HETA 88-279-2026
MARCH 1990
KARDON INDUSTRIES
ST. PARIS, OHIO

NIOSH INVESTIGATOR:
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I. Summary

In May 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at Kardon Industries, Inc., Composite Can and Tube Division, St. Paris, Ohio. This evaluation was requested by the production manager to evaluate the effectiveness of ventilation system modifications that were made to reduce employee exposures to acetaldehyde and formaldehyde at the waxing unit, as recommended in a previous NIOSH investigation (HETA 85-308).

NIOSH investigators visited the facility on July 27, 1988 and on February 22, 1989. During these visits, the hand wax line was no longer in use. Only the auto wax unit was currently involved in production. Air samples for acetaldehyde, formaldehyde, naphthas, and volatile organic compounds were obtained. The auto wax unit and its local exhaust ventilation was evaluated, and employees were questioned about health effects which they felt were job-related.

The environmental air sampling from the initial survey did not detect acetaldehyde, formaldehyde or any other aldehydes. However, the results of the seven general area formaldehyde samples collected by a more sensitive method during the second visit ranged from 0.024 to 0.029 parts per million of air (ppm). The results for the formaldehyde samples were all below the OSHA permissible exposure limit (PEL) of 1 ppm. NIOSH currently recommends that formaldehyde be treated as a potential human carcinogen and that exposures should be reduced to the lowest feasible level. This approach is taken because NIOSH is not aware of any data that describe a safe exposure concentration to a carcinogen.

The hydrocarbon screen also conducted during this visit did not detect any volatile organics being released from the waxing process. The results for the four personal breathing zone samples for naphthas ranged from 30 to 33 milligrams per cubic meter of air (mg/m^3) while the general area sample was 36 mg/m^3. The results for the naphtha samples were well below the evaluation criteria. Since naphthas are mixtures, the evaluation criteria is based upon its major components (petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, and Stoddard solvents). The NIOSH evaluation criteria for these components is 350 mg/m^3, however, the criteria for airborne concentrations of mixtures containing kerosene is 100 mg/m^3. These samples were quantitated using toluene as a calibration reference for this naphtha mixture because a bulk sample of the lubricating oil used in the stamping area on the day of sampling was unavailable. Therefore, these results are a best estimate, and the evaluation criteria of 100 mg/m^3 should be used since the presence of kerosene could not be ruled out.

The inspection of the ventilation system and the auto wax unit revealed some problems during the first visit (July, 1988). Many of the recommendations made by the NIOSH investigators to correct these problems were implemented before the return visit was conducted. These modifications seemed to reduce the potential for exposure, however, the recommendations that were not addressed should also be implemented to further reduce the potential for employee exposures.

Symptoms reported by employees included headache, burning eyes, throat and nose irritation, dizziness, and an altered taste sensation and nausea. Most of the employees associated their symptoms with the auto wax operation.

Although employee symptoms are not readily explained by the documented exposures, emissions from the heated polypropylene wax still appear to offer the most likely explanation. It is possible that a combined effect from the low levels of airborne substances measured, or a contaminant not evaluated because it was not known to be potentially present, are contributing to the symptoms. Improvements already made to the local exhaust ventilation system and the auto wax unit have reduced the potential for work-related exposures. Further improvements, which are presented in Section VIII, should be beneficial.

KEYWORDS: SIC 2655 (Fiber cans, tubes, drums, and similar products); composite cans, caulking tubes, aldehydes, amorphous polypropylene wax, formaldehyde, mineral oil, naphthas, headache, respiratory symptoms, eye, nose and throat irritation.

II. INTRODUCTION

On May 31, 1988, the National Institute for Occupational Safety and Health received a request to evaluate the effectiveness of modifications that were made to the auto wax unit at Kardon Industries, Inc., Composite Can and Tube Division, St. Paris, Ohio. This request was submitted by the production manager as a follow-up to a previous Health Hazard Evaluation (HETA 85-308-1829) conducted in June, 1985 and January, 1986, in which engineering changes on the auto wax unit were recommended. The original evaluation was requestly jointly by Kardon Industries and local 1467 of the United Paperworkers Union. According to the request, employees working with heated wax were reporting headaches and dry throats.

