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Especially for You, Limited
Coloma, Wisconsin

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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, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Kevin W. Hanley and Gregory Kinnes, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Juanita Nelson and Nichole Herbert. Review and preparation for printing was performed by Penny Arthur.

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Health Hazard Evaluation Report 96-0145-2684
Especially for You, Limited
Coloma, Wisconsin
April 1998

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SUMMARY

A Health Hazard Evaluation (HHE) was conducted on April 14-16, 1997, by the National Institute for Occupational Safety and Health (NIOSH) at Especially for You, Limited, located in Coloma, Wisconsin. This HHE was conducted following a confidential employee request regarding styrene vapor and sanding dust exposure in the Resin and Finishing department. The company manufactures a variety of home decorative items including plastic articles by curing polyester resin in preformed molds.

Air monitoring was conducted during the manufacturing activities for volatile organic compounds (VOCs), styrene, Stoddard solvent, methyl ethyl ketone peroxide (MEKP) as well as respirable and total dust. Personal breathing zone (PBZ) samples collected when workers were mixing and pouring liquid resin revealed that full-shift exposure concentrations to styrene ranged from 15 to 46 parts per million (ppm); some of the exposures exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value® (TLV) for styrene of 20 ppm and approached the NIOSH Recommended Exposure Limit (REL) of 50 ppm. In addition, short-term PBZ exposure to styrene during resin mixing exceeded both the ACGIH 15-minute Short-Term Exposure Limit (STEL) of 40 ppm and the NIOSH STEL of 100 ppm.

Gas chromatography-mass spectrophotometry (GC-MS) analyses identified other VOCs present in the air as a mixture of aliphatic hydrocarbons which produced a chromatogram pattern resembling Stoddard solvent. However, PBZ exposure to Stoddard solvent was determined to be well below relevant occupational health criteria. Area samples collected for MEKP did not detect this compound at "worst-case" locations when the (MEKP) accelerator was added to the resin.

Full-shift exposure concentrations to total particulates during sanding and finishing tasks ranged from 1.7 to 8.0 mg/m³. Although these dust exposures were below the ACGIH TLV, the use of a paint spray booth for exhaust of belt sander dust may not always be effective for control of workers' dust exposure.

NIOSH investigators concluded that a potential health hazard exists from exposure to styrene vapor during resin mixing and mold pouring activities. A number of recommendations are provided including improved local exhaust ventilation, periodic exposure monitoring, a more effective respiratory protection program, and safer chemical storage methods.

Keywords: SIC 3089 (Plastic products, not elsewhere classified), styrene, refined petroleum solvents, Stoddard solvent, mineral spirits, methyl ethyl ketone peroxide, MEKP, particulates, n.o.c., polyester resin, molded household items, ventilation, respiratory protection, chemical storage.

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INTRODUCTION

On April 14 through 16, 1997, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at Especially for You (EFY), located in Coloma, Wisconsin. This HHE was conducted as a result of a confidential employee request, which expressed concern about health effects possibly associated with exposures in the Resin and Finishing departments. In particular, it was reported that workers were concerned about:

1. Chronic cough, burning eyes, severe headaches, and nausea from exposure to airborne contaminants from liquid resin, acetone, stains, laquers, and sanding dust,
2. Skin irritation and burns to the hands and arms from dermal exposure to liquid resin and acetone, and
3. Back pain from excessive lifting.

After the HHE request was submitted on April 13, 1996, the EFY facility experienced a catastrophic fire that destroyed an entire building and dramatically disrupted the manufacturing operations at this site. The NIOSH investigation was postponed until the production schedule returned to normal, approximately nine months later.

BACKGROUND

Especially For You, Limited, is a small company that manufactures home decorative items primarily from wood, wrought iron, and plastics. This HHE focused on the plastics and finishing departments where a variety of rigid plastic articles are manufactured including figurines, wall plaques, boxes, and picture frames. These departments are located in a single building with an open floor design (i.e., limited walls separating areas) and are operated by approximately one dozen employees.

Batch quantities of liquid polyester (plastic) resin containing styrene are blended with fillers and pigments in a mixing vessel in a small inadequately ventilated chemical storage room. Five gallon buckets are used to transfer smaller allotments of the blended resin to the pouring tables in the main facility. Prior to pouring the resin into selected molds, an accelerator (catalyst) is measured and added to appropriate quantities of resin using a hand held squeeze bottle. The accelerator contains methyl ethyl ketone peroxide (MEKP) and stimulates a chemical chain reaction causing the liquid resin to solidify after a few minutes. After the article is fully cured, it is removed from the mold and sanded. The method of finishing and sanding depends on the product line as well as the shape, texture, and detail of the surface to be finished. Belt sanders, palm (orbital) sanders, and dremmel detailing tools are used in this area. Spray painting using water-based latex paints may be performed on some items after they are sanded. Detail painting by hand using small artist brushes is also used for some products.

Large quantities of solvent-based stains and enamels are no longer used at this facility. Acetone, formerly used for resin and solvent-based paint clean-up tasks, has also been discontinued. The company has switched to a water-based emulsifying agent for hand washing to remove resin from workers gloves, and to a less extent, skin.

METHODS

In response to the HHE request, NIOSH investigators conducted a site visit at the EFY facility to observe manufacturing processes, evaluate work practices, and identify potential occupational hazards, which may cause or contribute to the reported complaints. An opening conference was conducted by the NIOSH investigators on April 14, 1997, and included employee and company representatives. This HHE included a walk-through tour of the areas in question, review of technical information (i.e., chemical and toxicological information, Material Safety Data Sheets [MSDS], etc.), employee interviews, qualitative ventilation

assessment, and collection of industrial hygiene air samples to evaluate worker exposure.

