FILE NAME: Johns-Manville (JMA)

DATE: 1977-1978

DOC#: JMA014

DOCUMENT DESCRIPTION: Asbestos-Cement Air Duct Tests - Memos and Test Results

Transite Air Duct Tests

Johns-Manville

Internal Correspondence

To: G. L. SWALLOW - 1-06 WHQ

Date: FEBRUARY 28, 1977

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Subject: INDUSTRIAL HYGIENE SURVEY - POWERS REGULATOR COMPANY
TRANSITUBE DIVISION, DENVER, COLORADO
FEBRUARY 23, 1977

A special Industrial Hygiene survey was recently conducted at the Powers Regulator Company Kingston Street warehouse in Denver on 2/23 by K. J. Williams with the help of Mr. Jim Brietzke, Product Engineer for Powers. The object of this survey was to determine the environmental impact, if any, when Transite Korduct (J-M) pipe containing asbestos fiber has been substituted for PVC pipe in the company's pneumatic tube systems. Particular interest in the potential for expulsion of asbestos fibers, dislodged from the Korduct pipe interior by attrition from frequent "carrier" travel, into the workplace was indicated.

For the purposes of environmental testing, a model Courier brand "point-to-point" system equipped with Korduct piping was installed in the Kingston Street warehouse. The system consisted of seven joined 10'lengths of 4" diameter Transite Korduct (Type I/B TEL) anchored horizontally on a warehouse wall approximately 15' above the floor connected at both ends of the total 70' pipe run to 90° Transite bends (48" radius) having a downward orientation, as depicted in the attached drawing. As the drawing shows, all piping connected below the 90° bends was made of PVC. The entire system measured about 100' in length. The end of the system having the air moving equipment (blower) is commonly known as the "local" station. The opposite end of the system is referred to as the "remote" station. The carrier is transported by vacuum to the station nearest the blower and by pressure to the station farthest from the blower. Both stations have a sliding sleeve covering an access port for carrier entry and removal. The system blower delivered approximately 1.5 p.s.i. pressure and 120 CFM volume. A one-way carrier trip took about 6 seconds to complete.

Two types of carrier wear bands were used on different carriers at certain stages of the tests as outlined below. One was made of acrylic carpeting and the other of a material called VELCRO. Tests of carrier band durability were in progress during the

environmental testing. The carrier wear bands were apparently not an important factor in influencing test results. The carriers were operated through the pneumatic tube system on a continuous back-and-forth basis during the sampling period. Since these systems are rarely used on a completely continuous basis in actual field use, these tests should have represented a maximum air contamination condition. 400+ carrier round trips were made during the 5½ hours of consecutive testing.

The only significant difference between the model pneumatic tube system and a similar one in field use was that the Pressure Relief Valve shown in the drawing as being on the horizontal pipe run, was actually located vertically at the "remote" end of the system (see drawing). This modified arrangement should not have made any real difference in observed dust levels.

SAMPLE LOCATION	SAMPLE DURATION	RESULT
1' from "local" end blower exhaust point in center of air stream (i.e., axially).	2 hours	0.0 F/cc
	2 "	<0.1 F/cc
	1½ "	<0.1 F/cc
Area sample in vicinity of "local" end sliding sleeve (operator's position).	2 "	0.0 F/cc
	2 "	0.0 F/cc
	1½ "	0.0 F/cc
Area sample 10' from "local" end blower.	2 "	<0.1 F/cc
	2 "	0.0 F/cc
Area sample 20' from "local" end blower.	2 "	0.0 F/cc
	2 "	<0.1 F/cc
1' from "remote" end pressure relief valve exhaust point in center of air stream (i.e., axially).	2 "	<0.1 F/cc
	2 "	0.0 F/cc
	1½ "	0.0 F/cc
Area sample in vicinity of "remote" end sliding sleeve (operator's position).	2 "	0.0 F/cc
	2 "	0.0 F/cc
	1½ "	0.0 F/cc
Background area samples in warehouse area approximately 75' south of primary sampling area.	1½ "	<0.1 F/cc
	1½ "	<0.1 F/cc

The above results were obtained using the standard Millipore filter sampling/phase contrast microscopy analysis technique called for by NIOSH. Results shown as <0.1 F/cc (fibers/cubic centimeter) were

actually small fractions of 0.1 F/cc but were reported this way so as to avoid implying a technique precision that does not exist. Based on the foregoing test results, the particular "point-to-point" system tested should be considered an almost fiber-free operation. All results are well below any currently existing or proposed occupational health standards for airborne asbestos fibers.

