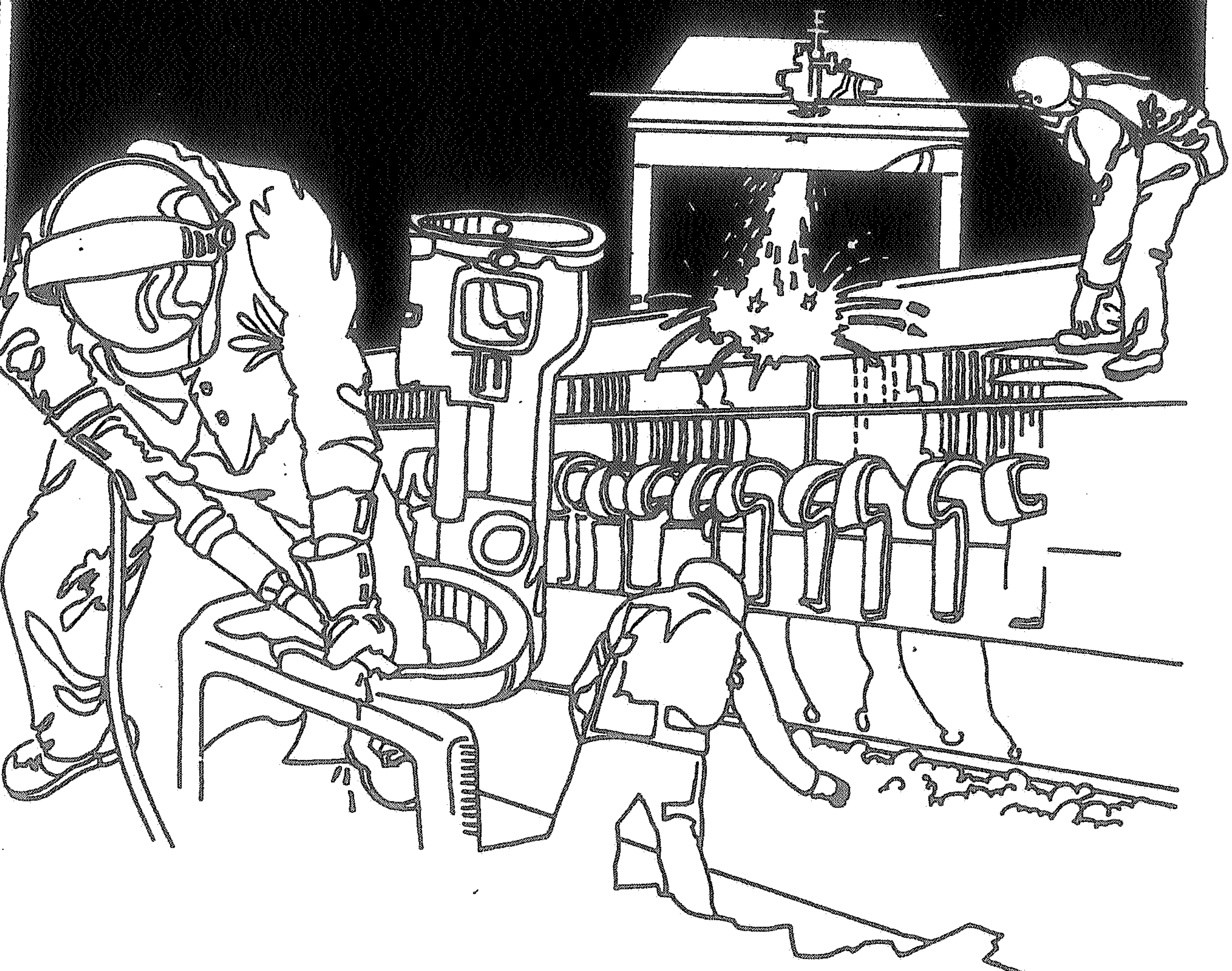
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 85-108-1593
CAREY PLASTICS DIVISION,
TOLEDO MOLDING AND DIE CORP.
CAREY, 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.

HETA 85-108-1593
May 1985
CAREY PLASTICS DIVISION,
TOLEDO MOLDING AND DIE CORP.
CAREY, OHIO

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I. SUMMARY

On December 17, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request to investigate an outbreak of illness in the workforce at Carey Plastics, Carey, Ohio. Carey Plastics produces plastic dashboard components for the automobile industry.

On December 18, 1984, NIOSH investigators conducted a walkthrough inspection of the production area. Environmental air samples and bulk samples were collected. Employees who had become ill on December 14 and 17 were interviewed.

Results of environmental samples for solvents (1,1,1-trichloroethane, methylene chloride, tetrachloroethylene, and trichloroethylene) used in the mold preparation or cleaning process, were below any recommended occupational exposure limits. The highest value recorded for a personal exposure was less than 7 mg/m^3 for 1,1,1-trichloroethane. Sample results for formaldehyde were nondetectable. Detector tube measurements showed no detectable levels of hydrogen sulfide or sulfur dioxide. Carbon monoxide levels were measured by detector tube in the press operator's breathing zone (<30 ppm); and in two potential sources of CO exposure: the plume from the molding press (<30 ppm) and the exhaust of a towmotor (<200 ppm).

