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WARNER AMEX
CINCINNATI, OHIO
NIOSH INVESTIGATORS:
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SUMMARY

In September, 1991, the National Institute for Occupational Safety anc Health (NIOSH) received a confidential request for a health hazard evaluation (HHE) from employees at the Van Kirk location of Warner Cat Communications in Cincinnati, Ohio. The request concerned employee ex to lead, asbestos, electromagnetic radiation, and poor air quality. A listed as a concern were psychological disorders attributed to "inadec working conditions."

Environmental measurements made by NIOSH investigators consisted of: 1) personal breathing zone (PBZ) exposures to airborne lead and tin; 2) personal and area measurements of magnetic and electric fields; 3) measurements of hydrogen chloride (HCl); and 4) carbon dioxide concent air temperatures, and relative humidities (RHs). Two bulk samples of collected from surfaces inside the building were analyzed for asbestos Two bulk samples of solder collected from the plant were qualitatively analyzed for thermal decomposition products. Informal interviews were conducted with employees to address the concern of psychological disor

Airborne lead and tin concentrations were below the minimum detectable concentration (MDC) from all samples except one. The concentrations c and tin in this sample were 1 microgram per cubic meter (µg/m^3) and 5 respectively. These values are well below the NIOSH and Occupational and Health Administration (OSHA) exposure limits. Average magnetic ar electric field measurements ranged from 0.6 to 7.6 milligauss (mG), ar 4.8 volts per meter (V/m), respectively. These values are well withir guidelines recommended by the American Conference of Governmental Indu Hygienists (ACGIH) of 10,000 mG and 25,000 V/m for field frequencies c 60 hertz. HCl was not detected in the air samples. Carbon dioxide concentrations ranged from 650 parts per million (ppm) to 900 ppm; wit the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) guidelines for adequate ventilation. Air temperatu ranged from 74 to 79^{o}F. The majority of the temperature measurements slightly above the temperature range of 69 to 76^{o}F recommended by ASHR Relative humidity levels ranged from 14 to 18%. These values are belc RH% range of 30 to 60% recommended by ASHRAE. Asbestos fibers were nc detected in either of the bulk particulate samples. Dimethylamine anc terpenes, which are mucous membrane irritants, were identified as ther decomposition products of the solder. Information obtained from emplc interviews did not support the concern that the workplace may be causi psychological disorders among personnel.

An occupational health hazard was not identified at the Van Kirk Facility. Recommendations provided in this report include steps to reduce the potential for lead exposures and provide a more comfortable working environment for employees in the repair shop.

KEYWORDS: SIC 4841 (Cable and Other Pay Television Services); lead, soldering, flux, indoor air quality, stress, electromagnetic fields, electronics repair, asbestos.

INTRODUCTION

In September, 1991, the National Institute for Occupational Safety anc Health (NIOSH) received a confidential request for a health hazard evaluation (HHE) from employees at the Van Kirk location of Warner Cak Communications in Cincinnati, Ohio. The request concerned possible ex of repair shop personnel to lead, electromagnetic radiation, asbestos, poor air quality; and exposures of warehouse personnel to asbestos. A listed as a concern were psychological disorders experienced by employ result of "inadequate working conditions."

The NIOSH investigation included four visits to the worksite. On September 25, 1991, NIOSH investigators met with management and employ representatives to discuss the HHE request and tour the facility. On December 18, 1991, air measurements were made that addressed the conce poor air quality, and informal interviews were conducted with employee Environmental monitoring of workers' exposures to airborne lead and electromagnetic radiation was performed on February 5, 1992. During t February site visit, several employees reported that the fumes from sc were irritating to the eyes, nose and throat. Air monitoring for hydr chloride (HCl), which was listed as a decomposition product of the sol flux, was performed on March 4, 1992, to determine if HCl emissions mi responsible for the irritation symptoms. Two bulk samples of solder w collected at that time for laboratory analysis of thermal decompositic products.

BACKGROUND

The Van Kirk facility occupies approximately 44,000 square feet (ft^2) leased space in a 192,000 ft^2 building. The building is approximately 45 years old. The Van Kirk facility is responsible for storing, testi repairing converter boxes used in providing cable television to Warner customers. Boxes that have failed in the field are tested and repaire converter repair shop. The repair shop operates two shifts (0730 to 1 1600 to 0030). Shipping and receiving of the boxes is performed by wa personnel who work from 0700 to 1530. At the time of the first NIOSH there were 34 repair shop employees and seven warehouse employees.

During the repair of converter boxes, some parts were attached by solc The solder used was 60% tin and 40% lead, with a rosin-based core flux exhaust ventilation was not provided, though management reportedly pla install a system in the future. Each technician that soldered was prc with a six inch fan to dissipate fumes.

Sources of magnetic and electric fields in the repair shop included te sets and video display terminals (VDTs) that were used to test the box There was also a microwave transmitter/receiver tower located approxim 50 meters north the repair shop. The tower transmitted at 12.7 and 13.2 Gigahertz (GHz). One of the workers' concerns regarding electrom radiation was the orientation of workbenches in the repair shop. At t of the request, the back of television sets and other equipment used b technician, faced the next closest technician. During the time perioc the December and February site visits, it was changed so that the back equipment faced the west wall (see Figure 1).

