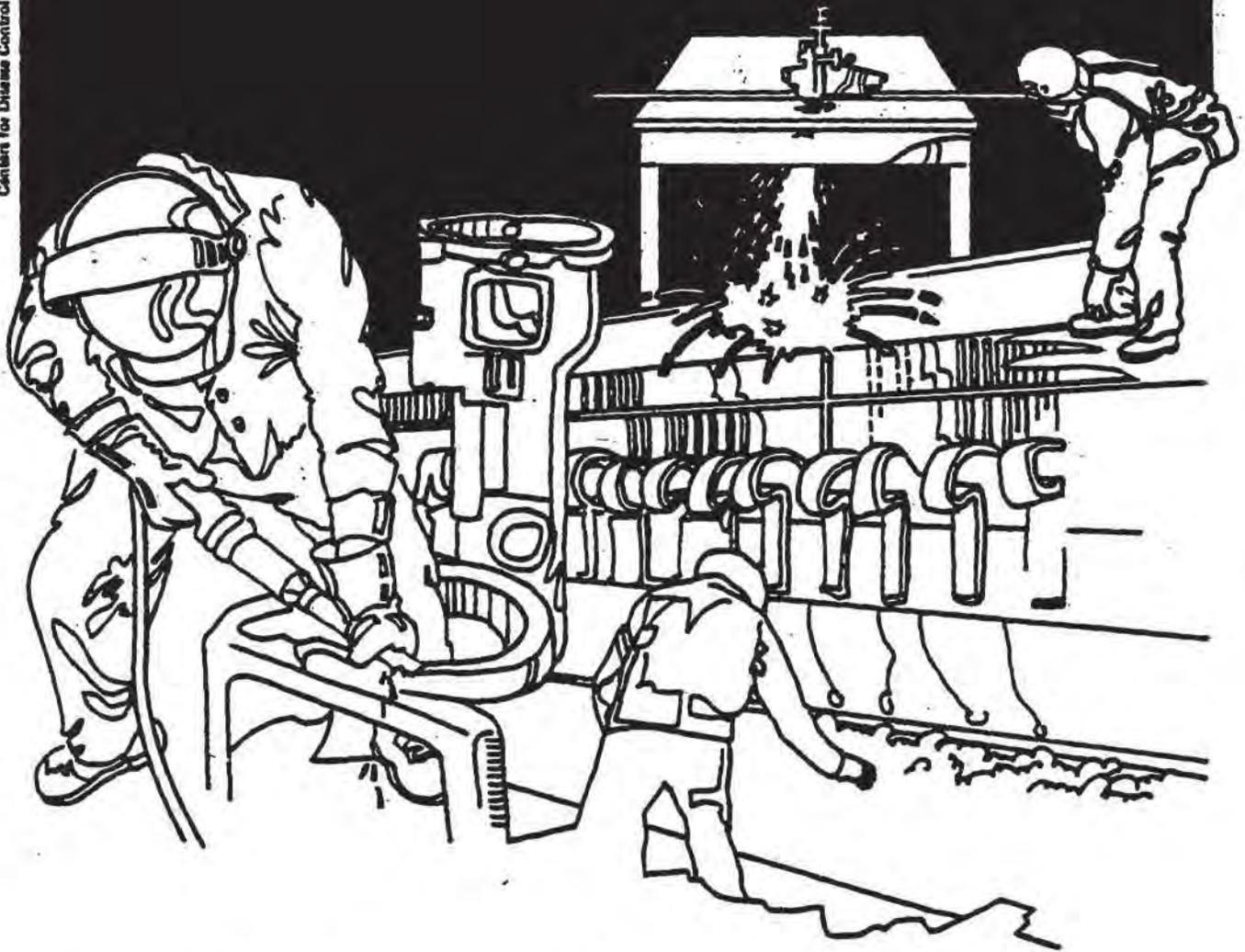


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service  
Centers for Disease Control ■ National Institute for Occupational Safety and Health

# NIOSH



## Health Hazard Evaluation Report

HETA 85-153-1714  
K & M COMPANY  
TORRANCE, CALIFORNIA

## 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 85-153-1714  
JULY 1986  
K & M COMPANY  
TORRANCE, CALIFORNIA

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## I. SUMMARY

On January 28, 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate six reported cases of breast cancer among Hispanic women occurring since 1979 at the Kingsbacher-Murphy (K & M) Company, Torrance, California. In addition, NIOSH was asked to determine the advisability of pregnant women working with radiofrequency (RF) heat sealers. The K & M Company uses RF heat sealers in the production of vinyl notebooks and three-ring binders.

On July 1-3, 1985, NIOSH evaluators conducted an initial visit to gather background information. A walk-through inspection of the plant was conducted and a medical questionnaire to ascertain any additional cancer cases and to determine reproductive outcomes was administered to 321 employees.

On July 23-24, 1985, NIOSH industrial hygienists conducted radiofrequency exposure monitoring at 23 of 28 RF heat-sealing machines in operation. Measurements of electric (E) and magnetic (H) fields were taken at the face, chest, hands, stomach, groin, thigh, knee and ankle of operators on 23 RF machines.

None of the 23 machines exceeded the Occupational Safety and Health Administration (OSHA) Standards for the E- and H-field exposure ( $4.0 \times 10^4 \text{ V}^2/\text{M}^2$  and  $0.25 \text{ A}^2/\text{M}^2$ , respectively), nor the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's) for the E-field ( $3.77 \times 10^3 \text{ V}^2/\text{M}^2$ ). However, 13 of 23 machines did exceed the ACGIH TLV for the H-field ( $0.027 \text{ A}^2/\text{M}^2$ ). There is no evidence that radiofrequency exposures were significantly higher in the past.

The rate of reported spontaneous abortions (SAB's), 8.8%, did not exceed what would be expected for the general population (10-20%). The rate of SAB's was still not excessive for Hispanics when analyzed by department or work history. A higher rate of SAB's was reported since employment (17.6%) than prior to employment at K & M (7.9%). Employees of the RF heat-sealing department reported a higher rate of adverse pregnancy outcomes (12.7%) resulting in SAB's than employees of other departments (8.1%). These observations, however, are subject to deferential recall on the part of the employees completing the questionnaires and should be interpreted with caution.

RF radiation causes birth defects in experimental animals at near-lethal levels of exposure. The effect of RF radiation on pregnancies in humans at the low levels of RF exposure observed here is

not known. While RF exposure poses a theoretical risk, the results from this study and the current medical literature are insufficient to establish a policy regarding the advisability of pregnant women working with RF heat sealers.

A total of eight breast cancer cases in female employees was reported. One case that occurred in a non-Hispanic female, and another that occurred prior to employment at K & M, and were excluded from further analysis. Compared with Hispanic women of Los Angeles County, where the plant is located, a greater than expected number of breast cancers has occurred at K & M since 1979, both plant-wide and in the heat-sealing department. The relation of this cluster of cases to occupational exposure is unclear.

