U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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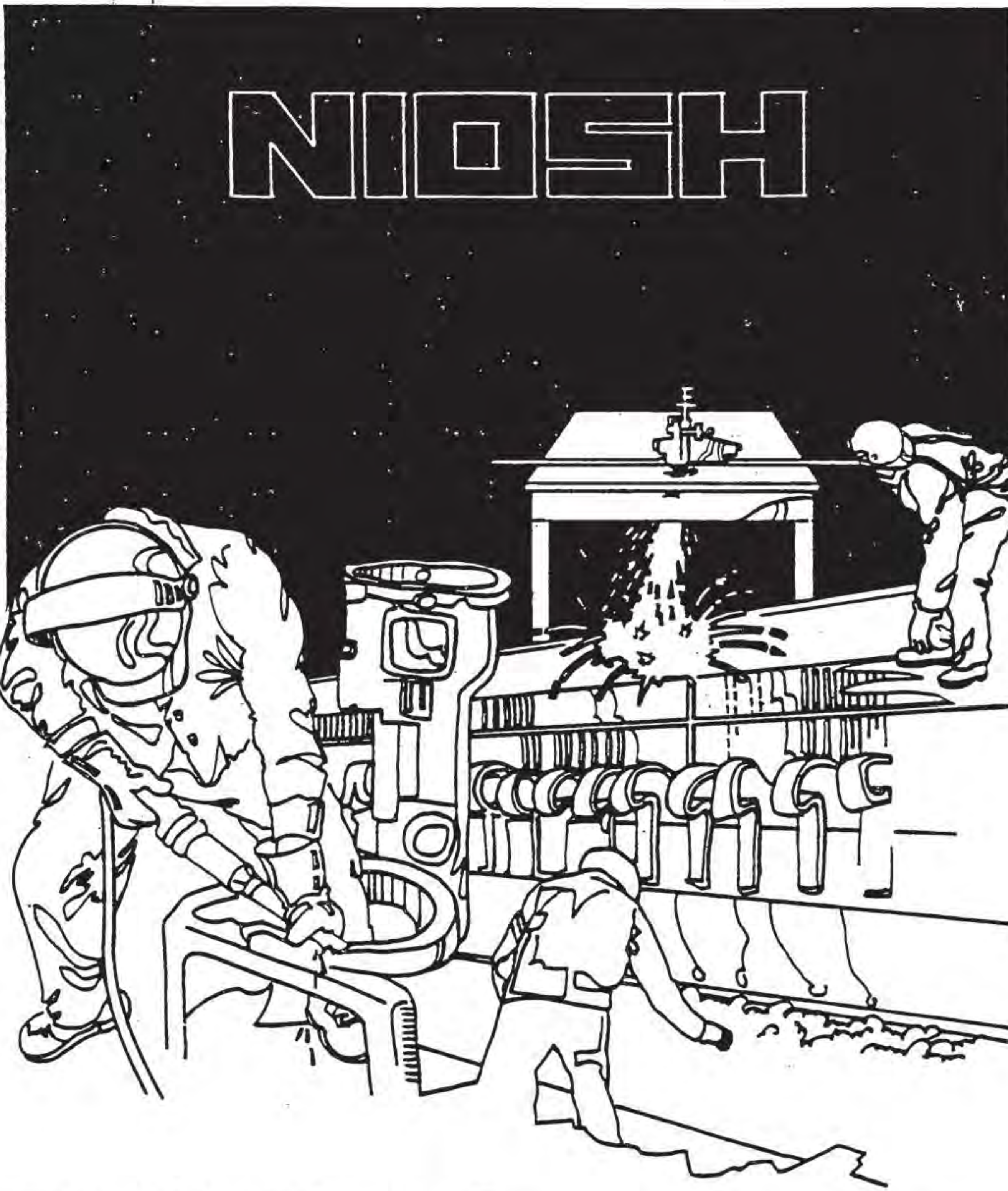

Health Hazard Evaluation Report

HETA 84-379
HETA 84-495-1687
METAL CONTAINER CORPORATION
COLUMBUS, 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.

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

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METAL CONTAINER CORPORATION
COLUMBUS, OHIO

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I. SUMMARY

In the summer of 1984 the National Institute for Occupational Safety and Health (NIOSH) initiated two health hazard evaluation (HHE) requests at Metal Container Corporation, Columbus, Ohio in the Automatic Banding Area (HETA 84-379) and Printer-Oven (deco) Area (HETA 84-495), respectively. These evaluations were in response to employee health complaints related to exposures to smoke, fumes, and/or chemicals.

Six air samples for formaldehyde were collected in the area of the printer and drying ovens. Measured formaldehyde concentrations ranged from 0.05 to 0.17 milligrams per cubic meter of air (mg/m^3) time-weighted average (TWA). NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen and that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. The current Occupational Safety and Health Administration (OSHA) standard is 3.7 mg/m^3.

The FECO ovens seem to be the major potential source of volatile organic compound (VOC) emissions in the plant. At the time of the NIOSH ventilation survey, two of these were found to be leaking smoke. One oven emitted smoke at the transition point between the curing and cooling sections because the local exhaust hood for controlling this source was not in place. The other oven leaked at a point where a moving mechanical part protruded.