These test results should represent a typical operating condition for a well-worn (i.e., several thousand completed carrier trips through the system) pneumatic tube system containing Transite Korduct piping. However, a problem may exist during the initial shakedown operation of a new system based on reported observation (not tested) of a light visible dust coating on carriers probably developing from residual dust on Korduct interiors left during pipe manufacture. Perhaps a washing or cleaning of pipe interiors during fabrication in J-M plants would alleviate this potential dust source. At any rate, the observed dust source should definitely not be ignored.

D. R. CHRISTENSEN
KJW:DRC
Attachment

I. GENERAL DESCRIPTION OF COURIER PNEUMATIC TUBE SYSTEMS

A. VACUUM PRESSURE POINT-TO-POINT SYSTEM

This vacuum/pressure point-to-point system, shown in Figure 1, is a simple tube system with two stations for transporting material from one point to another. Only one carrier can be in transit at a time. Carriers are transported to the terminal station by the blower by vacuum and are then sent to the terminal farthest from the blower. The system uses lightweight, transparent carriers (except 5" inch, which is manufactured with a heavy cover carrier). The carriers may be sent either one way and stored at an average speed of 25 feet per second.

System sizes available are 2", 3", 3 1/2", and 5" inch. The point-to-point system consists of the following components:

1. Two sliding sleeve (SS) stations per system and an electric blower/vacuum

2. Transmission tubing, bends, elbows and hoses

3. A blower box that includes the blower units and the power supply and blower system controls.

The tubing, bends, sleeves, line fittings, and sliding sleeve terminals are made of polyvinyl chloride (PVC) specially formulated with an antistatic additive for use in pneumatic tube systems.

The standard point-to-point system has a push-button at each station that may be used to transmit either the vacuum or pressure blower depending upon which end of the system your station is located. An optional system is also available at additional cost with a dispatch feature, a system in use light at each stations on the system, an incoming carrier alarm/call light and an annul reset button. Refer to Table 1 for a summary of standard and optional system features.

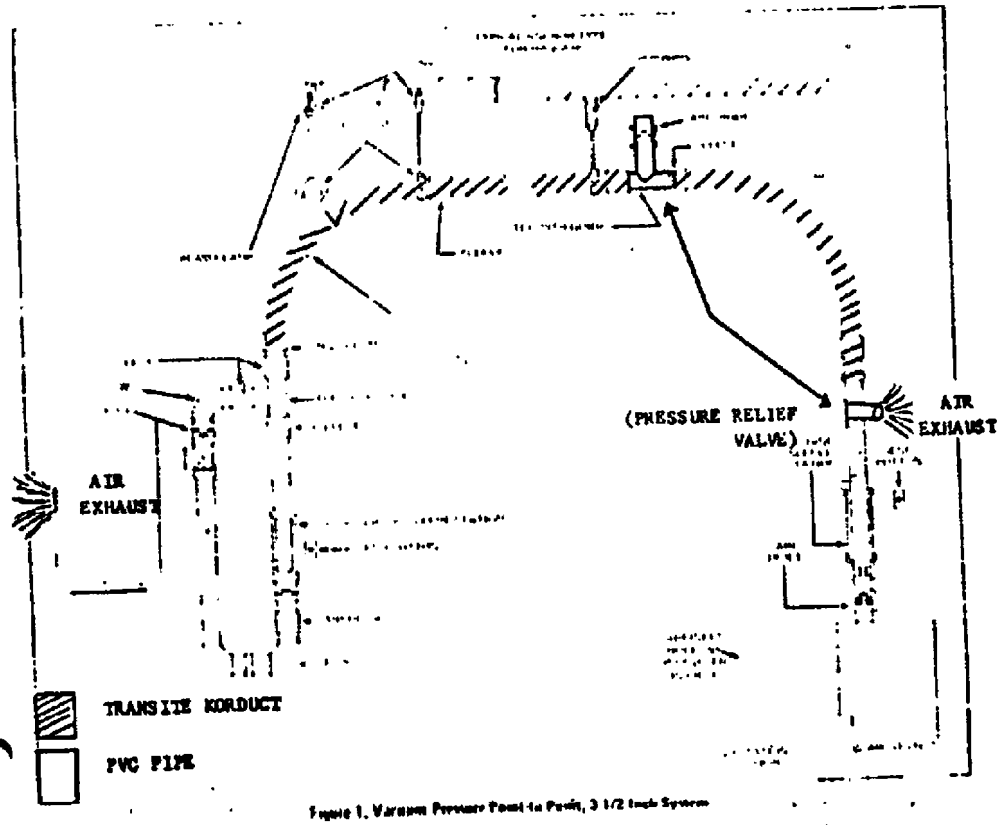
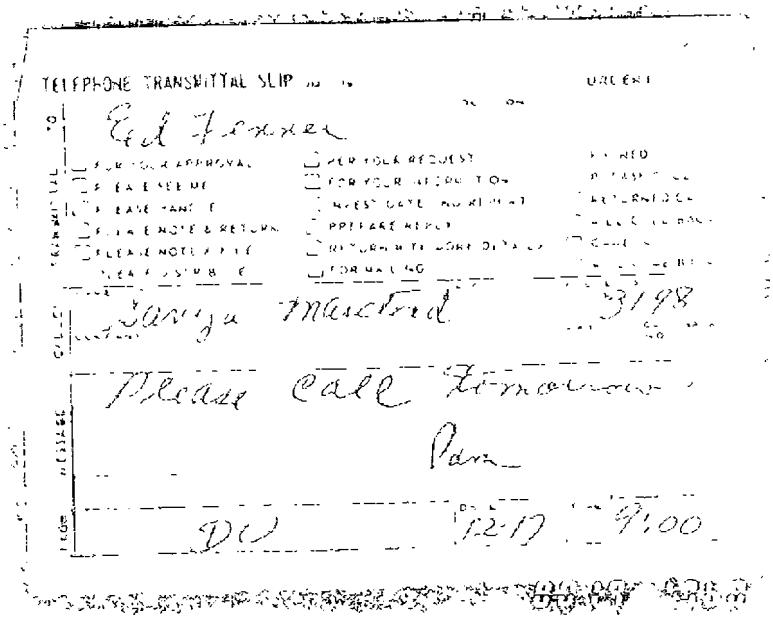


