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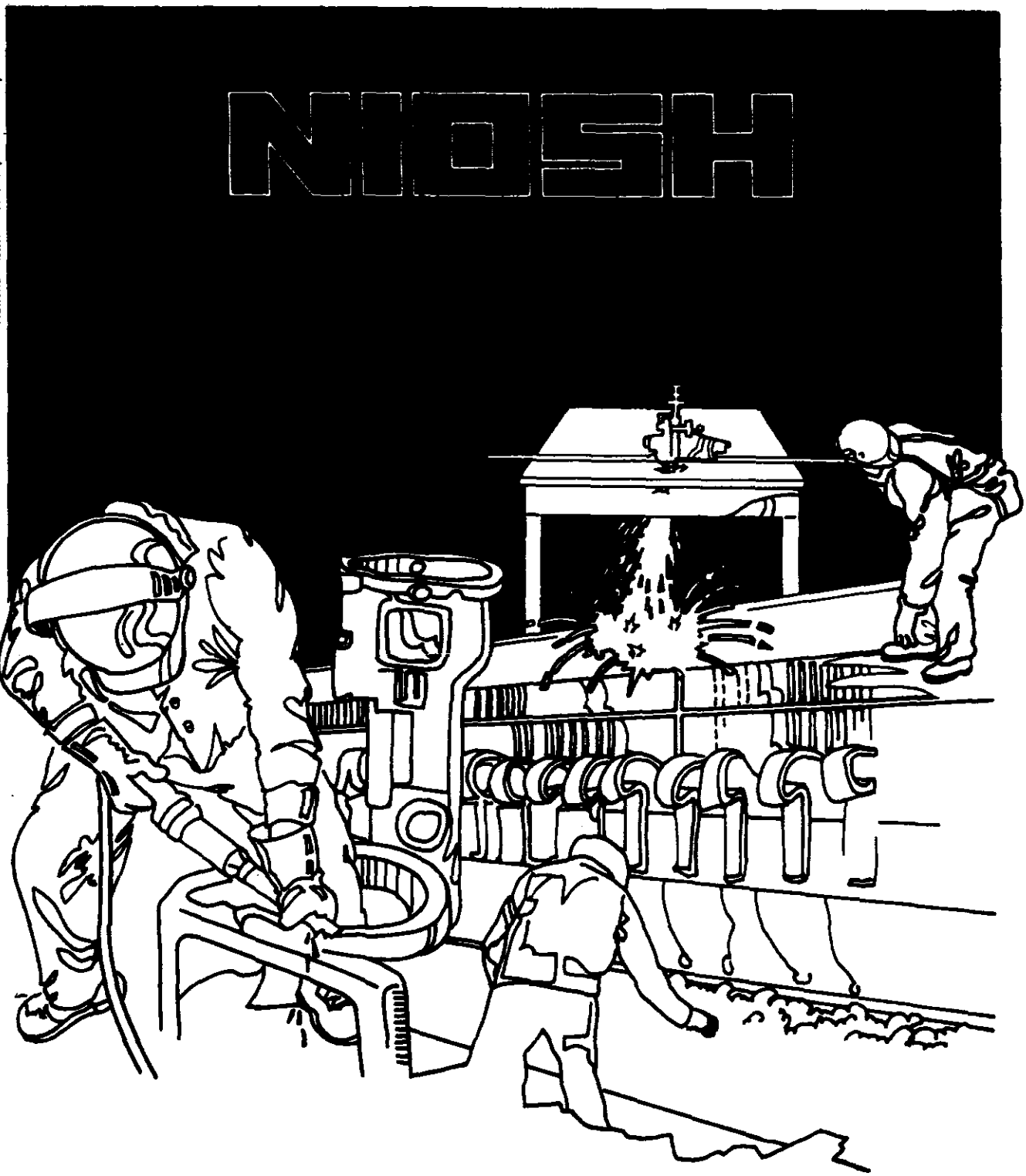

Health Hazard Evaluation Report

HETA 87-384-1895
POLYMER ENGINEERING, INC.
REYNOLDS, 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 or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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

HETA 87-384-1895
MAY 1988
POLYMER ENGINEERING, INC.
REYNOLDS, INDIANA

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I. SUMMARY

On August 21, 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from Polymer Engineering, Reynolds, Indiana, to evaluate potential exposures to styrene in the Compounding Department. Polymer Engineering is a manufacturer of thermoset microwave cookware and custom molded plastic parts.

