HETA 2000-0181-2841
Wire Rope Corporation of America, Inc.
Sedalia, Missouri

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PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Calvin K. Cook, Jeffery E. Hess, and Randy Tubbs of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by the Division of Applied Research and Technology (DART) and Data Chem Laboratories, Inc. Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Occupational Exposures at the Wire Rope Corporation of America

In June 2000, NIOSH investigators did a health hazard evaluation at the Wire Rope Corporation of America (WRCA) plant in Sedalia, Missouri. NIOSH had received a confidential request from WRCA employees who were concerned about their exposures to noise, asphalt fume, and metal dust.

What NIOSH Did

- We measured noise levels.
- We tested the air for asphalt fume and metal dust.
- We measured lighting levels.
- We talked to employees about their health.
- We looked for possible safety hazards.

What NIOSH Found

- WRCA has a hearing conservation program.
- Employees were exposed to hazardous noise levels.
- Employees were overexposed to asphalt fume.
- Some of the employees' symptoms, such as headache, respiratory irritation, and eye irritation, could be related to asphalt fume exposures.
- Metal dust levels were low.
- Most workstations had poor lighting.

What WRCA Management Can Do

- Continue plans to install local exhaust ventilation at the strander and the closer machines.
- Relocate the lube storage tank outdoors.
- Continue the hearing conservation program in its entirety.
- Replace missing or deteriorated acoustical material on machines to help reduce noise levels.
- Supply ear plugs that protect hearing, yet allow workers to hear important signals.
- Continue plans to improve lighting.

What the WRCA Employees Can Do

- Wear hearing protection in noisy areas.
- Tell supervisors about any health and safety problems that concern you.

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National Institute for Occupational Safety and Health NIOSH

Health Hazard Evaluation Report # 2000-0181-2841
Wire Rope Corporation of America
Sedalia, Missouri
May 2001

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SUMMARY

In March 2000, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from a group of employees to conduct a health hazard evaluation (HHE) at the Wire Rope Corporation of America (WRCA) in Sedalia, Missouri. The HHE request stated that some employees experienced symptoms of nose bleeds, eye irritation, and unspecified respiratory symptoms that were believed to be related to exposures to metal dust and asphalt fume at work. Employees were also concerned about hazardous noise levels, poor lighting, and lack of exhaust ventilation to control air contaminants.

A site visit on June 14-16, 2000, included a walk-through inspection of the facility's processes and medical interviews. On June 28-29, 2001, personal breathing-zone (PBZ) and area air samples were collected for metal dust and asphalt fume. To measure asphalt fume, air samples were collected and analyzed for the total particulate, the benzene-soluble particulate fraction, and polycyclic aromatic compounds (PACs). Noise exposures and lighting levels were also measured.

Six full-shift PBZ air samples showed exposures to metal dust that were less than 1 percent of the most stringent occupational exposure limit available. Six short-term air samples collected for asphalt fume (measured as total particulate) showed that utility workers' exposures ranged up to 3.2 milligrams per cubic meter (mg/m^3), below the NIOSH 15-minute ceiling limit of 5 mg/m^3. Air sampling for the benzene-soluble particulate fraction of asphalt showed a strander operator's time-weighed average (TWA) exposure as high as 0.8 mg/m^3, a concentration which exceeded the American Conference of Governmental Industrial Hygienists' (ACGIH) time-adjusted Threshold Limit Value (TLV®) of 0.25 mg/m^3 for a 12-hour TWA concentration. Two utility workers' exposures of 0.3 mg/m^3 and 0.4 mg/m^3 also exceeded the 12-hour adjusted ACGIH TLV for benzene-soluble particulate. Although no occupational exposure limits are currently available for PACs as a group, area air sampling showed the most abundant subclass of PACs were those believed to be associated with irritative effects.

A total of 15 workers were interviewed, including all three of the utility workers present during our site visit. The workers had complaints of headache, upper respiratory irritation, increases of allergy symptoms, cough, and dry eyes. The symptoms generally improve when the employees leave the work site. Interviewed employees noted that the majority of symptoms and complaints have decreased in frequency and severity following elimination of the scrap cutting and some descaling processes. Workers reported that current symptoms are frequently related to exposure to asphalt fume from the large lube holding tanks.

The vast majority of workers at the WRCA are exposed to excessive noise levels; some up to 9 ½ times the allowable dose for a 12-hour work shift. All employees surveyed have noise exposures that require them to be included in a hearing conservation program. Illumination levels range from 8 to 76 foot-candles, which are generally less than the American National Standard Institute (ANSI) recommended range of 50 to 100 foot-candles for machining processes at WRCA.

Workers who handle liquid asphalt are overexposed to asphalt fume (measured as benzene-soluble particulate). The majority of WRCA workers are exposed to excessive noise levels, and most areas of the plant are poorly illuminated. Interviewed workers complained of headache, upper respiratory irritation, increases of allergy symptoms, cough, and dry eyes. However, these employees have noticed a decrease in the frequency and severity of these symptoms and complaints since scrap cutting and some descaling processes have stopped. Workers also reported that current symptoms are frequently related to exposure to asphalt fume from the large lube holding tanks. Recommendations are offered to reduce exposures to asphalt fume and hazardous noise levels, and to improve lighting at work stations.

Keywords: SIC 3496 (Rope manufacturing, non- insulated wire) asphalt fume, noise, benzene-soluble, total particulate, polycyclic aromatic compounds, PACs, lighting, metals, unusual work schedules.

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INTRODUCTION

In March 2000, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request to conduct a health hazard evaluation (HHE) at the Wire Rope Corporation of America (WRCA) in Sedalia, Missouri. The request was prompted by employees' concerns about exposures to metal dust, asphalt fume, "hazardous" noise levels, the lack of local exhaust ventilation, and poor lighting in the workplace. The request stated that some employees experienced nose bleeds, eye irritation, and unspecified respiratory symptoms while at work.

On June 14-16, 2000, an initial site visit was made by NIOSH investigators that included an opening conference with management and employee representatives, followed by a walk-though inspection to gather information about the facility's processes and evaluate exhaust ventilation. Also, employees were interviewed and records were reviewed by the NIOSH medical officer. On June 28-29, 2000, a follow-up visit was made to conduct industrial hygiene activities that included air sampling for asphalt fume and metal dust, and measurements for noise and illumination.

