U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 79-36-€56

BELL HELMETS, INC.
NORWALK, CALIFORNIA

JANUARY 1980

TOXICITY DETERMINATION

A survey team from the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at Bell Helmets Inc., Norwalk, California, on January 15 - 16, February 13 - 14 and July 2, 1979. It was determined that a health hazard did not exist during the dates of this survey. This determination is based upon a field medical evaluation, discussions with private physicians, review of the relevant medical records, environmental measurements of air contaminants, review of pertinent literature, and observations of work practices and engineering controls.

Environmental air samples (personal and area) and one bulk chemical sample were collected at the visor mold injection operation for the following contaminants: butadiene, styrene, methyl ethyl ketone, methyl n-butyl ketone, acrylonitrile and benzene. Also, several suspect contaminants (carbon monoxide, carbon dioxide, hydrogen cyanide and formaldehyde) were measured with gas detector tubes. No hydrogen cyanide or formaldehyde gas was detected. The carbon monoxide and carbon dioxide gas concentrations were well below the NIOSH recommended criteria.

Airborne concentrations of butadiene, styrene and methyl ethylketone (MEK) were measured to be well below the NIOSH recommended criteria and the California Occupational Safety and Health Administration standards (CAL-OSHA). No detectable airborne levels were measured for acrylonitrile or methyl n-butyl ketone (MBK). No detectable levels of benzene were measured in the bulk sample of MEK.

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a) Bell Helmets Inc., Norwalk, California
b) Requestor - Confidential
c) CAL-OSHA
d) U. S. Department of Labor - Region IX

INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S. Code 669 (a)(6) authorizes the Secretary of Health, Education, and Welfare following a written request by an employer, or authorized representative of employees, or by one of three or less employees employed in the workplace, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative. The requestor alleged that exposure to "ketones and plastics" at the visor injection mold operation caused the workers' illness, diagnosed as polyneuropathy. Additionally, the requestor indicated that the degree of illness varied with the color of plastic used to manufacture visors (e.g. orange visors produced the worst fumes).

HEALTH HAZARD EVALUATION

A. Process Description and Evaluation

Bell Helmets, Inc. is a helmet and visor manufacturer. The company has been at their present facility for about 3 years, and they employ 250 personnel who work 10 hours per day, 4 days per week. The area of major concern was the Molding Department where the injection molding machine is located. One employee operates the visor injector molder. The only protective equipment the operator was observed wearing was a cotton glove in order to handle the hot visor (100°F) as it is ejected from the mold.

The company manufactures four visor models (No. 550, 510, 520, 530) in five colors (orange, yellow, black, grey and white). The visors are manufactured from a cycolac®* (HM-series) acrylonitrile/butadiene/styrene (ABS) plastic pellet. The ABS pellets are dessicated in an oven at 200°F for 1.5 hours. Afterwards, the pellets are loaded into a hopper which feeds the injector screw conveyor which feeds the extruder. The enclosed screw injector is heated to a maximum temperature of 430°F. The extreme temperature and pressure melts the ABS

*Mention of commercial names or products does not constitute endorsement by NIOSH.

pellets which are injected into either a steel or aluminum mold depending on the visor model. The cooler mold temperature 95°F) allows the visor to cure and prevents it from sticking.

Depending on the visor model, the visor mold door is either automatically opened (Model No. 500 and 530) and the part is ejected, or the visor mold door is manually opened. If the mold door is automatically opened, the visor is trimmed and punch snaps are applied at a later date.

The molds are cleaned at the beginning of each shift. MEK solvent, which is kept in a plunger can, is applied to a piece of cloth and used to wipe the mold clean. Occasionally, the mold may become dirty during the day thus requiring an additional wipe-out with MEK solvent.

The injection mold machine has no local exhaust ventilation. The ventilation system for the operation is dilution ventilation. Supplied air is directed towards the injection mold machine, which simultaneously dilutes any fumes emanating from the injector molder and cools the worker. During the summer, an additional fan is placed in a corner of the area to help move the stagnant air. The diluted air is exhausted through a roof-mounted exhaust system located in another department.

Evaluation Design/Methods

1. Environmental Survey

On February 13 - 14 and July 2, 1979, environmental air samples (personal and area) and a chemical bulk sample were collected at the injection mold operation in order to evaluate employee exposure to the following: acrylonitrile, butadiene, styrene, methyl ethyl ketone, methyl n-butyl ketone, benzene, carbon monoxide, carbon dioxide, hydrogen cyanide and formaldehyde. The personal samplers were attached to the worker's shirt collar in order to obtain breathing zone samples. The area samplers were placed at the site where the major source of contamination emanated.

