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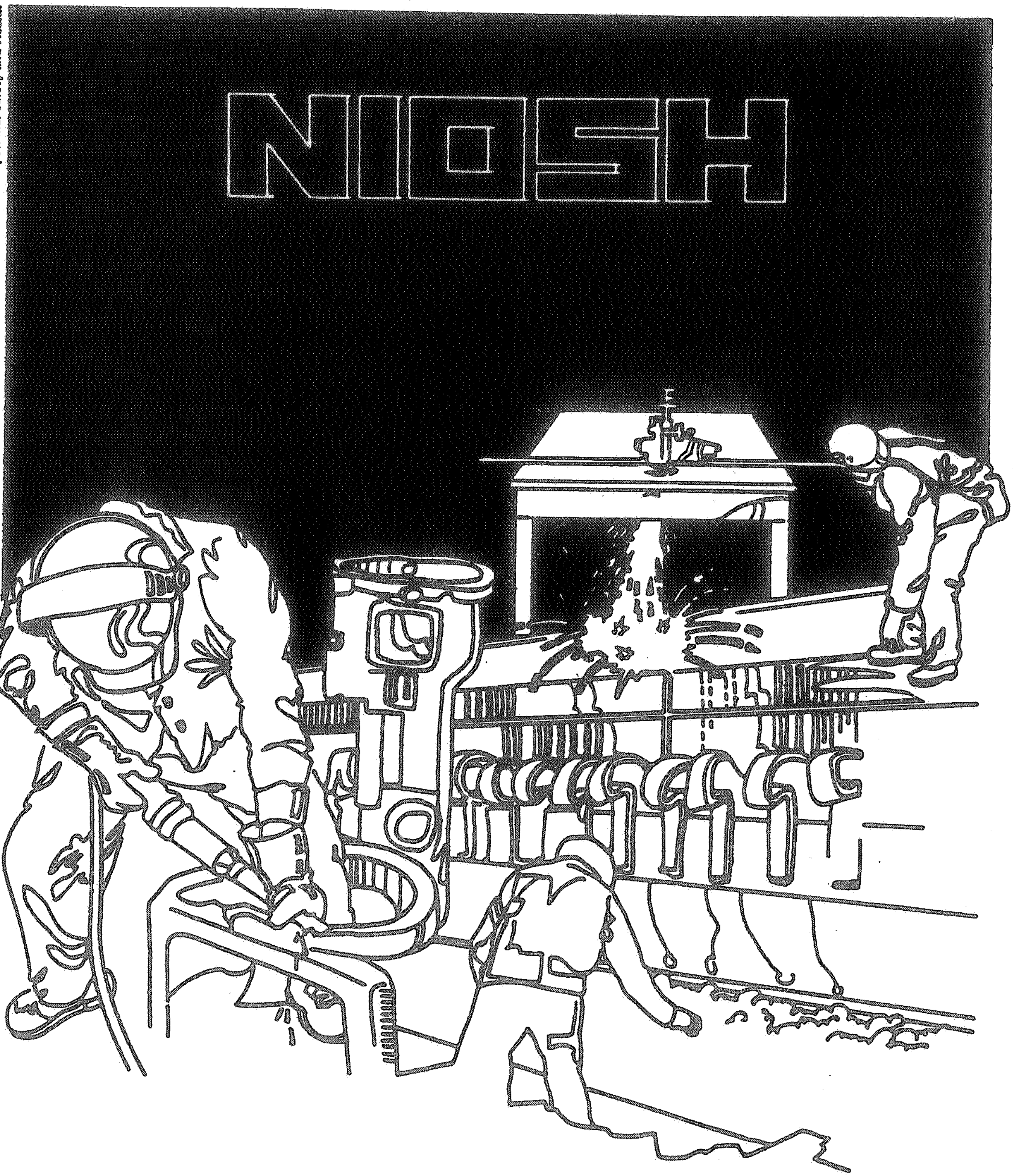


# Health Hazard Evaluation Report

HETA 85-449-1781

COSCO, INC.

COLUMBUS, INDIANA

# 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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COSCO, Inc.
COLUMBUS, INDIANA

NIOSH INVESTIGATORS:
Richard W. Hartle, CIH
William Albrecht, Ph.D.

## I. SUMMARY

On July 16, 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees of COSCO, Inc., in Columbus, Indiana. Statements attached to the request indicated that employees were concerned about exposures to radiofrequency (RF radiation), solvents, and metal fumes.

An initial site visit was made on August 27, 1985. A follow-up environmental and medical evaluation was conducted on December 4-5, 1985. Eighteen RF heat seal operators were monitored for exposure to non-ionizing radiation. One operator was exposed in excess of the OSHA standard of 10 milliwatts/square centimeter. Twelve of the operators were exposed in excess of the American Conference of Governmental Industrial Hygienist's (ACGIH) Threshold Limit Value (TLV) (a level approximately 10% of the OSHA standard).

Heat seal operators' exposures to methyl ethyl ketone, trichloroethane, tetrahydrofuran, methyl isobutyl ketone, toluene and xylene were all less than 5% of the most restrictive evaluation criteria, including the OSHA federal standards, ACGIH TLVs, and the NIOSH Recommended Exposure Limits (RELs).

Personal (breathing zone) monitoring of three welding operators was conducted for metals during two shifts. All exposures to a total of 26 metals were within their respective evaluation criteria, with the exception of one welder with an average exposure to nickel of 37 micrograms/cubic meter of air (ug/m$^3$). The NIOSH REL is 15 ug/m$^3$.

An analysis of normal versus adverse pregnancies among 59 women who had worked in the heat seal department since 1977 was undertaken. However, due to the limited number of study participants, we were unable to ascertain with any degree of confidence whether or not there was an association between working with heat sealers and pregnancy outcome.

Based upon results of environmental monitoring conducted during this evaluation, we determined that exposures to RF radiation within the heat seal department, and exposures to airborne nickel during welding pose a potential health hazard. Recommendations for remedial actions are made in Section VIII of this report, including grounding of the heat sealers, and improving ventilation at the welding stations.

KEYWORDS: (SIC 2519 - Household furniture not elsewhere classified) Non-ionizing radiation, radio frequency, heat seal, methyl isobutyl ketone, methyl ethyl ketone, tetrahydrofuran, 1,1,1-trichloroethane, toluene, xylene, welding, nickel.

## II. INTRODUCTION

On July 16, 1985, NIOSH received a confidential request for health hazard evaluation from employees of COSCO, Inc., Columbus, Indiana. The request was recommended to members of the local uhion at COSCO by an industrial hygienist of the United Brotherhood of Carpenters and Joiners of America, following their limited investigation of the COSCO facility on May 10, 1985. The union representative was investigating complaints of eye, nose and throat irritation plus skin rashes, and a burning sensation on the lips among heat seal department employees. Other plant areas visited by the union industrial hygienist and included (in a general nature) in the request for health hazard evaluation were the spray paint area, silk screening, welding, plastic regrind, press area, router area, and plating department.

