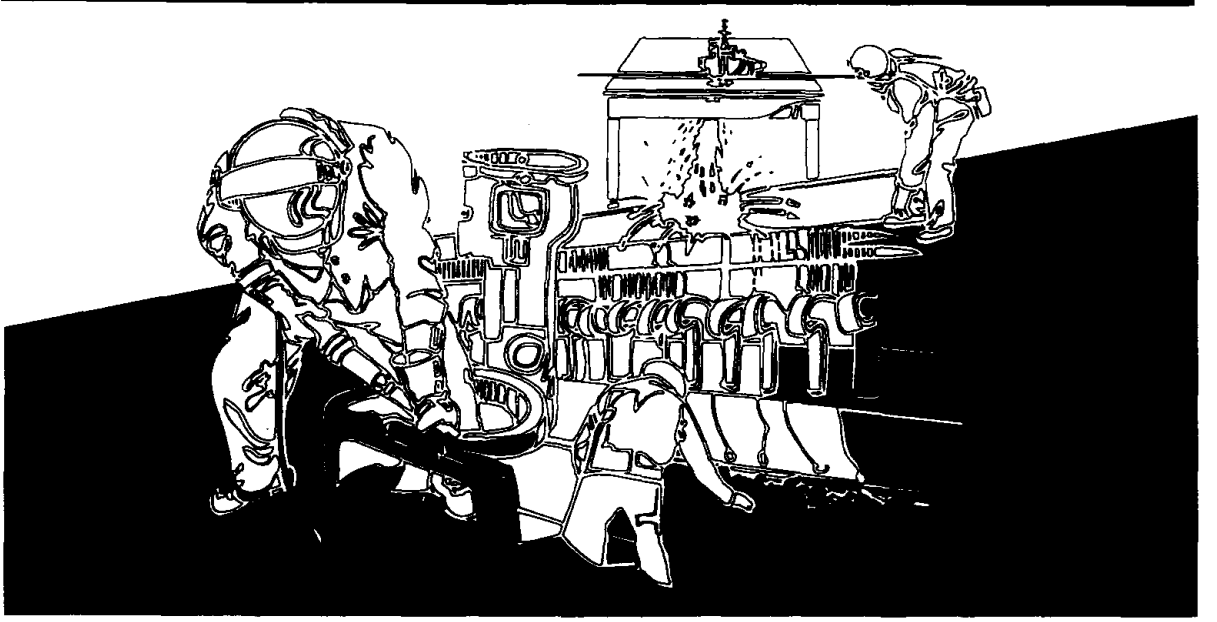
NIOSH

HEALTH HAZARD EVALUATION REPORT

HETA 92-182-2254
PIONEER VOCATIONAL INDUSTRIAL SERVICES, INC.
DANVILLE, KENTUCKY



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

CDC
CENTERS FOR DISEASE CONTROL

PREFACE

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

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

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SEPTEMBER 1992
PIONEER VOCATIONAL
INDUSTRIAL SERVICES, INC.
DANVILLE, KENTUCKY

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I. SUMMARY

On March 13, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Commonwealth of Kentucky Labor Cabinet for assistance in evaluating occupational radiofrequency radiation exposure of operators from a four kilowatt heat sealing machine at the Pioneer Vocational/Industrial Services, Inc. in Danville, Kentucky. The request did not cite the occurrence of any health effects. NIOSH investigators visited the facility on April 20, 1992, to evaluate the exposure.

Levels of radiofrequency radiation at 27.12 megahertz (MHz) at the operator position were found to range from non-detectable to 1×10^3 volts for the electric field and were non-detectable for the magnetic field. The highest operator induced body current level measured was 65 milliamperes (mA). These levels were below all current occupational exposure limits. No symptoms were reported to the NIOSH investigators during worker interviews.

Based on the data collected in this evaluation and comparison with current exposure criteria, the NIOSH investigators concluded that no health hazard from radiofrequency radiation existed on the day of measurement at the worksite. Recommendations are offered on other safety concerns found during the evaluation.

Keywords: SIC 8331 (Job Training and Vocational Rehabilitation Services), RF radiation, Heat Sealer, EMF, body current.

II. INTRODUCTION

On March 13, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Commonwealth of Kentucky Labor Cabinet (CKLC) for an evaluation of potential occupational exposure to radiofrequency (RF) radiation produced during the heating of plastic parts at the Pioneer Vocational/Industrial Services, Inc. (PVISI) in Danville, Kentucky. RF measurements were performed at PVISI on April 20, 1992, by NIOSH and CKLC investigators.

