

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
HEALTH SERVICES AND MENTAL HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
DIVISION OF FIELD STUDIES AND CLINICAL INVESTIGATIONS

DETERMINATION
OF
MAGNITUDE OF EXPOSURE
TO
ASBESTOS FIBERS ASSOCIATED
WITH
A WOMAN'S COAT CONTAINING 8% ASBESTOS

JUNE 30, 1971

1014 BROADWAY
CINCINNATI, OHIO 45202

FOREWARD

Upon a request from Dr. Dennis McGrath, Division of Hazardous Substances, Bureau of Product Safety, Food and Drug Administration, to Dr. Lewis J. Cralley, Director, Division of Epidemiology and Special Services, National Institute for Occupational Safety and Health, Public Health Service, a series of tests were conducted on a navy blue woman's coat containing 72% reprocessed wool, 20% nylon, and 8% asbestos. The tests were conducted to determine the magnitude of exposures to asbestos fibers associated with wearing or brushing the coat. The coat was dry cleaned to determine the effect that it might have on the coat and also the transferability of fibers to companion clothing.

ASBESTOS COAT

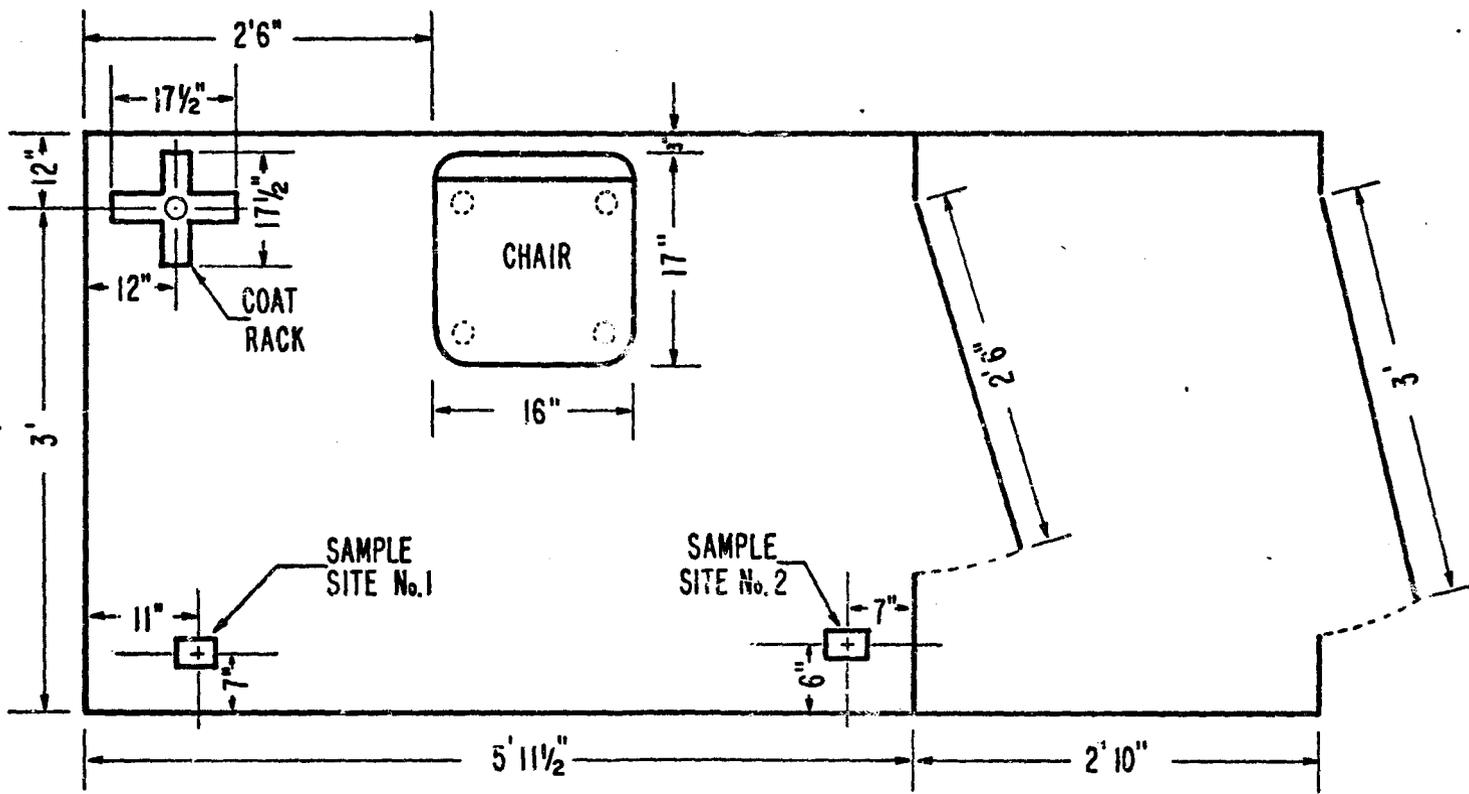
EQUIPMENT AND PROCEDURES

The tests were conducted in a plywood paneled dust chamber (5'-11 1/2" x 4'-0" x 7'-7 3/4") which contained a chair and coat rack. Drawing No. 1 shows the plan view of the chamber, and the locations of the chair, coat rack and sampling stations.

General room air samples were collected at two locations, Site No. 1 and Site No. 2. Personal samples were collected at the breathing zone of the subject. Samples were collected using Casella Personal Sampling Pumps at a rate of 1.7 liters per minute (lpm) on a 37mm membrane filter. The sample collection time varied according to the tests being conducted. See "Description of Tests Performed" for details. The general room air samples were collected with the same type of equipment as used for the personal samples.

Additional samples of general room air were collected at a higher rate, 10 lpm, in order to provide a higher concentration of sample for analyses by the electron microscope.

All samples were counted according to standard methods as approved by the American Conference of Governmental Industrial Hygienists. The whisk brooms were the standard type used for brushing clothes and a new whisk broom was used for each test.



DRAWING No. 1
PLAN VIEW OF DUST CHAMBER

In addition to the samples collected during the tests, blank samples and control samples were analyzed to monitor possible contamination. Blank samples were taken from the same box and analyzed for fibers. Control samples were run in the dust chamber prior to the various tests to determine if the chamber had been adequately purged. In all except the cases noted in Table No. 3, the controls and blanks were less than 0.05 fibers $>5\mu$ in length/cc.