BACKGROUND

Facility and Process Description

WRCA is the largest manufacturer of wire rope products in North America. The Sedalia plant is a 200,000 square-foot facility that employs about 12 administrative and 186 production personnel capable of producing 40 tons of wire rope over two shifts a day. Production personnel work 12-hour work shifts that includes 3 days on, 2 days off, then 2 days on during the course of a work week. Production jobs include wire draw operators, strander operators, closer operators, and utility workers. Maintenance and quality assurance personnel also work within the plant production area.

Wire rope manufacturing involves fabricating metal wire (made of high carbon steel) into wire strands and rope using high-speed wire spinning machines. From start to finish the production operations include wire drawing, stranding, closing, and forging. Other production phases may include descaling, pre-stretching, and extruding, which applies a plastic outer coating onto finished wire rope.

The descaling operation passes wire materials through an automated high-speed sander to remove any external coating or scale. Wire drawing forms wire into a desired diameter using machine dies and a dry soap lubricant. Both the descaling and wire draw operations are essentially enclosed and equipped with local exhaust ventilation that leads to a baghouse dust collector. The stranding operation combines wires into strands, and the closing operation assembles strands into rope. A pump in the strander and closer machines applies heated petroleum-based asphalt lubricants (lubes) over the wire or strand as it is being spun. Strander and closer operators both perform similar job tasks, and both have potential exposures to asphalt fumes and metal dust. Forging is a final operation which uses a Swager® machine to hammer finished rope into a desired form or shape. Because hazardous noise levels are produced by a variety of machines and processes, management has a written hearing conservation program (HCP) established for production personnel, which requires them to wear hearing protective devices (HPD) such as ear plugs and muffs.

According to material safety data sheets (MSDSs), the asphalt lubes contain tar or other viscous petroleum products that are solid or semi-solid at room temperature. Lubes are stored in four 55-gallon tanks and heated to 200-350° F, which allows them to be poured onto wire as it is being spun into strands or rope. Utility workers' manually transport the heated lubes from storage tanks to heated troughs at strander and closer machines. Asphalt fume is released directly into the work environment due to an absence of local exhaust ventilation at lube storage tanks, strander machines, and closer machines Utility workers reported that the most intense asphalt fume exposure occurs while filling the main lube storage tanks and after lifting the lid of one of the heated 55-gallon containers to remove lube for transport. Workers also reported that lubes occasionally (three to four times a year) become over-heated and produce thick, black smoke that fills the plant.

METHODS

Industrial Hygiene

Air Sampling

Six full-shift personal breathing-zone (PBZ) air samples for metal dust were collected on first-shift workers including wire draw operators, strander operators, and spooler operators. Air samples were collected on mixed cellulose ester (MCE) filter cassettes that were connected to battery-powered air sampling pumps pre- and post calibrated at a flowrate of 2 liters per minute (lpm). Samples were analyzed for 30 different metals and minerals in accordance with the NIOSH Manual of Analytical Method (NMAM) 7300.[1] We were specifically interested in chromium, iron, manganese, and nickel.

To evaluate workers' exposures to asphalt fume, four full-shift PBZ air samples for total particulate and the benzene-soluble particulate fraction were collected on utility workers and strander operators. A full-shift area air sample and five 15-minute area air samples were collected at lube storage tanks and one strander machine. Each air sample collected both the total particulate and the benzene-soluble fraction on a pre-weighed Teflon® filter. Sampling pumps were pre- and post-shift calibrated at a flowrate of 2 lpm for full-shift air samples and at 4 lpm for 15-minute air samples. Samples were analyzed in accordance with the NMAM 5042.[1]

Four area air samples for polycyclic aromatic compounds (PACs) were collected at lube storage tanks and a strander machine for about 10-hour periods. Air samples were collected using a sampling train that consisted of a Teflon® filter followed by an ORBO®-42 sorbent tube connected to air sampling pumps pre- and post-shift calibrated at a flowrate of 2 lpm. Air samples for PACs were analyzed in accordance with the NMAM 5800.[1]

Noise Dosimetry

Quest® Electronics Model Q-300 noise dosimeters were worn by employees during most of their 12-hour shift. The noise dosimeters were attached to the wearer's belt and a small remote microphone was fastened to the wearer's shirt at a point midway between the ear and the outside of the employee's shoulder. At the end of the shift, the dosimeters were removed and paused to stop data collection. The information was downloaded to a personal computer for interpretation with QuestSuite for Windows® computer software. The dosimeters were calibrated before and after the work shift according to the manufacturer's instructions.

Real-time area noise sampling was conducted with a Larson-Davis Laboratory Model 2800 Real-Time Analyzer and a Larson-Davis Model 2559 random incidence response microphone (½" size). The analyzer allows for the analysis of noise into its spectral components in a real-time mode. The ½" diameter microphone has a frequency response range (± 2 decibels [dB]) from 4 Hertz (Hz) to 21 kilohertz (kHz) that allows for the analysis of sounds in the region of concern. One-third octavebands consisting of center frequencies from 20 Hz to 20 kHz were integrated and stored in the analyzer. The analyzer was mounted on a tripod placed at various locations while the sound was integrated for 30 seconds. Measurements were taken only when the machine or machines were operational.

Lighting Measurements

To determine the adequacy of light for workers to perform work tasks, a general lighting survey was done that involved taking measurements at work stations. Lighting levels were measured with a hand-held light meter (Weston® Foot Candle Meter model 614, Daystrom, Inc. Newark, New Jersey) that gives readings in units of foot-candles.

Medical

The NIOSH medical officer conducted confidential interviews with utility workers and the general workforce within the plant. The interview consisted of questions regarding respiratory, neurologic, dermal, and mucous membrane symptoms. In addition, questions were asked concerning chemical and noise exposure. Individuals were given the opportunity to ask questions and voice additional concerns.

Interviews were conducted among employees of one of the two rotating employee groups who were working during the NIOSH site visit. All utility personnel working during the first and second shifts were asked to participate because we judged them to have the greatest potential for exposure to the asphalt fume. Every sixth employee listed on a daily attendance roster provided by the company for the first and second shifts (excluding utility workers) were also asked to participate in interviews with the NIOSH medical officer.