Symptoms reported by the 45 ill workers between December 14 (when the outbreak began) and December 18 included headache, irritation of mucous membranes, nausea, chest tightness, fatigue, shortness of breath, tingling or numbness of one or both hands, itching, flushed face, tingling and numbness around the mouth, and clumsiness or incoordination. A review of medical records of workers seen at local hospitals revealed no serious pathology related to the present outbreak, although carboxyhemoglobin levels suggested the possibility of low level exposure to carbon monoxide in the plant.

Many of the symptoms reported by the affected persons are compatible with exposure to chemical substances known to be used in this workplace. We conclude that there was not one causal agent, but a combination of factors which were present simultaneously which led to this outbreak of illness in this workforce. These factors are: an inappropriate mold clean/change operation in the vicinity of the index cases causing odor and possible exposure to solvents in a localized area of the plant; idling towmotors, possibly causing short term, low level CO exposure; the possible presence of odors from the waste coolant holding trench; and the possibility that the exhaust fans in the immediate area had been turned off. These factors, each of which had been reported in the past, would not be expected to cause an illness of these proportions when taken by themselves. We believe that anxiety and fear contributed to the spread of illness, considering the spatial and temporal relationship of the cases; the heightened concern for one's health caused by past injuries, health inspections, and prior news events; and the lack of substances and procedures in the workplace which could cause such a widespread outbreak.

Recommendations are presented in Section VIII of this report which are aimed at eliminating some of the causal factors of this outbreak.

KEYWORDS: Injection molding, polypropylene, carboxyhemoglobin, stress-induced reactions, SIC 3079 (Miscellaneous Plastics Products)

II. INTRODUCTION

On December 17, 1984, NIOSH received a request from the management and United Auto Workers Union local 2021 of Carey Plastics Division of Toledo Molding and Die Corporation, Carey, Ohio, to investigate the cause of an outbreak of illness in the first shift production workforce which occurred on December 14, 1984.

Environmental air sampling results were presented to the company in a letter dated December 21, 1984.

A. Description of the Facility and Process

Carey Plastics Division supports Ford Motor Company in the production of plastic components for motor vehicles. Plastic parts are produced by the standard injection molding process. The plant has been in operation at this site for 25 years. Prior to that time, a porcelain plant had occupied the site. Carey Plastics production floor is concrete, which was poured over the remains of the porcelain plant. Hence, underneath the concrete floor is the basement of the porcelain plant filled with sand and old porcelain (telephone pole glass insulators).

The predominately female production workforce consists of approximately 200 persons. Production is on a three-shift/day basis (8 a.m. - 4 p.m., 4 p.m. - 12 a.m., 12 a.m. - 8 a.m.). Generally it is a 5 day/week operation. Job classifications are press operator, floor help (floorwalker), hopper filler, inspector, assistant foreman, foreman, and indirect laborer.

There are 22 injection molding machines on the production floor, which are identified by numbers 1 through 24 (numbers 17 and 23 are not used). A depiction of the spatial relationship of these machines is presented in Figure 1. The production floor consists of three rooms joined by wide passageways. The production area dimensions are shown in the drawing; the ceiling height varies from 15 to 20 feet but appears to average 18 feet. There is a trench approximately two feet wide in the concrete floor across one dimension of the floor which is used to collect waste coolant oil and water from the molding machines. This trench is closed at both ends and therefore the waste liquid does not flow. Periodically the waste liquid is pumped from the trench. Although the trench is covered in places with metal plates and wooden boards, essentially it is open to the production area. There are several cracks in the concrete floor radiating away from this trench. In at least one place there is evidence of seepage, probably from the trench. This has been a source of concern among the workers.

Table 1 lists some information relative to each injection molding machine. The type of plastic used is basic polypropylene. The majority of the machines use general purpose (GP) polypropylene, while the remainder use either 20% talc-filled, 40% talc-filled, or Kodak (carbon-filled) polypropylene. Operating temperatures range from 400-450 degrees Fahrenheit; however, during startup (such as after a shift change) it is not uncommon for the operator to raise the temperature 100-200 degrees Fahrenheit in order to rapidly melt and force out any residue left on or in the feed cylinder. On a normal day, 16 to 19 machines are running; the remainder are shut down for maintenance. Work pace is dictated by the speed of the machines. There is no piece work.

The workplace is ventilated by numerous passive ceiling vents and ceiling and wall exhaust fans. There is no local exhaust ventilation system. The controls to both open the vents and start/stop the fans are accessible to everyone; hence there is frequent changing of the settings by the workers and no consistent pattern of operation of any exhaust system. The locations of the fans and vents are shown in Figure 1.

The production floor is heated with gas-powered space heaters located at ceiling level. Yearly maintenance occurs in October, just prior to winter use of the heaters.

Molds must be changed when the product changes. Considering the 22 molds, the company estimates that a mold change occurs at least once a day on the production floor. These changes occur most often on presses 18 through 22, and with lesser frequency on presses 8 and 9 and 10 through 12. To assist in mold changes, propane- and gasoline-powered forklifts are used to remove and replace the mold.

