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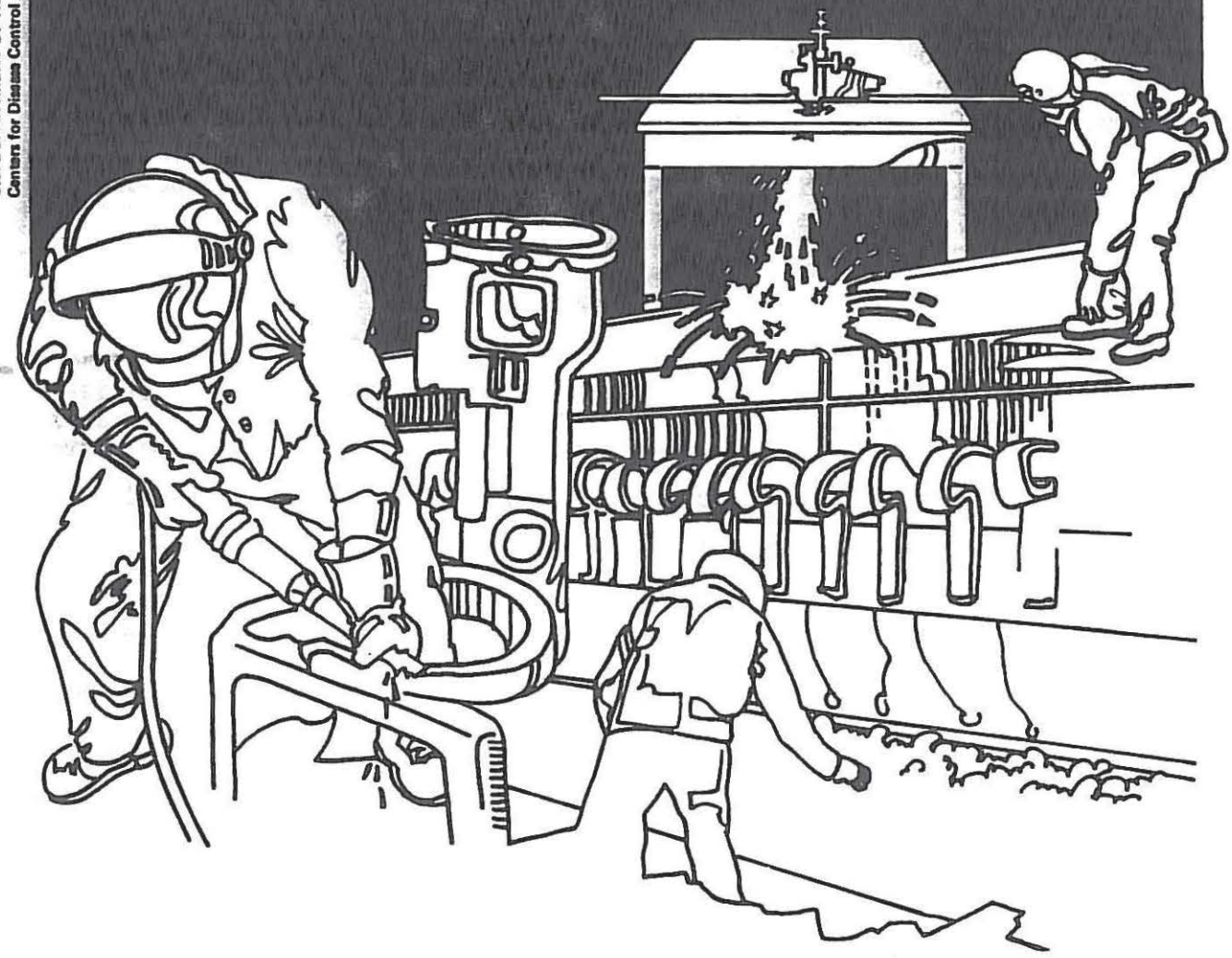

Health Hazard Evaluation Report

HETA 81-396-1118
KEEBLER COMPANY
CINCINNATI, OHIO

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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NIOSH INVESTIGATORS:
Cheryl Lucas IH
Gary Liss M.D.

I. SUMMARY

On July 27, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees at the Keebler Company Bakery, Cincinnati, Ohio. The requestor, reported that employees working on the A-1 Redi Serve Cracker Line were experiencing eye irritation. Employees at the plant also indicated that eye irritation was a problem in the bake area and expressed concern regarding the possibility of excess cancer deaths among employees in the plant.

On August 7, and September 29 and 30, 1981, NIOSH investigators conducted site visits. Personal and area air sampling for airborne contaminants, review of work practices and work conditions, medical interviews, limited physical examination, and a review of death certificates were performed.