Among Printer-Oven employees (33-34), reported mucous membrane symptoms were the most prevalent, with a range of 6-52% among those questioned in March and 15-53% in June 1985. The prevalence of all symptoms was generally highest among the operators and lowest among the maintainers. An exception is skin problems, which were reported to be highest among adjusters. In March 6%, and in June 15%, of the printer-oven employees complained of the "smoke, fume, odors from the bander," while 70% in March, and 67% in June, complained of "smoke, fume, odors from the ovens."

Like the printer-oven employees, automatic bander employees also reported a higher prevalence of symptoms of mucous membrane irritation, with a slight increase from March to June. Automatic Bander employees (11-12) complained more frequently (75% in March and 64% in June) of emissions from the ovens than from the Automatic Bander (67% in March and 54% in June).

Based on the environmental results, employee interviews, ventilation survey and available toxicological information, the NIOSH investigators concluded that a potential health hazard from formaldehyde and volatile organic compound exposure did exist at the time of this survey. Recommendations to aid in providing a safe and healthful working environment are presented in Section VIII of this report.

KEYWORDS: SIC 3411 (Metal Cans) formaldehyde, smoke, fumes, chemicals, ventilation.

II. INTRODUCTION

In June and August 1984, NIOSH received requests for health hazard evaluations at Metal Container Corporation, Columbus, Ohio in the automatic banding area (HETA 84-379) and printer-oven (deco) area (HETA 84-495). Both requests were in response to employee health complaints which they believed were related to exposures to smoke, fumes, and/or chemicals. A letter reporting results of the medical portion of the evaluation was distributed in September, 1985. A second letter reporting the results of the ventilation survey was distributed in November 1985, and a third letter reporting the findings from the formaldehyde survey was distributed in December 1985.

III. BACKGROUND

The Metal Container Corporation manufactures two-piece aluminum beverage containers at the rate of 4 million per day. A schematic process flow diagram appears in Figure 1.

The cans are formed from coiled aluminum sheet by the so-called draw and wall-iron method in which a "cup" is formed in a special press and forced through a redraw die and "3 wall ironing rings".[1] In this step the can is drawn to full length and thickness. The hemispherical shape of the bottom is also formed. After the tops of the cans are trimmed to obtain burr-free edges they are washed and treated (acid and alkali wash) in preparation for the application of inner and outer coatings. There are four washing/treating machines located on the upper deck. Cans from the washing operation are conveyed to one of four machines in which a water-based coating (called base coat) is applied from a system of rollers. As the cans leave the basecoat application rollers they are moved by a continuous "pin" conveyor, with each can being held on a 5-in. spindle or "pin" from the inside, to one of four "FECO" pin-ovens in which the basecoat (either white or clear during the visit) is cured.

The FECO ovens are divided into two sections. In the first section the basecoat is cured at 400°F in an indirect natural gas-fired curing section. Air (for both combustion and ventilation) is supplied to the curing section and exhausted to the outside through a 30-foot stack. The cans exit the curing section and enter the cooling section, where filtered ambient-temperature air is blown and exhausted to a stack. The FECO ovens were designed for negative pressure operation.

The basecoated cans exit the FECO oven through a chute and are conveyed to the decoration or "deco" machines where brand name and other information is printed. Inks of various colors are applied by a system of rollers in four deco machines, which have the capability of applying up to four colors simutaneously. The cans are then conveyed by pin conveyor to FECO ovens, where the ink is cured in the same fashion as the basecoat.

Following the ink cure, five machines on the first floor are used to apply an epoxy inner liner; the solution is sprayed from stationary nozzles. The cans are positioned by a rotating star-shaped wheel (turret). The spray from the nozzles is intermittent and is synchronized so that it occurs only when a can is in place. The cans are then conveyed to one of four curing ovens by one of four conveyors, each having horizontal and vertical runs. As in the case of FECO ovens, the inner spray "DESPATCH" curing ovens have two sections, one for curing and the other one for cooling. The cans exiting the DESPATCH oven are conveyed to a machine which forms a neck and a flange into the top portion where the end will be applied after the can is filled. After being tested for leaks, the cans are palletized and the pallets are strapped with 1/2 in. wide plastic film before shipping. The plant operates continuously with two 12-hour shifts per day. At maximum capacity, four "lines" may be in operation simultaneously, with each line producing 500,000 cans per shift.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Six air samples for formaldehyde were collected in the area of the printer and drying ovens located on the second floor of the Plant. Air was drawn through a midget impinger containing 20 milliliters (ml) of sodium bisulfite sampling solution at a flow rate of one liter/minute using a battery operated vacuum pump. Analysis for formaldehyde was by visible spectroscopy according to NIOSH Method 3500[2].

Air flow into the air supply (or make-up air) units was estimated by taking air velocity traverses using a Kurz hot wire anemometer. Gastech smoke tubes were used in estimating the efficiency of local exhaust devices and curing oven ventilation. In selcted areas, measurements of total hydrocarbons were made using a Photovac® Model "Tip" photoionization detector. At maximum sensitivity the instrument gave a reading of 185 parts per million (ppm) when it was exposed to a standard cylinder gas containing 50 ppm of isobutylether. Instrument readings taken in various areas of the plant did not reflect actual concentrations, but served to characterize relative differences.

During August, 1985, plant visits were made to evaluate the engineering controls in place to control emissions of volatile organic compound. The objectives of the evaluation were to:

- estimate the amount of fresh air being supplied by the general ventilation system

.determine whether the air distribution pattern effectively dilutes contaminants when they are emitted from sources described in an earlier section

.evaluate local exhaust systems incorporated into coating application machines, conveyors and cure ovens

.estimate the potential for the occurrence of adverse environmental conditions in the plant

Material In Use and Sources of Emission

As mentioned earlier there are a number of coatings in use at the Metal Container Corporation. A summary of the volatile constituents and total weight applied per can is given in Table 2. These values were reported in the Material Safety Data Sheets for the products.