On April 15 and 16, 1997, personal breathing-zone (PBZ) and area air samples were collected in the Resin and Finishing departments to measure volatile organic compounds (VOCs), styrene, petroleum distillates, MEKP, total dust, and respirable dust. The air samples were obtained by drawing air at measured rates through appropriate collection media; the media were submitted to an analytical chemistry laboratory for analyses. Brief summaries of the specific methods utilized for the collection and analyses of the air samples are provided in Table 1. Overall, a total of 42 charcoal tube air samples were collected and analyzed for styrene and petroleum distillates; 5 impinger (air drawn through liquid bubbler device) samples were collected for MEKP analysis; and 8 filter samples were obtained for either total or respirable dust. In addition, a thermal desorption tube sample was collected at a mold pouring table and at a paint booth. The thermal desorption tube samples were submitted for mass spectroscopy analysis to qualitatively identify other organic solvents.

The industrial hygiene sampling strategy included full-shift PBZ exposure assessments to styrene and petroleum distillate vapors for the resin mixer, 2 mold pourers, and a paint sprayer. Short-term exposure samples for these same air contaminants were also collected during job tasks anticipated to produce high exposure, such as batch mixing and resin pouring of large molds. Area air samples were obtained at selected locations to measure air contaminant concentrations near points of emission. In addition, full-shift PBZ samples were collected to evaluate worker exposure to total particulates during the operation of a belt sander, a palm sander, and a dremmel rotary tool.

Upon completion of the on-site investigation, a closing conference was conducted on April 16, 1997, with representatives of EFY management and employees; preliminary findings, conclusions, and recommendations were discussed in detail during this closing conference.

EVALUATION CRITERIA

To assess the hazards posed by workplace exposures, NIOSH investigators use a variety of environmental evaluation criteria. The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),¹ the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs),² and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs®).³ The objective of the chemical-agent criteria is to establish levels of inhalation exposure to which the vast majority of workers may be exposed for a working lifetime without experiencing adverse chronic health effects or to short-term levels to prevent acute health effects.

Evaluation criteria for chemical substances are usually based on full-shift PBZ exposure to the airborne substance averaged over an entire 8- to 10-hour workday, calculated as a time-weighted average (TWA). Personal exposures are usually expressed in parts per million (ppm), milligrams per cubic meter (mg/m³), or micrograms per cubic meter (µg/m³). When adverse effects from brief-duration (acute) exposures are recognized, some substances have a short-term exposure limit (STEL) for 15-minute peak periods; or a ceiling limit, which should not be exceeded at any time. Additionally, some chemicals have a "skin" notation to indicate that the substance may be appreciably absorbed through direct contact with the skin and mucous membranes.

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 in workplaces where OSHA has jurisdiction. OSHA

PELs are required to take into account the technical and economic feasibility of controlling exposures in the affected industries where the agents are present. The NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility and as such tend to be conservative. In 1989, OSHA promulgated updated PELs for hundreds of chemicals in the same rulemaking motion. However, a Court of Appeals decision vacated the OSHA (1989) "Final Rule" Air Contaminants Standard in *AFL-CIO v OSHA*, 965F.2d 962 (11th cir., 1992); OSHA currently enforces the previous air contaminant standards (as provided in the most current 29 CFR 1910.1000, Tables Z-1-A, Z-2, and Z-3).² Some states which have OSHA-approved State Plans continue to enforce the more protective Final Rule limits. NIOSH encourages employers to use the current ACGIH TLVs, OSHA Final Rule-1989 limits, or the NIOSH RELs, whichever are lower.

It is important to note that 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 health effects because of individual susceptibility, a pre-existing medical condition, previous exposures, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, medications, or personal habits of the worker (such as smoking, etc.) to produce health effects even if occupational exposures are controlled below the limits set by evaluation criteria. Synergistic and additive effects may not be considered by a chemical-specific evaluation criterion. Furthermore, many substances are appreciably absorbed by direct skin contact potentially increasing 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.

Summary information pertaining to exposure criteria and potential occupational hazards for the chemicals that were evaluated during this HHE are provided below.

Styrene

Styrene is a pale yellow to colorless, flammable organic liquid with a molecular structure consisting of a benzene ring with an ethylene group ($-\text{CH}=\text{CH}_2$) substitution. Styrene is used as a solvent for synthetic rubber and resins, as a chemical intermediate, and as a raw material in manufacturing polymerized synthetic plastic materials.⁴ Styrene has a distinctive odor with a very low odor threshold, estimated to be as low as 0.3 ppm.⁵

The major routes of occupational exposure to styrene are inhalation and skin absorption. Styrene vapor is an eye and respiratory tract irritant. Liquid styrene is a strong dermal irritant; repeated or prolonged skin contact can cause dermatitis.⁶ As with many organic solvents, the major target organ for workers exposed to styrene is the central nervous system (CNS).⁷ Acute exposures to high concentrations of styrene may cause irritation of mucous membranes of the upper respiratory system, eyes and mouth, headache, fatigue, nausea, inability to concentrate, and narcosis.^{4,8,9} Reduction of balance, coordination, and manual dexterity, and increased reaction times have been associated with styrene exposure.^{4,10} Workers exposed to concentrations averaging 50 ppm have exhibited acute adverse effects based on neuropsychological tests including tests of verbal learning skills.¹¹ Human studies of the reproductive effects among workers exposed to styrene are limited and have provided conflicting reports.^{12,13}

Currently, styrene is not considered to be a potential occupational carcinogen by NIOSH or ACGIH.^{1,3} Epidemiological studies of styrene-exposed workers have not revealed an excess in overall cancer mortality.^{6,10} The International Agency for Research on Cancer (IARC) has concluded that there is inadequate evidence for determining styrene carcinogenicity to humans, but there is limited

evidence of carcinogenicity in experimental animals.¹⁴

The OSHA PELs for styrene are contained in Table Z-2 of 29 CFR 1910.1000, and include a 100-ppm, 8-hour TWA; a 200-ppm short-term limit; and a maximum peak exposure limit of 600-ppm for 5 minutes in any 3-hour period. The NIOSH RELs for styrene are a 50-ppm TWA for an 8-hour workshift and a STEL of 100-ppm measured over a 15-minute interval. The ACGIH TLVs for styrene were recently lowered to a 20-ppm, 8-hour TWA and a 15-minute STEL of 40 ppm.