NIOSH investigators visited the facility on July 27, 1988 and on February 22, 1989. During these visits, the hand wax line was no longer in use. Only the auto wax unit was currently involved in production. Air samples for acetaldehyde, formaldehyde, naphthas, and volatile organic compounds were obtained. The auto wax unit and its local exhaust ventilation were evaluated, and employees were questioned about health effects which they felt were job-related.

During the first visit, both personal breathing zone and area air samples for acetaldehyde and formaldehyde were collected using solid sorbent tubes. The local ventilation system used to control emissions from the waxing unit was qualitatively evaluated using smoke tubes. Interviews of the potentially exposed employees were conducted to aid in the identification of any health problems. The stamping area was also inspected because of employee concerns about potential exposures to oil mists.

The second visit was conducted to characterize potential employee exposures at the waxing unit during winter (worst case) when the building was more insulated from the outside. Also, the transfer of the heated wax from a 55 gallon drum to the machine reservoir was automated as recommended after the first visit. During the visit, general area air samples for formaldehyde were collected using sodium bisulfite solution in impingers. This method was used because of its lower limit of detection. General area air samples were also collected using charcoal tubes to identify any volatile organics that might be released during the waxing process. In addition, personal breathing zone samples and a general area sample were collected in the stamping area using charcoal tubes. These samples were analyzed for naphthas, which are present in the lubricating oil.

Initial findings and recommendations were presented to management and union representatives at the conclusion of both site visits. Subsequently, results, recommendations and/or status reports were distributed via letters on August 17, 1988 and March 23 and July 5, 1989.

III. BACKGROUND

Kardon's Composite Can and Tube Division (CC&TD) consists of two plants, one of which is the Saint Paris, Ohio facility. This one-story facility produces cardboard caulking tubes. The facility employs a workforce of approximately 100 hourly employees with some departments operating three shifts per day. The plant was built in the early 1970's and Kardon Industries has occupied the plant since about 1975.

The structure of the composite can consists of three plies of paperboard, along with an inner liner and an outside label. These five plies are held together by a water-soluble glue. After the five plies are joined, an in-line process cuts the tube (cans) to a pre-determined length and the tube continues to flow, uninterrupted, down the production line. Depending on the inner liner used, which is dictated by customer specifications, a lubricant is applied (mineral spirits or mineral oil) to release the liner from the winding and/or cutting mandrel. The cans are then automatically seamed, placing a metal top with a plastic spout on the composite can. These are then packed in corrugated cartons for shipment to the customer. The metal tops mentioned above are produced in the St. Paris plant on punch presses in the stamping area. Operations evaluated during the NIOSH visits were the auto wax unit and several of the punch presses in the stamping area.

Depending on customer specifications, some of the composite cans are manufactured with an inner wax coating. An application of wax is sprayed by the auto wax unit into the back, or open end of the composite can. This is done so that when Kardon Industry customers insert a closing device after the composite can is filled at their facility, air and moisture penetration is reduced. The composite cans are automatically fed from the production lines to the auto wax operation. Two duplex spray heads operate simultaneously, spraying wax into the open end of the composite cans. During our first visit, the wax was preheated with mineral oil in a drum and then hand carried in open buckets to two melt tanks (reservoir) on the auto wax machine. This process was modified before our second visit so that the wax was automatically pumped directly from the heated 55 gallon drum to the reservoir. This eliminated the need to hand transfer the wax from the drum to the reservoir.

IV. METHODS

July, 1988 Survey

During this survey, both personal breathing zone and area samples for acetaldehyde and formaldehyde were collected using solid sorbent tubes. The local exhaust ventilation used to control emissions from the waxing unit was qualitatively evaluated with the aid of smoke tubes. Private interviews were conducted with the potentially exposed employees to aid in the identification of any work-related health problems. NIOSH was also requested to inspect the stamping area because of employee concerns about potential exposures to oil mists.