On August 27, 1985, three NIOSH investigators -- an industrial hygienist, a medical officer, and an engineer -- made an initial site visit of the COSCO facility to meet with management and employee representatives and to observe the processes included in the HHE request. A walk-through survey of the facility was conducted which included DECO (silk screen decoration), plating (nickel/chrome and zinc), heat seal, cutting and sewing, spray paint and paint mix, welding, and the router shed. A tour of the roof was also conducted to observe exit points for the general/local exhaust ventilation systems to determine if the exhaust streams were becoming re-entrainment and contaminating the heat seal department. During the walk-through evaluation, information on the occurrence and use of process chemicals was obtained, along with the number and location of employees. At that time, COSCO supplied the NIOSH investigators with environmental data previously collected within the facility (Table I).

The NIOSH medical officer conducted approximately fifteen non-directed interviews with employees in the heat seal department to ascertain the general prevalence of symptoms potentially associated with their jobs. These interviews indicated that most employees found that metal work surfaces near the heat seal machines occasionally became hot to the touch, and in one case, hot enough to cause a burn. From the information collected on the interviews, we determined that employees in the heat seal department were possibly experiencing symptoms consistent with radio frequency (RF) exposure. Due to the irritative symptoms experienced by these same employees, in addition to an RF survey, the follow-up evaluation also included environmental air monitoring for possible off-gassing products from the vinyl materials used at the heat seal operation, for possible contaminants generated from the near by plating line, and monitoring of welding fumes in the welding department. Based upon results of previous environmental monitoring (Table I) and our observations during the walk-through survey, we elected not to include the other areas of the facility in the follow-up evaluation.

## III. BACKGROUND

COSCO, Inc. manufactures juvenile and household furniture (safety car seats, high chairs, strollers, work benches, card tables and chairs, and play pens) at its Columbus, Indiana facility. Total plant employment was 975 at the time of the evaluation (15% salaried).

The primary areas of interest expressed by the requesters and the focus of the evaluation were the heat seal department, welding, and plating. Although exposures at the plating operation were minimal to the operators (Table I), the proximity of this operation to the heat seal department made effluents from the plating tanks possible contaminants in the heat seal department.

The heat seal and sewing departments are located in an upper level "penthouse" area. The majority of the remainder of the facility (with the exception of the spray painting area) is a one story complex; its roof being level with the floor of the heat seal and sewing departments. This was considered to be a potential problem due to re-entrainment of exhaust air because several local exhaust stacks are situated near the penthouse area.

The heat seal department operates on first shift only, employing 18 heat seal operators and material handlers. Twenty radio frequency heat sealing machines, manufactured by Thermatron, Faratron, and Sealomatic, are operated at 27 megahertz (MHz) at power levels ranging from 2.5 to 20 kilowatts. Various machining configurations were present, requiring from one to three operators on either sliding tray, turn table, or hand held sealing mechanisms. The majority of the heat sealing activities involve sealing foam backings into car seats, chairs, mattresses, or other types of furniture, contained in various types of vinyl. Shocks and burns were a reported frequent occurrence in the department, indicating a lack of proper grounding and/or shielding of the sealers. Remedial actions by the company included attempts at machine rearrangement, shielding, and cable grounding.

The stairway leading to the heat seal department provided a wide access to the main plant area. A plating line is located directly below the stair well, which could allow any effluents generated from the plating operation to move upward and into the heat seal area.

Adjacent to the heat seal area is the sewing department. Vinyl materials are cut and sewn in this area by 15 employees/shift for subsequent use in the heat seal department. Unlike the heat seal department, the sewing area is enclosed and air conditioned.

The plating department, located below the heat seal and sewing departments, consists of four plating lines; two chromium/nickel and two zinc plate. Employment on the lines typically consists of one loader and one operator per line.

The welding operations consisted of one double welding booth, an "auto welder", and a single MIG welder. All welding activities were conducted under local exhaust ventilation.

## IV. EVALUATION DESIGN AND METHODS

### A. ENVIRONMENTAL

RF radiation measurements were made with a calibrated Holaday Model HI 3002 Broadband Field Strength Meter equipped with an electric (E) field probe and a magnetic (H) field probe. Measurements of both fields were made at the left and right side of the operator's head, waist, and knee.

To determine the identity of airborne organic contaminants within the heat seal department, three high-volume, or "bulk air" charcoal tube air samples were obtained and submitted for qualitative gas chromatographic/mass spectrometric (GC/MS) analysis. All three samples had similar chromatograms varying only in concentration. The major GC "peaks" were identified as toluene, xylene, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK). Minor peaks identified were tetrahydrofuran (THF), 1,1,1-trichloroethane (1,1,1-TCE), isoamyl alcohol, cyclohexanone, n-propylbenzene, perchloroethylene, a series of molecular weight 120 aromatics such as trimethylbenzenes, a series of molecular weight 134 aromatics such as cumene, and n-alkanes ranging from $C_9$ to $C_{14}$. Based upon relative quantities of compounds on the bulk air samples, quantitative analysis was performed on the remaining charcoal tubes (obtained to determine actual airborne concentrations of these compounds) for MEK, 1,1,1-TCE, THF, MIBK, toluene, xylene, n-propylbenzene, and "total hydrocarbons". The total hydrocarbons analysis represents the series of alkanes and aromatic hydrocarbons identified from the bulk air analysis, and these were reported as approximations of airborne concentrations. The air samples were collected on standard 150 milligram (mg) charcoal tubes attached to pre-calibrated battery operated sampling pumps 0.1 liters per minute (LPM).

To determine concentrations of airborne metals generated from the plating lines and the welding operations, "AA" millipore filters were attached to pre-calibrated sampling pumps operated at 1 LPM. For analysis, the samples were digested with nitric and perchloric acids. The residues were dissolved in a dilute solution of the same acids. The resulting sample solutions were analyzed for trace metals content by inductively coupled argon plasma-atomic emission spectrometry. A total of 26 metals were quantitated for each sample.

Ventilation measurements were obtained on the local exhaust systems at the welding stations and the plating lines to assess their efficiency . Also, an assessment was conducted of the roof top exhaust stacks for the potential of re-entrainment of exhaust air into the penthouse areas, along with an investigation of the predominant wind patterns of the area obtained from the nearest NOAA weather bureau (Indianapolis, Indiana).

B. MEDICAL

In order to address the primary concern of the health hazard evaluation request, pregnancy outcomes were studied among women who worked with radiofrequency heat sealers during their pregnancy. Although no conclusive data exists which associates RF exposure and reproductive outcome, thermal effects (tissue heating) from exposures to RF are well-documented. Thus, the medical investigator's premise that excessive tissue heating might be responsible for adverse reproductive outcome became the working hypothesis for the study.