Samples were collected of the dry cleaning fluid for each of the steps in the cleaning process. Other clothing was included in the dry cleaning process to simulate a standard cleaning operation.

ASBESTOS COAT

DESCRIPTION OF TESTS PERFORMED

The overall testing of the coat was conducted in two phases: before dry cleaning and after dry cleaning. The tests in each phase were identical. Before the coat was dry cleaned the following tests were conducted in the order listed:

1. Simulated wear tests
2. Simulated baby tests
3. Brush Test
4. Simulated wear test
5. Simulated baby test

After the coat was dry cleaned, the above tests were repeated. Sizing operations were performed on general room air samples collected during each phase while the simulated wear tests were being conducted.

Simulated Wear Tests

This test consisted of the subject performing a series of exercises for a given period of time. Five different females participated in the tests in order to provide a variation in the performance of the exercises. The coat was initially placed on a coat hanger and hung up on the coat rack. The exercises consisted of a sequence of events that constituted a cycle of activity. The actual cycle began and ended when the coat was put on. The following exercises occurred during the cycle.

1. Putting on coat after having removed it from the coat rack or chair.
2. Walking and/or sitting activities while wearing coat in dust chamber.
3. Removing coat.
4. Hanging coat on wire clothes hanger on coat rack or laying on chair.

The duration of the tests was sixty (60) minutes with each of the four (4) females performing the exercises for a 15 minute period. Each participant wore a respirator to which the personal sampler was attached. Breathing zone samples were collected for thirty (30) and sixty (60) minute periods. Sixty (60) minute general room air samples were also collected.

Simulated-Baby Test

To test the potential to an infant from breathing asbestos fibers while being held against the coat, a simulated condition was accomplished by fabricating a box approximately the size of an infant with a membrane filter located at the site of the nose. The wearer simulated carrying the infant, while walking, standing, and sitting on a chair. The simulated infant was held in various positions which duplicated the normal activities associated with carrying an infant. Breathing zone samples of the simulated infant as well as two general room air samples were collected. These tests were of thirty (30) minutes duration.