Supelco Custom Jumbo ORBO* solid sorbent tubes were used to sample for both acetaldehyde and formaldehyde. In addition, formaldehyde was also collected using Supelco ORBO-22* solid sorbent tubes. These tubes were attached via flexible tubing to personal sampling pumps calibrated at a flowrate of 50 milliliters of air per minute (ml/min). The Jumbo ORBO tubes were desorbed separately for 1 hour in a sonic bath with 5 milliliters (ml) of toluene. The extracts were then analyzed by a gas chromatograph (GC) equipped with a Nitrogen Phosphorous Detector (NPD). The ORBO-22 tubes were desorbed separately for 1 hour in a sonic bath with 2 ml of isooctane. These extracts were then analyzed by a gas chromatograph equipped with a Flame Ionization Detector (FID) according to NIOSH Method 2502.[1]

February, 1989 Survey

During this visit, general area air samples for formaldehyde and hydrocarbons (hydrocarbon "screen") were collected. The formaldehyde samples were collected using sodium bisulfite solution in miniature impingers and activated charcoal tubes, respectively. The hydrocarbon screen was conducted to identify any volatile organics, besides formaldehyde, that might be released during the waxing process. Personal breathing zone and area air samples for naphthas (an ingredient of the lubricating oil) were also collected using charcoal tubes in the stamping area.

The formaldehyde samples were collected using 20 ml of 1% sodium bilsulfite solution in miniature impingers. These impingers were attached via flexible tubing to personal sampling pumps calibrated at a flowrate of 1.0 liter of air per minute (lpm). These samples were analyzed by taking a 4 ml aliquot of the solution and developing color by adding 0.1 ml of 1% chromotropic acid and 6 ml of concentrated sulfuric acid. They were then analyzed for formaldehyde using visible spectroscopy according to NIOSH Method 3500.[1]

The samples for both the naphthas and the hydrocarbons were collected with standard 150 mg charcoal tubes attached via flexible tubing to personal sampling pumps calibrated at a flowrate of 200 ml/min. Two samples (used to qualitatively identify the hydrocarbons present) were also collected on charcoal tubes. The sampling pumps used for these two samples were calibrated at a flowrate of 700 ml/min. All the charcoal tubes were desorbed in 1 ml of carbon disulfide. The samples for naphthas also had 1 microliter of hexane added as an internal standard. The two high-volume samples for hydrocarbon identification were then analyzed using gas chromatography/mass spectroscopy (GC/MS) to qualitatively identify any compounds that were present. The remaining tubes were analyzed by GC/FID to quantitate the compounds detected by GC/MS. The samples for the naphthas were also analyzed by GC/FID for the constituents found via analysis of a bulk sample of the cutting oil.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 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 Recommended Exposure Limits (RELs)[2], 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs)[3], and 3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs)[4]. Often the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA PELs. Both NIOSH RELs and ACGIH TLVs are usually based on more recent information than are the OSHA PELs. The OSHA PELs also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH 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 the lowest standard was used; however, industry is legally required to meet those levels specified by the 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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

A. ALDEHYDES

Aldehydes are aliphatic or aromatic organic compounds which contain the carboxyl group, C=O. They are used primarily as chemical feedstocks because of their relatively high reactivity. They are volatile, colorless liquids except for formaldehyde which is a gas. Typically, aldehydes are strongly irritating to the skin, eyes and respiratory tract. Acute exposure may cause pulmonary effects such as edema, bronchitis and bronchopneumonia. Skin and pulmonary sensitization may develop in some individuals and result in contact dermatitis and, more rarely asthmatic attacks. After hypersensitivity develops, individuals may develop symptoms due to other aldehydes.[5]