Along with employee interviews, the Occupational Safety and Health Administration's (OSHA) Summary of Occupational Injuries and Illnesses (OSHA 200 log) from January 10, 1999, through June 6, 2000, was reviewed. Additionally, a separate company injury and medical information log, which included data collected since January 2000, was reviewed. The company physician was interviewed by telephone.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 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 increases 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 Recommended Exposure Limits (RELs),[2] (2) the American Conference of Governmental Industrial

Hygienists' (ACGIH) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 95–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

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 STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term. However, for the purpose of this HHE exposure limits were adjusted to account for an unusual work schedule of 12-hour days experienced by WRCA's production employees.

Asphalt Fume (Petroleum)

The specific chemical content of asphalt, a brown or black solid or viscous liquid at room temperature, is difficult to characterize because it is extremely complex and variable. In general, asphalt primarily contains high molecular weight cyclic hydrocarbon compounds as well as saturated organic compounds. The chemical composition and physical properties of the asphalt products are influenced by the original crude petroleum and the manufacturing processes. The basic chemical components of asphalt include paraffinic, naphthenic, cyclic, and aromatic hydrocarbons as well as heteroatomic molecules containing sulfur, oxygen, and nitrogen.[5]

In a 1977 criteria document, NIOSH established a REL of 5 mg/m^3 (as a 15–minute ceiling limit) for asphalt fumes, measured as a total particulate.[6] This level was intended to protect against acute effects, including irritation of the serous membranes of the conjunctivae and the mucous membranes of the respiratory tract. Asphalt fumes can be absorbed through the lungs or the skin. Research has indicated that exposure to asphalt fume can result in nonmalignant lung diseases such as bronchitis, emphysema, and asthma.[7,8] Since publication of the 1977 criteria document, data have become available indicating that exposure to roofing asphalt fume condensates, raw roofing asphalt, and asphalt-based paints may pose a risk of cancer to occupationally exposed workers. In 1988, testimony to the U.S. Department of Labor, NIOSH recommended that asphalt fumes be considered a potential occupational carcinogen.[9] This recommendation was based on information presented in the 1977 criteria document and a study which demonstrates skin tumors in mice to asphalt fume condensate.[10]

Presented below is a summary of the toxicity and exposure criteria information for asphalt fume constituents evaluated – total particulate of asphalt fume, the benzene soluble particulate fraction, and total PACs.

Total Particulate

Although the composition of asphalt fume cannot be easily characterized, one evaluation technique has been to sample it as a total particulate. Total particulate is a measure of all airborne particulate collected on the sample filter. Current occupational exposure criteria from NIOSH for asphalt fume is expressed as total particulate. The NIOSH REL is 5 mg/m^3 for a 15-minute ceiling exposure.[2] There is no current OSHA PEL for asphalt fume.

Benzene-Soluble Fraction

Historically, the benzene-soluble fraction concentrations were measured in asphalt studies in an attempt to differentiate between exposures to the asphalt fume and dirt or other dust present at asphalt construction operations.[11] The benzene-soluble particulate fraction is that portion of the total particulate that is soluble in benzene. Organic compounds are generally soluble in benzene, whereas inorganic compounds are not benzene-soluble.

There are no exposure limits established by NIOSH or OSHA for the benzene-soluble fraction of asphalt fume. The only exposure criteria available for the benzene-soluble fraction is the ACGIH TLV® of 0.5 mg/m^3, which was developed to account for workers exposures during a normal 8-hour day, 40 hours/week.[3] However, for this HHE the TLV® for the benzene-soluble fraction was adjusted to 0.25 mg/m^3 to account for a 12-hour workday. NIOSH investigators used the "Brief and Scala model" for unusual work schedules to calculate an adjusted TLV® for the benzene-soluble fraction.[12] The Brief and Scala model reduces the TLV® proportionately for both increased exposure time and reduced recovery (non-exposure) time. ACGIH recommends the use of this model to adjust the TLV®s to assess exposures during unusual work schedules, such as those worked by production workers at WRCA.

Total Polycyclic Aromatic Compounds

PACs refer to a set of cyclic organic compounds that includes polycyclic aromatic hydrocarbons (PAHs) and also includes compounds that may have sulfur, nitrogen, or oxygen in the ring structure and alkyl-substituted cyclics.[11] Hundreds of PACs with varying degrees of alkyl substitutions are typically associated with asphalt materials. PAHs have received considerable attention since some have shown to be carcinogenic in experimental animals.[13]

NIOSH investigators have hypothesized that PACs with 2 to 3 rings (referred to in this report as PAC_{360}) are associated with irritative effects, while the 4- to 7-ring PACs (termed PAC_{400}) may have more carcinogenic and/or mutagenic effects.[11] It is not currently possible to definitively distinguish between these two PAC groups analytically; however, using two different spectrofluorometric detector wavelengths (360 nanometer [nm] and 400 nm) allows the detector to be more sensitive to PACs of low or high ring number, respectively. No exposure limits are established for PACs as a class.

Occupational Noise Exposures

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 (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.[14] 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 Hz (the hearing range is 20 Hz to 20000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.[15]

The A-weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dB(A) scale is logarithmic, increases of 3 dB(A), 10 dB(A), and 20 dB(A) represent a doubling, tenfold increase, and 100-fold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)[16] specifies a maximum PEL of 90 dB(A) for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dB(A) for no more than 4 hours, to 100 dB(A) for 2 hours, etc. Conversely, up to 16 hours exposure to 85 dB(A) is allowed by this exchange rate; 12-hr exposures have to be an average of 87 dB(A) or less. The duration and sound level intensities can be combined to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \text{ X } (C1/T1 + C2/T2 + ... + Cn/Tn),$$

where Cn indicates the total time of exposure at a specific noise level and Tn indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% are in excess of the OSHA PEL.

The OSHA regulation has an additional action level (AL) of 85 dB(A); an employer shall administer a continuing, effective hearing conservation program when the 8-hour TWA value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard 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.

