USPHS/CDC/NIOSH/DPSE

ENGINEERING CONTROL TECHNOLOGY BRANCH

CONTROL TECHNOLOGY ASSESSMENT OF ASBESTOS PIPE LAGGING REMOVAL USING TWO NEGATIVE-AIR GLOVE BAG REMOVAL METHODS

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Background: Many workers are exposed to asbestos:

Construction workers - Demolition, Renovation, Sprinkler Fitters, Sheet Metal, Roofing, etc.

Operations and Maintenance - Plumbing, HVAC, Electrical, House Keeping, etc.

Building Occupants - Office Workers, clients, students, customers, public, etc.

We proposed a pilot study in 1983 to assess need for research in the asbestos removal industry.

INTRODUCTION

- **PILOT STUDY , 1984**
- **PROTOCOL PEER REVIEW SPRING 1985**
- **FOUR SCHOOL STUDY SUMMER 1985**

WORKER PROTECTION & ENVIRONMENTAL PROTECTION

CONTROL AT THE SOURCE - THE BEST APPROACH

CONTAIN THE ASBESTOS BEFORE IT IS RELEASED INTO THE ENVIRONMENT.

JOINT PROJECT WITH EPA -SUMMER OF 1985

EPA PROVIDED FUNDING FOR ANALYSIS
NIOSH ADDED EVALUATION OF CLEARANCE AND EVALUATION OF EFFICACY

SOURCE CONTROLS

- FOR WORK AND ENVIRONMENT
- FIRST PRIORITY GLOVE BAGS WIDELY USED/OFTEN ALONE

Glove Bags were chosen as the first priority because they were widely used by the construction trades as well as by the O&M workers.

They are often used as the only control measure.

They seem to represent an economical source control technology.

GLOVE BAG PHASE

OBJECTIVES

- EVALUATE WORKERS' EXPOSURE DURING GLOVE BAG REMOVAL
- EVALUATE CLEARANCE SAMPLING METHODS
- EVALUATE THE EFFICACY OF THE GLOVE BAG REMOVAL METHODS

EVALUATE WORKERS

- By Personal Breathing Zone Full Term Seq.
- Half day activity -> Morning and Afternoon
- One Short Term sample on each worker AM & PM

EVALUATE CLEARANCE SAMPLING METHODS

- By comparing PCM & TEM analysis both methods.
  I will describe aggressive and nonaggressive
- Replicate samples were taken on polycarbonate & cellulose ester media for the two analysis

EVALUATE THE EFFICACY OF THE GLOVE BAG REMOVAL M

- By determining if the post levels are lower by collecting samples before and after

SAMPLING STRATEGY

- OUTDOOR AMBIENT
- PRE-REMOVAL - 2 METHODS
- PERSONAL BREATHING ZONE
  TWA AND SHORT TERM
- AREA DURING REMOVAL
- POST REMOVAL - 2 METHODS

OUTDOORS AMBIENT

- Paired 25mm Cellulose Ester - foil wrapped
- Gast pumps at 3.5 lpm for the full shift

PRE & POST REMOVAL -(First the room is sealed off)

- Two eight hour sequential sampling periods
  - 1st Non-Aggressive - Taken in a dry quiet room per EPA Blue Book guidance.
  - Aggressive - Taken in a dry room with blowers
    - Blow down room with leaf blower - 3 passes
      keep air moving with oscillating fans
- Triplicate Replicate sampling - 25 & 37mm

AREA DURING REMOVAL

- Duplicate Replicate sampling - 25 & 37mm

PBZ's 25mm cellulose esters in foil wrapped cowls

PRE AND POST REMOVAL

SAMPLING EQUIPMENT

FILTERS IN OPEN FACED CASSETTES AND MOUNTED ON A 9 POSITION SAMPLING RING:

- 3 - 37mm cellulose ester 0.8 u
- 3 - 37mm polycarbonate 0.4u with a 5.0 u cellulose ester backup
- 3 - 25mm cellulose ester 0.8u

SAMPLING PUMPS:

- 6 cassettes on a manifold, each with 3.5 lpm orifices with high powered GE and Gast vacuum pumps.
- 3 cassettes on dupont P4000 pumps

THREE MEHODS SIDE BY SIDE IN TRIPLICATE.

OTHER MONITORING

AMBIENT, SHORT TERM, FAM's

Ambient outside samples on paired 25mm cellulose ester filters with 2" foil wrapped cowls.

A 15 minute short term breathing zone sample on each worker, morning and afternoon.

FAM MEASURED RELATIVE LEVELS ONLY

REMOVAL ACTIVITY

MONITORING

Morning and afternoon sequential breathing zone and replicate area samples collected at 2.5 to 3.5 lpm.

Filters mounted in open faced cassettes.

