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CENTERS FOR DISEASE CONTROL
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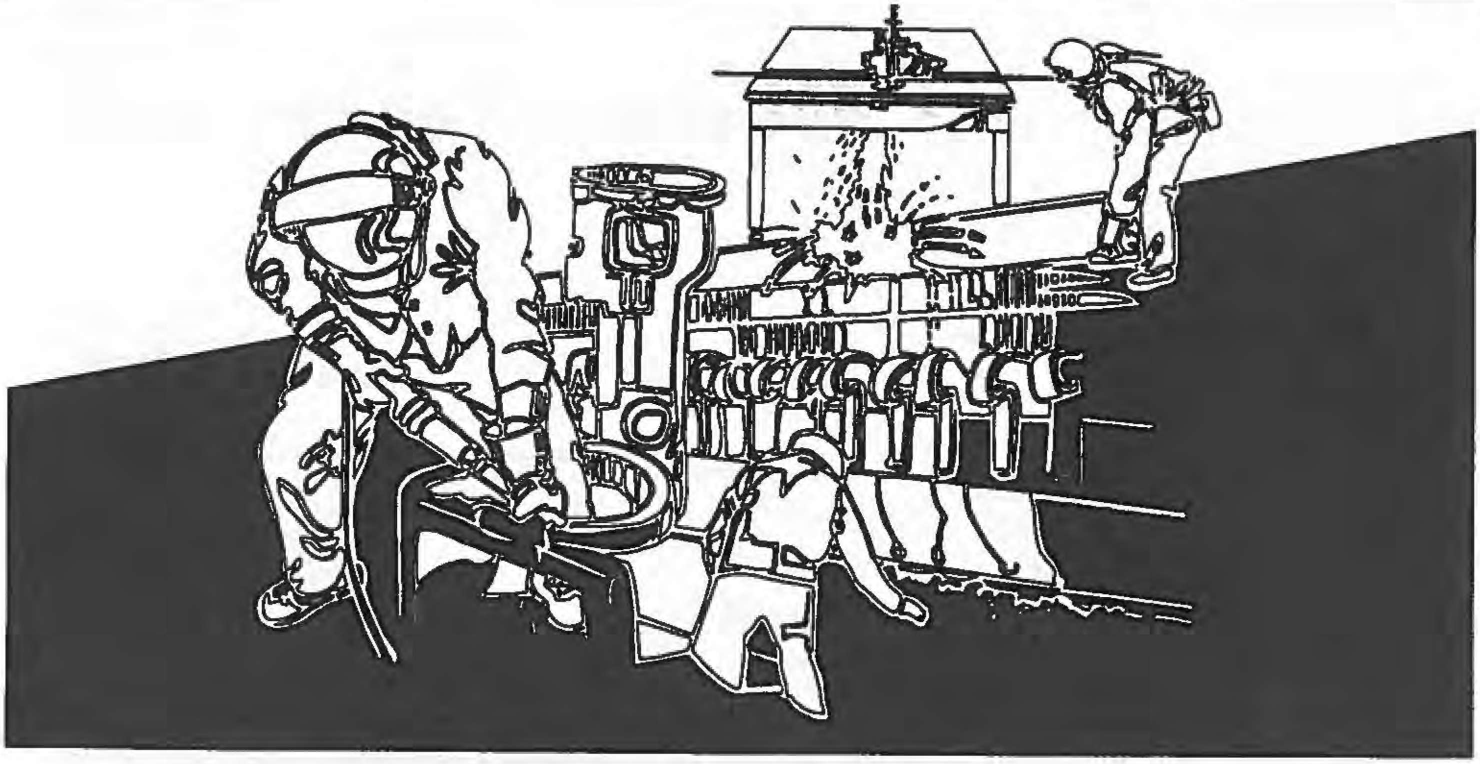
NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 91-0377-2383
GENEVA RUBBER COMPANY
GENEVA, OHIO



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

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 and 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 91-0377-2383
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GENEVA RUBBER COMPANY
GENEVA, OHIO

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I. SUMMARY

On September 5, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees at the Geneva Rubber Company located in Geneva, Ohio, to conduct a Health Hazard Evaluation (HHE). The request concerned worker exposures to rubber fumes generated in the injection-press area of the facility.

On December 17, 1991, a walkthrough survey and preliminary air sampling in the injection-press area was performed. On October 27-28, 1992, NIOSH investigators conducted a follow-up visit to evaluate personal exposures to volatile organic compounds (VOCs), carbon disulfide (CS_2), and amines in areas that include the injection-press area, the paint room, and the degreaser area. Measurements for respirable dust were made using a real-time aerosol monitor (RAM). In addition, 15 employees were interviewed confidentially by a NIOSH occupational physician.

Personal breathing zone (PBZ) samples collected on six workers in the injection-press area revealed low concentrations of tetrachloroethylene, toluene, 1,1,1-trichloroethane (1,1,1-TCE), and xylene. Nine full-shift PBZ samples collected in the degreaser area and the paint room detected concentrations of tetrachloroethylene, methyl isobutyl ketone (MIBK), methylene chloride ($MeCl_2$), xylene, and methyl ethyl ketone (MEK). Air concentrations of these individual substances were below their respective Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) and NIOSH recommended exposure limits (RELs), with the exception of tetrachloroethylene and $MeCl_2$. NIOSH classifies tetrachloroethylene and $MeCl_2$ as potential occupational carcinogens, and recommends that exposures to these substances be reduced to the lowest feasible level (LFL). Toluene exposures ranged up to 60 parts per million (ppm); some painters' exposures exceeded the American Conference for Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 50 ppm. Respiratory protective equipment was not used.