In the can manufacturing process there are a number of potential sources of volatile organic compound (VOC) emissions. These are:

.Coating application machines for basecoat, ink, and inner spray

.Wet cans conveyed from coating application machines to cure ovens

.Cure ovens (when they leak)

B. Medical

In order to determine the frequency of health complaints in the two areas, a NIOSH interviewer conducted a telephone survey of employees in the printer-oven and automatic banding areas. Using a personnel list supplied by the company (and organized by crews A-D), the interviewer chose every other name in the job categories of interest until approximately half of the employees in each category of each crew had completed an interview. The job categories pertinent to the printer-oven and automatic banding areas were the following: maintainers, adjusters, operators, and quality assurance (Q.A.) technicians. In the automatic banding area, operators work on the palletizer, adjusters work on the bander, and Q.A. technicians work on the banders. In the printer-oven area, operators work on the ovens or washer, adjusters work on the printer-coater or the inside-spray machines, maintainers work on the printer-coaters, and Q.A. technicians work on the oven lines. Maintainers also may work in other parts of the plant, and Q.A. technicians also work in the laboratory. There are 28 positions in the automatic banding area (four crews of seven people). There are 68 positions in the printer-oven area (four crews of 17 people).

The interviewer called employees at home between July 8 and 19, 1985, and administered a short questionnaire designed to obtain information regarding job classification and the prevalence of acute symptoms. Employees were asked where they had been working in the past month, whether (during just the past month) they had "been bothered while at work" by any of 17 symptoms, and if so, how frequently. In addition, employees were asked if they had been bothered, in the past month, by "smoke, fumes, odors" from the bander or from the ovens. They were then asked about the same things (although the symptoms were read in a different order) "in March, before the new ventilation system was put in."

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 chemcial and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

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

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

A. Formaldehyde

Formaldehyde gas may cause severe irritation to the mucous membranes of the respiratory tract and eyes. The aqueous solution splashed in the eyes may cause eye burns. Urticaria (meaning) has been reported following inhalation of gas. Repeated exposure to formaldehyde may cause dermatitis either from irritation or allergy. Systemic intoxication is unlikely to occur since intense irritation of upper respiratory passages compels workers to leave areas of exposure. If workers do inhale high concentrations of formaldehyde, coughing, difficulty in breathing, and pulmonary edema may occur. Formaldehyde has induced a rare form of nasal cancer in two test animals species as reported in a study by the Chemical Industry Institute of Toxicology. Formaldehyde has also been shown to be a mutagen in several systems.[3,4]

In 1976, NIOSH recommended that occupational exposure to formaldehyde be limited to a concentration of 1 ppm for any 30 minute sampling period.[5] This recommendation however, was based solely on the irritant effects of formaldehyde. In 1979, evidence for the carcinogenic potential of formaldehyde became known, and in 1980 NIOSH issued a new criterion which considered formaldehyde as a potential occupational carcinogen and recommended that exposures be reduced to the lowest feasible level.[4]

ACGIH[6], in its notice of intended changes for 1983-84, has proposed that exposure to formaldehyde be limited to a ceiling level of 1 ppm (1.5 mg/m^3).

The current federal OSHA[7] standard for exposure to formaldehyde is an 8-hour TWA of 3 ppm (3.7 mg/m^3), a ceiling level of 5 ppm, and an acceptable maximum peak above the ceiling level of 10 ppm for no more than a total of 30 minutes during an 8-hour workshift. These criteria are based on the irritant effects of formaldehyde rather than its potential carcinogencity. OSHA is presently reevaluating its standard, given recent evidence regarding formaldehyde's respiratory and carcinogenic effects.

VI. RESULTS AND DISCUSSION

A. Environmental

Results of the six area air samples collected for formaldehyde are presented in Table I. Formaldehyde concentrations ranged from 0.05 to 0.17 mg/m^3 TWA. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen and that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. The current OSHA Standard is 3.7 mg/m^3.

The FECO ovens seem to be the major potential source of volatile organic compound (VOC) emissions in the plant. At the time of the NIOSH ventilation survey, two of these were found to be leaking smoke. One oven emitted smoke at the transition point between the curing and cooling sections because the local exhaust hood for controlling this source was not in place. The other oven leaked at a point where a moving mechanical part protruded.

B. General Ventilation System

Air is supplied through ductwork and grills to the production and other areas of the plant by 10 "make-up air units" (MAU's), located on the roof. During winter the air is filtered and tempered using natural gas. In the summer the air is filtered but not cooled. The air distribution system consists of ductwork and grills suspended at a height of about 10 feet from floor level, both on the first floor and the upper deck. Air is exhausted in part at ceiling level through roof ventilators, the balance exiting the building through openings such as the loading dock. This occurs because more air is supplied than is exhausted.

Company officials reported that about 447,000 cubic feet/minute (cfm) of fresh air is supplied, while 343,000 cfm is exhausted. About 231,000 cfm is exhausted from the building through the ventilators, 21,500 cfm is exhausted from process equipment (ovens, coating application machines, etc), and 93,000 cfm from spot ventilation of such operations as welding, grinding, etc.