NIOSH, in its Criteria for a Recommended Standard,[17] and the ACGIH,[3] propose exposure criteria of 85 dB(A) as a TWA for 8 hours, 5 dB less than the OSHA standard. The criteria also use a more conservative 3 dB time/intensity trading relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to no more than 88 dB(A) for 4 hours or 91 dB(A) for 2 hours. Twelve hours exposures have to be 83 dB(A) or less according to the NIOSH REL.

Industrial Lighting

Adequate lighting in the workplace provides better seeing conditions for workers to safely perform tasks and may improve productivity.[18] Poor room or task lighting conditions in the workplace can lead to eye strain. Chronic eye strain does not to lead to any permanent eye damage. Eye strain symptoms include headache, tired eyes, and eye irritation. Workers over the age of 40 are more likely to experience symptoms of eye strain due to age-related visual decreases, and thus they require higher illumination levels to perform similar tasks than do younger workers in the same work environment.[19]

The American National Standard Institute (ANSI) offers guidelines for proper illumination levels.[19] Illumination is measured in units of foot-candles (lumens per square foot of surface area), which is the amount of light falling on the area where the visual task is being performed. ANSI's recommended levels may vary according to the job task demands of the worker. According to ANSI guidelines, the machining processes at WRCA should have illumination levels of 50 to 100 foot-candles for performance of visual tasks of medium contrast.

RESULTS

Industrial Hygiene

Air Sampling

Air sampling for metal dust revealed that workers were exposed to very low concentrations of all metals. The highest air concentration measured was iron oxide, which was only about 1 percent of its most stringent exposure criteria of 5 mg/m^3, as an 8-hour TWA concentration.

The air sampling results for the total particulate and benzene-soluble fraction are presented in Table I. Two utility workers' short-term exposure to total particulate were 2.2 mg/m^3 and 3.2 mg/m^3, both below the NIOSH 15-minute ceiling limit of 5 mg/m^3. These exposures, however, were close to and more than half the NIOSH ceiling limit for total particulate, which generally warrants actions to reduce exposures. Area air samples collected for 15-minute periods revealed total particulate concentrations as high as 69.7 mg/m^3 at lube storage tanks. Air sampling for the benzene-soluble fraction showed one strander operator's full-shift TWA exposures to be 0.8 mg/m^3, which exceeds the adjusted ACGIH TLV® of 0.25 mg/m^3 as an 12-hour TWA concentration.[3] Two utility workers' benzene-soluble particulate exposures of 0.3 mg/m^3 and 0.4 mg/m^3 also exceeded the adjusted ACGIH TLV® of 0.25 mg/m^3.

The air sampling results for total PACs are summarized in Table II. Total PACs are presented in two groups, based on spectrofluorometic detector wavelengths (360 nm and 400 nm). In every air sample collected, the PAC_{360} concentration was greater than the corresponding PAC_{400} concentration, an indication that the more irritative 2- to 3-benzenoid ring PACs are more abundant in the asphalt fume measured at WRCA.

Noise Dosimetry

A total of 15 employees wore noise dosimeters during the evaluation, 9 on the first day and 6 on the second day. Each employee worked on a different machine. The machines were selected to represent a cross-section of the types of equipment at the facility. The noise measurements collected by the dosimeters are reported in several formats, including the actual dose collected during the measurement period (Dose), the 8- and 12-hour extrapolated doses (Dose-8 and Dose-12), the dB(A) average for the measurement period (L_{AVG}), and the dB(A) values for 8-hour and 12-hour work shifts (TWA-8 and TWA-12). The Quest dosimeters collect data so that one can directly compare the information with the three different noise criteria used in this survey, the OSHA PEL and AL, and the NIOSH REL. The OSHA criteria use a 90 dB(A) criterion and 5-dB exchange rate for both the PEL and AL. The difference between the two is the threshold level employed, with a 90 dB(A) threshold for the PEL and an 80 dB(A) threshold for the AL. The threshold level is the lower limit of noise values included in the calculation of the criteria; values less than the threshold are ignored by the dosimeter. The NIOSH REL differs from the OSHA PEL in that the criterion is 85 dB(A), the threshold is 80 dB(A), and it uses a 3-dB exchange rate.

Tables III and IV detail the results from the noise dosimeter survey. The employees' exposures are generally high, with the evaluation criteria exceeded in most instances. The stranding area has the highest personal noise exposures in the facility where employees receive from 200% to over 900% of their daily allowed dose according to the PEL in the 12-hour work shift. Many of the evaluated closer machine employees (M-11, M-12, M-13, and M-14) had exposures that were less than the OSHA PEL. However, these same closer machine operators were all in excess of the 50% dose that defines the OSHA AL. In all 15 measurements, the NIOSH REL and OSHA AL were exceeded for the 12-hour work shift. When the extrapolated 8-hour shift noise dose is compared to the 12-hour shift, only two closer machine exposures (M-4 and M-5) changed from a less than the PEL condition to a greater than the PEL condition, 96% to 144% and 97% to 145%, respectively.

During the two day dosimeter evaluation, general area noise samples were also collected around the various machines on the production floor. The results from the area sampling are shown in Table V. These findings generally confirm the personal noise exposures, with the stranding machines emitting the highest noise levels. The area samples for the stranding machines were all in excess of 100 dB(A), with one exception at 99 dB(A). One of the closer machines, M-10, was found to be significantly higher than the other surveyed machines. M-10 was also louder than the two Swager® machines that are located across an aisle from it.

Nearly all employees in the manufacturing area were wearing hearing protection. Employees working in the stranding machines area were required by the company to wear double hearing protection, i.e., ear muffs over ear plugs. Employees who did not work on wire rope machines, such as supervisors, maintenance, and office staff, wore hearing protection whenever they entered the production area. WRCA offered several types of HPDs to the employees, including four brands of formable earplugs, one brand of pre-molded earplugs, and two brands of earmuffs. The HPDs' attenuation data supplied by the manufacturers were used with the octave-band noise data collected from the general area noise sampling to determine the effective level of noise exposure to the workers when wearing the protectors. The analyses indicated that the employees' noise exposures would be reduced to an acceptable level assuming that the HPDs were optimally worn to produce maximum noise reduction.