Since tetrachloroethylene, toluene, 1,1,1-trichloroethane, MIBK, $MeCl_2$, xylene, and MEK all affect the central nervous system (CNS), a combined TLV for mixtures (TLVm) was calculated. Three workers in the paint room each had a combined TLVm that exceeded the unity value of 1, indicating overexposure to a mixture of solvents.

Six full-shift PBZ air samples for CS_2 in the injection-press area revealed time-weighed average (TWA) concentrations that ranged from up to 0.79 ppm, with a mean concentration of 0.30 ppm. All CS_2 concentrations were below the OSHA PEL

of 4 ppm and the NIOSH REL of 1 ppm. Qualitative analyses of air samples for amines detected dimethylamine and dibutylamine. Quantitative analyses for amines could not be performed due to analytical limitations.

Real-time respirable dust measurements that were made in the abrasive blasting area ranged from 0.016 to 0.017 mg/m^3, and respirable dust concentrations in the Wheelobrator® area ranged from 0.45 mg/m^3 to 7 mg/m^3. There are no current ceiling limits for respirable dust that are adopted by OSHA.

The most commonly reported symptoms experienced by injection-press workers were irritation of the mucous membranes, cough, shortness of breath, sinus congestion, and sinus congestion with drainage.

Based on the environmental data obtained during this investigation, NIOSH investigators concluded that no specific substance(s) clearly accounted for the irritant and respiratory symptoms reported by injection-press workers. NIOSH investigators suspect that the symptoms reported were associated with occupational exposure to amine compounds, rubber pyrolysis products, or a combination of known and unknown substances. Environmental data show that paint room workers were overexposed to a mixture of organic solvents that affect the CNS. Recommendations are made in section IX of this report to: (1) provide direct exhaust ventilation in the injection-press area, (2) improve exhaust ventilation in the paint room and at the degreaser tank, (3) provide proper personal protective equipment, and (4) further evaluate worker exposures to rubber fumes and other air contaminants.

KEYWORDS: SIC 3567 (Rubber Curing Oven), rubber curing, vulcanization, spray painting, volatile organic compounds, amines, degreasing, tetrachloroethylene, organic solvents, carbon disulfide.

II. INTRODUCTION

In August 1991, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from a group of employees at the Geneva Rubber Company located in Geneva, Ohio, to conduct a Health Hazard Evaluation (HHE). The request concerned worker exposures to rubber fumes generated during rubber curing in the injection-press area of the facility. Workers felt that rubber fume generation had increased as a result of a process change which reduced the curing time from 120 to 55 seconds. A number of workers in the injection-press area had experienced symptoms including nose bleeds, chest pains, and nasal irritation that they believed were associated with the reduced curing time.

On December 17, 1991, an initial site visit was made by NIOSH investigators to conduct preliminary air sampling in the injection-press area. Air sampling results revealed that injection-press operators were exposed to relatively low concentrations of volatile organic compounds (VOCs) that were reportedly used in the degreaser area and paint room. An interim letter dated August 28, 1992, presented the results from the initial NIOSH evaluation and discussed plans for a follow-up evaluation. On October 27-28, 1992, NIOSH investigators made a follow-up visit to the plant to conduct a more comprehensive evaluation. An interim report dated June 22, 1993, presented the results of the follow-up NIOSH evaluation.

III. BACKGROUND

The Geneva Rubber Company manufactures molded rubber parts for appliances used in marine, electrical, and automotive products. The plant is an 18,000 square foot facility that (at the time of this survey) employed approximately 85 workers on an overlapping three shift schedule of 8.3 hours per day, five days per week.

Twelve workers on each shift were assigned in the injection-press area that included nine automatic steam-heated injection-presses. Generally, five presses were used during each shift, with one to three workers assigned to a press. During both NIOSH visits, three types of uncured ethylene-propylene-diene modified rubber (EPDM) stock (stock numbers 2632, 7443, and 7510) were in use. Rubber stock was heated to about 400°F with a curing time of about 55 seconds.

Several types of primer paints and paint thinners were used in the paint room adjacent to the injection-press area. The paint room had three work stations that included two small paint booths and a work bench. Spray painting was performed at the two paint booths that were equipped with local exhaust ventilation. Tasks such as dip painting were performed at the work bench that was equipped with down-draft exhaust ventilation. During dip painting, metal parts were manually immersed into paint that contained toluene. Generally, there were two to three workers assigned in the paint room. Painters wore hearing protection and safety glasses; however, respiratory protective equipment was not worn during the NIOSH investigation.

The degreaser area, located in the center of the facility, had a vapor degreaser tank that contained tetrachloroethylene. Metal parts were cleaned in the degreaser, which was operated by a platter operator, prior to adding rubber components. Above the top opening of the degreaser tank were two slot ventilation hoods that ran the length of the tank, and were ducted directly to the roof outdoors. The local exhaust system was reportedly always in operation. Located at the ceiling approximately 10 feet above the degreaser tank was a fan that exhausted room air directly to the outdoors. The degreaser tank was equipped with access doors that generally remained closed. The degreaser tank was used daily during the first shift only. Approximately 100 gallons of tetrachloroethylene were reportedly used each month.

Records on the operating specifications for the local exhaust ventilation in the paint room and the degreaser area were not available.

Adjacent to the degreaser tank was an abrasive blasting operation. Prior to assembling rubber components onto metal parts, two workers blasted metal parts using aluminum oxide shot in a small abrasive blasting cabinet.

Located near the abrasive blasting operation was a Wheelobrator® machine that was used to deflash or remove unwanted rubber on molded, rubber parts using aluminum oxide steel shot. Rubber parts were cooled using liquid nitrogen inside the Wheelobrator®. Ten to fifteen loads of rubber were deflashed each day by a worker who reportedly worked 12 hours per day, 6 days per week. This area was cleaned daily after each shift using a broom.

