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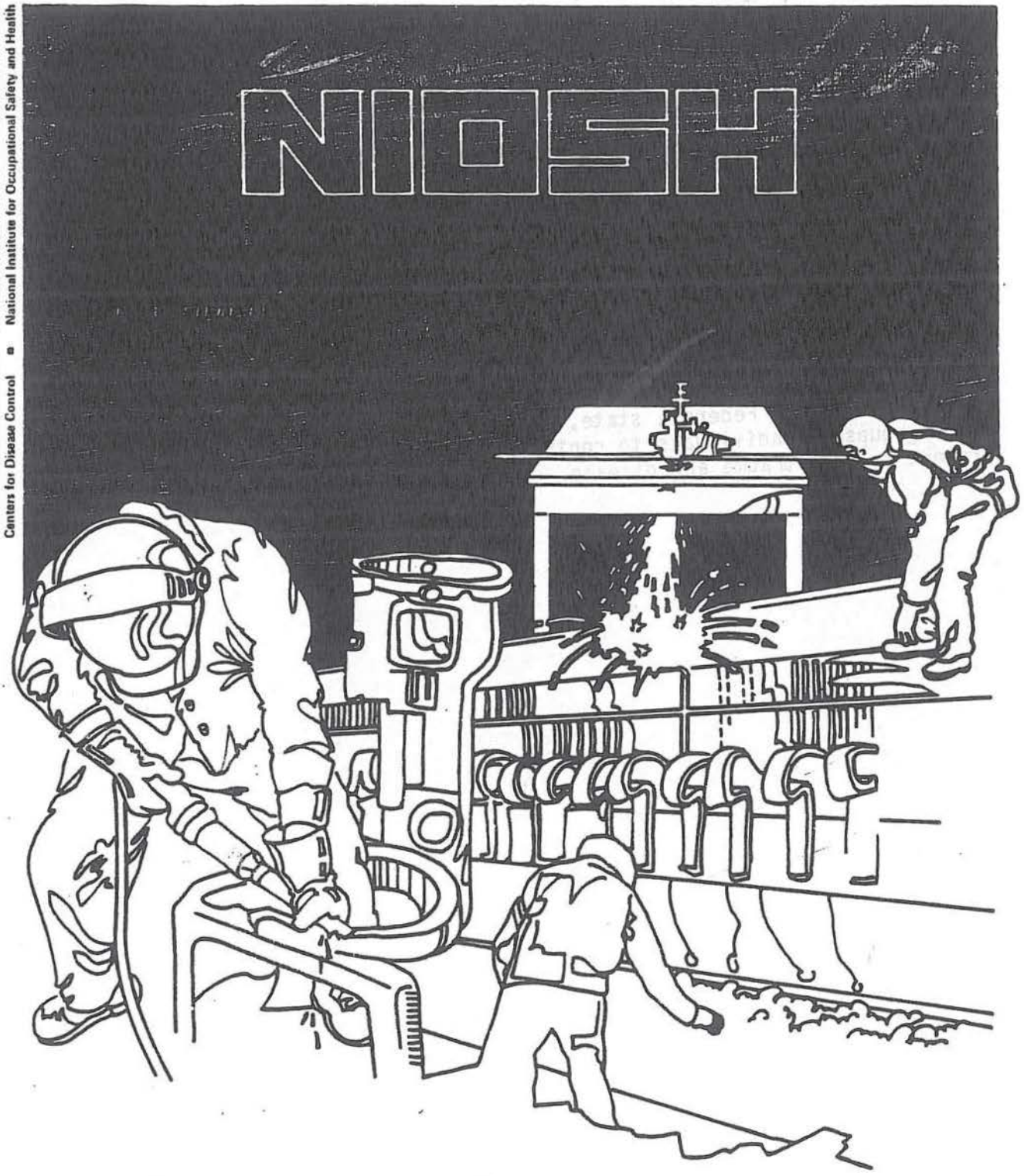

Health Hazard Evaluation Report

HETA 84-228-1582
SCHLEGEL CORPORATION
ROCHESTER, NEW YORK

PREFACE

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

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

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SCHLEGEL CORPORATION
ROCHESTER, NEW YORK

NIOSH INVESTIGATOR:
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I. SUMMARY

On March 2, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposures of workers using radiofrequency (RF) heat sealers at Schlegel Corporation, Rochester, New York. The company uses two heat sealers, both of which were unshielded, in the manufacture of vinyl moldings.

