

## EXPOSURES OF END-USERS TO AIRBORNE CONCENTRATIONS OF FIBROUS GLASS DURING INSTALLATION OF INSULATION PRODUCTS AND FABRICATION OPERATIONS

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### INTRODUCTION

Owens-Corning Fiberglas has supported for many years a comprehensive industrial hygiene program for the evaluation of employee exposures to fibrous glass and other airborne contaminants in the Corporation's manufacturing facilities. We have also collected and analyzed data on the exposures of end-users of the Company's products.

In order to expand the data on end-users, an extensive study of end-users' exposures to fibrous glass during the installation, fabrication, and use of the Company's products was instituted. This paper presents the results of this study, and compares exposures observed in end use applications to those normally seen in manufacturing situations.

### MATERIALS AND METHODS

Several hundred paired personal and area samples were collected in parallel on 0.8 micron pore size mixed cellulose ester filters mounted in 37 mm diameter polystyrene plastic cassettes with 16 mm non-electrically conductive extension cowls (i.e. NIOSH P&CAM 239 sampling method<sup>1</sup>) and in 25 mm diameter polystyrene plastic cassettes with 50 mm electronically conductive extension cowls (i.e. NIOSH 7400 sampling method<sup>2</sup>). This correlative sampling was performed since the majority of fibrous glass monitoring results obtained in the "in-plant" program were collected using the NIOSH P&CAM 239 Procedure. It was felt that if comparisons were to be made between the "in-plant" and end-user data, both sampling methodologies should be employed.

During the initial phase of the study, additional samples were collected using 0.45 polycarbonate filters mounted in 37 mm diameter cassettes with 16 mm extensions cowls. However, this approach was quickly discontinued due to the poor fiber retention (i.e. fibers were collected but were easily dislodged during transportation).

All samples were collected at a flow rate of two liters per minute (i.e. 2.0 l/m) using constant flow sampling pumps. The pumps were calibrated, with the filter and sampling train in line, before and after sampling using a precision rotameter calibrated against a primary standard (i.e. soap bubble meter for volumetric rate of air flow).

Applications sampled included installation operations involv-

ing traditional insulation products (i.e. batts, blankets, rolls, and loose fill insulation); and fabrication operations involving duct board, duct liner and other industrial products (e.g. range insulation, mobile home insulation, etc.). Both residential and commercial sites were evaluated.

All sample filters were mounted using the acetone/triacetin clearing method and analyzed via phase contrast optical microscopy (PCOM) at a magnification of 400X. Fiber counts for all sample filters were derived utilizing the procedures specified in both the NIOSH P&CAM 239 method as well as the NIOSH 7400 "A" method (i.e. all fibers > 5 microns in length with aspect ratios equal to or greater than 3:1 were counted). Glass fibers were differentiated from other fibers by morphology and shape recognition. For fibers that could not be easily identified by phase contrast microscopy, the samples were cross checked using polarized light microscopy. Additionally, fiber length and diameter measurements were determined for some of the samples.

To address fiber adherence to the sampling cowls, after filter removal, all cowls were rinsed with 25% isopropanol in distilled water. Rinse solutions were then filtered through 0.4 micron polycarbonate filters, and analyzed using the counting procedures described above.

To determine if some of the glass fibers present on the filters were too fine to be detected by optical microscopy, 40 filters were also counted by scanning electron microscopy. Two randomly chosen samples were also counted by transmission electron microscopy. Both analyses incorporated the "A" counting rules.

After all sample results had been obtained, matched pair results were analyzed statistically to determine differences between the 37 and 25 mm diameter filters. Natural log transformed data were used to determine statistical difference at the 0.05 significance level.

### RESULTS AND DISCUSSION

The sample results obtained from this study are presented in Tables I and II and Figures 1 and 2. Because a significant concentration of fibers were found adhering to the sidewalls of the cassettes (i.e. NIOSH P&CAM 239 Procedure) and to the sampling cowls (NIOSH 7400 Procedure), these fibers were

**Table I**  
**Total Airborne Fiber Concentrations**  
 Obtained by Using the NIOSH P&CAM 239 and 7400 "A" Methods  
 (Combined), Fibers per Cubic Centimeter

ITEM	ALL FIBERS							
	----- Filters -----				----- Filters and Cows -----			
	# Samples	Exp. Value	95% LL	95% UL	# Samples	Exp. Value	95% LL	95% UL
Plants	75	0.024	0.018	0.030	71	0.031	0.020	0.043
Batts - Installers	60	0.17	0.12	0.22	60	0.24	0.18	0.31
Loose Fill Loaders								
Cubed	86	0.23	0.19	0.28	86	0.37	0.31	0.43
Milled	18	0.37	0.29	0.56	18	0.56	0.34	0.81
Loose Fill Installers								
Cubed	88	0.75	0.66	0.83	87	1.0	0.87	1.1
Milled	20	0.91	0.51	1.4	20	1.3	0.77	1.8