IV. EVALUATION DESIGN AND METHODS

A. Initial Site Visit

On December 17, 1991, NIOSH investigators made an inial site visit to conduct a walkthrough survey and to collect general-area (GA) air samples for VOCs. Air samples for VOCs were collected on 150 milligram (mg) charcoal tubes for a period of about 2 hours, using battery powered air sampling pumps calibrated at a flowrate of 80 cubic centimeters (cc) per minute. Charcoal tube air samples were submitted for qualitative screening for VOCs and quantitative analyses based on VOC screening results. Gas chromatography/mass spectrometry (GC/MS) was used for qualitative analyses and a gas chromatograph equipped with a flame ionization detector (GC/FID) was used for quantitation.

Bulk material samples of three uncured rubber stocks were collected and submitted to the NIOSH analytical laboratory for qualitative analyses. To simulate the curing process, portions of each bulk sample were weighed, place in glass tubes, and heated at 400°F for a period of 10 minutes. Air samples of the emissions were subsequently analyzed using a Perkin-Elmer ATD 400 automatic thermal desorber interfaced directly to a HP5890A gas chromatograph and HP5790 mass selective detector (TD-GC-MSD).

B. Follow-up Site Visit

On October 27-28, 1992, NIOSH investigators made a follow-up visit to measure worker exposures to VOCs, carbon disulfide (CS_2), and amines, and to conduct confidential employee interviews. Real-time measurements for respirable dust were also made at the abrasive blasting and the Wheelobrator® machine.

Environmental monitoring was conducted during the entire first shift on October 27 and 28, 1992. VOC sampling was performed in the injection-press areas, the degreaser area, and the paint room. Air sampling for CS_2 and amines was conducted only in the injection-press area.

During the follow-up visit, 16 full-shift personal breathing-zone (PBZ) samples for VOCs were collected. Air samples for VOCs were collected and analyzed following the methods used in the initial survey. Six full-shift PBZ air samples for CS_2 were collected on charcoal tubes, using battery-powered air sampling pumps calibrated at a flowrate of 50 cc per minute. Dryer tubes were used during sampling for CS_2 as required by NIOSH method 1600.[1] Air samples were analyzed according to NIOSH method 1600 with modifications. The analyses were performed using gas chromatography with flame photometric detection. Draeger® colorimetric detector tubes were also used to evaluate worker exposure to CS_2. The colorimetric tubes had a minimum detection limit of 3 ppm.

Three GA air samples for amines were collected approximately 2-3 feet above injection-presses. Samples were collected on stainless steel thermal desorption tubes at a flowrate of 60 cc per minute. Samples were analyzed qualitatively using an automatic thermal desorption system interfaced directly to a gas chromatograph with a mass selective detector (TD-GC-MSD). Currently there are no reliable NIOSH analytical methods to quantify the amines of interest in this survey. NIOSH chemists are currently attempting to develop appropriate sampling methods to quantify these amines.

Respirable dust measurements were made to assess airborne concentrations at the Wheelobrator®. Measurements were made by using a direct reading GCA Environmental Instruments Model RAM-1 monitor. This portable, battery-operated instrument assesses changes in airborne particle concentrations via an infrared detector, centered on a wavelength of 940 nm. Air is sampled (2 liters per min) through a cyclone preselector, and then passes through the detection cell. Operating on the 0-2 mg/m^3 range with a 32-second time constant yields a resolution of 0.001 milligrams per cubic meter (mg/m^3).

Confidential medical interviews were conducted with 15 current employees selected by the union representative (11 from the injection press area, 3 from the Wheelobrator® area, and 1 from the degreaser area). Past and current medical history, current symptoms, and workplace hazards were reviewed at that time. Additionally, medical records of several employees who had recently visited a hospital Emergency Department were reviewed.

V. EVALUATION CRITERIA

A. General

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to ten hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),(2) (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),(3) and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).(4) The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in the report, industry is legally required to meet those levels specified by the OSHA standard. The applicable NIOSH, OSHA, and ACGIH exposure criteria are presented in Tables II and III.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a chemical substance during a normal 8- to 10-hour workday.

It should be noted that the current 8-hour TWA PELs for tetrachloroethylene, toluene, and MIBK are 100 ppm, 200 ppm, and 100 ppm, respectively. Under the Air Contaminants Standard passed in 1989, OSHA had lowered the PELs for tetrachloroethylene to 25 ppm, toluene to 100 ppm, and MIBK to 50 ppm. In July 1992, the 11th Circuit Court of Appeals vacated this standard. OSHA is currently enforcing the earlier standard for these substances; however, some states operating their own OSHA approved job safety and health programs will continue to enforce the more stringent exposure limits. OSHA continues to encourage employers to also follow the more stringent limits. NIOSH considers tetrachloroethylene to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest feasible limit.

B. Substance Specific Evaluation Criteria and Health Effects Summary

A list of the substances evaluated in this survey is presented in Table I, along with a brief summary of primary health effects. For VOCs, only those compounds which were found in significant concentrations are included in Table I.

C. Threshold Limit Values for Mixtures

When two or more hazardous substances which act upon the same organ system are present, their combined effect, rather than that of each individually, should be given primary consideration. In the absence of information to the contrary, the effects of the different hazards should be considered as additive. That is, if the sum of the following fractions,

$$C_1/T_1 + C_2/T_2 + \cdots C_n/T_n$$

exceeds the value of 1, then the threshold limit of the mixture (TLVm) should be considered as being exceeded. C_n indicates the observed atmospheric concentration and T_n the corresponding threshold limits.(2)

VI. RESULTS

Qualitative analyses of two GA air samples collected in the injection-press area during the initial site visit revealed the presence of toluene and tetrachloroethylene, with trace quantities of 1,1,1-trichloroethane and xylene isomers. Subsequent quantitative analysis of a GA air sample collected at the hood opening of injection-press #5 revealed concentrations of toluene and tetrachloroethylene of 0.54 ppm and 0.76 ppm, respectively. A GA air sample taken at the scale area located approximately 40 feet from injection-press #5 revealed concentrations of toluene and tetrachloroethylene of 0.25 ppm and 1.20 ppm, respectively. The presence of toluene and tetrachloroethylene is most likely due to the fact that the injection-press area was located approximately 200 feet from the paint room and the degreaser tank that contained tetrachloroethylene. The following substances were identified from the heated uncured rubber stocks: dimethylamine, dibutylamine, piperidine, cyclohexylamine, hydrogen sulfide, CS_2, carbonyl sulfide, cyclohexane, and methyl isobutyl ketone (MIBK).