Asbestos-containing insulation was removed from pipe surfaces in the w in August, 1991. The removal was contracted between the building owne private consultant. Employees were concerned that asbestos-containing particulate had escaped containment during the removal and contaminate surfaces in the building. Submitted with the HHE request were two par samples which employees requested NIOSH to analyze for asbestos. The were reported to be from: 1) the return duct of the heating, ventilat air conditioning (HVAC) system, and 2) from the surface of a "skid" ir warehouse.

The HVAC system for the repair shop consisted of three single-zone, cc air volume, air handling units (AHUs). During the December site visit thermostats were in the temperature-dependent mode. In this mode, the operated only when the thermostat calls for heating or cooling of the Natural gas was used for heating. Two of the AHUs were equipped with refrigerant cooling coils with condensation units located on the roof. air was provided to the occupied areas by externally insulated ducts l above the false ceiling. Air was returned to the units through grills installed in the walls approximately one foot from the floor. The HVA did not provide for the delivery of outside air to the occupied zone. were three doors leading from the repair shop; one lead to the warehou to facility offices, and one to the outside. Workers reported that th doors were closed most of the time. There was one window in the north the shop that contained a small window air conditioning unit.

METHODS

Five personal breathing zone (PBZ) air samples were collected from tec for elemental lead and tin using NIOSH Method 7300.[1] Air was drawn th 37 millimeter mixed cellulose filters at a flow rate of 2.0 liters per minute (lpm) using battery powered sampling pumps. The average sample was 840 liters. Four measurements of airborne HCl concentrations were using Drager short-term detector tubes. These measurements were made breathing zone of bench technicians while they were soldering.

A limited number of measurements for magnetic and electric fields were the converter repair shop. These measurements were not intended to re an in-depth evaluation of the radiation fields at the site, but were i to approximate occupational exposure levels found on the days of measu Detailed information on the type of samples collected, the equipment u the location of the samples is included in Appendix I (a report of the evaluation of electromagnetic fields at the facility).

Temperature, relative humidity (RH), and CO_2 measurements were made tw during the day at nine locations (see Figure 1). Carbon dioxide concentrations were measured using a Gastech Model RI-411A, portable C meter. Temperatures and RHs were measured using a Vaisala HM 34 Humic Temperature Meter. The ventilation system was visually inspected for biological contamination.

The two bulk samples of dust submitted with the HHE request were analy asbestos fiber content. The sample collected from the return duct was analyzed using polarized light microscopy (PLM). The sample collectec the warehouse was analyzed by transmission electron microscopy (TEM) b the particle size was too fine for PLM.

Two bulk samples of solder were collected from the repair shop and ana for products of thermal decomposition. The samples were heated to 70C four minutes. The temperature of 700°F was chosen to simulate the app temperature of a soldering iron. Thermal decomposition products were qualitatively analyzed by gas chromatography and mass spectrometry (GC

Informal, confidential interviews were conducted with employees on day The employees interviewed represented all three job titles in the repa (Converter Repair Specialist, Bench Technician I, Bench Technician II) Interviews also were conducted with the two day shift supervisors and facility manager. The focus of the interviews was the concern of psychological disorders among employees that was cited in the HHE requ Workers were asked about working conditions, workload, employee-manage relations, job demands and expectations, and possible work-related hea problems.

EVALUATION CRITERIA

Environmental

As a guide to the evaluation of the hazards posed by work place exposu NIOSH field staff employ environmental evaluation criteria for the ass of a number of chemical and physical agents. These criteria are inter suggest levels of exposure to which most workers may be exposed up to per day, 40 hours per week for a working lifetime without experiencing health effects. It is, however, important to note that not all worker be protected from adverse health effects if their exposures are mainta below these levels. A small percentage may experience adverse health because of individual susceptibility, a pre-existing medical conditior a hypersensitivity (allergy). In addition, some hazardous substances in combination with other work place exposures, the general environmer with medications or personal habits of the worker to produce health ef even if the occupational exposures are controlled to the level set by evaluation criterion. These combined effects are often not considerec evaluation criteria. Also, some substances are absorbed by direct cor with the skin and mucous membranes, and thus potentially increase the exposure. Finally, evaluation criteria may change over the years as r information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the work are: 1) NIOSH Criteria Documents and Recommended Exposure Limits (REL 2) the American Conference of Governmental Industrial Hygienists' (ACG Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OS Permissible Exposure Limits (PELs). The OSHA PELs may be required to into account the feasibility of controlling exposures in various indus where the agents are used; the NIOSH-recommended exposure limits, by c are based primarily on concerns relating to the prevention of occupati disease. In evaluating the exposure levels and the recommendations fo reducing these levels found in this report, it should be noted that ir is legally required to meet those levels specified by an 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. So substances have recommended short-term exposure limits (STELS) or ceil values (C) which are intended to supplement the TWA where there are re toxic effects from high, short-term exposures. Short-term exposure li defined as 15 minute TWA exposure which should not be exceeded at any during the work shift. Ceiling values are limits for instantaneous ex which should not be exceeded at any time during the work shift.