During our visits, measurements of air flow into four of the make-up air units were made. These units supply air to grills in the oven and washer area on the upper deck. The results of the measurements were as follows:

MAU #	Air flow cfm
2	40,000
3	35,900
6	35,200
7	35,000

During the site visit, company officials revealed data on air flow measurements from the MAU's at the time the plant was started up. The flow from the MAU's was variable and fell in the range of 30,000 and 46,000 cfm. Based on the four measurements by NIOSH we estimate that the air supply rate is about 1.5 cfm per sq. ft of floor space when all the MAU's are in operation. This estimate is close to the 2.00 cfm per sq ft recommended by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for industrial ventilation (Ref. 8, P. 19.3) under heat loads between 100 and 125 Btu/hr - ft^2. It must be noted that heat sources on the upper deck (washers and ovens) may combine with heated outside air to produce uncomfortably warm temperatures for workers in winter.

On the basis of air supply, we estimate that the hourly air change rate is about four. At the time of the August 1985 visit there was evidence that the general ventilation system was not capable of diluting contaminants emitted in certain areas of the plant. Among these were emissions from a leaking FECO oven (the one closest to the northeastern wall of the plant). The emission occurred about 4 ft. below ceiling level. Accumulation of the smoke was alleviated by opening a fire door in the ceiling. This of course would not be possible in wet weather. Another area where dilution of contaminants is not achieved is at the feed end of the DESPATCH ovens. An upper respiratory irritant (presumed to be an ingredient in the inner spray) was strongly felt in that area by the NIOSH investigators. Measurements using the Photovac® indicated levels between 11-16 ppm (as isobutylether) in that vicinity. Even though workers are not routinely present in the area, those who perform maintenance tasks there have complained of the irritant effects.

Recently Goldfield (ref.9) reported on calculations and experiments to compare the effectiveness of local and general exhaust ventilation for dust control. His conclusions were that local exhaust is much more effective for control of contaminants as it produces orders of magnitude higher "air change rates" than general ventilation. Also, data taken in a large factory where dust is generated indicated that even when the general ventilation rate was increased nine-fold, the reduction in dust levels was only 50%.

C. Potential for Contamination of Supply Air

The oven exhaust stacks and the roof ventilators are located on the roof in the general vicinity of the MAUs. Some of the roof ventilators exhaust air through 30 foot stacks, while other exhaust the air at roof level. This latter situation could lead to reentrainment of exhausted air to an MAU. While performing the air flow measurements at one MAU, the NIOSH investigator was able to smell smoke issuing from an open fire door nearby.

1. Local Exhaust Systems

Local exhaust devices have been installed to control VOC from the following sources:

a. Points of coating application in machines used for this purpose.

b. Conveyors of cans from inside spray application machines to DESPATACH ovens.

c. Points where pin conveyors exit the curing section of FECO ovens and enter the cooling section for both basecoat and deco-type coatings.

d. Points where cans enter the DESPATCH ovens.

In machines where the basecoat or the deco ink is applied, a system of rollers is used to pick up liquid coating from a sump and apply it to the cans. Even though these are water-based coatings with a relatively low VOC content, the rollers and sump are enclosed and the enclosure ventilated. Testing with smoke tubes indicated that these ventilated enclosures were effective when their structural integrity was preserved. In some of the deco application machines, cardboard was substituted for the metal enclosure. VOC levels in the vicinity of a deco application machine were 0.5 - 1.3 (as isobutylether) ppm as indicated by the Photovac®.

Local exhaust systems at five inside spray application machines were evaluated using smoke tubes. Down draft hoods designed to control the spray aerosol are in place. Smoke tests showed the hoods to be working on all five machines. The odor level was low (as experienced by the investigators) in comparison to that at the feed end of the DESPATCH ovens. The Photovac® indicated levels between 1 and 4 ppm as isobutylether.

The can conveyors (elevators) from the inside spray machines to the DESPATCH ovens consist of two runs. One is horizontal and the other vertical to the upper deck. Certain sections of the enclosed conveyors, especially the vertical area, did not exhibit a negative pressure when tested with smoke. In some cases this was the result of not having some of the panels tightly shut. It is also suspected that the roof ventilator used to draw air from the enclosure is not capable of overcoming the pressure drop associated with the flow necessary to properly ventilate the elevator (Ref 8 p.19.4).

The cans with inside spray applied enter the DESPATCH oven through a wide perforated platform. The movement of the cans into the oven is facilitated by blowing air into the perforations. However, this also enhances the opportunity for the dispersion of irritants present in the inside spray in the immediate oven entrance area. The existing 6" x 48" canopy hood over the entrance of the oven is not capable of capturing the fumes generated over the platform. However, it may be useful in capturing smoke from the oven at the entrance point if a drop in the pressure differential occurs.

During the NIOSH visit the FECO and DESPATCH ovens were tested for negative pressure (with respect to the indoors) using smoke tubes. The technique was found non-invasive and more informative than taking velocity traverses of openings such as entrances and exits and transition points between curing and cooling sections. In most cases a negative pressure was indicated, except for the transition points of the FECO ovens and one oven which was leaking through the upper part where a bearing protrudes through the outer shell. At the transition points between curing and cooling, the FECO ovens have been fitted with local exhaust flanged circular hoods of unknown efficiency. At one oven where the hood was not in place, smoke was observed to be emitted at the point where the cans were exiting the curing section. It is speculated that the fast-moving cans induce a net airflow in the direction of their movement. This induced airflow apparently overcomes the inward airflow caused by the negative pressure, therefore liberating smoke at that point.