There were more breast cancer cases among current K & M employees and among employees of the radiofrequency heat-sealing department than would be expected for a population of similar age and size. RF exposures did not exceed the OSHA standard for the E- and H-fields, or the ACGIH TLV for the E-field. However, 13 of 23 machines did exceed the ACGIH TLV for the magnetic field. Recommendations for reducing RF exposures and for medical surveillance are presented in Section VIII of this report..

**KEYWORDS:** SIC 2782 (Blankbooks, Looseleaf Binders and Devices)  
radiofrequency heat-sealers, breast cancer, spontaneous abortions

## II. INTRODUCTION

On January 28, 1985, NIOSH received a confidential request from employees of the K & M Company, Torrance, California to evaluate a cluster of breast cancer cases among Hispanic women and to determine the advisability of pregnant women working with radiofrequency (RF) heat sealers. Six cases of breast cancer occurring since 1979 were initially reported.

NIOSH investigators conducted an initial visit on July 1-3, 1985, at which time a medical questionnaire was administered to employees. NIOSH industrial hygienists conducted radiofrequency exposure monitoring on July 23-24, 1985. On September 9, 1985, a letter summarizing the results of the industrial hygiene survey, along with recommendations for additional shielding of the RF heat sealers, was sent to all parties.

## III. BACKGROUND

The Torrance facility of the K & M Company was constructed in 1951. At the time of our initial visit, there were 480 employees, 420 hourly, and 60 salaried. The company produces a variety of general office supplies including three-ring binders, pad folios, and sheet protectors.

The K & M Company uses RF heat sealers in the production of vinyl notebooks and three-ring binders. When the heat-sealing department of the plant is operating at full capacity, there are 28 heat-sealing machines in operation. Polyvinyl chloride (PVC) materials are purchased preformed for assembly into the notebooks and folios. A silk-screening department uses a variety of solvents in addition to vinyl inks and lacquers.

In May 1983 the California Occupational Safety and Health Administration (CAL/OSHA) conducted an industrial hygiene survey of the plant. Exposures to RF were found to be below the OSHA standard. The presence of isophorone, isopropyl alcohol, cyclohexanone, toluene, n-butyl alcohol, and n-butyl acetate in the silk-screening area were measured near or below 5% of the OSHA permissible exposure limits (PEL) for each one of these solvents. In addition, measurements conducted by CAL/OSHA at that time, for hydrogen chloride (HCl), a thermal decomposition product of PVC, revealed levels less than 0.04 ppm.

At the time of the CAL/OSHA survey, the six cases of breast cancer were reported, and a NIOSH health hazard evaluation was suggested.

## IV. METHODS

### A. Initial Survey (July 1-3, 1985)

Following a meeting with the manufacturing manager, plant engineer,

and union steward, a walk-through of the entire plant facility was conducted to obtain information on the normal operating procedures and to identify jobs with potential RF exposure and chemical exposures.

NIOSH investigators met with groups of employees on two shifts from throughout the plant to explain and assist in the completion of a self-administered questionnaire. All employees were eligible to participate. The questionnaire, which was prepared in both English and Spanish to facilitate completion, asked for personal identifying information, occupational history, reproductive history, and information on any diagnoses of breast cancer. For the six previously identified employees with a history of breast cancer since employment at K & M, medical records were sought to confirm the diagnoses. Person-years of employment were determined from seniority lists provided by the management of K & M. Further case finding for diagnoses of breast cancer or other cancers through the company that manages the health plan for the K & M employees or directly from the health centers that serve the employees was not attempted.

B. Follow-up Survey (July 23-24, 1985)

During this survey, RF exposure measurements were made at 23 heat sealers in normal operation. RF measurements were made with a calibrated Holaday Model HI 3002 broadband field strength meter equipped with an electric (E) probe and a 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 strengths for the E- and H-probes were  $0.5 \times 10^3 V^2/M^2$  and  $0.005 A^2/M^2$ , respectively.

E- and H-field strength measurements were taken at the worksite of each operator for the 23 heat sealers. Measurements were taken at the face, chest, hands, stomach, groin, thigh, knee, and ankle positions. Since the RF output of all 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 was considered to be the RF on-time divided by the total process time.

V. EVALUATION CRITERIA

A. Environmental 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 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 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 (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's 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.

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 short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The Occupational Safety and Health Administration radiation protection standard for occupational exposure to RF and microwave radiation (29 CFR 1910.97) applies to the frequencies of 10-100,000

MHz. It establishes as a limit for occupational exposures a maximum power density of  $10 \text{ mW/cm}^2$ , as averaged over any possible 6-minute period. In the far field, a power density of  $10 \text{ mW/cm}^2$  is equivalent to a mean squared electric (E) field strength of  $40,000 \text{ volts}^2/\text{meter}^2$  ( $\text{V}^2/\text{M}^2$ ) or a mean squared magnetic (H) field strength of  $0.25 \text{ amperes}^2/\text{meter}^2$  ( $\text{A}^2/\text{M}^2$ ).<sup>1</sup>

By comparison, the American Conference of Governmental Industrial Hygienists (ACGIH) currently recommends threshold limit values (TLV's) of  $3.77 \times 10^3 \text{ V}^2/\text{M}^2$  (E-field) and  $0.027 \text{ A}^2/\text{M}^2$  (H-field).

## VI. RESULTS

### A. Environmental

RF exposures at none of the 23 machines exceeded the OSHA standards for the E- and H-fields or the ACGIH TLV for the electric field. However, magnetic field strength at 13 of the 23 machines exceeded the ACGIH TLV of  $0.027 \text{ A}^2/\text{M}^2$  (Tables I and II). Overexposures to magnetic fields occurred at machines 72, 73, 77, 78, 79, 83, 86, 88, 89, 91, 92, 95, and 100.

Tables III and IV summarize the exposure data by anatomical location from all machines. E-field exposures to all parts of the body surveyed were below both the OSHA standard and ACGIH TLV. In addition, H-field exposures to all body parts surveyed were also below the OSHA standard. However, the average H-field exposures to the stomach, groin, hands, chest, and thigh (in order of decreasing exposure) were slightly above the ACGIH TLV for H-field.

### B. Medical

#### 1. Reproductive outcomes

Table V presents the demographic data (age, race, sex, duration of employment, distribution by department and job title) of the 321 employees who completed the questionnaire. Hispanics comprised 90.7% of those completing the questionnaire. Among the female employees 93.2% were Hispanic. The average age of employees was 34.5 years with an average length of employment of 4.6 years (range 0-19.2 years). The heat-sealing department (65/75) maintains the largest number of employees, 110 (34.3%).