**Table II**  
**Total Airborne Fiber Concentrations**  
 Obtained by Using the NIOSH P&CAM 239 and 7400 "A" Methods  
 (Combined), Fibers per Cubic Centimeter

ITEM	ALL FIBERS							
	----- Filters -----				----- Filters and Cows -----			
	# Samples	Exp. Value	95% LL	95% UL	# Samples	Exp. Value	95% LL	95% UL
Fabricators	44	0.11	0.033	0.14	44	0.16	0.11	0.19
Metal Building Ins	26	0.034	0.028	0.042	26	0.046	0.030	0.069
Mobile Home	20	0.11	0.062	0.17	20	0.17	0.096	0.24
Pipe	19	0.12	0.067	0.18	19	0.16	0.066	0.23
Range	25	0.054	0.034	0.075	25	0.069	0.041	0.097
Duct Liner	24	0.024	0.013	0.036	24	0.030	0.013	0.048
Water Heater	13	0.037	0.022	0.063	13	0.047	0.022	0.071
Flex Duct	60	0.062	0.049	0.074	60	0.078	0.060	0.096

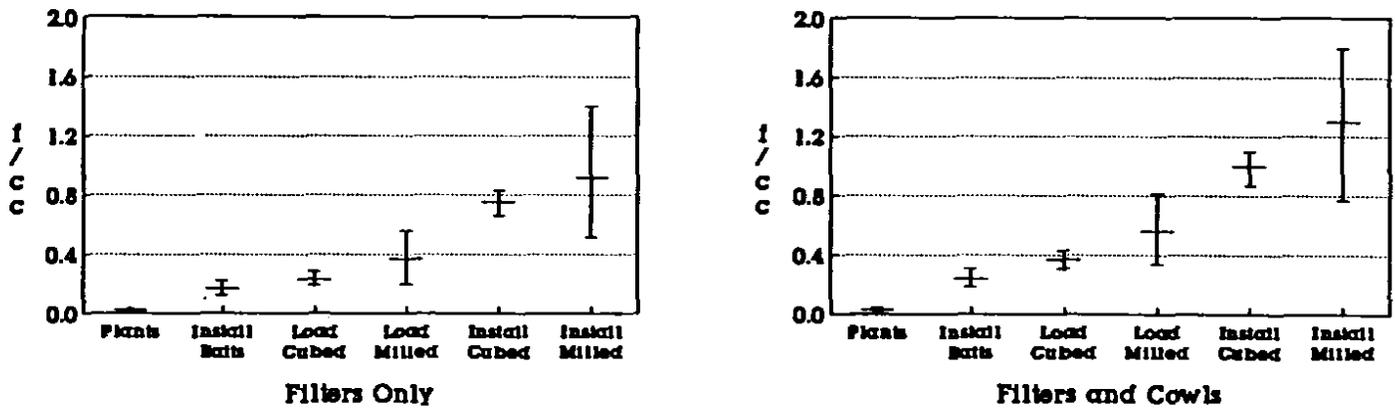


Figure 1.

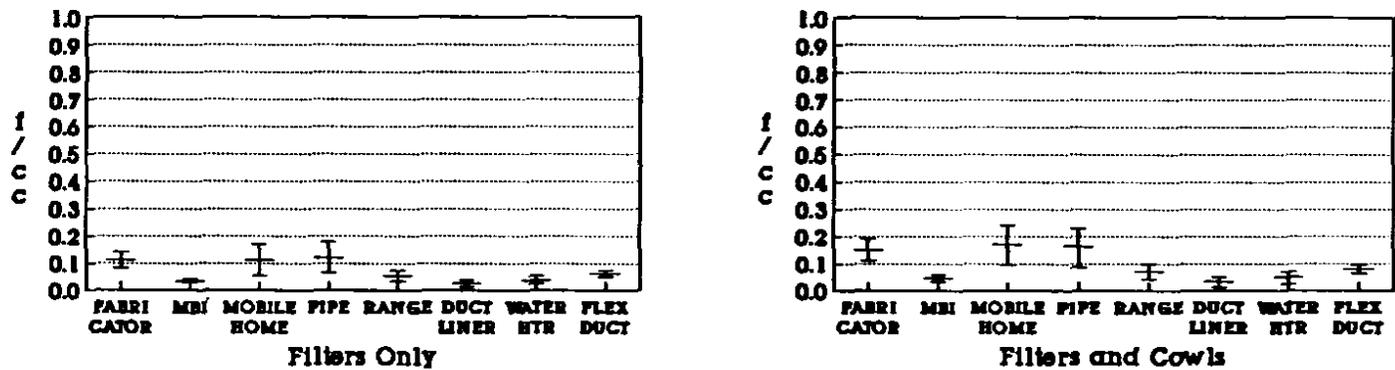


Figure 2.