Results of full-shift exposure monitoring for VOCs during the follow-up visit are presented in Tables II and III. Full-shift PBZ samples collected on workers in the injection press area detected low concentrations of several substances that include tetrachloroethylene, toluene, 1,1,1-trichloroethane (1,1,1-TCE), and xylene. PBZ samples collected on workers in the degreaser area and the paint room detected concentrations of tetrachloroethylene, MIBK, methylene chloride ($MeCl_2$), xylene, and methyl ethyl ketone (MEK). Trace amounts of p-chlorotoluene and n-butyl acetate were also detected on some samples. The concentration of individual substances were below the respective OSHA PELs and NIOSH RELs, with the exception of tetrachloroethylene and $MeCl_2$. NIOSH classifies tetrachloroethylene and $MeCl_2$ as potential carcinogens, and recommends that exposures to these substances be reduced to the lowest feasible limit (LFL). Worker exposures to toluene ranged from none detected to 60 parts per million (ppm); some painters' exposures exceeded the ACGIH TLV of 50 ppm.

Some of the samples exceeded the TLVm of 1 for a mixture of tetrachloroethylene, toluene, 1,1,1-trichloroethane, MIBK, $MeCl_2$, xylene, and MEK. These substances all affect the central nervous system (CNS), and they are assumed to be additive for the purposes of this investigation. Tetrachloroethylene, toluene, and MIBK also affect the liver and kidneys. As previously stated, tetrachloroethylene and $MeCl_2$ are classified as potential carcinogens. When considering the additive effects of these substances, three worker overexposures were documented in the paint room.

Full-shift PBZ air sampling results for CS_2 revealed time-weighed average (TWA) concentrations that ranged from none detected to 0.79 ppm, with a mean concentration of 0.30 ppm. All CS_2 concentrations were below the OSHA PEL of 4 ppm and the NIOSH REL of 1 ppm. CS_2 was not detected on the colorimetric tubes.

Qualitative analyses of air samples for amines detected dimethylamine and dibutylamine. As previously stated, there are no reliable NIOSH methods to quantify these amines.

Since the dust collector inside the Wheelobrator® was not functioning (and had reportedly been out of operation for several months), dust was observed discharging out of the Wheelobrator® door. Measurements for real-time respirable dust made in the vicinity of the Wheelobrator® ranged from 0.45 to 7 mg/m^3. There are no current ceiling limits for respirable dust that are adopted by OSHA.

Many of the 15 employees interviewed reported symptoms which they believed to be associated with exposures at work. Generally, these symptoms improved with time away from work (for example, on weekends). The most commonly reported symptoms were irritation of the mucous membranes (i.e., watery eyes or nasal burning), cough, shortness of breath, and sinus congestion and drainage. The most commonly implicated workplace exposure was the rubber fumes from the injection-presses. Type and degree of symptoms did not seem to vary among the interviewed employees, regardless of their specific work area. Medical records were reviewed from several employees who had hospital Emergency Department visits for symptoms potentially related to occupational exposures. Discharge diagnoses included upper and lower respiratory involvement. However, no definitive testing was completed to verify diagnoses, especially related to lower respiratory symptomology. No other medical records were available for review.

VII. DISCUSSION AND CONCLUSION

In the rubber curing industry, the total number of compounds that may conceivably be released during rubber curing can be as many as 1000.(5) These compounds may include amines, ammonia, organic sulfides, hydrocarbons, acids, and esters. It is clearly infeasible to investigate each of the compounds formed that are used in the industry. Because so many reaction products are produced during a curing process, it is difficult to predict the identities of those released in amounts sufficient to affect workers' health. In addition, air sampling methods do not currently exist for some of these potential air contaminants.

Initially, the NIOSH evaluation focused on the assessment of personal exposures to rubber fumes during the curing process. Preliminary GA sampling results revealed the presence of tetrachloroethylene and toluene in the injection-press area. Based on the results of the laboratory simulated curing process, where toluene and tetrachloroethylene were not detected, it was concluded that these substances were not components of the rubber fumes. The paint room and the degreaser area, both located approximately 200 feet from the injection-press area, were more probable sources of these solvents.

Based on the environmental data obtained during this survey, paint room workers, in particular, were overexposed to a mixture of solvents. However, no specific substance(s) clearly accounted for the irritant and respiratory symptoms reported by injection-press workers. Qualitative analyses of full-shift air samples collected for amines during the follow-up visit detected dimethylamine and dibutylamine. Symptoms reported by workers such as nosebleeds, and irritation of the mucous membrane and respiratory tract are consistent with the health effects associated with amines.(6)

VIII. RECOMMENDATIONS

1. The most effective strategy for controlling occupational exposure to any toxic substance is to use a less toxic substance. If feasible, a less toxic degreaser solvent should be considered to eliminate the exposures associated with tetrachloroethylene. For assistance in selecting a substitute, the journal article entitled "An Analytical Approach for Reducing Workplace Health Hazards Through Substitution" can be consulted.(7)

2. NIOSH recommends that worker exposure to tetrachloroethylene be reduced to the lowest feasible limit. Tetrachloroethylene concentrations were measured at almost every work area where air sampling was conducted. It is presumed that engineering controls at the degreaser tank were not effective in controlling these solvent vapors. The exhaust ventilation system at the degreaser tank should be evaluated to ensure that it operates according to specifications recommended by the ACGIH.(8) Appendix A contains examples of ventilation designs applicable to a variety of industrial operations, including degreasing and spray painting. These ventilation designs were obtained from Industrial Ventilation: A Manual of Recommended Practice (20th Edition), a document published by ACGIH.

