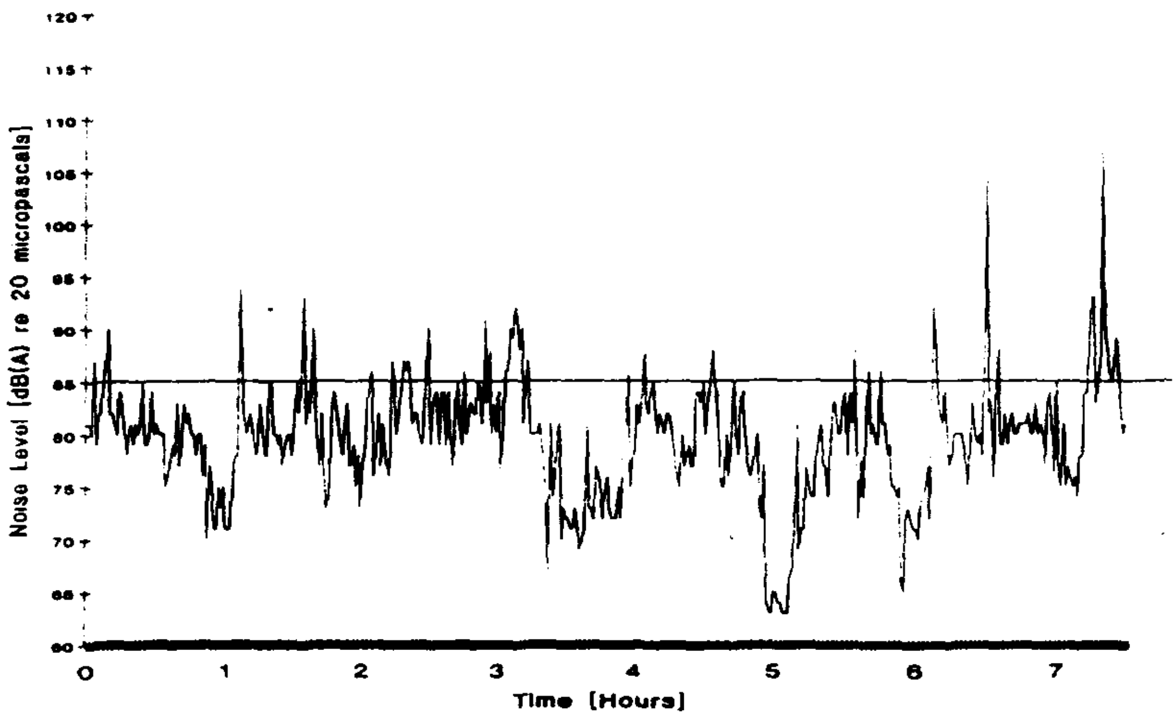
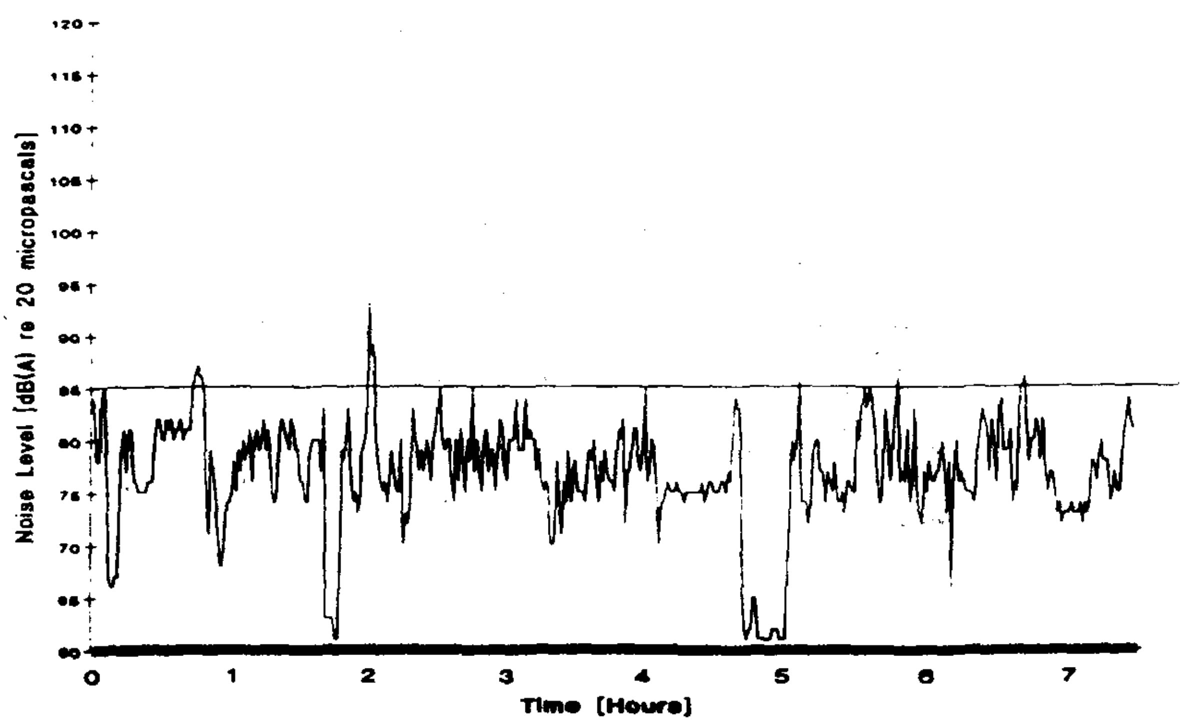