Of the 205 females who responded to the questionnaire, 158 have been or were currently pregnant; 146 (92.4%) were Hispanic; five (3.2%) were pregnant at the time of the survey. A total of 441 pregnancies were reported, 411 (93.2%) among Hispanics. The outcomes of these pregnancies were noted in 401 (90.9%) of the 441 pregnancies reported (Table VI).

Thirty-five SAB's were reported accounting for 8.8% of all pregnancy outcomes. Assuming the worst case, that is all 40 unreported outcomes were spontaneous abortions, then the number of spontaneous abortions (SAB's) would have been 75 (17.0%) of 441 outcomes.

Of the 401 pregnancy outcomes recorded, 371 (92.5%) were among Hispanics (Table VI). All 35 SAB's reported were among Hispanics, accounting for 9.4% of all pregnancy outcomes in this group. Assuming the worst case, that is all 40 unreported outcomes were spontaneous abortions among Hispanics, then the number of SAB's would have been 75 (18.2%) of 411 outcomes.

Based on national averages indicating that between 10-20% of all pregnancies result in a spontaneous abortion,<sup>2</sup> there is no excess of SAB's among the employees in this plant. Unpublished data from a birth defect's study in California<sup>3</sup> indicate that rates of spontaneous abortions (SAB's), stillbirths, birth defects, and other adverse reproductive outcomes are similar among Hispanics to the general population. The rate of SAB's in Hispanics is influenced, as in the general population, by maternal age at conception and previous history of SAB's, among other factors. Maternal age at conception has a strong effect on SAB rates, with women in their 30's having twice the SAB rate of women in their 20's.

We examined pregnancy outcomes among Hispanics in relation to employment history, date of employment, and department. Of the 371 outcomes recorded, 74 (17.6%) occurred during the year of first employment or subsequent to employment at K & M (Table VII). A comparison of pregnancy outcomes among Hispanics prior to and during employment at K & M revealed a two-fold greater rate of spontaneous abortions during employment. This difference was statistically significant (RR=2.8, p=0.01). Stratifying for age of pregnancy, the post-employment increase in SAB's among Hispanics continued to be significant (Mantel-Haenszel summary chi-square = 14.18, p < 0.001).

Pregnancy outcomes by current department were examined for Hispanics before and during employment (Table VII). There were no significant differences in the folding (RR=2.2, p=1.0), assembling (RR=2.2, p=0.3), and silk-screening (RR=2.5, p=0.6) departments. However, an increase in SAB's during employment was noted in the heat-sealing department (RR=3.2, p=0.03, Fisher's exact test, two-tailed). Stratifying for age of pregnancy, the during-employment increase in SAB's among Hispanics in the heat-sealing department continued to be significant (Mantel-Haenszel summary chi-square = 4.12, p < 0.05).

The differences observed in numbers of spontaneous abortions pre- and during employment at K & M is largely accounted for by employment in the heat-sealing department.

These results are discussed in Section VII-A.

Among males, there were no reported problems related to infertility, difficulty in conception, or adverse reproductive outcomes.

2. Breast cancer cluster

From 1973 to present, seven Hispanic and one non-Hispanic women have been diagnosed as having breast cancer. For one Hispanic woman, the diagnosis occurred prior to employment at K & M. The one case in the non-Hispanic woman was excluded from analysis because comparable rates for breast cancer in this woman's racial category were not available. For each of the individuals with a breast cancer diagnosis, information was sought from the medical records to confirm the diagnosis. To determine whether this number of breast cancers represented a number greater than expected, a comparison between the rate of breast cancer among Hispanic women at K & M and the general Hispanic population of Los Angeles county was undertaken. Breast cancer rates for Hispanic women were provided by the Los Angeles County Cancer Registry for the period 1972-1983. These rates, stratified by age, were as follows:

<u>Age</u>	<u>Rate/100,000 persons</u>
35-44	67.3
45-54	155.9
55-64	198.0

Person-years of exposure were determined from the seniority roster of all individuals who were employed at K & M on July 2, 1985 who were Hispanic females. In addition, person-years of exposure were determined for all Hispanic female employees of the heat-sealing department. If an individual has been employed for ten years at K & M, then she contributed ten person-years of exposure.

For the period 1977-1984, 713 factory employees were terminated from K & M, but, 591 were subsequently rehired. The determination of the contribution of person-years of exposure of the 122 employees not rehired is shown in Appendix I. For the calculations below it was assumed that no further breast cancer cases in the not rehired population occurred.

Using the number of person-years stratified by age and the Los Angeles county breast cancer rates for Hispanic women, an expected number of breast cancer for this population for each age stratum was calculated. The observed number of breast cancers based on the age of diagnosis was then compared to this calculated expected number. The results for all Hispanic women, for Hispanic women in the heat-sealing department, and for Hispanic women outside of the heat-sealing department are presented below:

All Hispanic women

<u>Age</u>	<u>Rate/100,000*</u>	<u>Person-years</u>	<u>Expected</u>	<u>Observed</u>	<u>O/E</u>
35-44	67.3	509.0	0.34	2	5.88
45-54	155.9	337.0	0.53	4	7.55 <sup>++</sup>
55-64	198.0	40.9	<u>0.08</u>	<u>0</u>	<u>0</u>
			0.95	6	6.32 <sup>+++</sup>

For heat-sealers (with radiofrequency exposure)

<u>Age</u>	<u>Rate/100,000*</u>	<u>Person-years</u>	<u>Expected</u>	<u>Observed</u>	<u>O/E</u>
35-44	67.3	279.5	0.19	2	10.53 <sup>+</sup>
45-54	155.9	186.3	0.29	2	6.90
55-64	198.0	11.4	<u>0.02</u>	<u>0</u>	<u>0</u>
			0.50	4	8.00 <sup>++</sup>

\* - breast cancer rates from Los Angeles County Cancer Registry for period 1972-1983 for Hispanic women.

+ - p < 0.05 based on confidence limits for the expectation of a Poisson variable

++ - p < 0.01

+++ - p < 0.002

For all other departments

<u>Age</u>	<u>Rate/100,000*</u>	<u>Person-years</u>	<u>Expected</u>	<u>Observed</u>	<u>O/E</u>
35-44	67.3	229.5	0.15	0	0
45-54	155.9	150.7	0.23	2	8.70 <sup>+</sup>
55-64	198.0	29.5	<u>0.06</u>	<u>0</u>	<u>0</u>
			0.44	2	4.55

\* - breast cancer rates from Los Angeles County Cancer Registry for period 1972-1983 for Hispanic women.

+ - p < 0.05 based on confidence limits for the expectation of a Poisson variable

++ - p < 0.01

+++ - p < 0.002

These results are discussed in Section VII-B.

VII. DISCUSSION

A. Reproductive outcomes

The proportion of reported spontaneous abortions (SAB's) reported among female Hispanic employees either prior to or during employment at K & M did not exceed what would be expected for the general population. The prevalence of SAB's was still not excessive when stratified by department or work history. The SAB rate among pregnancies during employment was greater than among pregnancies prior to employment at K & M. This observation, however, is subject to differential recall on the part of the employees completing the questionnaires and should be interpreted with caution. Employees of the RF heat-sealing department reported a greater rate of SAB's than employees of other departments.