Butadiene; MEK and Styrene

A sampling train, consisting of a vacuum pump and a 150 milligram activated charcoal tube, was used to collect a known volume of air. Air contaminants are adsorbed to the charcoal grains and later analyzed. Each of the two sections of the charcoal tube are separately desorbed with carbon disulfide, which contains ethyl benzene as an internal standard. Aliquots of the samples were analyzed by gas chromatography. The limits of detection for the analysis of butadiene, MEK and Styrene are 0.02 milli-

gram (mg), 0.01 mg and 0.03 mg respectively. (See Tables I and II). A further discussion of the analytical methods may be found in the NIOSH manual of analytical methods, Volume I-V, methods S-3, S-30 and S-91. (See references)

Acrylonitrile

A sampling train was used to collect a known volume of air. The collection medium, a 150 mg dual section activated charcoal tube, was separately desorbed with methanol and analyzed by gas chromatography according to NIOSH physical and chemical analytical method S-156, modified, using a gas chromatograph with a nitrogen-phosphorus detector. The limit of detection was calculated to be 0.001 mg of acrylonitrile per tube. (See Table III).

Methyl n-butyl ketone

A known volume of air was passed through a 150 mg activated charcoal tube. Each of the two sections of the charcoal tube was desorbed with carbon disulfide and analyzed by gas chromatography according to NIOSH analytical method No. 127. The limit of detection was 0.01 mg per tube. (See Table IV).

Carbon Monoxide, Carbon Dioxide, Hydrogen Cyanide and Formaldehyde

Each of these four gases were sampled with a direct reading gas detector tube (Drager®). A detector tube, for each contaminant, was placed at the point where the fume generation was considered to be the most concentrated.

Bulk Sample

Approximately 25 milliliters of MEK solvent was collected from the bulk supply and submitted to the laboratory for analysis.

2. Medical

A medical survey was conducted on January 15th and 16th, 1979. On January 15th, the NIOSH investigators conducted a walk-through survey of the entire facility. Particular attention was directed to the injection molding operation. No solvent usage was observed at this position during our visit.

There is no plant physician or nurse, and no pre-placement examinations are carried out. There is a first-aid room, and there are 4-5 first-aiders among the employees. Should the necessity arise, employees are referred to their private physicians or a local hospital.

There had been no other cases of neuropathy reported to management.

Subsequent to the walk-through, the investigators visited the requestor's residence where a work, medical, and family history was obtained. A brief, private neurological examination was performed.

The requestor confirmed management's statement that there had been no other cases of peripheral neuropathy reported at the plant.

As forms authorizing release of medical information to NIOSH had been completed, on January 16th, the medical investigator contacted by telephone, and/or visited the requestor's physicians. The results of all medical investigations undertaken to date were discussed, as was the diagnosis of her disability. Copies of relevant medical records were obtained.

C. Evaluation Criteria

1. Environmental

There are several criteria used to evaluate the toxic air contaminants of an employee's work environment: (1) NIOSH Criteria Documents for a Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLV's) as suggested by the American Conference of Governmental Industrial Hygienists (ACGIH), 1976, (3) The Federal Occupational Safety and Health Administration Standards (OSHA). In California, CAL-OSHA enforces most of the ACGIH-TLV's as their standards.

The concentration of each contaminant is based upon the current state of knowledge concerning toxicity of these substances. The criteria are designed to allow an occupational exposure for up to a 10-hour work day, 40-hour work week as a time weighted average (TWA) over a normal lifetime without the worker experiencing adverse health effects at or below the TWA.

There are some airborne contaminants for which this TWA is inadequate; consequently, the substance may be preceeded by the letter "C". This letter indicates a ceiling value for a sampling interval of 30 minutes or less. The ceiling value is used to identify hazardous substances which are fast acting, and it should never be exceeded.

The criteria have been tabulated, footnoted and compared to the CAL-OSHA standard. Title 8, California Administrative Code, Paragraph 5155 (B)(2). The OSHA standards have been cited so that the reader may see which of the substances have been exceeded.

TABLE A

SUBSTANCE	8-HOUR	10-HOUR	CEILING VALUE	MINUTES
Acrylonitrile[1]		8.7 mg/m^3[a]		
Butadiene[2]	2200 mg/m^3			
Styrene[3]	420 mg/m^3		2520 mg/m^3	5 min/3 Hrs.
MEK[4]		590 mg/m^3		
MBK[5]		4 mg/m^3		
Benzene[6]		3.2 mg/m^3		
Carbon Monoxide[7]		40 mg/m^3	229 mg/m^3	
Carbon Dioxide[8]		18000 mg/m^3	54000 mg/m^3	10
Hydrogen Cyanide[9]			5 mg/m^3	10
Formaldehyde[10]			1.2 mg/m^3	30

a) mg/m^3 - milligrams of contaminant per cubic meter of air.

1. NIOSH Criteria Document (1978). The CAL-OSHA standard 8-hour TWA is 70 mg/m^3.

2. The CAL-OSHA standard is cited above. NIOSH has no Criteria Document for this contaminant.

3. The CAL-OSHA standard is cited above. NIOSH has no Criteria Document for this contaminant.

4. NIOSH Criteria Document (1978). The CAL-OSHA standard 8-hour TWA is 590 mg/m^3.

5. NIOSH Criteria Document (1978). The CAL-OSHA standard 8-hour TWA is 410 mg/m^3.

6. NIOSH Recommendation Revised as a part of NIOSH testimony at Federal OSHA hearing (1977). The CAL-OSHA standard 8-hour TWA is 30 mg/m^3 and the maximum ceiling concentration is 150 mg/m^3 for 10 minutes per eight hours.