The cohort selected for study was chosen to be all past and present female employees of COSCO who had ever worked with heat sealers for at least one week since 1977. 1977 was the first year that reasonably complete records of heat seal department employees were available. From these records, and from "word-of-mouth", 75 women were identified. Of these 75, 59 participated in the study, for a 79% response rate.

## 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 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 (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 Exposure Limits (RELs), 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.

Radio Frequency (RF) Radiation

The term "microwave" refers to electromagnetic radiation extending from frequencies of approximately 10 to 300,000 megaHertz ("mega" equals 1,000,000; a Hertz equals 1 cycle per second). The terms "microwave" and "radio frequency radiation" (RF) are sometimes used interchangeably. RF sealers generally operate within the band of frequencies from 10 to 70 megaHertz (MHz). All sealers at the COSCO facility were reported as operating at 27 MHz, which is typical for these types of heat sealers. RF electromagnetic energy emitted from an RF sealer is considered non-ionizing radiation by virtue of its frequency and energy. Ionizing radiation (alpha, beta, gamma, and x-rays) is associated with the ability to remove electrons from neutral atoms (thus "ionization") and is generated at frequencies and powers greatly in excess of the capabilities of heat sealing operations.

RF radiation attains its desired thermal effect in industrial applications by acting upon the polar disposition of molecules. When a polar molecule is placed in a changing electric field, it attempts to align itself with the field. In the example of microwave cooking, the water molecules (which usually make up greater than 50% of the aggregate molecules) will change directions by 180° 2.5 billion times every second. With every change in direction, the molecules give off heat. This principle is also used for RF heat sealing operations. Although lower frequencies are used (27 MHz vs. 2450 MHz for microwave cooking) heat is generated by rapidly changing the polar disposition of molecules within the targeted plastic.

RF electromagnetic radiation can be described in terms of interrelated electric and magnetic fields propagating through space in the form of waves. The wave has an electric field strength (E-field), expressed volts per meter (V/m) and a magnetic field strength (H-field), expressed in amperes per meter (A/m). The E-field is measured by the force that it exerts on an electric charge, while the H-field is measured by the force that it exerts on a magnetic north pole. Power density is also an important quantity used to describe an electromagnetic wave. Power density is defined as the rate at which energy is transported across an area, averaged over one cycle of the wave. Power density has traditionally been expressed in units of milliwatts per square centimeter ($mW/cm^2$). While the E and H-fields can be measured at any distance from the RF source, a power density can only be measured in the far field (far field is defined as at least one to five wave lengths away from the source; usually 10-11 yards in the case of RF heat sealers), because the E and H-fields must have sufficient distance to align themselves perpendicularly. Reflections near the source interfere with this alignment.

Traditional problems encountered with measurement of RF energy involve expression of the evaluation criteria in the form of a power density; the Occupational Safety and Health Administration radiation protection standard for occupational exposure to RF and microwave radiation (29 CFR 1910.97) specifies a maximum power density of 10 $mW/cm^2$, as averaged over any possible 6-minute period during the work shift. In the far field (10-11 yards from the source) a power density of 10 $mW/cm^2$ is equivalent to a mean squared E-field strength of 40,000 $volts^2/meter^2$ ($v^2/m^2$) or a mean squared H-field strength of 0.25 $amperes^2/meter^2$ ($A^2/m^2$).

However, a power density value, which can be measured or calculated for far-field conditions, is not appropriate (or possible) for quantifying near-field exposure of a worker operating a RF heat sealing device. Therefore, measurements of both the E-field and H-field are necessary for exposure evaluations. While these cannot be directly converted to a power density as prescribed in the OSHA protection standard, they can be compared to the far-field equivalencies (40,000 $v^2/m^2$ and/or 0.25 $A^2/m^2$).

The ACGIH TLV for RF radiation specifies various field strengths dependant upon the frequency. At 27 MHz (the frequency of the heat sealers used at the COSCO facility) the TLV would be 4654 $v^2/m^2$ (E-field) and 0.033 $A^2/m^2$ (H-field). In terms of power density equivalents, these are approximately one-tenth of the OSHA standard.

Airborne Contaminants

Table II presents the evaluation criteria and a brief summary of the primary health effects of the airborne contaminants measured during the evaluation.

## VI. RESULTS AND DISCUSSION

### A. Environmental

#### 1. Non-ionizing Radiation

Table III presents results of the RF measurements obtained at the left and right position of heat seal operators' head, waist, and knees. One operator was exposed to RF radiation in excess of the OSHA standard for occupational exposure to RF and microwave radiation (29 CFR 1910.97) of 10 $mW/cm^2$, as averaged over any possible 6-minute period during the work shift. In the far field (10-11 yards from the source) a power density of 10 $mW/cm^2$ is equivalent to a mean squared E-field strength of 40,000 $volts^2/meter^2$ ($v^2/m^2$) or a mean squared H-field strength of 0.25 $amperes^2/meter^2$ ($A^2/m^2$). The operator of heat seal (H.S.) #6 was exposed to levels above this standard at the left waist (41250 $V^2/m^2$).

When compared to the ACGIH TLV for RF radiation (a level of approximately 10% the OSHA standard), 12 of the 18 heat seal operators were exposed to radiation levels above this criteria (4654 $v^2/m^2$ E-field, and 0.033 $A^2/m^2$ H-field). This included operators of H.S. #s 1 (both operators), 3, 5 (both operators), 6, 8, 10, 11, 14, 19, and 20. Over-exposures were measured for both the E and H-fields (Table III).

This type of over-exposure situation appears to be prevalent throughout the heat sealing industry. In a recent study by NIOSH researchers of 82 heat seal operators in 13 facilities, 55% of the operators were exposed to levels for the E-field above the OSHA standard, and 21% were exposed to levels for the H-field above the standard.(1) This type of environmental information, along with experimental animal studies which suggest that the potential consequences of absorbing excessive amounts of RF energy may include changes in the eye, central nervous system, conditioned reflex behavior, heart rate, chemical composition of the blood, and the immune system, prompted NIOSH to publish a Current Intelligence Bulletin in 1980 recommending precautionary measures to be instituted to protect workers form unwarranted exposure to RF energy.(2) These precautionary measures are listed in Appendix A.