The interpretation of the observation of excess SAB's in the heat-sealing department compared with other departments within the plant is subject to the limitations of this type of study. Pregnancy outcome data were based on the questionnaire survey, which was self-administered. No attempt was made to independently verify the pregnancy outcomes. A definition of what constituted a spontaneous abortion was not provided on the questionnaire. Self-reporting of outcomes is subject to recall bias, unfavorable pregnancy outcomes may be recalled more frequently, and more recent outcomes, those related to recent employment, may also be differentially recalled.

Rates of SAB's increase with age so that during-employment SAB's, reflecting pregnancies that occurred at an older age, would be expected to be higher. However, stratifying the analysis by the age of the employee at the outcome of each pregnancy should have accounted for the effect of increasing age on SAB rates.

The overall increased rate of SAB's during employment among all departments argues in favor of either a differential recall in pregnancy outcomes or an undescribed effect related to employment in general and not any specific exposure. The observation that the during-employment prevalence of SAB's for the entire population surveyed (17.6%) is still within the range of SAB's expected in the general population strengthens the contention that a differential recall may have resulted in an underreporting of pre-employment adverse pregnancy outcomes. Although the during-employment prevalence of SAB's was higher in the heat-sealing department (25%), one would still anticipate the same influences which may have resulted in a differential recall of adverse pregnancy outcomes.

The effect of RF radiation on reproduction in animals has been studied extensively<sup>4</sup>. Extremely high doses, resulting in considerable heating of the internal tissues, appears necessary to produce a reproductive effect. RF radiation is teratogenic at high whole-body average specific absorption rates (SAR) that approach lethal levels for the pregnant animal. Maternal rectal temperatures in the experimental animals of 41 to 42°C were required to induce birth defects. Lower SAR's do not appear to result in adverse pregnancy outcomes. The effects on reproduction both for males and females appear to be directly related to the degree of SAR and resultant thermal heating of sensitive tissues.

There is no good evidence in humans that RF radiation exposure causes adverse pregnancy outcomes. Two recent studies of physiotherapists who use RF equipment (diathermy) in their occupation described poor pregnancy outcomes in female physiotherapists,<sup>5</sup> but neither study provided quantitative information on radiation levels in the work environment.

#### B. Breast cancer

There is a greater number of breast cancer cases among all Hispanic females currently employed at K & M than would be expected for a population of similar age and size (O/E = 6.32,  $p < 0.002$ ), and for Hispanic women employed in the heat-sealing department (O/E = 8.00,  $p < 0.01$ ). However, breast cancer cases occurred in Hispanic women with no prior or current employment in the heat-sealing department, as noted in the age stratum 45-54 in the all-other-departments category (O/E = 8.70,  $p < 0.05$ ).

An excess of breast cancers of this magnitude or greater would be observed by chance alone in 2% of clusters selected at random; however, "as the present cluster was not selected at random, the probability that such an excess would have come to attention by chance alone cannot be assessed."<sup>6</sup> Given that the observation of an excess of breast cancer was not based on an a priori hypothesis and tested controlling for the other known risk factors for breast cancer weakens the interpretation of the result.

It is unlikely that a study would have been carried out had the initial observation of breast cancers not given some grounds for concern. This non-random selection of the study population, where it is known in advance that an excess exists, results in a "statistically significant" excess.

The mean latency for development of breast cancer at K & M (the time between employment/first exposure and the diagnosis of the cancer) was 7.2 years (range 3-9 years). Whether this latency is biologically plausible is not known, as the latency for breast cancer has not been described in settings following exposure to a known or potential carcinogenic agent specific to that organ.

There is no convincing evidence that RF radiation is a primary carcinogen (cancer inducer). However, few studies examining the effects of RF exposure have used cancer incidence as end points. Those studies that have considered cancer as an end point have lacked the statistical power to exclude cancer as an effect of RF exposure.

Radiofrequency radiation-induced cancer has not been demonstrated in medical surveillance examination of RF workers or military service personnel.<sup>7</sup> Ten or more years of follow-up of occupationally exposed workers to varying power densities have not revealed malignancies of any type. However, these workers were mostly men so the ability to detect an excess of breast cancer in women in this population was low.

Chronic exposure to RF radiation has resulted in cancer promotion or cocarcinogenesis in three different tumor systems in mice. In one study, repeated exposure to 2450-MHz radiation at 5 or 15 mW/cm<sup>2</sup>, two hours per day, six days per week, for up to 10 months, accelerated the appearance of spontaneous mammary cancer in female mice and skin cancer and neoplastic nodules in the lung in male mice treated with 3,4-benzopyrene during or after microwave treatment.<sup>8</sup> Of note is that stress produced by chronic confinement of the mice in crowded compartments produced the same effect in terms of cancers as the 5-mW/cm<sup>2</sup> exposure.

The question of RF-radiation carcinogenesis has not been answered. None of the complete reports in the literature presents a

convincing case for the existence of a significantly increased risk of cancer induction in exposed populations. Neither theory nor the existing data on RF-radiation mutagenesis support the notion of a role of RF radiation in cancer induction. The results in mice (presented above) raise the possibility that RF radiation may act as a cancer promoter even at levels within the physiologic limits of thermal regulation of the animal. Whether RF radiation acts as a promoter or inhibitor of cancers is yet to be confirmed in other systems and laboratories.

#### VIII. RECOMMENDATIONS

1. For the 13 machines where H-field exposures exceeded the ACGIH TLV, we recommend additional shielding around the press die to further reduce exposures to the magnetic field. The shielding should be constructed from perforated aluminum sheet stock and flexible phosphor bronze contact. The aluminum sheet stock should be used to construct a box-like enclosure around the press die. The phosphor bronze contact should be attached to the bottom of the enclosure to insure good electrical contact. Ten of the 23 machines that had RF emissions below the TLV should not require any additional shielding.
2. After the shielding has been installed a follow-up survey should be performed to show that exposure levels are within the ACGIH TLV's.
3. A medical surveillance program, tailored to the expected degree of employee use of RF equipment and potential for exposure to RF energy, should be developed. This type of surveillance program should be designed to develop information regarding the safety of women, in particular, pregnant women, in working with RF heat-sealers.

The program should include preplacement examination of all new employees and an initial examination of all present employees subject to occupational exposure to RF energy. The preplacement examination should include, but not necessarily be limited to, the following components:

- A. Medical history - to include a detailed reproductive history, a family history for risk factors related to breast cancer, and a work history.
- B. Physical examination - to include an eye and gynecologic examination including an examination of the breasts. Breast self-examination should be taught and encouraged.