Petroleum Distillates

Petroleum distillates (naphtha), also referred to as refined petroleum solvents, is a general term used to describe a class of complex hydrocarbon solvent mixtures. Petroleum naphtha is composed mainly of aliphatic hydrocarbons (as distinguished from coal-tar naphtha which is a mixture composed primarily of aromatic hydrocarbons).¹⁵ Petroleum distillates are further characterized by the boiling range of the mixture; typically, the larger hydrocarbon chain length equates to a higher distillation fraction. Specific names for some typical petroleum distillate mixtures are presented below, in order of increasing temperature of boiling ranges: petroleum ether, rubber solvent, varnish makers' and painters' (VM & P) naphtha, mineral spirits, stoddard solvent, and kerosene.¹⁶ Boiling ranges of these mixtures overlap, therefore, some of these mixtures contain the same hydrocarbons but in different proportions.

Effects from exposure to refined petroleum solvents are primarily acute, unless significant amounts of substances that have chronic toxicity are present, such as benzene, n-hexane, or glycol ethers. Exposure to refined petroleum solvents (i.e., mineral spirits, Stoddard solvent) can cause dry throat, burning or tearing of the eyes, mild headaches, dizziness, CNS depression, respiratory irritation, and dermatitis.^{10,15,16,17}

Petroleum naphtha appears to have weak skin cancer-causing potential in laboratory mice.¹⁸ The IARC has determined that there is only limited evidence implicating petroleum naphtha as a carcinogen in animals and insufficient evidence associating exposure to petroleum naphtha and the development of cancer in humans.¹⁹ However, depending upon the manufacturing process, petroleum naphtha may sometimes contain varying amounts of aromatic hydrocarbons that are classified as carcinogenic such as benzene.

Many petroleum naphtha mixtures used throughout industry contain n-hexane or other simple alkanes. Prolonged and repeated exposure to n-hexane may damage peripheral nerve tissue and result in muscular weakness and loss of sensation in the extremities.¹⁶ Studies indicate that methyl ethyl ketone (MEK) may potentiate peripheral neuropathy caused by n-hexane.²⁰

Since naphthas are mixtures of aliphatic hydrocarbons, the evaluation criteria are based upon the mixture composition in relation to the most commonly available products: petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, and Stoddard solvent. The NIOSH REL for all of the petroleum distillate mixtures is 350 mg/m³ as a full-shift TWA exposure, for up to 10 hours per day providing a 40-hour work week is not exceeded. In addition, a ceiling limit of 1800 mg/m³ is recommended by NIOSH. The OSHA PEL for petroleum distillates (naphtha, rubber solvent) is 2000 mg/m³ for an 8-hr TWA exposure, and the full-shift PEL for Stoddard solvents is 2900 mg/m³. The ACGIH has established an 8-hr TLV-TWA of 1590 mg/m³ for rubber solvent; 1370 mg/m³ for VM & P naphtha; and 525 mg/m³ for stoddard solvents.

Methyl Ethyl Ketone Peroxide

MEKP is an organic liquid that is used as a curing agent for initiating polymerization of polyester (plastic) resins and as a hardener for fiberglass-reinforced plastics.¹⁰ This substance is a severe skin and eye irritant, is corrosive to the skin

and mucous membranes, and has produced liver and kidney damage in experimental animals.⁶ In a mice toxicity study, simultaneous MEKP exposure with ultraviolet light was shown to produce weak tumor activity.²¹

Very little toxicity or health effects information is available for MEKP. ACGIH established a TLV for MEKP by analogy to another organic peroxide (hydrogen peroxide) because of the similar toxicity and irritancy reported for these materials.¹⁰ The ACGIH TLV and NIOSH REL for MEKP are the same, a ceiling limit of 1.5 mg/m³ that were established primarily to protect against eye and dermal irritation. An OSHA PEL for MEKP exposure has not been promulgated.

Total and Respirable Particulates

When the chemical components of an airborne particulate do not have established occupational health exposure criteria, it has been the convention to apply a non-specific exposure criterion. Formerly referred to as nuisance dust, the current ACGIH TLV term for non-specific dust is particulates, not otherwise classified (PNOC), (and particulates, not otherwise regulated [n.o.r.], for the OSHA PEL).

These criteria are intended for airborne dusts which do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.¹⁰ These criteria were established to minimize mechanical irritation of the eyes and nasal passages, and to prevent visual interference. NIOSH has not developed criteria for total or respirable PNOC. The OSHA PEL for total particulate, n.o.r., is 15.0 mg/m³ for total dust and is 5.0 mg/m³ for the respirable fraction, determined as 8-hour averages. The ACGIH TLVs recommended for exposure to particulates, n.o.c., is 10.0 mg/m³ for the inhalable dust fraction and is 3.0 mg/m³ for the respirable fraction, measured as 8-hour TWAs.