NIOSH conducted an initial survey on April 16-17, 1984. Measurements of the electric (E) and magnetic (H) fields were taken at the neck, waist, knee, and hand positions of operators and helpers of both unshielded heat sealers. Exposures, when corrected for work cycles of the machines, ranged up to 6.6×10^4 V^2/M^2 for the E-field and up to 0.057 A^2/M^2 for the H-field. By comparison, ACGIH currently recommends TLVs of 3.77×10^3 V^2/M^2 (E-field) and 0.027 A^2/M^2 (H-field). The E and H field strength equivalents of the OSHA standard are 4.0×10^4 V^2/M^2 and 0.25 A^2/M^2, respectively. On the basis of these measurements, it was recommended that the company install appropriate shielding on both heat sealers to reduce RF exposures.

Since the company indicated that they would retrofit the heat sealers with shielding, we offered to reevaluate these units to determine whether the shielding was effective in reducing RF exposures.

Accordingly, a follow-up survey was conducted on November 26-27, 1984, shortly after the shielding was installed. The shielding consisted of a box-shaped enclosure around the press die fabricated from perforated aluminum sheet stock with flexible phosphor bronze contact around the bottom of the enclosure. RF measurements taken at both shielded heat sealers revealed E and H field strengths no higher than 1.4×10^3 V^2/M^2 and 0.006 A^2/M^2, respectively, which were within the ACGIH TLVs.

On the basis of the data collected during this evaluation NIOSH determined that workers were overexposed to RF radiation while using the unshielded heat sealers. However, after the heat sealers were equipped with appropriate shielding, as recommended by NIOSH, exposures were reduced to within the environmental criteria.

KEYWORDS: SIC 2299 (Miscellaneous Textile Goods, not elsewhere classified), heat sealers, radiofrequency radiation, shielding.

II. INTRODUCTION

On March 2, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from an authorized representative of the Amalagamated Clothing and Textile Workers Union - Local 3T to evaluate radiofrequency (RF) radiation from heat sealers at Schlegel Corporation, Rochester, New York. No specific health and safety complaints were reported.

On April 16-17, 1984, an industrial hygienist from NIOSH conducted a survey at the plant and found RF exposures in excess of the OSHA standard and the more stringent ACGIH guidelines. At the closing conference on April 17, the NIOSH investigator informed the Company and union of the findings and recommended that appropriate shielding be installed on the heat sealers to reduce exposures. Since the company indicated that they would install the shielding NIOSH made arrangements to repeat the measurements to determine whether the shielding was effective in reducing exposures below the ACGIH guidelines. On November 26-27, 1984, the NIOSH investigator returned to the facility and made these measurements.

Findings from the initial and follow-up surveys were summarized in letter reports (dated May 24, 1984 and January 9, 1985) which were sent to representatives of the company and union.

III. BACKGROUND

The radiofrequency (RF) heat sealers are currently used at Schlegel Corporation in the manufacture of vinyl moldings. Each heat sealer is normally "manned" by two workers, an operator and a helper, who are located alongside a turntable which automatically feeds the vinyl material into the press. The operator is stationed at the side of the heat sealer about 2 ft. from the source while the helper is stationed directly in front about 6 ft. from the source.