Air samples were collected for dimethylpolysiloxane (DMPS), aldehydes, alcohols, oxides of nitrogen (NO_x), carbon monoxide (CO), natural gas, and mercaptans. All personal and area air samples for DMPS were below the detection limit of the analytical method (N.D.). Personal and area air samples for aldehydes ranged between 0.09 and 3.20 milligrams per cubic meter of air (mg/m^3); formaldehyde ranged between (0.09 - 1.28 mg/m^3), acetaldehyde, (0.52 - 2.34 mg/m^3); propionaldehyde, (N.D.); n-butyraldehyde, (N.D.); and n-valeraldehyde, (N.D.). Acetaldehyde levels were well below the OSHA standard of 360 mg/m^3 TWA. Formaldehyde levels were below the OSHA standard, however, they were in excess of past levels associated with eye irritation.[13,19] NIOSH currently recommends that formaldehyde levels be controlled to the extent feasible, based on recent evidence on carcinogenicity.[12] All personal and area air samples for alcohols were (N.D.) with the exception of ethanol which ranged from 3.35 to 127 mg/m^3 well below the OSHA standard of 1900 mg/m^3, and two area methanol samples which were 1.7 and 2.0 mg/m^3 well below the NIOSH criteria and OSHA standard of 260 mg/m^3 TWA. Colorimetric detector tube measurements taken for acetaldehyde, NO_x, natural gas, CO, and mercaptans at various places in the oven area indicated relatively low levels. CO Ecolyer measurements showed levels ranging from 6 to 36 ppm. NIOSH recommends that CO exposures be controlled to a 10 hour (TWA) of 35 ppm or less.

The medical study showed a high prevalence of eye irritation throughout the plant at Keebler. In the A-1 Redi Serve area 20 of 30 (67%) workers reported symptoms of eye irritation. However, in only 7 of these 20 was this of onset after or worsened since starting on the new A-1 Redi Serve line. The prevalence of eye irritation symptoms reported by bake shop employes was higher (92%). These medical findings were consistent with the atmospheric formaldehyde levels, which were higher in the baking division. No conclusion can be drawn involving the cancer deaths at Keebler because the number of deaths is too small to support statistical analysis.

On the basis of the evaluation, a health hazard associated with eye irritation exists at Keebler, and environmental sampling results indicate that it is caused by atmospheric formaldehyde concentrations in the plant. Other substances which could contribute to the potential for irritation include DMPS, alcohols and other aldehydes, CO and general dust containing salt. CO levels measured beside the #4 oven were above the NIOSH recommended standard. Recommendations to minimize employee exposures are contained in Section VIII of this report.

KEYWORDS: SIC 2050 bakery, formaldehyde, carbon monoxide, Dimethylpolysiloxane, aldehydes, alcohols

II. INTRODUCTION/STATEMENT OF REQUEST

On July 27, 1981 the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the Keebler Company Bakery in Cincinnati, Ohio. The request, submitted by an authorized representative of the Bakery, Confectionery, and Tobacco Workers Union, Local 253, stated that employees working on the A-1 Redi Serve Cracker Line were experiencing eye irritation. Employees at the plant also indicated that eye irritation was a problem in the bakery area and expressed concern regarding the possibility of excess cancer deaths among employees in the plant.

Potentially toxic substances of concern include dimethylpolysiloxane (DMPS), C_2-C_5 alcohols, formaldehyde, C_2-C_5 aldehydes and carbon monoxide. "Exposed" personnel include employees in the Redi Serve Cracker Line machine and oven areas.

Interim survey results were submitted to the company and local union in a report dated November 1981.

III. BACKGROUND

A. Description of Process and Workforce

The Keebler Company in Cincinnati bakes crackers and cookies which are distributed and sold to consumers in various grocery stores throughout the country. The plant has been in operation since 1942, and presently employs a total of about 1000 workers covering 3 shifts.

Keebler Bakery is composed of two major divisions: baking and packing. Baking consist of 3 areas; mixing, where the dough is formed; machining, where the dough is shaped into the appropriate size; and ovening, where the product is baked. Packing consists of several different areas. Those covered during the survey (A-1 and #4 Redi Serve Cracker Lines) are discussed later in this section.

In mixing there are two major types of workers, those who transfer mixing tubs, both full of dough and empty, and mixer operators who operate the mixer controls. The tubs of dough spent several hours in a climate controlled room at approximately 80°F to allow for yeast fermentation before being transfered to machinery.

The dough shaping machines are automatic, requiring one machine operator for a control panel. The machine operator is also responsible for making hourly checks on the system, i.e. gauging the thickness of the dough.

There are 6 ovens in the oven area, and all are fueled by natural gas. Oven #1 is new (only about 1 year old), and slightly different than the older ovens. Its burners are enclosed for better efficiency, and it uses the circulation of hot air around the crackers to bake them. Older ovens rely on exposing the

cracker to radiant heat directly from the burner for baking. A typical oven requires 1 operator, 1 inspection person, and a few trouble shooters. The operators spend most of their time at the discharge end of the oven operating the control panel. Remaining time is spent making periodic checks on oven operation by walking the oven line. Inspection personnel are responsible for picking broken crackers off the conveyor belt at the discharge end of the oven. Trouble shooters are located about 100-200 feet down stream from the inspector, and are responsible for keeping crackers properly aligned on the conveyer belt.

The packing section, where crackers are wrapped in various types of containers, receives all freshly baked crackers from the ovens. A-1 Redi Serve Cracker Line (receives crackers from oven #1) is composed of 4 machines which automatically feed crackers two at a time into a plastic lining, then cuts and heat seals them into individual 2 cracker packages. The cutting and heat sealing is done by a piece of metal called a crimper at about 300°F. Dimethylpolysiloxane oil is automatically dropped onto the crimper at a rate of 3 drops every 5 minutes to keep the plastic from sticking to the crimper. A-1 Redi Serve has been in operation since the beginning of June 1981 and packages, on the average, 2200 boxes each containing about 500 two-cracker packages per day. The workforce in Redi Serve consists of around 10 people, 2 machine operators, 4 packers, 1-2 boxmakers, and 2-3 nonclassified packers. The machine operators monitor the controls of all 4 packing machines. The relief (nonclassified) employees monitor the line of crackers being fed into the machine on the conveyer belt system. The boxmakers assemble small cardboard boxes and give them to the packers who manually transfer the two cracker packages from the machines into the box. Machine operators, packers, boxmakers and relief people alternate jobs spending about 2 hours at each.