Inorganic Lead:

Inhalation (breathing) of dust and fume, and ingestion (swallowing resulting from hand-to-mouth contact with lead-contaminated food, cigarettes, clothing, or other objects are the major routes of wor exposure to lead. Once absorbed, lead accumulates in the soft tis and bones, with the highest accumulation initially in the liver an kidneys.[2] Lead is stored in the bones for decades, and may cause t effects as it is slowly released over time. Overexposure to lead in damage to the kidneys, gastrointestinal tract, peripheral and c nervous systems, and the blood-forming organs (bone marrow).

Lead-contaminated surface dust represents a potential exposure to through ingestion, especially by children. This may occur either direct hand-to-mouth contact with the dust, or indirectly from han mouth contact via clothing, cigarettes, or food contaminated by le dust. Previous studies have found a significant correlation betwe resident children's blood lead levels (BLL) and house dust lead le In homes with a family member occupationally exposed to lead, lead may be carried home on clothing, skin and hair, and in vehicles.

Under the OSHA standard regulating occupational exposure to inorga lead in general industry, the PEL is 50 micrograms per cubic meter ($\mu g/m^3$) as an 8-hour TWA.[4] The NIOSH REL for lead is less th 100 $\mu g/m^3$ as a TWA for up to 10 hours. This REL is an air concentr to be maintained so that worker BLL remains below 60 micrograms pe deciliter (µg/dl) of whole blood. NIOSH is presently reviewing literature on the health effects of lead to re-evaluate its REL. the goals specified in Healthy People 2000: National Health Promo and Disease Prevention Objectives[5] is to eliminate exposures which in workers having BLLs greater than 25 µg/dl of whole blood.

Male BLLs are associated with increases in blood pressure, with no apparent threshold. Studies have suggested decreased fertility in BLLs as low as 40 µg/dl. Prenatal exposure to lead is associated reductions in: 1) gestational age, 2) birthweight, and 3) early m development, at prenatal maternal BLLs as low as 10 to 15 µg/dl.[6]

Inorganic Tin:

Overexposure to tin oxide, either as dust or fume, causes stannosi pneumoconiosis[a] for which there are no reported symptoms or abnorma findings upon physical examination. The NIOSH REL, OSHA PEL, and TLV for tin is 2 milligrams per cubic meter (mg/m^3) as an 8-hour TW

Electromagnetic Fields:

For frequencies of 60 hertz (Hz), the ACGIH TLVs for magnetic and electric fields are 10,000 milligauss (mG) and 25,000 volts per meter (V/m), respectively. A discussion of the ACGIH TLVs, includ formulas used to calculate the values, are included in Appendix I.

Air Quality:

The American Society of Heating, Refrigerating, and Air-Conditioni Engineers (ASHRAE) defines acceptable indoor air quality as air th 1) contains no known contaminants at harmful concentrations, and 2) 80% or more of the occupants do not express dissatisfaction wit Factors affecting occupants' perception of air quality include air temperature, the amount of moisture in the air, and airborne conta levels.

Indoor air temperatures are generally controlled through a HVAC sy Some HVAC systems are also capable of controlling RH levels. The temperature range recommended by ASHRAE for winter months is approximately 69 to 76°F, with slight corrections made for RH leve The recommended range of RH is 30 to 60%.[8] The range of 30 to 60% designed to minimize: 1) the drying and irritation of mucous memb and 2) the growth of allergenic or pathogenic organisms.

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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.

Airborne contaminants may include dust, chemicals, and biological contaminants. Sources of airborne chemical contaminants include emissions from job processes (e.g., soldering), cleansers and disinfectants, tobacco smoke, and normal body emissions such as CO Airborne biological contaminants include fungal spores or bacilli resulting from fungal or bacterial growth inside the building or n outside air intakes.

Methods used to control contaminant levels include routine cleanin mechanical ventilation. Biological contaminants are generally con by cleaning and disinfecting surfaces to inhibit growth, and maint RH levels below 60%. Cleaning of surfaces can also be effective a reducing the amount of particulate that can become airborne.

Mechanical ventilation systems generally belong to one of two desi local exhaust ventilation system is designed to "capture" contamin the location where they are produced. If designed and maintained properly, this type of system is effective at controlling contamin resulting from a job process such as soldering. The principles of exhaust ventilation are discussed in ACGIH's Industrial Ventilatio Manual of Recommended Practice.[9]

HVAC systems reduce contaminant levels by providing outside air fo dilution. If properly designed and maintained, HVAC systems can effectively control contaminant levels of CO_2, odors, and other contaminants common in occupied buildings. The system should prov appropriate rate of outside air based on the number of occupants. ASHRAE[7] recommends outside air supply rates of 20 cubic feet per m per person (cfm/person) for office spaces and conference rooms.

