MEASUREMENT OF AIRBORNE ASBESTOS FIBER BY THE MEMBRANE FILTER METHOD

ASBESTOS TEXTILE INSTITUTE
(FOUNDED 1944)

Printed in U.S.A.

Price: $1.00 per copy

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OUTLINE OF METHOD .....

APPARATUS AND MATERIALS .....

CLEANLINESS .....

PREPARATION OF MOUNTING SOLUTION

AEROSOL FIELD MONITOR AND FILTERS

CALIBRATION OF EQUIPMENT .....

SAMPLING .....

COUNTING .....

CALCULATION OF RESULTS .....

INDUSTRIAL HYGIENE WORK SHEET .....

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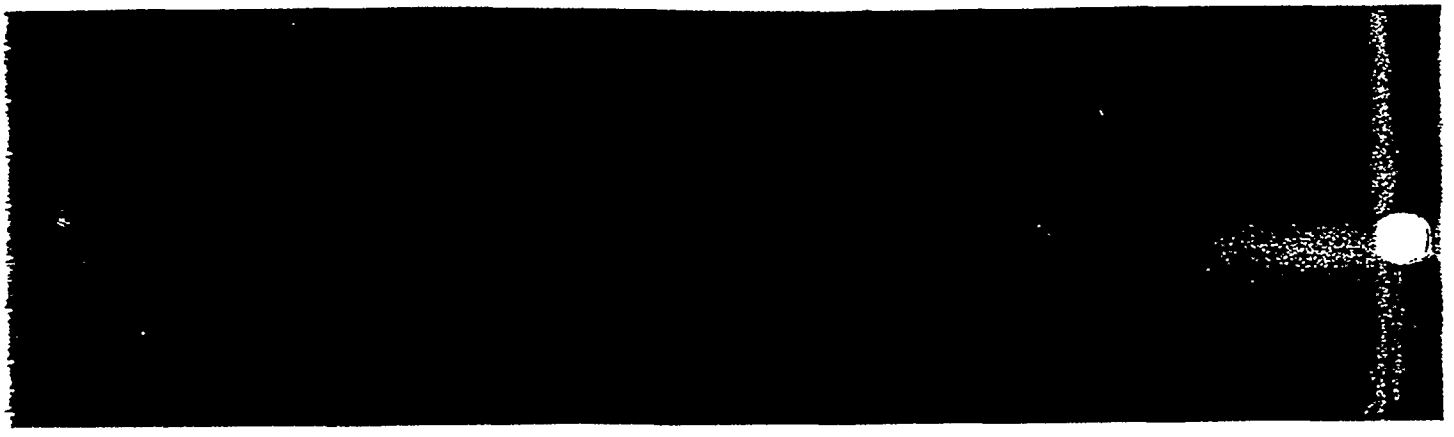

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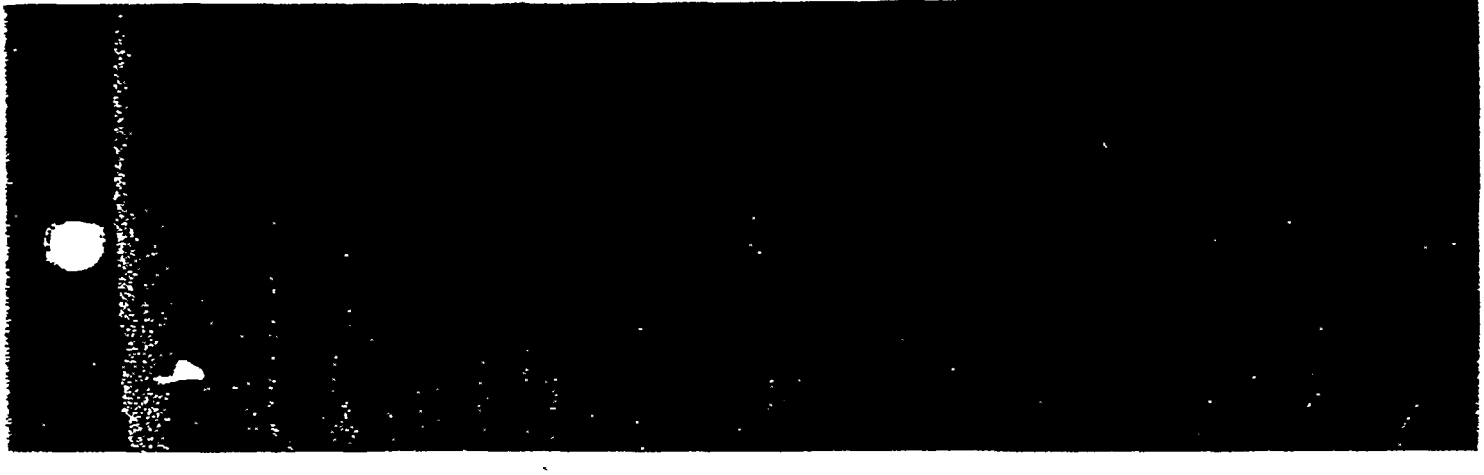
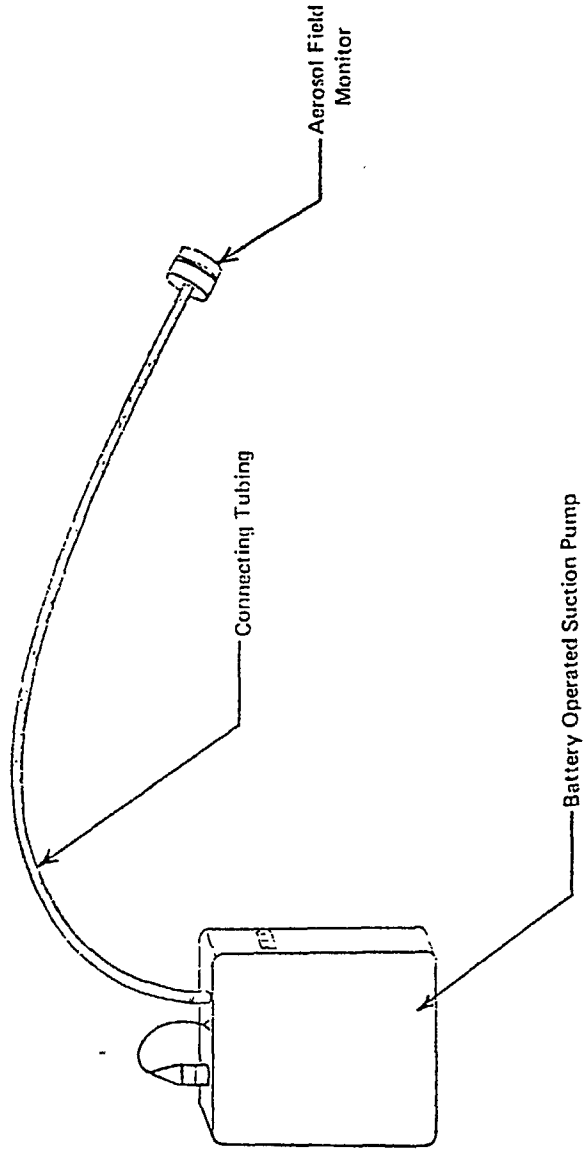