Areas mounted on 4 position ring

- **2 - 37 mm Polycarbonate 0.4u**
- **2 - 25 mm cellulose ester 0.8u**

in aluminum foil wrapped 2"cowls

DUPONT P4000 SAMPLING PUMPS

AREA SAMPLING EQUIPMENT



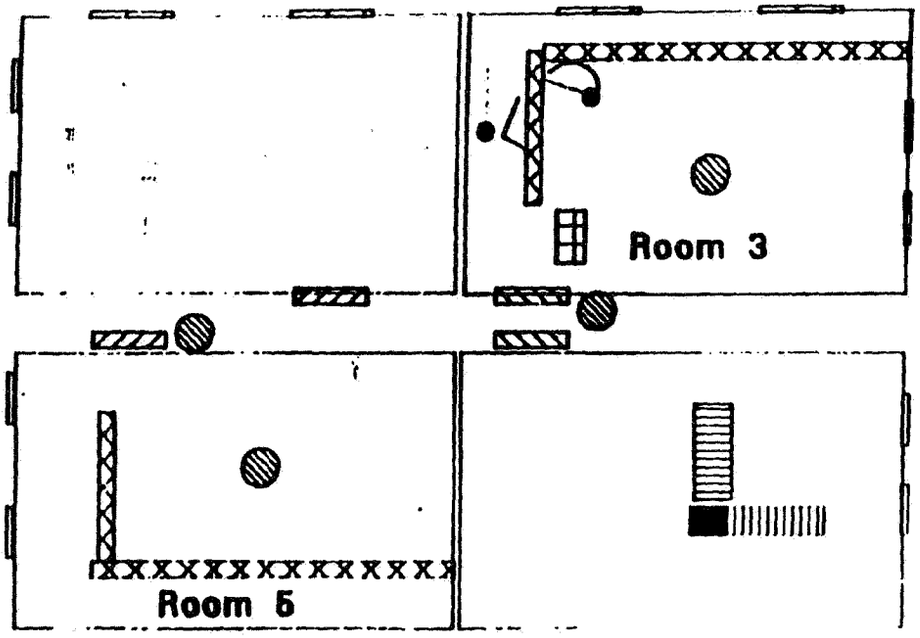
This is a shot of the area sampling equipment.

In the foreground the sampling tree used for centeral room sampling and outside areas.

In the background the Mobile Cart sampling tree used in the vicinity of the work activity.

EAMS are located next to both of these sampling trees. They provided real-time monitoring.

TYPICAL SAMPLING LAYOUT



STAIRWAY

INTERIOR AREA SAMPLER

WORKER

MOBILE CART

POLY FLAP DOORWAY

AMBIENT AIR SAMPLE
HUNG OUT UPSTAIRS
WINDOWS

GLOVE BAG REMOVAL PROCESS

- PREPARATION
  - *MIST LAGGING WITH AGENT
  - *COVER PIPE LAGGING WITH POLY
  - *INSTALL BAGS OVER COVERING
- REMOVAL WORK INSIDE GLOVE BAG
  - *REMOVE POLY AND WET LAGGING
  - *REMOVE LAGGING & BRUSH CLEAN
- MOVE OR REPLACE GLOVE BAG
  - *WASH WELL AND TIE OFF BAG
- CLEANUP AND DISPOSE OF WASTE

Preparation: First mist lightly to suppress dust.
Cover lagging in poly envelope then glovebags.
*** SEE PHOTOS ***
Removal: Done inside sealed bags using long gloves
-Cut poly envelope & lagging at joints. USE CARE
-WET lagging and wash bag down OFTEN AND HEAVILY.
-Wash and Brush the pipe. Bottle or horse brushes
*** SEE PHOTOS ***
Moving/Removing Bag:VERY CRITICAL OPEN BAG TASK
-Wet the asbestos and wash bag thoroughly.
-Use HEPA vacuum when collapsing bag - tie it off
*** SEE PHOTOS ***
Cleanup: Ongoing task use HEPA and wet mopping
-Double bag/label and dispose in approved fill.

HWBU0000917

VIDEO CONVENTIONAL
GLOVE BAG METHOD STUDIED

NIOSH CONTROL TECHNOLOGY ASSESSMENT

A brief video presentation of the types of work activities and equipment associated with the asbestos removal methods studied.

Also a illustration of the monitoring and site preparations for this control technology study.

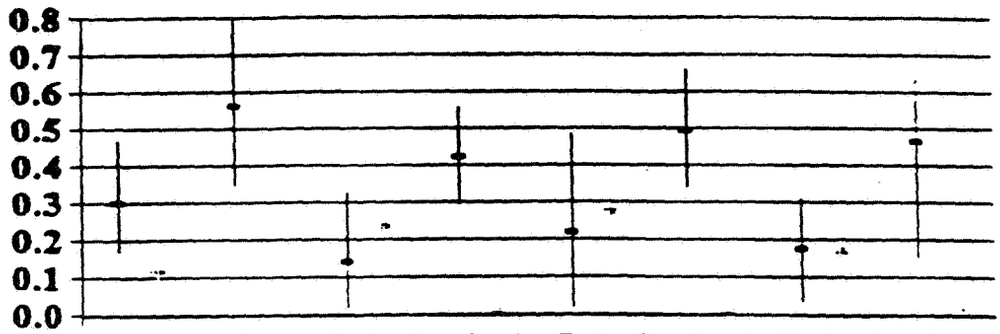
FINDINGS
WORKING CONCENTRATIONS

PBZ AND AREA MONITORING

TWA EXPOSURE RANGES FOR

FOUR WORKERS AT FOUR SITES 14 DAYS

FIBERS/CUBIC CENTIMETER (f/cc)



WORKER A, B, C, D

FACILITY 1,2,3,4

NIOSH 7400 METHOD (B RULES)

Here you see a summary of the four workers' TWA exposures at all four sites.