RESULTS

Overall, a total of 57 air samples were collected during April 15 and April 16, 1997. The industrial hygiene survey focused on evaluating the resin handling activities, as 45 out of 57 samples were collected in the PBZ of either the resin mixer or mold pourers, or at areas close to these workers. Table 2 presents the full-shift (and partial-shift) PBZ exposure results for the resin mixer, mold pourers, and a paint sprayer. The partial-shift sampling results can be used to approximate full-shift exposure when the manufacturing activities and exposure conditions are similar throughout the workshift. The styrene concentrations measured in the PBZ of resin department workers ranged from 4.5 to 46 ppm. These levels are below the 50-ppm NIOSH REL (8-hr TWA) for styrene. However, 3 out of 6 measured styrene concentrations exceeded the ACGIH TLV of 20-ppm for an 8-hr TWA exposure, and 2 other measured concentrations were only slightly below this criterion. The resin mixer's low exposure result (4.5 ppm) was collected when he fixed a power tool instead of working with liquid resin. Styrene concentrations measured in the PBZ of workers during resin pouring ranged from 15 to 19 ppm on April 15, and from 34 to 46 ppm on April 16. The outdoor temperature on the first sampling day was in the mid 50 to 60s°F, compared to low 40s°F for the second day. The higher styrene results observed on the morning of the 16th are probably due to the cooler weather since the doors of the building remained closed for most of the sampling time. On the previous day, milder outdoor temperatures allowed workers to open the back door which improved ventilation near the mold pouring tables.

Dispersion of styrene vapor in this small manufacturing plant, with its "open" floor design, was evident by the styrene odor that was noticeable throughout all areas. The styrene air sample concentrations measured in the PBZ of a paint sprayer who was working with water-based latex paint (1.4 to 2.8 ppm) confirmed that low styrene

exposure can be expected near the paint spray booths.

Table 3 presents the results from the short-term PBZ air samples for styrene and Stoddard solvent that were collected during this HHE. These samples were collected during approximately 15-minute time periods when job tasks resulted in higher exposures including charging and blending the resin tank with raw materials in the mix room, and pouring several larger molds at the pouring table at the same time. The NIOSH REL for short-term styrene PBZ exposure (100 ppm) was exceeded when only a half batch of resin was blended. This task required the manual transfer of a few buckets of liquid resin from the bottom spigot to the top of the mixing tank. The short-term exposure concentrations of the mold pourers to styrene were between 18 and 30 ppm. These concentrations were similar to the full-shift exposure measurements, indicative of an evenly distributed work schedule. Although these short-term concentrations were below the NIOSH STEL and ACGIH STEL, some of the TWA concentrations collected during 2-hour periods of mold pouring were close to, or exceeded, the ACGIH STEL of 40 ppm.

Table 4 contains the styrene solvent vapor concentrations measured in the mix room, and near a ventilation hood located above a pouring table. The styrene area concentrations obtained near a pouring station ranged from 12 to 43 ppm over 1- to 2-hour durations, levels similar to those determined with the PBZ samples. The styrene concentrations inside the mix room ranged from 40 to 238 ppm, suggesting that the highest styrene vapor levels are present in this area.

Thermal desorption tubes were analyzed using gas chromatography-mass spectrophotometry (GC-MS) to identify other organic compounds present in the vapor emissions from the resin and paint. This qualitative method is extremely sensitive which allows identification of volatile organic compounds at very low concentrations (i.e., in the parts per billion [ppb] range). The GC-MS analyses revealed styrene as the largest single component present in

both the resin and paint air samples. The GC-MS chromatogram also revealed that straight chain aliphatic hydrocarbons (resembling Stoddard solvent) were present. Other minor constituents included alkyl benzenes, xylene, acetone, methyl ethyl ketone, alcohols, and chlorofluorocarbons. Hence, the charcoal tube samples collected for styrene were also analyzed for "other hydrocarbons" (minus the styrene peak) and compared to an analytical standard of Stoddard solvent. Tables 2, 3, and 4 also present the results for Stoddard solvent air samples collected during this evaluation. All measured Stoddard solvent concentrations were at least an order of magnitude (10 times) less than the NIOSH REL of 350 mg/m³, the lowest occupational exposure criteria available for Stoddard solvent.

The data obtained from the MEKP impinger samples is presented in Table 5. Five area air samples representing worst-case exposure scenarios were collected directly on the pouring tables. These samples were taken when the DDM-9 accelerator was mixed with resin, immediately preceding a mold pour. No MEKP was detected in any of these air samples. The minimum detectable concentration for this method and sample (air) volumes is 0.7 mg/m³, which is well below the 1.5 mg/m³ ceiling limit recommended by NIOSH and ACGIH for MEKP.

Table 6 provides the total dust results for PNOC, collected in the PBZ of workers operating the belt sander, palm sander, and dremmel rotary tool. The highest total dust concentration was observed with the belt sander operator, but this measurement was voided since the calculated sample result of 29 mg/m³ would have seriously affected visibility, a condition that was not observed at this ventilated job location. Laboratory error, sample contamination, tampering, or pump failure are some possible explanations. The second highest PNOC total dust concentration, 8.0 mg/m³, was also collected in the PBZ of a belt sander operator. Although the ACGIH TLV and OSHA PEL were not exceeded, the exposure concentrations observed for the belt sander are reason for concern, especially considering that dust control was provided by a paint booth. The air

flow face velocities measured at the booth opening ranged from 75 to 185 feet per minute (fpm), velocities that are more effective for gaseous air contaminant removal than for particulate matter.

CONCLUSIONS

Styrene (& other solvent) exposure – Full-shift and short-term exposure to styrene vapor during the mixing and pouring of polyester resin exceeded the ACGIH TWA and STEL TLVs, the NIOSH STEL, and approached the NIOSH TWA-REL. At the time of this investigation, manufacturing production was reduced because of the seasonal nature of the company's product line. Worker exposure to styrene vapor will likely increase during the time of the year when the company experiences higher production demands.

Dust exposure – The belt sander operator's exposure to total dust (PNOC) approached the ACGIH TLV; total dust exposure when operating the palm sander and dremmel at this facility were below the ACGIH TLV and OSHA PEL for particulates, not otherwise classified.

