HETA 94-0298-2499
GEN CORP AUTOMOTIVE
WABASH, INDIANA

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.

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

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APRIL 1995
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I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at Gen Corp Automotive in Wabash, Indiana, at the request of the United Rubber, Cork, Linoleum, and Plastic Workers of America, Local 626. An initial site visit on July 6, 1994, revealed potential for exposures to nitrosamines and to the aromatic hydrocarbons methyl isobutyl ketone (MIBK), xylene, toluene, propylene glycol methyl ether acetate (PGMEA), and 1,1,1-trichloroethane (1,1,1-TCE). Spot measurements with a sound level meter also suggested that noise exposure in some areas may be above 85 decibels, A-weighted (dBA).

Based on the initial site visit, a follow-up survey was conducted on November 8, 1994. Personal breathing zone (PBZ) and general area (GA) samples were collected to evaluate nitrosamine exposure in the press room and in the tube room along the salt bath line. The five air samples analyzed for nitrosamines had detectable concentrations of nitrosodimethylamine (NDMA), ranging from 0.11 micrograms per cubic meter ($\mu g/m^3$) to 77.2 $\mu g/m^3$. Personal breathing zone samples were also collected in the guide lamp area, the flock room, the department 239 paint room and glass insert area, and the tube room to evaluate exposures to the aromatic hydrocarbons detected on the qualitative samples from the first site visit. Exposures to aromatic hydrocarbons were either not detected or well below the relevant exposure criteria for all the analytes except 1,1,1-TCE. 1,1,1-TCE was detected in the following work areas: the flock room, at concentrations ranging from 12.1 parts per million (ppm) to 33.2 ppm; the guide lamp area, at concentrations ranging from 7.0 ppm to 72.9 ppm; and in the department 239 paint room, at concentrations ranging from 15.1 ppm to 55.7 ppm for short term samples. Also, some personal noise exposure measurements were collected which revealed that some workers are potentially exposed to noise levels above the NIOSH Recommended Exposure Limit (REL) and the Occupational Safety and Health Administration (OSHA) action level (AL) of 85 dB(A).

Workers are exposed to NDMA in the tube room and in the press room. Better engineering controls are needed to reduce these exposures. Workers were also exposed to 1,1,1-TCE, but since the survey its use has been greatly reduced. In 1995, 1,1,1-TCE is supposed to be completely eliminated, and thus inhalation exposure to organic solvents would be minimal. Dermal exposure to these solvents should also be low with the new glove policy. General design and maintenance of the ventilation systems is poor and needs to be improved, and the company needs to perform a thorough noise survey and implement a complete hearing conservation program in the areas where noise levels exceed 85 dB(A).

KEYWORDS: SIC 3061 (molded, extruded, and lathe-cut mechanical rubber goods), rubber, nitrosamines, nitrosodimethylamine (NDMA), organic solvents, 1,1,1-trichloroethane, noise

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at Gen Corp Automotive in Wabash, Indiana, at the request of the United Rubber, Cork, Linoleum, and Plastic Workers of America (URW), Local 626. At the time, NIOSH was investigating another Gen Corp plant and had found significant exposures to nitrosamines in the salt bath area. Since the rubber stock for this other facility comes from the Wabash plant and since the Wabash plant has one salt bath line, the URW submitted this HHE request. Workers in Wabash were concerned about their potential exposures to nitrosamines and to other chemicals used in the plant.

An initial site visit on July 6, 1994, revealed potential for exposures to nitrosamines in the press room and the tube room, and to the aromatic hydrocarbons methyl isobutyl ketone (MIBK), xylene, toluene, propylene glycol methyl ether acetate (PGMEA), and 1,1,1-trichloroethane (1,1,1-TCE) in various departments. Neither polynuclear aromatic hydrocarbons (PNAs) nor nitrosamines were detected in the mixing area. Spot measurements with a sound level meter also suggested that noise exposure in some areas may exceed 85 decibels, A-weighted (dBA). These results were reported in an interim letter on September 30, 1994.

Based on the initial site visit, a follow-up survey was conducted on November 8, 1994. Personal breathing zone (PBZ) and general area (GA) samples were collected to evaluate nitrosamine exposure in the press room and in the tube room along the salt bath line. Personal breathing zone samples were also collected in the guide lamp area, the flock room, the department 239 paint room and glass insert area, and the tube room to evaluate exposures to the aromatic hydrocarbons detected on the qualitative samples from the first site visit. Also, personal noise exposure measurements were collected.