Molds first are cleaned with a solution containing 1,1,1-trichloroethane, methylene chloride, tetrachloroethylene, and "naphtha spirits". [This is a combination name of varnish makers and painters naphtha and mineral spirits, both of which are general purpose solvents.] This is done by aspirating the liquid out of a hand-held plastic container through a hose by a compressed air line. This technique sprays the solvent across the mold surface and debris is removed with the assistance of brushes. It also causes the aerosolization of the solvent into the workplace. There are no provisions for collecting this aerosol. Approximately 1/2 gallon of solvent is required to complete the process. Occasionally the molds are warm when cleaned; this probably increases the amount of solvent vapor liberated.

There have been no significant, recent changes in production. Antifreeze (ethylene glycol-based) had been added to the enclosed mold coolant system.

B. Chronology of Events

At approximately 9 a.m. on Friday, December 14, 1984, a group of three employees working at press number 9 and a floorwalker in the same area became ill. Symptoms in one employee available for interview by the NIOSH investigators, included headache, nausea, "shakiness", lightheadedness, sore throat, and, as the morning wore on, numbness of both hands.

Throughout the morning other employees became ill with similar and additional symptoms, until the plant was closed around noon and all employees either were sent home or to local emergency rooms. A total of 27 workers were reported to have been sent for evaluation to emergency rooms in the area on December 14.

The plant reopened on December 17 at the midnight shift. A similar, although smaller, epidemic of illness occurred. Six workers were sent to the hospital on the 8 a.m. - 4 p.m. shift (including three who had been sick the 14th); and six workers reported symptoms on the 4 p.m. - 12 a.m. shift, but were not sent to the hospital. Ten workers were sent to the emergency room on the 12 a.m. - 8 a.m. shift December 18.

A number of events may havve affected the reaction of the workforce to this outbreak.

In June and July 1983, a labor dispute occurred over, among other things, the establishment of a safety committee. No progress was made until approximately three weeks prior to the outbreak of illness. The concern of the production workforce had been increased by the occurence of three accidents: in September, one worker shot a staple through her finger and it was feared that she would have to have her finger amputated. In November two workers shot staples through their fingers. One worker had to have her finger amputated.

On December 7, 1984, the waste coolant-holding trench was drained of fluid. On December 10-12, an OSHA investigator was in the production area conducting a safety inspection. During this last day, a "gas" odor was reported by workers. The odor seemed to be concentrated around press 9. December 13 apparently was uneventful.

On Friday, December 14, at some time during the morning, sewer workers began working on the system outside the building. At approximately 8 a.m. that morning, a mold change operation began on press 6, and finished at 1 p.m. It was reported that a towmotor was idling in the area in preparation for removing the mold after it was cleaned.

III. EVALUATION DESIGN AND METHODS

A. Environmental

When we arrived at the Carey Plastics plant, operations had been shut down because of the illness episodes experienced the day before. Since it was important for us to inspect the operation under normal conditions, we asked for volunteers from either the production or office workforce to run the presses. We were only partially sucessful and were able to start production with only three presses (#s 18 - 20). However, after a meeting with the 8 a.m. - 4 p.m. and the 4 p.m. - 12 a.m. workforce at shift change, in which we explained our intentions and assured them that a life-threatening situation did not exist, we were largely sucessful, and came very close to full production and the process was observed under nearly normal conditions. Also, a mold cleaning operation was conducted for our benefit.

Several types of air sampling were conducted. Process samples, collected as close (6 - 12 inches) to the ejection point of the plastic part as possible, were obtained to estimate the concentration of any decomposition products resulting from the mold. This allowed us to estimate a worst-case exposure, that is, the exposure to an operator if he or she would work this close to the ejection point. In addition, personal breathing zone air samples were collected from operators in their normal work position. All air samples for solvents were collected on standard (100/50 milligram) activated charcoal tubes. Personal sampling pumps were used. Samples were submitted to the laboratory for analysis for 1,1,1-trichloroethane, methylene chloride, tetrachloroethylene, as well as for identification of any other compounds present in significant concentration. Gas chromatography and mass spectrometry were employed in the analysis. In addition, personal as well as process samples were collected for formaldehyde on ORBO-22 sampling tubes. The sampling and analytical methods are listed in Table 2.

Bulk samples of the mold-release and mold-cleaning agents used were collected. In addition, a sample of the waste liquid from the trench was collected. This waste liquid sample was analyzed for volatile components by placing it in a vial and drawing laboratory air across the surface. This air was collected on a charcoal tube and analyzed in the same fashion as the other charcoal tubes. This sample was collected in order to determine if any volatile chemicals were emanating from the trench.

In order to determine if there was any immediate airborne exposure problem, an H-Nu photoionizer (a direct reading instrument) was used to survey the production area. In addition, various detector tubes (phosgene, carbon monoxide, and carbon dioxide) were used.

The ventilation system was inspected for its efficiency in removing the smoke from the molding machines by determining the air flow patterns with smoke tubes.

B. Medical

We interviewed 27 people, the majority of whom were workers taken to the local emergency rooms, either on Friday, December 14, or when the plant reopened on Monday, December 17. A sample of the workers interviewed was asked a structured series of questions about symptoms which were determined in early interviews to be the most common symptoms.