Number 4 Redi Serve Cracker Line is very similar to A-1 except that the machines are much older and the dimethylpolsiloxane is applied manually to the crimper once or twice a day.

B. Environmental Controls

General ventilation supplied by the heating/air conditioning system is relied on to control airborne contaminants. The air conditioning and heating system consists of 13 air handing units with a total rated capacity of 594,100 CFM. The recirculation rate varies between 20 and 80 percent depending on the outside air temperature. Oven emissions are exhausted to the outside via stacks to the roof. Located on the roof are 7 fans which supply a total of 103,800 CFM makeup combustion air to the ovens, and 3 emergency exhaust fans capable of pulling a total of 54,000 CFM which are used, when accidental fires etc. contaminate oven area air. The area served by the ventilation system consists of 267,680 square feet.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

1. Sampling Decisions

Initially research was conducted in the form of a literature review and contact with Keebler's material suppliers to compare known effects of substances in use with the health effects described on the request. DMPS had been commonly associated with eye irritation, but there were no reports found in the literature on sampling airborne levels of DMPS. Since DMPS has a relatively high molecular weight, it seemed unlikely that appreciable airborne levels would exist at Keebler Company. However, because the DMPS was being subjected to 300°F temperatures, the possibility that it could be broken down into smaller lower molecular weight polymers increasing its volatility, was considered; therefore airborne sampling was conducted for DMPS. No sampling for the plastic pyrolysis products was conducted based on the fact that temperatures of 300°F are not sufficient to cause a breakdown of the plastic used to form the seal on the cracker packages. Based on information collected on the process at Keebler (ie. gas fueled ovens emissions, and yeast cracker fermentation by products such as alcohols which when subjected to oven heat are oxidized to aldehydes) and past health effects data, airborne sampling was conducted for aldehydes, alcohols, nitrogen oxides (NO_2, NO), carbon monoxide (CO), natural gas, and mercaptans.

2. Dimethylpolysiloxane

Two personal breathing zone and four area air samples for DMPS were collected. Half of the DMPS samples were collected using personal sampling pumps operating at 1.5 liters of air per minute (Lpm) on PVC filters with charcoal tube (CT) in line, so that DMPS vapor as well as mist would be captured. The other half of the DMPS air samples were collected using a PVC filter alone with pumps operating at 2.5 Lpm. The CT was omitted from the sampling train in order to decrease the pressure drop across the pump, so that the sampling rate could be increased, thus increasing the sensitivity of the method. CT's were desorbed with carbon disulfide (CS_2) and analyzed by gas chromotography (GC) equipped with a flame ionization detectors (FID) using a 25 meter methyl silicone fused silica capillary column (splitless mode). Filters were placed in 1,1,2-Trichloro- 1,2,2-trifluoroethane ($C_2CL_3F_3$) to dissolve the DMPS. After the filters were removed and the $C_2CL_3F_3$ solvent was evaporated, the resulting samples were dissolved in CS_2 and placed in a 1.0 mm NaCl cell where infrared absorbance was measured on a detector.

Eighteen wipe samples were taken on the face of exposed and nonexposed individuals for DMPS on Whatman filter paper tabs to address the possibility that employees were contaminating their eyes by hand-to-face contact. Dry filter tabs were wiped across face area surrounding the eyes. Analysis was done in the same manner as the PVC filters.

3. Aldehydes

Six personal breathing zone and two area air samples for various aldehydes including formaldehyde, acetaldehyde, propionaldehyde, n-butylaldehydes, and n-valeraldehyde were collected in midget impingers containing 10 ml of a collecting solution using personal sampling pumps operating at 2.0 Lpm. Samples were analyzed by a GC equipped with a FID (NIOSH Method P & CAM 127) with the following modifications: a 6' x 1/4" glass 5% Igepal on 40/60 chromosorb T. column, oven conditions were 170°C isothermal, and helium was used as the carrier gas.

4. Alcohols

Two personal breathing zone and three area air samples for methanol were collected using silica gel tubes with personal sampling pumps operating at 0.05 Lpm. Methanol samples were desorbed in 1.7 ml. of deionized distilled water containing 1 ul/ml sec-butanol as an internal standard and analyzed by GC with a FID (NIOSH Method 5-59 with minor modifications). Modifications included:

Desorption process: 4 hours in 1.7 mL deionized distilled water containing 1 uL/mL sec-butanol as internal standard

Gas Chromatograph: Hewlett-Packard 5731 equipped with a flame ionization detector and accessories for capillary use

Column: 30 m x 0.31 mm I.D. fused silica capillary coated internally with 1.0 um DB-1

Oven conditions: 60°C isothermal

Other: Helium was used as the carrier gas in the split mode of operation with a split ratio of 1:20

Five personal breathing zone air samples for ethanol, propanol, butanol, and pentanol were collected on Charcoal tubes (CT's) using personal samples pumps operating at 0.05 Lpm. The samples were desorbed with CS_2 and analyzed by GC with a FID (NIOSH Method 5-59 with modifications). Modifications included:

The A and B tube sections of the samples were separately desorbed in 1 mL of carbon disulfide containing 1% n-hexanol as a desorbing aid and 1 uL/mL benzene as an internal standard.