III. BACKGROUND

The Wabash plant began operating around 1900 as a tire plant, and then it made military equipment during wartime. The current facility is now actually two separate plants – a vibration control (VC) plant and a vehicle sealing (VS) plant. The VC plant has two mixing departments and several molding and finishing departments, including the press room and the guide lamp area. In the mixing departments, rubber stock is made that is used in the rest of the plant and also shipped to other Gen Corp plants. In the other departments, automotive vibration control parts are made. The VS plant has three tube room departments and several molding and finishing departments, including the flock room and department 239 paint room and glass insert. In the tube room there is one salt bath curing line and three gas-fired oven curing lines. In this plant, rubber vehicle sealing is made, molded, and finished. At the time of the survey, there were approximately 800 employees, not counting the office staff.

IV. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ evaluation criteria for the assessment of a number of chemical and physical agents. The primary sources of environmental evaluation criteria for the workplace are the following: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), (2) the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs), and (3) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs).[1,2,3] The objective of these criteria is to establish levels of exposure to which the vast majority of workers may be exposed without experiencing adverse health effects.

Full-shift and shorter duration criteria are available depending on the specific physiologic properties of the agent. Full-shift limits for chemical agents are based on the time-weighted average (TWA) airborne concentration of a substance that workers may be repeatedly exposed to during an eight or 10 hour work day, up to 40 hours a week for a working lifetime, without adverse health effects. Some substances have short-term exposure limits (STELs) or ceiling limits (CLs) which are intended to supplement the full-shift criteria where there are recognized irritative or toxic effects from brief exposures to high airborne concentrations. Short-term exposure limits are based on 15 minute TWA concentrations, whereas CL concentrations should not be exceeded even momentarily.

Occupational health criteria are established based on the available scientific information provided by industrial experience, animal or human experimental data, or epidemiologic studies. Differences between the NIOSH RELs, OSHA PELs, and ACGIH TLVs may exist because of different philosophies and interpretations of technical information. It should be noted that RELs and TLVs are guidelines, whereas PELs are standards which are legally enforceable. The Occupational Safety and Health Administration PELs are required to take into account the technical and economical feasibility of controlling exposures in various industries where the agents are present. The NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility of the affected industries. The ACGIH is not a government agency; it is a professional organization whose members are industrial hygienists or other professionals in related disciplines and are employed in the public or academic sector. The TLVs are developed by consensus agreement of the ACGIH TLV committee and are published annually. The documentation supporting the TLVs (and proposed changes) is periodically reviewed and updated if believed necessary by the committee.

Not all workers will be protected from adverse health effects if their exposures are maintained below these occupational health exposure criteria. A small percentage may experience adverse effects due to individual susceptibility, a pre-existing medical condition, previous exposures, or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, or with medications or personal habits of the worker (such as smoking) to produce health effects

even if the occupational exposures are controlled to the limit set by the evaluation criterion. These combined effects are often not considered by the chemical specific evaluation criteria. Furthermore, many substances are appreciably absorbed by direct contact with the skin and thus potentially increase the overall exposure and biologic response beyond that expected from inhalation alone. Finally, evaluation criteria may change over time as new information on the toxic effects of an agent become available. Because of these reasons, it is prudent for an employer to maintain worker exposures well below established occupational health criteria.

The evaluation criteria for the compounds analyzed during this health hazard evaluation are discussed below.

N-nitrosamines

Nitrosamines are compounds characterized by the -N--N=O functional group. They result from the combination of primary, secondary, or tertiary amines with nitrite. These reactions can occur in the laboratory; in various food, household, or industrial products; in industrial processes; and in vivo. Because of the variety of amines and reaction conditions possible, there are hundreds of nitrosamines; and because of the large number of exposure sources, including formation in vivo, there is a complicated matrix of total nitrosamine exposure. Occupational exogenous exposures have been observed in rubber industries, leather tanning industries, metal working industries, chemical industries, mining, pesticide production, detergent production, and fish factories.