3. Efforts should be made to reduce worker exposure to paint solvents and thinners used in the paint room. To ensure the engineering controls (i.e., spray paint booths and downdraft exhaust ventilation) provided in the paint room operate according to specifications recommended by ACGIH (see Appendix A), the exhaust ventilation at the three workstations should be evaluated by a person knowledgeable in industrial ventilation.(8)

4. Local exhaust ventilation should be provided at each injection-press to minimize worker exposure to rubber pyrolysis products from the curing process. Based on the employee interviews, rubber pyrolysis products from the curing ovens contributed to the symptoms experienced by the workers.

5. Until actions are taken that will reduce solvent exposures below the applicable exposure criteria (ACGIH), a respiratory protection program should be written and implemented for workers in the paint room that is consistent with OSHA requirements and NIOSH recommendations.(9,10) A respiratory protection program should include the following:

   (a) medical evaluation to determine individual worker's ability to use a respirator and to perform the work required when wearing a respirator

   (b) regular training of personnel

   (c) respirator fit testing

   (d) periodic environmental monitoring

   (e) proper maintenance, inspection, cleaning, and storage of respirators.

   The appropriate type of respirator for these workers is an air purifying respirator equipped with cartridges designed to protect against organic vapor and paint spray. It should be noted that respiratory protection should not be used as the primary means of controlling exposures.

6. A worker in the paint room was observed using paint containing toluene for several hours without protective gloves. Also, the platter operator was observed wearing cloth gloves while handling metal parts that were wet with tetrachloroethylene. Repeated or prolonged skin contact with toluene or tetrachloroethylene causes drying and dermatitis.(6) The absence of protective gloves or the use of gloves made of cloth material while handling solvents or paints is not recommended. Workers who handle parts that are wet with solvents should be provided with protective gloves that are resistant to permeation by these solvents. If proper protective clothing is not selected, toxic chemicals can be absorbed through the skin. Glove materials that offer good permeation resistance to both toluene and tetrachloroethylene include polytetrafluoroethylene (Teflon®) and fluorocarbon rubber (Viton®). While these glove materials offer better permeation resistance, a glove's resistance to cuts, snags, abrasions, punctures, or tears must also be considered. Another factor is an adequate sleeve (or cuff) length to protect the forearm from solvent exposure.

7. A worker was observed smoking near the degreaser tank where a NO SMOKING sign was located. Although the tetrachloroethylene solvent in the degreaser tank is classified as a non-combustible liquid, the use of tobacco products, as well as eating and drinking while working, can increase worker exposure by way of ingestion. Workers who work with paints, solvents, or other hazardous substances should be encouraged to wash hands and face prior to these activities. Because environmental tobacco smoke is classified as a carcinogen, smoking should be prohibited at the worksite, or at least restricted to smoking lounges that are separately ventilated.[17]

8. A worker operating the Wheelobrator® was wearing a dust/mist mask that was not certified by NIOSH or the Mine Safety and Health Administration (MSHA). Workers should only use respirators that have been certified by NIOSH. In addition, the dust collector motor in the Wheelobrator® should be serviced to help reduce dust generation.

9. Because sweeping with a broom will disperse dust into the air and can elevate worker exposure to dust, this should be avoided when cleaning the Wheelobrator® area. To help reduce worker exposure to dust while cleaning, a vacuum cleaner should be used.

10. Full-shift PBZ air sampling for total and respirable particulates was not performed on abrasive blasters and the Wheelobrator® operator. PBZ measurements should be conducted by Geneva Rubber Company to assess worker exposures to these particulates.

11. Management should provide a worker education program intended to inform workers about the health risks from exposure to substances in the workplace, the proper use of personal protective equipment, and proper work practice procedures. This should involve more than simply handing out literature for the employees to read. Health care personnel or others knowledgeable about these issues should discuss each of these topics with the employees.

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1. Geneva Rubber Company
2. Confidential requestor
3. 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

HEALTH EFFECTS SUMMARY
GENEVA RUBBER COMPANY
GENEVA, OHIO
HETA 91-377

Substance	Primary Health Effects
Aluminum oxide	Aluminum oxide is classified as a nuisance dust and exposures in humans may cause a nodular response in the lungs.[6]
Carbon disulfide	Carbon disulfide causes harm to the central and peripheral nervous systems and is known to advance the development, or aggravate, coronary heart disease.[6]
Dimethylamine	Dimethylamine is an irritant of the skin, eyes, mucous membranes, and respiratory tract. Prolonged exposure can result in dermatitis and conjunctivitis.[11]
Methylene chloride	Methylene chloride is a mild central nervous system (CNS) depressant, and irritating to the eyes, skin, and respiratory tract. This substance is a known carcinogen in animals and is considered a suspected human carcinogen.[6]
Methyl isobutyl ketone	Methyl isobutyl ketone is a solvent that is irritating to the eyes, mucous membranes, and skin. Exposures at high concentrations it causes narcosis in animals, and it is expected to have the same effect in humans.[12]
Tetrachloroethylene	Tetrachloroethylene (commonly known as perchloroethylene) is a solvent that produces central nervous system depression and liver damage. Exposure can also cause dizziness, light-headedness, and difficulty in walking and speaking.[13]
Toluene	Toluene is a central nervous system depressant. Low to moderate occupational exposure can cause tiredness, headaches, confusion, memory loss, nausea, and loss of appetite.[14]
1,1,1-Trichloroethane	Exposure to 1,1,1-trichloroethane can cause central nervous system depression; at high concentrations it causes lightheadedness, loss of balance and coordination. Studies in animals have shown that damage to the breathing passages and lungs, as well as mild liver effects, can result from breathing chronic exposure to high concentrations.[15]
Xylene	Exposure to xylene is an irritating to the eyes, nose, throat, mucous membranes, and skin. Occupational exposure to xylene has reportedly been known to cause headache, vertigo, stomach, discomfort, and drunkenness. Exposures to high concentrations can causes narcosis.[16]