7. NIOSH Criteria Document (1973). The CAL-OSHA standard 8-hour TWA is 55 mg/m^3.

8. NIOSH Criteria Document (1976). The CAL-OSHA standard 8-hour TWA is 9,000 mg/m^3.

9. NIOSH Criteria Document (1977). The CAL-OSHA standard 8-hour TWA is 11 mg/m^3.

10. NIOSH Criteria Document (1977). The CAL-OSHA standard 8-hour TWA is 3 mg/m^3.

2. Toxicity Data

Ketone solvents have many uses in industry, and, in this particular instance, methyl ethyl ketone was used as a mold cleanser.

Local Effects

Ketones may produce a dry, scaly and fissured dermatitis after repeated skin contact. High vapor concentrations may irritate the eye, and mucous membranes of the nose and throat.

Systemic Effects

In high concentrations, central nervous system effects predominate, with symptoms of headache, light-headedness, dizziness and lack of balance, which could proceed to loss of consciousness if exposure is prolonged. This result is most unlikely where there is free egress, given the intensely irritant nature of these chemicals.

Over the past few years, reports have indicated that exposure of workers to methyl-n-butyl ketone has been associated with the development of peripheral neuropathy after heavy exposure. These findings have been confirmed in animal studies. Similar experiments with methyl ethyl ketone produced negative results.

There has been an isolated report of a case of peripheral neuropathy associated with the use of methyl ethyl ketone and other compounds, but the causative agent was not established. Furthermore, in two similar plants investigated by NIOSH, cases of peripheral neuropathy were documented in the plant using methyl-n-butyl ketone, whereas none were detected in the other, where methyl ethyl ketone was used.

D. Evaluation Results and Discussion

1. Environmental

Environmental air sampling was performed for each of the five ABS colors used to manufacture the visors. Also, air sampling was performed for each of the two operational modes (automatic and manual) performed by the operator. The production data for 1978 indicated that 85 percent of the visors were manufactured in the automatic mode, and 15 percent were manufactured in the manual mode. Also, visor production data according to color was calculated to be as follows: white - 56%, black - 11.5%, yellow - 11.5%, orange - 6.5%, and grey - 14.5%.

Ten personal and area air samples were collected for butadiene, styrene and methyl ethyl ketone (Table I). The area samples were positioned so that the maximum contaminant concentration

would be collected. The airborne concentrations for each of these contaminants were well below the criteria.

Five personal and area samples were collected for butadiene. The airborne concentrations for this contaminant were well below the NIOSH recommended criteria (Table II).

Nine personal and area samples were collected for acrylonitrile (Table III). None of these samples indicated any acrylonitrile accumulation on the filters.

A bulk sample of MEK was collected and analyzed for purity. Methyl-n-butyl ketone was detected in the bulk sample; therefore a follow-up survey was performed for completeness of the survey.

Eight personal and area samples were collected for MBK and MEK. The area samples were collected next to the MEK plunger can where the solvent concentration was expected to be the greatest. No airborne MBK concentrations were detected, and only one sample identified low levels of MEK solvent (Table IV). Also, another bulk chemical sample of MEK solvent was obtained for laboratory analysis. No MBK was detected in the bulk sample. The product data sheet obtained from the company for MEK indicated the solvent to be 99.5 percent pure MEK.

It was alleged that the mold was cleaned out several times a day with MEK. However, the injection mold machine operator was observed cleaning out the visor mold at the beginning of the shift only. No other mold clean-out was observed during the day.

It was observed that the mold temperature was periodically adjusted to keep the visor from sticking to the mold; however, no additional fumes were noted either before or after the mold temperature adjustment.

2. Medical

After review of all information obtained during the private medical interview/examination; from discussions with the requestor's neurosurgeon and neurologist, and examination of relevant medical investigations undertaken to date i.e., myelograms, electromyography, nerve conductance velocity testing, and back and neck X-rays, no medical evidence was found to support the requestor's allegation that her polyneuropathy was caused by work-place exposure to "ketones and plastics". Nor would this exposure aggravate her disability.

In order to protect the requestor's medical confidentiality, specific findings and diagnosis will not be discussed in this report.

RECOMMENDATIONS

1. The supply air duct for dilution ventilation should be extended closer to the mold machine door so that the air does not blow on the worker's back.

2. The operator should wear an impervious glove when applying MEK to the cloth to clean out the mold.

3. Keep exposure to all potentially toxic agents to a minimum.

4. Medical surveillance as recommended in the NIOSH Criteria Document on ketones is considered inappropriate in this plant, as potential methyl ethyl ketone exposure is very brief and intermittent.

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