Most nitrosamines are suspected to be human carcinogens, but direct causal associations have not yet been proven. Cancer is believed to be a multistage process, beginning with (1) *exposure* to a carcinogen or procarcinogen and followed by (2) *initiation* of a cell to a genetically altered cell by damage to the DNA; (3) *promotion* of the altered cell to a preneoplastic lesion; (4) *conversion* of the preneoplastic lesion to a malignant tumor through a genetic change; and finally (5) *progression* of the tumor to clinical cancer. Exposure to a carcinogen must result in a genetic change in order to initiate a cell; likewise, there must also be a genetic change for a preneoplastic lesion to convert into a malignant tumor.[4] These genetic changes can occur from spontaneous mutations, and they can also occur with DNA adduct formation from exposure to carcinogens that are initiators or promoters, or both. These genetic changes also must occur in certain chromosomal locations in order to cause the next step in carcinogenicity. Mutations in some of these chromosomal locations have been identified, such as activation of proto-oncogenes or inactivation of tumor suppressor genes, but these and other processes are still being researched.[4]

There are many confounding factors that prevent every exposure to a carcinogen from resulting in clinical cancer. Genetic predisposition—inheritance of certain genetic mutations, variations in activity of metabolizing enzymes and DNA repair enzymes, variations in immunity and immune cell enzymes—plays an important role in the

development or lack of development of cancers. Variations in lifestyle and overall health can also play a part as these may affect immune function and intracellular repair processes.

The suspected mechanism of carcinogenesis of nitrosamines is that nitrosamines, from exogenous or endogenous sources, are metabolized into reactive intermediates which can then covalently bind to macromolecules, including DNA. If the adducts to the DNA result in a genetic mutation during the replication process, and if that mutation is in certain areas of the genome, the cell could undergo the second and third stages of carcinogenesis—initiation and promotion. If there was a second genetic change in the right place, conversion to a malignant tumor could result.

Although a causal association between nitrosamine exposure and human cancer has not yet been firmly established, there is circumstantial evidence that nitrosamines could cause cancer in humans. In 1956, Magee and Barnes demonstrated the carcinogenic potential of nitrosodimethylamine (NDMA) in rats.[5] Since then, nitrosamines have been studied extensively in laboratory animals. Approximately 90% of the 300 tested nitrosamines have shown carcinogenic effects in bioassays and laboratory animals. The animals that have been studied include mammals, birds, fish, and amphibia. Of the approximately 40 animal species tested, none has been resistant. The tumor sites depend on the specific nitrosamine, the species tested, and the route of administration. Nitrosamine affects have been demonstrated in the bladder, bronchi, central nervous system, earduct, esophagus, eyelid, duodenum, forestomach, glandular stomach, hematopoietic system, intestine, jaw, kidney, larynx, nasal cavity, oral cavity, ovary, liver, mammary glands, pancreas, pelvis, peripheral nervous system, pharynx, respiratory tract, skin, testes, trachea, uterus, and vagina.[6] Dose-response studies with rats have shown “no effect levels” corresponding to dietary concentrations of 1 parts per million (ppm) NDMA, 1 ppm NDEA, and 1 ppm nitrosopyrrolidine (NPYR).[6] These n-nitrosamines and others appear to be very potent carcinogens.

All of the biochemical, pathological, and experimental data provides little evidence that humans might be resistant to the carcinogenic potential of nitrosamines.[7] Human tissues from the trachea, bronchus (lung), esophagus, colon, pancreatic duct, bladder, and buccal mucosa have been shown to metabolize nitrosamines into DNA-binding compounds.[7] Human liver tissue appears to metabolize nitrosamines with a similar activity to rodent liver tissue, and rodents have similar acute symptoms of liver necrosis and cirrhosis similar to those that have been observed in humans.[7] A few human DNA adduct studies have revealed higher levels of nitrosamine-related DNA adducts in cancer cases than in controls.[8,9] Studies in experimental animals have shown similar DNA adduct formation to those detected in the human studies.[10-12]

Only one nitrosamine, nitrosodimethylamine, is regulated in the United States. Both OSHA and NIOSH regulate NDMA as an occupational carcinogen, recommending

that its exposure be reduced to the lowest feasible concentration. There are no established numerical exposure limits in this country.