B. FORMALDEHYDE

Symptoms of exposure to low concentrations of formaldehyde include irritation of the eyes, throat, and nose; headaches; nausea; congestion; asthma; and skin rashes. It is difficult to ascribe particular health effects to specific concentrations of formaldehyde to which people are exposed, because of variability in subjective responses and complaints. Irritation may occur in people exposed to formaldehyde at concentrations as low as 0.1 ppm, but more frequently in exposures of 1.0 ppm and greater. Some sensitive children or elderly, those with preexisting allergies or respiratory diseases, and persons who have become sensitized from prior exposure may have symptoms from exposure to concentrations of formaldehyde between 0.05 and 0.10 ppm. Formaldehyde-induced asthma and bronchial hyperreactivity developed specifically to formaldehyde are uncommon.[6]

Formaldehyde vapor has been found to cause a rare form of nasal cancer in Fischer 344 rats exposed to a 15 ppm concentration for 6 hours per day, 5 days per week, for 24 months. Whether these results can be extrapolated to human exposure is the subject of considerable speculation in the scientific literature. Conclusions cannot be drawn with sufficient confidence from published mortality studies of occupationally exposed adults as to whether or not formaldehyde is a carcinogen. Studies of long term human occupational exposure to formaldehyde have not detected an increase in nasal cancer. Nevertheless, the animal results have prompted NIOSH to recommend that formaldehyde be considered a potential occupational carcinogen and that workplace exposures be reduced to the lowest feasible limit.[7] OSHA has recently reduced its PEL for formaldehyde to 1.0 ppm.[8] In addition, a 15-minute short term exposure limit (STEL) was set at 2 ppm. ACGIH has given formaldehyde an A2 designation, indicating that ACGIH considers formaldehyde a suspected human carcinogen. The ACGIH-TLV for formaldehyde is 1 ppm as an 8-hour TWA and 2 ppm as a 15-minute STEL.[3,5] Formaldehyde is currently listed in the 1989-90 ACGIH "Notice of Intended Changes" at a proposed ceiling TWA-A2 value of 0.3 ppm. If, after two years no evidence comes to light that questions the appropriateness of the proposed change, the value will be reconsidered for adoption into the TLV listing.

C. NAPHTHAS

Effects of exposure to these solvents are primarily acute, unless significant amounts of substances shown to be chronically toxic are present, such as benzene or glycol ethers. Epidemiologic studies have shown that exposure to similar refined petroleum solvents (mineral spirits, Stoddard solvent) can cause dry throat, burning or tearing of the eyes, mild headaches, dizziness, respiratory irritation, and dermatitis.[9] (The manufacturer reported these potential effects, including the possibility of sensitization in some individuals, in the material safety data sheet (MSDS) for this solvent. The manufacturer also recommends that care should be taken to avoid eye contact or inhalation from excessive misting.)

Since naphthas are mixtures, the evaluation criteria are based upon its major components (petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, and stoddard solvents). The NIOSH REL for this mixture is 350 mg/m^3 TWA exposure for up to a 10-hour work shift, 40-hour workweek. In addition, a ceiling concentration limit (15 minutes duration) of 1800 mg/m^3 is identified. However, the REL for airborne concentrations of mixtures containing kerosene is 100 mg/m^3.

VI. RESULTS

July 1988 Survey

Six employees who worked on or near the autowaxer were monitored for full-shift aldehyde and formaldehyde exposures. Five area locations were sampled in the same manner as the personal breathing zone samples. These locations were either on the autowaxer or in close proximity to it. All samples were analyzed as described previously; however, neither formaldehyde or acetaldehyde were detected. The limit of detection for the samples taken using the Jumbo ORBO tubes was 0.043 and 0.029 ppm for formaldehyde and acetaldehyde, respectively. The samples for formaldehyde that were collected using the ORBO-22 tubes had a 0.037 ppm limit of detectection.

The results of interviews with seven auto wax area employees were consistent with the health effects reported in the original health hazard evaluation (HETA 85-308-1829). These symptoms included headache, burning eyes, nose and throat irritation, dizziness, an altered taste sensation and nausea. Most of the employees associated their symptoms with the auto wax operation.