The monitoring of CO_2, a normal constituent of exhaled breath, can useful as a screening technique to evaluate whether adequate quant of outside air are being introduced into an occupied space. Indoo concentrations are normally higher than the generally constant amb CO_2 concentration (range 300-350 parts per million [ppm]). When in CO_2 concentrations exceed 1000 ppm in areas where the only known C source is exhaled breath, inadequate ventilation is suspected.

Asbestos:

Exposure to asbestos can cause asbestosis, lung cancer, mesothelio other cancers. Asbestosis is a scarring of the lung tissue which the ability of the lungs to transport oxygen. Mesothelioma is a malignant cancer associated with the pleura or peritoneum, the tis lining the chest and abdominal cavities, respectively.

Psychological Disorders

NIOSH recognizes psychological disorders as a leading occupational hea problem.[10] Scientific evidence is growing that a wide range of working conditions, both physical and psychosocial, pose a threat to psycholog well being.[11] Psychologically hazardous physical aspects of work inclu exposure to neurotoxic agents and physical and ergonomic characteristi the task and workplace. For example, certain metals and organic compo (mercury, lead, solvents, etc.) are known to cause psychological disor Likewise, psychological problems, can be secondary to the physical dis that arise from poor ergonomic conditions, as seen in recent research office automation.[12]

Although the term psychosocial has not been succinctly defined in refe working conditions, in general usage it connotes the social environmen work, organizational aspects of the job, and the content of the tasks performed. Unlike neurotoxic agents and ergonomic hazards, hazards ir psychosocial factors respect no occupational boundaries. Thus, the po for exposure to this class of health risks is ubiquitous, and a great psychosocial factors have been identified as potentially hazardous. T firmly established among these include: (1) excessive workload or wor (2) difficult work schedules; (3) ambiguous and/or conflicting job dut (4) job future ambiguity; (5) poor interpersonal relationships; (6) na fragmented, invariant, and short-cycle tasks; and (7) limited opportur make decisions regarding the job.[10]

RESULTS

Environmental Monitoring

Airborne lead and tin concentrations were below the minimum detectable concentration (MDC) for four of the five PBZ measurements. (The MDC f 840 liter sample was 1 µg/m³ for lead, and 2 µg/m³ for tin.) The air concentration measured from the remaining sample were 1 µg/m³ for lead 5 µg/m³ for tin. These values are well below the OSHA and NIOSH expos limits.

The magnetic fields ranged from 0.6 to 7.6 mG. The electric fields ra from 0.9 to 4.8 V/m. These values are well within the guidelines reco by the ACGIH. A more detailed presentation and discussion of the resu the magnetic and electric field measurements is included in Appendix I

Results of the temperature, RH, and CO_2 measurements are provided in T Carbon dioxide concentrations ranged from 650 to 900 ppm indoors. Alt above the outside level of 375 ppm, these indoor concentrations of CO_2 indicate a deficiency in the amount of outside air being brought into repair shop on the day of the survey. The air temperatures indoors ra from 73 to 79°F. Temperature measurements made at all but one of the locations were above the temperature range recommended by ASHRAE (69 t

All RH levels measured indoors (14-18%) were below the range of 30-60% recommended by ASHRAE. Signs of moisture or biological growth were nc observed in any of the three AHUs. The return plenum for each of the AHUs was dirty, as were the condensate tray and filters for unit A. I addition, most of the supply diffusers in the repair shop were also di The condensate tray for unit C was not inspected during the HHE becaus not accessible.

Asbestos fibers were not detected in either of the bulk dust samples s for analysis.

HCl was not detected during soldering operations (the limit of detecti the method is reported to be 1 ppm).[13] Many volatile organic compounds detected from analysis of the bulk solder. Compounds identified that mucous membrane irritants were dimethylamine and various terpenes.

Additional sources of potential chemical exposures in the repair shop two commercial products used to clean the converter boxes. According the Material Safety Data Sheets (MSDS), one product (BH-38) contains 2-butoxyethanol, an irritant of the eyes and mucous membranes that is through the skin.[14] The other product (CSD-43) contains methylene chlo and perchloroethylene, both of which are considered to be potential occupational carcinogens by NIOSH. Company policy restricts smoking t outside the building; therefore, exposure to environmental tobacco smo the Van Kirk facility was not believed to be a health concern.

Employee Interviews

Ten employees were interviewed, including five men and five women rang age from 27 to 51 years. They had worked in the repair department fro to five years. The most common concerns among the employees were:

1. Lack of incentives. Employees described bonus programs in other departments and indicated that similar programs were no longer i place in the repair department.

2. Lack of recognition. The majority of employees interviewed felt they received little recognition within the company for the impo of the work they do and for the skill level required for the job

3. Lack of training and promotion opportunities.

4. Workplace conditions. Many employees reported that the work environment was dusty; some reported that it was warm and stuffy Several employees experienced headache, sinus problems, and eye irritation, all of which abated when they left work.