SAMPLING EQUIPMENT
USED IN THE
MEMBRANE FILTER METHOD



1. SCOPE:

1.1 This method covers a procedure fo fiber concentration in air. The proc the determination of concentr : using phase contrast microscop.

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2. DEFINITION:

2.1 A fiber is any particle having a leng greater.

3. OUTLINE OF METHOD:

3.1 Airborne asbestos fibers are collected of air through a membrane filter by fibers are deposited on the filter.

A representative section of the f i on a microscope slide, and exa .e (or 400x) using phase contrast optics. of fibers observed in a given area unde this figure is used to calculate the nun meter (cc.) of air sampled.

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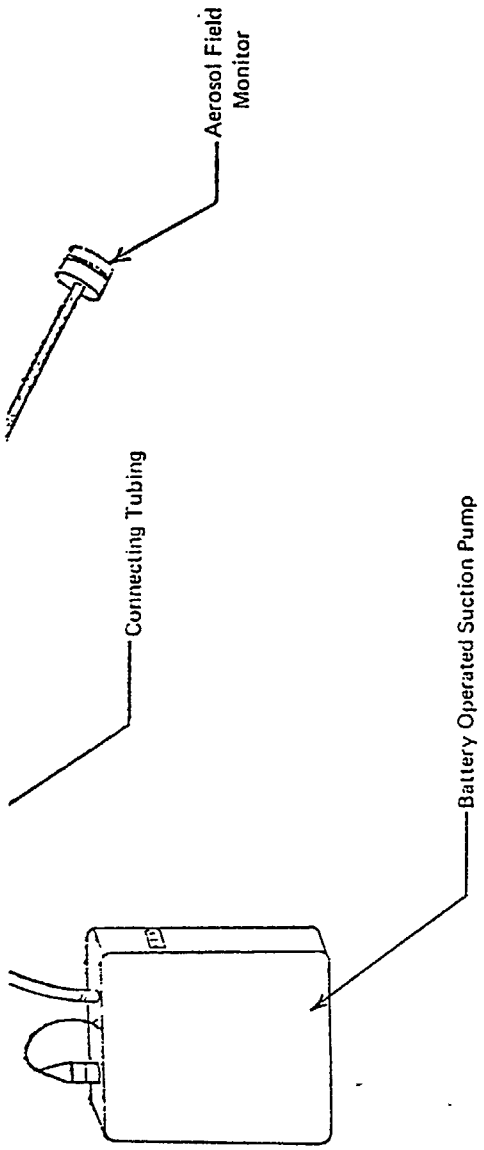
4. APPARATUS AND MATERIALS:

4.1 Sample Collector:
The samples shall be collected on a filt



1. SCOPE:

1.1 This method covers a procedure for the determination of asbestos fiber concentration in air. The procedure is designed specifically for the determination of concentrations of fibers 5 microns or longer using phase contrast microscopy.

This method is also useful for the determination of fibers shorter than 5 microns, the minimum length detectable being limited only by the inherent limitations of ordinary light microscopy using phase contrast optics. Further, this method is meant to be used for fiber determinations only in areas where airborne fibers, if present, are predominantly or entirely asbestos fibers; it does not specify procedures for distinguishing between asbestos and other types of fibers. All fibers detected by this procedure are assumed to be asbestos fibers and are reported as such, unless independent evidence is at hand to warrant other assumptions.

This method can be used to assess conformance of asbestos fiber concentrations to standards as set forth by Federal, State, or Provincial statutory requirements for Asbestos Threshold Limit Value.