Emergency room physicians who treated workers at three local hospitals were questioned to determine the course of patients seen from the plant. Selected laboratory results were compiled for a cohort of workers seen at two of the hospitals on the first day of the outbreak (December 14). Finally, contact was continued with the plant for several days after the visit, in order to collect information on any further illnesses.

IV. EVALUATION CRITERIA

A. Environmental Criteria

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

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

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Criteria Documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's) [2,3], and (3) the U.S. Department of Labor (OSHA) occupational health standards. [4] 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.

B. Specific Substances

1. <u>1,1,1-Trichloroethane</u> [5-8]

1,1,1-Trichloroethane (methyl chloroform) is a degreaser and solvent of relatively low toxicity. Vapor may be mildly irritating to eyes. At vapor concentration over 1000 ppm, anesthetic effects including lightheadedness, dizziness, and incoordination have been reported. Liver and kidney toxicity are low. As is the case with other halogenated hydrocarbons, cardiac arrhythmias resulting from excessive exposure have been reported. No physiological effects have been reported when vapor concentrations are below the TLV. Repeated skin contact can lead to dermatitis secondary to defatting. NIOSH recommends that 1,1,1-trichloroethane be treated in the workplace with caution because of its similar chemical structure to four other chloroethanes which have been shown to be carcinogenic in laboratory animals. The current OSHA standard is 350 ppm, 8-hour TWA (time-weighted average).

2. Methylene chloride (9,10)

Methylene chloride, a widely used industrial solvent, causes fatigue, weakness, sleepiness, lightheadedness, numbness and tingling of the hands and feet. The liquid irritates the eyes and skin, and its vapor is a respiratory tract irritant. Methylene chloride is metabolized to carbon monoxide, so its potential toxicity is additive to that of inhaled carbon monoxide. [Carbon monoxide, by combining with hemoglobin in the blood and preventing it from carrying oxygen, causes headache, weakness, dizziness, nausea, confusion, and loss of consciousness.] NIOSH recommends that occupational exposure to methylene chloride (in the absence of carbon monoxide exposure) not exceed a 10-hour TWA of 75 parts per million (ppm), nor a 15-minute ceiling of 500 ppm. The current OSHA standard is 500 ppm, 8-hour TWA.

3. Naphtha spirits (11)

Naphtha spirits is probably a manufacturer's designation for one of a class of substances better known as special naphthas. Two more familiar names might be varnish makers° and painters° naphtha, Stoddard solvent, and mineral spirits. All of these fall into a wide category of substances called refined petroleum solvents, which are produced by refinement and fractionation of crude petroleum. These solvents generally are composed of C-7 to C-12 straight-chain hydrocarbons, with a boiling range of approximately 200 - 400 degrees Fahrenheit. Usually the aromatic content (ring structure rather than straight-chain) is limited to less than 20% to meet this class definition. They are usually water-white with a sweet, aromatic odor. Uses include solvents for paints and varnishes, and drycleaning fluids.

Eye, nose, and throat irritation, dermatitis, and effects on the nervous system have been found in workers exposed to some refined petroleum solvents. Benzene (a human carcinogen) is present in small amounts in many refined petroleum solvents, and care should be exercised when purchasing these solvents so that only those with negligible levels of benzene are selected.

Currently, there is no OSHA standard for refined petroleum solvents. However, NIOSH recommends that workplace exposure to refined petroleum solvents be limited to a 350 mg/m^3 TWA concentration for up to a 10-hour work shift, 40-hour work week. NIOSH further recommends that a concentration of 1800 mg/m^3 not be exceeded for any 15-minute period.

4. Tetrachloroethylene (12,13)

Tetrachloroethylene, or perchloroethylene, is a volatile liquid with an odor detectable at about 340 mg/m^3. It is a solvent widely used in drycleaning, fabric finishing, metal degreasing, and other applications. Occupational exposure to tetrachloroethylene has resulted in effects on the central mervous system, mucous membranes, eyes, lungs, liver, kidney, heart and skin, with the CNS effects of dizziness, headache, vertigo or light narcosis being reported most frequently.

In 1976, NIOSH recommended an exposure limit of 340 mg/m^3 for up to a 10-hour day, 40-hour week. However, based on a long-term laboratory animal study conducted by the National Cancer Institute, in which it was determined that tetrachloroethylene causes liver cancer in mice, NIOSH currently recommends that tetrachloroethylene be handled in the workplace as if it were a human carcinogen. Contact with tetrachloroethylene should be minimized.

The OSHA standard is 680 mg/m^3, 8-hour TWA, with a ceiling exposure limit of 1360 mg/m^3.

V. RESULTS AND DISCUSSION

A. Environmental

The air sampling with the H-Nu photoionizer failed to discover any areas of the plant with high or excessive levels of chemical contaminants, including the breathing zone of the operators of press #19 (none detected), above the trench behind press #9 (2 ppm), above the oil pan of press #12 (none), or above the crack in the floor where the seepage is (none). The levels in the general secretary's and the plant manager's office, and the QC office were all below the limits of quantitation.