The analysis of ethanol, 2-propanol, n-butanol and n-pentanol was performed using a Hewlett-Packard 5710A gas chromatograph equipped with a flame ionization detector. A 15' x 1/8" stainless steel column packed with 80/100 mesh Carbopack C/0.1% SP-1000 was used with the oven programmed from 110°C to 220°C at a rate of 16°C/minute.

N-propanol was analyzed using a Hewlett-Packard 5730A gas chromatograph equipped with a flame ionization detector. A 20' x 1/8" stainless steel column packed with 5% FFAP on 40/60 Chromosorb T was used with the oven temperature programmed from 90°C to 180°C at a rate of 32°C/minute.

5. Other Analysis

Colorimetric detector tube measurements were taken for nitrogen oxides, natural gas, carbon monoxide, and mercaptans at various places in the oven area.

6. Carbon Monoxide

Carbon monoxide (CO) levels were monitored all day with a CO Ecolyzer. During the morning the Ecolyzer was set up beside 1-A oven and during the afternoon it was situated beside #4 oven.

B. Medical

1. Eye Irritation

The NIOSH physician examined the eyes and interviewed two groups of employees: (1) essentially all current A-1 Redi Serve Line workers (on all three shifts), many of whom had previously worked on #4 Redi Serve Line prior to the opening of A-1 Redi Serve and (2) approximately one-half of the day-shift employees in the bake shop area where obvious eye irritation had been noted during the walk-through.

2. Cancer

To investigate the possibility of excess cancer deaths, names of deceased employees and approximate dates of death were obtained from (1) the union local president, (2) some Keebler employees being interviewed and (3) an examination of company personnel files that had been marked "deceased". In addition, the Health Benefits Fund and the Pension Fund of the Bakery, Confectionery and Tobacco Workers (in Kensington, Maryland) were contacted to determine the completeness and availability of their files on Keebler employee deaths. The Secretary-Treasurer of the Union local was confident that the mechanisms ensuring that the Funds received notice of all deaths were effective.

V. EVALUATION CRITERIA

Exposure criteria have been developed to evaluate workers' exposures to toxic substances in an occupational setting. Based on available human and animal studies, and industrial experience, these values represent levels to which it is believed that nearly all workers may be exposed for an 8 hour day, 40 hour workweek, throughout a working lifetime without adverse effects. The exposure criteria cited in this report are NIOSH recommended standards, American Conference of Governmental Industrial Hygienists' (ACGIH) threshold limits values (TLV's), and Occupational Safety and Health Administration Standards (OSHA) which are listed along with primary health effects in Table I.

Current Formaldehyde criteria shown in Table I were developed to protect workers against irritant effects. Formaldehyde may cause irritation to the mucous membranes of the respiratory tract and eyes, including tearing, blinking, rhinorrhea and throat irritation. Recent research published in the literature has associated conjunctivitis/ eye irritation with formaldehyde levels in the range of 0.1 ppm.[13,19]

Recently, on-going studies by Chemical Industry Institute of Technology and New York University have shown that formaldehyde induced a rare form of nasal cancer in rats and mice. Based on these animal studies NIOSH recommends that formaldehyde be handled in the workplace as a potential carcinogen. Since safe levels of carcinogens have not been demonstrated it is recommended that occupational exposures be reduced to the lowest feasible level, assuming that the probability of developing cancer should be reduced by decreasing exposure.[12]

VI. RESULTS

A. Environmental

1. Dimethylpolysiloxane

All personal and area air samples for DMPS were below the detection limit of the analytical method (see Table II). Since observations of employees in the A-1 Redi Serve Line indicated that their hands were contaminated with DMPS, it seemed likely that some DMPS would be transferred to the worker face during the day. However, no DMPS was detected on any face wipe samples collected during the survey day. It is possible that these samples are biased, since employees were told the day before that the wipe samples would be collected, so that they would not wear makeup which might have contaminated the wipe samples. This knowledge could have made them more aware of contaminating their eyes with hand contact, and therefore cause them to be more careful than usual.