Each vertical entry shows the range, Max and Min, and Mean for the specified worker and school.

Note that nearly all of the Daily TWA's were above .1 f/cc and many were above .2 f/cc

The percentages are shown in the next slide.

WORKER BREATHING ZONE
FINDINGS

- **DAILY TWA LEVELS:**
  - *37 / 51 (73%) ARE ABOVE 0.1 f/cc
  - *30 / 51 (58%) ARE ABOVE 0.2 f/cc
- **PREPARATION VS REMOVAL LEVELS:**
  - *PREPARATION AVG 0.02 f/cc
  - *REMOVAL WORK AVG 0.35 f/cc
- **SHORT TERM LEVELS: HIGH> 9.3 f/c**
  - *16 / 69 (23%) ARE ABOVE 1.0 f/cc

NIOSH 7400 METHOD (B RULES)

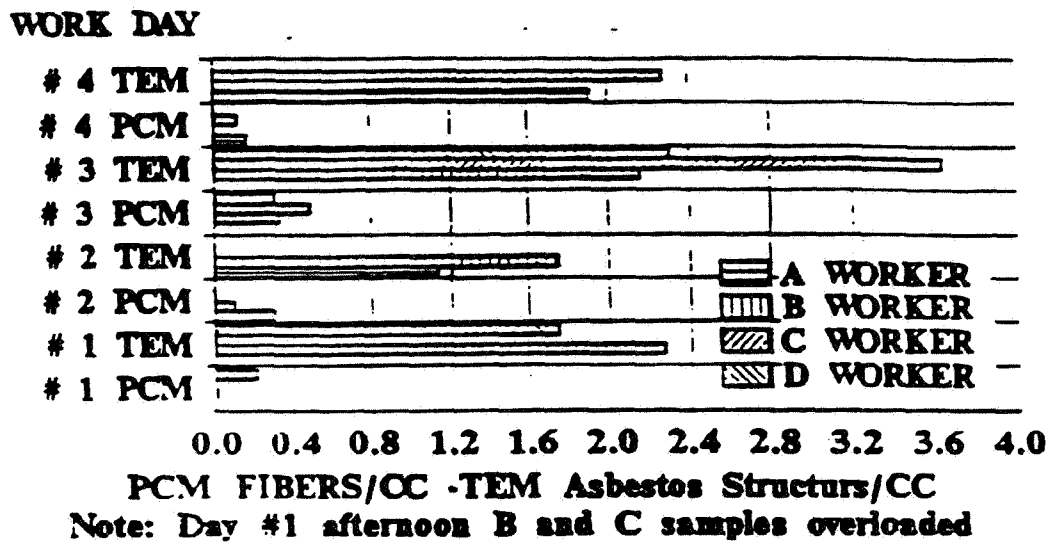
Daily TWA'S reflect a significant exposure potential above recommended control limits.

Activity related exposure levels show that the removal exposures are an order of magnitude higher than the preparation work exposures.

Short Term levels were peaked by the unplanned episode with a 9.0 f/cc. Also the 1.0 f/cc level was exceeded 23% of the time overall.

FACILITY #1 DAILY TWA

NIOSH 7400 (B RULES)/TEM YAMATE



PCM FIBERS/CC -TEM Asbestos Structurs/CC

Note: Day #1 afternoon B and C samples overloaded

Note: Day one workers B and C samples were overloaded with particulate. Unable to count.

The TEM analysis was done on the same Cellulose Ester 25mm filter that the PCM Personal Beathing Zone analysis was. Due to limited support these are the only worker PBZ samples done by TEM.

WORKER GLOVE BAG EXPOSURE OBSERVATION & CONCLUSION

- WORKERS WITH LIMITED TRAINING AND EXPERIENCE HAVE EXPOSURES ABOVE NIOSH RECOMMENDATIONS AND OSHA CRITERIA LEVELS.
- GLOVE BAGS ALONE DO NOT SUFFICE IN CONTROLLING EXPOSURES *UNDER THESE CONDITIONS*.

It is prudent to use respiratory protection during any glove bag operation due to potential leaks.

OSHA permits the use of high efficiency, air purifying respirators for asbestos; However, NIOSH recommends that type C positive pressure, supplied air respirators be used if levels exceed the REL.

As a minimum it is appropriate to seal off the air ducts and doorways to avoid contamination from an accidental release during glove bag work.

More extensive work should likely include the use of decontamination facilities and negative air.

Glove Bag Evaluation Status

Negative Air Technology

Two types of negative air glove enclosures have been studied. The AERO-PIPE CAPSULE manufactured by Aerospace America, Inc. and a Custom Fabricated Glovebag designed to operate under negative pressure conditions.

Preliminary PCM results would indicate that both methods produced adequate control to meet the OSHA PEL and the NIOSH REL. However, TEM analysis of the post removal aggressive sampling have shown many thin fibers. We are awaiting TEM analysis of some of the working area samples to quantify the workers actual fiber exposure levels.