Detector tube measurements for hydrogen sulfide and sulfur dioxide collected directly (less than 1 foot) above the trench were nondetectable also. However, the faint odor of hydrogen sulfide was noticed by both NIOSH investigators at either end of the trench.

Carbon monoxide was measured by detector tube in the press operators° breathing zone, in the press smoke plume, in a towmotor exhaust, and in various areas of the plant. The highest levels recorded were 10 ppm at press 20, 30 ppm from press 2, greater than 200 ppm, and 30 ppm in the vicinity of press 12, respectively. Towmotor exhaust CO is the greatest contributor ot the CO in the workroom air. However, it does not appear to cause widespread CO exposure since other CO measurements were low.

Personal breathing zone air sampling data are presented in Table 3. All results were below any recommended exposure limits. 1,1,1-Trichloroethane values ranged from less than 0.5 mg/m^3 to 10 mg/m^3; the recommended exposure limit is 1910 mg/m^3. All trichloroethylene, tetrachloroethylene, and toluene values were less than 0.5 mg/m^3; the recommended exposure limits are 536, 340, and 375 mg/m^3, respectively. Methylene chloride values ranged from less than 0.5 mg/m^3 to 4 mg/m^3; the recommended exposure limit is 261 mg/m^3. All values for formaldehyde were below the air adjusted limit of quantitation of 0.08 mg/m^3.[14]

Numerous other compounds were seen in the analysis, but these were too small to either identify or quantitate individually. However, their individual concentrations have been summed to give an idea of the total concentration of these substances. Expressed as C-9 alkanes, the highest concentration was 1 mg/m^3. The recommended exposure limit is 350 mg/m^3.

Ingredient information was obtained from the manufacturers of the mold cleaning and release agents used on the molds. DiElect-25 is composed of methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, and naphtha spirits; Molykote metal protector contains tetrachloroethylene; Camie 888 contains methylene chloride, 1,1,1-trichloroethane, and dimethylpolysiloxane; and Camie A-1000 contains tetrachloroethylene, tetrafluoroethylene, and 1,1,1-trichloroethane.

1. Medical

A case of illness was defined as a production worker who went to the emergency room or left for home because of symptoms at work on December 14, 17 or 18. There were 27 cases on the first day of the outbreak (December 14); 11 on December 17 (6 on the 8 a.m. - 4 p.m. shift; 5 on the 4 p.m. - 12 a.m. shift); and 10 on December 18 between 12 a.m. and the time of the arrival of the NIOSH investigators at 9 a.m. In all, 45 workers were affected prior to the NIOSH visit. (three of the six workers on the 8 a.m. - 4 p.m. shift December 17 also had been affected on December 14). To our knowledge, no non-production workers were affected.

Based on initial interviews with employees who had been affected, a structured series of symptom questions were asked of a subset of 11 workers who had been sick on one of the three days. (Table 4). Almost all workers reported headache or irritation of mucous membranes (eyes, nose, or throat). Eight of the 11 had dizziness or lightedheadness. Other common symptoms were nausea (one case with vomiting) and chest tightness. Drowsiness (4 workers) and fatigue (6 workers) were reported to occur at work and, along with headache, were the most common symptoms to persist after leaving the work environment.

Because of the urgency attached to the NIOSH visit, there was not enough time to prepare a formal survey questionnaire for all employees interviewed. However, the symptoms reported by the eleven workers interviewed with the structured series of symptom questions were similar to those reported by the rest of the workers. Although not specifically asked for in the structured survey, many workers also reported shortness of breath and tingling or numbness of one or both hands. Less common symptoms not specifically sought were itching and tingling skin, abdominal pain, red or flushed face, tingling or numbness around the mouth, fainting, and clumsiness or incoordination. Although the most serious symptoms occurred on December 14, several workers noted that they had noticed some similar symptoms at other times in the past, in particular symptoms of eye or mucous membrane irritation associated with the molding operations.

Workers also complained about other conditions within the plant which were noted to be a cause of illness not related to the present outbreak. There is excessive noise in several parts of the plant. Speed-up is reportedly common in order to increase production. Several workers have suffered painful "repetitive motion" injuries (carpal tunnel or tenosynovitis) which is attributed to the pace of work at the presses. There were complaints of exposure to dust in the grinding room.

Brief physical examinations were conducted by the NIOSH investigators on selected workers. Neurologic examination was uniformly normal. Examination of chest and mucous membranes did not indicate serious pathology or suggest any particular chemical exposure.

The physicians available who had taken care of the workers from the plant on December 14 or December 17 in the emergency rooms reported that all were examined and released. To our knowledge, no one was hospitalized. Except for the administration of oxygen, no specific treatment was given for the acute symptoms. Physical examinations were reported to be unimpressive with the exception of tachycardia (fast heart rate) and several workers with flushed, red faces.

The following possible causes for the outbreak were identified by workers:

1. fumes from the open trench used to collect waste coolant.

2. fumes from the solvents used to clean the molds.
3. carbon monoxide from the forklift.
4. fumes and gases from the injection molds.
5. work on the sewer done outside the plant with resultant contamination of the plant atmosphere.