2. Airborne Organics

Results of airborne monitoring for organic substances within the heat seal department are presented in Table IV. All airborne concentrations were less than 5% of the applicable evaluation criteria. The most likely source of these airborne organic substances is the plastic material used in the manufacture of the various furniture pieces; either as constituents of the plastics or as non-stick agents applied to the rolled material prior to shipment. Based upon the results of the environmental monitoring, no long-term health effects would be expected at these levels of exposure. However, exposure to 1,1,1-trichloroethane warrants special consideration. In 1976, NIOSH published a Criteria Document for a Recommended Standard for Occupational Exposure to 1,1,1-trichloroethane, recommending that exposures be controlled below a ceiling concentration of 350 ppm. This level was designed to prevent acute respiratory, eye, nose and throat irritation, and chronic effects on the central nervous system . In 1978, NIOSH published a Current Intelligence Bulletin (#27) which reviewed the toxicity of nine chloroethane compounds, four of which should be handled in the workplace as if they were human carcinogens. The CIB recommended caution in the use of 1,1,1-trichloroethane because of its chemical similarity to the four chloroethane compounds designated as potential carcinogens. The National Toxicology Program under its Carcinogenesis Testing Program is currently studying the carcinogenic potential of 1,1,1-TCE in laboratory animals. Results of this research should soon be available. In the interim, NIOSH recommends prudence in the use of this substance, including control of workplace exposures to the fullest possible extent.

3. Airborne Metals

Airborne metals were measured at the central area of the heat seal department, the sewing department, and at the upper level of the stair well to the heat seal department. These samples were collected to determine whether excessive concentrations of metals were present as a result of the proximity of the nickel and zinc plating lines to the heat seal and sewing departments. The analytical method used for the metal samples provides measurement of 26 metal compounds. Only five metals were identified at airborne levels above the analytical limit of detection (LOD = 1 ug/sample). These included calcium, iron, magnesium, sodium, and zinc. Airborne concentrations of these metals were all below 20 ug/$m^3$, and well within the appropriate evaluation criteria (less than 10% of assigned TLVs or OSHA standard).

Personal (breathing zone) monitoring of welding operators was conducted for metals during two shifts. Again, the analytical method provided measurement of 26 metal compounds. Of these, six were reported at significant concentrations, including calcium, copper, iron, magnesium, manganese, and nickel (Table V). All concentrations were within their respective evaluation criteria, with the exception of the nickel exposure obtained from the MIG welder, measured at 37 ug/$m^3$. The NIOSH REL for nickel is 15 ug/$m^3$, based upon this substance's potential carcinogenicity.

4. <u>Ventilation</u>

The 11271 Base Welder, located at Col. E 20-21, is served by a blower drawing approximately 4300 cubic feet/minute (CFM). The hood canopy (4'x10' opening) should have an average face velocity of 108 feet per minute (FPM), based upon the air volume throughput and the canopy opening. However, velocities were measured at several points around the hood edge and at work points, but none exceeded 90 FPM. Because the blower serves only this hood, no explanation is offered as to low face velocities other than possible unobservable leaks in the ductwork. Possible improvements would include placing smaller local ventilation hoods directly at the weld site, which would not use the total vent capacity of the blower.

The 234 Base Welder is serviced by a 4" flexible duct with an inlet velocity of approximately 1600 FPM. If the end of the duct were placed directly at the weld site, this velocity would be adequate. However, at the time of the evaluation, the inlet was 14" from this site, with a resulting capture velocity of only 20-30 FPM. The blower servicing this system also services a large hood at column D17. The efficiency of the flexible hose could be improved by either moving it nearer the weld site, dampering the hood at D17, or replacing the 4" flexible hose with one of 6" diameter.

The 11271 Base Welder at Columns D17-E17 is serviced by two rotating hoods. These hoods rotate for the load and weld positions, with each having perforated steel plate vents that open into a common plenum. The perforated steel plates have burn holes, which have a negative effect on the air flow pattern into the hood. Air flows were measured at the weld site and at the edges of the flow hood. The maximum velocity measured was 100 FPM with an average velocity of 70 FPM on the left hood (toward building front) and 53 FPM on the right hood. The velocity at the weld point was 65 FPM at the left station and 70 FPM on the right. These flows are far below the 1400-2000 FPM recommended for welding fumes. However, based upon the blower output capacity, the recommended minimum 3000 FPM duct velocity (to prevent settling of dust in the restrictions of the duct work) is exceeded within this system. The current design of the hoods permits air to ventilate from both, even though only one can be used at a time. A system to damper the unused hood would greatly increase the system's collection efficiency.

The Zinc Barrel Plating Tank has a push-pull air flow system at the periphery of its surface. This system has had the push air disconnected and air curtains have been installed from an overhead 10'x18' hood. The effect is a channelling of the air flow into the hood at an average velocity of 83 FPM. The pull section of the ventilation system continues to function, pulling 720 CFM with an average velocity of about 120 FPM. This 12' long hood, to the left of the plating bath, effectively provides protection for the adjacent operator walkway (demonstrated with smoke tubes). The total flow of air into these hoods was not measured because the roof outlet was inaccessible. The estimated flow is approximately 10,000 CFM.

The location of the welding ventilation roof blowers is such that any fumes/vapors would be more apt to affect the sewing area in the penthouse rather than the heat seal department. The location of the exhaust stack for the plating operation is nearer to the heat seal area but has been raised above the roof level of the penthouse. Even though the wind is from the northwest 25% of the time (according to local weather service information) it is doubtful that the plating vapors from the stack are entering the heat seal department.

B. MEDICAL

The 59 study participants had an aggregate of 147 pregnancies (2.49/woman). Of these, 25 pregnancies occurred during the woman's employment at COSCO. Of these 25, 11 were among women who worked in heat seal. Four of these 11 women (36.4%) reported an adverse outcome (miscarriage or stillbirth) compared to 3 of 14 (21.4%) among women who worked in other areas of the plant.

Although the occurrence of adverse outcome among RF-exposed women is higher than the incidence among non-exposed women, this difference is not significant ($p = 0.35$). Based upon these data, we cannot conclude that pregnant women working in the heat seal department are at a greater risk for miscarriage than women not working in the heat seal department.

This analysis has some shortcomings. Probably foremost is the fact that we have no information on non-respondents or their reason for departure from COSCO. Hence, if these women were of child-bearing age, were working in heat seal during their pregnancy, and had normal reproductive outcomes, they would have added these pregnancies to the normal/heat seal category, changing the relative risk toward no association.

## VII. CONCLUSIONS

In conclusion, the NIOSH investigators determined that one heat seal operator was exposed in excess of the OSHA standard of 10 $mw/cm^2$ and twelve of the operators were exposed in excess of the TLV. Heat seal operators' exposures to methyl ethyl ketone, trichloroethane, tetrahydrofuran, methyl isobutyl ketone, toluene and xylene were all less than 5% of the most restrictive evaluation criteria, including the OSHA federal standards, ACGIH TLVs, and the NIOSH RELs.

Breathing zone monitoring of welding operators indicated that one welder was exposed to excessive levels of airborne nickel (37 $ug/m^3$). The NIOSH REL is 15 $ug/m^3$.

Although an analysis of normal versus adverse pregnancies among 59 women who had worked in the heat seal department since 1977 was undertaken we were unable to ascertain (with any degree of confidence) that an excessive adverse outcome was associated with working with heat sealers.