Dermal contact – Dermal contact with liquid resins, solvents, and other chemicals can be a difficult problem with this type of manufacturing. Although personal protective gloves were used by the resin mixer and mold pourers, more appropriate glove material could be selected to reduce the potential for chemical penetration and subsequent dermal contact. The use of the water-based emulsifier instead of acetone for clean-up tasks is a substantial improvement in regards to reducing the potential for skin irritation and dermatitis.

Respirator use – Workers mixing and pouring significant amounts of plastic resin wore respiratory protection. However, improvements in the respiratory protection program will provide greater protection for employees who must use air purifying respirators.

Ventilation deficiencies – The local (and general) exhaust ventilation systems provided for the pouring tables and mix room need modifications to reduce employee exposure to styrene. The use of paint booths for dust control is inefficient and only marginally effective in controlling PBZ exposure.

Materials lifting – Repetitively lifting 5 gallon buckets, fully loaded with resin, over shoulder height is cause for concern because of the potential for back stress and spillage of a flammable liquid.

RECOMMENDATIONS

1. **Exhaust Ventilation.** Modify local exhaust ventilation systems and/or install new systems to remove styrene vapor and dust at the source of emissions so that the air contaminants do not travel through the workers' breathing zone. Exhaust ventilation systems should also be designed and operated to prevent the recirculation and accumulation of styrene throughout the facility. General "dilution" ventilation may be necessary where local exhaust systems are not feasible or to supplement the local exhaust ventilation.

An engineering consultant company specializing in the design and installation of industrial ventilation should be retained to complete this work. Modifications to existing ventilation and installation of new systems should be conducted in accordance with generally accepted design practices and guidelines, such as those provided in ACGIH Industrial Ventilation, 22nd Edition, A Manual of Recommended Practice.²² Locations where ventilation changes are warranted include mold pouring tables, storage locations of "in-use" resin buckets, resin mixing tank and room, and the belt sander. Enclosing the pouring tables within a separate room may prove to be effective at this facility, providing local exhaust modifications and general room ventilation are also installed.

2. **Respiratory Protection.** The use of respiratory protection should be continued during the interim prior to installation of engineering controls, or

if employees exposure are otherwise excessive. However, air purifying respirator cartridges specifically for “organic vapors” should be used for styrene exposure instead of the combination “acid mist/organic vapor” respirators. A dust pre-filter is recommended during resin mixing since charging the tank with powdered fillers and pigments produces a noticeable dust emission.

NIOSH recommends that respiratory protection be used for worker protection only when engineering controls are not technically feasible, during the interim while the controls are being installed or repaired, or when an emergency and other temporary situations arise.²³ Respirators are the least preferred method of worker protection to air contaminants because an effective respiratory protection program must be implemented to assure the reliability of the protection, and the cooperation of the workers is critical for respirators to afford adequate protection.

If respirators must be used, the company should implement an effective respiratory protection program in accordance with the requirements described in 29 CFR 1910.134.²⁴ Publications developed by NIOSH which should be consulted when developing a respirator program include NIOSH Respirator Decision Logic and the NIOSH Guide to Industrial Respiratory Protection.^{23,25} A respiratory protection program should always address the following elements:

- a. written operating procedures
- b. appropriate respirator selection
- c. employee training
- d. effective cleaning of respirators
- e. proper storage
- f. routine inspection and repair
- g. exposure surveillance
- h. program review
- i. medical approval
- j. use of approved respirators

The written respirator program should also contain information on the following topics: (1) the departments/operations which require respiratory protection; (2) the correct respirators required for

each job/operation; (3) specifications that only NIOSH/MSHA approved respiratory devices shall be used; and (4) the criteria used for the proper selection, use, storage, and maintenance of respirators, including limitations.

3. Exposure Monitoring. Exposure monitoring should be conducted periodically (and records maintained) to determine the magnitude of worker exposure, to identify high-exposure tasks, to evaluate the effectiveness of engineering controls, and to assess work practices that may be altered to reduce exposure. This is particularly important after modifications to engineering controls are complete or if production requirements increase.

4. Dermal protection. When the potential for skin contact with organic solvents or other chemicals is high, chemical resistant gloves (and other protective clothing, if necessary) should be used to minimize dermal contact. Not all glove materials provide adequate protection against permeation for the chemical products of concern. Refer to a selection guide²⁶ or consult with the glove manufacturer or supplier to obtain advice regarding the glove material choices that are appropriate for specific chemicals that are used. Typically, a variety of glove types are needed to allow versatility for choosing the appropriate protective glove for the job tasks and chemicals in question. The gloves that were used for protection against dermal exposure to the resin were constructed from neoprene and natural latex. This glove material does not provide sufficient resistance to chemical permeation of styrene and petroleum distillates (Stoddard solvent). Better choices include gloves that are made from polyvinyl alcohol (PVA), Teflon™, Viton™, 4H™, or Barricade™. Continue to provide and encourage the use of water-based emulsifiers for clean-up tasks, and prohibit the use of solvents for washing hands, arms, and other skin surfaces. (Often workers will want to use solvents for skin washing because it is quicker in removing skin contamination.)