2. DEFINITION:

2.1 A fiber is any particle having a length to diameter ratio of 3:1 or greater.

3. OUTLINE OF METHOD:

3.1 Airborne asbestos fibers are collected by drawing a specified volume of air through a membrane filter by use of a suction pump. The fibers are deposited on the filter.

A representative section of the filter is removed, properly mounted on a microscope slide, and examined at a magnification of 430x (or 400x) using phase contrast optics. The number and length range of fibers observed in a given area under the microscope is noted and this figure is used to calculate the number of fibers per cubic centimeter (cc.) of air sampled.

Fiber concentrations are categorized with respect to length in the following manner; total number of fibers seen, greater than 5 microns, and greater than 10 microns per cubic centimeter of air.

4. APPARATUS AND MATERIALS:

4.1 Sample Collector:

The samples shall be collected on a filter having a pore size of 0.8 ±

0.05 micrometers (microns), supported on a thick pad to control air distribution and mounted in a segmented enclosure (filter holder, field monitor) to prevent contamination of the filter prior to exposure.(1)

4.2 Cellulose Bands:
The segments of the filter holder (field monitor) containing the filter and pad shall remain sealed against contamination until ready for examination.(2)

4.3 Tubing:
Rubber or plastic tubing of suitable length is connected to the inlet side of the pump and to the filter holder assembly. One quarter inch inside diameter, non-collapsable tubing is recommended.

4.4 The suction pump shall be capable of providing a constant air flow rate of 2 liters per minute for the duration of a test when connected to the filter assembly through a required length of tubing. It is desirable, although not necessary, that the pump have an explosion-proof motor.(3)

4.5 Microscope and Accessories:
A binocular microscope fitted with phase contrast optics should be used for counting the asbestos fibers. Any reticle, such as Porton or Patterson Globe and Circle, which projects a constant counting area and has provision for sizing, is suitable. This procedure is written using the Bausch and Lomb phase-equipped microscope and the Porton reticle. All set up procedures correspond with this equipment. However, any good microscope with phase contrast accessories is acceptable.

The reticle is mounted in the non-adjustable eyepiece and a stage micrometer is used to calibrate the dimensions of the counting area.

Microscope slides size 3 x 1 inch and cover glasses No. 1½, 18mm. must be used.

(1) A suitable filter assembly is a Type AA, 37mm., 0.8 micron cellulose ester filter, pad and plastic "field monitor" – obtainable from the Millipore Corporation, Bedford, Mass. 01730.

(2) Cellulose bands for this purpose may be obtained from the W. H. Jelly and Co., Inc., Franklin Park, Illinois 60131.

(3) Suitable pumps may be obtained from: a) Mine Safety Appliance Co., Pittsburgh, Penna. 15208; b) Willson Products, Div., Reading, Penna. 19603; c) Unico Environmental Instruments Inc., Fall River, Mass. 02720.

4.6 Miscellaneous:
A 1:1 mixture of dimethyl phthalat
for preparing the sample mountin- m

Tweezers, scalpel, lens tissue, a.. a
ing cleanliness of the microscope and

5. CLEANLINESS:

5.1 All equipment used in fiber countir
only for this purpose. Fiber countin
part of the laboratory; and, if pos
microscope and accessories should b
cedures for care of the microscope ar
manufacturer's recommendations.

6. PREPARATION OF MOUNTING SOLUTI

6.1 The mounting solution used in thi
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If samples are to stand for longer peri
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viscous solution delays the migratic
the center of the mount. The sampi
apparent loss in concentration for app

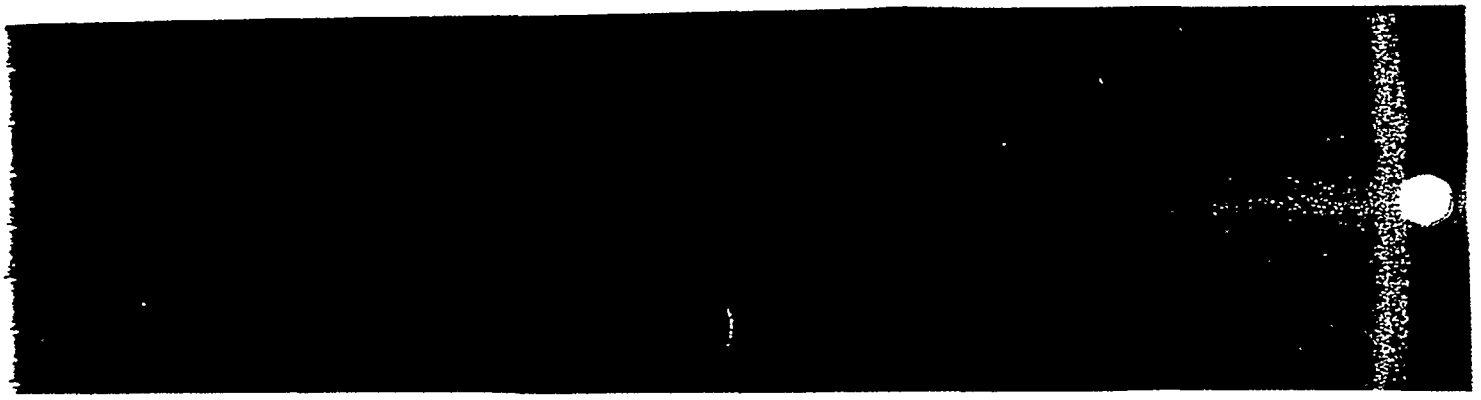
7. AEROSOL FIELD MONITOR AND FILTE

7.1 The monitors may be reused af a
oughly in warm detergent water and ri

8. CALIBRATION OF EQUIPMENT:

8.1 Pump:
The frequency of calibration is dep
handling of the instrument. The calib
is carried out with a filter in place. It
intermediate standard be used in the ca