Germany has strict regulations for occupational exposures to nitrosamines. In general industry, the total exposure to all nitrosamines present may not exceed 1 microgram per cubic meter ($\mu g/m^3$). In special cases, such as the tire storage warehouses, exposures to all nitrosamines present may not exceed 2.5 $\mu g/m^3$. In addition to these regulations, eight nitrosamines are regulated individually—nitrosodimethylamine, nitrosomorpholine, nitrosopiperidine, phenyl-ethylnitrosamine, phenyl-methylnitrosamine, di-N-butylnitrosamine, di-iso-propylnitrosamine, diethylnitrosamine.

Organic Solvents

Methyl isobutyl ketone (MIBK), xylene, toluene, propylene glycol methyl ether acetate (PGMEA), and 1,1,1-TCE are all organic solvents. Exposure to organic solvents can occur through inhalation of the vapors and absorption through the skin. Acute effects from exposure to high concentrations of solvents often include anesthesia, central nervous system (CNS) depression, impaired motor function, respiratory arrest, unconsciousness, and death.[13] At lower concentrations, symptoms of dizziness, headaches, fatigue, lightheadedness, weakness, poor concentration, and mucous membrane irritation may occur.[13,14] Chronic effects that have been reported among some workers exposed to organic solvents include peripheral neuropathies, organic affective syndrome, and mild chronic toxic encephalopathy. Organic affective syndrome is characterized by fatigue, memory impairment, irritability, difficulty in concentration, and mild mood disturbance. Mild chronic toxic encephalopathy is manifested by sustained personality or mood changes such as emotional instability, diminished impulse control and motivation, and learning capacity. The extent to which chronic neurotoxicity is reversible remains to be established.[13]

The relevant evaluation criteria for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE are listed in Table 1.

Table 1. Relevant Evaluation Criteria – NIOSH Recommended Exposure Limits (RELs), OSHA Permissible Exposure Limits (PELs), and ACGIH Threshold Limit Values (TLVs) – for Select Aromatic Hydrocarbons.

Compound	NIOSH REL	OSHA PEL	ACGIH TLV
MIBK	50 ppm TWA 75 ppm STEL	100 ppm TWA	50 ppm TWA 75 ppm STEL
xylene	100 ppm TWA 150 ppm STEL	100 ppm TWA	100 ppm TWA 150 ppm STEL
toluene	100 ppm TWA 150 ppm STEL	200 ppm TWA 300 ppm CL	50 ppm TWA skin
PGME*	100 ppm TWA 150 ppm STEL	—	—
1,1,1-TCE	350 ppm CL	350 ppm TWA	350 ppm TWA 450 ppm STEL

* The criteria for propylene glycol mether ether (PGME) is used here because PGMEA is metabolized to PGME in the body.
ppm - parts per million
TWA - time weighted average
STEL - short term exposure limit (15 minute time-weighted average)
CL - ceiling limit
Skin - indicates that dermal absorption can be a significant route of exposure

Noise

The NIOSH REL for noise is 85 decibels, A scale-slow response (dB(A)) for 8 hours, using a 5 dB time/intensity relationship.[15] This relationship means that a worker may only be exposed to 90 dB(A), which is 5 dB greater than the exposure limit of 85 dB(A), for half the amount of time allowed at 85 dB, or 4 hours. Conversely, a worker may be exposed to 80 dB(A), which is 5 dB less than the exposure limit of 85 dB(A), for double the amount of time allowed at 85 dB, or 16 hours. The OSHA PEL for noise is 90 dB(A) with a 5 dB exchange;[16] and the ACGIH TLV is 85 dB(A) with a 5 dB exchange.[3]

The OSHA regulation has an action level (AL) of 85 dB(A) at which an employer must administer a continuing, effective hearing conservation program. The program must include personal monitoring, audiometric testing, employee notification of results, hearing protection, training programs, and record keeping.[16] This standard also requires that noise levels in excess of the OSHA PEL be reduced through feasible engineering and administrative controls to the extent possible.[16]

V. EVALUATION METHODS

N-nitrosamines

General area (GA) air samples were collected for the analysis of the following n-nitrosamines: nitrosodimethylamine (NDMA), nitrosodiethylamine (NDEA), nitrosodipropylamine (NDPA), nitrosodibutylamine (NDBA), nitrosopiperidine (NPIP), nitrosopyrrolidine (NPYR), and nitrosomorpholine (NMOR). These GA air samples were collected using Gillian® high-flow pumps at flow rates of either 1.0 or 1.5 liters per minute (l/min), and analyzed in a NIOSH laboratory using a capillary column gas chromatograph and a mass spectrometer (MS) in the selected-ion-monitoring (SIM) mode.