5. Chemical storage. Bulk quantities of the DDM9 resin accelerator should be stored in a secure, flammable material safety cabinet and separated

from other chemical substances. This accelerator contains MEKP which is an organic peroxide that is very reactive and is incompatible with many other chemical materials (i.e., oils, other petroleum-based products, acetone, acids, alkalis, etc.). Uncontrolled mixing or excessive amounts of accelerant can produce a fire safety hazard. Bulk quantities of unreacted resin also need to be stored properly. This is especially true during summer months because excessively high temperatures can cause auto-polymerization (and possibly the release of uncontrolled energy and heat). Approved fire safety containers, in lieu of plastic buckets, are recommended for containing daily quantities of “in-use” resin, a Class 1C flammable liquid. Furthermore, an electrical bond (with a conductive wire) between the dispensing vessel and the receiving container during transfer of flammable liquids is recommended to reduce the potential of a static energy discharge, a possible source of ignition. Refer to “Flammable and Combustible Liquids” section of the Labor regulations (29 CFR 1910.106) for the general industry standards promulgated by OSHA regarding this issue.²⁷

6. Resin Mixing Practices. It may be beneficial to provide a hoist or some other lifting aid to securely raise and tilt the 5 gallon containers of resin in the mix room. A dolly, hand truck, or cart may also be useful for moving loaded buckets from the mix room to the pouring tables. Consider the option of installing a recirculating pump, designed for handling flammable materials, on the mixing tanks as an alternative to repetitively transferring buckets from the bottom to top of the mixing tank. If this is practical, it would reduce the lifting problem and allow the worker to spend less time in the mix room, thereby reducing exposure to styrene.

7. Training programs. Implement more effective health and safety training programs that address hazard communication, respiratory protection, industrial hygiene exposure monitoring, work practices, and standard operating procedures. Communications between management and employees should always be maintained to facilitate the exchange of concerns about safety and health

issues at the facility. Commitment from top management and consistent involvement of employees are very important to ensure effective personal protection programs.

This document is the final report of this health hazard evaluation. In accordance with Federal regulations (42 CFR Part 85.11[c]), this report must be posted by the company in a prominent place accessible to all employees, for a period of 30 calendar days. If we can be of any further assistance, please do not hesitate to contact either Mr. Kevin Hanley at (513) 841-4314 or Mr. Gregory Kinnes at (513) 841-4409.

REFERENCES

1. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.
2. Code of Federal Regulations [1997]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.
3. ACGIH [1997]. 1997 threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
4. NIOSH [1983]. Criteria for a recommended standard: occupational exposure to styrene. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 83-119.
5. Amoore JE, Hautala E [1983]. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for

214 industrial chemicals in air and water dilution. *J Applied Toxic* 3 (6): 272–289.

6. Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1991]. *Chemical hazards of the workplace*. 3rd ed. New York, NY: Van Nostrand Reinhold.

7. Andrews LS, Snyder R [1986]. Chapter 20. Toxic effects of solvents and vapors. In: Doull J, Klaassen C, Amdur MO, eds. *Casarett and Doull's toxicology: the basic science of poisons*. 3rd ed. New York, NY: Macmillan Publishing Company, Inc.

8. NIOSH [1977]. *Occupational diseases: a guide to their recognition*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77–181.

9. NIOSH [1981]. *NIOSH/OSHA occupational health guidelines for chemical hazards*. Cincinnati, OH: U.S. Department of Health, and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 81–123.

10. ACGIH [1992]. *Documentation of threshold limit values and biological exposure indices for chemical substances and physical agents*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

11. Mutti A, et al. [1984]. Exposure–effect and exposure–response relationships between occupational exposure to styrene and neuropsych functions. *Amer J Ind Med* 5:275–286.

12. Lemasters GK, Hagen A, Samuels SJ [1985]. Reproductive outcomes in women exposed to solvents in 36 reinforced plastic companies. *J Occup Med* 27(7):490–494.

13. Harkonene H, Holmberg PC [1982]. Obstetric histories of women occupationally exposed to styrene. *Scand J Work Env Hlth* 8:74–77.

14. IARC [1987]. *Monographs on the evaluation of carcinogenic risk of chemicals to humans, overall evaluations of carcinogenicity: Update of IARC Monographs*. Lyon, France: International Agency for Research on Carcinogenicity. Vol 1–42, supplement 7, 345–347.

15. Browning E [1965]. *Toxicity and metabolism of industrial solvents*. New York, NY: Elsevier, pp 141–144.

16. NIOSH [1977]. *Criteria for a recommended standard: occupational exposure to refined petroleum solvents*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77–192.

17. NIOSH [1977]. *Criteria for a recommended standard: occupational exposure to alkanes*. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77–151.

18. Witschi HP, Smith LH, Frome EL, et al. [1987]. Skin tumorigenic potential of crude and refined coal liquids and analogous petroleum products. *Fundamental and Applied Toxicology* 9(2): 297–303.

19. IARC [1989]. *IARC monographs on the evaluation of carcinogenic risks to humans, occupational exposures in petroleum refining, crude oil and major petroleum fuels*. Lyon, France: International Agency for Research on Cancer 45:39–117.

20. Ellenhorn MJ, Barceloux DG [1988]. *Medical toxicology: diagnosis and treatment of human poisoning*. New York, NY: Elsevier, pp 1000–1001.

21. Logani MK, et al. [1984]. Skin-tumor promoting activity of methyl ethyl ketone peroxide—A potent lipid-peroxidizing agent. *Food Chem Toxicol* 22(11):879-882.
22. ACGIH [1990]. *Industrial ventilation. A manual of recommended practice.* 22nd edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
23. NIOSH [1987]. *NIOSH respirator decision logic.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.
24. Code of Federal Regulations [1997]. 29 CFR 1910.134. *Respiratory protection.* Washington, DC: U.S. Government Printing Office, Federal Register.
25. NIOSH [1987]. *NIOSH guide to industrial respiratory protection.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.
26. Forsberg K, Mansdorf SZ [1993]. *Quick selection guide to chemical protective clothing.* 2nd ed. New York, NY: Van Nostrand Reinhold.
27. Code of Federal Regulations [1997]. 29 CFR 1910.106. *Flammable and Combustible Liquids.* Washington, DC: U.S. Government Printing Office, Federal Register.