Many of the machines have removable covers or enclosures, and some of the covers had been treated with acoustical damping materials to help reduce noise emissions. For example, M-23 has acoustical foam on the underside of the cowling that covers the machine while it is in motion. However, it is evident that the foam has been in place for a long period of time since it crumbles very easily when handled, indicating that it is no longer an effective noise control. Also, in the strander area, a noticeable vibration could be felt through the floor in the aisle between M-30 and M-31 at about the mid-point of the two machines. The noise levels seemed subjectively higher at this location. It is possible that the rotating axis of one or both machines is out of balance, leading to excessive vibrations and noise.

Lighting Measurements

Illumination levels ranged from 8 to 76 foot-candles. The lowest illumination levels were measured in the wire draw area (the northeast end of the plant), and the highest levels were measured in the machine shop (the southeast end of the plant). Illumination levels ranged from 20 to 38 foot-candles in the middle of the plant where strander machines are located.

Medical

Four utility workers (100% of utility personnel working during the NIOSH site-visit) and 11 selected general plant employees (15% of those employees working during the site visit) were interviewed. This encompassed 44% of all the utility workers and 6% of the production and maintenance personnel at the plant. None of the individuals selected for interview declined to participate.

Among the utility workers, none reported having been diagnosed with asthma or emphysema which would increase the individual's likelihood of experiencing respiratory related symptoms. Symptoms reported by this group included occasional headache (3), nasal congestion (2), upper respiratory irritation (3), nosebleeds during winter months (2), eye irritation (1), occasional productive cough (4), and frequent upper airway infections (3). Irritant symptoms related to the upper respiratory tract was most commonly reported during the utility worker interviews. Those employees related the noted symptoms to exposure to vapor and smoke inhaled when working in the lube storage tank area. Headaches reported occurred from once-a-month to daily, and were almost uniformly associated with exposure to lube vapors or smoke. One utility worker reported dry, irritated eyes on a daily basis, while the other three individuals reported little or no eye irritation. All of these individuals reported having three or more upper respiratory or sinus infections per year that occasionally required medical treatment to resolve.

The general plant population reported symptoms similar to those reported by utility workers, including occasional headache (3), upper respiratory irritation (6), increase in allergy symptoms (1), cough (4), and dry eyes (5). Upper respiratory and eye irritation were the most frequently reported symptoms felt to be work related by the general plant employees interviewed. Those interviewed reported noting these symptoms most commonly when a lube tank overheated and smoked, or when scrap wire cutting was performed. Three of those interviewed reported difficulty breathing and shortness of breath due to lube smoke when present. These symptoms generally resolved after the employee went outside or left the plant. One individual was unable to wear contact lenses while at work due to eye dryness and irritation. Two other individuals interviewed reported generalized irritation and dryness of the eyes . The majority of reported eye-related symptoms developed following the production of smoke from an overheated lube tank or from the scrap wire cutting process. General plant workers did not report the increased upper respiratory infection frequency noted by utility workers. However, one worker did report an increase in the frequency and severity of allergy symptoms (watery eyes, runny nose, nasal congestion, and sneezing) when working in the plant that would resolve after leaving the plant.

The amount of dust in the air was a general concern of all the employees interviewed, with most noting black material in the nasal mucous following completion of a work shift. Employees reported no specific symptoms related to this finding. Employees did report that the amount of black material noted in nasal mucous had decreased since the company has stopped performing the scrap wire cutting operation.

Of the individuals interviewed, all stated that hearing protection was readily available within the plant and that areas of the plant requiring use of hearing protection are well known. All employees stated that they routinely wore hearing protection, and that the company was testing their hearing at least yearly.

Review of the OSHA 200 log for the past two years predominantly showed injuries such as strains of muscles and joints, contusions, and lacerations. No respiratory illnesses or respiratory-related conditions were recorded. The company's injury and medical information log was begun in January 2000 to track injury and illness reports not recordable in the OSHA 200 log. Review of these data demonstrated findings similar to those noted in the OSHA 200 log, such as muscle and joint strains, contusions, and lacerations, with the addition of several reports of skin burns and puncture of skin from wire. There were no reports of respiratory, dermal, or ocular irritation contained within the log.

The company utilized a local physician for work placement evaluations and treatment of work-related injuries. The physician stated that he had toured the plant facility on several occasions to acquaint himself with the physical environment and job tasks performed. He stated that he had not treated any WRCA employee for respiratory, dermal, or ocular conditions related to work exposures.

DISCUSSION AND CONCLUSIONS

Air Sampling

The air sampling results showed that both strander and utility workers were overexposed to the benzene-soluble fraction of asphalt fume for the duration of their 12-hour work shift. Short-term exposures to asphalt fume as a total particulate were below the exposure limit for a 15-minute sampling period, however. Air sampling for total PACs showed PAC_{360} to be more abundant in the asphalt fume. PAC_{360} are believed to be associated with irritative health effects and are consistent with the upper respiratory irritation reported by workers.

Because some employees elected not to wear air sampling pumps, the number of PBZ air samples obtained was less than desired. In addition, it was not always possible to collect full-shift samples because respective employees left work early or were relocated to another work area during the sampling period. Thus, additional air sampling may be necessary to better characterize dust exposures among workers in the descaling and wire drawing areas where dust is reported to be a problem.

Noise Dosimetry

The vast majority of workers at the WRCA are exposed to noise levels that exceed all the evaluation criteria used in this HHE. Some machine operators surpass the OSHA regulation for noise exposures up to 9½ times of the allowable dose for a 12-hour work shift. All of the employees surveyed have noise exposures that require them to be included in a hearing conservation program. The company should continue its HPD program for the employees as aggressively as it currently does while it investigates other engineering controls that can effectively reduce noise exposures in some or all parts of the facility. It is possible that certain engineering controls along with administrative controls (e.g., shorter work shifts) may lower exposures to safe levels. Also, the company needs to continue to test workers' hearing through the audiometric testing program and use these data to pinpoint groups of workers or areas in the facility where the noise controls are not working at an optimal level and implement additional noise protection.

The two-day dosimeter survey revealed that the employees' noise exposures are excessive, exceeding at least one of the three evaluation criterion referenced in this evaluation. The NIOSH REL and OSHA AL was exceeded in all 15 samples. The OSHA PEL was exceeded in two-thirds of the samples. This comparison is for the 12-hour work shifts that WRCA has in place. The 12-hour TWAs ranged from 82 to 106 dB(A). However, if the company were to reduce the work time to a more traditional 8-hour shift, the employees' noise levels would still usually be greater than the OSHA regulations, particularly for the action level, ranging from 79 to103 dB(A). Therefore, a change in the work shift would not be an effective administrative noise control by itself.