D. Medical

Questionnaires were completed with 53 employees. Eight of these were eliminated from the analysis because they were either crew chiefs who worked throughout both areas or operators who had worked approximately one-half of the time in each of the two areas during March and/or June.

Originally, we planned to compare the prevalence of employees' acute symptoms in June and March. We thought that if the new ventilation system (which became operational in late April) had improved environmental conditions in the printer-oven and automatic banding areas, employees would tend to report experiencing more symptoms in March than in June. As it turned out, however, many employees had rotated to different jobs between March and June. Therefore, the questionnaire responses were evaluated for March and June as if they were unpaired samples (that is, two independent time periods). For example, if an employee worked as an oven operator in June, his/her responses were counted in the "June printer-oven" category. If that same employee had worked as a palletizer operator in March, his/her responses were counted in the "March automatic banding" category.

The rotation patterns resulted in different numbers of employees in the various job categories for March and June. For example, 11 of the 45 employees worked in the automatic banding area in June, and 12 employees reported they had worked in the automatic banding area in March. The 12 for March included 3 palletizer operators, 2 adjusters, and 7 Q.A. technicians; the 11 for June included 4 palletizer operators and 7 Q.A technicians.

Tables 3 and 4 list the symptoms reported by printer-oven employees in March and June respectively, and Tables 5 and 6 list similar information for the automatic bander area employees. Only symptoms reported by employees as bothering them "most days" were counted as significant for listing in these tables.

Similar symptoms are grouped together in the tables. For examples, eye, nose, and throat irritation are grouped with stuffy nose, frequent sneezing, and sinus congestion as symptoms indicating upper respiratory (or mucous membrane) irritation. Difficulty breathing, shortness of breath, wheezing, and chest tightness are lower respiratory irritation (lung) symptoms. Coughing can be evidence of upper or lower respiratory irritation. Bloody mucus when blowing the nose can be considered a milder degree of nasal irritation than that resulting in actual nosebleeds. Headache and lightheadness can be evidence of central nervous system effects. Nausea and skin problems (rash, irritation, dryness, itching) are listed individually.

The tables reveal the following patterns of symptoms:

<u>Printer-oven Area</u>

1. Among printer-oven employees, mucous membrane symptoms were the most prevalent, with a range of 6-52% in March and 15-53% in June.

2. In the printer-oven area, the prevalence of all symptoms was generally highest among the operators and lowest among the maintainers. An exception is skin problems, which were highest among adjusters.

3. From March to June, there was a tendency to a lower prevalence of all symptoms other than those of mucous membrane irritation. However, the difference is not great, and there was a slightly higher prevalence of mucous membrane irritation symptoms in June than in March.

4. In March 6% and in June 15% of the printer-oven employees complained of the "smoke, fume, odors from the ovens."

Automatic Bander Area

The prevalences of symptoms are listed for the separate job categories, mostly for consistency in reporting. The number of employees in each job category in this area is small, and it would be prudent not to over-interpret the difference, for example, between 25 percent (when that figure reflects one of four employees) and 50 percent (when that is two of four employees). It is more reasonable to focus on the total for each month. Like the printer-oven employees, automatic bander employees also reported the highest prevalence of symptoms of mucous membrane irritation, with a slight increase from March to June. Automatic bander employees complained more frequently (75% in March and 64% in June) of emissions from the ovens than from the automatic bander (67% in March and 54% in June).

The predominance of symptoms of mucous membrane irritation in both areas is consistent with the exposures, for example to (1) cellosolve-containing sprays and butanol in the printer-oven area, and (2) acetic anyhdride and acetaldehyde in the pyrolysis products of the polyester strapping used in the automatic bander.

As mentioned earlier, we intended to compare the prevalences of employees' symptoms in March and June as a measure of the effects of the new ventilation system. The comparison of symptom prevalences in March and June was confounded by several factors, however:

1. The reference periods (March and June) are in different seasons, raising the possibility that higher ambient temperatures in the plant could contribute to employees' discomfort. (Several employees noted in their interviews that fumes and odors seemed worse in hotter weather).

2. Recall may have been inaccurate; that is, employees may not have been able to remember distinctly how they felt in March and/or may have been biased by the questionnaire itself to report symptoms for March similar to those they had just reported for June.

VII. CONCLUSIONS

A. Environmental

NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen and that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit.

The NIOSH investigators suspect that even the very low levels of formaldehyde from decomposition products of the base coat and bottom varnish sprayed on the cans and cured at 400°F may cause adverse health reactions in certain individuals. Therefore, we recommend that 1) the ovens be under negative pressure at all times by periodically monitoring the air flow in the stack; 2) the stacks be periodically cleaned to prevent pluggage; and 3) ovens that leak be shutdown and repaired immediately.

B. Ventilation

In the absence of entrainment of VOC in the MAU's, the total air supplied, on a once-through basis at a rate of 1.5 cfm per square foot, may be considered adequate from the point of view of comfort in the winter and when the temperature is not over 85°F in the summer. The local drops at the exit of the DESPATCH ovens may prove to be uncomfortable in wintertime. Velocities of 100 fpm were measured at workstations in those areas. Also heat sources in the vicinity of workers located at the point where cans exit the washers would tend to render temperatures too high for comfort in the wintertime.