Table 1
Summary of Air Sampling and Analytical Methods
Especially for You, Limited, Coloma, Wisconsin
HETA 96-0145-2684

<i>Substance</i>	<i>Air Flow (L/min)</i>	<i>Sample Media</i>	<i>Analytical Method</i>	<i>Comments</i>
Volatile organic compounds (VOC) “qualitative screen”	0.05	Thermal desorption tubes	Samples analyzed using the Tekmar thermal desorber interfaced directly to a gas chromatograph with a mass spectrophotometric detector.	Each thermal desorption tube contains three beds of sorbent materials: (1) a front layer of Carbotrap C; (2) a middle layer of Carbotrap; and (3) a back section of Carbosieve S-III.
Styrene and petroleum distillates “quantitative analysis”	0.2	Activated charcoal sorbent tubes (100 milligram front section/50 milligram back section)	Currently existing NIOSH methods were merged and modified (i.e., NIOSH method 1501 for styrene, and 1550 for petroleum distillates.) The activated charcoal was desorbed with carbon disulfide; an aliquot of this solution was analyzed using GC-FID.	Specific VOC analytes that were quantitatively analyzed included styrene, and petroleum distillates (i.e., other hydrocarbons normalized to stoddard solvent).
Methyl ethyl ketone peroxide	1.5	Impinger (sample bubblers) containing 15 ml dimethyl phthalate	Analyses were performed using a visible absorption spectrophotometer at a wavelength of 565 nm, in accordance with NIOSH analytical method No. 3508.	Interior surfaces of glassware (impingers and shipping vials) were silanized prior to sample collection. Samples were chilled immediately after collection and were shipped to the laboratory cold.
Total Particulate	2.0	Tared PVC filter (37 mm diameter, 0.8µm pore size)	NIOSH Method No. 0500, Gravimetric analysis	Both personal breathing-zone and area samples were collected.
Respirable Particulate	1.7	Tared PVC filter (37 mm diameter, 0.8µm pore size)	NIOSH Method No. 0600, Gravimetric analysis	Dorr-Oliver nylon cyclone used as particle size selector.

Abbreviations:

L/min = Liters per minute
mm = millimeter
µm = micrometer
ml = milliliter
nm = nanometer

GC-FID = Gas chromatography-flame ionization detector
MEKP = Methyl ethyl ketone peroxide
PVC = Polyvinyl chloride (sampling filter)

Table 2
Full-shift PBZ Exposure Concentrations of Styrene and Stoddard Solvent Vapor
Especially for You, Limited, Coloma, Wisconsin (HETA 96-0145-2684)

Sampling Date	Job Title	Sampling Time (t _i) (minutes)	Styrene Concentration (ppm)		Stoddard Solvent Concentration † (mg/m ³)	
			Conc.(c _i)	TWA‡	Conc (c _i)	TWA‡
4/15/97	Resin Mixer	125	26	27	21	32
		122	42		82	
		97	27		4.9	
		69	2.4		4.4	
4/15/97	Mold Pourer	125	16	15	8.0	5.7
		123	23		5.8	
		96	9.6		6.6	
		69	3.8		Trace [1.2 < x < 3.8]	
4/15/97	Mold Pourer	125	28	19	42	17
		123	26		11	
		97	9.7		6.3	
		70	2.5		Trace [1.2 < x < 3.9]	
4/15/97	Paint Sprayer	96	2.5	2.8	Trace [0.8 < x < 2.7]	1.2
		317	2.9		1.6	
4/16/97	Resin Mixer	124	6.1	4.5	3.3	1.7
		126	3.0		Trace [0.6 < x < 2.1]	
4/16/97	Mold Pourer	132	54	46	50	37
		123	38		24	
4/16/97	Mold Pourer	132	38	34	20	15
		125	30		8.9	
4/16/97	Paint Sprayer	253	1.4	1.4	1.6	1.6
Evaluation Criteria for full-shift PBZ exposure:				Styrene (ppm)	Stoddard Solvent (mg/m³)	
NIOSH REL				50		350
OSHA PEL				100		2900
ACGIH TLV				20		525
Notes:						
† Qualitative mass spectra of thermal desorption tube air samples revealed an aliphatic hydrocarbon pattern consistent with Stoddard Solvent. Stoddard Solvent air samples were determined by GC/FID using the summation of other hydrocarbon peaks minus the styrene peak. These concentrations are expressed in milligrams per cubic meter (mg/m ³).						
‡ Time-weighted averages were computed using the "actual" sampling times with the following formula:						
$TWA = \frac{\sum (conc_i \times time_i) + \dots + (conc_n \times time_n)}{\text{total time}}$						
Trace - Sample result was between the Minimum Detectable Concentration (MDC) and Minimum Quantifiable Concentrations as shown in brackets. The MDC is calculated by dividing the analytical limit of detection (LOD) by the air sample volume.						
Abbreviations:						
ppm = part per million mg/m ³ = milligrams per cubic meter						

Table 3
Short-term PBZ Concentrations of Styrene and Stoddard Solvent Vapor
Especially for You, Limited, Coloma, Wisconsin
HETA 96-0145-2684

Sampling Date	Job Title	Sampling Time (minutes)	Short Duration PBZ Exposure	
			Styrene (ppm)	Stoddard Solvent† (mg/m ³)
4/15/97	Resin Mixer	17	111	17
4/15/97	Mold Pourer	15	24	Trace [2.7 < x < 8.7]
4/15/97	Mold Pourer	15	18	Trace [2.7 < x < 8.7]
4/16/97	Mold Pourer	16	30	22
Evaluation criteria for short-term PBZ exposure:			Styrene (ppm)	Stoddard Solvent (mg/m³)
NIOSH REL			100	1800
OSHA PEL			200	NA‡
ACGIH TLV			40	NA‡
<p>Notes:</p> <p>† Qualitative mass spectra of thermal desorption tube air samples revealed an aliphatic hydrocarbon pattern consistent with Stoddard Solvent. Stoddard Solvent air samples were determined by GC-FID using the summation of other hydrocarbon peaks minus the styrene peak. These concentrations are expressed in milligrams per cubic meter (mg/m³).</p> <p>‡ Non Applicable: neither OSHA nor ACGIH has established a short term exposure limit (STEL). The NIOSH REL of 1800 mg/m³ is a 15 minute ceiling limit.</p> <p>Trace - Sample result was between the analytical Limit of Detection (LOD) and the Limit of Quantitation (LOQ). Hence, the airborne concentration is between the Minimum Detectable Concentration (MDC) and Minimum Quantifiable Concentrations as shown in brackets. The MDC is calculated by dividing the analytical LOD by the air sample volume.</p> <p>Abbreviations: ppm = part per million mg/m³ = milligrams per cubic meter</p>				