Brush Test

A standard whisk broom was used on the coat and companion clothing to perform a brush test. Samples were collected at the breathing zone of the participant, at the coat next to the brushing area, and at the two general room locations as in the previous tests. Samples were collected during the brushing periods of two (2) and five (5) minutes duration.

Dry Cleaning

The jacket was dry cleaned with companion clothing [two men's sport coats and three (3) pairs of men's slacks] which contained no asbestos. The cleaning fluid was perchlorethylene, a standard dry cleaning fluid. The clothing was cleaned in an Econo-crest, Class 2206, dry cleaning machine manufactured by American Laundry Machinery Industries. This machine is the type used in coin-operated cleaners and has a capacity of twelve (12) pounds.

The cleaning process consisted of two washes, an extraction, and a drying cycle. New perchlorethylene was put into the machine with the clothing and allowed to wash. Following the initial wash the machine was stopped and the perchlorethylene was put into its original container. Another batch of perchlorethylene was put into the machine and the clothing was washed for a second time. On completion of the wash cycle the machine was stopped again and the second batch of perchlorethylene drained into its original container. The machine was then restarted and allowed to continue until the cycle was completed. After the extraction process the perchlorethylene was collected. This means that the following

samples of perchlorethylene were collected: (1) New; (2) After the first washing; (3) After the second washing; and, (4) After the extraction process. A measured amount of perchlorethylene from each of the above samples was filtered through a 37mm membrane filter and the fiber concentration was determined using the same standard methods as used for the air samples.

A brush test was conducted on the two coats that were dry cleaned with the asbestos coat. This test was the same as the brush test conducted on the asbestos coat.

Fiber Sizing

Photomicrographs for sizing operations were taken of the general room air samples that were collected on 37mm membrane filters at 10 liters per minute. A Leitz Dialux Pol microscope with 10X eyepiece and 21X objective and a green filter in conjunction with a Leica 35mm camera using a Tri-X Pan black and white film. The actual fiber sizing was done on 8"x10" prints.

ASBESTOS COAT

DISCUSSION OF RESULTS

The number of cycles performed in the wear tests are listed in Table No. 1. The minor variations from 123 to 145 can be attributed to the fact that five different females were used for these tests with no established routine predetermined. Each participant was permitted to perform at her own rate of speed.

Table No. 2 contains the results for the series of tests performed with the asbestos coat before dry cleaning. The concentrations measured during the first and second wear tests were essentially the same. The highest wear test concentration measured was 2.3 fibers $>5\mu$ in length/cc. The concentrations measured during both the first and second baby tests were lower than the concentrations from the wear tests, with all concentrations less than 1.0 fibers $>5\mu$ /cc. While the concentrations measured at the brushing site during the whisk broom test were high, the breathing zone concentrations of the person doing the brushing were virtually the same as during the wear tests.

After the first series of tests the coat was dry cleaned in a load with companion clothing containing no asbestos. The same series of tests was performed on the coat after dry cleaning. A whisk broom test was also done on articles of the companion clothing.

TABLE NO. 1
NUMBER OF CYCLES PERFORMED
DURING WEAR TESTS

DESCRIPTION	NUMBER OF CYCLES
<u>Before Dry Cleaning</u>	
First Wear Test	142
Second Wear Test	123
<u>After Dry Cleaning</u>	
First Wear Test	145
Second Wear Test	132

TABLE NO. 2

CONCENTRATIONS OF ASBESTOS FIBERSBEFORE DRY CLEANING

DESCRIPTION OF TEST	DURATION OF SAMPLE min.	TYPE OF SAMPLE	CONCENTRATION OF ASBESTOS FIBERS $>5\mu$ in length/cc
First Wear Test	30	Personal	1.8
	60	Personal	2.3
	60	General Room Site No. 1	2.1
	60	General Room Site No. 2	1.4
First Simulated Baby Test	30	Baby Breathing Zone	0.9
	30	General Room Site No. 1	0.5
	30	General Room Site No. 2	0.5
First Whisk Broom Test	2	Personal	2.3
	2	Brushing Site	11.3
	2	General Room Site No. 1	2.3
	5	Personal	3.6
	5	Brushing Site	10.0
	5	General Room Site No. 1	4.5
Second Wear Test	30	Personal	1.4
	60	Personal	1.8
	60	General Room Site No. 1	1.1
	60	General Room Site No. 2	0.6
Second Simulated Baby Test	30	Baby Breathing Zone	0.3
	30	General Room Site No. 1	0.3
	30	General Room Site No. 2	0.5

Table No. 3 contains the results of the second series of tests performed with the asbestos coat. The concentrations measured after dry cleaning were generally lower than those measured before dry cleaning, although the differences were not great.

