

## EXPOSURES OF PRODUCTION EMPLOYEES TO AIRBORNE CONCENTRATIONS OF FIBROUS GLASS DURING THE MANUFACTURING PROCESS

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### INTRODUCTION

Airborne concentrations of fibrous glass can be evaluated either gravimetrically or by optical fiber counting methodologies. However, numerous studies<sup>1,2</sup> have demonstrated that there is little correlation between gravimetric results and concentrations of fibrous glass present. For this reason, optical fiber counting methodologies rather than gravimetric analysis have become the methods of choice for fibrous glass analysis.

Prior to the publication of the Occupational Safety and Health Administration's Revised Asbestos Standard (29CFR 1910.1001) in June of 1986,<sup>3</sup> the generally accepted procedure for the determination of airborne concentrations of asbestos, fibrous glass, and other man-made mineral fibers was the NIOSH P&CAM 239 method.<sup>4</sup> However, with the promulgation of this Standard, a new methodology for the evaluation of airborne concentrations of fibrous materials was introduced, the NIOSH 7400 method.<sup>5</sup>

This method introduced a new sampling train for fiber collection (i.e. 25 mm cassette with 50mm extension cow) as well as alternative methods for fiber counting (Rules "A" and "B"). Though similar in other respects to the NIOSH P&CAM 239 method, the new NIOSH 7400 method quickly began to receive increased attention from the industrial hygiene community as it was utilized to evaluate individuals' exposures to not only asbestos, but other man-made mineral fibers as well. Of particular concern was the notable adherence of fibers to the sampling cowl and the differing results obtained when fibers were counted via the "A" versus the "B" rules.<sup>6</sup>

With a considerable body of data on employees' exposures to fibrous glass obtained through use of the NIOSH P&CAM 239 method, it became imperative for Owens-Corning Fiberglas to evaluate the correlation between the two methods in terms of the sample results produced and to determine if the NIOSH 7400 method should be adopted for future exposure evaluations. Furthermore, since most of the information concerning use of the NIOSH 7400 method had been generated as a result of asbestos monitoring, it was felt that additional information could be gleaned through the use of the method to evaluate airborne concentrations of a man-made mineral fiber such as fibrous glass. Thus, the following study was designed and implemented.

### MATERIALS AND METHODS

Seventy-five 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) or in 25 mm diameter polystyrene plastic cassettes with 50 mm electrically conductive extension cowls (i.e. NIOSH 7400 sampling method). During the initial phase of the study, additional samples were collected using 0.45 polycarbonate filters mounted in 37 mm diameter cassettes with 16mm extensions cowls for analysis by scanning electron microscopy. 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). Samples were collected at specific sites along plant manufacturing lines during the production of a variety of fibrous glass insulating products (e.g. batts, blankets, and loose fill). Samples were collected over significant portions of the work shift and are believed to be representative of full shift exposures.

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 shape recognition using polarized light microscopy. Additionally, fiber length and diameter measurements were determined for a fraction 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.

After all sample results had been obtained, matched pair results were analyzed statistically to determine differences between the 37 and 25 mm diameter filters and corresponding cowls. 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 indicated in Table I. The mean total fiber exposure and the lower and upper 95% confidence limits are shown for the forehearth, line, packer, bagger, rollup, repack cubed, and repack milled operators. The overall 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 (NIOSH P&CAM 239 and 7400 methods combined). Additional analyses revealed that 70 to 75% were glass fibers and that 60% of the glass fibers were of a respirable size (i.e. diameters <3.5 microns, lengths of 5 to 250 microns, and length to diameter ratios of 3:1 or greater). Furthermore, these sample results were consistent irrespective of the type of product produced (i.e. faced vs. unfaced insulation) or the physical parameters of the product produced (i.e. R 30 vs. R19 or 24" width vs. 18" width).

