HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
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SOUTHERN BELL TELEPHONE COMPANY
ATLANTA, GEORGIA
MAY 1990

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
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INTRODUCTION

On September 8, 1989, industrial hygienists from the Atlanta Regional Office of the National Institute for Occupational Safety and Health (NIOSH) evaluated exposures to organic diisocyanates and other volatile organic compounds potentially released when removing and applying a re-enterable encapsulant (CasChem D Encapsulant CAO-8735) used to protect telephone cable splices. NIOSH did this investigation in response to a Health Hazard Evaluation request from three Southern Bell employees. In this request, one of the employees reported experiencing a raspy voice, shortness of breath, and headaches from working with the encapsulants.

BACKGROUND

Over the past several years, telephone field service technicians who repair and splice underground telephone cable have voiced concerns about their use of polyurethane encapsulants in underground cable vaults. NIOSH has conducted at least two previous investigations of this application.

In November 1985, NIOSH conducted a Health Hazard Evaluation (HETA 85-538-1667) at the General Telephone Company, in Sherman, Texas. The encapsulant being used during this evaluation was identical in composition to the D Encapsulant now used by Southern Bell. The NIOSH investigator conducting this evaluation reported that an Occupational Safety and Health Administration (OSHA) compliance officer had collected air samples during four separate pouring operations at General Telephone. The samples were analyzed for 2,4-toluene diisocyanate (2,4-TDI); 2,6-TDI; hexamethylene diisocyanate (HDI); and methylenebisphenyl diisocyanate (MDI). No diisocyanates were detected in any of the samples. Results from a self-administered questionnaire, which only 28% of the potentially exposed workers completed and returned, showed no indication that acute exposures to isocyanates had occurred during routine splicing operations.

In July 1986, the NIOSH regional office in Atlanta investigated the use of "126 encapsulant" by workers assigned to the Southern Bell facility in Athens, Georgia. During one mixing and pouring operation, air samples were collected for MDI and 1,3-butadiene with negative results. Qualitative analysis of bulk air samples found only trace amounts of other volatile organic compounds (VOCs). The VOC of highest concentration was a butadiene dimer identified as 4-vinyl-1-cyclohexene (4VC). This compound was volatilizing from inside a previously re-entered cable casing that had been repaired and readied for pouring. The 4VC concentration was estimated at 5 parts per million (ppm) inside the cable casing, and less than 0.5 ppm inside the cable vault. Accurate sample quantitation was not attempted during this survey because no (4VC) laboratory standard was available.

This most recent concern about cable splice encapsulants originated from a former field service technician. He had requested and was granted a transfer to another job to prevent his possible exposure to isocyanates. This technician suspected he may have been sensitized to MDI, but no positive diagnosis was ever obtained from a physician. Southern Bell retained a private consultant in October 1988 to assess a Field Service Technician's exposure to MDI during a cable splicing operation using D encapsulant. Exposure to methyl chloroform (1,1,1-trichloroethane), used to wipe down cable surfaces before encapsulant is applied, was also monitored. During this 35-minute task, no MDI exposures were detected. During the 9 minutes required to wipe down the cables, personal exposure to methyl chloroform was only 16 ppm. This concentration was well below the OSHA Permissible Exposure Limit (PEL) of 350 ppm.

Because all previous monitoring efforts involved the use of sampling and analytical methods designed to detect only TDI, HDI, or MDI monomers, NIOSH agreed to conduct another evaluation, but this time NIOSH evaluated exposures using NIOSH sampling and analytical method 5521.[1] This method not only detects isocyanate monomers but also isocyanate prepolymers (oligomers) which, although less volatile, are also believed to cause respiratory sensitization.

EVALUATION DESIGN AND METHODS

On September 8, 1989, NIOSH investigators from the Atlanta Regional Office evaluated exposures during a simulated cable repair in an underground cable vault located on the corner of Ellsworth Industrial Drive and Chattahoochee Drive, in Atlanta. Bellsouth's Industrial Hygienist, their Occupational Safety Manager, and their Environmental Health Manager were present during the evaluation. Two Southern Bell employees were also on site to performed the simulated cable splice reentry and encapsulation. Two cable splice casings were brought to the site for the test. The first casing had been sealed with D Encapsulant two days before the test. The other casing contained only the cable. This casing was used for the pouring operation.

VOC Monitoring

After Southern Bell workers installed a ventilation blower and verified with direct reading instruments the vault was safe to enter, the casings were taken below and mounted on two empty cable racks.