NIOSH investigators conducted site visits at the plant on August 25, and September 1-3, 1987. Personal samples for styrene and total nuisance dust were collected, and work practices and conditions throughout the plant were observed. Eight-hour time weighted average (TWA) personal sampling results showed that airborne concentrations of styrene ranged from 0.2 to 81.0 parts per million (ppm) with a mean level of 28.8 ppm. Airborne TWA concentrations for all three extruder operators monitored exceeded the NIOSH Recommended Exposure Limit (REL) for styrene of 50 ppm. Total nuisance dust exposures throughout the plant ranged from 1.0 to 12.3 milligrams per cubic meter (mg/m^3) with a mean concentration of 4.5 mg/m^3. The American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Value (TLV) for total nuisance dust is 10.0 mg/m^3.

NIOSH investigators interviewed 21 production employees to determine if they have experienced any adverse health effects that may be related to their working conditions. One employee reported an infected lung which the employee felt was related to the work environment. No other significant health effects were reported during the survey.

NIOSH investigators determined that a health hazard existed at the time of this evaluation in the Compounding Department at each of the four extruding operations where styrene levels were above NIOSH REL and at the preweigh station where nuisance dust exposures exceeded the ACGIH TLV. Recommendations are directed toward improving the general ventilation in the Compounding Department, installing a local exhaust ventilation system at the extruder operations to control styrene exposures and enclosing the preweigh station to reduce the level of nuisance dust.

KEYWORDS: SIC 3079 (Plastics Molding), styrene, nuisance dust

II. INTRODUCTION

On August 21, 1987, NIOSH received a request for a health hazard evaluation from the Management of Polymer Engineering Inc., Reynolds, Indiana. Polymer Engineering manufactures thermoset microwave cookware and a limited amount of custom molded plastic parts. Management requested NIOSH to evaluate the potential health hazards from styrene based resins used in the manufacture of thermoset microwave products.

A walk-through survey of the plant was conducted on August 25, 1987. On September 1-3, 1987, personal breathing-zone (PBZ) samples for styrene and total dust were collected in the Baking, Compounding, and Pressing Departments. Preliminary recommendations concerning the custom molding process were presented to Polymer Engineering officials at the closing conference on September 3, 1987 and in an interim correspondance dated, September 21, 1987.

III. BACKGROUND

Polymer Engineering is located in a single story (approximately 600,000 cubic feet (ft^3)) building, on U.S. 421 North, in Reynolds Indiana. Polymer Engineering purchased the facility in 1980 from a metal fabricator, following a fire that had damaged the facility. Polymer employs approximately 175 employees, of whom 150 are production employees. Polymer primarily manufacturers thermoset microwave cookware products with approximately 15% of their total production directed towards custom molded industrial plastic parts. Thermoset plastics are irreversibly hardening upon heat application. The production rate for Polymer is approximately 500 to 600 pieces per day.

The facility is divided into five major areas. In the Compounding Department, the primary constituents of the plastics are weighed, mixed, blended, extruded, and placed in crates for transport to the Pressing Department where they are molded to the desired shape. The molded products are shipped to the Baking Department where they are placed in the oven to set the thermoset plastics. Finished products are sent to the packing area to be boxed and prepared for shipment to the customer. The office area is occupied by approximately 25 employees for adminstrative and research support.

The highest potential for exposure to airborne styrene concentrations was in the Compounding Department where styrene based resins are used. Styrene based resins are dispensed into a 55 gallon drum and dumped into a blade mixer with a catalyst, filler, modifier, pigments, reinforcer, and shrink control materials to form the primary batch. The four blade mixers are equipped with local exhaust ventilation. The primary batch is manually dumped from the mixer into a cart for transport to one of four extruders. The material is manually fed into the extruder by an employee wearing gloves, cut to the desired length and weight by the extruder operator, and placed in cartons for transport to the curing room.