TABLE II

FULL-SHIFT VOLATILE ORGANIC COMPOUND CONCENTRATIONS
GENEVA RUBBER COMPANY
HETA 91-377

October 27, 1992

Sample Description	Air Volume (liters)	Time-Weighed Average Concentration (ppm)[1]									
		Tetrachloroethylene	Toluene	MIBK	1,1,1-TCE	Xylene	$MeCl_2$	n-Butyl acetate	p-Chlorotoluene	MEK	Mixture TLV[2]
Platter Operator	30.5	3.9	ND[3]	ND	ND	ND	ND	ND	ND	ND	0.08
Abrasive blaster	35.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA[4]
Injection-press Operator	36.8	5.0	0.4	ND	0.2	0.2	ND	ND	ND	ND	0.10
Injection-press Operator	36.6	4.8	ND	ND	ND	ND	ND	ND	ND	ND	0.10
Injection-press Operator	35.8	0.1	0.1	ND	ND	ND	ND	ND	ND	ND	< 0.01[5]
Painter 1	32.3	4.4	17.0	4.3	2.4	4.9	ND	ND	ND	1.2	0.58
Painter 2	36.8	3.7	25.4	9.9	8.9	4.0	2	ND	ND	ND	0.88
NIOSH REL		LFC[6]	100	50	C[7] 350	100	LFC	150	NA[7]	200	
OSHA PEL		100	200	100	350	100	500	150	NA	200	
ACGIH TLV		50	50	50	350	100	50	150	NA	200	

[1] ppm = parts per million
[2] TLV = threshold limit value
[3] ND = none-detected
[4] NA = not applicable
[5] < = less than
[6] LFC = lowest feasible concentration
[7] C = ceiling

TABLE III

FULL-SHIFT VOLATILE ORGANIC COMPOUND CONCENTRATIONS
HETA 91-377
GENEVA RUBBER COMPANY

October 28, 1992

Sample Description	Air Volume (liters)	Time-Weighed Average Concentration (ppm)[1]									
		Tetrachloroethylene	Toluene	MIBK	1,1,1-TCE	Xylene	$MeCl_2$	n-Butyl acetate	p-Chlorotoluene	MEK	Mixture TLV[2]
Injection-press Operator	37.0	1.3	ND[3]	ND	ND	ND	ND	ND	ND	ND	0.03
Injection-press Operator	36.6	0.9	0.5	ND	0.2	ND	ND	ND	ND	ND	0.02
Injection-press Operator	36.0	1.0	0.6	ND	0.2	ND	ND	ND	ND	ND	0.03
Platter Operator	35.9	5.3	0.1	1.6	0.9	0.4	0.3	0.1	ND	ND	0.14
Abrasive blaster	35.8	0.03	0.1	ND	ND	ND	ND	ND	ND	ND	< 0.01[4]
Painter 1	35.6	3.0	52.0	7.4	24	5.3	2.0	0.2	6.6	ND	1.43
Painter 2	35.4	3.8	60.0	12.9	11.8	8.5	1.5	0.2	6.6	ND	1.73
Preparation Metal Painter	34.6	1.0	53.3	37.3	1.1	2.3	0.3	0.2	2	ND	1.89
NIOSH REL		LFL[5]	100	50	C[6] 350	100	LFL	150	NA[7]	200	
OSHA PEL		100	200	100	350	100	500	150	NA	200	
ACGIH TLV		50	50	50	350	100	50	150	NA	200	

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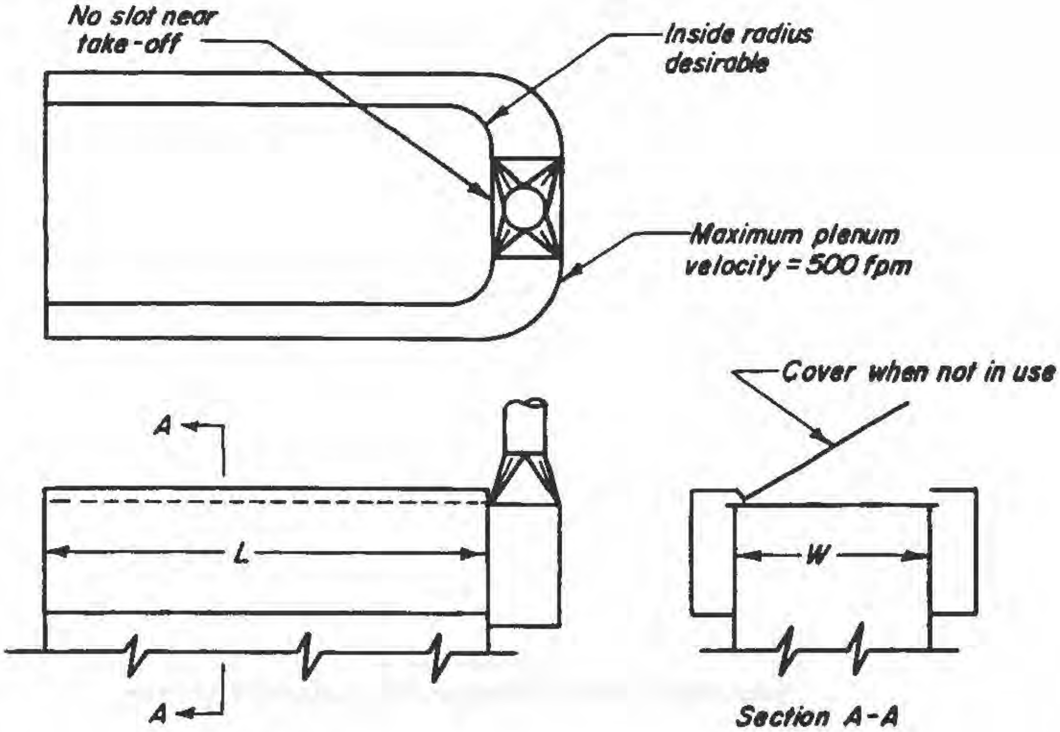
[1] ppm = parts per million
[2] TLV = threshold limit value
[3] ND = none-detected
[4] < = less than
[5] LFL = lowest feasible limit
[6] C = ceiling
[7] NA = not applicable