2. Aldehydes

Personal and area samples for aldehydes ranged between 0.09 and 3.20 mg/m^3 (see Table III). The breakdown on each type of aldehydes is as follows: Formaldehyde, 0.09-1.28 mg/m^3; Acetaldehyde, below the detectable limit of the method (N.D.) 2.34 mg/m^3; Propionaldehyde, (N.D.)-1.04 mg/m^3; n-Butyraldehydn, N.D. and; n-Valeraldehyde, N.D. NIOSH currently recommends that formaldehyde exposure be controlled to the extent feasible, based on recent evidence of carcinogenicity. Formaldehyde exposure were below the OSHA standard of 4.5mg/m^3 time weighted average (TWA) 7.5 mg/m^3 15 minute ceiling limit, and 15 mg/m^3 peak exposure limit. However the OSHA standard was established before the recent evidence on carcinogenicity was published. Since aldehyde exposures are time weighted averages, it is possible that higher short term exposures exceeding ceiling and peak limits did occur at some time during the sample day. All acetaldehyde exposures were well below the ACGIH TLV of 180 mg/m^3 and the OSHA standard of 360 mg/m^3. Since formaldehyde is the most irritating of the aldehydes, it should be given greater attention. Generally, formaldehyde exposures measured on the machine operators were higher than those measured on the oven operators which would be expected, since machine operators are located on the receiving end of the oven where craker dough is first exposed to this oven heat causing the alcohols liberated from the yeast fermentation to form aldehydes. Also as expected, samples collected around the older #4 oven in general resulted in higher level than those taken around the new enclosed #A-1 oven. The #A-1 Redi Serve packer exposure measured was much lower than the old Redi Serve packer. This is easily explained by the fact that A-1 Redi Serve is located in a separate room from the machine and oven area, whereas the old Redi Serve is located in the same room, relatively close to the ovens. Since eye irritation from formaldehyde has been documented at levels as low as 0.15 mg/m^3, it appears that formaldehyde levels measured at Keebler are high enough to produce eye irritation.

3. Alcohols

Personal and area samples for alcohols are shown in Table IV. Two area samples for methanol on the receiving end of oven #4 and 1A in the machining area showed levels of 1.7 and 2.0 mg/m^3 which are well below the NIOSH recommended criteria and OSHA standard both 260 mg/m^3 TWA. Ethanol exposures ranged from 3.4-127 mg/m^3 all well below the OSHA standards of 1900 mg/m^3 TWA. All other alcohol exposures measured were below the detection limit of the analytical method.

4. Other Measurements

Colorimetric detector tube measurements taken for acetaldehyde, No_2, NO, natural gas, CO, and mercaptans at various places in the oven area, indicated zero to trace levels of contaminants except the CO and acetaldehyde samples, which showed levels of 10 ppm, and 50 ppm respectively. However, it should be kept in mind that the acetaldehyde tubes will react with any easily oxidizable material. Therefore, the readings from this tube are indicative of total aldehydes and total alcohols.

5. Carbon Monoxide

Graph I shows the carbon monoxide (CO) levels with respect to time beside oven #1. Levels range between 6 and 10 ppm during the morning of September 30, 1981. Graph II shows carbon monoxide (CO) levels beside oven #4 during the afternoon of September 30, 1981. The levels ranged between 5 and 36 ppm, of which exceeded the current NIOSH recommended standard of 35 ppm (10 hour TWA) for 1 1/2 hours between 1:00pm and 2:30pm. The time taken for the CO level recorded to climb from 5 ppm to 36 ppm (see graph II) is due to ecoholizer stablization, therefore, it is assumed that 36 ppm level is consistant throughout a typical day provided that oven #4 is in operation. Notice the extreme drop in CO concentrations at about 2:30pm. This can be directly attributed to the shut down of old #4 oven indicating that the inefficiency of this oven could be a major source of contamination in the area.

B. Medical

1. A-1 Redi Serve Area

Of the 30 Redi Serve Area employees interviewed, 20 (67%) reported symptoms of eye irritation. Of these, 6 claimed onset only after coming to the line, one of whom was only bothered during the first two weeks of operation, possibly associated with excess DMPS being used then. Among the 6 there were 4 packers (who have the most intimate contact with DMPS), 1 machine operator and 1 nonclassified packer. Two of these had conjunctival redness on examination. The other 14 reporting eye irritation had onset prior to coming to Redi Serve. Only 1 of these claimed the symptoms were worse now.

In general, the eye symptoms were described as eye burning with some discharge and occasional redness occurring usually within 1/2 hour of coming to work and lasting most of the shift. Thus in summary, 7 of 30 (23%) of A-1 Redi Serve employees had eye irritation which began or worsened since starting on the line. In contrast, 14 of 30 or 47% reported irritation starting previous to coming to the line. At least 2 of the 7 with recent symptoms noted getting DMPS on their hands, and these 2 had redness of their eyes.

2. Bake-Shop Area

The reported symptom prevalence of the 13 bake shop employees interviewed is shown in Table V. 12 of 13 or 92% reported eye irritation, usually of immediate onset (i.e. within one-half hour of beginning work). Most remarked that it was worse between ovens 3 and 4. The one individual not reporting eye irritation reported nose irritation.

Two of the three NIOSH personnel reported definite eye irritation (burning and tearing); one had nose irritation.

Thus it appears that there may be a source of irritation in the Redi Serve area itself, possibly mediated through DMPS on hands applied to the eye area. However, (1) the greater prevalence of symptoms starting previously in Redi Serve, (2) the almost universal prevalence in the bake shop, and (3) the bake shop symptoms noted by NIOSH personnel suggest a cause of eye irritation in this area that may diffuse through much of the plant. Fourthly, the presence of environmental contaminants, in particular formaldehyde, was detected in the concentration range associated with conjunctivitis/ eye irritation. The bake area had the highest concentration. The concentration of formaldehyde associated with eye irritation published in the literature[11,13,19] of 0.1 ppm (0.15 mg/m^3) was exceeded in both personnel breathing zone and area environmental samples by up to an order of magnitude. The other substances, (e.g. alcohols and other aldehydes) plus the dust and salt (NaCl) present may have also contributed to the potential for irritation.