Aromatic Hydrocarbons

General area air samples were collected on charcoal tubes using Gillian® low-flow pumps at a flow rate of 100 milliliters per minute (ml/min). These samples were analyzed qualitatively for identification of the aromatic hydrocarbons using gas chromatography (GC) and mass spectrometry (MS). Personal breathing zone air samples were collected on charcoal tubes using Gillian® low-flow pumps at a flow rate of 50 ml/min. These samples were analyzed quantitatively for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE using GC and flame ionization detection (FID).

Polynuclear Aromatic Hydrocarbons (PNAs)

General area air samples were collected on 2-micrometer (µm), 37-millimeter (mm) polytetrafluoroethylene (PTFE) filters and ORBO 43® sorbent tubes using Gillian® high-flow pumps at a flow rate of 2 l/min. Analysis was performed following NIOSH Method 5515.

Noise

To determine whether or not it would be necessary to perform noise monitoring at this facility, a Quest® Type II Sound Level Meter (SLM) was used to make spot noise measurements throughout the plant. The same instruments were used as personal dosimeters to determine individual noise exposures over a work shift.

VI. RESULTS AND OBSERVATIONS

First Site Visit (July 6, 1994)

During the first site visit, GA air samples for PNA analysis were collected in the mixing department at the bottom of Banbury mixer #3 and at the cure mill, and in the VC

department at press line #221. None of these samples contained detectable amounts of PNAs. GA air samples for n-nitrosamine analysis were also collected in the mixing department at the bottom of Banbury mixer #3 and at the cure mill, as well as in the tube room on line 2 at the end of the first and second ovens, in VS at the mold heat-set work cell LH 3560, and in the press room at press line #221 and at the hayroller press #3480. Of the eight samples, only two had detectable concentrations of nitrosamines. The sample collected at press line #221 had a concentration of 0.71 $\mu g/m^3$ of nitrosopiperidine (NPIP); and the sample collected in the tube room at the end of the first oven along line 2 had a concentration of 2.9 $\mu g/m^3$ of NPIP. The salt bath in the tube room was not operating on the day of the site visit. Other salt bath processes in other facilities have been documented to release nitrosamines.

Also during the first visit, GA air samples for aromatic hydrocarbon analysis were collected and analyzed qualitatively to identify which, if any, volatile organic solvents were present in the air. The identified compounds are presented in Table 2. This analysis does not quantify the amount of solvent vapor detected, but the chemist is able to see which compounds are present in relatively higher concentrations than others. Worker exposures to propylene glycol methyl ether acetate (PGMEA), methyl isobutyl ketone (MIBK), and toluene appeared to be a potential in the tube room; and exposures to 1,1,1-TCE appeared to occur in the coating room and the guide lamp area.

Spot measurements of noise levels using a sound level meter (SLM) were also taken during the first site visit. In the tube room, measurements ranged from 86 dB(A) to 89 dB(A). Along the press lines, the levels were 87 dB(A) to 88 dB(A). Near the hayroller, the levels ranged from 80 dB(A) to 86 dB(A). In general, the SLM measurements were above 85 dB(A) throughout the VC and VS areas.

When the exhaust and ventilation systems were observed from the roof, it was estimated that about 30% of the exhaust systems were not operating properly. For example, one fan in the flock room exhaust system had a missing blade and another fan motor was not operating. One of the exhaust fan motors in the salt bath exhaust system had no belts, and two other motors were burned out. Also, there were air intake fans just below the flock room exhausts, and there was an outside air intake within one inch of the salt bath exhaust. Both of these situations create the potential for reintrainment of exhaust air. Along with some poor designing of the systems, there appeared to be a general lack of maintenance to the ventilation systems. Another observation was that in some areas, such as the flock room, the local exhaust ventilation (LEV) was being over-powered by floor fans.

This Gen Corp plant hired a glove manufacturer to survey the plant and recommend the appropriate personal protective equipment (PPE). Nevertheless, NIOSH investigators noticed several employees handling oils and solvents while wearing cotton gloves. Also, eating and smoking were observed at workstations.