Air samples for VOC analysis were collected by drawing air through glass tubes packed with vapor adsorbing activated charcoal. The charcoal tubes were connected via plastic tubing to precalibrated battery powered air sampling pumps operating at a flow rate of 200 cubic centimeters (cc) per minute. Two area samples inside the vault, and one personal breathing zone sample from the worker who performed the reentry and pouring were collected. For the personal sample, the charcoal tube holder was placed in the worker's breathing zone by attaching the holder to the worker's shirt collar. A control sample was collected outside the vault about 30 feet from the vault opening. Two sets of VOC samples were collected, one set was obtained during encapsulant reentry which took about 15 minutes. The other set was collected during the 20-minute mixing and pouring operation. During the splice reentry task, the worker being sampled removed the cover from the first casing and, while wearing latex gloves

and safety glasses, he began pulling large chunks of encapsulant from around the cable strands. After the cable strands were adequately exposed, the charcoal tubes in all the VOC samplers (excluding the outside air sample) were exchanged with a second set of charcoal tubes for monitoring the mixing and pouring operation.

After sampling, the charcoal tubes were capped and shipped to the NIOSH laboratory for analysis. Two area samples (OV-2 and OV-6) were qualitatively analyzed by gas chromatography - mass spectrometry (GC/MS) to identify any detectable VOCs. The other charcoal tubes were analyzed by gas chromatography and flame ionization detection (GC-FID) for 4VC and other VOCs identified in the two area samples.

During the mixing and pouring operation, one worker (not sampled) mixed the encapsulant while working inside the vault. This worker also wore gloves and safety glasses. To prepare one batch (called a kit) of encapsulant, the technician poured all of D Encapsulant Part I (127.5 grams of MDI prepolymer) into a can containing 622.5 grams of D Encapsulant Part II, a polyol resin. The two components where then blended together with a small spatula for about two minutes. The other technician then poured batch into the empty cable casing. Three 750-gram encapsulant kits (Parts I and II) were required to fill the casing.

Sampler locations and monitoring times are summarized below.

VOC SAMPLING

SAMPLE NUMBER	SAMPLE LOCATION	TYPE SAMPLE	SAMPLE DURATION
OV-1	cable re-entry	personal	8:26 - 8:50
OV-2	on cable rack near casing	area	8:28 - 8:50
OV-3	vault recess near ladder	area	8:29 - 8:50
OV-4	outside air	area	8:20 - 9:29
OV-5	encapsulant pouring	personal	9:01 - 9:24
OV-6	on cable rack near casing	area	9:01 - 9:24
OV-7	vault recess near ladder	area	9;01 - 9:24

Isocyanate Monitoring

Sampling for isocyanates, which included MDI monomer as well as MDI oligomers (prepolymers) containing unreacted isocyanate groupings, was done according to NIOSH Sampling and Analytical Method 5521[1]. Air samples were collected using spill-proof midget impingers. Each impinger contained 15-milliliters (mL) solution of 1-(2-methoxphenyl)-piperazine in toluene. The impingers were connected via plastic tubing to pre calibrated air sampling pumps operating at a flow rate of 1 liter of air per minute (L/min). Two area air samples were collected inside the vault, and one personal sample was collected from the worker who poured encapsulant into the casing. To collect the personal sample, the impinger was mounted in a leather holster and placed in the worker's breathing zone by pinning the holster to the worker's shirt. A control sample was collected outside the vault about 30 feet from the vault opening. After sampling, the impinger solutions were placed in glass vials and shipped to the NIOSH contract laboratory for analysis by high performance liquid chromatography, using electrochemical and UV detection.

The sampling locations and monitoring times are summarized below.

ISOCYANATE SAMPLING

SAMPLE NUMBER	SAMPLE LOCATION	TYPE SAMPLE	SAMPLE DURATION
I-100	pouring encapsulant	personal	9:04 - 9:26
I-200	on cable rack near casing	area	9:06 - 9:30
I-300	vault recess near ladder	area	9:08 - 9:28
I-400	outside air	area	9:10 - 9:30

RESULTS AND DISCUSSION

VOC Results

Results of analysis air samples for VOCs showed the only compound detectable was toluene. The analytical laboratory attributed toluene detection to the sampling for isocyanates which involved the use of impingers containing a toluene based collection solution. However, the laboratory reported that all samples contained toluene. These included blanks, the outside air sample, and also the samples collected before isocyanate sampling had begun. Apparently air samples were contaminated from the toluene solvents used at the site to collect isocyanates. It's possible that contamination occurred from the handling of charcoal tubes in the vicinity of the impinger solutions, but trace amounts of toluene are typically found in most air samples collected on activated charcoal. Results of analysis for 4-vinyl-1-cyclohexene showed no exposures above the limit of detection for the sampling and analytical method used. Based on the air sample volume collected from the worker performing the encapsulant re-entry, this detection limit was 0.05 ppm