The results of the ventilation evaluation showed that there were instances when exposures to the wax emissions could occur and that there were still some design problems with the unit. Visible emissions could be seen evolving in the inspection area from the tubes that had just been waxed. These emissions were entering the breathing zone of the employees in this area. The ventilation system was not efficiently designed. The ducts contained many 90-degree bends and abrupt expansions and contractions. Also, many of the connections in the ducts were held together with masking tape. An axial fan was being used in the ventilation system. This type of fan cannot handle the static pressure drops associated with most local exhaust ventilation systems and is not appropriate for handling this type of air stream. Since this system exhausts emissions from heated wax, it is possible for wax to build up on the fan blades and adversely affect the efficiency of the system. The electrical power for the ventilation system was linked to the conveyor system. The ventilation system operated only while the conveyor system was activated. During typical operation, tubes frequently jam at some point in the autowaxer. When this happened, the conveyor was shut off until the jam could be cleared. Therefore, the ventilation system would not operate during these periods, and the potential for exposure was increased. Many employees mentioned that the conveyor has been started while they were either cleaning or clearing jams from the wax injection area. The ventilation system in this area includes an enclosure equipped with access doors. These doors lack an interlock switch which prevents operation of the the conveyor while the doors are open. This could lead to accidental injury if someone is working on the injector when the conveyor is started.

The methods used for wax handling and cleaning of equipment could also have allowed exposures to occur. The autowaxer has a reservoir of melted wax that supplies the injector. A worker fills the reservoir by dipping a can into a barrel of melted wax and then transferring it to the reservoir. This barrel of melted wax was under a ventilation hood which limited the escape of vapor to the general work area, but pulled the vapor through the breathing zone of the employee who fills the reservoir. Wax build-up and leaks at the injection heads could also lead to potential exposures. The workers must clean the injection heads at certain times during operation. Many of the employees did not wear protective gloves while they cleaned this area. This could contribute to potential exposures from skin absorption and cause skin burns. Also, this procedure increased the possibility of being accidently caught in the machine when it is turned on unknowingly.

February 1989 Survey

This survey was conducted to characterize employee exposures during the winter (worst case) when the building is more insulated from the outside. Our original visit occurred during the summer when the building was better ventilated (windows and doors open). The formaldehyde samples for this survey were collected using sodium bisulfite solution in impingers. This method has a lower limit of detection than the one used in the previous survey. Also, during the time between the two surveys, many engineering controls recommended after the first survey had been implemented by the company. The most important, from the perspective of reducing employee exposures, was automating the transfer of heated wax from the storage barrel to the reservoir. The other changes had been made to address safety issues identified during the first survey.

Seven area air samples for formaldehyde were collected from locations on the autowax unit. Six area air samples were also collected for volatile organic compounds which may have been released from the process. Four personal breathing zone samples and one area air sample were collected in the stamping area to determine the extent of exposure to naphthas in the oil mist.

The results for these samples are listed in Table 1. The results for the seven general area formaldehyde samples ranged from 0.024 to 0.029 ppm. The hydrocarbon screen did not detect any volatile organics being released from the waxing process. The results of the four personal breathing zone samples for naphthas ranged from 30 to 33 mg/m^3 while the general area sample was 36 mg/m^3.

The results for the formaldehyde samples are all below the OSHA permissible exposure limit (PEL) of 1 ppm. NIOSH currently recommends that formaldehyde be treated as a potential human carcinogen and that exposures should be reduced to the lowest feasible level. This approach is taken because NIOSH is not aware of any data that describe a safe exposure concentration to a carcinogen.