Both heat sealers were manufactured by Thermatron Company and were identical models (KA 64) with nominal operating frequencies of 30 megahertz (MHZ). The heat sealers were commonly referenced by plant personnel as the "aisle" (serial no. 580) and the "corner" (serial no. 54964) units, and will be identified as such in this report.

The shielding used to control RF emmissions from the heat sealers was constructed with perforated aluminum sheet stock and flexible phosphor bronze contacts. The aluminum sheet stock was used to construct a box-like enclosure around the press die and was connected to the dielectric insulation supporting the top plate of the heat sealer. The phosphor bronze contacts were attached around the bottom of the

enclosure and were used to ensure good electrical contact between the bottom fixed (ground) plate of the sealer and the open bottom of the aluminum enclosure.

IV. MATERIALS AND METHODS

During the initial and follow-up surveys, production was such that only one the heat sealers was scheduled for use. However, the company had the workers run both heat sealers so that we could measure exposures from each unit.

RF measurements were made with a calibrated Holaday Model HI 3002 broadband field strength meter equipped with an electric (E) probe and magnetic (H) probe. The E field probe was used to measure the electric field strength in volts squared per meter squared (V^2/M^2). The H field probe was used to measure the magnetic field strength in amperes squared per meter squared (A^2/M^2). The minimum detectable field strength for the E and H probes was 0.5×10^3 V^2/M^2 and 0.005 A^2/M^2, respectively.

E and H field strength measurements were taken at the operator and helper of both heat sealers. Measurements were taken on the right and left side of the body at the neck, waist, knee, and hand positions. Since the RF output of both Thermatron heat sealers was not continuous, the measurements made with the Holaday monitor were corrected for the work cycle of the heat sealer before comparisons could be made with occupational exposure standards. The work cycle of the heat sealer is the RF on-time divided by the total process time. Observations of processing times for both heat sealers revealed a work cycle of 0.19 for the "aisle" unit and 0.21 for the corner unit. (These values were the same for each unit during both surveys). The product of the meter reading and the work cycle correction factor is equivalent to the employee's exposure.

V. EVALUATION CRITERIA

A. Environmental 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 up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage

may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hyper-sensitivity (allergy).

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

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Criteria Documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and (3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the 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 disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

For radiation in the radiofrequency and microwave range of 30 MHZ to 100 MHZ, ACGIH recommends TLVs of 3.77×10^3 V^2/M^2 for the E-field and 0.027 A^2/M^2 for the H-field.[1] OSHA specified, in 29 CFR 1910.97, a power density exposure limit of 10 milliwatts per centimeter squared (mW/cm^2) averaged over any 6-minute period.[2] In the far field this power density level corresponds to 4×10^4 V^2/M^2 (E-field) and 0.25 A^2/M^2 (H-field). The ACGIH TLVs for the E and H fields, as can be seen, are about 10 times lower than the corresponding levels in the OSHA standard.

B. Biological effects of radiofrequency radiation.

Radiofrequency (RF) radiation is that portion of the nonionizing electromagnetic spectrum from approximately 0.01 - 300,000 MHz. The prinicpal biological effect of RF radiation is heating of tissues.[3] The extent of heating is primarily dependent on the

water content of the tissue and the intensity and duration of the RF energy. Most parts of the body have sufficient blood supply to dissipate heat resulting from absorption of RF radiation. However, the eye (especially the lens) is particularly vulnerable to heating since it lacks an efficient blood supply to dissipate heat. Consequently, damage may occur to the transparent cells around the lens resulting in the formation of cataracts.[4] Other tissues which display high sensitivity to heat include the testes and brain (specifically the reticular formation of the brain stem and hypothalamus).[5]

In addition to thermal effects absorption of RF radiation may result in nonthermal effects which may occur without a measurable increase in tissue or body, and at RF field strengths lower than those necessary to cause thermal effects.[6] Nonthermal effects have been widely reported in the Soviet and Eastern European literature. Effects which have been described but poorly substantiated include those on the nervous system (headache, fatigue, irritability, altered memory function, altered EEG recordings, and sleep disturbances), and effects on the blood (leukocytosis, thrombocytopenia). Also reported are sweating, hypotension, dyspnea, chest pain, cardiac arrhythmias, and changes in blood levels of enzymes, hormones, and immunity factors. These studies, however, have been severely criticized for problems with subjective measurements and for lack of appropriate experimental design and statistical analysis of data.