The engineering controls already in place are enclosures over some of the machines. It appears that these controls have been in place for some time and have not received any routine maintenance or replacement of the acoustical treatment. Noise levels can be reduced by maintaining the machines that have been acoustically treated. Replacement of the current foam material with either similar material or other material that may have a longer, useful life should be considered as an engineering control for the production area. If the new materials result in noise reductions, then enclosing other machines with a similar covering can be included in future noise controls. The company also may be able to use the plant layout to its advantage in reducing noise exposures for some of the employees. The noisiest machines, the standers, are located in one area of the plant. Isolating this area with acoustic walls and ceilings will reduce noise for the operators of adjacent machines. However, the personnel in the stranding area will most likely have increased noise exposures because the noise produced by their machines will not be able to escape to the adjacent areas. Thus, this isolation should be considered in conjunction with efforts to reduce the noise emitted by the standers through better machine enclosures and reduction of vibrations produced by unbalanced machines.

The loudest machine in the plant was closer machine M-10. Initially, management and workers believed that the highest noise levels were produced by the Swager® machine located adjacent to closer machine M-10. However, inspection of the noise dosimeter data and general area noise samples show that the closer produces higher levels of noise than the two Swager® machines (M-9 and M-99). Through discussions with the operator of M-10 during the evaluation it was noted that M-10 has subjectively grown louder over the time since it was initially installed in its current location. Increasing machine imbalance may be part of the reason for this increase in noise emission. Routine preventative maintenance and rotational vibration monitoring may be an engineering fix for this particular machine.

The third level of noise control in the hierarchy of controls is personal protective equipment (PPE). The use of HPDs at WRCA is extensive. All employees are required to wear hearing protectors whenever they are on the production floor. Workers in the stranding area are further required to wear double protection, i.e., ear muffs worn over ear plugs. Compliance with this company policy was observed to be excellent. Both office and production workers were always seen wearing their HPDs by the NIOSH investigators. The requirement for double hearing protection in the stranding area is consistent with NIOSH recommendations that this level of protection be used whenever the TWA levels exceed 100 dB(A).[17] The one deviation from this policy is closer machine M-10. The 12-hour TWA was loud enough to warrant double protection also. The M-10 operator on the day of the survey reported that he was using both plugs and ear muffs for most of the day.

The analysis of the effective hearing protection attenuation for the noise spectra at WRCA was done using NIOSH Method #1, the long method.[16,20] The manufacturer's attenuation data used in the analysis were collected according to the older ANSI standard for measuring HPD effectiveness.[21] These calculations show that in areas where only single protectors are required, the employees are reducing their noise exposures to levels less than 85 dB(A) when using any of the types of HPDs used at WRCA. Unfortunately, the amount of attenuation that the workers are really getting is generally less than predicted because of the less than perfect sizing and fit of the protector. To account for this lack of precision, the HPDs are usually derated by some amount. NIOSH recommends that earmuffs be derated by 25%, formable ear plugs by 50%, and all other earplugs by 70%.[17] If the recommended deratings are used in the analyses, then there are situations where some of the HPDs offered by the company may not offer enough attenuation to reduce exposures to less than 85 dB(A). Specifically, the pre-molded, triple-flanged ear plug may not reduce the noise sufficiently for the M-4, M-5, M-9, and M-99 machine areas. Also, the "lite" version of one of the foam ear plugs may not offer enough noise reduction in the M-4 and M-5 machine area. It must be noted that these latter products will be effective in these areas if they are properly fitted and sized for the employees.

During the closing meeting of this evaluation, employees expressed concerns about hearing their machines when wires break during manufacturing of the rope or its components. This was especially true in the strander area where double hearing protection is required. WRCA management may want to consider using newer ear plugs on the market that are characterized as having moderate attenuation and uniform or "flat" attenuation specifications in conjunction with the ear muffs currently in use. This kind of ear plug will distort the signals that workers need to hear less than conventional plugs that reduce high frequency sounds much more than low frequency sounds. The flatter attenuation response acts more like a volume control in that it just turns down the noise. This may help workers who need to hear some important signals but yet still be protected by the high noise exposures produced by the stranders.

Lighting Levels

The lighting survey showed inadequate lighting at nearly all work stations. Illumination levels were generally less than the ANSI recommended range of 50 to 100 foot-candles for processes at WRCA.[19] Although employees did not report eye strain related to inadequate lighting, there were general concerns about the low illumination levels.

Medical Evaluation

Employees reported a variety of symptoms thought to be related to asphalt fume exposure from the large lube holding tanks; the symptoms were reported to generally improve when the employees leave the worksite. Overall, the WRCA management has implemented numerous health and safety changes since acquiring the plant last year. Most interviewed employees stated that the new owners seemed genuinely concerned about the working conditions within the plant and addressed the health and safety concerns of the workforce. Of note were three major changes management stated that they had implemented within the last six months to improve the health and safety of the workforce. First, the plant is no longer utilizing wire that required descaling using the shot blaster. This process was reported to have produced a large amount of dust within the plant. Since this process was discontinued, the interviewed employees have noted a decrease in dust-related symptoms such as dry eyes and respiratory complaints. The second major change involved switching contractors for scrap wire removal, which eliminated the need for scrap wire rope and strand to be cut before disposal. Since this process ended, the workforce has noted a decrease in the number and frequency of headache, eye irritation, and dust levels in the environment. The third change involved the removal of ready access to solvents by employees. Several different solvents had been used to clean lube off of equipment and to remove lube from skin surfaces. The company now closely controls the use of all solvents. Small amounts of solvent are issued to workers, along with the appropriate personal protective equipment, from a central location.

RECOMMENDATIONS

1. Management should continue their plan to relocate lube storage tanks to the outdoors. Because the plant's indoor environment is sometimes filled with visible fumes and smoke created by overheated asphalt, relocating the lube storage tanks should reduce asphalt fume exposures among utility workers and other machine operators. In addition, local exhaust ventilation should be installed at strander machines to reduce asphalt exposures.

