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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a joint management/union request to conduct a health hazard evaluation (HHE) at the NYNEX facility in Syracuse, New York. The request concerned the use of heat-shrink plastic covers during the de-reeling, cutting, and end-capping of telecommunication cable and employee complaints of eye irritation and odors. The union was concerned about a possible association between this operation and esophageal (throat) cancer in two retired NYNEX employees.

In October, 1990, the Telesector Resources Group (a subsidiary of New England Telephone and NYNEX) collected air samples at the request of NYNEX during a series of end capping operations for organic vapors (including total hydrocarbons, cyclohexanone, ethyl acetate and ethyl acrylate), metals, chlorine, acetic acid, oxides of nitrogen, carbon dioxide, carbon monoxide, ozone, petroleum hydrocarbons, amines, and toluene diisocyanate (TDI) during a series of end-capping operations. All of their measurements, with the exception of TDI, were either non-detectable or below their respective occupational exposure limits. Toluene diisocyanate was detected by colorimetric detector tubes in 2 of 19 short-term (15 minute) air samples. The highest of these 2 samples measured TDI at approximately 0.1 parts per million (ppm), a level which exceeds the Occupational Safety and Health Administration's Permissible Exposure Limit of 0.02 ppm.

In monitoring by NIOSH, neither TDI nor toluene diamine (a possible by-product when TDI reacts with water) was detected. One bulk sample (ARAM 100) identified hydrochloric acid, a possible decomposition product from the polyvinyl chloride present in the cable sheathing. Decomposition products identified by NIOSH on the remaining bulk materials were all similar, containing aldehydes, high molecular weight unsaturated aliphatics (alkenes or cycloalkanes) in the C_{16} to C_{26} range, some C_6 to C_{13} alkanes, alcohols, and ketones. Aldehydes from C_1 (formaldehyde) to beyond C_{16} (hexadecanal) were detected, with acetaldehyde and pentanal predominating.

The evaluation identified one current worker with likely occupational dermatitis. The lack of similar exposures among the two retired workers with esophageal cancer and the presence of other risk factors associated with this tumor argue against an occupational cause for their disease. A further examination of the esophageal cancer incidence among NYNEX workers does not appear warranted at this time. The industrial hygiene survey conducted by the company did not identify any significant chemical exposures associated with the end-capping operation. Subsequent NIOSH analysis also failed to identify any chemical exposures which may account for the esophageal cancer among the NYNEX employees performing this job. However, some of the chemicals which were identified, such as the aldehydes and hydrochloride acid, are upper respiratory irritants.

Keywords: SIC 3661 (Telephone and Telegraph Apparatus), esophageal cancer, dynamic headspace analysis.

INTRODUCTION

An initial site visit was made by investigators from the National Institute for Occupational Safety and Health (NIOSH) to the NYNEX facility on November 28, 1990. Following an opening conference which was attended by representatives from the Telesector Resources Group (a subsidiary of New England Telephone and New York Telephone) and the Communications Workers of America (CWA), Local 1123, a walk-through inspection of the cable de-reeling and capping operations was conducted. Product information was obtained, employees were interviewed, and preliminary air sampling results from a survey conducted by NYNEX were reviewed.

BACKGROUND

This plant, formerly part of Western Electric, has been in operation since 1953. The current workforce of approximately 100 is involved in telephone cable de-reeling, cable cutting, and end-capping. Over 85% of the facility is now devoted to warehousing.

Plastic end caps are used to protect the cut ends of telephone cable from moisture and physical damage. From 1953 to approximately 1982, Western Electric (NYNEX) employees tapped end caps onto the cables. Beginning in 1982-83, NYNEX employees began using heat-shrinkable end caps for the capping operation. Currently only the New York Telephone company, according to NYNEX management, requires end-capping.

1. DESCRIPTION OF OPERATION

The installation of cable end caps is performed at either of two work stations and involves two employees (one per station). The Raychem Corporation is the largest supplier of end caps to NYNEX. The self-adhering, heat-shrinkable end caps are supplied in three sizes which can accommodate cable diameters of 0.4 to 3.5 inches. Designed to make pressure tight seals on polyethylene jacketed cables, the caps are installed using a thermostatically-controlled, electric-powered hot air heating method. Depending on the heating chamber used, the hot air is regulated between 500 to 1000^{o}F. The process operation consists of the operator slipping a cap on the cut cable end and then inserting the cable and cap into the heating chamber (also referred to as the heat gun) for approximately 20 to 30 seconds. The operator visually determines when the end cap has sufficiently heated to obtain a tight seal on the cable. At the time of this evaluation the end-capping was performed in an open area of the plant, adjacent to a warehousing operation.