IV. EVALUATION DESIGN AND METHODS

Based on information obtained during the walk-through evaluation it was determined that conditions on all shifts were basically identical, therefore, sampling was conducted only on the first shift, on September 2, 1987. The product manufactured during the shift was a thermoset microwave bowl. PBZ samples for styrene were collected in the Baking, Compounding, and Pressing Departments. Additionally, PBZ samples for total dust were collected in the Compounding and Pressing Departments. PBZ samples were collected by placing the sample media near the employee's breathing zone.

Styrene samples were collected on a solid sorbent (activated charcoal) tube connected via Tygon tubing to battery powered pumps calibrated at a flow rate of 0.1 liters per minute (lpm). The charcoal tubes were analyzed via gas chromatography according to NIOSH Method 1501[1]. Styrene is desorbed from the charcoal using a toluene, carbon disulfide mixture (99:1). The sample is run through a 30 m x 0.32 mm fused silica capillary coated column and analyzed with a flame ionization detector. The limit of detection (LOD) was 0.04 mg per sample. The limit of quantitation (LOQ) was 0.12 mg per sample.

Full-shift personal air samples for total dust were collected on preweighed 37 millimeter filters connected via Tygon tubing to battery powered pumps that were calibrated at a flow rate of 1.7 lpm. The total weight of each sample was determined by weighing the sample plus the filter on an electrobalance and subtracting the previously determined tare weights of the filters. The LOD was 0.01 mg per sample.

V. EVALUATION CRITERIA

A. Enviromental Criteria

As a guide to the evaluation of the hazards posed by the workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These

combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of enviromental evaluation criteria for the workplace are: 1) NIOSH Recommended Exposure Limits (RELs),[2] 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[3] and 3) the U.S. Department of Labor (OSHA) occupational health standards.[4] Often, the NIOSH RELs and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH RELs and ACGIH TLVs ussually are based on more recent information than are the OSHA standards. The OSHA sandards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA satndard.

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

B. Styrene Evaluation Criteria

Styrene is a major industrial chemical which is widely used in making polystyrene plastics, protective coatings, styrenated polyesters, and as a chemical intermediate. Styrene-butadiene rubber is the most widely employed type of synthetic rubber.[5]

Styrene readily undergoes polymerization when heated or exposed to light. The polymerization releases heat and may become explosive. Vapor concentrations of styrene between 1.1% and 6.1% are flammable.[5]

The primary mode of exposure to styrene is through inhalation (breathing). The odor threshold of styrene is less than 1.0 ppm. Early symptoms of styrene exposure include irritation of the eyes and throat. Delayed effects due to styrene are headache, fatigue, dizziness, confusion, drowsiness, malaise, difficulty in concentrating, and a feeling of intoxication. Objective signs of

these effects are altered equilibrium, delayed reaction times, and abnormal EEGs. There have also been some reports of liver injury, peripheral nervous system dysfunction, abnormal pulmonary function, chromosomal exhanges, reproductive effects, and carcinogenicity. Although data concerning these latter adverse effects are not well defined at this time, they do provide cause for concern.[6]

NIOSH recommends that styrene exposures be controlled so that workers are not exposed to styrene concentrations greater than 50 ppm, determined as a TWA exposure concentration for up to 10-hour workshift, 40 hour workweek. A ceiling concentration of 100 ppm, as determined during any 15-minute sampling period, is also recommended. The 100 ppm ceiling concentration is set to prevent central nervous system depression and irritation of the eyes and respiratory tract.[6]

C. Nuisance Particulates

The primary mode of exposure to nuisance particulates is through inhalation. Nuisance particulates can be an irritant to the eyes, nose, throat, and lungs. In severe cases nuisance dust may cause chronic bronchitis, emphysema, bronchial asthma, and dermititis.

NIOSH currently utilizes the ACGIH recommendation that workers should not be exposed to total nuisance dust concentrations greater than 10 mg/m^3 determined as a TWA exposure concentration for up to 8-hour workshift, 40 hour workweek.[3]

VI. RESULTS

PBZ sample results for styrene and total dust are presented in Tables 1-3. NIOSH RELs, ACGIH TLVs and OSHA Permissible Exposure Limits (PELs) are referenced at the bottom of each table as a guideline.