8.1.1 Suction pumps equipped with
calibrated by a primary stan
cedure is shown in Fig. 1. A
direct measure of air volume d



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4.6 Miscellaneous:

A 1:1 mixture of dimethyl phthalate and diethyl oxalate is needed for preparing the sample mounting medium.

Tweezers, scalpel, lens tissue, and a camel's hair brush for maintaining cleanliness of the microscope and accessories are needed.

5. CLEANLINESS:

5.1 All equipment used in fiber counting should be isolated and used only for this purpose. Fiber counting should be done in the cleanest part of the laboratory; and, if possible, in a separate room. The microscope and accessories should be kept clean at all times. Procedures for care of the microscope and accessories should follow the manufacturer's recommendations.

6. PREPARATION OF MOUNTING SOLUTION:

6.1 The mounting solution used in this method is a 1:1 mixture of dimethyl phthalate and diethyl oxalate. This solution may be used when the sample is to be counted within 24 hours after preparation. If samples are to stand for longer periods of time an alternate solution should be used. This solution may be prepared by dissolving 0.05 grams of membrane filter material per milliliter of solution. The purpose of the dissolved material is to provide a solution with as high a viscosity as possible without being difficult to handle. The highly viscous solution delays the migration of particles outward from the center of the mount. The samples will remain stable with no apparent loss in concentration for approximately 30 days.

7. AEROSOL FIELD MONITOR AND FILTERS:

7.1 The monitors may be reused after each test by cleaning them thoroughly in warm detergent water and rinsing with distilled water.

8. CALIBRATION OF EQUIPMENT:

8.1 Pump:

The frequency of calibration is dependent on the use, care, and handling of the instrument. The calibration for the suction pump is carried out with a filter in place. It is suggested that a primary or intermediate standard be used in the calibration.

8.1.1 Suction pumps equipped with a floating-ball gauge may be calibrated by a primary standard. The set up for this procedure is shown in Fig. 1. A primary standard provides a direct measure of air volume displaced per unit time.

Before starting the calibration, be sure the pump battery is fully charged. Fill a 250 ml. graduate with water and invert in a beaker of water. Note the starting level in the graduate. Let the water come to room temperature. Adjust the ball float to one of the lines on the gauge scale. Insert the tubing from the discharge side of the pump into the graduate. Start the pump and timer simultaneously. As the liquid level in the graduate approaches the liquid level in the beaker, simultaneously stop the timer and lift the graduate from the discharge tube. The pump is still operating. The mouth of the graduate should remain below the level of water in the beaker during this step. Stop the pump and note the final level in the graduate.

Calculate the flow rate in standard liters/min. from the formula,

$$Q = \frac{V_i - V_f}{T} \times \frac{60 \times K}{1000}$$

where:

Q	= flow rate in standard liters/min.
Vi	= initial volume in ml. from graduate.
Vf	= final volume in ml. from graduate.
T	= time in seconds of calibration.
60	= conversion from seconds to minutes when T is in seconds.
1000	= conversion from ml. to liters.
K	= factor taking into consideration — temperature and pressure corrections.

To calculate the value of K, use the following formula,

$$K = \frac{Pa - Pv}{760} \times \frac{530}{460 + F}$$

where:

Pa	= atmospheric pressure in mmHg.
Pv	= vapor pressure of water at room temperature in mmHg.
F	= room temperature in °F

Duplicate tests should be run at each major scale division on the flowmeter gauge. On a plot of flowmeter setting

versus air flow rate (Q), dra
the points. From this line, th
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adjusted to this setting n

An alternate method for cali
test meter, which is an i
method, the pump's suction
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displacement is indicated by
After the meter is leveled and
the apparatus is assembled a
watch, time the wet test mete
If the meter does not indicat
adjustment should be made
proper setting. The actual air
times a conversion factor (K).
The calculation of the value
above in the primary calibrati

8.2 Microscope:
Before using the microscope for coun
must be in proper adjustment. This prc

8.2.1 Screw the 10x and 43x phas
nosepiece and insert the 10x e

8.2.2 Position the 10x objective f
slide on the stage, turn on th
diaphragm on the condenser al

8.2.3 Set the phase ring to th c
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8.2.4 Close the iris diaphragm on
point where only a small brig
Adjust the iris set screws on t
is centered in the field.