Some of the roof ventilators exhaust air at roof level. Since this air may be entrained into the fresh air supplied by the MAU's under certain conditions (oven leaks, shifts in wind direction, etc.) it is suggested that stacks be installed for discharging the pollutants at a higher level.

The FECO ovens seem to be the major potential source of VOC in the plant. At the time of the NIOSH visit in August 1985, two of these were found to be leaking smoke. One oven emitted smoke at the transition point between the curing and cooling sections because the local exhaust hood for controlling this source was not in place. The other oven leaked at a point where a moving mechanical part protruded. That leak may have been controlled by a portable 18 inch diameter circular hood placed in the vicinity of the leak.

C. Medical

Possibly the improvements in the ventilation system in the printer-oven did contribute to the observed decrease, from March to June, in the automatic bander employees' complaints regarding the emissions from the banders and ovens. However, the fact that there were not substantial differences in the prevalences of symptoms reported in March and June would suggest that the ventilation system has not significantly improved environmental conditions in the printer-oven and automatic banding areas.

Based on the environmental results, employee interviews, ventilation survey, and available toxicological information, the investigators concluded that a potential health hazard from formaldehyde and volatile organic compound did exist at the time of this survey.

VIII. RECOMMENDATIONS

1. Install portable hoods (one for each oven) attached to a distribution plenum by "Elephant-Trunk" to control the leaks. Each hood should be capable of suction at the rate of 1000 CFM. The plenum may be designed to handle flow through 3 or 4 hoods simultaneously.

2. An oven can lose negative pressure in a number of ways, such as loss of exhaust fan performance or the plugging of an exhuast stack. One way to prevent the occurrence of such an event would be to periodically monitor the air flow in the stack. The stack should also be periodically cleaned to prevent pluggage.

3. The use of smoke tubes will provide a convenient and rapid method for determining whether the oven is under negative pressure.

4. Ovens that leak are not shutdown and repaired immediately apparently because of the economic penalties associated with such a shutdown. One way around this shutdown is to build redundency into the curing operation by installing additional ovens (perhaps two) so that cans may be diverted from leaky ovens to ones in working order.

5. The elevators which convey cans from the inside spray machines to the DESPATCH ovens are a source of an irritant VOC. There are two ways this source may be effectively controlled. The first would consist of maintaining a negative pressure in the enclosure by providing a series of take offs through which air is exhausted to a fan through a manifold. Another method, which may prove cheaper than the first, would utilize the air flow induced by the high speed motion of the cans within the enclosure. Such a flow was detected in the horizontal portion of one elevator during the NIOSH visit. Assuming turbulent air flow within the enclosure, the induced air flow may be estimated from knowledge of the velocity profile within the enclosure and assuming a flat plate of cross section equal to the longitudinal section of the can. The velocity of the plate is approximated by the production rate of the line. Ventilation for the enclosure would be provided at the end of the run and would equal the induced air flow in addition to the desired air suction at the point where the cans exit the conveyor (150 fpm times the ft^2 area of the opening).

6. Control of emissions from the perforated platform at the feed end of the DESPATCH ovens may be accomplished by installing a "canopy" hood that covers the entire area of the platform. The operation of the hood will be aided by the air sparged through the platform.

IX. REFERENCES

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1. Metal Container Corporation, Columbus, Ohio
2. United Steelworkers of America, Local 8622, Columbus, Ohio
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.

