

FILE NAME: Electrical Insulation (ELEC)

DATE: 1999

DOC#: ELEC009

DOCUMENT DESCRIPTION: Article from Scientific Journal

Microscopical Studies of Asbestos Fiber Release During Cutting and Stripping of Wire Cables

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KEYWORDS

Asbestos, Wire cable, Polarized light microscopy, Phase contrast microscopy, Transmission electron microscopy.

ABSTRACT

Microscopical tests including polarized light microscopy (PLM), phase contrast microscopy (PCM), and transmission electron microscopy (TEM) were used in the testing for possible fiber release during cutting and stripping of wire cables that contain asbestos insulation. The testing was done in controlled plastic enclosures large enough for a worker to cut and strip wire cables as had been done for making electrical connections. The concentrations of airborne fibers greater than 5 μm in length were not significantly different from the detection limits during cutting and stripping of the four wire cables containing asbestos that were tested. The concentrations of asbestos fibers of all sizes in the air (TEM concentrations) were not increased over detection limits.

INTRODUCTION

Wire cables used to carry electrical power have been known to contain asbestos fibers in their insulating covers. The cutting and stripping of wire cables may release asbestos dust. This study was designed to determine under controlled conditions, the levels of asbestos, if any, which might be released into the air when four different types of asbestos-containing wire cables were cut and stripped.

MICROSCOPICAL METHODS

Polarized light microscopy techniques for the analysis of bulk samples were used to determine whether the wire cable samples contained asbestos fibers in their insulation (1).

Air samples are analyzed for asbestos using both light and electron microscope techniques. The standard procedure for the analysis of air samples for asbestos in an occupational environment is the National Institute of Occupational Safety and Health (NIOSH) Method 7400 (2). This procedure uses PCM to count fibers greater than 5 μm in length and greater than a 3 to 1 aspect ratio. The method counts all fibers seen at 400X magnification without distinguishing asbestos fibers from other fibers. It only counts fibers greater than approximately 0.25 μm in diameter, the optical resolution limit of the PCM.

A draft version of International Standards Organization (ISO) Standard Method for the analysis of directly prepared air filters for asbestos by transmission electron microscope was used to provide information about the asbestos structures in the air samples (3). This method eventually became the standard method for ambient air by TEM: ISO 10312. Asbestos structures containing asbestos fibers greater than 0.5 μm in length were counted using this technique.

STUDY SITE

The study was conducted in a warehouse in Norcross, Georgia. The study team conducted the wire cable cutting and stripping tests after an asbestos abatement contractor had prepared a containment area with four chambers. The containment barriers in each area consisted of two layers of 6-mil polyethylene plastic sheets on the floor, walls and ceiling of each chamber. The total containment area was approximately 150 square feet with an 8-foot ceiling height and 4 individual chambers each 4 feet by 8 feet (32 square feet). All personnel inside the containment area were protected by air purifying respirators and complete head and body coverings. The decontamination system consisted of a changing room outside the testing area, a shower room and a clean suitup room. The decontamination system was used each time a person exited the study area.

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EQUIPMENT

Asbestos analysis was done by PLM utilizing an Olympus BH-2 polarized light microscope having a magnification range from 40X to 1000X. The air samples were analyzed by PCM with a Nikon Alphaphot-2 light microscope and by TEM with an analytical Phillips 400 electron microscope (AEM) equipped with an EDS X-ray analysis system.

MATERIALS

Four (4) different wire cables of 1.125 or 1.25 inch diameter were tested. Each cable contained a ribbon inside the outer covering which identified the manufacturer. Based on PLM, all cables contained chrysotile asbestos inside the outer cover. Descriptive information for the product materials follows:

Experiment #1. Sample MDGA-19(14) was a 1.25 inch diameter cable with 20 copper wires, woven steel sheath with a rubber-like black insulating coating. The interior ribbon read: "General Cable Corporation, Bayonne, NJ, 1967 MIL-C-915A".

Experiment #2. Sample THFA-30 was a 1.125 inch diameter cable with 3 copper wires with a woven metal sheath on black rubber-like coating. The interior ribbon read: "M'd'd. by Phelps Dodge Copper Products Corp. - Habirshaw Cable & Wire Division, Yonkers, NY 1944 Navy".