2. NYNEX INDUSTRIAL HYGIENE EVALUATION - 1990

A 1990 NYNEX report containing the results of air sampling conducted by the Telesector Resources Group on the materials used in the de-reeling and end capping operation was received by NIOSH on

January 3, 1991. This report detailed area air sampling results for a variety of organic vapors, including total hydrocarbons, cyclohexanone, ethyl acetate and ethyl acrylate. Air samples were also collected for metals such as nickel, lead, copper, iron, and aluminum. Direct reading detector tubes were used to sample for chlorine, acetic acid, oxides of nitrogen, carbon dioxide, carbon monoxide, ozone, petroleum hydrocarbons, amines, and toluene diisocyanate (TDI). All of the measurements, with the exception of TDI, were either non-detectable or below their respective occupational exposure limits. Toluene diisocyanate was detected in two of nineteen short-term (15 minute) air samples. The highest of these two samples measured TDI at approximately 0.1 parts per million (ppm), a level which exceeds the Occupational Safety and Health Administration's Permissible Exposure Limit of 0.02 ppm.

It should be emphasized that all of the concentrations measured in the NYNEX study, including TDI, were obtained from general area air samples which represented "worse case" conditions (ie. small room, no ventilation, air samples collected near the heating chamber). Personal exposures under actual working conditions may be lower because of the open area in which the end-capping was performed during this evaluation. In addition, direct reading colorimetric detector tubes for TDI are subject to possible interferences and may be less specific than other methods used to measure this compound. This is significant since TDI would not be expected to be present based on the types of plastics used in the cable or the end caps.

MEDICAL EVALUATION

Three current workers involved with using heat shrink covers were interviewed. A limited dermatologic exam was conducted on one worker with skin complaints. Telephone interviews were conducted with the two retired NYNEX workers whose names were provided by the union because of concern about throat (esophageal) cancer. Since both workers were unable to speak normally because of throat surgery, the interviews were conducted with the help of their wives.

INDUSTRIAL HYGIENE EVALUATION

Eighteen bulk samples of telephone cable sheathing were obtained from NYNEX. Of these, the following ten samples were selected (at least one from each supplier) and submitted for qualitative analysis of the possible decomposition products found in the heated headspace (the space above the heated sample). All bulk materials were heated to approximately 200^{o}C, the approximate temperature which is used to soften and shrink the plastic end caps onto the telephone cables.

GB-1	BKMH 900	Essex
GB-2	AFMW 100	ALCATEL
GB-3	BHAA 50	GENERAL CABLE
GB-4	BKMA 300	ALCATEL
GB-5	BHAH 200	ESSEX
GB-6	DKTN 600	NORTHERN TELCOM
GB-7	FIBER OPTIC	SEICOR
GB-8	ARAM 100 (FD6118)	AT&T
GB-9	RAYCHEM END CAP	RAYCHEM
GB-10	BHAG 200	SUPERIOR

All heated headspace samples were generated by heating in a microcombustion furnace equipped with a quartz/Pyrex glass tube. The outlet end of the oven tube was connected to a glass tee so that two sorbent samples could be collected simultaneously. Small (milligram-size) portions of the bulk material were placed in ceramic boats prior to heating in the furnace. Samples were then heated at 200ºC. In all cases, the effluent from the furnace was sampled with both a charcoal and an ORBO-23 sorbent tube. The charcoal sorbent was sampled at a flow rate of 100 cubic centimeters (cc) per minute. The ORBO-23 sorbent tube was sampled at a flow rate of 50 cc/minute. All samples were collected for approximately one hour.

Since TDI was detected (using direct reading colorimetric detector tubes) in two of nineteen short-term (15 minute) air samples collected in the NYNEX evaluation, two bulk samples (the same cable samples in which TDI was found by NYNEX) were also sampled with an impinger containing toluene. The sampling and subsequent analysis for TDI and toluene diamine (a possible by-product when TDI reacts with water) was according to NIOSH Method 5516. The toluene impinger solutions from these two bulks were concentrated by evaporating off most of the solvent prior to analysis by GC-FID using a 30 meter DB-1 column.

The charcoal samples were desorbed with 1 milliliter (ml) of carbon disulfide and screened by gas chromatography-flame ionization detector (GC-FID), using a 30 meter DE-1 fused silica capillary column. Front and back sections were desorbed and analyzed separately. Front sections and several of the backup sections were further analyzed by gas chromatography-mass spectrometry detection (GC-MSD) to identify individual contaminants.

ORBO-23 sorbent tubes were desorbed with 1 ml of toluene in an ultrasonic bath for 60 minutes. Front and back sections were desorbed and analyzed separately. These tubes were analyzed by GC-MSD (full scan) using a 15 meter DB-1301 column.

EVALUATION CRITERIA

Tobacco and alcohol use and dietary factors have been linked to esophageal cancer in several epidemiologic studies.[1] Workers expressed concern about reports of esophageal cancer among firefighters who responded to an electrical fire in Utica, New York, in 1981. This fire, which occurred in a chamber lined with a polyurethane foam tile, heavily exposed the firefighers to large amounts of heavy black smoke containing high levels of toxic gases and chemicals. The firefighters involved have had an unusually high incidence of several cancers since this episode occurred, including esophageal cancer.[2] Although no causal relationships have been previously demonstrated between occupational exposures and esophageal cancer, this episode may have represented a unique combination of exposures resulting in an increased incidence of these tumors in exposed workers.