In an effort to identify possible adverse effects associated with exposure to RF energy, annual examinations should be considered for workers who may be exposed to RF energy on a regular, long-term basis. These annual examinations should include:

- A. Medical history - an update of any pregnancies or changes in reproductive status, and any changes in job status.
- B. Physical examination - screening examinations geared toward the early detection of breast cancer performed per the recommendations of the American Cancer Society.<sup>8</sup>

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4. CAL/OSHA
5. NIOSH, Region IX
6. OSHA, Region IX

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 I  
ELECTRIC & MAGNETIC FIELD STRENGTH MEASUREMENTS  
TORRANCE, CALIFORNIA  
JULY 23, 1985

(Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 95</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1 (Operator)			
Sitting	FACE	1.2 x 10 <sup>2</sup>	0.108
	CHEST	6.7 x 10 <sup>2</sup>	0.135
	HANDS	6.7 x 10 <sup>2</sup>	0.175
	STOMACH	1.5 x 10 <sup>3</sup>	0.175
	GROIN	1.4 x 10 <sup>3</sup>	0.175
	THIGH	2.7 x 10 <sup>2</sup>	0.027
	KNEE	*	0.027
	ANKLE	*	0.2
<u>MACHINE 95</u>			
Worker 2			
Sitting	FACE	1.3 x 10 <sup>2</sup>	0.067
	CHEST	6.7 x 10 <sup>2</sup>	0.108
	HANDS	1.1 x 10 <sup>2</sup>	0.108
	STOMACH	1.4 x 10 <sup>3</sup>	0.203
	GROIN	1.4 x 10 <sup>3</sup>	0.203
	THIGH	*	0.162
	KNEE	4.1 x 10 <sup>2</sup>	0.054
	ANKLE	<u>2.7 x 10<sup>3</sup></u>	<u>0.108</u>
ACGIH Evaluation Criteria (TLV)		3.7 x 10 <sup>3</sup>	0.027
OSHA Standard		4.4 x 10 <sup>4</sup>	0.25

\*Below detection level of 0.5 x 10<sup>3</sup> V<sup>2</sup>/M<sup>2</sup> for E- Field and 0.005 A<sup>2</sup>/M<sup>2</sup> for H - Field

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 77</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Sitting	FACE	2.2 x 10 <sup>2</sup>	0.004
	CHEST	2.2 x 10 <sup>2</sup>	0.004
	HANDS	3.5 x 10 <sup>2</sup>	0.004
	STOMACH	2.2 x 10 <sup>2</sup>	0.008
	GROIN	2.2 x 10 <sup>2</sup>	0.008
	THIGH	*	0.011
	KNEE	2.7 x 10 <sup>2</sup>	0.007
	ANKLE	*	0.012
Worker 2			
Standing	FACE	4.1 x 10 <sup>2</sup>	0.017
	CHEST	3.5 x 10 <sup>2</sup>	0.022
	HANDS	5.4 x 10 <sup>2</sup>	0.040
	STOMACH	1.4 x 10 <sup>2</sup>	0.040
	GROIN	2.7 x 10 <sup>2</sup>	0.014
	THIGH	1.4 x 10 <sup>2</sup>	0.007
	KNEE	*	0.007
	ANKLE	*	0.005

TABLE I (CONT'D)  
(Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 91</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Sitting	FACE	2.9 x 10 <sup>2</sup>	0.017
	CHEST	4.4 x 10 <sup>2</sup>	0.043
	HANDS	4.4 x 10 <sup>2</sup>	0.029
	STOMACH	8.7 x 10 <sup>2</sup>	0.029
	GROIN	8.7 x 10 <sup>2</sup>	0.029
	THIGH	1.2 x 10 <sup>3</sup>	0.029
	KNEE	1.2 x 10 <sup>3</sup>	0.029
	ANKLE	4.4 x 10 <sup>2</sup>	0.043
Worker 2			
Sitting	FACE	5.8 x 10 <sup>2</sup>	0.043
	CHEST	5.8 x 10 <sup>2</sup>	0.043
	HANDS	1.0 x 10 <sup>2</sup>	0.043
	STOMACH	4.4 x 10 <sup>2</sup>	0.043
	GROIN	4.4 x 10 <sup>2</sup>	0.058
	THIGH	1.2 x 10 <sup>3</sup>	0.058
	KNEE	1.2 x 10 <sup>3</sup>	0.029
	ANKLE	2.9 x 10 <sup>2</sup>	0.023

TABLE I (CONT'D)  
(Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 92</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1 (Operator)			
Sitting	FACE	5.0 x 10 <sup>2</sup>	0.005
	CHEST	5.0 x 10 <sup>2</sup>	0.015
	HANDS	2.5 x 10 <sup>3</sup>	0.015
	STOMACH	2.5 x 10 <sup>2</sup>	0.015
	GROIN	2.5 x 10 <sup>2</sup>	0.015
	THIGH	2.5 x 10 <sup>2</sup>	0.045
	KNEE	1.0 x 10 <sup>2</sup>	0.045
	ANKLE	2.5 x 10 <sup>2</sup>	0.020
Worker 2			
Standing (2-Feet from Source)	FACE	*	*
	CHEST	*	*
	HANDS	*	*
	STOMACH	*	*
	GROIN	*	*
	THIGH	*	*
	KNEE	*	*
	ANKLE	*	*

\* Below detection limits

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 88</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Standing	FACE	1.2 x 10 <sup>3</sup>	0.05
	CHEST	1.0 x 10 <sup>3</sup>	0.08
	HANDS	1.0 x 10 <sup>3</sup>	0.08
	STOMACH	3.0 x 10 <sup>2</sup>	0.08
	GROIN	3.0 x 10 <sup>2</sup>	0.05
	THIGH	3.0 x 10 <sup>2</sup>	0.03
	KNEE	2.0 x 10 <sup>2</sup>	0.03
	ANKLE	2.0 x 10 <sup>2</sup>	0.02
Worker 2			
Sitting	FACE	1.0 x 10 <sup>3</sup>	0.06
	CHEST	1.2 x 10 <sup>3</sup>	0.06
	HANDS	1.2 x 10 <sup>3</sup>	0.08
	STOMACH	3.0 x 10 <sup>2</sup>	0.08
	GROIN	3.0 x 10 <sup>2</sup>	0.08
	THIGH	3.0 x 10 <sup>2</sup>	0.08
	KNEE	1.2 x 10 <sup>3</sup>	0.03
	ANKLE	1.0 x 10 <sup>2</sup>	0.02