Appendix A
Selected Local Exhaust Ventilation Designs

Source:
Industrial Ventilation Manual, 20th Edition
American Conference of Governmental Industrial Hygienists



$Q = 50LW$

Slot velocity = 1000 fpm maximum

Entry loss = 1.78 slot VP + 0.25 duct VP

Duct velocity = 2500-3000 fpm

Also provide:
1. Separate flue for combustion products if direct-fired unit.
2. For cleaning operation, an air-line respirator is necessary.
3. For pit units, the pit should be mechanically ventilated.
4. For further safe guards, see VS-501.1

NOTE: Provide downdraft grille for parts that cannot be removed dry; Q = 50 cfm/sq ft grille area.

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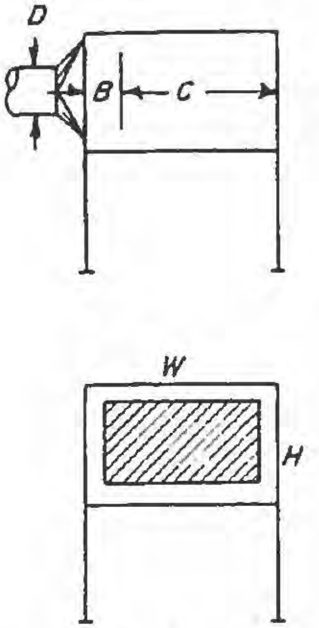
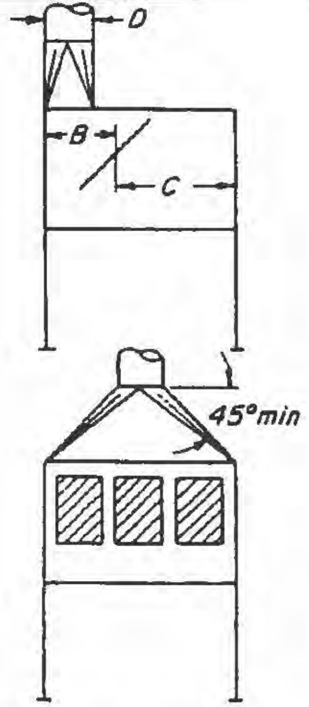
SOLVENT DEGREASING TANKS

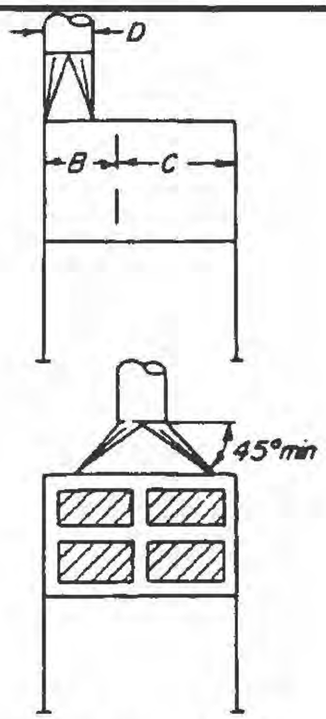
DATE 1-78 | VS-501



1. Solid Baffle
$B = 0.75D$
Baffle area $= 0.60WH$



2. Angular Baffle
$B = D + 6''$
Baffle area $= 0.60WH$



3. Split Baffle or Filters
$B = D + 6''$
Baffle area $= 0.75WH$

For filter area See Note 2

Air spray paint design data

Any combination of branch ducts and baffles may be used
W = work size + 12"
H = work size + 12"
$C = 0.75\ W$ or H, whichever is larger.
Q = 200 cfm/sq ft (200WH) – for face area up to 4 sq ft
= 150 cfm/sq ft – for face area over 4 sq ft
Entry loss = Baffles: 1.78 slot VP + 0.25 duct VP
= Filters: Dirty filter resistance + 0.25 duct VP
Duct velocity = 1000 – 3000 fpm

Airless spray paint design data

Q = 125 cfm/sq ft (125WH) – for face area up to 4 sq ft
= 100 cfm/sq ft – for face area over 4 sq ft

Notes:

1. Baffle arrangements shown are for air distribution only.
2. Paint arresting filters usually selected for 100 - 500 fpm, consult manufacturer for specific details.
3. For construction and safety, consult NFPA(113)