Figure 1. Vacuum Pressure Point to Point, 3 1/2 Inch System


TELEPHONE TRANSMITTAL SLIP

URGENT

Ed Jones

Sanya Macleod 3198

Please call Jones

Pam

DU 12:17 $9.00

11/26/79

T. O'Ovidio — Tulsa data

T-1	Outside	.006	6019	F/M³	7
T-2	Family Room	.002	1904	F/M³	4
T-3	Bedroom	.002	2071		7
T-1A	1-A Outside	.0006	558	F/M³	11.
	2-A Family	.005	4791	"	4
	3-A Bedroom	.003	2387	"	7

Free fiber only - no lumps
18,000 X
20 Fields
4 Fibers to 1 Fiber. 20 Fields

Logic distribution

Prepared identically to those used from P D building.

FIELD TEST
Asbestos Cement Air Duct

Test location: 14 year old 7 room house
Tulsa, Oklahoma

Heating system: Forced hot air
A/C supply ducts
Fiberglass return ducts

Test protocol:

Sampling locations: (1) At bedroom supply register
(2) Center of family room
(3) Back yard under covered patio
30 ft from house

Sampling equipment: High volume air samplers (2)
operating at 25/30 CFM
8"x 10" 0.8 μ pore size
Millipore filter

Sampling modes: Test A - house unoccupied
Test B - Normal house activity

Sampling duration: 10 hours each. Three
samples taken simultaneously

Analysis procedure: Transmission electron microscopy using 43,000 magnification. 20 fields per sample

Test results

Test #	Sampling location	Asbestos Fibers/cc	Total fibers - 20 fields
A	1	.002	7
A	2	.002	4
A	3	.006	9
B	1	.003	7
B	2	.005	8
B	3	<.001	1

Fiber size distribution

No significant difference between inside + outside

TRANSITE AIR DUCT TESTING

Johns-Manville

Internal Correspondence

To G. L. Swallow - 1-06 Date January 8, 1980

From V. E. Wolkodoff - R&D
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Subject TEM EVALUATION OF TRANSITE PIPE AIR DUCT SAMPLES FROM PRIVATE HOME IN TULSA, OKLAHOMA. M79-240

Introduction

Six high volume air samples collected on 8 x 10 inch Millipore AA (0.8 µm) filters were submitted by the Industrial Hygiene Laboratories for quantification and characterization of asbestos fibers by TEM (transmission electron microscopy) methods. The samples were obtained from a private home, Tulsa, Oklahoma, containing a TRANSITE pipe air duct system.