also counted. Results are reported as filter only and as filter and cowl combined. Statistical analysis indicated that there was no difference between the total fiber results obtained from the NIOSH P&CAM 239 and 7400 methods using the "A" counting rules for either filters only or filter and cowls combined. Therefore, results from the two sampling methodologies were combined for the data summary and statistical analysis.

As indicated in Table I and Figure 1, the mean total fiber (both glass fiber and all other fiber) exposures of employees in OCF production facilities involved in the manufacture of fibrous glass insulation products were 0.024 f/cc for filters only and 0.03 f/cc for filters and cowls combined. Further analyses revealed that 70 to 75% were glass fibers. Of the glass fibers, 60% were of a respirable size. (Respirable fibers are defined as those with diameters < 3.5 microns, lengths of 5 to 250 microns, and length to diameter ratios of 3:1). These exposures are representative of 8-hour time weighted average exposures.

The mean total fiber (both glass fiber and all other fiber) exposures of individuals installing batt, blanket, and roll insulation was 0.17 f/cc for filters only and 0.24 f/cc for filters and cowls combined. Additional analyses revealed that 50% were

glass fibers. Of the glass fibers, 75% were of a respirable size. As anticipated, loose fill loaders and installers were exposed to higher mean concentrations of total fiber in the range of 0.23 to 0.91 f/cc for filters only and 0.37 to 1.3 f/cc for filters and cowls combined, primarily due to the nature of the installation process. Additional analyses revealed that 50 to 75% were glass fibers. Of the glass fibers, 50 to 75% were of a respirable size. These exposures represent those measured during the actual installation operations and not during transportation and preparation activities. Therefore, actual 8-hour time weighted average exposures will be less than those reported above.

Exposures of employees involved in installing a variety of OCF products are indicated in Table II and Figure 2. Mean total fiber (both glass fiber and all other fiber) ranged from 0.024 f/cc to 0.12 f/cc for filters only and 0.03 to 0.17 f/cc for filters and cowls combined.

Scanning electron microscopy analysis of 40 samples, collected at OCF plants and during installation of OCF products, revealed that all fibers (i.e. length > 5 micron and length to width ratio > 3:1) are seen by phase contrast microscopy. Two samples analyzed by transmission electron microscopy also revealed that all fibers are seen by phase contrast microscopy.

## CONCLUSIONS AND RECOMMENDATIONS

Total fiber exposures of both OCF insulation production employees and end users are appreciably lower than the NIOSH recommended exposure limit for glass fibers (i.e. 3 f/cc). Statistical analysis indicated that there was no difference between the total fiber results obtained from the NIOSH P&CAM 239 and 7400 methods using the "A" counting rules. A significant concentration of fibers were found adhering to the sidewalls of the cassettes (i.e. NIOSH P&CAM 239 Procedure) and to the sampling cowls (NIOSH 7400 Procedure).

There was no statistical difference between the total fiber results obtained from the NIOSH P&CAM 239 method when combining fibers counted from the filters and cassette sidewalls and the total fiber results obtained from the NIOSH 7400 method when combining fibers counted from the filters

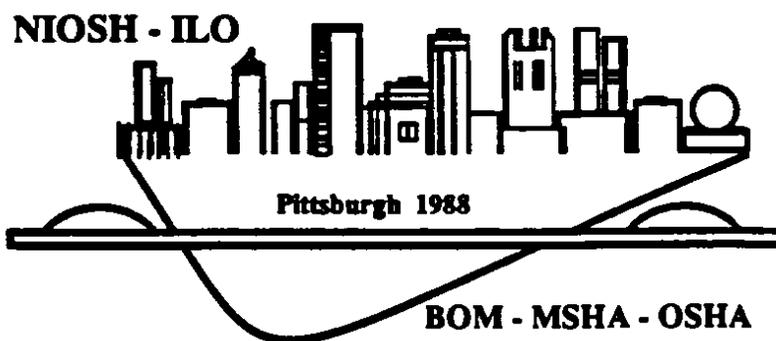
and cowls. Furthermore, scanning electron microscopy analysis revealed that all fibers (i.e. length > 5 micron and length to width ratio > 3:1) are seen by phase contrast microscopy. Additional research is needed on the optical microscopy methodologies for determining respirable fibers and for identifying glass fibers.

## REFERENCES

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