## VIII. RECOMMENDATIONS

1. Heat Sealers:

Employee exposures to RF energy within the heat seal department were measured at levels above the ACGIH TLV at several operator locations (12 of the 18 operators monitored), and above the OSHA standard at one location (heat sealer #6). Because remediation efforts performed by the company to date have been unsuccessful, either the manufacturers of the heat sealing devices or a private consultant should be contracted for exposure reduction measures. A traditional method of exposure reduction is through shielding. Figure 1 presents a schematic of a shielded heat sealing device using phosphor-bronze spring metal at the periphery of the top plate and ground plate. In addition to these engineering measures, Appendix A contains a set of precautionary measures developed for publication in a joint NIOSH/OSHA Current Intelligence Bulletin for continued employee protection against RF radiation. Pending implementation of these recommendations, the company should consider removing pregnant women and women who wish to become pregnant and placing them in other departments

Based upon results of environmental monitoring for airborne substances within the heat seal department (Table IV), no long-term health effects would be expected. However, transient effects such as upper respiratory or eye irritation may be experienced by sensitive individuals.

2. Welding

One personal sample collected from the operator of the 234 base welder (MIG weld) showed an airborne concentration of nickel above the NIOSH Recommended Exposure Limit. The ventilation assessment of this operation indicated a deficiency in air movement at the weld point. To increase the air flow across this point, the local exhaust hood should be modified for non-interference with the welding operation and moved closer. The flexible ducting for the hood should be increased from 4" to 6" duct. Also, the roof blower for this hood draws the majority of exhaust air from a large hood located near column D17. By dampering this hood, more exhaust air could be directed to the base welder.

3. General

<u>DECO Area</u>

Solvent soaked rags should be disposed of in a covered receptacle and disposed of daily. Commercial solvent waste cans would be appropriate for this application

<u>Spray Paint Area</u>

Solvents such as toluene should not be used as a general cleaning compound, especially for hand cleaning prior to breaks and at the end of the shift.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

| | |
|---|---|
| Report Prepared by: | Richard W. Hartle<br>Industrial Hygienist<br>Industrial Hygiene Section |
| | William Albrecht, Ph.D.<br>Medical Officer<br>Medical Section |
| Field Assistance: | James Boiano<br>Industrial Hygienist<br>Industrial Hygiene Section |
| | William Todd<br>Chemical Engineer<br>Division of Physical Sciences and Engineering |
| | Mazen Anastas<br>Chemical Engineer<br>Division of Physical Sciences and Engineering |
| Originating Office: | Hazard Evaluations and Technical Assistance Branch<br>Division of Surveillance, Hazard Evaluations, and Field Studies |

## XI. 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. COSCO, INC.
2. Local 1155, UBCJA
3. NIOSH, Cincinnati Region
4. OSHA, Region V

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

SUMMARY OF PREVIOUS EXPOSURE MONITORING

COSCO, INC.
Columbus, Ind.
HETA 85-449

| OPERATION/LOCATION | SUBSTANCE | DURATION | CONCENTRATION |
|---|---|---|---|
| Cummins Report; March '85 | | | |
| Heat Seal/South | HCl | 20 min | ND* |
| Heat Seal/Mid | HCl | 20 min | ND |
| Heat Seal/North | HCl | 20 min | ND |
| Plate Line/Pickle Tank | HCl | 20 min | Trace (0. 1ppm) |
| Plate Line/Rack Stripper | HCl | 20 min | ND |
| Sew Area/North | HCl | 20 min | ND |
| IOSH Report; Jan '85 | | | |
| Heat Seal/Operator | Formaldehyde | 8 hr | 0.15 ppm |
| Heat Seal/Operator | Formaldehyde | 8 hr | 0.1 ppm |
| Plate Line/Operator | Chrome III | 6.5 hr | 0.002 mg/m$^3$ |
| Paint Mix/Operator | Toluene | 50 min | 83 ppm |
| Paint Mix/Operator | Benzene | 50 min | ND |
| Paint Mix/Operator | Acetone | 50 min | ND |
| Paint Mix/Operator | MEK | 50 min | ND |
| Spary Paint/Operator | Toluene | 102 min | 4 ppm |
| Spray Paint/Operator | Benzene | 102 min | ND |
| Spray Paint/Operator | Acetone | 102 min | ND |
| Spray Paint/Operator | MEK | 102 min | ND |
| Cummins Report; Dec '84 | | | |
| Heat Seal | Formaldehyde | 4 hr | ND |
| Heat Seal | Formaldehyde | 4 hr | ND |
| Heat Seal | Formaldehyde | 4 hr | ND |
| Heat Seal | Formaldehyde | 4 hr | ND |
| General Casualty Insurance; July '84 | | | |
| Heat Seal/Stairs | Chromic Acid | 1 hr | ND |
| Heat Seal/Stairs | Chromic Acid | 1 hr | ND |
| Heat Seal/Stairs | Nickel | 1 hr | ND |
| Heat Seal/Stairs | Nickel | 1 hr | ND |
| 2nd Floor | Chromic Acid | 1 hr | ND |
| 2nd Floor | Chromic Acid | 1 hr | ND |
| 2nd Floor | Chromic Acid | 1 hr | ND |
| Heat Seal/west wall | Chromic Acid | 1 hr | ND |
| Heat Seal/west wall | Chromic Acid | 1 hr | ND |
| Heat Seal/west wall | Nickel | 1 hr | ND |
| Heat Seal/east wall | Chromic Acid | 1 hr | ND |
| #1 Plate Line | Chromic Acid | 1 hr | ND |

(cont.)

Table I (cont.)