RESULTS

1. MEDICAL

Medical history and examination of the current workers revealed one worker with a likely occupational dermatitis of the hands, due most likely due to repeated hand washings. Other reported symptoms were not consistent with an occupational disease.

One of the retired workers reported no history of having worked with heat shrink covers. The other worker worked briefly (probably less than one year on alternate weeks) with heat shrink covers prior to retirement. Both workers had non-occupational risk factors for the development of esophageal cancer.

2. INDUSTRIAL HYGIENE

Neither toluene diisocyanate nor toluene diamine was detected in the NIOSH analysis of two heated bulk samples of cable sheathing which were suspected to decompose to form TDI, based on results obtained by NYNEX in their evaluation.

An ORBO-23 sorbent tube collected from a heated bulk sample of ARAM 100 (Product no. FD6118, supplied by AT&T) indicated the presence of a strong acid. Other compounds present on a charcoal tube sample collected from this bulk sample showed the presence of benzene and several chloroalkanes, indicating that a polyvinyl chloride (PVC) or PVC copolymer may have been present in the cable sheathing. Since hydrochloric acid (HCl) is a known decomposition product of PVC materials, another portion of ARAM 100 was heated and sampled with an HCl detector tube and pH paper. The HCl detector tube gave a strong blue to yellow color change, indicating the presence of HCl. The pH of the condensate was highly acidic.

The general classes of other compounds found on ARAM 100 were phthalate esters, chloroalkanes, aliphatic alcohols and acetates, benzene, and toluene. Aldehydes detected on the backup section of the ORBO-23 sorbent tube included acetaldehyde, formaldehyde, propanol, acrolein, butanol, and pentanal.

Decomposition products identified on the remaining bulk materials were all similar. The bulk sample of BKMA 300, a cable supplied by Alcatel, was typical of these, containing aldehydes, high molecular weight unsaturated aliphatics (alkenes or cycloalkanes) in the C_{16} to C_{26} range, some C_6 to C_{13} alkanes, alcohols, and ketones. Aldehydes from C_1 (formaldehyde) to beyond C_{16} (hexadecanal) were detected with acetaldehyde and pentanal predominating on most of the ORBO sorbent tube samples.

DISCUSSION AND CONCLUSIONS

This evaluation identified one current worker with likely occupational dermatitis. There is no apparent similarity between the firefighter exposures at the Utica General Electric facility and worker exposures (documented by NYNEX) at the shrink capping operation. The apparent lack of similar exposures among the two retired workers with esophageal cancer and the presence of other risk factors associated with this tumor argue against an occupational cause for their disease. A further examination of the esophageal cancer incidence among NYNEX workers does not appear warranted at this time.

As noted earlier, the industrial hygiene survey conducted by the Telesector Resources Group did not identify any significant chemical exposures resulting from the end capping operation. Subsequent NIOSH analysis, using dynamic headspace techniques on several of the plastics used in the end-capping operations, followed by GS/MS analysis, identified chemicals such as aldehydes and hydrochloride acid which are upper respiratory irritants. Two other carcinogenic compounds identified in the analysis of the heated bulk samples, formaldehyde and benzene, have not been associated with esophageal cancer.

It should be stressed that the dynamic headspace analysis performed by NIOSH on the bulk samples is a **qualitative** analysis, meaning that the reported chemicals were detectable (but in an unknown amount) in the space directly above the heated sample. This type of analysis has no direct bearing on determining what (if any) the personal breathing-zone air concentration may be for these substances. These bulk samples were also heated during this headspace analysis for a much longer period of time (approximately 1 hour) than the 20-30 seconds that the end cap and cable typically remain inserted in the heating chamber during a capping operation. Thus, while personal breathing-zone air sampling was not conducted during the end-capping operation, it is the opinion of the NIOSH investigators that, based on the relatively brief time in which the end caps (and cable sheathings) are heated, along with the open area in which the operation is performed, the airborne levels of most, if not all, of these compounds should be very low (or not detectable). The low concentrations found in the "worse case" monitoring performed by NYNEX investigators under poorly ventilated conditions in 1990 support this conclusion.

As previously noted, TDI (or its precursor, toluene diamine) was not found in the two heated bulk samples from which NYNEX investigators had previously identified these compounds using colorimetric detector tubes. This apparent discrepancy may be explained by the presence of interfering compounds during the NYNEX monitoring which affected the performance of the detector tubes.

RECOMMENDATIONS

The use of abrasive soaps should be avoided since they alone can irritate and damage skin. Moisturizing creams should be available at the workplace and should be applied when hands are

washed. Whenever feasible, protective gloves should be worn by cable workers.

REFERENCES

1. American Cancer Society [1990]. Massachusetts Division, Boston. Cancer Manual, 8th edition.

2. Melius J [1990]. Cancer in the Utica Fire Department Following 1981 General Electric Fire. November 27, 1990, report from NY State Department of Health, Division of Occupational Health and Environmental Epidemiology.

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