Table 1 presents personal 8-hour TWA exposures to styrene measured in various departments. Ten PBZ samples collected for styrene ranged from 0.2 to 81.0 parts per million (ppm) throughout the plant. The highest personal TWA exposures were located in the Compounding Department with a mean exposure level of 44.6 ppm, resulting from six PBZ samples. Exposures for all three extruder operators monitored exceeded the 50.0 ppm NIOSH REL.

Table 2 presents personal short-term (15 minutes in duration) exposures to styrene measured in the Compounding Department. Short-term exposures ranged from 26.6 ppm to 39.1 ppm, with a mean level of 32.9 ppm. The data presented shows that the 8-hour TWA levels exceeded the short-term exposure limits (STELs), indicating that short-term exposures were higher at some point during the shift than those obtained from these measurements.

Table 3 presents personal TWA exposures to total nuisance dust. Total dust exposures throughout the plant ranged from 1.0 to 12.3 milligrams per cubic meter (mg/m^3) with a mean concentration of 4.5 mg/m^3. The personal sample collected from the pre-weigher in the Compounding Department showed an exposure level of 12.3 mg/m^3, which is above the ACGIH recommended TLV of 10.0 mg/m^3.

The reported analytical results for both styrene and total dust were not field blank corrected. Analytical difficulties precluded blank correction: however the reported concentrations are consistent with past surveys conducted by Indiana OSHA at the facility and we do not feel that the blank corrections should significantly influence the reported results.

Personal interviews with employees did not reveal any significant findings. One employee reported an infected lung which the employee felt was related to the work environment. The employee stated that the condition had subsided and was not experiencing any more symptoms. An attempt to contact the Company Doctor to confirm this condition was unsuccessful.

VII. DISCUSSION

Two extruder operations were observed running continuously during the 8-hour shift when the environmental data was collected. Two employees were responsible for operating each extruder throughout the shift. The helper was responsible for feeding the batch into the extruder, while the operator was responsible for cutting the extruded material to a paticular length and weight. It is apparent from the sample results that the extruder operators are exposed to the highest airborne concentrations of styrene, above the NIOSH REL of 50 ppm. Installing a local exhaust ventilation system at each of the four extruders will reduce airborne concentrations of styrene. The local exhaust ventilation system installed at the extruders could be similar to the system that exists at each of the four blade mixers. The only difference in the systems should be a hood extended over both the operator's and the feeder's positions. Installing a hood at the source of exposure for both employees should reduce their personal exposure levels to styrene.

Visual observations of air patterns using smoke tubes indicated that the Compounding Department was under negative pressure. At the time of the survey there was no source of outside make-up air in the Compounding Department. Therefore, the ceiling fan in the Compounding Department was pulling its make-up air from the Baking and Pressing Departments. As evidenced by the sample results, the air from the other Departments is contaminated with styrene, hence; this will increase the environmental concentration of styrene present in the Compounding Department. An outdoor supply of fresh, tempered air in

the Compounding Department will provide a source of dilution ventilation, reducing airborne concentrations of both styrene and total nuisance dust.

It was observed during the survey that the Compounding Department was extremely dusty. The entire Department was covered with a white dust which appeared to be the filler material. The source of the dust is the preweigh station where the filler material is dumped onto the scale in order to be added to the batch. At the time of the survey there were no engineering controls at the pre-weigh station, causing visible clouds of dust to be generated as the material was being weighed. An enclosure should be constructed at this station to contain the large quantities of dust. It was also apparent from the survey that there is no routine housekeeping policy enforced to eliminate the accumulation of dust. Installing engineering controls at the source of the dust and incorporating a housekeeping policy will reduce airborne concentrations of total dust in the Compounding Department.

VIII. CONCLUSION

On the basis of the information obtained during this evaluation, it has been determined that a health hazard existed in the Compounding Department at each of the four extruding operations where styrene levels were above NIOSH REL and at the preweigh station where total nuisance dust exposures exceeded the ACGIH TLV.

IX. RECOMMENDATIONS

The following recommendations are made to help reduce the potential for exposure to styrene and total nuisance dust, and to ensure the safety of the workers at Polymer Engineering. These recommendations are based upon the environmental sampling results, observations made during the evaluation, and discussions with Polymer Engineering officials.