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 78</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1 (Operator)			
Standing	FACE	5.4 x 10 <sup>2</sup>	0.010
	CHEST	6.7 x 10 <sup>2</sup>	0.081
	HANDS	6.7 x 10 <sup>2</sup>	0.081
	STOMACH	6.7 x 10 <sup>2</sup>	0.024
	GROIN	1.4 x 10 <sup>2</sup>	0.005
	THIGH	*	0.005
	KNEE	*	0.005
	ANKLE	*	0.005
Worker 2			
Standing	FACE	2.7 x 10 <sup>2</sup>	0.016
	CHEST	4.1 x 10 <sup>2</sup>	0.016
	HANDS	4.1 x 10 <sup>2</sup>	0.016
	STOMACH	4.1 x 10 <sup>2</sup>	0.041
	GROIN	4.1 x 10 <sup>2</sup>	0.041
	THIGH	2.7 x 10 <sup>2</sup>	0.041
	KNEE	2.7 x 10 <sup>2</sup>	0.041
	ANKLE	*	0.027

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 89</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1 (Operator)			
Sitting	FACE	1.7 x 10 <sup>3</sup>	0.034
	CHEST	1.0 x 10 <sup>3</sup>	0.068
	HANDS	1.2 x 10 <sup>3</sup>	0.068
	STOMACH	4.3 x 10 <sup>2</sup>	0.085
	GROIN	4.3 x 10 <sup>2</sup>	0.085
	THIGH	6.0 x 10 <sup>2</sup>	0.068
	KNEE	8.5 x 10 <sup>2</sup>	0.068
	ANKLE	1.7 x 10 <sup>2</sup>	0.034
Worker 2			
	FACE	8.5 x 10 <sup>2</sup>	0.068
	CHEST	9.4 x 10 <sup>2</sup>	0.068
	HANDS	9.4 x 10 <sup>2</sup>	0.068
	STOMACH	3.4 x 10 <sup>2</sup>	0.068
	GROIN	3.4 x 10 <sup>2</sup>	0.068
	THIGH	6.0 x 10 <sup>2</sup>	0.034
	KNEE	6.0 x 10 <sup>2</sup>	0.034
	ANKLE	2.6 x 10 <sup>2</sup>	0.015

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 90</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Standing	FACE	3.0 x 10 <sup>2</sup>	0.002
	CHEST	3.0 x 10 <sup>2</sup>	0.002
	HANDS	4.5 x 10 <sup>2</sup>	0.006
	STOMACH	1.2 x 10 <sup>3</sup>	0.003
	GROIN	3.0 x 10 <sup>2</sup>	0.003
	THIGH	1.5 x 10 <sup>2</sup>	0.018
	KNEE	1.5 x 10 <sup>2</sup>	0.021
	ANKLE	*	0.015
Worker 2			
Sitting	FACE	3.0 x 10 <sup>2</sup>	*
	CHEST	1.5 x 10 <sup>2</sup>	0.003
	HANDS	1.5 x 10 <sup>2</sup>	0.003
	STOMACH	1.5 x 10 <sup>2</sup>	0.002
	GROIN	1.5 x 10 <sup>2</sup>	0.002
	THIGH	1.5 x 10 <sup>2</sup>	0.008
	KNEE	*	0.008
	ANKLE	*	*

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 96</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Sitting	FACE	3.8 x 10 <sup>2</sup>	0.004
	CHEST	3.8 x 10 <sup>2</sup>	0.013
	HANDS	3.8 x 10 <sup>2</sup>	0.019
	STOMACH	0.95 x 10 <sup>2</sup>	0.010
	GROIN	0.95 x 10 <sup>2</sup>	0.010
	THIGH	0.95 x 10 <sup>2</sup>	0.008
	KNEE	0.95 x 10 <sup>2</sup>	0.008
	ANKLE	*	0.002
Worker 2			
Sitting	FACE	2.9 x 10 <sup>2</sup>	0.002
	CHEST	1.9 x 10 <sup>2</sup>	0.008
	HANDS	1.9 x 10 <sup>2</sup>	0.003
	STOMACH	0.95 x 10 <sup>2</sup>	0.008
	GROIN	0.95 x 10 <sup>2</sup>	0.008
	THIGH	1.90 x 10 <sup>2</sup>	0.004
	KNEE	*	0.004
	ANKLE	*	0.013

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 83</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Sitting	FACE	6.8 x 10 <sup>2</sup>	0.004
	CHEST	6.8 x 10 <sup>2</sup>	0.004
	HANDS	6.8 x 10 <sup>2</sup>	0.004
	STOMACH	4.1 x 10 <sup>2</sup>	0.012
	GROIN	4.1 x 10 <sup>2</sup>	0.012
	THIGH	5.9 x 10 <sup>2</sup>	0.010
	KNEE	5.9 x 10 <sup>2</sup>	0.027
	ANKLE	*	0.016
Worker 2			
Sitting	FACE	6.8 x 10 <sup>2</sup>	0.004
	CHEST	4.1 x 10 <sup>2</sup>	0.008
	HANDS	4.1 x 10 <sup>2</sup>	0.008
	STOMACH	2.7 x 10 <sup>2</sup>	0.014
	GROIN	2.7 x 10 <sup>2</sup>	0.014
	THIGH	4.1 x 10 <sup>2</sup>	0.040
	KNEE	*	0.035
	ANKLE	*	0.022

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 82</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Sitting	FACE	8.1 x 10 <sup>2</sup>	0.004
	CHEST	6.8 x 10 <sup>2</sup>	0.005
	HANDS	6.8 x 10 <sup>2</sup>	0.005
	STOMACH	2.7 x 10 <sup>2</sup>	0.016
	GROIN	2.7 x 10 <sup>2</sup>	0.016
	THIGH	2.7 x 10 <sup>2</sup>	0.016
	KNEE	2.7 x 10 <sup>2</sup>	0.016
	ANKLE	*	0.008
Worker 2			
Standing	FACE	4.1 x 10 <sup>2</sup>	0.007
	CHEST	5.4 x 10 <sup>2</sup>	0.007
	HANDS	5.4 x 10 <sup>2</sup>	0.010
	STOMACH	1.4 x 10 <sup>2</sup>	0.010
	GROIN	1.4 x 10 <sup>2</sup>	0.010
	THIGH	1.4 x 10 <sup>2</sup>	0.009
	KNEE	1.4 x 10 <sup>2</sup>	0.007
	ANKLE	*	0.005

TABLE I (CONT'D)  
 (Turntable Station, 2 Workers)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 71</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1 (Operator)			
Sitting	FACE	4.6 x 10 <sup>2</sup>	0.012
	CHEST	3.5 x 10 <sup>2</sup>	0.012
	HANDS	3.5 x 10 <sup>2</sup>	0.016
	STOMACH	2.3 x 10 <sup>2</sup>	0.009
	GROIN	2.3 x 10 <sup>2</sup>	0.016
	THIGH	2.3 x 10 <sup>2</sup>	0.016
	KNEE	3.5 x 10 <sup>2</sup>	0.021
	ANKLE	*	0.016
Work 2			
Sitting	FACE	1.2 x 10 <sup>2</sup>	0.002
	CHEST	*	0.002
	HANDS	*	0.002
	STOMACH	*	0.002
	GROIN	*	0.002
	THIGH	*	0.001
	KNEE	*	0.001
	ANKLE	*	0.003