A. Sample Identification

Sample No.	Location	Volume of Air M^3	Date Sampled
T-1	Outside Home	462	Oct. 24, 1979
T-2	Family Room	514.8	Oct. 24, 1979
T-3	Bedroom	828	Oct. 24, 1979
T-1A	Outside Home	438.9	Oct. 25, 1979
T-2A	Family Room	516	Oct. 25, 1979
T-3A	Bedroom	594	Oct. 25, 1979

B. TEM Grid Preparation

Gold 200-mesh TEM grids were used throughout the study and individual grid openings measured 81 by 81 µm for 1 set and 91 by 91 µm in another set. From the center of each filter, a 22 mm diameter cut-out was taken as a representative area. The 22 mm cut-out filter was collapsed and clarified by conventional methods and from which three 3.1 mm plugs were cut out to fit the diameter of the TEM gold grids. These plugs were coated with a thin layer of carbon in the evaporator under vacuum, placed carbon coated side down on the TEM grids, exposed to methyl ethyl ketone fumes to soften clarified filter and fix asbestos fibers in situ. The filters fixed on the TEM grids were then placed in a reflux unit (cold finger) for about 20 minutes in the "cuff" zone of hot acetone fumes to remove organic material and leaving fibers fixed in place. The TEM grids were placed again in the evaporator for another thin coating of carbon for sandwich effect of fibers between two layers of carbon. The rudimentary parts

of this technique and methods used in counting and verifying asbestos fibers are similar to Tentative Procedure for Detection and Evaluation of Asbestos Fibers by C. Anderson, et al, EPA Research and Development Division, Athens, Georgia. The Phillips EM-400 TEM unit was used in this study and magnifications from 1,500x up to 100,000x were used for cursory study (uniformity of distribution, artifacts, rips in carbon, if any, uniformity or carbon film depositions, and other check out procedures). The nominal magnification employed in traversing each grid opening completely was 48,000x and each fiber was positively identified by either electron diffraction patterns and/or energy dispersive spectrometry for chemistry of ions of atomic number 11 and higher. In the Johns-Manville technique of the EPA procedure for grid preparation, the entire procedure takes 20 minutes rather than 8 to 16 hours by EPA methods and also fiber loss, if any, is negligible. During the entire handling and preparation technique, blanks are run to verify absence of fibers in refiltered Class 100 Clean Room and in filtered acetone and refiltered distilled water systems as well as washing and cleaning procedures of glass ware. One asbestos fiber was detected in a blank (20 openings). Two grids from each sample, usually 10 openings each, were used in the quantification of asbestos. All openings were randomly selected.

C. Results

1. Fiber Concentration per M^3 and Two Sigma Limits

Sample No.	Fibers Per M^3	Two Sigma Limits Lower	Upper	Asbestos Clumps/M^3 ①
T-1	6000	2000	10000	1300
T-2	1900	0	3800	475
T-3	2000	500	3500	ND
T-1A	560	0	1700	ND
T-2A	4800	1400	8000	ND
T-3A	2900	700	5100	400

① Clumps are not included in total calculation but are reported separately as per EPA practice. A clump is defined as two or more fibers loosely knit, or entangled, or protruding from a matrix.

2. Fiber Count Per 20 Grid Openings

Sample No.	Grid Openings	Area per 20 Openings mm^2	Asbestos Fibers Detected	Asbestos Clumps Detected
T-1	20	0.131	9	2
T-2	20	0.166	4	1
T-3	20	0.166	7 ①	ND
T-1A	20	0.166	1	ND
T-2A	20	0.131	8	ND
T-3A	20	0.166	7	1
Blank ②	20	0.166	1	ND

① Six fibers detected in one grid opening.

② In this exercise, one blank was used to characterize background for all six samples and all steps involved. The urgency of this report did not permit individual blanks for each sample since reading 20 grid openings requires from 4 to 8 man-hours.

3. Fiber Characterization

Sample No.	Average Diameter, µm	Diameter Range, µm	Average Length, µm	Length Range, µm	Standard Deviation, µm Diameter	Length
T-1	0.025	0.010-0.037	0.29	0.123-0.624	0.01	0.17
T-2	0.032	0.013-0.062	0.728	0.208-1.664	0.02	0.64
T-3	0.036	0.021-0.042	0.413	0.187-0.728	0.01	0.19
T-1A	0.021	—	0.208	—	—	—
T-2A	0.03	0.017-0.062	0.649	0.187-1.248	0.02	0.42
T-3A	0.026	0.021-0.042	1.034	0.166-2.184	0.01	0.82