Although there are two plants under two different managers at this site, there is only one health and safety manager (who is under a manager of health, safety, and environment) and no additional health and safety staff. There is a written health and safety policy; but at the time of the initial survey, it was missing many sections that are listed in its Table of Contents, such as the management training section, the task analysis section, the task observations section, the PPE section, the health control section, the program evaluation section, and the off-job safety section. Also, the workplace inspection program section only addressed housekeeping inspections.

The Hazard Communication program was inadequate. It consisted of a description of labels and Material Safety Data Sheets (MSDSs), but no training on the hazards of specific job-related chemicals. Prior to the NIOSH site visit, the local union had been requesting of the company that the Hazard Communication program be updated and the training be redone. The union also requested that the MSDSs be made available not only in the medical or security departments, but also in the work areas, since employees were required to obtain a pass to leave their work area to go to the medical or security department to view a MSDS. At the time of the site visit, these changes had not been made.

Although there was not a complete hearing conservation program, there were two areas that required annual audiometric testing based on previous sound level mapping. The present health and safety manager did not know when the testing was performed, nor did they have the records. It was noticed that some workers, such as maintenance who work in many different areas of the plant, were not aware that hearing protection (HP) was available for certain areas of the plant. Also, annual training was either not performed or not documented.

In the VC plant, the supervisors were supposed to hold monthly safety meetings. It was reported by the union that these meetings only occurred four to six times a year, and always focused on housekeeping and safety, never on health hazard issues. In the VS plant, the supervisors were also supposed to hold monthly safety meetings to review operating statistics and safety statistics. Environmental training was occasionally provided on an as-needed basis.

Table 2. Aromatic Hydrocarbons Detected at Gen Corp Automotive, Wabash, Indiana. July 6, 1994. HETA 94-0298

Sample Location	Aromatic Hydrocarbons Detected
Tube room, line 2 where add adhesive for flock	* propylene glycol methyl ether acetate (PGMEA) † methyl isobutyl ketone (MIBK) xylenes 1-methoxy-2-propanol trimethoxymethane toluene acetone some unidentified aliphatic oxy- compounds
Mixing department, cure mill	trichloroethylene (TCE) - trace amounts MIBK - trace amounts toluene - trace amounts ‡ tert-butyl isothiocyanate - trace amounts
Tube room, line 2 at end of the second oven	* toluene 1,1,1-trichloroethane (1,1,1-TCE) PGMEA MIBK xylenes
Coating room (Flock room)	*† 1,1,1-TCE p-dioxane ethyl oxirane (could be impurity in 1,1,1-TCE) dichloroethylene - trace amounts (could be impurity in 1,1,1-TCE) toluene xylenes MIBK PGMEA
Mixing department, Banbury mixer #3	PGMEA - trace amounts ‡ tert-butyl isothiocyanate - trace amounts
Guide lamp area	*† 1,1,1-TCE p-dioxane ethyl oxirane (could be impurity in 1,1,1-TCE) dichloroethylene - trace amounts (could be impurity in 1,1,1-TCE) toluene xylenes methylcyclohexyl methacrylate
Department 241, paint line	1,1,1-TCE TCE toluene xylenes perchloroethylene MIBK a chloromethyl benzene or benzyl chloride isomer

* Major component detected on the sample tube.
† Also detected on the back-up section of the sorbent tube, indicating break through.
‡ If an amine was present, the isothiocyanate compound could be present as a reaction product of the corresponding aliphatic amine (t-butyl) on charcoal, desorbed with carbon disulfide (heat generated).

Second Site Visit (November 8, 1994)

Based on the results of the first site visit, NIOSH investigators returned to perform more extensive sampling. Nitrosamine sampling was conducted based on the fact that NPIP was detected on two GA air samples collected on July 6, 1994; and the salt bath line in the tube room, a potential source for nitrosamines, was not running during the initial site visit. Air samples for organic solvents in the flock room, the guide lamp area, the tube room, and department 239 paint room and glass insert area were also collected. Since noise level spot measurements in several departments exceeded 85 db(A), noise dosimetry was also performed. No additional sampling for PNAs, nitrosamines, or organic solvents were conducted in the mixing department during the second site visit.