Table No. 4 contains the results of the whisk broom tests performed on two men's sport coats dry cleaned with the asbestos coat. The concentrations measured in these tests were approximately the same as in the whisk broom tests of the asbestos coat. Since the sport coats contained no asbestos, it is apparent that garments cleaned with the asbestos coat can pick up asbestos fibers during the cleaning process.

Results of the analysis of the dry cleaning fluid support this conclusion. Table No. 5 contains the concentrations of asbestos fibers in the three cycles of cleaning fluid. Samples of the new dry cleaning fluid were analyzed for fibers and none were found. It should be pointed out that these concentrations are of fibers found in the dry cleaning fluid and not airborne fibers as presented in the other tables. In a normal dry cleaning cycle the dry cleaning fluid is filtered and/or distilled during each cleaning cycle. This is all done automatically with make-up fluid added to replace the normal losses.

General room air samples, collected during the wear tests before and after the coat was dry cleaned, were analyzed for fiber size distribution using photomicrographs. Results of the fiber size distribution are shown on Table No. 6. One hundred and eighty (180) fibers were sized

TABLE NO. 3

CONCENTRATIONS OF ASBESTOS FIBERS

AFTER DRY CLEANING

DESCRIPTION OF TEST	DURATION OF SAMPLE min.	TYPE OF SAMPLE	CONCENTRATION OF ASBESTOS FIBERS >5 μ in length/cc
First Wear Test	30	Personal	0.5
	60	Personal	0.7
	60	General Room Site No. 1	0.5
	60	General Room Site No. 2	0.5
First Simulated Baby Test	30	Baby Breathing Zone	0.5
	30	General Room Site No. 1	0.2
	30	General Room Site No. 2	0.2
First Whisk Broom Test	2	Personal	4.5
	2	Brushing Site	6.8
	2	General Room Site No. 1	2.3
	5	Personal	3.6
	5	Brushing Site	3.6
	5	General Room Site No. 1	1.8
Second Wear Test	30	Personal	1.2
	60	Personal	1.4
	60	General Room Site No. 1	0.6
	60	General Room Site No. 2	1.0
Second Simulated Baby Test	30	Baby Breathing Zone	0.5
	30	General Room Site No. 1	0.3
	30	General Room Site No. 2	0.6
Control #5	60	Site No. 1	0.2
Control #6	60	Site No. 2	0.1

TABLE NO. 4

ASBESTOS FIBER CONCENTRATIONS

FROM COMPANION CLOTHING

AFTER DRY CLEANING

DESCRIPTION OF TEST	DURATION OF SAMPLE min.	TYPE OF SAMPLE	CONCENTRATION OF ASBESTOS FIBERS $>5\mu$ in 10010/cc
Whisk Broom Test	2	Personal	4.5
	2	Brushing Site	4.5
	2	General Room Site No. 1	4.5
	5	Personal	4.5
	5	Brushing Site	5.4
	5	General Room Site No. 1	3.6

TABLE NO. 5

ASBESTOS FIBER CONCENTRATIONS

IN

DRY CLEANING FLUID

DESCRIPTION OF DRY CLEANING FLUID	CONCENTRATION OF ASBESTOS FIBERS >5 μ in length/cc
New	0.0
After First Washing	1.6 x 10 ⁶
After Second Washing	1.1 x 10 ⁶
After Extraction	1.1 x 10 ⁶

TABLE NO. 6

ASBESTOS FIBER LENGTHS

DESCRIPTION	NUMBER OF FIBERS SIZED	RANGES OF FIBER LENGTHS μ	MEDIAN FIBER LENGTH μ
General Room Air During Wear Test - Before Dry Cleaning	80	1.4 to > 22	4.6
General Room Air During Wear Test - After Dry Cleaning	200	2.0 to > 37	7.6

from the samples collected before the coat was dry cleaned and they had a size range from 1.4μ to greater than 22μ in length and a median fiber length of 4.6μ . There were 200 fibers sized from the sample collected after the coat was dry cleaned and they had a size range from 2μ to greater than 37μ with a median fiber length of 7.6μ .