The working diagnosis of the initial examining emergency room physicians on the first day (December 14) was that the Carey workers had carbon monoxide poisoning. Symptoms such as lightheadedness, drowsiness or confusion, nausea, and headache, as well as the flushed red faces could all be caused by carbon monoxide poisoning. The NIOSH investigators reviewed the blood carboxyhemoglobin levels drawn at two of the hospitals (table 5). The tests from hospital A were reported to have been drawn on room air within 20 minutes to 1 hour of leaving the plant. The blood from hospital B was taken after the workers had been given oxygen (which would accelerate the clearance of carbon monoxide from the body). The results in Table 5 are divided into smokers and non-smokers, because smoking contributes to the body burden of carbon monoxide (as reflected in carboxyhemoglobin levels).

For this subset of all employees who had carboxy-hemoglobin levels determined, the highest level was 13.9%, with a range of 5.7 to 13.9% for smokers and 1.4 to 4.5% for non-smokers. These included the three early cases working at press 9. These levels are slightly higher than might be expected, especially for non-smokers, and suggest that workers may have had some carbon monoxide exposure in the plant. The U.S. Environmental Protection Agency uses a target ceiling for environmentally induced carboxyhemoglobin level of 2% for non-smokers.(15) However, symptoms rarely occur at levels below 15%.(15) We conclude that carbon monoxide may have contributed to the initial illnesses, but could not have been solely responsible.

In addition to these results many patients had chest x-rays and electrocardiograms done. According to the examining physicians, none showed any abnormalities referable to the reported symptoms.

Illness was not localized to a specific location within the plant. For example, 27 of the 53 production workers on the 8 a.m. - 4 p.m. shift on December 14 were affected. Comparing the foreman's log of work assignments with the list of people sent to the emergency room that day, workers at presses in all areas of the plant were affected. In fact, only at presses 11, 14, 15, and 22 were there no cases of illness.

The cases sent to the emergency room in approximate order of falling ill, as reported on interview, are presented in Figure 1. These illnesses occurred between 8:30 a.m. - 1 p.m. on December 14. The plant was closed at 1 p.m.. It appears that the first five cases all occurred in Area II near press 6 (and including presses 7, 8, and 9), where the mold changing operation was taking place. The next cases occurred in a sporatic pattern throughout the plant. On December 17, during the 8 a.m. - 4 p.m. and the 4 p.m. - 12 a.m. shifts, and on December 18 on the 12 a.m. - 8 a.m. shift, cases of illness again occurred in various parts of the plant. There was no consistent pattern to where illness first occurred or how it spread through the plant. While the timing or order of cases is based on individual recall and probably is not exact, it suggests that all parts of the plant were affected and not in a consistent order (which might suggest a single source of exposure). Illness was not localized to particular machines or area of the plant, to the area around the trench in Areas I and IV, to a particular ventilation duct, or to any identifiable particular activity or process in the plant.

The distribution of these illnesses within the plant and the lack of a single plausible chemical exposure suggests that there may have been more than one factor responsible for this outbreak. Solvent fumes or carbon monoxide might cause headache, dizziness and nausea; heated polypropylene, particularly if heated to the point of decomposition, might produce gases which would irritate the throat, eyes or lungs.(16) Some combination of fumes could cause the symptoms which occurred. However, at least at the time of the NIOSH visit, there were no significant levels of hazardous chemicals measured. All the theories for a single source of exposure (fumes from the open trench, fumes from solvents, carbon monoxide, and work on the sewer) were inconsistent with the industrial hygiene or medical data. Although a local combination of solvent vapors, towmotor exhaust (containing carbon monoxide), and irritant pyrolysis products from heated polypropylene could account for the initial cases of illness, we suspect that anxiety and fear of an unknown, unidentified hazard may have contributed to the spread of this epidemic. Some of the symptoms (e.g. dizziness, lightheadedness, tingling or numbness of extremities, and numbness around the mouth) are at least compatible with hyperventilation associated with anxiety and fear. The flashing lights and sirens, the unidentified cause for the illness in a plant where various potential health hazards exist (workers reported excessive noise and repetitive motion injuries), the recent OSHA inspection, and a perceived policy of production speed-up, are conditions which previously have been described as contributors to the anxiety associated with job-related illness. (17,18)

The interim recommendations made by NIOSH at the end of the initial visit were intended to prevent local concentrations of fumes and gases, and to resolve other health hazards and workplace conditions which might have contributed to the outbreak. Management hired a nurse to be on duty at the plant to attend to any further illness which might occur. There were seven workers who were subsequently reported to us as having sought this medical attention on December 19; eleven on December 20; seven on December 21; and six on December 22. The plant then closed for the Christmas holidays, and there were no further outbreaks of illness reported to us after the plant reopened in January.

VII. RECOMMENDATIONS

Most of the following recommendations were presented to management and the union during our visit.

1. Do not idle towmotors unnecessarily. This action contributes to the buildup of carbon monoxide and other exhaust components. In addition, regular maintenance should be scheduled to keep the motors in tune.

2. Do not continue to clean molds in the fashion we witnessed. The spray procedure adds solvent vapors to the workroom air. The molds should be removed to a well-ventilated place before any cleaning is done.