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SMALL PAINT BOOTH

DATE 1-86 | VS-604

Solvent vapor degreasing refers to boiling liquid cleaning systems utilizing trichloroethylene, perchloroethylene, methylene chloride, Freons®, or other halogenated hydrocarbons. Cleaning action is accomplished by the condensation of the solvent vapors in contact with the work surface producing a continuous liquid rinsing action. Cleaning ceases when the temperature of the work reaches the temperature of the surrounding solvent vapors. Since halogenated hydrocarbons are somewhat similar in their physical, chemical, and toxic characteristics, the following safeguards should be provided to prevent the creation of a health or life hazard:

1. Vapor degreasing tanks should be equipped with a condenser or vapor level thermostat to keep the vapor level below the top edge of the tank by a distance equal to one-half the tank width or 36 inches, whichever is shorter.
2. Where water-type condensers are used, inlet water temperature should not exceed 80 F (27 C) and the outlet temperature should not exceed 110 F (43 C). For some solvents, lower water temperatures may be required.
3. Degreasers should be equipped with a boiling liquid thermostat to regulate the rate of vapor generation and with a safety control at an appropriate height above the vapor line to prevent the escape of solvent in case of a malfunction.
4. Tanks or machines of more than 4 ft^2 of vapor area should be equipped with suitable gasketed clean out or sludge doors, located near the bottom, to facilitate cleaning.
5. Work should be placed in and removed slowly from the degreaser, at a rate no greater than 11 fpm (0.055 m/s), to prevent sudden disturbances of the vapor level.
6. CARE MUST BE TAKEN TO PREVENT DIRECT SOLVENT CARRYOUT DUE TO THE SHAPE OF THE PART.
7. Maximum rated workloads as determined by the rate of heat transfer (surface area and specific heat) should not be exceeded.
8. Special precautions should be taken where natural gas or other open flames are used to heat the solvent to prevent vapors* from entering the combustion air supply.
9. Heating elements should be designed and maintained so that their surface temperature will not cause the solvent or mixture to breakdown* or produce excessive vapors.
10. Degreasers should be located in such a manner that vapors* will not reach or be drawn into atmospheres used for gas or electric arc welding, high temperature heat treating, combustion air, or open electric motors.
11. Whenever spray or other mechanical means are used to disperse solvent liquids, sufficient enclosure or baffling should be provided to prevent direct release of airborne vapor above the top of the tank.
12. An emergency quick-drenching facility should be located in near proximity to the degreaser for use in the event of accidental eye contact with the degreasing liquid.

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* Electric arcs, open flames, and hot surfaces will thermally decompose halogenated hydrocarbons to toxic and corrosive substances (such as hydrochloric and/or hydrofluoric acid). Under some circumstances, phosgene may be formed.

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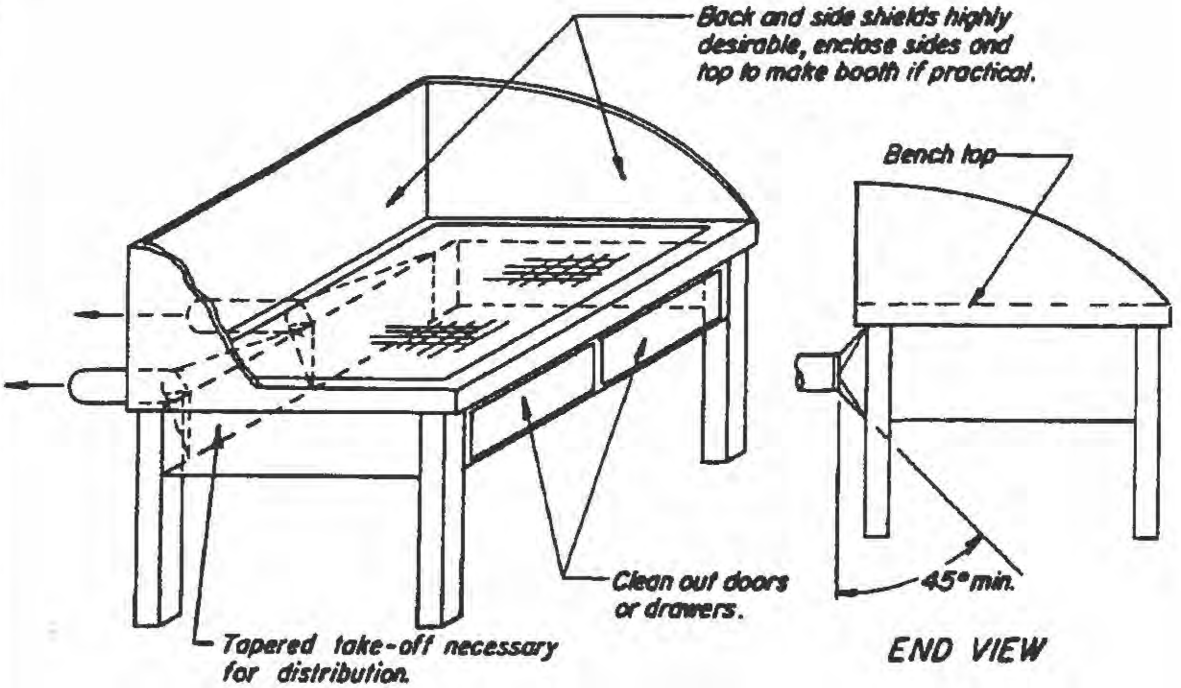
SOLVENT VAPOR DEGREASING

DATE *1-91*
FIGURE *VS-70-21*



Q = 150 - 250 cfm / sq ft of bench area.
Minimum duct velocity = 3500 fpm
Entry loss = 0.25 VP for tapered take-off.

Grinding in booth, 100 fpm face velocity also suitable.

For downdraft grilles in floor: Q = 100 cfm / sq ft of working area.

Provide equal distribution. Provide for cleanout.

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PORTABLE HAND GRINDING

DATE 1-64 | VS-412

Delivering on the Nation's promise:

Safety and health at work
For all people
Through prevention

NIOSH

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