VIDEO OF NEGATIVE-AIR
GLOVE BAG METHOD STUDIED

NIOSH CONTROL TECHNOLOGY ASSESSMENT

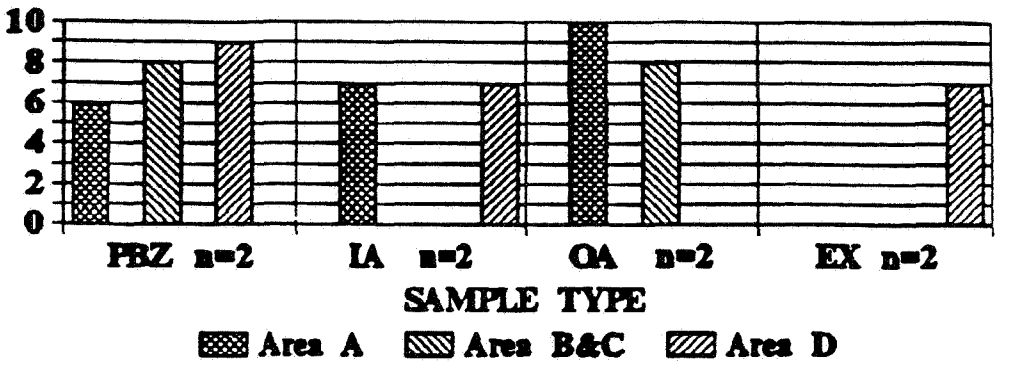
A brief video presentation of the types of work activities and equipment associated with the asbestos removal methods studied.

Also a illustration of the monitoring and site preparations for this control technology study.

Negative Air Glovebag

PCM Results BELOW LOD

LOD FIBERS/CC BY NIOSH 7400 METHOD
x 1/1,000



AERO-PIPE CAPSULE/AEROSPACE AMERICA,INC.

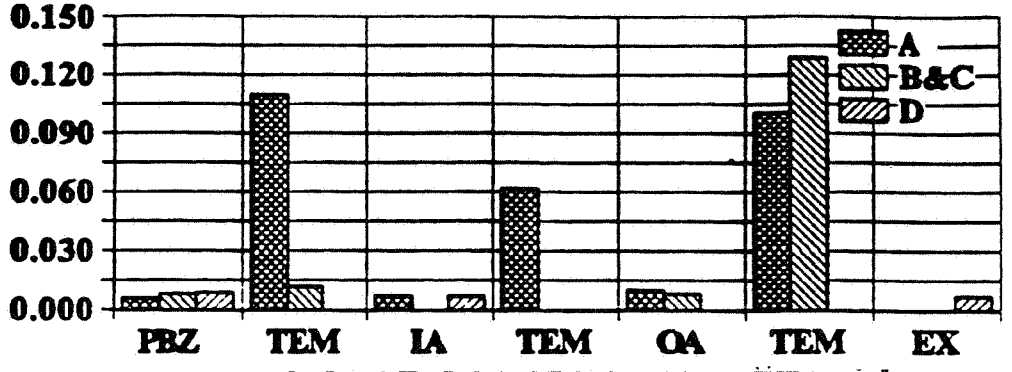
These results are all below the LOD and therefore differences reflect the sample volume. The lower less than concentrations representing longer times for sample collection. Two short term samples of 20 minute duration were taken in area D. The also were below the LOD around < 0.05 f/cc.

We have received preliminary results of our TEM on these personal breathing zone samples. They indicate higher concentrations of asbestos that must be confirmed by a more complete analysis which is pending. The pre and post TEM analysis shows many fine fibers outside the PCM range.

Negative Air Glovebag

PCM BELOW LOD vs TEM as/cc

TOTAL FIBERS BY NIOSH 7400 METHOD vs TEM



AERO-PIPE CAPSULE/AEROSPACE AMERICA,INC.

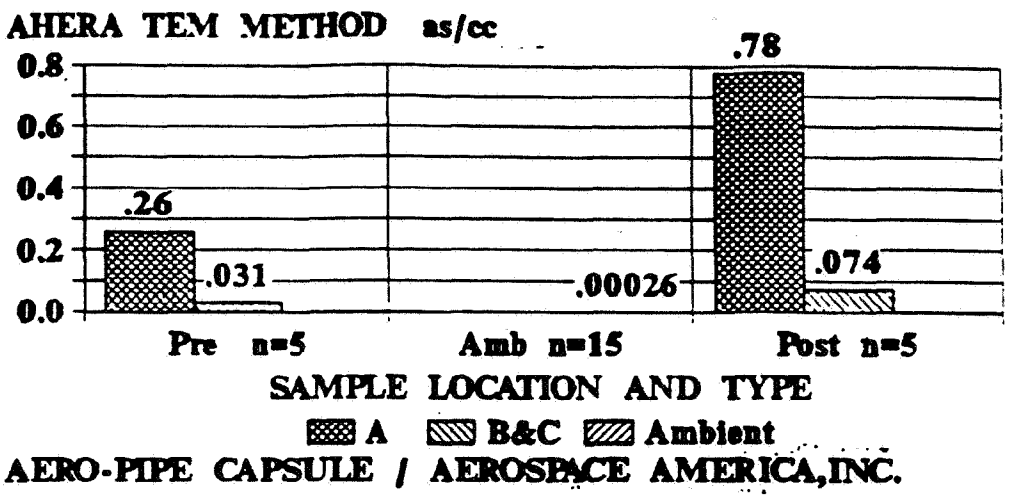
PCM results are presented to the left of TEM for: Personal Breathing Zone (PBZ), Interior Area (IA), Outer Area (OA) and the HEPA Exhaust (EX).