Experiment #3. Sample MHFF-37 was a 1.25 inch diameter cable with 8 copper wires (color coded) in a black rubber-like coating. The interior ribbon read: "U.S. Steel Corp. Worchester, Mass. 1957 to U.S. Navy Specs MIL-C-915A".

Experiment #4. Sample MHFF-30 was a 1.125 inch diameter cable with over 20 color-coded copper wires. The interior ribbon read: "General Cable Corporation Eltkton, MD 1968 MIL-C-915-A".

PARTICLE RELEASE TESTING

In the controlled containment areas, background area air samples were collected before any work was performed on the wire cables. The rooms were aggressively swept with a broom during the collection of the background samples. Area air samples and personal monitoring samples were collected while the material was cut (in a dry condition) with a hack saw and the wires stripped of insulation. For each of the cables, a piece of wire cable was cut and the individual wires stripped as would be done for making an

electrical connection. The cutting and stripping was done after discussions with an electrician who had worked in shipyards for many years installing this type of material.

Air samples using mixed cellulose ester filters were collected during the cutting and stripping. Each activity tested lasted about 30 minutes. Separate air samples were also collected during a dry broom sweeping period which lasted approximately 5 minutes. The person cutting and stripping the cables was fitted with two personal air sampling devices. Two area air samples were also collected. The personal air samples were collected at rates of 0.8 and 1.9 liters per minute. One area air sample was collected with a personal air pump at a rate of 2.5 liters per minute. The other was collected at a rate of approximately 5.1 liters per minute.

RESULTS

The results of air monitoring are summarized in Tables 1 - 4. The asbestos concentration values of the area samples were always less than those of the personal samples. The limits of detection varied with the volume of air collected. The PCM concentrations of airborne fibers greater than 5 μ m in length were either at or below the detection limits of the method during cutting and stripping of the wire cables tested. The concentrations of asbestos fibers of all sizes in the air (TEM concentrations) were not increased significantly over detection limit values during the cutting and stripping of the wire cables containing asbestos.

REFERENCES

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Table 1.
Results of Experiment #1, Cable MDGA-19(14)

Sample Description	Air Volume (L)	PCM 7400 Fibers*/cc	TEM Structures**/cc
Background	790	0.007	<0.006
Background	790	<0.003	Not Analyzed
Personal During Stripping	57	<0.05	0.08
Personal During Stripping	25	0.11	0.8
Personal During Sweeping	11	<0.2	0.4
Personal During Sweeping	5	<0.5	<0.95

Table 2.
Results of Experiment #2, Cable THFA-30

Sample Description	Air Volume (L)	PCM 7400 Fibers*/cc	TEM Structures**/cc
Background	790	<0.003	<0.006
Background	790	0.006	Not Analyzed
Personal During Stripping	57	<0.04	0.2
Personal During Stripping	25	<0.1	<0.2
Personal During Sweeping	11	<0.4	<0.5
Personal During Sweeping	5	<0.6	<1.1

Table 3.
Results of Experiment #3, Cable MHFF-37

Sample Description	Air Volume (L)	PCM 7400 Fibers*/cc	TEM Structures**/cc
Background	790	<0.003	<0.006
Background	790	0.007	Not Analyzed
Personal During Stripping	57	<0.04	0.3
Personal During Stripping	25	<0.1	0.2
Personal During Sweeping	11	<0.2	<0.4
Personal During Sweeping	5	<0.5	<0.95

Table 4
Results of Experiment #4, Cable MHFF-30

Sample Description	Air Volume (L)	PCM 7400 Fibers*/cc	TEM Structures**/cc
Background	790	0.015	0.006
Background	790	0.01	Not Analyzed
Personal During Stripping	57	0.06	<0.08
Personal During Stripping	25	<0.1	<0.2
Personal During Sweeping	11	<0.3	<0.5
Personal During Sweeping	5	<0.6	<0.9

* Fibers > 5 μ m in length

** Structures contain asbestos fibers > 0.5 μ m in length

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