| OPERATION/LOCATION | SUBSTANCE | DURATION | CONCENTRATION |
|---|---|---|---|
| General Casualty Insurance; July '84 | | | |
| #1 Plate Line | Nickel | 1 hr | ND |
| #2 Plate Line | Chromic Acid | 1 hr | ND |
| #2 Plate Line | Nickel | 1 hr | ND |
| #4 Plate Line | OCB** | 50 min | 0.5 ppm |
| Heat Seal/Stair top | OCB | 50 min | 0.5 ppm |
| Cummins; Feb '84 | | | |
| Heat Seal | Organics | 4 hr | trace |
| Heat Seal | Organics | 4 hr | trace |
| #4 Plate Line | Organics | 4 hr | trace |
| #4 Plate Line | Organics | 4 hr | trace |
| Reliance Insurance; June '83 | | | |
| #4 Plate Line | OCB | 62 min | ND |
| #4 Plate Line | Xylene | 62 min | 1.0 ppm |
| #4 Plate Line | Benzene | 62 min | 0.01 ppm |
| Heat Seal (5 samples) | OCB | 1 hr | ND |
| | Xylene | 1 hr | 1.0 ppm |
| | benzene | 1 hr | 0.01 ppm |
| | MEK | 1 hr | ND |
| | MIBK | 1 hr | ND |
| | Toluene | 1 hr | ND |
| | Acetone | 1 hr | ND |
| | Styrene | 1 hr | ND |
| Spray Paint/Operator | Toluene | 33 min | ND |
| Spray Paint/Operator | Xylene | 33 min | ND |
| Spray Paint/Operator | MEK | 33 min | ND |
| Spray Paint/Operator | DGME*** | 33 min | ND |
| Paint/Touch-up | Toluene | 33 min | ND |
| Paint/Touch-up | Xylene | 33 min | ND |
| Paint/Touch-up | MEK | 33 min | ND |
| Paint/Touch-up | DGME | 33 min | ND |
| Paint Mix/Area | Toluene | 39 min | 2.55 ppm |
| Paint Mix/Area | Xylene | 39 min | ND |
| Paint Mix/Area | MEK | 39 min | ND |
| Paint Mix/Area | DGME | 39 min | ND |
| Heat Seal/Operator | VCM | 67 min | ND |
| Heat Seal/Operator | VCM | 1 hr | ND |
| Plate Line/Operator | Chromic Acid | 78 min | ND |
| Plate Line/Area | Nickel | ----- | ND |
| Cummins; May '83 (2-ethoxye hanol replaced with Benchmark F-283 June '83) | | | |
| Heat Seal/Operator | 2-EH**** | 6 hr | 25 $mg/m^3$ |
| Heat Seal/Operator | 2-EH | 6 hr | 1.7 $mg/m^3$ |
| Heat Seal/Operator | 2-EH | 6 hr | 10.2 $mg/m^3$ |
| Heat Seal/Operator | 2-EH | 6 hr | 39.8 $mg/m^3$ |

*ND = Non-Detected **OCB = Orthochlorobenzaldehyde ***DGME = diethylene glycol monobutyl ether ****2-EH = 2-ethoxyethanol

TABLE II

EVALUATION CRITERIA

COSCO, INC.
Columbus, Ind.
HETA 85-449

| Substance | Evaluation Criteria ($mg/m^3$) NIOSH | OSHA[3] | ACGIH[4] | Primary Health Effects |
|---|---|---|---|---|
| Methyl ethyl ketone | 590[5] | 590 | 590 | This class of solvents may produce a dry, scaly, and fissured dermatitis after repeated exposure. High vapor concentrations may irritate the conjunctiva and mucous membranes of the nose and throat, producing eye and throat symptoms. Narcosis is also possible at high concentrations, with headache, nausea, light-headedness, incoordination, and unconsciousness.[7,18] |
| 1,1,1-Trichloroethane | LFL* | 1900 | 1900 | In 1976, NIOSH published a Criteria Document for a Recommended Standard for Occupational Exposure to 1,1,1-trichloroethane, recommending that exposures be controlled below a ceiling concentration of 350 ppm.(6) This level was designed to prevent acute respiratory, eye, nose and throat irritation, and chronic effects on the central nervous system . In 1978, NIOSH published a Current Intelligence Bulletin (#27) which reviewed the toxicity of nine chloroethane compounds, four of which should be handled in the workplace as if they were human carcinogens.(7) The CIB recommended caution in the use of 1,1,1-TCE because of its chemical similarity to the four chloroethane compounds designated as potential carcinogens. NIOSH recommends prudence in the use of this substance, including control of workplace exposures to the fullest possible extent. |
| Tetrahydrofuran | ----- | 590 | 590 | Possible liver and kidney injury following high levels of exposure, and the liquid may be irritative to the skin. |
| Methyl Isobutyl Ketone | 200[3] | 410 | 205 | May produce a dry, scaly, and fissured dermatitis following repeated exposure. High vapor concentrations may irritate the eyes, nose, and throat, and repeated exposure to high concentrations may produce symptoms of headache, nausea, light headedness, vomiting, and dizziness. |

(cont.)

Table II (cont.)

| Substance | Evaluation Criteria ($mg/m^3$) NIOSH | OSHA[3] | ACGIH[4] | Primary Health Effects |
|---|---|---|---|---|
| Toluene | 375[8] | 750 | 375 | May cause irritation of the eyes, respiratory tract, and skin. Acute exposures to high levels results in central nervous system depression. |
| Xylene | 434[9] | 434 | 435 | May cause irritation of the eyes, respiratory tract, and skin. High exposure may result in central nervous system depression and minor reversible effects upon the liver and kidneys. |

TABLE III

RF RADIATION MEASUREMENTS: HEAT SEAL DEPARTMENT

COSCO Inc.
COLUMBUS, INDIANA

DECEMBER 4-5, 1985
HETA 85-449

| | | CONCENTRATION | | | | | |
|---|---|---|---|---|---|---|---|
| | | Head | | Waist | | Knee | |
| Location | | $v^2/m^2$ | $A^2/m^2$ | $v^2/m^2$ | $A^2/m^2$ | $v^2/m^2$ | $A^2/m^2$ |
| H.S. #1 | left: | 1200 | 0.012 | 4000 | 0.048 | 3600 | 0.020 |
| | right: | 4000 | 0.008 | 4000 | 0.012 | 4000 | 0.020 |
| H.S. #1 | left: | 4000 | 0.008 | 1600 | 0.012 | 3200 | 0.028 |
| | right: | 12000 | 0.012 | 4000 | 0.028 | 6000 | 0.028 |
| H.S. #2 | front: | 1800 | 0.015 | 1500 | 0.021 | 600 | 0.030 |
| H.S. #3 | left: | 3600 | 0.008 | 200 | 0.020 | 1200 | 0.008 |
| | right: | 2600 | 0.003 | 1600 | 0.004 | 6800 | 0.004 |
| H.S. #5 | left: | 2833 | 0.005 | 1333 | 0.008 | 1666 | 0.018 |
| | right: | 8333 | 0.007 | 8333 | 0.020 | 500 | 0.020 |
| H.S. #5 | left: | 20000 | 0.017 | 1666 | 0.027 | 833 | 0.020 |
| | right: | 1666 | 0.003 | 1833 | 0.007 | 26666 | 0.083 |
| H.S. #6 | left: | 15000 | 0.056 | 41250 | 0.056 | 37500 | 0.094 |
| | right: | 26250 | 0.056 | 37500 | 0.038 | 18750 | 0.225 |
| H.S. #7 | left: | 400 | 0.004 | 3200 | 0.008 | 1200 | 0.004 |
| | right: | 4000 | 0.016 | 1200 | 0.028 | 240 | 0.032 |
| H.S. #8 | left: | 10294 | 0.059 | 14706 | 0.088 | 2941 | 0.147 |
| | right: | 2059 | 0.029 | 2059 | 0.044 | 4706 | 0.059 |
| H.S. #9 | left: | 833 | 0.003 | 417 | 0.004 | 556 | 0.004 |
| | right: | 1111 | 0.001 | 278 | 0.001 | 833 | 0.003 |
| H.S. #10 | left: | 2000 | 0.007 | 1833 | 0.003 | 2000 | 0.133 |
| | right: | 1333 | 0.003 | 1667 | 0.030 | 3333 | 0.033 |

(cont.)