The PCM data represent two samples each. The TEM data is from an unetched half of one of the two 0.8 u MCE filter samples used for the PCM. Our laboratory had poor etching results.

The other half from the remainder of the PCM have been submitted to the same laboratory which did the pre and post analysis to eliminate this TEM interlaboratory variability factor.

Negative Air Glovebag

PRE and POST TEM as/cc



AERO-PIPE CAPSULE / AEROSPACE AMERICA,INC.

Five pre and post abatement samples were taken for six and a quarter hours using aggressive sampling in a poly enclosure at eight to ten liters per minute for a minimum sample volume of 3000 liters.

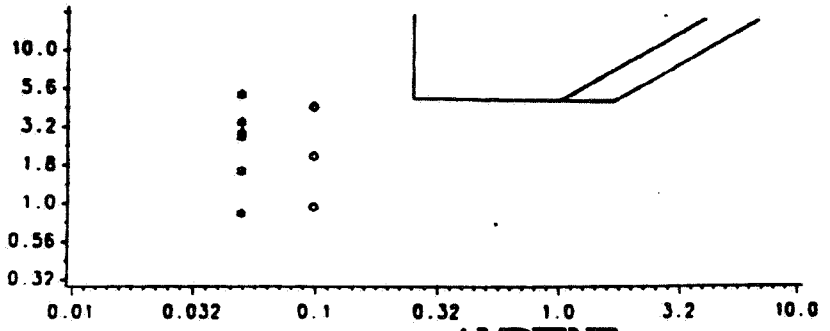
Both the post sample sets are significantly higher than pre using a t-test on ln(concentration) with p-values 0.0014 for area A and 0.0013 for area B/C

The 15 outdoor ambients were at or below 0.0012 as/cc. As shown above all of the mean values for both area A (0.26 - 0.78) and for area B/C (0.013-0.074) well above this ambient level.

PLOT OF STRUCTURES

BY LENGTH AND DIAMETER

STRUCTURE LENGTH, MICROMETERS



AMBIENT

STRUCTURE DIAMETER, MICROMETERS

AHERA TEM METHOD/ AERO-PIPE

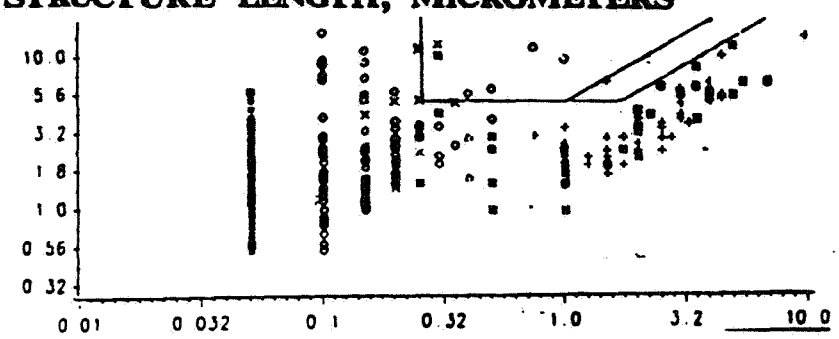
This slide shows the size distribution of asbestos structures from all fifteen outdoors ambient samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.0012 as/cc.

—— PCM METHOD 7400	• • • 1 CHRYSOTILE F	• • • 1 CHRYSOTILE B
+ + 1 CHRYSOTILE M	■ ■ ■ 1 CHRYSOTILE C	x x x 1 AMPHIBOLE F
▲ ▲ 1 AMPHIBOLE B	0 0 0 1 AMPHIBOLE M	□ □ □ 1 AMPHIBOLE C
B B 1 AMBIGUOUS F	● ● ● 1 AMBIGUOUS B	z z z 1 AMBIGUOUS M
C C 1 AMBIGUOUS C	N N N 1 NON ASBESTOS F	v v v 1 NON ASBESTOS B
W W 1 NON ASBESTOS M	Y Y Y 1 NON ASBESTOS C	

PLOT OF STRUCTURES

BY LENGTH AND DIAMETER



This slide shows the size distribution of asbestos structures from all five pre-removal aggressive samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

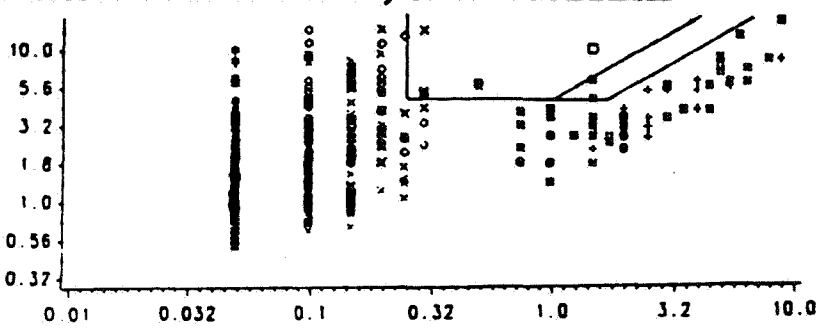
Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.26 as/cc.