Appendix A contains four (4) electron micrographs which are representative of the asbestos fibers of the general room air samples collected during the wear tests before the coat was dry cleaned. Appendix B are the electron micrographs of samples taken after the coat was dry cleaned.

APPENDIX A

1 μ



ELECTRON MICROGRAPH 1

1 μ



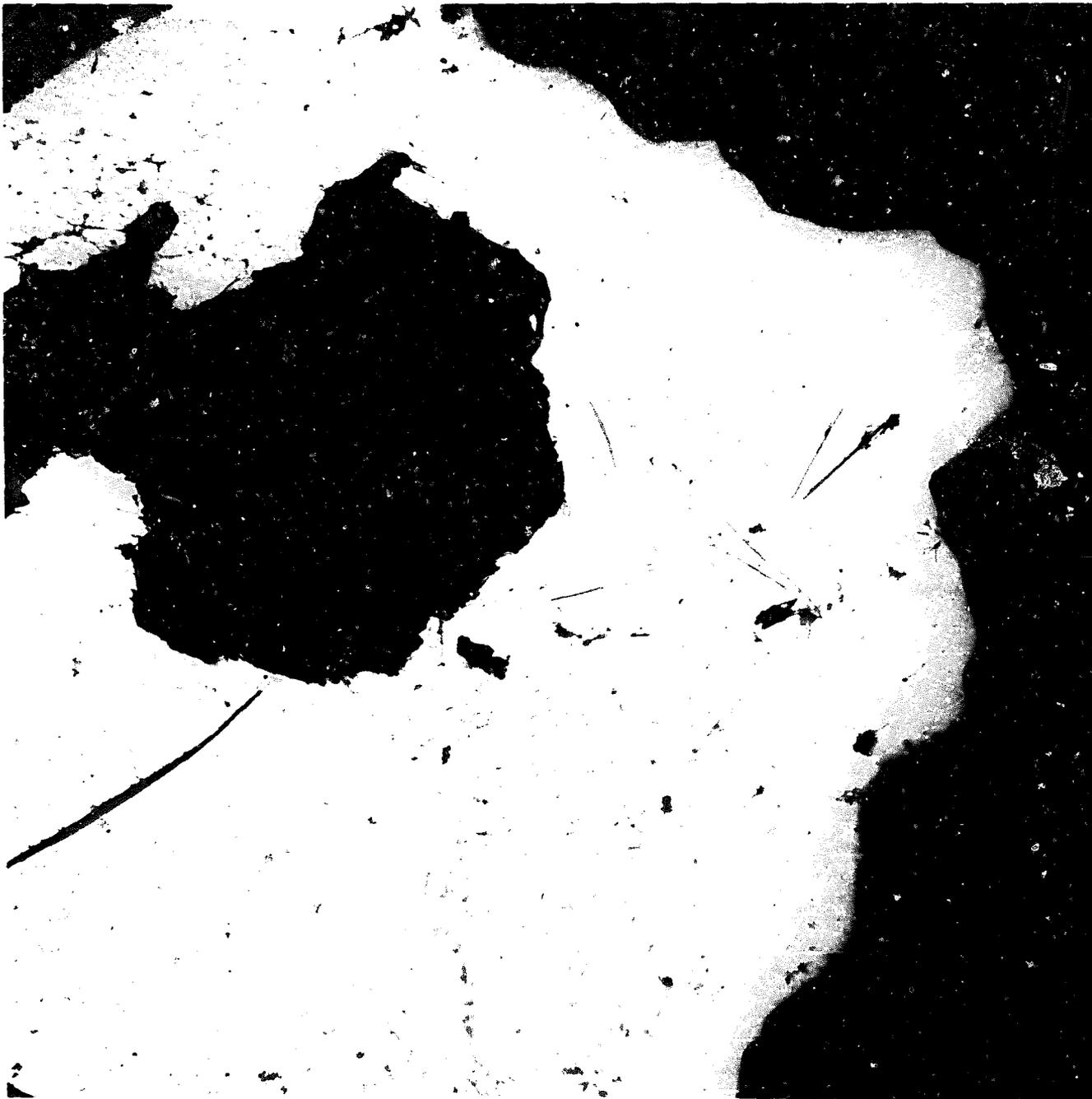
ELECTRON MICROGRAPH 2

1 μ



ELECTRON MICROGRAPH 3

I₂



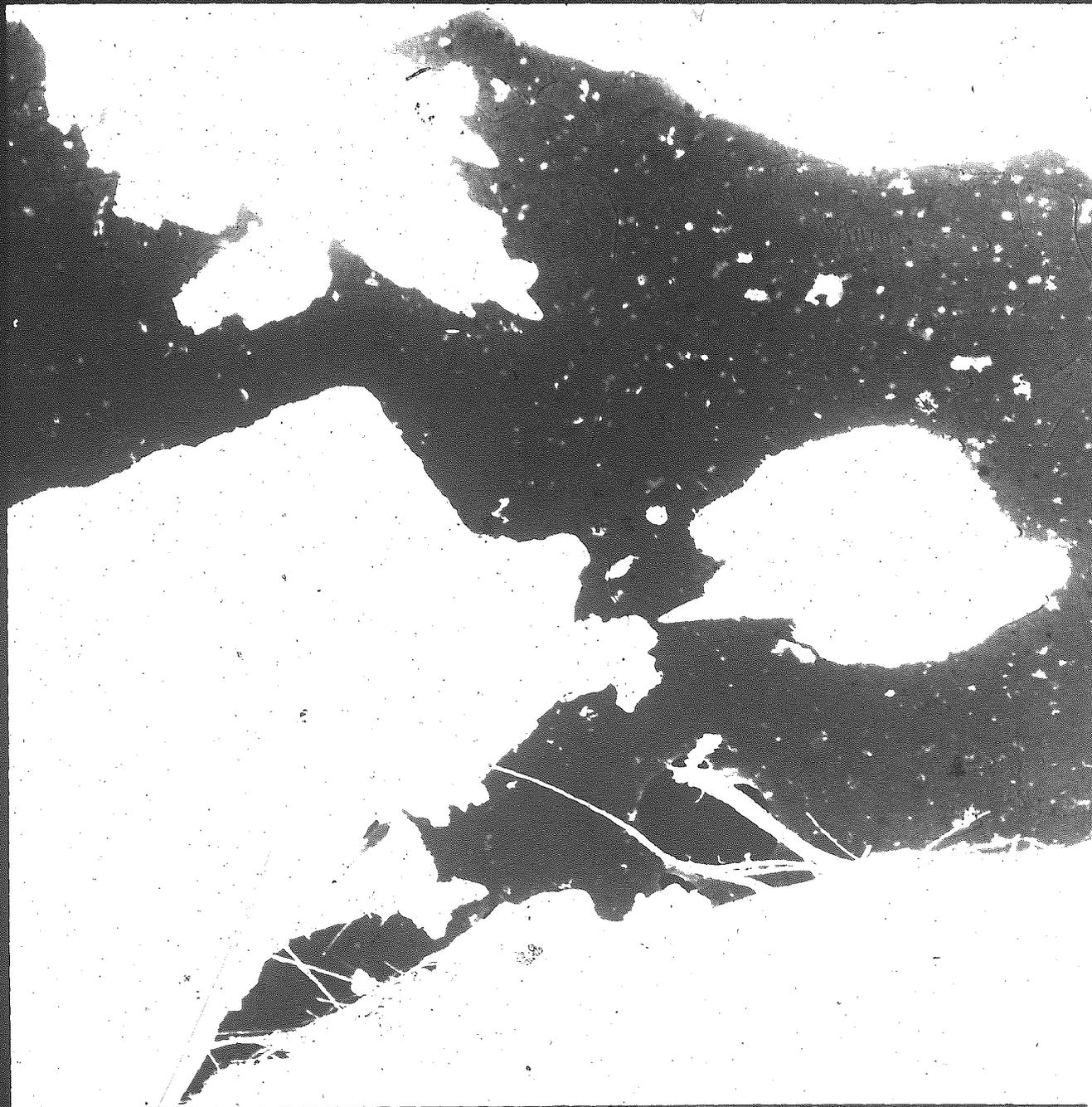