Experimental and observational data from animal and human studies indicate no carcinogenic or mutagenic effects resulting from exposure to RF radiation.[6] Human studies indicate that no teratogenic effects occur, but are inconclusive as to whether reproductive effects occur. Animal studies have shown some reproductive and teratogenic effects, but the evidence is often contradictory. It appears that the reproductive effects in animals correlate well with RF-induced heat production. NIOSH will soon complete a criteria document which will review in detail the potential health hazards of RF radiation.

VI. RESULTS AND DISCUSSION

Table 1 summarizes RF radiation exposures of operators and helpers of the aisle and corner heat sealers, before and after installation of shielding. Individual exposure measurements (by job and anatomical site) for unshielded and shielded units are presented in Table 2 and 3, respectively.

Before shielding was installed, RF exposures of the operator and helper of the aisle Thermatron unit ranged from 7.2×10^2 to 6.6×10^4 V^2/M^2 (E-field) and from nondetectable (less than 0.005 A^2/M^2)

to 0.019 A^2/M^2 (H-field). E and H field strength exposures for the same crew when using the corner Thermatron unit ranged from 4.6×10^2 to 2.5×10^4 V^2/M^2 and from nondetectable to 0.057 A^2/M^2, respectively. Operators and helpers of both units had E-field exposures approaching or exceeding the ACGIH TLV of 3.77×10^4 V^2/M^2. In addition the operator of the aisle unit was exposed to RF energy exceeding the E-field equivalent of 4.0×10^4 V^2/M^2 of the OSHA standard. Only the operator of the corner Thermatron unit had H-field exposures above the ACGIH TLV of 0.027 A^2/M^2. No H-field exposures exceeded the OSHA standard.

In general, the operator had higher RF exposure and more so to the left side of the body than the helper. This was due to their proximity and orientation relative to the press.

After shielding was installed, E and H field strength exposures of operators and helpers of both units were no higher than 1.4×10^3 V^2/M^2 and 0.006 A^2/M^2, respectively. By comparison, these levels were below the ACGIH TLVs.

VII. CONCLUSION

On the basis of the data collected during this evaluation, shielding of the heat sealers was effective in reducing RF exposures of workers below the most stringent occupational health guidelines.

VIII. RECOMMENDATIONS

To ensure that RF exposures continue to be within the ACGIH guidelines, it is recommended that the phosphor bronze contacts be periodically checked, and adjusted if needed, so that they are flush with the tabletop when the press is in the down position, in order to prevent unnecessary leakage of RF radiation.

IX. REFERENCES

1. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1984-85. Cincinnati, Ohio ACGIH, 1984.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X1. DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Schlegel Corporation, Rochester, New York
2. Almagamated Clothing and Textile Workers Union - Local 3T
3. NIOSH, Region II
4. OSHA, Region II

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

Table 1

Summary of RF Radiation Exposures at
Unshielded and Shielded Thermatron Heat Sealers*

Schlegel Corporation
Rochester, New York
HETA 84-288

April 17, November 26-27, 1984

	"Aisle" Thermatron							
	E-field (V^2/M^2)				H-field (A^2/M^2)			
	unshielded		shielded		unshielded		shielded	
operator	7.2×10^2	6.6×10^4	1.9×10^2	1.4×10^3	ND	0.019	ND	0.006
helper	1.3×10^3	3.4×10^3	ND	7.6×10^2	ND	0.016		ND
	"Corner" Thermatron							
operator	4.6×10^2	2.5×10^4	1.6×10^2	1.0×10^3	ND	0.057	ND	0.002
helper	8.0×10^2	1.0×10^4	1.0×10^2	5.8×10^2	0.001	0.004		ND
Evaluation Criteria (ACGIH):			3.77×10^3			0.027		
OSHA Standard:			4.0×10^4			0.25		

*Measurements are corrected for work cycle and are given as a range.
ND = nondetectable, less than 0.5×10^3 V^2/M^2 (E-field) or 0.005 A^2/M^2 (H-field).