Table 4
Area Air Concentrations of Styrene and Stoddard Solvent Vapor
Especially for You, Limited, Coloma, Wisconsin
HETA 96-0145-2684

Sampling Date	Location	Sampling Time (minutes)	Styrene Concentration (ppm)		Stoddard Solvent† Concentration (mg/m³)	
			Conc.	TWA‡	Conc	TWA‡
4/15/97	Mix room, south wall	116	75	68	16	8.3
		122	71		11	
		93	73		8.0	
		60	40		Trace [2.7 <x< 8.9]	
4/15/97	North pouring table	120	22	25	18	12
		121	43		18	
		93	12		6.0	
		60	18		Trace [2.7 <x< 8.7]	
4/15/97	Mix room, south wall	133	239	179	22	17
		124	114		12	
4/16/97	North pouring table	135	35	37	14	14
		124	39		13	
Evaluation Criteria for full-shift PBZ Exposure:				Styrene (ppm)	Stoddard Solvent (mg/m³)	
NIOSH REL				50	350	
OSHA PEL				100	2900	
ACGIH TLV				20	525	
Notes:						
† Qualitative mass spectra of thermal desorption tube air samples revealed an aliphatic hydrocarbon pattern consistent with Stoddard Solvent. Stoddard Solvent air samples were determined by GC/FID using the summation of other hydrocarbon peaks minus the styrene peak. These concentrations are expressed in milligrams per cubic meter (mg/m³).						
‡ Time-weighted averages were computed using the “actual” sampling times with the following formula:						
$TWA = \frac{\sum (\text{conc}_i \times \text{time}_i) + \dots + (\text{conc}_n \times \text{time}_n)}{\text{total time}}$						
Trace - Sample result was between the analytical Limit of Detection (LOD) and the Limit of Quantitation (LOQ). Hence, the airborne concentration is between the Minimum Detectable Concentration (MDC) and Minimum Quantifiable Concentrations as shown in brackets. The MDC is calculated by dividing the analytical LOD by the air sample volume.						
Abbreviations:						
ppm = parts per million			mg/m³ = milligrams per cubic meter			

Table 5
Area Air Concentrations of Methyl Ethyl Ketone Peroxide Vapor
Especially for You, Limited, Coloma, Wisconsin
HETA 96-0145-2684

<i>Sampling Date</i>	<i>Area</i>	<i>Sampling Time (minutes)</i>	<i>MEKP Concentration (mg/m³)</i>
4/16/97	North pouring table	42	ND (< 0.63)
4/16/97	North pouring table	64	ND (< 0.42)
4/16/97	North pouring table	54	ND (< 0.49)
4/16/97	South pouring table	40	ND (< 0.67)
4/16/97	South pouring table	53	ND (< 0.50)
Evaluation Criteria for PBZ Exposure:			MEKP (mg/m³)
NIOSH REL			Ceiling - 1.5
OSHA PEL			n.a.
ACGIH TLV			Ceiling - 1.5
Notes:			
ND (<#) - Not Detected (below the Minimum Detectable Concentration). The value which is shown in brackets is the minimum detectable concentration (MDC) for this sample. The MDC is calculated by dividing the analytical Limit of Detection by the air sample volume and is reported as a less than (<) value.			
Ceiling - An exposure limit which should never be exceeded, even momentarily.			
Abbreviations:			
mg/m ³ = milligrams per cubic meter			

Table 6
Full-Shift PBZ and Area Concentrations of Total Airborne Dust
Especially for You, Limited, Coloma, Wisconsin
HETA 96-0145-2684

<i>PBZ Concentrations</i>			
<i>Sampling Date</i>	<i>Job Title</i>	<i>Sampling Time (minutes)</i>	<i>Particulates, n.o.c. TWA Concentration (mg/m³)</i>
4/15/97	Dremmel & Finisher	426	1.8
4/15/97	Belt Sander	405	8.0
4/15/97	Palm Sander	210	5.6
4/16/97	Belt Sander	240	NR†
4/16/97	Palm Sander	238	1.7
<i>Area Concentrations</i>			
<i>Sampling Date</i>	<i>Location</i>	<i>Sampling Time (minutes)</i>	<i>Particulates, n.o.c. TWA Concentration (mg/m³)</i>
4/15/97	South Assembly Bench (light work)	412	0.73‡
4/16/97	Center Assembly Bench (no work)	243	0.11
Evaluation Criteria for PBZ Exposure:			Particulates, n.o.c. TWA Concentration (mg/m ³)
NIOSH REL			n.a.
OSHA PEL			15.0
ACGIH TLV			10.0
<p>Notes:</p> <p>† NR - not reported. The sample result of 29 mg/m³ is invalid since dust levels this high would have seriously affected visibility which was not observed at this ventilated job location. Laboratory error, sample contamination, tampering, or pump failure are some possible explanations. Repeat monitoring is recommended.</p> <p>‡ Respirable dust sample results collected at this location did not detect a gravimetric weight gain (i.e., respirable dust was < 0.02 mg/m³).</p> <p>Abbreviations: mg/m³ = milligrams per cubic meter</p>			



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