Table III (cont.)

| Location | CONCENTRATION: Head $v^2/m^2$ | Head $A^2/m^2$ | Waist $v^2/m^2$ | Waist $A^2/m^2$ | Knee $v^2/m^2$ | Knee $A^2/m^2$ |
|---|---|---|---|---|---|---|
| H.S. #11 left: | 200 | 0.001 | 200 | 0.010 | 800 | 0.020 |
| right: | 1800 | 0.006 | 300 | 0.012 | 200 | 0.036 |
| H.S. #13 left: | ND | 0.001 | ND | 0.002 | 154 | 0.003 |
| right: | 77 | 0.001 | 39 | ND | 77 | 0.002 |
| H.S. #14 left: | 350 | 0.007 | 15000 | 0.013 | 2000 | 0.013 |
| right: | 5500 | 0.002 | 5000 | 0.003 | 15000 | 0.006 |
| H.S. #15 left: | 3000 | 0.006 | 300 | 0.004 | 100 | 0.002 |
| right: | 300 | 0.001 | 3000 | 0.001 | 100 | 0.002 |
| H.S. #17 left: | 1000 | 0.001 | 100 | 0.002 | 150 | 0.002 |
| right: | 150 | ND | 300 | ND | 200 | 0.001 |
| H.S. #19 left: | 8000 | 0.004 | 2000 | 0.008 | 1600 | 0.012 |
| right: | 200 | 0.020 | 400 | 0.002 | 600 | 0.004 |
| H.S. #20 left: | 5550 | 0.010 | 12500 | 0.038 | 3750 | 0.075 |
| right: | 3500 | 0.003 | 7500 | 0.015 | 2000 | 0.043 |
| Evaluation Criteria: | | | | | | |
| OSHA: | 40,000 | 0.25 | 40,000 | 0.25 | 40,000 | 0.25 |
| ACGIH: | 4,654 | 0.033 | 4,654 | 0.033 | 4,654 | 0.033 |

TABLE IV

AIR SAMPLING RESULTS: HEAT SEAL DEPARTMENT

COSCO Inc.
COLUMBUS, INDIANA

DECEMBER 4-5, 1985
HETA 85-449

| No. | Location | Concentration ($mg/m^3$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | MEK | TCE | THF | MIBK | Toluene | Xylene | Total HC |
| CT-1 | H.S. #8 | 4.1 | 1.5 | 0.2 | 3.1 | 1.6 | 1.6 | 3.2 |
| CT-2 | H.S. #11 | 4.6 | 1.2 | 0.3 | 3.9 | 1.5 | 1.7 | 3.6 |
| CT-3 | H.S. #1 | 3.0 | 0.3 | ND | 3.4 | 1.2 | 1.4 | 2.5 |
| CT-4 | H.S. #3 | 8.3 | 0.9 | 0.6 | 3.4 | 2.2 | 1.3 | 3.0 |
| CT-5 | H.S. #14 | 3.9 | 1.3 | 0.2 | 2.6 | 2.4 | 2.4 | 3.4 |
| CT-6 | H.S. #17 | 4.2 | 1.2 | ND | 2.2 | 1.6 | 1.4 | 2.9 |
| CT-21 | H.S. #2 | 16.4 | ND | 2.2 | 5.5 | 4.1 | 0.8 | 2.8 |
| CT-23 | H.S. #7 | 4.9 | 0.4 | 0.3 | 3.4 | 2.4 | 1.7 | 3.4 |
| CT-24 | H.S. #1 | 2.8 | ND | trace | 1.8 | 1.1 | 0.6 | 2.1 |
| CT-26 | H.S. #19 | 3.0 | ND | 0.2 | 1.5 | 1.6 | 0.6 | 1.4 |
| Evaluation Criteria: | | | | | | | | |
| | NIOSH | 590 | LFL* | --- | 200 | 375 | 434 | 350 |
| | OSHA | 590 | 350 | 590 | 410 | 750 | 434 | 500 |

*LFL = lowest feasible level

TABLE V

AIR SAMPLING RESULTS: WELDING OPERATIONS

COSCO Inc.
COLUMBUS, INDIANA

DECEMBER 4-5, 1985
HETA 85-449

| Location | Concentration (mg/m3) | | | | | |
|---|---|---|---|---|---|---|
| | Calcium | Copper | Iron | Manganese | Magnesium | Nickel |
| Left base weld | 0.002 | 0.005 | 0.432 | 0.036 | 0.001 | ND |
| Right base weld | 0.003 | 0.017 | 1.412 | 0.118 | 0.002 | ND |
| "MIG" weld (234 base weld) | 0.013 | 0.012 | 1.571 | 0.130 | 0.003 | 0.037 |
| Auto weld | 0.003 | ND | 0.143 | 0.009 | 0.002 | ND |
| Left base weld | 0.005 | 0.036 | 3.908 | 0.002 | 0.138 | ND |
| Right base weld | 0.004 | 0.019 | 1.599 | 0.137 | 0.002 | ND |
| Auto weld | 0.004 | 0.006 | 0.116 | ND | 0.005 | ND |
| EVALUATION CRITERIA | | | | | | |
| NIOSH: | ----- | ----- | ----- | ----- | ----- | 0.015 |
| OSHA: | 5.0 | 0.100 | 10.000 | 5.000 | 15.000 | 1.000 |
| ACGIH: | 2.0 | 0.200 | 5.000 | 1.000 | 10.000 | 1.000 |