Table 2

Electric and Magnetic Field Strength Measurements at the
Unshielded "Aisle" and "Corner" Thermatron Heat Sealer

Schlegel Corporation
Rochester, New York
HETA 84-298

April 17, 1984

Aisle Thermatron

Job/ Anatomical Location	E-Field Meter Reading V^2/M^2	E-Field Average Exposure[1] V^2/M^2	H-Field Meter Reading A^2/M^2	H-Field Average Exposure[1] A^2/M^2
Operator				
Neck (R)	0.8×10^4	1.5×10^3	<0.005	<0.001
Neck (L)	3.5×10^4	6.7×10^3	0.037	0.007
Waist (R)	3.8×10^3	7.2×10^2	0.005	0.001
Waist (L)	1.2×10^4	2.3×10^3	0.100	0.019
Knee (R)	1.2×10^4	2.3×10^3	0.010	<0.001
Knee (L)	1.0×10^4	1.9×10^3	0.100	0.019
Hand (R)	2.0×10^4	3.8×10^3	0.012	0.002
Hand (L)	3.5×10^5	6.6×10^4	0.075	0.014
Helper				
Neck (R)	1.8×10^4	3.4×10^3	<0.005	<0.001
Neck (L)	0.9×10^4	1.7×10^3	<0.005	<0.001
Waist (R)	0.7×10^4	1.3×10^3	0.009	0.002
Wasit (L)	0.9×10^4	1.7×10^3	0.005	0.001
Knee (R)	0.8×10^4	1.5×10^3	0.085	0.016
Knee (L)	0.9×10^4	1.7×10^3	0.009	0.002
Hand (R)	1.5×10^4	2.8×10^3	0.016	0.003
Hand (L)	1.4×10^4	2.7×10^3	<0.005	<0.001

(continued)

Table 2 (continued)

Corner Thermatron

Job/ Anatomical Location	E-Field Meter Reading V^2/M^2	E-Field Average Exposure[1] V^2/M^2	H-Field Meter Reading A^2/M^2	H-Field Average Exposure[1] A^2/M^2
Operator				
Neck (R)	0.8×10^4	1.7×10^3	0.005	0.001
Neck (L)	4.8×10^4	1.0×10^4	0.055	0.011
Waist (R)	2.2×10^3	4.6×10^2	0.008	0.002
Waist (L)	1.5×10^4	3.1×10^3	0.112	0.023
Knee (R)	2.8×10^4	5.9×10^3	<0.005	<0.001
Knee (L)	4.5×10^4	9.4×10^3	0.275	0.057
Hand (R)	1.8×10^4	3.8×10^3	0.012	0.002
Hand (L)	1.2×10^5	2.5×10^4	0.112	0.023
Helper				
Neck (R)	1.8×10^4	3.8×10^3	0.005	0.001
Neck (L)	1.5×10^4	3.1×10^3	0.005	0.001
Waist (R)	3.8×10^3	8.0×10^2	0.007	0.001
Wasit (L)	0.5×10^4	1.0×10^4	0.012	0.002
Knee (R)	1.8×10^4	3.8×10^3	0.014	0.003
Knee (L)	1.8×10^4	3.8×10^3	0.011	0.002
Hand (R)	1.5×10^4	3.1×10^3	0.020	0.004
Hand (L)	1.5×10^4	3.1×10^3	0.009	0.002
Evaluation Criteria (ACGIH TLV):		3.77×10^3		0.027
OSHA Standard:		4.0×10^4		0.250