3. The smoke from the presses should be exhausted from the workplace. A canopy hood with either a top or side takeoff should be used. If a top takeoff is used it should be adjustable so that the molds can be removed. A ventilation engineer should be contracted for this work so that good ventilation design principles are followed, such as the proper capture velocity at the smoke evolution point and the proper fan size. The use of local exhaust ventilation rather than general exhaust ventilation will be less costly in the long run in terms of heating costs.

4. Clean the nozzle of the feed lance on the press to reduce the amount of smoke being emitted.

5. Do not increase the temperature of the mold beyond the normal operation temperature.

6. Put locks on the controls of the fans so that the settings cannot be adjusted whimsically.

7. Determine if it is possible to run the presses continually through shift changes to avoid having to "burn out" residual polypropylene. Alternatively, reach the proper operating temperature or plastic flow rate by running partial molds rather than shooting plastic freely into an open mold.

8. Remove the trench since it is a source of odors.

9. Considering the complaints suggestive of carpal tunnel syndrome, it would be appropriate for management to have an ergonomist evaluate the manual tasks associated with the press operations. Redesign of the tools used to trim off rough edges of product parts may be necessary in order to alleviate this health problem.

10. The grinders in the grinding room should be overhauled and the dump end enclosed in order to control the amount of dust escaping into the workroom. Eye protection is necessary in order to protect workers from kickback at the feed end.

11. Noise levels in the area of presses 6 and 8 should be measured to insure that 8-hour time weighted average noise exposure is not in excess of 85 dBA, NIOSH's recommended exposure limit.

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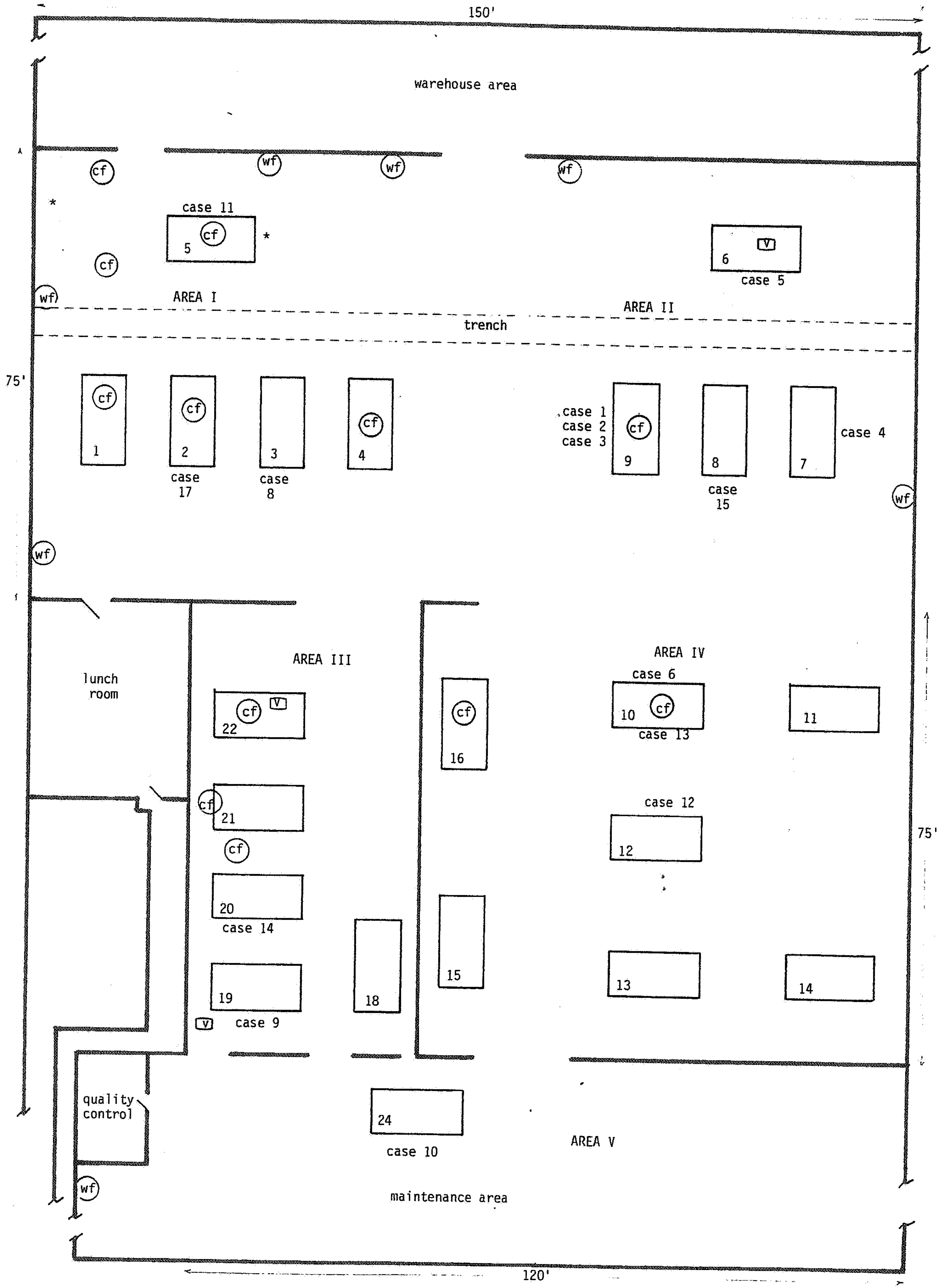
Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Carey Plastics Division of Toledo Molding and Die Corporation
2. United Automobile Workers Union, local 2021
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.