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 also counted. Results are reported on Table I and Figure I as filter only and as filter and cowl combined. Figure I also includes results of samples collected in end-user applications. The data indicate that there was no statistically significant difference in sample results obtained from the NIOSH P&CAM 239 and 7400 methods when the "A" counting rules were used (see Figure 1). Furthermore, this result was consistent irrespective of the fiber type or size analyzed (i.e. total fiber, total glass fiber, or respirable glass fiber).

Statistical analysis also 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 when the fibers on the filters and cowls were combined, Table II. Table II also includes results of samples collected in end-user applications. As indicated in Table II, the ratio, R, of (fibers deposited on cowls + fibers deposited on filters)/ fibers deposited on filters, was 1.7 for the NIOSH P&CAM 239 method (i.e. 16 mm sampling cowl) and 1.5 for the NIOSH 7400 method. There was no statistical difference between these ratios.

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 Cowls			
	# Samples	Exp. Value	95% LL	95% UL	# Samples	Exp. Value	95% LL	95% UL
FOREHEARTH	20	0.017	0.008	0.028	19	0.025	0.003	0.048
LINE	2	0.003	0.000	0.032	2	0.008	0.000	0.076
PACKER	30	0.028	0.017	0.040	29	0.038	0.017	0.056
BAGGER	8	0.023	0.012	0.033	7	0.030	0.002	0.057
ROLLUP	2	0.021	0.001	0.041	2	0.028	0.000	0.082
REPACK-CUBED	9	0.024	0.008	0.040	9	0.033	0.002	0.086
REPACK-MILLED	4	0.040	0.013	0.088	3	0.046	0.000	0.110