1. Average of two measurements
2. Corrected for duty cycle of sealing operation

Table 3

Electric and Magnetic Field Strength Measurements at
the Shielded "Aisle" and "Corner" Thermatron Heat Sealers

Schlegel Corporation
Rochester, New York
HETA 84-228

November 26-27, 1984

Aisle Thermatron

Job/ Anatomical Location	E-Field Meter Reading[1] V^2/M^2	E-Field Average Exposure[2] V^2/M^2	E-Field Meter Reading[1] A^2/M^2	E-Field Average Exposure[2] A^2/M^2
Operator				
Neck (R)	2.0×10^3	3.8×10^2	<0.005	<0.001
Neck (L)	3.0×10^3	5.7×10^2	<0.005	<0.001
Waist (R)	2.0×10^3	3.8×10^2	0.010	0.002
Waist (L)	5.0×10^3	9.5×10^2	0.020	0.004
Knee (R)	1.5×10^3	2.8×10^2	0.010	0.002
Knee (L)	1.0×10^3	1.9×10^2	0.030	0.006
Hand (R)	6.5×10^3	1.2×10^3	0.005	0.001
Hand (L)	7.5×10^3	1.4×10^3	<0.005	<0.001
Helper				
Neck (R)	1.0×10^3	1.9×10^2	<0.005	<0.001
Neck (L)	2.5×10^3	4.7×10^2	<0.005	<0.001
Waist (R)	1.0×10^3	1.9×10^2	<0.005	<0.001
Waist (L)	2.5×10^3	4.7×10^2	<0.005	<0.001
Knee (R)	$<0.5 \times 10^3$	$<9.5 \times 10^1$	<0.005	<0.001
Knee (L)	0.75×10^3	1.4×10^2	<0.005	<0.001
Hand (R)	2.5×10^3	4.7×10^2	<0.005	<0.001
Hand (L)	4.0×10^3	7.6×10^2	<0.005	<0.001

(continued)

Table 3 (continued)

Corner Thermatron

Job/ Anatomical Location	E-Field Meter Reading[1] V^2/M^2	E-Field Average Exposure[2] V^2/M^2	E-Field Meter Reading[1] A^2/M^2	E-Field Average Exposure[2] A^2/M^2
Operator				
Neck (R)	1.5×10^3	3.1×10^2	<0.005	<0.001
Neck (L)	1.25×10^3	2.6×10^2	<0.005	<0.001
Waist (R)	1.5×10^3	3.1×10^2	<0.005	<0.001
Waist (L)	3.0×10^3	6.3×10^2	0.007	0.001
Knee (R)	0.75×10^3	1.6×10^2	<0.005	<0.001
Knee (L)	0.75×10^3	1.6×10^2	0.010	0.002
Hand (R)	1.5×10^3	3.1×10^2	<0.005	<0.001
Hand (L)	4.75×10^3	1.0×10^3	0.005	0.001
Helper				
Neck (R)	1.25×10^3	2.6×10^2	<0.005	<0.001
Neck (L)	1.5×10^3	3.1×10^2	<0.005	<0.001
Waist (R)	1.0×10^3	2.1×10^2	<0.005	<0.001
Waist (L)	1.75×10^3	3.7×10^2	<0.005	<0.001
Knee (R)	1.25×10^3	2.6×10^2	<0.005	<0.001
Knee (L)	0.5×10^3	1.0×10^2	<0.005	<0.001
Hand (R)	1.5×10^3	3.1×10^2	<0.005	<0.001
Hand (L)	2.75×10^3	5.8×10^2	<0.005	<0.001
ACGIH TLV		3.77×10^3		0.027
OSHA STANDARD:		4.0×10^4		0.250

1. Average of two measurements
2. Corrected for duty cycle of sealing operation