case 7 and 16 - floorwalkers, locations unknown

cf - ceiling exhaust fan
wf - wall exhaust fan
v - ceiling vent
* - location of case known but time of symptoms not known

FIGURE 1

PRODUCTION FLOOR DIAGRAM
CAREY PLASTICS, CAREY, OHIO

Table 1

Injection Molding Machine Information
Carey Plastics Division
Carey, Ohio
HETA 85-108

December 18, 1984

Machine No. Size of Machine	Required	No. Operators	Type Plastic Used (ton)
1	3	GP Polypropylene	800
2	3	GP Polypropylene	800
3	3	20% Talc filled	450
4	2	GP Polypropylene	450
5	2	20% Talc filled	1000
6	3	GP Polypropylene	1500
7	1	Carbon black filled	300
8	1	20% Talc filled	450
9	2	20% Talc filled	450
10	3	GP Polypropylene	1000
11		20% Talc filled	75
12	2	GP Polypropylene	650
13	1	20% Talc filled	700
14		GP Polypropylene	300
15	1	40% Talc filled	650
16	4	GP Polypropylene	1000
18	2	20% Talc filled	400
19	2	GP Polypropylene	300
20	3	20% Talc filled	400
21	1	40% Talc filled	400
22	1	GP Polypropylene	450
24	3	GP Polppropylene	1000

* General Purpose

Table 2

Sampling and Analytical Parameters
Carey Plastics Division
Carey, Ohio
HETA 85-108

December 18, 1984

Substance	Method	Reference
Chlorinated solvents and bulk trench liquid	Collection on activated charcoal, CS_2 desorption; gas chromatography/mass spectroscopy with flame ionization detector and DB-1 fused silica cap column	unpublished
Formaldehyde	collection on ORBO-22 tubes, isooctane desorption; gas chromatography with flame ionization detector and Durawax DX-4 fused silica cap column	(1)
Carbon monoxide, sulfur dioxide, hydrogen disulfide	detector tubes	

Table 3

Carey Plastics Division
Carey, Ohio
HETA 85-108

December 18, 1984

Operator at:	Sample Duration (min)	Substance Concentration (mg/M3): 1,1,1-Trichloro-ethane	Trichloro-ethylene	Tetrachloro-ethylene	Toluene	C-9 Alkanes	Methylene Chloride	Formalde-hyde
First Shift								
Press 19	323	10	<1	<1	<1	1	4	
Press 18	320	<1	<1	<1	<1	<1	ND	
Press 21	315	ND	<1	<1	<1	<1	ND	
Press 20	315	<1	<1	<1	<1	<1	<1	
Second Shift								
Press 8	374	9	ND	ND	<1	<1	4	
Press 4	62	ND	ND	ND	ND	ND	ND	
Press 18	369	9	<1	<1	<1	<1	2	
Press 19	368							<0.1
press 10	368							<0.1
Press 6	373							<0.1
Lower limit of quantitation		0.5	0.3	0.3	0.5	0.1	0.5	0.08
Recommended exposure limit		1910** (NIOSH)	*** (NIOSH)	*** (NIOSH)	375 (NIOSH)	350 (NIOSH)	261 (NIOSH)	*** (NIOSH)

*Nondetectable
**Not to be exceeded for any 15 minute period during the work day.
***Lowest feasible level, potential human carcinogen.

Table 4

Responses of Sample of Eleven Affected Workers
to a Symptom Questionnare
Carey Plastics Division
Carey, Ohio
HETA 85-108

December 18, 1984

Symptom	Number Affected	% Affected
Headache	9	82
Dizziness or lightheadedness	8	72
Itching or burning eyes	7	64
Dry, scratchy, or burning throat	7	64
Irritated or burning nose	6	55
Chest tightness	6	55
Fatigue	6	55
Nausea	5	45
Drowsiness	4	36
Cough	3	27
Pain or burning in ears	3	27
Uncontrolled belching	2	18
Confusion	1	9

Table 5

Carboxy-hemoglobin Levels from Workers at Carey Plastics seen at Blanchard Valley or Wyandot Emergency Rooms
Carey Plastics Division
Carey, Ohio
HETA 85-108

December 18, 1984

	Hospital A Carboxy-hemoglobin (%)		Hospital B Carboxy-hemoglobin (%)
Smokers	10.8	Smokers	8.6
	11.7		9.4
	6.0		5.7
	7.2		11.0
	10.5		
	13.9		
	6.7		
Average	9.5	Average	8.7
Nonsmokers	4.6	Nonsmokers	2.1
	4.5		1.4
	3.8		
	3.4		
Average	3.4	Average	1.8