8.2.5 Focus sides of Decagon with
Sides will appear blue when fo
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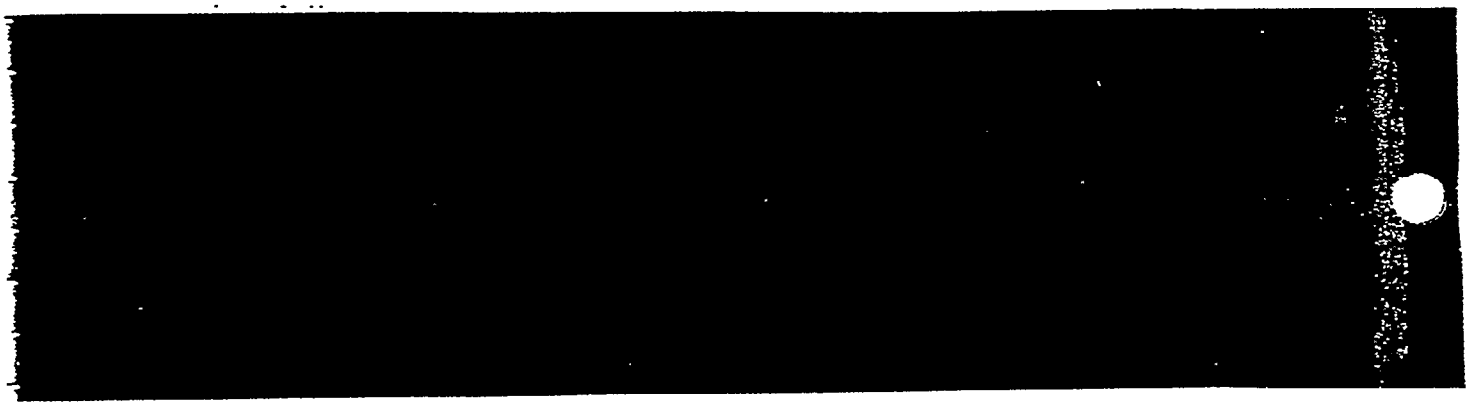
phragm to cover entire field of

8.2.6 With the phase ring setting stil
piece and insert the centering



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apor pressure of water at room tempera-
ure in mmHg.
oom temperature in °F

could be run at each major scale division
r gauge. On a plot of flowmeter setting

versus air flow rate (Q), draw the best straight line through the points. From this line, the flowmeter setting corresponding to two liters/min. is determined. The pump should be adjusted to this setting when taking samples.

An alternate method for calibrating pumps is by using a wet test meter, which is an intermediate standard. In this method, the pump's suction is determined by the displacement of water in the meter by the gas being measured. This displacement is indicated by a dial on the face of the meter. After the meter is leveled and the sight gauge properly filled, the apparatus is assembled as shown in Fig. 2. Using a stopwatch, time the wet test meter displacement for one minute. If the meter does not indicate two LPM at 6" H_2O, then an adjustment should be made on the pump to obtain the proper setting. The actual air flow rate is the calibrated rate times a conversion factor (K) for temperature and pressure. The calculation of the value of K is the same as described above in the primary calibration procedure.

8.2 Microscope:
Before using the microscope for counting, its phase contrast optics must be in proper adjustment. This procedure is described below.

8.2.1 Screw the 10x and 43x phase contrast objectives into the nosepiece and insert the 10x eyepieces.

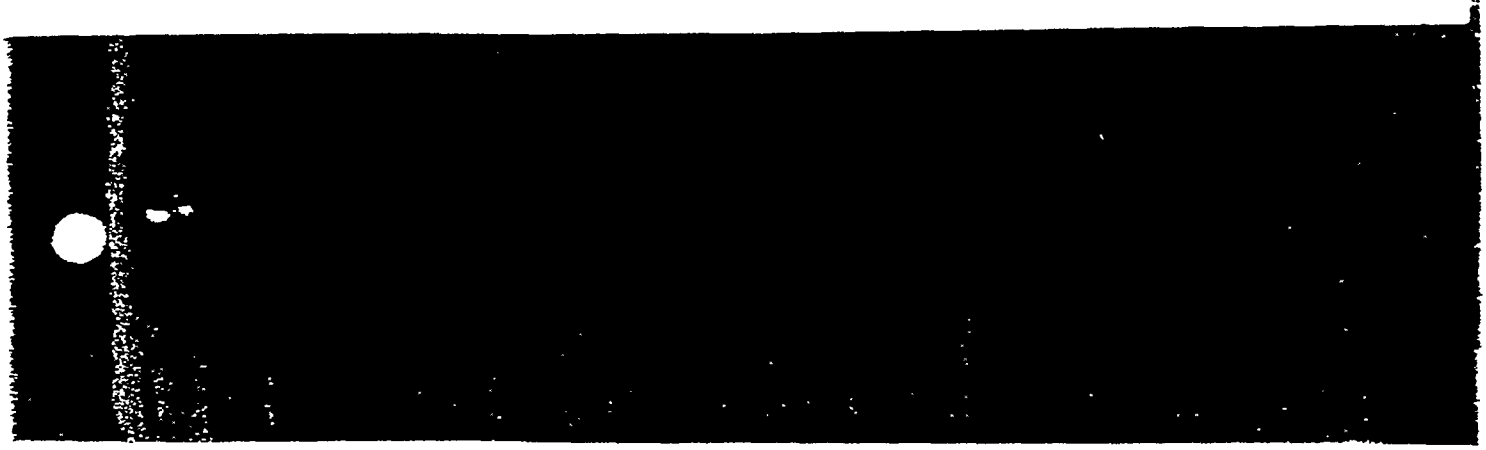
8.2.2 Position the 10x objective for viewing, place a specimen slide on the stage, turn on the illuminator, and set the iris diaphragm on the condenser about half open.