3. Death Certificates

A total of 53 death certificates were obtained, representing all on file with Pension Fund and those of the Health Benefits Fund back to 1970. Review of the death certificates revealed that 19 of the 53 deaths (35.8%) were associated with cancer. The primary sites (where specified) identified from the certificates are shown in Table VI. The most common type was lung cancer and this is seen in most cancer series. There were no more than 2 cases of any other type, and there were no unusually rare types.

The age range of all cancer deaths was 29-82 years (median 62 years), while for the seven cancer deaths in white males, the age range was 54-71 years (median 66 years). The latency period, aronlable for 18 of the 19 cancers ranged from 2-35 years (median 25 years, mean 22.6 years). The number of cancers is too small to support a statistical analysis. However, a potential carcinogenic exposure was identified in this workplace--formaldehyde. At Keebler, no nasal cancers were identified, the site at which cancers developed in rats in the Chemical Industry Institute of Toxicology (CIIT) study[14,15]. Formaldehyde and hydrogen chloride can combine in the

environment to form bis(chloromethyl)ether (BCME), a known lung and nasal carcinogen in rats[15]. HCl was sampled in the plant (by detector tube) but was not detectable at the time of the study. Moreover, employees in bakeries have other exposures including organic dusts.

Three NIOSH-supported studies provide background data on cancer among bakers[16-18]. A Washington state study examined 1,001 deaths among bakers during the period 1950-1971[16]. Statistically significant increased proportionate mortality ratios (PMRs) were observed for cancer of the buccal cavity and pharynx (PMR = 191) and the large intestine (PMR = 190). These findings were not replicated in a similar analysis of California decedents in the period 1959-1961[17]. In this study, cancer of the stomach (PMR = 170) was disproportionately higher among decedents employed as bakers. A feasibility study conducted in the San Francisco Bay area[18] examined the cancer experience of 1,164 bakers (982 males, 182 females). Standardized incidence ratios (SIR) were computed for the cancer experience of the cohort during the period 1972 to 1977. Male and female bakers experienced less overall cancer than the population of the Bay area but an excess SIR was observed for primary cancer of the buccal cavity (SIR = 269) in males. No cases of buccal cavity cancer were observed in females. In summary, while there is some preliminary suggestion in the medical literature of carcinogenicity related to bakers and the baking industry, the findings have been neither consistent nor been confirmed in a definitive epidemiologic study. As mentioned above, there are not sufficient numbers of deaths available to draw conclusions concerning excess cancer at Keebler.

VII. CONCLUSION

All environmental contaminants measured at Keebler were well below current evaluation criteria, or not detected using current sampling and analytical methods, except carbon monoxide and formaldehyde. Medical results indicated that a problem did exist at Keebler involving eye irritation, but were not conclusive concerning the cancer death question. The high carbon monoxide levels can be directly associated with the open burning of #4 oven, formaldehyde levels were also generally higher around the #4 oven; therefore when the oven is taken out of service, contaminant levels should be reduced.

The fact that formaldehyde levels measured in the baking division are in excess of those previously associated with eye irritation in the literature,[11,12] and that the highest formaldehyde levels were measured in the baking division, supports the results of the medical interviews which indicates that the eye irritation is more prevalent in the baking division than in the packing division. Both environmental and medical data lead to NIOSH's conclusion that formaldehyde does exist at excessive levels at Keebler, and is most likely the major cause of employee eye irritation.

It is possibile that eye irritation in the packing division is caused partially by DMPS contaminated hand eye contact. Face wipe samples taken for DMPS indicate that this did not occur on the survey day, but does not rule out hand eye contamination having occurred in the past.

VIII. RECOMMENDATIONS

Since NIOSH recommends that formaldehyde levels be controlled to as low as possible and formaldehyde levels perhaps in combination with other substances appear to be causing employee eye irritation at Keebler, the following recommendations are made.

1. Since the old #4 oven appears to be causing the majority of the inside air contamination, NIOSH supports Keebler's intentions of taking it out of service.

2. Environmental monitoring for formaldehyde should be conducted after the #4 oven is retired and periodically thereafter. Based on these subsequent formaldehyde sampling results, a decision can be made concerning how to further reduce atmospheric formaldehyde levels, if necessary.

3. Employees should be educated on the potential for eye irritations from contact with DMPS and the importance of good personal hygiene practices.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Cheryl Lucas
Industrial Hygienist
Industrial Hygiene Section

Gary M. Liss, M.D.
Medical Section

Originating Office:

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By:

Betty L. Widener
Clerk-Typist
Industrial Hygiene Section

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 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. Keebler Company
2. Bakery, Confectionery, & Tobacco Workers Union Local 253
3. NIOSH, Region V
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