TABLE II  
 ELECTRIC & MAGNETIC FIELD STRENGTH MEASUREMENTS  
 RADIOFREQUENCY HEAT SEALERS  
 KINGSBACHER-MURPHY COMPANY  
 TORRANCE, CALIFORNIA  
 JULY 23, 1985

(One person per station)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 73</u>		<u>Exposure</u>	<u>Exposure</u>
Worker 1			
Standing	FACE	2.5 x 10 <sup>2</sup>	0.038
	CHEST	1.8 x 10 <sup>2</sup>	0.062
	HANDS	1.3 x 10 <sup>2</sup>	0.062
	STOMACH	2.5 x 10 <sup>2</sup>	0.075
	GROIN	2.5 x 10 <sup>2</sup>	0.062
	THIGH	*	0.050
	KNEE	*	0.050
	ANKLE	*	0.038
 <u>MACHINE 80</u>			
Sitting 10 ft. away from source	FACE	*	*
	CHEST	*	*
	HANDS	*	*
	STOMACH	*	*
	GROIN	*	*
	THIGH	*	*
	KNEE	*	*
	ANKLE	*	*
 <u>MACHINE 81</u>			
Sitting	FACE	1.6 x 10 <sup>2</sup>	.001
	CHEST	0.8 x 10 <sup>2</sup>	.002
	HANDS	0.8 x 10 <sup>2</sup>	.002
	STOMACH	0.8 x 10 <sup>2</sup>	.001
	GROIN	0.8 x 10 <sup>2</sup>	.001
	THIGH	0.4 x 10 <sup>2</sup>	.002
	KNEE	0.4 x 10 <sup>2</sup>	.002
	ANKLE	*	*

TABLE II (CONT'D)

(One person per station)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 79</u>			
Worker 1		<u>Exposure</u>	<u>Exposure</u>
Sitting	FACE	1.2 x 10 <sup>2</sup>	0.035
	CHEST	1.2 x 10 <sup>2</sup>	0.035
	HANDS	1.2 x 10 <sup>2</sup>	0.058
	STOMACH	1.2 x 10 <sup>2</sup>	0.058
	GROIN	1.2 x 10 <sup>2</sup>	0.081
	THIGH	1.8 x 10 <sup>2</sup>	0.184
	KNEE	2.8 x 10 <sup>2</sup>	0.184
	ANKLE	2.3 x 10 <sup>2</sup>	0.092
 <u>Machine 100</u>			
Worker 1			
Sitting	FACE	1.7 x 10 <sup>2</sup>	0.034
	CHEST	*	0.034
	HANDS	3.0 x 10 <sup>2</sup>	0.017
	STOMACH	1.7 x 10 <sup>2</sup>	0.034
	GROIN	1.7 x 10 <sup>2</sup>	0.025
	THIGH	1.2 x 10 <sup>2</sup>	0.017
	KNEE	1.2 x 10 <sup>2</sup>	0.009
	ANKLE	*	0.090

TABLE II (CONT'D)

(One person per station)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 86</u>			
One Worker		<u>Exposure</u>	<u>Exposure</u>
Sitting	FACE	5.5 x 10 <sup>2</sup>	0.066
	CHEST	5.5 x 10 <sup>2</sup>	0.066
	HANDS	5.5 x 10 <sup>2</sup>	0.077
	STOMACH	2.2 x 10 <sup>2</sup>	0.077
	GROIN	2.2 x 10 <sup>2</sup>	0.077
	THIGH	4.4 x 10 <sup>2</sup>	0.066
	KNEE	1.1 x 10 <sup>2</sup>	0.066
	ANKLE	0.5 x 10 <sup>2</sup>	0.066
<u>MACHINE 87</u>			
One Worker			
Sitting	FACE	1.0 x 10 <sup>2</sup>	.002
	CHEST	1.0 x 10 <sup>2</sup>	.002
	HANDS	1.0 x 10 <sup>2</sup>	.002
	STOMACH	1.0 x 10 <sup>2</sup>	.002
	GROIN	1.0 x 10 <sup>2</sup>	.002
	THIGH	1.0 x 10 <sup>2</sup>	.001
	KNEE	1.0 x 10 <sup>2</sup>	.001
	ANKLE	1.0 x 10 <sup>2</sup>	.002
<u>MACHINE 93</u>			
One Worker	FACE	0.6 x 10 <sup>2</sup>	*
	CHEST	0.6 x 10 <sup>2</sup>	*
	HANDS	1.3 x 10 <sup>2</sup>	*
	STOMACH	0.4 x 10 <sup>2</sup>	*
	GROIN	*	*
	THIGH	*	*
	KNEE	*	*
	ANKLE	*	*

TABLE II (CONT'D)

(One person per station)

<u>JOB</u>	<u>BODY LOCATION</u>	<u>E - Field (V<sup>2</sup>/M<sup>2</sup>)</u>	<u>H - Field (A<sup>2</sup>/M<sup>2</sup>)</u>
<u>MACHINE 85</u>		<u>Exposure</u>	<u>Exposure</u>
Standing	FACE	3.5 x 10 <sup>2</sup>	0.005
	CHEST	3.5 x 10 <sup>2</sup>	0.005
	HANDS	3.5 x 10 <sup>2</sup>	0.005
	STOMACH	3.5 x 10 <sup>2</sup>	0.005
	GROIN	9.2 x 10 <sup>2</sup>	0.021
	THIGH	1.2 x 10 <sup>2</sup>	0.021
	KNEE	1.2 x 10 <sup>2</sup>	0.006
	ANKLE	1.2 x 10 <sup>2</sup>	0.006
 <u>MACHINE 99</u>			
Standing 10 ft from source	FACE	*	0.002
	CHEST	*	0.003
	HANDS	*	0.003
	STOMACH	*	0.004
	GROIN	*	0.004
	THIGH	*	0.001
	KNEE	*	0.001
	ANKLE	*	0.003
 <u>MACHINE 72</u>			
Sitting	FACE	2.4 x 10 <sup>2</sup>	0.016
	CHEST	1.0 x 10 <sup>2</sup>	0.060
	HANDS	*	0.040
	STOMACH	1.0 x 10 <sup>2</sup>	0.050
	GROIN	1.0 x 10 <sup>2</sup>	0.050
	THIGH	4.0 x 10 <sup>2</sup>	0.030
	KNEE	4.0 x 10 <sup>2</sup>	0.030
	ANKLE	2.0 x 10 <sup>2</sup>	0.002

TABLE III  
ELECTRIC FIELD EXPOSURES  
BY ANATOMIC LOCATION  
KINGSBACHER-MURPHY COMPANY  
TORRANCE, CALIFORNIA  
JULY 23, 1985

E-FIELD\*  
(N=35)

<u>Location</u>	<u>Mean Exposure x 10<sup>3</sup> (+ 1 S.D.)</u>	<u>Range**</u>
Face	0.41 ± 0.36	(0.01-1.70)
Chest	0.40 ± 0.32	(0.01-1.20)
Hands	0.45 ± 0.49	(0.01-2.50)
Stomach	0.33 ± 0.37	(0.01-1.50)
Groin	0.31 ± 0.34	(0.01-1.40)
Thigh	0.32 ± 0.51	(0.01-2.70)
Knee	0.26 ± 0.35	(0.01-1.20)
Ankle	0.15 ± 0.45	(0.01-2.70)

\*Evaluation criteria for E-fields ( $V^2/M^2$ )

ACGIH Evaluation Criteria (TLV)	$3.7 \times 10^3$
OSHA Standard	$4.4 \times 10^4$

\*\* Exposures below the limit of detection were given the value of 0.01 for the purposes of calculating the means and standard deviations.