8.2.3 Set the phase ring to the 0 position and focus on the specimen.

8.2.4 Close the iris diaphragm on the illuminator down to the point where only a small bright area is visible in the field. Adjust the iris set screws on the illuminator until this spot is centered in the field.

8.2.5 Focus sides of Decagon with phase contrast control knob. Sides will appear blue when focused up and red when focused down. The proper focus is mid-point. Open the iris diaphragm to cover entire field of view.

8.2.6 With the phase ring setting still at 0, remove the right eyepiece and insert the centering telescope. Adjust the tele-



scope until the dark circle comes into sharp focus and lock it in position with the set screw provided.

8.2.7 Turn the phase ring to the 10 setting. By using the adjustment screws on the side of the condenser, move the rings until they are perfectly concentric.

8.2.8 Rotate the 43x objective into viewing position and turn the phase ring to the 43 setting. Align the two rings as described in 8.2.7.

8.2.9 Remove the telescope and replace the 10x eyepiece. Use fine adjustment for proper focus. The microscope is now adjusted for phase contrast viewing at 430x magnification.

8.3 Reticle:
The microscope must contain a reticle. Calibration of the reticle is done by means of a stage micrometer. The Porton reticle is a rectangle divided into two squares. The counting area is divided into six rectangles which constitutes the left square. A series of circles in which every other circle doubles in diameter is located on the top and bottom of the large rectangle. The diameter, D, of each is given by the formula: $D = L\sqrt{2^N}$ where L is a unit of length and N represents the circle number. The length of the large reticle is 200 L units. By measuring the actual length of the rectangle using the stage micrometer and dividing this value by 200, the value of L at 430x magnification is obtained. With this value for L, the actual diameter of each of the circles can be determined.

The calibration of the Porton reticle need be done only once, unless the eyepieces or objectives are changed, the magnification is altered in any way, or the microscope had been disassembled for cleaning prior to use.

9. SAMPLING:

9.1 The suction pump battery must be in a fully charged condition before each test. Recommended battery life for constant pumping rate is furnished by the manufacturer and must not be exceeded for any one test (see paragraph 4.4).

9.2 After inserting pad and filter into each of the plastic holders (Aerosol Field Monitors) they are immediately capped and plugged. The junctures of the holders are then sealed with cellulose bands.

All loaded monitors must be carried to the test sites in a closed carrying case. An extra monitor must be taken along to serve as a blank. All monitors must be marked for identification.

9.3 At the test site, the top section of t
filter" testing. The outlet plu e
an appropriate length of 1/4 in... cu
the pump intake. Sampling can be ei
In taking general area samples it
assembly be mounted on a tripod
floor level. For a personal sample tl
bly is worn by the person being t
close to the person's breathing zone

The sampling time should be gauged
the filter for satisfactory counting. E
avoided since no dilution is possit
flow rate of two liters per minute.
field monitor must be re-sealed.

10. COUNTING:

10.1 Remove the cover of the field monit
be examined. Cut out a pie shaped s
scalpel. The section to be about 1 cm.

10.2 Place a drop of mounting solution on
the drop into a shape corresponding t

10.3 Remove the sample section from the
tweezers and deposit it. sample side
and cover with a clean cover glass. I
with the tweezers until it is in intima
tion and solution, being carefu
cover glass. Mounts may take 3
tion is completely dissolved.

10.4 Place a sample slide on the stage and fo
because dust is retained only in the top
The total fiber count should be at leas
whichever is less.

If a fiber crosses the limits of the cou
two adjacent sides are counted. The sid
of the counter, but they are always th
The fibers counted are estimated as t
either the top or bottom of the reticle
three size groups: all fibers seen, all fib
and all fibers longer than ten microns.

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er into each of the plastic holders (Aerosol mmediately capped and plugged. The junc- en sealed with cellulose bands.

be carried to the test sites in a closed carry- must be taken along to serve as a blank. All for identification.

9.3 At the test site, the top section of the monitor is removed for "open filter" testing. The outlet plug is removed, the adapter inserted, and an appropriate length of 1/4 inch tubing is connected between it and the pump intake. Sampling can be either general area or personalized. In taking general area samples it is recommended that the filter assembly be mounted on a tripod approximately five feet above floor level. For a personal sample the entire pump and filter assembly is worn by the person being tested with the filter attached as close to the person's breathing zone as is feasible.

The sampling time should be gauged to obtain sufficient material on the filter for satisfactory counting. Excessive dust deposits should be avoided since no dilution is possible. Sampling shall be at an air flow rate of two liters per minute. When the test is completed the field monitor must be re-sealed.

10. COUNTING:

10.1 Remove the cover of the field monitor to expose the filter that is to be examined. Cut out a pie shaped section of the filter using a clean scalpel. The section to be about 1 cm. on the arc side.

10.2 Place a drop of mounting solution on a clean frosted-end slide. Smear the drop into a shape corresponding to the size of the sample section.

10.3 Remove the sample section from the plastic field monitor with clean tweezers and deposit it, sample side up, onto the mounting solution and cover with a clean cover glass. Press lightly on the cover glass with the tweezers until it is in intimate contact with the sample section and solution, being careful not to trap any bubbles under the cover glass. Mounts may take 30-60 minutes before the sample section is completely dissolved.

10.4 Place a sample slide on the stage and focus on the top surface of filter because dust is retained only in the top 10 to 15 microns of the filter. The total fiber count should be at least 100 fibers, or twenty fields, whichever is less.