III. BACKGROUND

PVISI is a non-profit corporation that provides eligible handicapped persons with improved opportunities to participate in and contribute to the working community in Kentucky. The facility at Danville serves about 60 clients daily in its 23,000 square foot building. PVISI offers specialized programming in the areas of job/worker analysis, job selection, and career development that is directed toward assisting handicapped individuals in entering the labor market or upgrading their current employment.

In order to perform some of the work tasks PVISI acquired a four kilowatt (kW) Callahan Model 18X42 radiofrequency heat sealing unit in 1989 that operates at 27.12 megahertz (MHz). The heat sealer is of a conventional design, has a rectangular-shaped welding head, is operated by one person, and is used to seal plastic parts. NIOSH was asked to assist the Commonwealth of Kentucky's Occupational Safety and Health Program in making measurements on this particular heat sealer.

IV. EVALUATION DESIGN AND METHODS

The RF measurements were performed with a Holaday Model 3002 survey meter using two probes: a Model STE-02 for the electric (E) field and a Model STH-02 for the magnetic (H) field. The E-field probe is designed for the frequency range of 0.5 to 6000 MHz and measures the electric field strength in units of volts squared per meter squared $(V/m)^2$. The lowest meter indicating level (LMIL) for this probe is 500 V/m^2. The H-field probe is designed for the frequency range of 5 to 300 MHz and measures the magnetic field strength in units of amperes squared per meter squared $(A/m)^2$. The LMIL for the probe is 0.005 A/m^2. Electric and magnetic field intensity measurements were taken at selected anatomical locations at distances where the operator sat in performing job tasks and at locations where other workers could be exposed to RF radiation during the work day. Body current levels were also taken at the site where the operator sat as well as at those locations where non-heat sealer personnel were positioned when the heat sealers were in operation.

Since the RF output of the heat sealer was not continuous (i.e., operations were for short time intervals over a long time), all measurements were corrected for the work cycle before comparisons were made with applicable occupational exposure standards. This was accomplished by multiplying the measured duty cycle times by the recorded RF exposure value. The duty cycle is defined as the total length of RF on-time in seconds measured during any six minutes sampling period divided by 360 seconds. The duty cycle is expressed as a fraction and for this evaluation was found to be 0.33.

The frequency of the heat sealer was measured using a Continental Specialties Corporation Mini-max Model MM50 battery powered frequency counter.

Body currents resulting from occupational exposure to electric fields were evaluated using a body current detector system.[1] This system is based on the principle that when RF energy is absorbed by the body, electrical currents are induced within the body. These body currents can be measured by using a foot current sensor designed to respond only to currents induced by external electric fields. The body currents were measured by having the worker stand on a 6 millimeter-(mm) thick 32-by 32-centimeter (cm) polyethylene sheet clad on both sides with copper. The current from the upper plate, where the worker stands, passes to the lower copper plate, which is in contact with the floor surface, through a non-inductive carbon resistor located in the center of the bi-layer sensor. The RF current across the resistor is measured with a calibrated RF milliammeter. All current measurements were made with the worker standing on the sensor in front of the heat sealer with shoes on. A "background" measurement is made without the worker on the sensor in order to eliminate spurious readings that could occur from sources of electromagnetic radiation interference. Body current values were not corrected for the duty cycle.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed without experiencing adverse health effects. It is, however, important to note that not all 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 situation. In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criteria. Also, some substances are absorbed by direct

contact with the skin and mucous membranes, and thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information about chemical and physical agents become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH criteria documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational diseases. In evaluating the exposure levels and the recommendations for reducing these levels found in these reports, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

Absorption of RF energy can adversely affect a worker's health since human and animal studies indicate that this type of radiation can cause harmful biological effects due to excessive heating of body tissues.[2-4] Absorption of RF energy may also result in "non-thermal" effects on cells or tissues, which occur without a measurable increase in tissue or body temperature. Such effects are reported to occur from exposure to RF energy at levels lower than those sufficient to cause thermal effects.

RF radiation can penetrate the body and cause heating of internal tissues. The body's heat sensors are located in the skin and do not readily sense heating deep within the body. Therefore, workers may absorb large amounts of radiation without being immediately aware of the presence of such energy. There have been reports that personnel exposed to RF fields from radar equipment, RF heaters and sealers, and radio/TV towers have experienced a warming sensation some time after being exposed.