Many positive features relating to workplace stress were noted in inte with both employees and management. There was no apparent problems wi attendance, and turnover rates were low. In general, employees were comfortable in bringing their concerns to management, felt that manage responsive, and were pleased by management-initiated changes that have occurred in the past year or two. Production levels were monitored cl management and posted on the wall of the repair shop, but strict produ quotas were absent. Most employees did not feel pressured by unrealis production requirements. Employees appeared to care about what they c take pride in their work. Employees have an annual performance apprai is used to determine salary increases.

The company has a health and safety committee with management and empl representation. A new program, the Employee Involvement Program (EIP) on appropriate workers to discuss issues of concern to management.

CONCLUSIONS

Airborne lead and tin concentrations in the repair shop did not repres health hazard to employees. However, solder particulate was observed present on work surfaces, representing a potential exposure of workers through ingestion. If this particulate is taken home on contaminated such as clothing, it also represents a potential exposure to occupants home, particularly children.

Exposures to magnetic and electric fields in the repair shop did not r a health hazard. A discussion of recent research and the health impli is included in Appendix I.

The CO_2 concentrations indicate that the amount of outside air brought the repair shop on the day of the survey may be adequate. This may va however, because the sources of outside air (infiltration from door ar casings) would be subject to wind direction, weather conditions, and adjustment by occupants.

Temperature and RH measurements were outside the range recommended by ASHRAE. Although temperature and humidity were not specifically menti employee concerns, these are common complaints associated with the per of poor air quality. Relative humidities can be increased by using ei portable humidifier or a unit incorporated into the AHUs. Because of of biological contamination, mechanical humidification should only be proper maintenance of the humidification system is provided.

Workers in the repair shop reported that the environment was dusty. T which were dirty, may be responsible for the distribution of much of t in the shop. The contractor responsible for maintenance reported that not aware of a preventive maintenance program for the AHUs in the repa There were no signs of biological contamination observed in the AHUs; the condensate tray of unit C was not accessible for inspection.

Hydrogen chloride was not detected during soldering, but organic compo which are known to cause irritation of the mucous membranes were ident potential thermal decomposition products. The six-inch fans were limi their effectiveness at directing solder emissions away from workers. reported that the fans often directed emissions into the breathing zor workers nearby. Exposures to the soldering fume could effectively be using local exhaust ventilation. During the March site visit, managem pointed out that the current arrangement of workstations allows for ea station to have a separate exhaust unit which can be operated as neede (i.e., operated only when soldering). For this type of design, it is important that each unit be capable of capturing fumes regardless of w nearby units are operating. It is also important that an adequate amc make-up air be provided. The latter is best accomplished by providinc powered source of outside air.[9]

In addition to emissions from soldering, workers in the repair shop we potentially exposed to several toxic compounds, two of which are consi be potential occupational carcinogens by NIOSH.

The findings of the investigation did not support the requestor's conc about psychological disorders in the workplace. The positive psychoso organizational attributes identified during interviews with management employees can help prevent the development of work-related stress. Sc issues, however, were raised by employees. Management attention to th issues would likely improve the level of employee job satisfaction anc positively impact productivity. Recommendations provided below (5-9) based on well-recognized principles for designing jobs to reduce occup stress and its negative consequences.[15]

In addition, two deficiencies in the hazard communication program at t facility were observed. First, employees in the repair shop used non- beverage containers to store the solutions used to clean the boxes. S Material Safety Data Sheets of products used at the facility were not available at the Van Kirk location. Item one was brought to the atter the Van Kirk manager during the September site visit. By December, mc appropriate containers had been purchased for the cleaning solutions, plans were made to obtain proper labels. (At the time of the March si visit, these labels had not been purchased.)

RECOMMENDATIONS

1. Eating and drinking should not be allowed in the shop, and the w of hands by shop personnel before eating or smoking should be emphasized. Care should also be taken by employees to avoid tak home lead contaminated objects such as clothing.

2. Provide local exhaust ventilation in the repair shop to reduce employee exposures to potentially irritating emissions from sold

3. The two commercial products currently used to clean the converte boxes should be replaced with products that are less toxic.

4. Modify the HVAC system to provide at least 20 cfm/person of outs air. This would help to: 1) provide a more comfortable environ and 2) control levels of contaminants such as dust and body odor more comfortable work environment will also be provided by maint temperatures and RHs in the range recommended by ASHRAE.

5. A preventive maintenance program for the AHUs in the repair shop should be established. This should include routine inspections AHUs, cleaning the return air plenums, and periodic changing of filters. To help assure that biological contamination is not pr the condensate tray for AHU C should be made accessible to facil periodic inspection and cleaning.

6. Maintain open and complete communication with employees when wor changes are planned. For example, employees are pleased by effo expand workers' skill through cross-training but are disappointe slow implementation of the plan. Management should keep employe informed about exactly how they plan to implement the plan and a them of problems as they arise.

7. Provide all employees with adequate notice of job opportunities the repair department and in other departments throughout the co

8. Inform all employees of the requirements and benefits associated the company program for reimbursement of education expenses.