If a fiber crosses the limits of the counting field, only those crossing two adjacent sides are counted. The sides chosen are at the discretion of the counter, but they are always the same for any given counter. The fibers counted are estimated as to length, using the circles at either the top or bottom of the reticle. The counts are recorded in three size groups: all fibers seen, all fibers longer than five microns, and all fibers longer than ten microns.

PRIMARY CALIBRATION

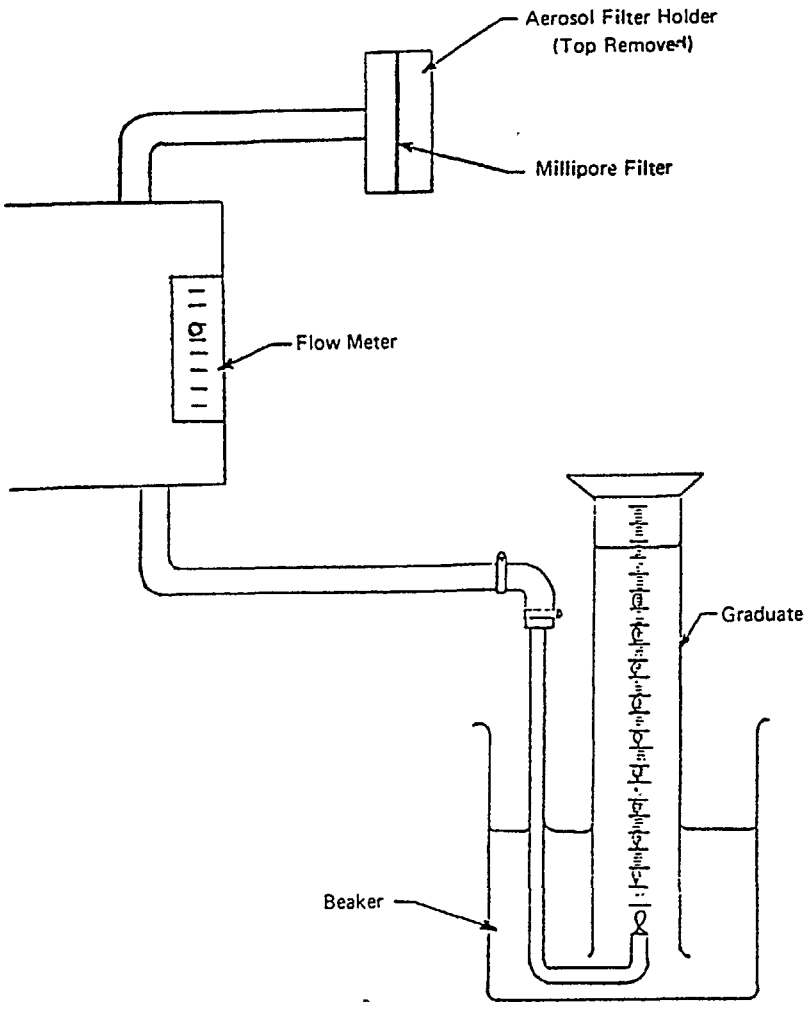
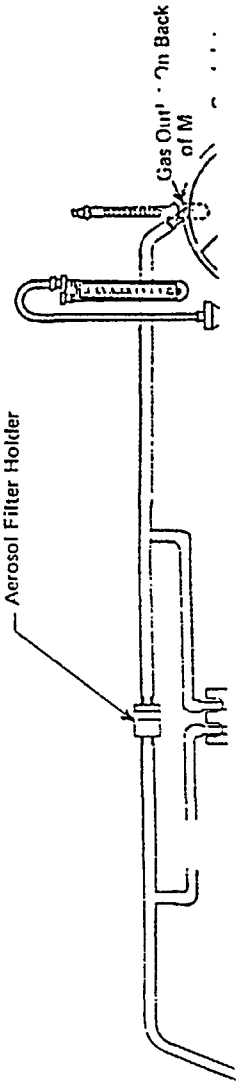
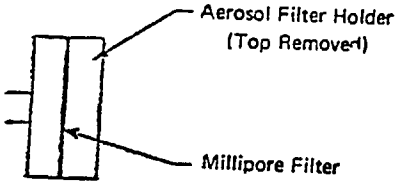
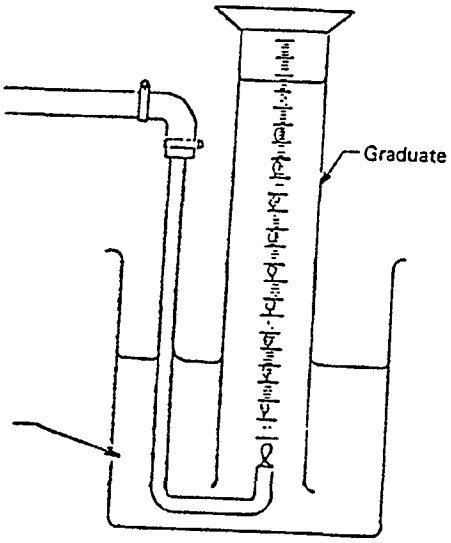