PCM METHOD 7400	1 CHRYSOTILE F	1 CHRYSOTILE B
1 CHRYSOTILE M	1 CHRYSOTILE C	1 AMPHIBOLE F
1 AMPHIBOLE B	1 AMPHIBOLE M	1 AMPHIBOLE C
1 AMBIGUOUS F	1 AMBIGUOUS B	1 AMBIGUOUS M
1 AMBIGUOUS C	1 NON ASBESTOS F	1 NON ASBESTOS B
1 NON ASBESTOS M	1 NON ASBESTOS C	

PLOT OF STRUCTURES

BY LENGTH AND DIAMETER

STRUCTURE LENGTH, MICROMETERS



POST AREA A

STRUCTURE DIAMETER, MICROMETERS

AHERA TEM METHOD/ AERO-PIPE

This slide shows the size distribution of asbestos structures from all five post-removal aggressive samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.78 as/cc.

— PCM METHOD 7400	e e e I CHRYSOTILE F	e e e I CHRYSOTILE B
+ + I CHRYSOTILE M	s s s I CHRYSOTILE C	x x x I AMPHIBOLE F
A A I AMPHIBOLE B	O O O I AMPHIBOLE M	D D D I AMPHIBOLE C
B B I AMBIGUOUS F	e e e I AMBIGUOUS B	Z Z Z I AMBIGUOUS M
C C I AMBIGUOUS C	N N N I NON ASBESTOS F	V V V I NON ASBESTOS B
W W I NON ASBESTOS M	Y Y Y I NON ASBESTOS C	

EFFICACY CONCLUSIONS
NEGATIVE AIR METHODS

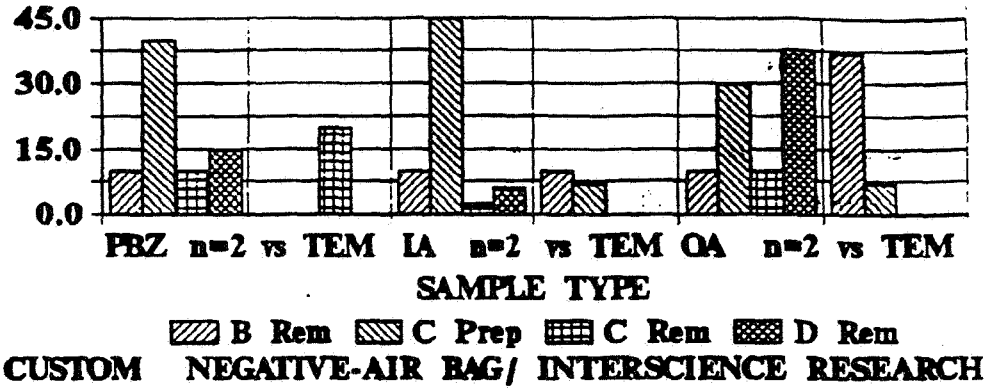
- THIS UNIT MET THE OSHA PEL AND NIOSH REL FOR CONTROL OF WORKERS EXPOSURE TO ASBESTOS.
- FURTHER STUDY IS NEEDED TO DETERMINE THE SOURCE OF THE FINE ASBESTOS FIBERS SEEN IN TEM ANALYSIS.

AERO-PIPE CAPSULE/AEROSPACE AMERICA,INC.

Negative Air Glovebag

PCM Results vs TEM as/cc

PCM TOTAL FIBERS/CC BY NIOSH 7400 METHOD
x 1/1,000



CUSTOM NEGATIVE-AIR BAG/ INTERSCIENCE RESEARCH

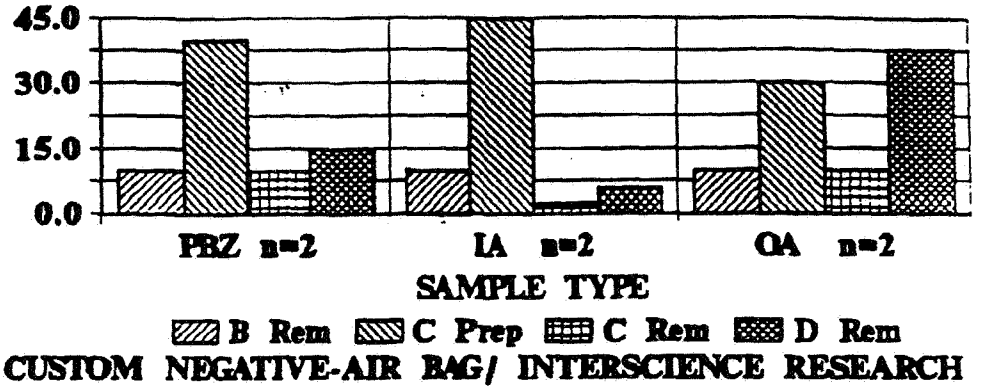
PCM results are presented to the left of TEM for: Personal Breathing Zone (PBZ), Interior Area (IA), Outer Area (OA). Area B samples were taken during removal activity. Area C Prep samples were taken during Preparation activity and C Rem were taken during removal activity in area C.