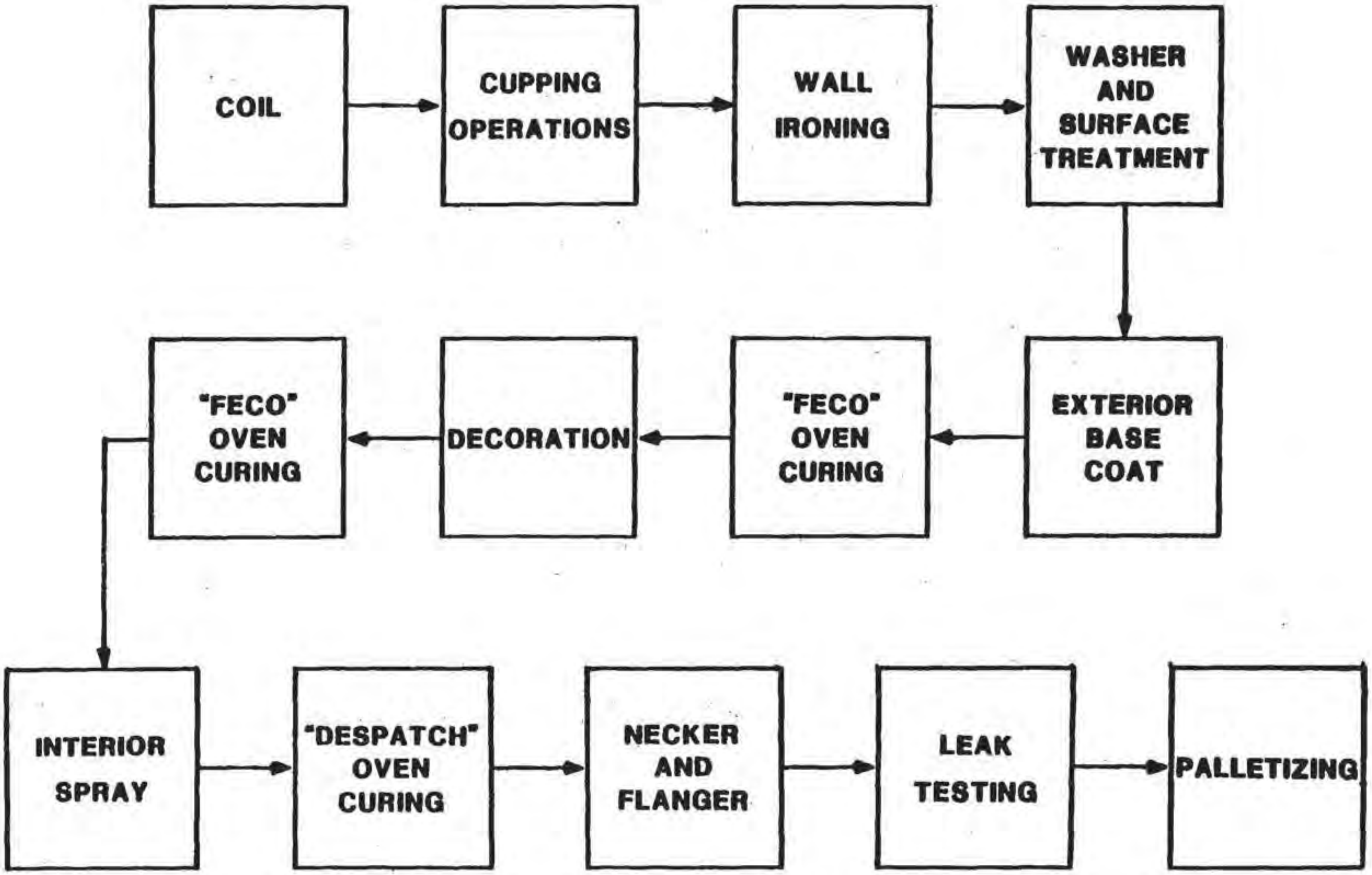

Figure 1. Process Flow Diagram for Two-Piece Can Fabricating and Coating Operation

TABLE 1

Results of Area Air Samples for Formaldehyde

Metal Container Corporation
HETA 84-495
October 9, 1985

JOB AND/OR LOCATION	Sampling Period	Sample Volume (Liters)	Total Formaldehyde mg/m^3*
Line Three Inside Spray DESPATCH Oven	0836-1607	451	0.07
Line Four Inside Spray DESPATCH Oven	0839-1608	449	0.05
Line One Inside Spray Operator Station	0843-1609	446	0.10
Line Four Inside Spray Operator Station	0845-1610	445	0.12
Between Line Three and Four Inspection Table	0846-1611	445	0.17
Line One Printer Oven	0854-1612	438	0.11
Environmental Criteria (NIOSH)			**See Below
Limit of Detection			1 ug

*mg/m^3 = milligrams of substance per cubic meter of air sampled.

**All concentrations are time-weighted averages for the period sampled. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen. An estimate of the extent of the cancer risk to workers exposed to various levels of formaldehyde at or below the current OSHA 3.7 mg/m^3 standard has not yet been determined. In the interim, NIOSH recommends that as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit.

TABLE 2 VOLATILE CONSTITUTENTS IN VARIOUS COATINGS

COATING	Constituents	WT %	% Volatile by Volume	lb WT per gal	Coating application rate mg/can
Base Coat					
White	Ethylene Glycol Monobutyl Ether	5	52.6	11.7	300
	N,N-Dimethyl Ethanolamine	<5			
	Diethylene Glycol Monobutyl Ether	<5			
	Normal Butyl Alcohol	<5			
Clear	Dimethylaminoethanol	2	85.3	8.5	300
	Butanol	8			
	Ethylene Glycol Monobutyl Ether	7			
Inks (Typical)	Long Chain Alcohols	25	75	Not Available	Not Available
	Glycol Ether				
	Acetate Solvents				
	Organic Base Stabilizers				
Inner Spray	Ethylene Glycol Monobutyl Ether	7	84.8	8.4	130
	Butanol	7			
	Dimethylaminoethanol	1			

TABLE 3. Symptoms Reported by PRINTER-OVEN Employees in MARCH 1985

SYMPTOM/COMPLAINT	OPERATORS (9) #	OPERATORS (9) (%)	MAINTAINERS (10) #	MAINTAINERS (10) (%)	ADJUSTERS (14) #	ADJUSTERS (14) (%)	TOTAL (33) #	TOTAL (33) (%)
Eye irritation	7	(78)	3	(30)	4	(29)	14	(42)
Nose irritation	7	(78)	2	(20)	8	(57)	17	(52)
Throat irritation	4	(44)	2	(20)	2	(14)	8	(24)
Stuffy nose	4	(44)	2	(20)	5	(36)	11	(33)
Frequent sneezing	0	(--)	0	(--)	2	(14)	2	(6)
Sinus congestion	5	(56)	2	(20)	5	(36)	12	(36)
Difficulty breathing	3	(33)	2	(20)	3	(21)	8	(24)
Shortness of breath	3	(33)	2	(20)	0	(--)	5	(15)
Wheezing	1	(11)	0	(--)	0	(--)	1	(3)
Chest tightness	3	(33)	1	(10)	0	(--)	4	(12)
Coughing	3	(33)	1	(10)	2	(14)	6	(18)
Bloody mucus	2	(22)	1	(10)	3	(21)	6	(18)
Nosebleeds	1	(11)	0	(--)	1	(7)	2	(6)
Headache	3	(33)	1	(10)	2	(14)	6	(18)
Lightheadedness	2	(22)	0	(--)	2	(14)	4	(12)
Nausea	0	(--)	0	(--)	0	(--)	0	(--)
Skin problems	3	(33)	2	(20)	8	(57)	13	(39)
Bander smoke, etc.	0	(--)	2	(20)	0	(--)	2	(6)
Oven smoke, etc.	8	(89)	6	(60)	9	(64)	23	(70)