The results for the naphtha samples were well below the evaluation criteria. Since naphthas are mixtures, the evaluation criteria is based upon its major components (petroleum ether, rubber solvent, varnish makers' and painters' naptha, mineral spirits, and Stoddard solvents). The NIOSH evaluation criteria for this mixture is 350 mg/m^3; however, the criteria is reduced to 100 mg/m^3 if the mixture contains kerosene. These samples were quantitated using toluene as a calibration reference for this naphtha mixture because a bulk sample of the lubricating oil used in the stamping area on the day of sampling was unavailable. (The analysis of a lubricating oil bulk sample, obtained after the environmental sampling was completed, did not chromatographically match the analysis of the air samples.) Therefore, these results are a best estimate, and the evaluation criteria of 100 mg/m^3 should be used since the presence of kerosene could not be ruled out.

VII. DISCUSSION AND CONCLUSIONS

Although employee symptoms are not readily explained by the documented exposures, emissions from the heated polypropylene wax still appear to offer the most likely explanation. It is possible that a combined effect from the low levels of airborne substances measured, or a contaminant not evaluated because it was not known to be potentially present, are contributing to the symptoms. Improvements already made to the local exhaust ventilation system and the auto wax unit have reduced the potential for work-related exposures. Further improvements, which are presented in Section VIII, should be beneficial.

Also, the environmental sampling results do not support the conclusion that the potential for employee exposure increases during the winter months.

VIII. RECOMMENDATIONS

1. Local ventilation, such as a slotted exhaust hood, should be installed at the inspection area, since visible emissions were seen in the inspector's breathing zone.

2. The current ventilation system contains many 90-degree bends and abrupt expansions and contractions. The use of fewer bends with tapered expansions and contractions would make the system more efficient.

3. An axial type fan is presently being used in the ventilation system. Thought should be given to replacing this fan with one which can handle greater static pressure drops, especially if additions are made to the present system. Centrifugal fans are more suited for greater pressure drops, as well as being more suited for the material being exhausted. A fan manufacturer or ventilation consultant would be qualified to recommend an appropriate fan. Also, thought should be given to consulting a ventilation expert whenever major changes are to be made to the ventilation system.

4. A preventative maintenance program for the ventilation system should be implemented. This should include inspection of the fan and ducts for wax build-up. Connections in the ducts should also be checked. Presently, masking tape is being used on the connections. This should be replaced with an appropriate type of tape, such as duct tape. The fan belts and motor should also be inspected on a regular basis to assure proper performance.

5. Wax build-up and leaking at the injection heads should be evaluated to determine if it is feasible to eliminate these problems. This situation could lead to burns and further exposures due to the need to keep these parts clean. Until this is done, the workers should use appropriate protective gloves (i.e. neoprene supported).

6. While the waxing unit is turned off for cleaning and maintenance, the ventilation should be operating to limit any possible exposures. Also, respiratory protection for the maintenance workers may need to be considered. If this alternative is needed, a respirator protection program should be set up according to the NIOSH respirator decision logic provided in the OSHA respiratory protection program (29 CFR 1910.134). These maintenance personnel should also wear protective gloves as discussed above in recommendation #5.

7. The oil mist created by machines in the stamping area should be controlled by installing a local exhaust ventilation system. The oil was identified as containing naphthas, which have been determined to cause irritation.[8]

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 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. Kardon Industries

2. United Paper Workers Union, Local 1467

3. United Paper Workers International Union

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 1
Personal Breathing-Zone and General Area
Air Concentrations of Formaldehyde and Naphthas
Kardon Industries, Inc.
St. Paris, Ohio
HETA 88-279
February 22, 1989

Sample Description	Contaminant	Sampling Time (minutes)	Concentration
Area above wax injector	Formaldehyde	397	0.027 ppm
On conveyor b/w injector and inspection area	"	377	0.024
Inspection area	"	387	0.027
Packaging area	"	372	0.024
On platform next to the injector	"	368	0.029
Over wax drum	"	371	0.029
Across aisle from the wax machine	"	357	0.027
On 2nd stamping machine	Naphthas	409	31 mg/m^3
Stamping machine operator*	"	408	31
Stamping machine operator*	"	403	33
Stamping machine operator*	"	404	36
Stamping machine operator*	"	398	30

* Personal Breathing-Zone Sample