TABLE IV  
MAGNETIC FIELD EXPOSURES  
BY ANATOMIC LOCATION  
KINGSBACHER-MURPHY COMPANY  
TORRANCE, CALIFORNIA  
JULY 23, 1985

H-FIELD\*  
(N=35)

<u>Location</u>	<u>Mean Exposure</u> ( $\pm$ 1 S.D.)	<u>Range**</u>
Face	0.021 $\pm$ 0.026	(0.001-0.108)
Chest	0.031 $\pm$ 0.035	(0.001-0.135)
Hands	0.033 $\pm$ 0.040	(0.001-0.175)
Stomach	0.037 $\pm$ 0.047	(0.001-0.203)
Groin	0.036 $\pm$ 0.047	(0.001-0.203)
Thigh	0.031 $\pm$ 0.042	(0.001-0.184)
Knee	0.026 $\pm$ 0.034	(0.001-0.184)
Ankle	0.027 $\pm$ 0.041	(0.001-0.200)

\*Evaluation criteria for H-fields ( $A^2/M^2$ )

ACGIH Evaluation Criteria (TLV)	0.027
OSHA Standard	0.25

\*\* Exposures below the limit of detection were given the value of 0.001 for the purposes of calculating the means and standard deviations.

TABLE V  
 DEMOGRAPHICS  
 KINGSBACHER-MURPHY COMPANY  
 TORRANCE, CALIFORNIA  
 JULY 1985

Sex/Race

	<u>Hispanics</u> (%)	<u>White</u>	<u>Black</u>	<u>Asian</u>	<u>Unknown</u>	<u>TOTAL</u>
Male	100(87.0)	13(11.3)	1(0.9)		1(0.9)	115
Female	191(93.2)	5(2.4)	2(1.0)	5(2.4)	2(1.0)	205
Unknown	_____	_____	_____	_____	_____	<u>1</u>
TOTAL	291(90.7)	18(5.6)	3(0.9)	5(1.6)	3(1.2)	321

Age      Mean - 34.5 years ± 11.1  
               Median - 32.2 years  
               Range - 16.3 - 61.3 years

Duration of employment    Mean - 4.6 years ± 4.5  
   Median - 3.2 years  
   Range - 0 - 19.2 years

Department(#)

Heat-sealing (65/75)	110(34.3%)
Assembling (66/76)	83(25.9)
Folding (63/73)	41(12.8)
Shipping (41/70)	36(11.2)
Cutting (61/71)	29 (9.0)
Quality Control (67/77)	10 (3.1)
Silk-screening (64)	7 (2.2)
Maintenance (69/79)	3 (0.9)
NC	<u>2 (0.6)</u>
TOTAL	321

Job Title

Machinist	121(37.7%)
Assembler	85(26.5)
Shipping & receiving	39(12.1)
Set-up	35(10.9)
Cutter	21 (6.5)
Lead man	5 (1.6)
Quality control	5 (1.6)
Supervisor	5 (1.6)
Janitor	2 (0.6)
Maintenance	2 (0.6)
NC	<u>1 (0.3)</u>
TOTAL	321

TABLE VI  
 PREGNANCY OUTCOMES  
 KINGSBACHER-MURPHY COMPANY  
 TORRANCE, CALIFORNIA  
 JULY 1985

All employees

Normal	341 (85.3%)
Spontaneous Abortion	35 ( 8.8%)
Therapeutic Abortion	17 ( 4.3%)
Stillborn	4 ( 1.0%)
Premature	3 ( 0.8%)
Birth defect	<u>1</u>
TOTAL	401

Hispanic employees only

Normal	312 (84.1)
Spontaneous Abortion	35 ( 9.4)
Therapeutic Abortion	16 ( 4.3)
Stillborn	4 ( 1.1)
Premature	3 ( 0.8)
Birth defect	<u>1</u> ( 0.3)
TOTALS	371

TABLE VII  
 PREGNANCY OUTCOMES IN HISPANICS  
 KINGSBACHER-MURPHY COMPANY  
 TORRANCE, CALIFORNIA  
 JULY 1985

During employment at K & M

Normal	55 (74.3%)
Spontaneous Abortion	13 (17.6%)
Therapeutic Abortion	3 ( 4.1%)
Premature	2 ( 2.7%)
Stillborn	<u>1</u> ( 1.4%)
TOTALS	74

Comparison of SAB's by employment status

<u>Employment</u>	<u>Normal</u>	<u>SAB</u>
Pre-	257(92.1%)	22(7.9%)
During	55(80.9%)	13(19.1%)

Comparison of SAB's by employment status and department

<u>Department</u>	<u>Pre-</u>		<u>Outcomes</u>	
	<u>Normal</u>	<u>SAB</u>	<u>Normal</u>	<u>SAB</u>
Cutting (61/71)	1	-	-	-
Folding (63/73)	39	3	6	0
Silk-screening (64)	10	4	3	3
Heat-sealing (65/75)	107	11	24	8
Assembling (66/76)	98	4	22	2
Quality Control (67/77)	<u>2</u>	<u>-</u>	<u>-</u>	<u>-</u>
	257	22	55	13

APPENDIX I  
EMPLOYMENT PROFILE  
K & M COMPANY, 1972-1984

<u>Year</u>	<u>Total factory employees</u>	<u>Total Factory terminations</u>	<u># layoffs not recalled</u>
1984	391	63	32
1983	338	30	
1982	339	45	15
1981	288	77	
1980	245	19	
1979	239	113	
1978	395	214	55
1977	287	152	20
1976	205	N/A	
1975	144	N/A	
1974	171	N/A	
1973	175	N/A	
1972	158	N/A	

Of the 122 employees not recalled during the 1977-1984 period, 76 (59.5%) were probably Hispanic females with an average duration of employment of 4.6 years (reflecting the current demographics of the plant population). These 76 employees accounted for an additional 349.6 person-years of exposure risk in the calculations of expected numbers of breast cancers presented in the text.

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