Figure 7

Tape Machine #4393 Operator
Siemens E & A - Cincinnati, OH
HETA 91-305
February 27, 1992



APPENDIX I

The Occupational Safety and Health Administration's General Industrial Standard on respiratory protection, 29 CFR 1910.134, requires that a respiratory protection program be established by the employer and that appropriate respirators be provided and be effective when such equipment is necessary to protect the health of the employee. They should be used as a primary control for employee protection only where engineering controls are not feasible or are currently being installed. The standard requires the employer to address eleven basic requirements which would provide for an acceptable respiratory protection program. These requirements are summarized below for easy reference:

I. Provide Written Operating Procedures

The employer must prepare written standard operating procedures governing the selection and use of respirators. The procedures must include a discussion or explanation of all items specified in 29 CFR 1910.134(b).

II. Proper Selection of Respirator

The proper selection of a suitable respirator is dependant upon a number of parameters including: physical nature of the contaminant, concentration of contaminant in the air, toxicity of contaminant and warning properties of the substance (e.g., odor or irritation, which can indicate the end of the service life of the respirator).

III. Training and Fitting for the Employee

Requires that the user be instructed and trained in the proper use of respirators and their limitations, as well as with their maintenance. Qualitative fit testing of respirators fit in a test atmosphere is required. Some OSHA standards now require quantitative fit testing before assignment of a respirator to any employee. In addition, the employee shall be familiar with personal face fit testing techniques and perform this practice of fitting each time the respirator is worn.

IV. Exclusive Employee Use

Where practical, a respirator should be assigned to individual workers for their exclusive use.

V. Cleaning and Disinfecting

Respirators should be cleaned and disinfected on a daily basis if used routinely throughout the day or less frequently if used less often. Respirator cleanliness is particularly important in dusty environments or where respirators are shared by several individuals.

VI. Storage

Respirators should be stored in a dry, clean storage area which is protected from extremes in temperature, sunlight or physical damage.

VII. Inspection and Maintenance

Inspection schedules vary in frequency for specific types of respiratory protection equipment but should at least be inspected for damage or malfunctions both before and after each daily use. Records must be kept for emergency use respirators of at least monthly inspection dates and the inspectors findings. Developing a check list of items to look for is a good idea when inspecting any reusable respirator.

VIII. Work Area Surveillance

Surveillance by the employer of the work area is required and includes identification of the contaminant, nature of the hazard, concentration at the breathing zone, and if appropriate, biological monitoring.

IX. Inspection and Evaluation of Program

The effectiveness of the instituted program measures should be periodically evaluated. It is the employer's responsibility to administer the respiratory protection program so that it is effective. This includes mandatory employee participation where appropriate and provision of all other items cited herein.

X. Medical Examination

It is required that a medical assessment of the employees ability to wear a respirator be performed prior to providing him with a respirator. This requirement determines the employees capability of enduring the added stress to his heart when wearing a respirator.

XI. Approved Respirators

Only respiratory protection devices approved by NIOSH or OSHA, or both, can be used. Interchanging parts of different respirators nullifies approval.

Further information on respirators and instructions for establishing an appropriate respiratory protection program can be found in the NIOSH guide to Industrial Respiratory Protection, DHHS (NIOSH) Publication No. 87-116. Single copies are available free and can be obtained from:

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