2. After the lube storage tanks are relocated outdoors and local exhaust ventilation is installed at strander machines, additional air sampling for asphalt fume should be conducted. Air sampling data (before and after controls) is useful for determining the effectiveness of implemented controls and documenting improvement of the plant's air quality. A qualified industrial hygienist should be consulted.

3. Management needs to continue its hearing conservation program in its entirety. Because of the high noise exposures found in the production area, the company must pursue all aspects of an effective hearing conservation program. As a guideline for such a program, a copy of the NIOSH publication, "Preventing Occupational Hearing Loss - A Practical Guide" is enclosed with this report.[22]

4. Existing engineering controls seen on some of the machines need to be evaluated. Replacement of acoustic materials and routine maintenance should be completed to bring these controls back to their design specifications. These kinds of controls should be reviewed to see if other similar rope machines are amenable to an engineering change that will reduce noise exposures.

5. The use of rotational vibration monitoring should be investigated as a way of discovering machines that are becoming unbalanced and producing increasing levels of noise. This control may have the added benefit of reducing wear on the machines by uncovering changes in the machine's operation before it results in a major breakdown and the need for replacement of parts.

6. Ear plugs that have uniform or flat attenuation characteristics should be tried by WRCA. Employees who are required to wear double protection should try these plugs to see if they improve their ability to hear important machine and communication sounds. The employees who use these HPDs should be tracked through the

audiometric testing program to make sure that these devices continue to offer adequate protection to the employees wearing them. Moderate attenuation HPDs can also be tried in areas where the TWA exposures are near 90 dB(A) and only single protection is required. However, these employees also need to have their audiometric data monitored to assure that they are not exhibiting a increased hearing loss. Methods for monitoring the audiometric data are addressed in the NIOSH practical guide on hearing conservation in the chapter titled “Program Evaluation”.[22]

7. To improve lighting at work stations throughout the plant, management should proceed with their plans to install a new industrial lighting system. A more comprehensive lighting survey should be conducted to confirm our results. A qualified illuminating engineer should be consulted.

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Table I
Air Sampling Results for Asphalt Fume: Benzene-Soluble Fraction and Total Particulate
Wire Rope Corporation of America
Sedalia, Missouri
HETA 00-0181-2841

Sample Type and Location	Sampling Time (minutes)	Sample Flow Rate (liters per minute)	Sample Volume (liters)	Concentration, milligrams per cubic meter (mg/m^3)	
				Total Particulate	Benzene-Soluble Fraction
June 28, 2000					
PBZ - Strander Operator at M-11	330†	2	660	(0.6)	**0.2****
PBZ - Strander Operator at M-17	696	2	1392	(2.9)	**0.8***
PBZ - Utility Worker	626	2	1252	(7.4)	**0.4***
PBZ - Utility Worker	160†	2	320	(0.7)	**0.3***
June 29, 2000					
PBZ - Utility Worker	15	4	60	2.2	(1.2)
PBZ - Utility Worker	15	4	60	**3.2****	(1)
Area - Lube Storage Tank	15	4	60	24.7	(21.7)
Area - Lube Storage Tank	15	4	60	69.7	(56.2)
Area - Lube Storage Tank	15	4	60	8.7	(5.5)
Area - Lube Storage Tank	15	4	60	18	(7)
Area - Strander M-23	632	2	1264	0.5	0.3
Exposure Criteria (expressed in milligrams per cubic meter)					
ACGIH Threshold Limit Value (TLV®), as an 8-hr. TWA				none	0.5
Adjusted ACGIH TLV®, as a 12-hr. TWA				NA	0.25
NIOSH Recommended Exposure Limit (REL), as a 15-minute TWA				5	none
OSHA Permissible Exposure Limit (PEL)				none	none

Abbreviations and Comments:
PBZ = personal breathing-zone
† = short sampling period because worker discontinued work.
( ) = the numerical values in parenthesis cannot be directly compared to the applicable exposure criteria due to the sampling period.
* = exceeds the exposure criteria
** = more than half the exposure criteria
TWA = time weighed-average
NA = Per the OSHA Model, no adjustment made for unusual work schedule.

Table II
Air Sampling Results for Asphalt Fume:
Polycyclic Aromatic Compounds (PACs)
Wire Rope Corporation of America
Sedalia, Missouri
HETA 00-0181-2841

Sample Type and Location	Sampling Time (minutes)	Sample Flow Rate (liters per minute)	Sample Volume (liters)	Concentration, micrograms per cubic meter (µg/m³)	
				PAC_{360}	PAC_{400}
June 28, 2000					
Area - PBZ height of lube storage tank	546	2	1092	41	5.1
Area - above lube storage tank	573	2	1146	34	4.2
June 29, 2000					
Area - at opening of lube storage tank	559	2	1118	2500	290
Area - strander machine	631	2	1262	28	3.2
Exposure Criteria (expressed in micrograms per cubic meter)					
NIOSH Recommended Exposure Limit (REL)				none	none
ACGIH Threshold Limit Value (TLV®), as an 8-hr. TWA				none	none
OSHA Permissible Exposure Limit (PEL)				none	none

Abbreviations:
PBZ = personal breathing-zone
PAC_{360} = polycyclic aromatic compounds with 2-to 3-benzenoid-rings
PAC_{400} = polycyclic aromatic compounds with 4-to 7-benzenoid-rings
TWA = time-weighted average

Table III
Personal Noise Dosimeter Results - Day One
Wire Rope Corporation of America, Inc.
Sedalia, Missouri
HETA 00-0181-2841
June 28-29, 2000