D. TEM Negatives on File

Sample No.	Negative No.	Magnification	Major Elements by EDS
T-1	EM-0800	48,000x	Mg, Si, Fe
T-2	EM-0799	48,000x	Mg, Si, Fe
T-3	EM-0793	48,000x	Mg, Si, Fe
	EM-0794	48,000x	Mg, Si, Fe
	EM-0795	48,000x	Mg, Si, Fe
T-1A	None	—	—
T-2A	None	—	Mg, Si, Fe
T-3A	EM-0796	28,000x	Mg, Si, Fe
	EM-0797	22,000x	
	EM-0798	22,000x	

F. D'Ovidio

F. D'Ovidio

V. E. Wolkodoff

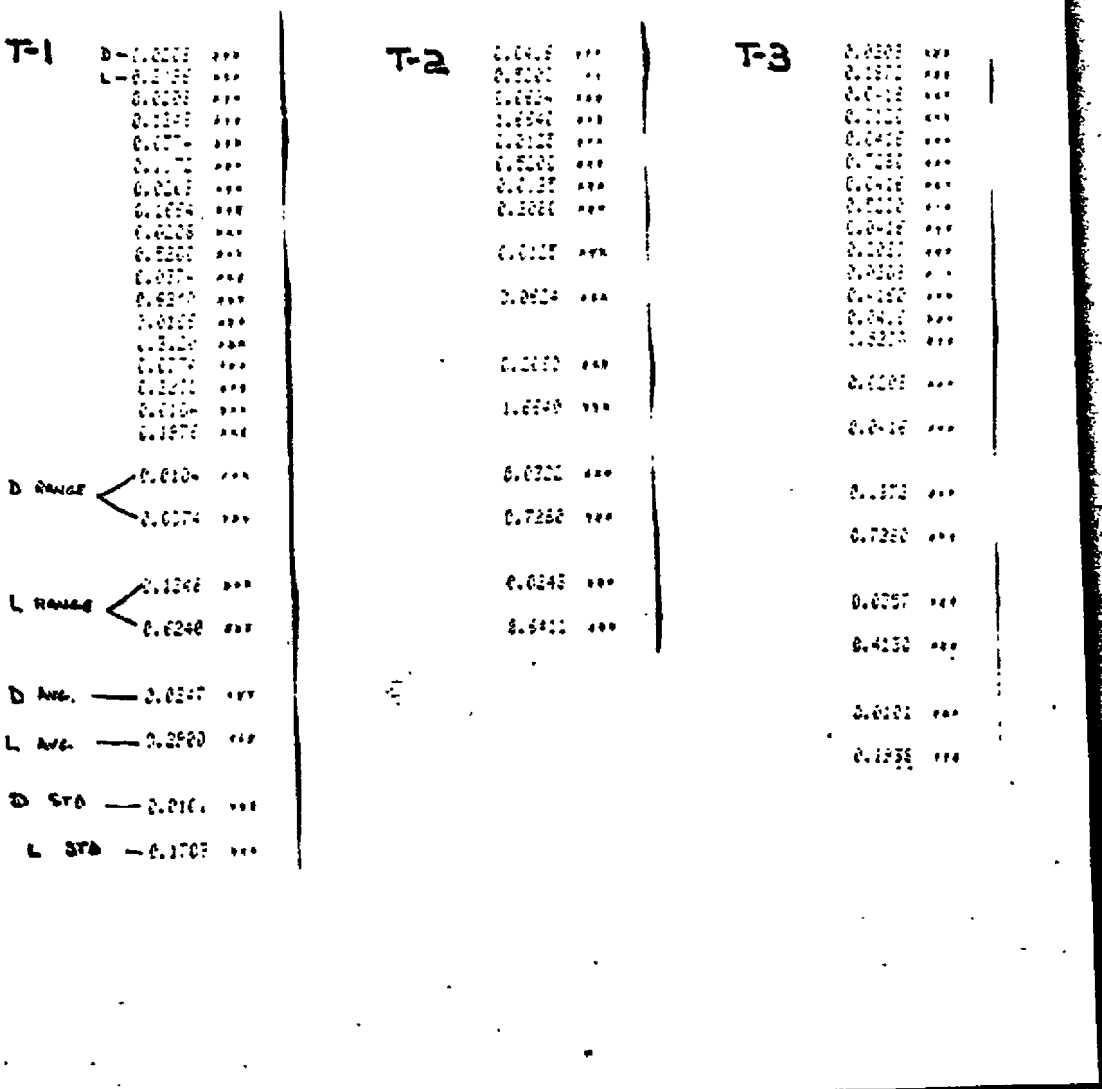
V. E. Wolkodoff

NB 5059, pgs. 41-43, also HP-97 tapes, attached, listing length and diameter of each asbestos fiber encountered.