Fig. No. 1

INTERMEDIATE CALIBRATION







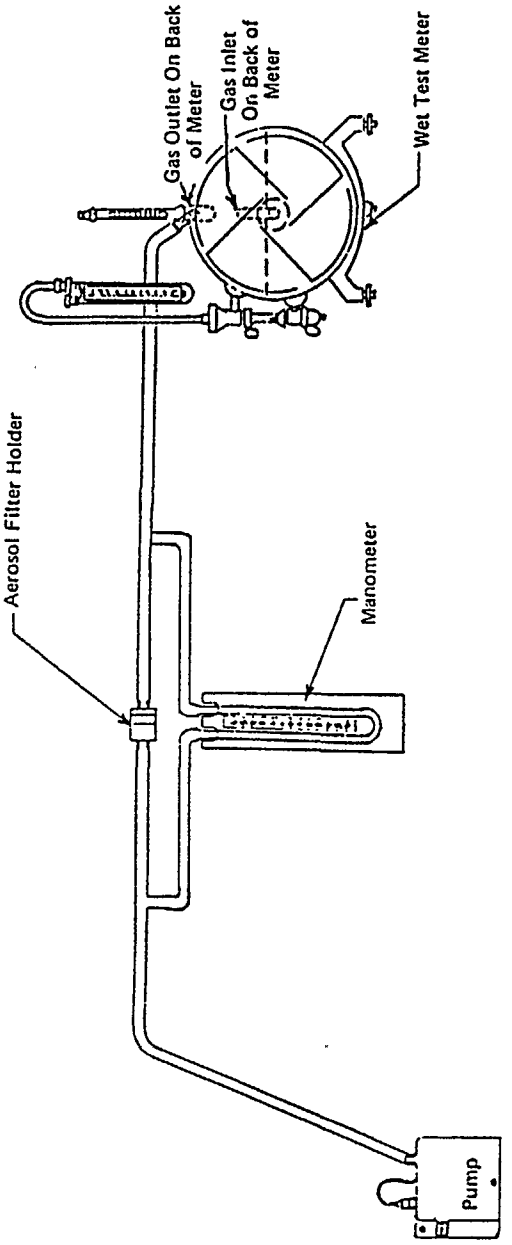


Fig. No. 2

10.5 In shifting from one area of examination to another, the choice must be random. Once chosen, the field must be counted regardless of the number of fibers observed. In shifting from one field to another the operator should take his eyes away from the eyepieces and concentrate them on moving the stage to a new location. The choice of the new location should be arbitrary, except that areas near the edge of the sample should be avoided. During the count it is very important to constantly adjust the fine focus back and forth. This brings into focus fibers that might not be seen otherwise.

11. CALCULATION OF RESULTS:

The concentration of fibers shall be expressed as the number of fibers per cubic milliliter of air reported to two (2) significant figures only.

$$\text{Concentration} = \frac{(\text{Av. Fiber Count})\,(\text{Filter Area})}{(\text{Field Area})\,(\text{Sample Volume})\,(1000)}$$

where:

Av. Fiber Count: Average Fiber Count Per Size Range.
Filter Area: 855mm^2 for 37mm. dia. membrane filters.
Field Area: Area of counting field in mm^2.
Sample Volume: Total Time x Flow Rate, Express in liters.
1000: Converts liters to milliliters.

If blanks are used, subtract the average blank count of the same size range from the average fiber count.

INDUSTRIAL HYGIENE V

1. STATION NUMBER _____ PU
DEPARTMENT _____
PLANT _____ TI
DIVISION _____ TI
DATE SAMPLED _____ E
DATE ANALYZED _____ V

2. STATION LOCATION
3. SPECIFIC PRODUCT AND MATERIALS
4. OPERATORS AND PROTECTION
5. VENTILATING CONTROL
6. DRAFTS
7. REMARKS

TOTAL

ANALYSIS: _____ F/cc
TLV: _____ F/cc
SAMPLED BY _____

TOT. _____
AV. _____

ea of examination to another, the choice must en, the field must be counted regardless of the rved. In shifting from one field to another the nis away from the eyepieces and concen- the e to a new location. The choice of the e arbitrary, except that areas near the edge of voided. During the count it is very important e fine focus back and forth. This brings into not be seen otherwise.

JLTS:

shall be expressed as the number of fibers per d to two (2) significant figures only.

Count) (Filter Area)
a) (Sample Volume) (1000)

age Fiber Count Per Size Range.
for 37mm. dia. membrane filters.
unting field in mm^2.
l Time x Flow Rate, Express in liters.
o milliliters.

the average blank count of the same size range

INDUSTRIAL HYGIENE WORK SHEET

1. STATION NUMBER ______________ PUMP NUMBER ______________
   DEPARTMENT ______________ RATE ______________ L/M.
   PLANT ______________ TIME FINISHED ______________
   DIVISION ______________ TIME STARTED ______________
   DATE SAMPLED ______________ ELAPSED TIME ______________ MIN.
   DATE ANALYZED ______________ VOL. SAMPLED ______________ CC
2. STATION LOCATION
3. SPECIFIC PRODUCT AND MATERIALS ______________ (Field Area) ______________ (Blank)
4. OPERATORS AND PROTECTION ______________ (Initials) ______________ (Concentration)
5. VENTILATING CONTROL
6. DRAFTS
7. REMARKS

	TOTAL	FIBERS >5u	>10u
TOT.			
AV.			

ANALYSIS: ______________ F/cc

TLV: ______________ F/cc

SAMPLED BY ______________

ASARCO ELP 0003617

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