ELECTRON MICROGRAPH 4

- 22 -

APPENDIX B



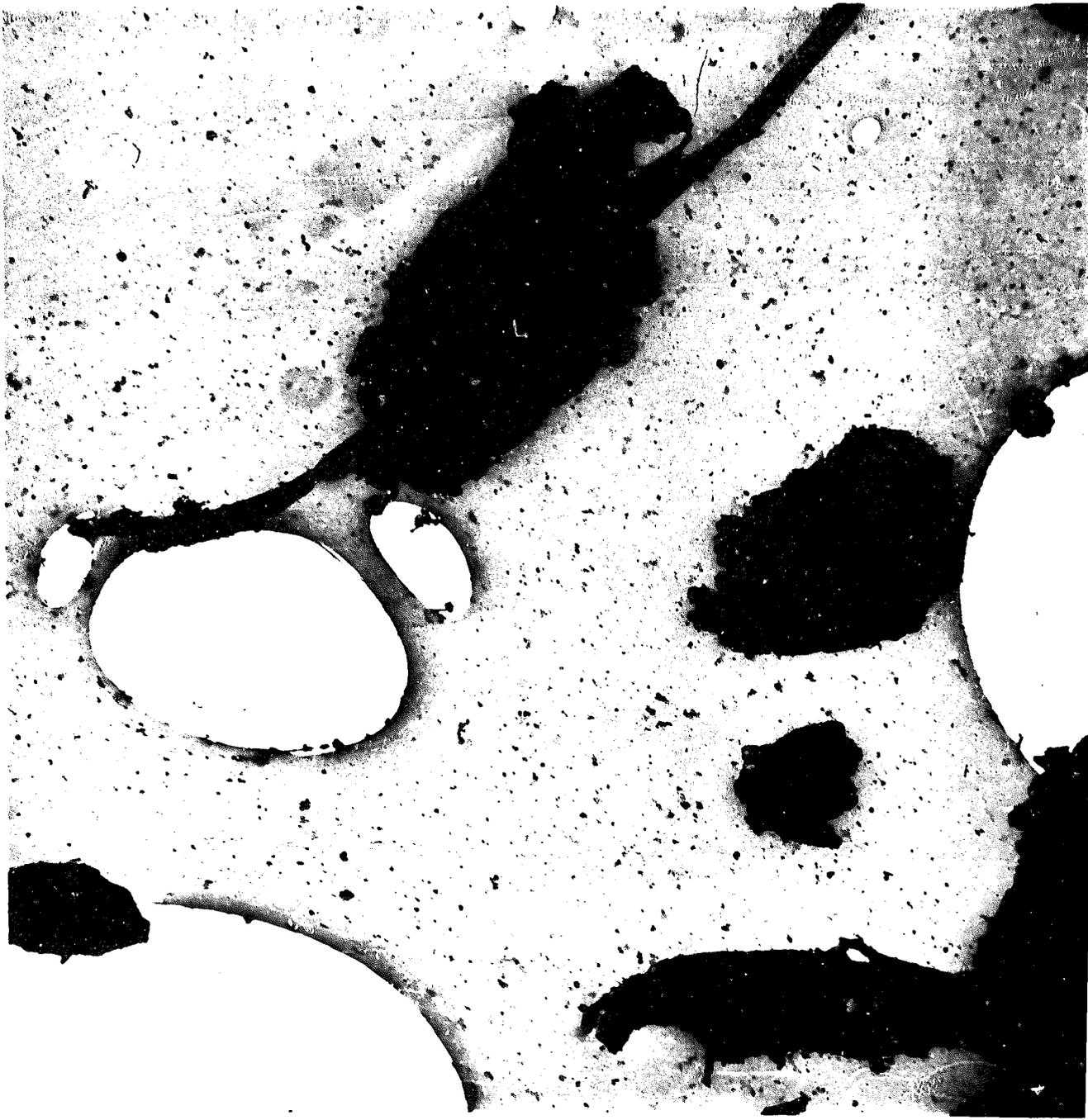
ELECTRON MICROSCOPE 5
-- 24 --



ELECTRON MICROSCOPE 6
25



ELECTRON MICROSCOPE 7
- 26 -



ELECTRON MICROSCOPE 2
- 27 -