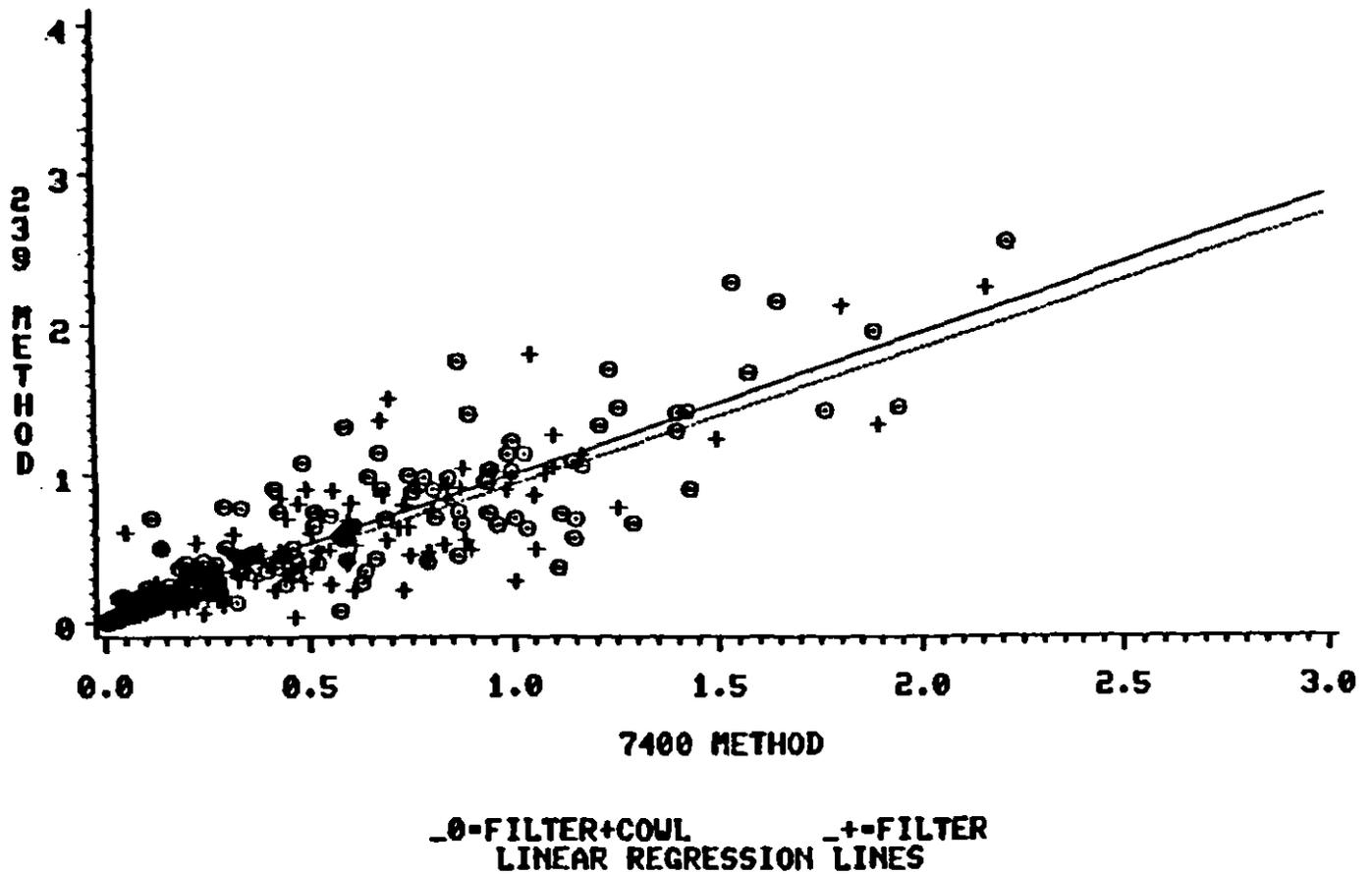


Figure 1. Total fibers per cc—random field counts.

Table II  
 Ratio of (Fibers Deposited on Cowls + Fibers Deposited on Filters)  
 Fibers Deposited on Filters for NIOSH P&CAM 239 and NIOSH 7400 Methods\*

<u>METHOD</u>	<u># OF SAMPLES</u>	<u>AVERAGE</u>	<u>MEDIAN</u>	<u>STANDARD DEVIATION</u>
239	162	1.7	1.5	0.90
7400A	160	1.5	1.4	0.52

**NOTE: STATISTICALLY THE RATIOS FOR METHODS 239 AND 7400A ARE NOT DIFFERENT.**

Significant fiber deposition on sampling cowl has been reported previously by Seixas et. al.<sup>6</sup> Also, in commenting on this phenomenon, some investigators have suggested that a high ratio of fibers detected on sampling cowl versus fibers found on filters is merely an artifact produced by undercounting of fibers deposited on filters.<sup>7</sup> This was not found to be the case, however, since the ratio, R, was consistently high for low as well as medium and high fiber counts.

## CONCLUSIONS

The results obtained from our studies indicated that mean employee exposures to total fibers in Owens-Corning Fiberglas manufacturing facilities was 0.024 fibers/cc for filters only and 0.03 f/cc for filters and cowl combined. There was no statistically significant difference in the results obtained when the NIOSH P&CAM 239 and 7400 "A" methods were utilized. However, the study also demonstrated that there was a significant concentration of fibers deposited on the sampling cowl used for both methods which should conceivably be considered in determining the total level of exposures to fibrous glass.

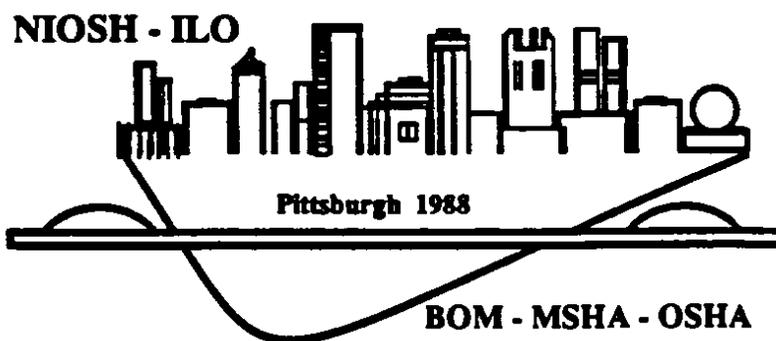
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