9. Utilize the Employee Involvement Program to address issues raise employees as well as those identified by management.

10. Provide positive feedback to employees about their work and impl a program to recognize the contribution of employees to the comp

11. Fulfill all requirements of the OSHA Hazard Communications Stand (29 CFR 1910.1200). This includes the proper labelling of conta and maintaining an MSDS file in an area accessible to employees Van Kirk site, that includes all compounds or products used at t facility.

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1. Requester
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3. Director of Human Resources
   Warner Cable Communications
4. OSHA Region Five

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

Table 1

Indoor Air Quality Data

Warner Communications
Cincinnati, Ohio
December 18 1991
HETA 91-390

Location	Time	CO_2 (ppm)	Temp (F)	RH (%)	No. of Occupants
1	0930 1445	775 775	74 75	18 17	1 2
2	0932 1448	825 850	77 76	16 18	0 2
3	0935 1450	825 750	78 77	17 16	1 1
4	0945 1452	900 750	79 79	15 15	1 1
5	0948 1457	850 775	77 78	15 16	2 0
6	0950 1455	875 650	78 79	15 14	1 0
7	1000 1500	850 650	77 76	15 14	1 1
8	1015 1502	900 650	75 76	17 16	1 1
9	1010 1505	375 375	29 32	44 34	0 0

The numbered locations correspond to those numbered locations pr
in Figure 1

Figure 1

N ↓

Warner Communications
Cincinnati, Ohio
HETA 91-390

WAREHOUSE

A, B, and C represent the location of the AHUs.

The numbers indicate locations where temperature, RH, and CO2 measurements were made.

A/C represents location of window-mounted air conditioner

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APPENDIX I
Warner Communications
Cincinnati, Ohio
HETA 91-390

EVALUATION OF ELECTROMAGNETIC FIELDS AT THE VAN KIRK FACILITY OF WARNER CABLE

C. EUGENE MOSS AND DON BOOHER

BACKGROUND

The Warner Cable Communication Company facility, located at Van Kirk S
is designed for electronic personnel to repair converters boxes, for u
its clients. In performing this work repair personnel can be exposed
several types of electronic devices that produce electromagnetic fielc
as television sets, soldering equipment, lamps, video display terminal
cable TV converters. In addition, the facility has a microwave transm
and receiver tower located approximately 50 m from the converter repai
shop (CRS). The tower transmits at 12.7 to 13.2 Gigahertz (GHz). The
schematic for the CRS at the Van Kirk facility is shown in Figure 1-A.

MATERIALS AND METHODS

The evaluation was designed to survey workers' actual exposures to bot
electric and magnetic fields while they performed their repair and
refurbishing tasks. The limited number of measurements taken in and a
the facility were not intended to represent an in-depth evaluation of
radiation fields at the site, but were intended to approximate occupat
exposure levels found on the days of measurement.

Workers' exposure to various fields were measured using the following
equipment:

A Holaday Industries, Inc. model HI-3602 ELF Sensor, connected to a
HI-3600 survey meter, was used to document both the magnitude of
60 hertz (Hz) electric and magnetic fields and the electrical frequ
(as well as the waveforms) produced by such fields. The electric
field (E-field) strength can be measured either in volts per meter
or kilovolts per meter (kV/m). The magnetic field strength (H-fie
be expressed in units of milligauss (mG).

Measurements were made with the EMDEX II exposure system, developec
Enertech Consultants, under project sponsorship of the Electric Pow
Research Institute, Inc. The EMDEX II is a programmable data-acqui
meter which measures the orthogonal vector components of the magnet
field through its internal sensors. Measurements can be made in th
instantaneous read or storage mode. The system was designed to mea
record, and analyze power frequency magnetic fields in units of mG
frequency range from 30 to 800 Hz.

Average magnetic fields were documented by use of the AMEX-3D expos meter. This small, lightweight three-axis magnetic field meter car worn by a worker to monitor average magnetic field exposures. The stores an electrical charge, proportional to the time-integral of the magnetic field frequency, which can then be read-out and con into field exposure or into average magnetic field. The AMEX-3D fr response is from 35 to 1000 Hz. The AMEX-3D exposure meter is manufactured by Enertech Consultants, in Campbell, California.

Measurements of the microwave field produced by the tower was made Narda Electromagnetic Radiation Monitor Model 8616 and a Narda Isot Probe Model 8621D. The probe is designed to measure microwave radi in the frequency range from 0.3 to 40 GHz. The lowest meter indica level (LMIL) for this monitor/probe combination is 0.01 milliwatts square centimeter (mW/cm^2).

Holaday Industries Models HI-3600-01 and HI-3600-02 survey meters w used to document the electric and magnetic fields in the VLF and EL frequency bands produced by TV sets and video display terminals (VD were located on various worktables in the CRS. The instruments als provided for the ability to measure the frequencies of emitted radi Measurements were made at locations where repair personnel worked d the day.