TABLE 4 Symptoms Reported by PRINTER-OVEN Employees in JUNE 1985

SYMPTOM/COMPLAINT	OPERATORS (8) #	(%)	MAINTAINERS (11) #	(%)	ADJUSTERS (15) #	(%)	TOTAL (34) #	(%)
Eye irritation	6	(75)	3	(27)	4	(27)	13	(38)
Nose irritation	5	(63)	2	(18)	11	(73)	18	(53)
Throat irritation	5	(63)	2	(18)	2	(13)	9	(26)
Stuffy nose	6	(75)	2	(18)	5	(33)	13	(38)
Frequent sneezing	0	(--)	0	(--)	5	(33)	5	(15)
Sinus congestion	5	(63)	1	(9)	6	(40)	12	(35)
Difficulty breathing	2	(25)	1	(9)	5	(33)	8	(24)
Shortness of breath	1	(13)	1	(9)	1	(7)	3	(9)
Wheezing	0	(--)	0	(--)	0	(--)	0	(--)
Chest tightness	1	(13)	2	(18)	0	(--)	3	(9)
Coughing	2	(25)	0	(--)	0	(--)	2	(6)
Bloody mucus	1	(13)	0	(--)	2	(13)	3	(9)
Nosebleeds	0	(--)	0	(--)	1	(7)	1	(3)
Headache	2	(25)	1	(9)	1	(7)	4	(12)
Lightheadedness	1	(13)	0	(--)	1	(7)	2	(6)
Nausea	0	(--)	0	(--)	0	(--)	0	(--)
Skin problems	1	(13)	4	(36)	7	(47)	12	(35)
Bander smoke, etc.	1	(13)	2	(18)	2	(13)	5	(15)
Oven smoke, etc.	7	(88)	5	(45)	9	(60)	21	(62)

TABLE 5 Symptoms Reported by AUTOMATIC BANDER Employees in MARCH 1985

SYMPTOM/COMPLAINT	OPERATORS N=3 #	(%)	Q.A. TECH'S N=7 #	(%)	ADJUSTERS N=2 #	(%)	TOTAL N=12 #	(%)
Eye irritation	1	(33)	2	(29)	1	(50)	4	(33)
Nose irritation	1	(33)	3	(43)	1	(50)	5	(42)
Throat irritation	1	(33)	2	(29)	0	(--)	3	(25)
Stuffy nose	1	(33)	3	(43)	1	(50)	5	(42)
Frequent sneezing	0	(--)	2	(29)	0	(--)	2	(17)
Sinus congestion	1	(33)	2	(29)	1	(50)	4	(33)
Difficulty breathing	1	(33)	0	(--)	0	(--)	1	(8)
Shortness of breath	0	(--)	2	(29)	0	(--)	2	(17)
Wheezing	0	(--)	0	(--)	0	(--)	0	(--)
Chest tightness	0	(--)	1	(14)	0	(--)	1	(8)
Coughing	0	(--)	3	(43)	0	(--)	3	(25)
Bloody mucus	0	(--)	0	(--)	0	(--)	0	(--)
Nosebleeds	0	(--)	0	(--)	0	(--)	0	(--)
Headache	1	(33)	0	(--)	0	(--)	1	(8)
Lightheadedness	1	(33)	0	(--)	0	(--)	1	(8)
Nausea	1	(33)	0	(--)	0	(--)	1	(8)
Skin problems	2	(66)	1	(14)	0	(--)	3	(25)
Bander smoke, etc.	1	(33)	6	(86)	1	(50)	8	(67)
Oven smoke, etc.	2	(66)	6	(86)	1	(50)	9	(75)

TABLE 6 Symptoms Reported by AUTOMATIC BANDER Employees in JUNE 1985

SYMPTOM/COMPLAINT	OPERATORS (4) #	(%)	Q.A. TECH'S (7) #	(%)	TOTAL (11) #	(%)
Eye irritation	2	(50)	2	(29)	4	(36)
Nose irritation	3	(75)	3	(43)	6	(54)
Throat irritation	2	(50)	2	(29)	4	(36)
Stuffy nose	2	(50)	3	(43)	5	(45)
Frequent sneezing	0	(--)	2	(29)	2	(18)
Sinus congestion	2	(50)	3	(43)	5	(45)
Difficulty breathing	0	(--)	1	(14)	1	(9)
Shortness of breath	0	(--)	1	(14)	1	(9)
Wheezing	2	(50)	0	(--)	2	(18)
Chest tightness	0	(--)	1	(14)	1	(9)
Coughing	2	(50)	3	(43)	5	(45)
Bloody mucus	1	(25)	0	(--)	1	(9)
Nosebleeds	1	(25)	0	(--)	1	(9)
Headache	3	(75)	0	(--)	3	(27)
Lightheadedness	0	(--)	0	(--)	0	(--)
Nausea	1	(25)	0	(--)	1	(9)
Skin problems	2	(50)	1	(14)	3	(27)
Bander smoke, etc.	1	(25)	5	(71)	6	(54)
Oven smoke, etc.	2	(50)	5	(71)	7	(64)

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