Evaluation Criteria and Toxicology
Keebler Company
Cincinnati, Ohio
HETA 81-396

SUBSTANCE	PRIMARY HEALTH EFFECTS	RECOMMENDED CRITERIA	REFERENCE SOURCE	OSHA(1) STANDARD
DMPS	Relatively nontoxic; mild eye irritation	--	--	--
Formaldehyde	Severe irritation to eyes and respiratory tract; carcinogen	***	NIOSH	4.5 mg/m^3 7.5 mg/m^3** 15 mg/m^3*
Acetaldehyde	Irritation to eyes and respiratory tract	180 mg/m^3	ACGIH	360 mg/m^3
Propionaldehyde	Irritation to eyes and respiratory tract	--	--	500 mg/m^3
n-butyl aldehyde	Irritation to eyes and respiratory tract	--	--	--
n-valeraldehyde	Irritation to eyes and respiratory tract	50	ACGIH	--
Methanol	Headaches; nausea; loss of consciousness liver and kidney damage; optic nerve damage	260 mg/m^3 1040 mg/m^3**	NIOSH	260 mg/m^3
Ethanol	" " " "	--	--	1900 mg/m^3
Propanol	Mild eye and upper respiratory irritation; CNS depression drowsiness; headache; incoordination	--	--	500 mg/m^3
Butanol	"" "" ""	--	--	300 mg/m^3
Pentanol	"" "" ""	--	--	--
Nitrogen Oxides	Cough; mucoid frothy sputum; dyspmea;chest pain; pulmonary edema; eye irritation	1.8 mg/m^3**	NIOSH	9 mg/m^3
Carbon Monoxide	Headaches; nausea; weakness; dizziness; confusion; loss of consciousness	35ppm 200ppm	NIOSH	50ppm
Natural Gas	Simple asphyxiant	--	--	--
Mercaptans	Irritation to eyes, upper respiratory tract, and skin; headaches; dizziness; nausea; vomiting; central nervous system depression	10ppm	ACGIH	10ppm

* - indicates a peak exposure limit
** - indicate 15 minute ceiling limits, all other criteria are time weighted averages (TWA).
*** - NIOSH recommends that formaldehyde exposures be controlled to as low as feasibly possible, based on recent evidence of carcinogenicity.
-- indicates that no criteria exists.
mg/m^3 - indicates milligrams of contaminant per cubic meter of air.
ppm - indicates part of contaminant per million parts of air.

TABLE II

Personal and Area Air Samples for Dimethyl-polysiloxanes
Keebler Company
Cincinnati, Ohio
HETA 81-396

JOB/LOCATION	SAMPLE TIMES	*PERSONAL SAMPLES DIMETHYL-POLYSILOXANES
Packer/A-1 Redi Serve Line	7:45a-2:50p	ND
Machine operator/A-1 Redi Serve Line	7:18a-3:00p	ND*
	Area Samples	
Old Redi Serve Line	7:18a-3:00p	ND
" "	" "	ND*
A-1 Redi Serve Line/Above #2 Crimper	6:55a-2:58p	ND
" "	" "	ND*

* - indicates that sampling was conducted with a charcoal tube and PVC filter, all other samples were taken on PVC filters alone.
ND - Not detected.

TABLE III

Personal and Area Air Samples for Aldehydes
Keebler Company
HETA 81-396

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	FORMALDEHYDE (mg/m^3)	ACETALDEHYDE (mg/m^3)	PROPIONALDEHYDE (mg/m^3)	n-BUTYR ALDEHYDE (mg/m^3)	n-VALERALDEHYDE (mg/m^3)	TOTAL ALDEHYDES (mg/m^3)
Packer/old redi serve line	7:15a-2:55p	0.16	1.30	0.43	ND	ND	1.89
Machine operator/ #4 oven	8:50a-2:40p	1.08	1.74	ND	ND	ND	2.82
Oven operator/ #4 oven	8:20a-2:45p	0.34	2.34	0.52	ND	ND	3.20
Machine operator/ #A1 oven	8:10a-2:35p	0.78	0.52	ND	ND	ND	1.30
Oven operator/ #A1 oven	8:00a-2:25p	0.16	1.30	1.04	ND	ND	2.50
Packer/A-1 Redi Serve Line	7:30a-2:54p	0.09	ND	ND	ND	ND	0.09
AREA SAMPLES							
Between oven #3 and #4, column 32	9:00a-2:45p	1.28	0.58	ND	ND	ND	1.86
Between oven #A1 and #2, column 30	8:45a-3:16p	0.25	1.28	1.02	ND	ND	2.55
NIOSH recommended criteria		***	--	--	--	--	--
OSHA standard		4.5	360	--	--	--	--
		7.5**	180	--	--	--	--
		15*					

* - indicates peak exposure limit
** - 15 minute ceiling limit.
*** - Based on recent evidence of carcinogenicity, NIOSH recommends that formaldehyde exposure be controlled to as low as feasibly possible.
ND - Not detected.

TABLE IV

Personal and Area Air Samples for Alcohols
Keebler Company
HETA 81-396

PERSONAL SAMPLES

JOB/LOCATION	SAMPLE TIME	METHANOL (mg/m^3)	ETHANOL (mg/m^3)	PROPANOLE (mg/m^3)	n-BUTANOL (mg/m^3)	n-PENTANOL (mg/m^3)
#1A oven operator	8:00a-3:00p	--	7.2	ND	ND	ND
#1A oven machine operator	8:10a-3:00p	--	127.0	ND	ND	ND
#4 oven operator	8:00a-3:00p	--	25.7	ND	ND	ND
Packer/old Redi Serve Line	7:30a-3:00p	ND	7.3	ND	ND	ND
Packer/A-1 Redi Serve Line	7:40a-2:55p	ND	3.4	ND	ND	ND
AREA SAMPLE						
#4 oven machine area	8:25a-4:25p	1.65	--	--	--	--
#1A oven machine area	8:15a-3:15p	2.0	--	--	--	--
#2A oven control panel	8:05a-3:00p	ND	--	--	--	--
NIOSH recommended criteria		260/1040*	--	--	--	--
OSHA Standard		260	1900	500	300	--
ACGIH TLV		--	--	--	150	--

* - 15 minute ceiling limit, all other criteria are time weighted averages TWA's.
- no sample taken
ND - Not detected.