E-field induced body currents were measured by applying a conductiv wristband to the arm of the operator. The wristband was connected input terminal of a Fluke model 8060A digital multimeter, in the microampere (µA) measurement mode, while the other test lead was co to the chassis of the VDT taken to be ground potential. It has bee from previous NIOSH evaluations[1-2] that the highest induced current typically induced in workers using TV and VDT equipment occurred wh entire hand was placed in contact with the screen surface.

ELF electric and magnetic fields results were documented with EMDEX and Holaday systems in the CRS. The EMDEX units were worn in pouch five selected workers at waist height (about 3.5 ft) from the floor AMEX units were positioned at various locations within the repair s In addition, a limited number of area measurements were made with t Holaday monitors at selected work locations inside the facility. A measurements were made during daylight hours at waist height. When possible, at least two readings were taken at each measurement site the Holaday monitors and the average reading recorded.

Measurements with the NARDA monitor/probe systems were made in fron the tower, inside the repair shop, and at the four corners of the V facility. The measurements were performed at two different times. measurements were found to be less than the LMIL level of any monitor/probe combination.

All systems were calibrated either by NIOSH or the manufacturer wit six months of the date of this evaluation.

EVALUATION CRITERIA

The American Conference of Governmental Industrial Hygienists (ACGIH) published Threshold Limit Values (TLVs) for sub-radiofrequency electri magnetic fields.[3] The TLV for magnetic fields states "routine occupa exposure should not exceed:

$$B_{TLV} = 60/f \text{ mT}$$

where B is the magnetic flux density in units of millitesla (mT), f is frequency in hertz." Conversely, the electric field TLV states "occup exposures should not exceed a field strength of 25 kV/m from 0 to 100 For frequencies in the range of 100 hertz to 4 kHz, the TLV is given b

$$E_{TLV} = 2.5 \times 10^6/f \text{ V/m}$$

where f is the frequency in hertz. A value of 625 V/m is the exposure for frequencies from 4 kHz to 30 kHz."

This means, for example, at 60 hertz (Hz), which is classified as extr low frequency (ELF), the electric field intensity TLV is 25,000 volts meter (V/m) and the magnetic flux density TLV is 1 mT which equals 10, At 30 kilohertz (kHz), which is classified as very low frequency (VLF) electric field intensity TLV is 625 V/m and the magnetic flux density 20 mG.

The basis of the ELF E-field TLV is to minimize occupational hazards a from spark discharge and contact current situations. The TLV for the flux density addresses induction of magnetophosphenes in the visual sy production of induced currents in the body.

Recently, the Institute of Electrical and Electronics Engineers, adopt contact current limit for the frequency range from 3 to 100 kHz of 100 where f is the frequency in MHz.[4]

RESULTS

A total of 14 AMEX dosimeters were mounted in pouches and taped to the at selected locations in the CRS (see Figure 1-A), at a height of 4.5 above the floor. The AMEX dosimeters were left at their locations for six hours. The magnetic fields documented in this evaluation ranged f low of 0.6 mG to a high of 7.6 mG. The average for all 14 dosimeters was 3.6 mG. The maximum level occurred at a site above one of the wor and the minimal level was recorded next to a storage area. Eight of t dosimeters were placed above work tables and six were placed at other locations. The average of the eight work table dosimeters was 3.5 mG the six non-work sites was 3.7 mG.

The six EMDEX dosimeters, worn by workers, gave similar results as tho recorded by the AMEX dosimeters. The 6-hour average results for worke ranged from 1.03 to 8.73 mG. Figures 2-A through 6-A show the time-ir distribution for these dosimeters. One of the dosimeters was placed c in an office manned by three workers and is not shown. The average va recorded for this dosimeter was 0.91 mG.

It is apparent from Figures 2-A though 6-A, that the nature of work pe in the CRS can produce very variable magnetic field exposures. The do time-intensity graphs, recorded by job titles, suggest considerable va of exposure with time as workers move in and out of proximity to varic electrical devices that can operate over a wide frequency range. In evaluating these types of assessments it must be kept in mind the strc spatial variation of the magnetic fields as well as the fact that work perform more than one work task a day.

Figures 2-A through 6-A have some unique characteristics that need to mentioned. In general, there does not appear to be any consistent pat work which results in extremely high exposures, although there is some to some of the data.

Fig 2-A.
The two highest peaks occurred around the noon break when worker wa wearing the dosimeter outside the CRS.

Fig 3-A.
Pattern of exposure demonstrates a quasi-repetitive nature typical repair work.

Fig 4-A.
Low levels except for two peaks that occurred in short time.

Fig 5-A.
Consistent exposure during day except for two peaks. The smallest occurred around mid-day break, and the highest peak, oddly enough, occurred at the same time as one of the peaks in Fig 4-A.

Fig 6-A.
Pattern of exposure demonstrates a quasi-repetitive typical of repa work.

Waveforms were analyzed at several sites in the repair room. Several different waveforms were captured by the Holaday meter and displayed c digital oscilloscope and found to be of the normal sinusoidal varying types. Waveform patterns from the television sets were found to be sc more complex.

The results of ELF/VLF measurements made on VDTs and TV sets at worker locations are shown in Table 1-A. All occupational ELF/VLF electric a magnetic field levels from these devices were below ACGIH exposure lim addition, induced currents limits were not exceeded for any of the sou listed in Table 1-A.