Isocyanate Air Sample Results

Results of the analysis of impinger samples showed no exposures to MDI monomer were detectable above the 0.4 micrograms(µg)/sample limit of detection for the sampling and analytical method used. Based on the air sample volume for the personal sample taken from the worker performing the 20-minute encapsulant pouring task, this detection limit was 0.001 ppm. The 15-minute short term exposure limit permitted by OSHA for MDI monomer is 0.02 ppm.[2] NIOSH recommends limiting exposures to below 0.02 ppm (200 µg/m^3) for exposures not to exceed 10 minutes duration. The American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour time weighted average (TWA) Threshold Limit Value (TLV)[4] and NIOSH Recommended 8-hour TWA exposure limit for MDI monomer[3] is 0.005 ppm (51 µg/m$_3$)

Semi-quantitative results were obtained inside the cable vault during the mixing and pouring of D Encapsulant for airborne concentrations of unreacted MDI prepolymers (oligomers). The results are reported as MDI monomer equivalents. Thus, the total quantity of reactive isocyanates attached to MDI based prepolymerized oligimers were reported by the analytical laboratory as the equivalent amount of MDI monomer that could supply this same concentration of reactive isocyanate groups.

MDI PREPOLYMER RESULTS

SAMPLE LOCATION	TYPE SAMPLE	SAMPLE DURATION	MDI EQUIVALENTS ($\mu g/m^3$)
pouring encapsulant	personal	9:04 - 9:26	18
on cable rack near casing	area	9:06 - 9:30	30
vault recess near ladder	area	9:08 - 9:28	ND
outside air	area	9:10 - 9:30	55

OSHA 15-minute ceiling limit (as MDI Monomer) ---------- 200
NIOSH recommended ceiling limit (10-minutes) ---------- 200

Bulk Sample Results

Laboratory analysis by direct injection of a bulk liquid sample of D Encapsulant (Part I activator) to a high performance liquid chromatography (HPLC) found the sample contained approximately 7% residual MDI monomer. Prepolymer oligimers in the sample were reported by the laboratory to contain reactive isocyanate groups equivalent to 2.6% MDI monomer.

CONCLUSIONS

Although the D Encapsulant activator (Part I) contained a considerable amount of residual MDI monomer, as well as some unreacted isocyanate groups, air monitoring in the cable vault during mixing and pouring of D Encapsulant showed no exposures above the 0.001 ppm limit of detection. The results indicate that although MDI monomer is in the activator, mixing the activator with the Part II polyol may quickly inhibit release of MDI vapor into the breathing zone. If D Encapsulant is used as demonstrated during this investigation, MDI exposures should be well below current exposure standards, and the risk of MDI sensitization should be minimal.

RECOMMENDATIONS

1. Based on the sampling results from this investigation, use of respirators during the mixing and pouring operation would not be required for protection from potential MDI exposure. For those individuals who may experience occasional upper respiratory irritation from any other VOCs released when performing this task, organic vapor cartridge respirators could be used and should be provided by Southern Bell to the worker if requested. If a worker elects to use a respirator, OSHA requirements as outlined under 29 CFR 1910.134 must be implemented.

2. As required by the OSHA Hazard Communications Standard, all Southern Bell employees who work with cable splice encapsulants or other polyisocyanate materials should be informed of the potential respiratory sensitization hazard.

3. When mixing and pouring encapsulants, workers should conscientiously follow to the encapsulant manufacturer's precautions and instructions for safe use and disposal. Protective gloves and safety glasses should be worn when mixing and pouring encapsulants. Cable repair vehicles should also be equipped with hand washing facilities and portable eye wash stations.

REFERENCES

1. National Institute for Occupational Safety and Health. *NIOSH manual of analytical methods, 3rd Ed. (with supplements).* Cincinnati, OH: National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) Publication No. 84-100).

2. U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA). CFR Title 29, Part 1910--Occupational Safety and Health Standards, Subpart Z--Toxic and Hazardous Substances.

3. U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control (CDC). *NIOSH recommendations for occupational safety and health standards.* Morbidity and Mortality Weekly Report (MMWR), Supplement. August 26, 1988, Vol. 37, No. 7-S.

4. American Conference of Governmental Industrial Hygienists (ACGIH). *Threshold limit values for chemical substances in the work environment adopted by ACGIH with intended changes for 1989-90.* Cincinnati, Ohio: ACGIH, 1989.