The PCM data represents two samples each. The TEM data is from an unetched half of one of the two 0.8um MCE filter samples used for the PCM. Since this TEM method may undercount embedded fibers, the other half have been submitted to the same lab that performed etched pre and post TEM analysis.

Negative Air Glovebag

PCM Results

TOTAL FIBERS/CC BY NIOSH 7400 METHOD
x 1/1,000

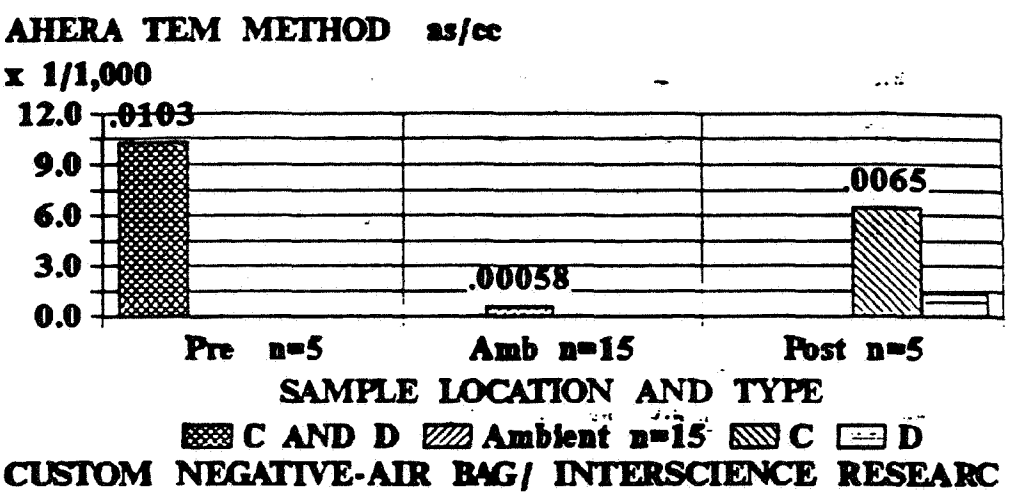


CUSTOM NEGATIVE-AIR BAG/ INTERSCIENCE RESEARCH

These results are all below the OSHA PEL and NIOSH REL. TEM analysis have shown there are asbestos structures present here although not as numerous as in the other study. It is noted that these PCM results would have indicated higher levels in this survey. Each abatement environment well present a different relationship between the PCM results and the actual fiber distribution as shown by TEM.

Negative Air Glovebag

PRE and POST TEM as/cc



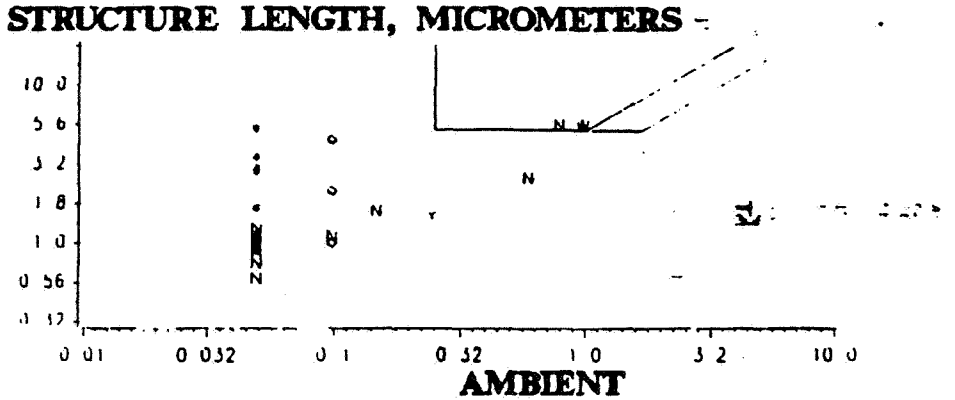
Five pre and post abatement samples were taken for six and a quarter hours using aggressive sampling in a poly enclosure at eight to ten liters per minute for a minimum sample volume of 3000 liters.

Area D post samples are significantly lower than the pre. Using a t-test on ln(concentration) yield p-values of 0.16 for area C and 0.0001 for area D.

The 15 outdoor ambients were at or below 0.0011 as/cc. As shown above all of the mean values for both area C (0.010 - 0.0065) and area D (0.010 - 0.014) were slightly above ambient level.