Machine ***Criterion***	**Sample Time [hh:mm]**	**Dose**	**Dose-8**	**Dose-12**	**L_{AVG} [dB(A)]**	**TWA-8 [dB(A)]**	**TWA-12 dB(A)]**
M-10	10:36						
OSHA PEL		343 %	259 %	388 %	98.9	96.9	99.8
OSHA AL		376 %	284 %	425 %	99.6	97.5	100.4
NIOSH REL		5606 %	4225 %	6337 %	102.5	101.3	103.0
M-9, M-99	10:38						
OSHA PEL		157 %	118 %	178 %	93.3	91.2	94.1
OSHA AL		187 %	141 %	211 %	94.5	92.5	95.4
NIOSH REL		1028 %	772 %	1159 %	95.1	93.9	95.6
M-4	10:40						
OSHA PEL		128 %	96 %	144 %	91.8	89.7	92.6
OSHA AL		157 %	118 %	177 %	93.3	91.2	94.1
NIOSH REL		752 %	564 %	846 %	93.8	92.5	94.3
M-12	10:42						
OSHA PEL		65 %	48 %	72 %	86.8	84.7	87.7
OSHA AL		111 %	83 %	125 %	90.8	88.7	91.6
NIOSH REL		387 %	289 %	434 %	90.9	89.6	91.4
M-14	10:43						
OSHA PEL		51 %	38 %	57 %	85.1	83.0	85.9
OSHA AL		95 %	71 %	106 %	89.6	87.5	90.4
NIOSH REL		440 %	328 %	492 %	91.4	90.2	91.9
M-32, M-33	10:49						
OSHA PEL		604 %	446 %	669 %	103.0	100.8	103.7
OSHA AL		614 %	454 %	680 %	103.1	100.9	103.8
NIOSH REL		7310 %	5398 %	8097 %	103.6	102.3	104.1
M-30, M-31	10:51						
OSHA PEL		836 %	616 %	924 %	105.3	103.1	106.0
OSHA AL		841 %	620 %	930 %	105.4	103.2	106.1
NIOSH REL		13414 %	9887 %	14831 %	106.3	104.9	106.7
M-90, M-91, M-95	10:55						
OSHA PEL		856 %	627 %	941 %	105.5	103.2	106.2
OSHA AL		859 %	630 %	944 %	105.5	103.3	106.2
NIOSH REL		15450 %	11319 %	16978 %	106.9	105.5	107.3
M-18, M-19, M-21	10:59						
OSHA PEL		194 %	141 %	212 %	94.8	92.5	95.4
OSHA AL		216 %	157 %	235 %	95.5	93.3	96.2
NIOSH REL		1290 %	939 %	1408 %	96.1	94.7	96.5

Column headings are described in Results Section of report.

Table IV
Personal Noise Dosimeter Results - Day Two
Wire Rope Corporation of America, Inc.
Sedalia, Missouri
HETA 00-0181-2841
June 28-29, 2000

Machine *Criterion*	Sample Time [hh:mm]	Dose	Dose-8	Dose-12	L_{AVG} [dB(A)]	TWA-8 [dB(A)]	TWA-12 dB(A)]
M-26, M-27	11:21						
OSHA PEL		545 %	384 %	576 %	102.2	99.7	102.6
OSHA AL		554 %	391 %	586 %	102.4	99.8	102.8
NIOSH REL		6566 %	4628 %	6942 %	103.2	101.7	103.4
M-66	11:06						
OSHA PEL		34 %	25 %	37 %	82.3	79.9	82.8
OSHA AL		91 %	65 %	98 %	89.3	86.9	89.9
NIOSH REL		362 %	261 %	391 %	90.6	89.2	90.9
M-11	11:04						
OSHA PEL		32 %	23 %	35 %	81.8	79.5	82.4
OSHA AL		90 %	65 %	97 %	89.2	86.9	89.8
NIOSH REL		330 %	238 %	358 %	90.2	88.8	90.5
M-13	11:10						
OSHA PEL		32 %	23 %	34 %	81.7	79.3	82.2
OSHA AL		91 %	65 %	97 %	89.3	86.9	89.8
NIOSH REL		349 %	250 %	374 %	90.4	89.0	90.7
M-3, M-6	10:52						
OSHA PEL		254 %	187 %	280 %	96.7	94.5	97.4
OSHA AL		270 %	199 %	298 %	97.2	95.0	97.9
NIOSH REL		1924 %	1415 %	2123 %	97.8	96.5	98.3
M-5	10:51						
OSHA PEL		131 %	97 %	145 %	92.0	89.8	92.7
OSHA AL		173 %	128 %	192 %	94.0	91.8	94.7
NIOSH REL		910 %	671 %	1006 %	94.6	93.3	95.0

Column headings are described in Results Section of report.

Table V
Area Noise Sampling Results - dB(A)
Wire Rope Corporation of America, Inc.
Sedalia, Missouri
HETA 00-0181-2841
June 28-29, 2000

Stranders	dB(A)	Closers	dB(A)	Others	dB(A)
M26, M27		M4, M5		M66 - Wire Drawing	
take-off spool	101.9	take-off spool	92.5	take-off spool	87.9
operator's bench	107.4	operator's bench	96.2	operator's bench	87.3
1/3 way down	107.5	mid-point	97.9	first (largest) encl.	85.4
2/3 way down	106.1	core supply spool	91.7	supply spool	83.5
beginning of M26	102.5	M10			
		take-off spool	97.8	M9 - Swager	
M30, M31		operator's bench	100.7	take-off spool	98.4
take-off spool	102.8	2 of 9 drums down	106.4	oper. control panel	99.9
wire wrap point	106.8	5 of 9 drums down	109.6	supply spool	98.2
3 drums down	112.4	8 of 9 drums down	109.4		
5 drums down	110.0	M11		M99 - Swager	
beginning of M31	109.1	take-off spool	81.2	take-off spool	87.6
beginning of M30	110.4	wire wrap point	81.6	oper. control panel	95.6
		cover #8	80.4	supply spool	96.6
M90, M91		cover #18	83.0		
take-off spool	99.0	cover #28	82.7		
operator's bench	103.3	cover #38	81.9		
mid-point	111.4	cover #48	81.1		
beginning	105.3	M13			
		take-off spool	82.6		
		operator's bench	84.9		
		1 of 4 drums down	86.4		
		3 of 4 drums down	91.1		
		4 of 4 drums down	86.7		
		M17			
		take-off spool	86.2		
		wire wrap point	93.2		
		1/3 way down	98.1		
		2/3 way down	107.1		
		core supply spool	96.6		

db(A)	=	decibel, A-weighted. This is the preferred unit for measuring sound levels to assess worker noise exposures.

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4674)
or visit the NIOSH Web site at:
www.cdc.gov/niosh