TABLE VI

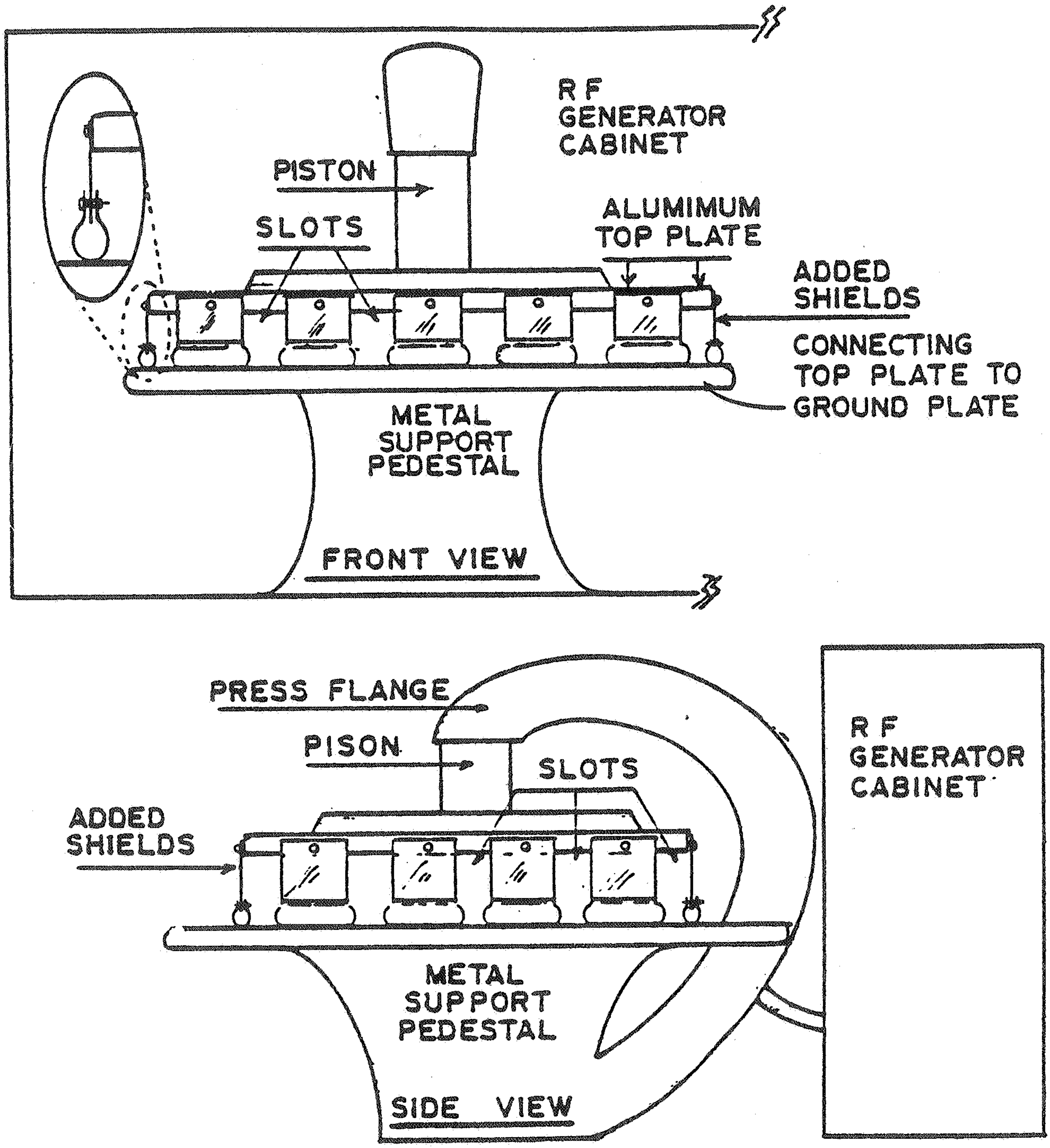
2X2 TABLE OF RF EXPOSURE VS PREGNANCY OUTCOME

COSCO Inc.
COLUMBUS, INDIANA

DECEMBER 4-5, 1985
HETA 85-449

| | | Pregnancy Outcome | | |
|---|---|---|---|---|
| | | Normal | Adverse | Totals |
| Job area | Heat seal | 7 | 4 | 11 |
| | Not Heat seal | 11 | 3 | 14 |
| | Totals | 18 | 7 | 25 |

FIGURE 1


R F
GENERATOR
CABINET
PISTON
SLOTS
ALUMIMUM
TOP PLATE
ADDED
SHIELDS
CONNECTING
TOP PLATE TO
GROUND PLATE
METAL
SUPPORT
PEDESTAL
FRONT VIEW
PRESS FLANGE
PISON
SLOTS
ADDED
SHIELDS
R F
GENERATOR
CABINET
METAL
SUPPORT
PEDESTAL
SIDE VIEW

## APPENDIX A

### Recommendations for RF Hazard Control

#### Immediate Actions

Control of the emission of RF energy from RF sealers and heaters should rely on the application of properly designed and installed shielding material. The shielding should be placed on or around the equipment so as to minimize occupational exposure due to emissions of stray RF energy. All shielding material should be properly grounded. Shielded conductors should be used for conveying RF current, and path impedance should be minimized by using good conductor materials.

The distance between the worker and the source of RF energy emission should be maximized. Examples of means to accomplish this include the use of automatic feeding divices, rotating tables, and remote materials handling.

The RF sealing and heating equipment should be electronically tuned to minimize the stray power emitted.

Whenever possible, equipment should be switched off when not being used. Maintenance and adjustment of the equipment should be performed only while the equipment is not in operation.

After the performance of maintenance or repair, all machine parts, including cabintry, should be reinstalled so that the equipment is intact and its configuration is unchanged.

#### Warnings and Information

Access to the vicinity of RF sealers and heaters where there may be stray RF energy should be limited as much as possible to the operator and necessary assistants, maintenance personnel, and industrial hygiene or safety personnel. Use of the RF equipment should be restricted to properly trained personnel.

Areas in which exposures to RF energy have been determined to be appreciable should be posted. Any signs should be of such size as to be recognizable and readable from a distance of three meters. All warning signs must be printed in English and in the predominant languages of non-English-reading workers, and should conform to the desing recommended by OSHA.

Areas in which the RF energy is present at levels higher than the permissible exposure limit also should be posted. The warning signs should contain the following additional information: HAZARD -- DO NOT ENTER. The sign must be readable from a distance of three meters. The perimeter of the restricted area should be clearly demarcated with signs visible to all personnel approaching the area.

## Medical Monitoring

A medical surveillance program, tailored to the expected degree of employee use of RF equiment and potential for exposure to RF energy, should be developed. 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, annual examinations should be considered for workers who may be exposed to RF energy on a regular, long-term basis. Work histories should be included in all examinations.

Medical histories and physical examinations should have particular emphasis upon target organs potentially affected by RF energy including the eye (cataracts), the central nervous system, the blood (decreased leukocyte count), the immune defense system, and the reproductive system. Adverse reproductive effects may involve both maternal and paternal exposure. For persons occupationally exposed to RF energy, medical records including health and work histories should be maintained throughout the period of employment and for an extended period after termination of employment.

## Exposure Measurements

Areas in the occupational environment where levels of RF energy have been determined to be appreciable should be surveyed at regular intervals. Immediately following a physical or electronic alteration of the equipment or an alteration in the process, a complete survey should also be performed. If measurments taken during a survey indicate that occupational exposure exceeds the permissible exposure limit, a second survey should be made on the next workday. If the limit is still exceeded, the use of RF equiment producing excessive values should be prohibited until appropriate controls have been instituted. The survey data sheets should contain all information pertaining to the survey, and should include the date and time of measurement, the type of monitoring equipment used, the employees° names,, and the remedial actions taken, if any. These records should be maintained for an extended period of time.

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