TABLE V
Keebler Company
Cincinnati, Ohio
HETA 81-396

Reported Symptom Prevalence in 13 Bake Shop Employees

Eye irritation	12 (92%)
Headache	5 (38%)
Nose irritation	3 (23%)
Lightheadedness	1 (8%)
Paraesthesia	1 (8%)

TABLE VI

Cancers Identified from Death Certificates, by Primary Site
Keebler Company
Cincinnati, Ohio
HETA 81-396

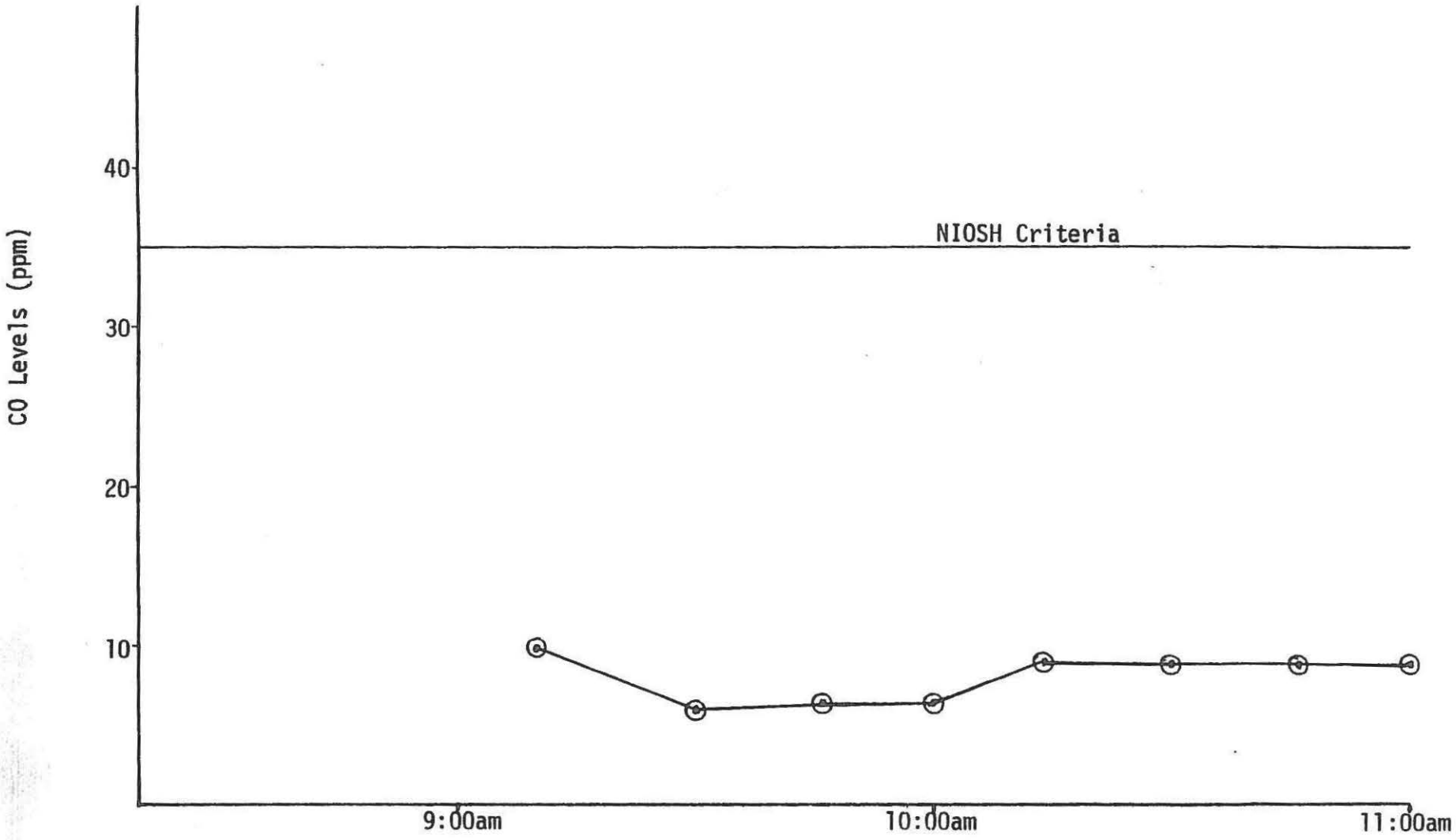
Lung	5
Lymphoma	2*
Stomach	2
Prostate	2
Kidney	2
Breast	2
Brain	1
Larynx	1
Gall bladder	1
Metastatic	1
Total	19

* 1 histiocytic lymphoma, 1 chronic lymphocytic leukemia

GRAPH I
CARBON MONOXIDE LEVELS
OVEN 1, COLUMN 32

KEEBLER COMPANY
CINCINNATI, OHIO
HETA 81-396

OCTOBER 30, 1981



GRAPH II
CARBON MONOXIDE LEVELS
OVEN 4, COLUMN 32

KEEBLER COMPANY
CINCINNATI, OHIO
HETA 81-396

OCTOBER 30, 1981