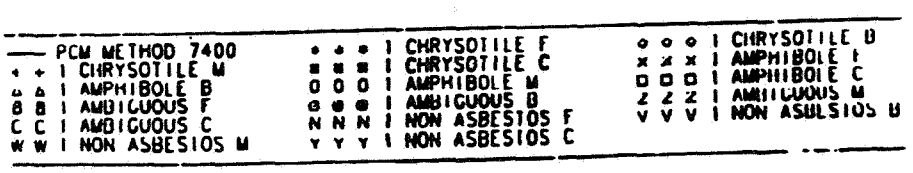
PLOT OF STRUCTURES

BY LENGTH AND DIAMETER



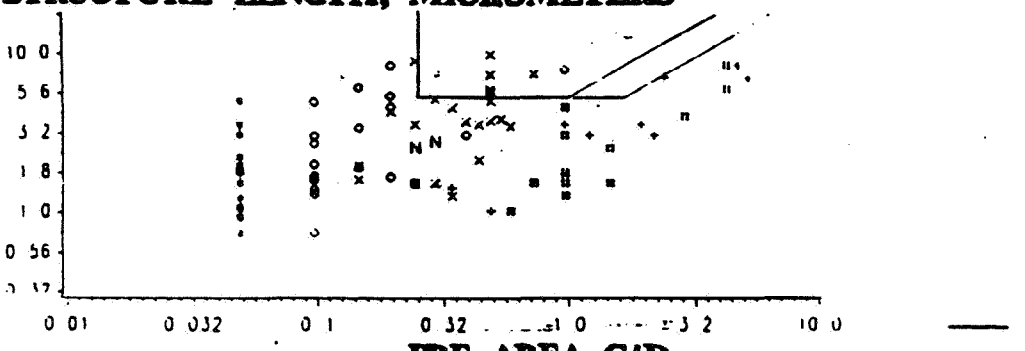
This slide shows the size distribution of asbestos structures from all fifteen outdoors ambient samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.0002 as/cc.



PLOT OF STRUCTURES

BY LENGTH AND DIAMETER



AHERA TEM METHOD/ CUSTOM GLOVEBAG

This slide shows the size distribution of asbestos structures from all five pre-removal aggressive samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

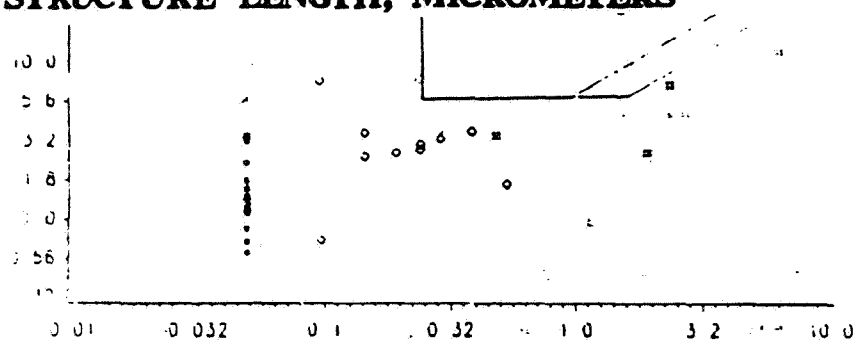
Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.01 as/cc.

— PCM METHOD 7400	▲ ■ ● 1 CHRYSOTILE F	● ● ● 1 CHRYSOTILE B
+ + 1 CHRYSOTILE M	■ ■ ■ 1 CHRYSOTILE C	× × × 1 AMPHIBOLE F
▲ ▲ 1 AMPHIBOLE B	D D D 1 AMPHIBOLE M	□ □ □ 1 AMPHIBOLE C
B B 1 AMBIGUOUS F	● ● ● 1 AMBIGUOUS B	Z Z Z 1 AMBIGUOUS M
C C 1 AMBIGUOUS C	N N N 1 NON ASBESTOS F	V V V 1 NON ASBESTOS B
W W 1 NON ASBESTOS M	Y Y Y 1 NON ASBESTOS C	

PLOT OF STRUCTURES

BY LENGTH AND DIAMETER

STRUCTURE LENGTH, MICROMETERS



POST AREA C

STRUCTURE DIAMETER, MICROMETERS

AHERA TEM METHOD/ CUSTOM GLOVEGAB

This slide shows the size distribution of asbestos structures from all five post-removal aggressive samples. The region outlined in the upper right quarter defines the ranges visible to PCM analysis for a 3:1 and 5:1 aspect ratio.

Clearly there would not be a large number of PCM fibers on any one filter. The mean concentration for these samples was 0.0065 as/cc.

— PCM METHOD 7400	* * * I CHRYSOTILE F	o o o I CHRYSOTILE B
+ + I CHRYSOTILE M	x x x I CHRYSOTILE C	x x x I AMPHIBOLE T
△ △ I AMPHIBOLE B	□ □ □ I AMPHIBOLE M	□ □ □ I AMPHIBOLE C
8 8 I AMBIGUOUS F	◇ ◇ ◇ I AMBIGUOUS B	Z Z Z I AMBIGUOUS M
C C I AMBIGUOUS C	N N N I NON ASBESTOS F	V V V I NON ASBESTOS B
W W I NON ASBESTOS M	Y Y Y I NON ASBESTOS C	

EFFICACY CONCLUSIONS
NEGATIVE AIR METHODS

- THIS UNIT MET THE OSHA PEL AND NIOSH REL FOR CONTROL OF WORKERS EXPOSURE TO ASBESTOS.
- FURTHER STUDY OF THIS CONTROL, UNDER VARIED WORK CONDITIONS, IS RECOMMENDED.

CUSTOM NEGATIVE-AIR BAG/ INTERSCIENCE RESEARCH.