The five air samples analyzed for nitrosamines had detectable concentrations of NDMA, but not of the other six nitrosamines. One PBZ sample was collected on a press operator in the press room, and the sample had a concentration of 0.69 $\mu g/m^3$ NDMA. The PBZ sample collected for the tube operator at the front of the salt bath line had a concentration of 0.11 $\mu g/m^3$ NDMA; while the one collected for the tube operator at the take-off of the salt bath line had a concentration of 3.34 $\mu g/m^3$ NDMA. A third salt bath line tube operator was sampled and estimated to have a PBZ exposure of 1.2 $\mu g/m^3$ NDMA. This sample is only an estimate because at the end of the day the pump was not flowing steadily and the exact air volume for the sample could only be estimated. A GA air sample collected at the drill press along the salt bath line had a concentration of 77.2 $\mu g/m^3$ NDMA. The PBZ exposure to the take-off operator (3.34 $\mu g/m^3$) was above the German standard of 1 $\mu g/m^3$ for general industry and 2.5 $\mu g/m^3$ for specialized industries.

Three consecutive PBZ samples were collected for each of four employees in the flock room, and analyzed for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE. MIBK, xylene, toluene, and PGMEA were all detected on these samples, but at concentrations below 0.7 ppm. These samples also had detectable concentrations of 1,1,1-TCE, ranging from 12.1 ppm to 33.2 ppm. All of these exposures were lower than the relevant guidelines and standards.

Three consecutive PBZ samples were collected for each of two employees in the guide lamp area, and analyzed for xylene, toluene, and 1,1,1-TCE. Xylene and toluene were detected on the samples at concentrations below 1.9 ppm. The employee performing the gluing operation was exposed to 7.0 ppm 1,1,1-TCE, TWA over the sampling time of 7.2 hours; and the employee performing the pack and clean operation was exposed to 72.9 ppm 1,1,1-TCE, TWA over the sampling time of 7.2 hours. The latter had two PBZ samples of 57.0 ppm (sample size of 6.2 liters) and 44.9 ppm (sample size of 7.5 liters), respectively, and a third sample of 111.5 ppm (sample size of 8.0 liters). The work process did not appear to change between the first two samples and the third one, but the fact the exposure doubled during the last sampling period suggests that slight alterations in the way the process is performed could significantly increase or decrease exposures. Nevertheless, all of the exposures in this area were below the relevant guidelines and standards – the xylene and toluene concentrations were orders of magnitude lower.

Two consecutive PBZ samples were collected for the line 2 flocking operator in the tube room and analyzed for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE. None of the samples had detectable levels of any of the analytes, and the minimal detectable concentrations (MDCs) were all below 1.2 ppm.

One PBZ sample was collected at the glass insert operation in department 239 and analyzed for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE. MIBK and toluene were detected, but were below the minimal quantifiable concentration (MQC) of 0.06 ppm. Xylene and PGMEA were not detected (MDC of 0.04 ppm), and 1,1,1-TCE was detected at 1.0 ppm.

Two short-term PBZ samples were collected in the paint room of department 239 — one for 15 minutes and one for an hour. These were collected on the employee who wipes the parts with 1,1,1-TCE, and were analyzed for MIBK, xylene, toluene, PGMEA, and 1,1,1-TCE. Neither sample had detectable concentrations of MIBK, xylene, toluene, or PGMEA (MDC of 1.5 ppm). The 15-minute sample (1.6 liters) had a concentration of 55.7 ppm 1,1,1-TCE; and the 60-minute sample (5.9 liters) had a concentration of 54.2 ppm 1,1,1-TCE. In this same department, a PBZ sample was collected when an employee mixed the adhesives and paint that were applied in the spray booths following the wiping process. The mixing process only lasted for two minutes (0.2 liter sample) and the only analyte detected was 1,1,1-TCE at a concentration of 15.1 ppm.

Three personal noise level exposures were collected during the site visit. In the press area, an injection molder had an average exposure of 87 dB(A) over the 6 hours and 43 minutes of sampling time, and a peak exposure of 131 dB(A). In the tube room, a line 2 flock operator had an average exposure of 88 dB(A) over the 6 hours and 40 minutes of sampling time, and a peak exposure of 133 dB(A). The third sample was collected in the tube room at the division mark operation, but the dosimeter did not function properly.

During the second site visit, it was noticed that employees that handled solvents were using new Ni-tech® gloves, a nitrile rubber glove with a case-hardened chlorinated finish. The manufacturer reports that these gloves are resistant to chlorinated solvents. The gloves being used appeared to be in good condition and employees appeared to have good access to replacement gloves when necessary. Another change between the first and second site visits was that the former health and safety manager left and was replaced by a new one. NIOSH investigators noticed significantly improved communication between the union and management regarding health and safety issues.