Levels of ELF electric fields, as measured along the mid-line of the C range from 0.9 to 4.8 V/m and are below occupational limits promulgate ACGIH.

DISCUSSION AND CONCLUSIONS

Table 2-A shows the range of all electric and magnetic fields measured Van Kirk facility in the course of this evaluation. Examination of th measured electric and magnetic field strength values obtained in this evaluation shows that in no instance do either the VLF, ELF, or microw fields (or contact current levels), as measured at occupationally impo locations in the CRS, exceed applicable exposure limits on the day of measurement. Based on these findings, it is concluded that occupation exposure to various electric and magnetic fields at Warner Amex are substantially less than the currently accepted exposure limits.

The results from this evaluation at Warner Cable could be compared to reported on ELF measurements performed in a microelectronics fabricati facility.[5] In that study, magnetic field levels measured in the work aisles ranged from 0.2 to 7.0 mG and electric field levels ranged from 5.0 V/m. It was also noted that the magnetic fields were larger near electronic devices. Also it was reported that these magnetic fields f quickly depending upon the size of the electronic device.

This evaluation, as with all previous ELF evaluations performed by NIO demonstrated that magnetic field exposure levels were significantly hi near the ELF sources than they are at distances away. While this drop pattern of magnetic field as a function of distance does exist, the ra not obey an inverse square law relationship. It has been previously s that magnetic field near large devices (TV sets, transformers, etc.) w drop-off more slowly than fields produced by smaller devices (switches etc). This observation is based on the fact that large devices have m extended space (volume) for the electric current to move in than does devices-and hence a slower drop-off rate. Since magnetic fields can d quickly, it becomes important to document distances workers are locate ELF sources in order to suggest practical occupational exposure measur Electric field levels in the ELF frequency region apparently do not ha same drop-off characteristics.

While all average field levels documented in this evaluation were rela low, it is noted that Figure 4-A and 5-A show momentary elevated peaks least 200 mG and as high as 865 mG. In keeping with the philosophy of "prudent avoidance," it is suggested that a review of work practices b performed for technicians to eliminate or modify those procedures whic result in short-term elevated magnetic field levels.

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TABLE 1-A
CHARACTERISTICS OF EMF SOURCES FOUND AT WORK STATIONS IN REPAIR ROOM

WARNER-AMEX CABLE
HETA 91-390
FEBRUARY 5, 1992

SOURCE	MAXIMUM FREQUENCY RANGE (kHz)	MAXIMUM VLF FIELDS		MAXIMUM ELF FIELDS		DISTANCE MEASUREMENTS MADE (cm)	CONTACT CURRENTS (µA) AT SCREEN CONTACT
		E (V/m)	H (mG)	E (V/m)	H (mG)		
TELEX 078 VDT #17	23	0.8	0.20	0.5	0.2	30	0.9
GE TV SET # 1	15.9	1.1	0.02	34.4	0.8	30	14.0
TELEX 07 VDT #16	25.6	0.7	0.05	2.1	0.3	60	8.3
SONY TV # 6	15.8	1.6	0.21	6.4	3.6	100	2.6
GE TV # 5	15.5	1.7	0.22	14	2.7	75	3.8
? TV #10	4.5	0.6	0.33	2.5	3.3	75	1.7
GE TV #11	4.5	4.1	0.03	10	3.5	75	1.4
GE TV #14	4.5	3.0	0.23	24.8	1.2	75	6.2
G - L (SOLDERING BOX)	--	--	--	7	30	31	--

(a) EVERY WORK STATION HAS A DIFFERENT TV SET

TABLE 2-A
RANGE OF EMF MEASURED IN EVALUATION

WARNER-AMEX CABLE
HETA 91-390
FEBRUARY 5, 1992

EMF FIELD MEASURED	LOCATION	MEASUREMENT INSTRUMENT	LEVEL
MAGNETIC - ELF	WALLS/DESK	AMEX	0.6 - 7.6 mG (AVG)
MAGNETIC - ELF	WORKER WAIST	EMDEX	1.03 - 8.73 mG (AVG)
MAGNETIC - VLF	TV & VDT	HOLADAY	0.02 - 0.33 mG
ELECTRIC - VLF	TV & VDT	HOLADAY	0.7 - 4.1 V/m
MAGNETIC - ELF	TV & VDT	HOLADAY	0.2 - 30 mG
ELECTRIC - ELF	TV & VDT	HOLADAY	0.5 - 34.4 V/m
CURRENTS	TV & VDT	VOM	0.9 - 14 µA
ELECTRIC - ELF	MID-LINE AISLE	HOLADAY	0.9 - 4.8 V/m
MICROWAVE	INSIDE & OUTSIDE	NARDA	N/D

Figure 1-A
Location of Electromagnetic Field Measurements

Warner Communications
Cincinnati, Ohio
HETA 91-390

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* D  TV MONITORS             *         /)))))))))Q          S)))))))))1
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