1. A local exhaust ventilation system should be installed at the extruder machines, as this operation appears to be the highest source of exposure to styrene. Two hoods should be designed at each of the four machines. The hoods should be located at the operator's position and the feeder's position.

2. A source of make-up air should be provided to supply fresh, tempered air to balance that exhausted by the ceiling fan in the Compounding Department. The fresh air will serve as general ventilation to dilute the airborne concentration of styrene in the department, and maximize the capture efficiency of the ceiling fan.

3. An enclosed area should be constructed where the preweighing takes place. The enclosure could be constructed with a clear plastic curtains to allow easy visibility and access to the area.

4. A general housekeeping policy should be instituted in the Compounding Department to prevent the accumulation of nuisance dust. A weekly cleaning in combination with the enclosure at the preweigh area will prevent the accumulation of large quantities of nuisance dust.

5. The flex duct connected to the blade mixers should be extended to utilize the exhaust ventilation during the dumping phase of the operation.

6. A written emergency response program for potential styrene spills should be established. The written program should be accompanied with adequate employee training.

7. Until the airborne concentration to styrene is reduced to below the NIOSH REL, a complete respiratory protection program should be established and enforced according to OSHA Part 29 Code of Federal Regulations 1910.134. A copy of the respirator standard was included in an interim correspondence.

8. The following observed hazardous work practices should be discontinued:

   a. Placing hands in the blade mixer while it is in operation.
   b. Eating food at work stations throughout the plant.
   c. Washing hands with acetone in the Compounding Department.

9. The compressed gas cylinders in the Machine Department must be secured at all times. Also, as according to OSHA regulations, acetylene and oxygen tanks must be stored at least 20 feet apart or separated by a partition.

10. Noise levels throughout the plant may exceed the 85 decibel level, requiring a hearing conservation program. It is recommended that an outside consultant be contacted to evaluate this potential problem.

X. REFERENCES

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5. Sax NI (ed), Lewis RJ (ed). Hawley's Condensed Chemical Dictionary, pp 1101. 11 ed. New York, New York; Van Nostrand Reinhold Company, 1981.

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XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Polymer Engineering, Inc.
2. NIOSH, Cincinnati Region
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I
8-hour PBZ Exposure Concentrations for Styrene
Polymer Engineering Inc.
Reynolds, Indiana
HETA 87-384

September 2, 1987

Job/Location	Sample Time (minutes)	Sample Volume (liters)	8-hour TWA Concentration for Styrene (ppm)
Extruder/Compound Dept	452	45.2	81.0
Extruder/Compound Dept	452	90.4	58.2
Extruder/Compound Dept	455	46.0	64.3
Quality Control/Compound	456	43.7	8.4
Premixer/Compound Dept	455	46.0	12.1
Preweigh/ Compound Dept	464	44.3	43.5
Operator/Press Dept	445	43.1	9.4
Operator/Press Dept	339	34.6	0.2
Operator/ Oven Dept	441	43.4	1.2
Wrap/Oven Dept	440	44.6	9.2

NIOSH REL	50.0
OSHA PEL	100.0
ACGIH TLV	50.0

Table II
Personal Short-Term Exposure Concentration for Styrene

Polymer Engineering Inc.
Reynolds Indiana
HETA 87-395

September 2, 1987

Job/Location	Sample Time (minutes)	Sample Volume (liters)	15-minute Concentration for Styrene (ppm)
Extruder/Compound Dept	15	15	32.9
Extruder/Compound Dept	15	15	26.6
Premixer/Compound Dept	15	15	39.1

NIOSH Ceiling	100.0
OSHA Ceiling	200.0
ACGIH STEL	100.0

Table III
8-hour PBZ Exposure Concentration for Total Dust

Polymer Engineering, Inc.
Reynolds, Indiana
HE 87-284

September 2, 1987

Job/Location	Sample Time (minutes)	Sample Volume (liters)	8-hour TWA Total Dust (mg/m^3)
Extruder/Compound Dept	454	772	1.7
Quality Control/ Compound	466	792	1.0
Pre-Weigh/Compound Dept	455	774	12.3
Pre-Mix/Compound Dept	461	784	5.8
Operator/Compound Dept	444	755	1.5
		OSHA PEL	15.0 mg/m^3
		ACGIH TLV	10.0 mg/m^3