At the time of the survey, management was planning to eliminate the use of 1,1,1-TCE from the flock room and department 239. In February 1995, the manager of health, safety, and environment reported that the flock room had been eliminated and replaced by a coating process, and that the use of 1,1,1-TCE had been eliminated in department 239 except in the primer. However, the primer will soon be replaced by a xylene-based one.

The wiping process now uses a water-based solvent instead of 1,1,1-TCE. Management also reported that to comply with new Environmental Protection Agency guidelines, all use of 1,1,1-TCE would be eliminated from both the VS and VC plants by December 1995.

VII. CONCLUSIONS AND RECOMMENDATIONS

1. NIOSH considers NDMA to be an occupational carcinogen and therefore recommends that exposures be reduced to the lowest feasible concentration. Engineering controls, such as effective ventilation are recommended. Although the salt bath is enclosed and ventilated, the drill press does not have any local exhaust ventilation (LEV). Since a significant airborne concentration of NDMA was detected at the drill, and at other drills on salt bath lines of other plants, an effective LEV system should be designed and installed.

2. The maintenance of the ventilation systems is poor. It is important that ventilation design and maintenance be part of the health and safety program because engineering controls should be the primary form of reducing exposures. To ensure proper functioning, there should be a routine maintenance schedule for all the ventilation systems, and especially for the LEV systems. Also, there should be routine air monitoring to ensure that the systems are performing the task they were designed to perform, such as reducing exposures to a byproduct or providing clean make-up air to a work area. For example, the exhaust systems that had fans that were not operating could not possibly be performing the desired job; and the outside air intakes close to the flock room exhaust and the salt bath exhaust could be re-entraining exhaust back into the building.

3. The noise monitoring suggests that some workers, at least in the press room and the tube room, are potentially exposed to noise levels higher than the NIOSH REL of 85 dB(A) and OSHA AL of 85 dB(A). It is recommended that Gen Corp perform a noise survey of the plant; and for all areas where TWA exposures exceed the AL, implement a hearing conservation program (HCP). 29 CFR 1910.95 stipulates that a hearing conservation program must include noise monitoring, employee notification, observation of monitoring, an audiometric testing program, provision of HP, a training program, and record keeping. Presently Gen Corp performs annual audiometric testing for workers in two areas, but there does not appear to be a complete HCP. Also, it would be prudent to maintain the monitoring records longer than two years to have for future reference.

4. Although several of the health and safety programs in this plant were inadequate, NIOSH investigators believe that the improved communications between the union and the new health and safety manager is a step in the right direction. There is an extensive Table of Contents in the written health and safety policy, but very few

written programs, especially those that apply to industrial hygiene. The new glove policy is a start to a more thorough PPE policy; and the improved union-management communication could lead to an improved Hazard Communication Program. The health and safety manager should focus on developing a more extensive health and safety policy which is practiced and documented well on paper.

5. Gen Corp should have at least one health and safety manager at the corporate level that is educated and experienced in the field of industrial hygiene to ensure that the health and safety department can focus as much on health as it does on safety. The department would be even more improved by having regional industrial hygienists at each plant.

6. An effective Hazard Communication Program is essential to a healthy work environment, and information and training are a critical part of the program. If workers express concern about not understanding the hazards of their workplace, then the program is not effective. The National Institute for Occupational Safety and Health investigators recommend that both the union and the management work together to develop more effective hazard communication training and better monthly safety meetings. One suggestion is that the monthly safety meetings also address health issues, and that they actually occur each month. A better understanding of potential workplace hazards and open lines of communication should not only reduce worker exposures, but also worker anxieties about potential exposures that are not understood.

7. Since the use of 1,1,1-TCE is being eliminated in the plant, any recommendations for reducing exposures to it would be obsolete. However, Gen Corp needs to be aware that even though the inhalation exposures to other organic solvents are low, dermal absorption is a potentially significant route of entry. The new glove policy appears to be working well and should be continued even when the use of 1,1,1-TCE is completely eliminated. As stated in the interim report, cotton gloves should not be used when handling solvents. Also, the chemical replacements for the 1,1,1-TCE in a process may require different protective gloves, so the PPE program needs to be kept up–to–date.

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