There is general agreement that the incidence and severity of RF biological effects are related to the magnitude of radiation power absorbed by the body. This absorption depends strongly upon the frequency and intensity of the radiation, the size and shape of the exposed worker, and the worker's orientation in the radiation field. The human body absorbs maximally in the frequency range of 30 to 300 Megahertz (MHz). Outside this range, much less energy is absorbed by the body from the field.

At present there is limited information from OSHA on exposure criteria for workers exposed to physical agents. Criteria for physical agents

not covered by OSHA come from either ACGIH, NIOSH, or in some cases from consensus standards promulgated by the American National Standards Institute (ANSI).

Table 1 shows the occupation limits of 27 MHz electric and magnetic fields permitted by OSHA, ACGIH, and ANSI. Exposures for these standards are averaged over a 0.1 hour period.

Table 1. Comparison of Occupational Exposure Limits 27.0 MHz RF Radiation[5-7]

ORGANIZATION	E^2 $(V/m)^2$	H^2 $(A/m)^2$
OSHA	3770	0.026
ACGIH	4613	0.032
ANSI	4610	0.36

In addition to electric and magnetic field exposure limits, the IEEE C95.1 - 1991 committee has recently adopted a body current limit of 200 milliampere (mA) through both feet. This value of 200 mA limits the partial body specific absorbed rate (SAR) to levels less than 20 watts per kilogram (W/kg) in the extremities. The exposure for this particular standard is not duty cycle factor averaged.

VI. RESULTS

The operator sat about four feet from the center edge of the housing. At this location, the occupational magnetic field exposure level was not detectable and the electric field level was about 1 x 10^3 $(V/m)^2$ (duty cycle factored). The field intensity levels measured at the worker location did not exceed applicable ACGIH, OSHA, or ANSI standards.

The highest readings (duty cycle factored) occurred near the housing surrounding the heat sealer contact bars. These readings were 1.98 x 10^{-2} A^2/m^2 for the magnetic field and 2.3 x 10^4 V^2/m^2 for the electric field. These levels do not represent a concern for the magnetic field, however, the electric field level exceeds all exposure limits. Hence, if the operator was ever positioned for long periods of time closer than four feet from the edge of the metal contact bars of the heat sealer, a potential excessive occupational exposure to the E-field would exist.

The highest operator induced body current level recorded, 65 mA, does not exceed the ANSI recommended level of 200 mA.

VII. CONCLUSION AND RECOMMENDATIONS

Electric and magnetic field exposures, as well as body current levels, measured on the day of this evaluation, do not represent a health

hazard to the operator and personnel working in the heat sealing operations. However, the following safety hazards were observed that require attention by PVISI personnel:

1. The heat sealing area needs to be appropriately posted to identify the presence of RF energy.

2. The heat sealer operator must be instructed not to extend hands and arms towards the direction of the unit during the "on-cycle." Positioning the arms and hands closer to the unit would increase the body currents, increase exposure to electric and magnetic fields, and could result in an increased risk of electrical shock.

3. At extremely close distances to the heat sealer, there is some radiation leakage. These leakage sites should be identified and eliminated by the use of commercially available RF finger stock.

4. On the day of measurement there was trash and debris in and around the heat sealing machine. The unit was dirty (dust, paper, styrofoam peanuts, burnt nylon residue) and needs to be kept cleaner for proper operation and to reduce the potential for electrical fires.

5. The NIOSH investigators recommend that the water taps and drains, which are located within two feet of the sealer, be relocated in order to eliminate possible electrical safety concerns.

6. Nylon tape was used at the facility to help establish a mold to hold the plastic parts being sealed and also to hold the insulator onto the metal sealing surfaces. As a result of the heating process, the nylon tape became brittle and fragmented into small airborne particulates. The breakdown of the tape resulted in RF leaks around the metal housing. The NIOSH investigators recommend that another method of fastening be used instead of nylon tape in order to eliminate RF leakage as well as airborne particulates.

7. The heat sealer should be inspected yearly for possible RF leakage and that PVISI consider purchasing a RF survey meter.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Copies of this report have been sent to:

1. Pioneer Vocational Technical Services, Danville, Kentucky.
2. Occupational Safety and Health Program, Commonwealth of Kentucky, Frankfort, Kentucky.
3. NIOSH.
4. OSHA, Region IV.

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