ck

APPENDIX II

COMPUTER LISTING OF ASBESTOS FIBER DIAMETER AND LENGTH IN μm



COMPUTER LISTING OF ASBESTOS FIBRE DIAMETER AND LENGTH IN μm

T-1A

T-2A

D =
L =

D RANGE
L RANGE
D AVG —
L AVG —
D STD —
L STD —

T-3A

Johns-Manville
Research and Development Center

Report No. 425-T-1413

Date August 22, 1979

Title: TRANSITE AIR VENT DUCT-EVALUATION FOR AIRBORNE ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPY - SALES SERVICE REQUEST NO. 324

SUMMARY

Three series of tests were performed on 8 in. TRANSITE air/vent duct to evaluate levels of airborne asbestos by transmission electron microscopy.

Two ten foot lengths of 8 in. air/vent duct were assembled connected by a 90° elbow. 8 in. stevenson couplings were used throughout the system. Suction in the system was provided by a 15 H.P. centrifugal blower. Air velocities in all tests were approximately 4600 ft/min.

Some tests were performed with no holes cut into the system, others were performed with two 3-1/2 in. holes cut into one of the ducts.

The first series of tests were performed with the air ambient background sampled about 6 ft from the system air intake. The remaining 2 series of tests were performed with a 3 ft length of 8 in. PVC pipe assembled with a stevenson coupling to the intake of the system. The air ambient background was measured inside the PVC pipe approximately 2-1/2 ft back from the intake.

A brief summary of the test results follows:

Test Series No. 1

	No. of fibers or clumps per cubic meter
Pipe only (no holes)	4,638,000
Pipe with two - 3-1/2 in holes	241,000
Ambient air background (6 ft from intake)	154,000

Test Series No. 2

	No of fibers per cubic meter	No. of Asbestos clumps per cubic meter
Pipe only (no holes)	78,000	31,000
Ambient air (in PVC pipe)	15,500	11,700
Pipe with two 3-1/2 in. holes	475,000	85,000
Ambient air (in PVC pipe)	43,000	19,000

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Notebook

Keywords

TRANSITE Air/Vent Duct
Asbestos
Transmission Electron Microscopy
Airborne Asbestos Fibers

Test Series No. 3

	No. of fibers per cubic meter	No. of Asbestos clumps per cubic meter
Pipe with two 3-1/2 in. holes	307,000	85,000
Ambient air (in PVC pipe)	62,000	19,000

Special appreciation is given to D. R. Christensen and staff who collected the samples and to V. E. Wolkdoff and F. D. D'ovidio who performed the transmission electron microscopy and did all of the analysis work. Much of the text and data presented in this report is taken directly from their reports.

Contents: Summary, Discussion, Results, Comments, Appendices I and II.

Reported by _____
H. S. Goodspeed
Pipe Technology Section

pk

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H. S. Goodspeed
R&D Information Center (4)

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DISCUSSION

The Industrial Products Division placed a request on the pipe research group to evaluate air/vent duct for levels of airborne asbestos.

Three series of tests were performed on 8 in. TRANSITE air/vent duct.

The test set up consisted of two ten ft lengths of 8 in. TRANSITE air/vent duct connected with a 90° elbow. 8 in. stevenson couplings were used for connections throughout the system. Suction in the system was provided by a 15 H.P. centrifugal blower. Air velocities in all the tests were approximately 4600 ft/min. (See Figure 1).

Each test was run for a period of two hours with air sampling taken continuously during this period.

Samples were taken in accordance with currently accepted EPA sampling. Methodology, the air stream inside the pipe was isokinetically sampled for the asbestos fiber. (See figure 2) All samples were collected by D. R. Christensen and staff.

Analysis was conducted by the most advanced state of the art in transmission electron microscopy as presented in the following paragraphs:

Filter Media

The Millipore AA filters measure 8 by 10 inches and on which the actual area of deposition for each filter measures 175.5 mm by 227.5 mm.

TEM Grid Preparation

Gold 200-mesh TEM grids were used throughout the study and individual grid openings measured 89.9 by 89.9 um. From the center of each filter, a 22 mm diameter cut-out was taken as a representative area. The 22 mm cut-out filter was collapsed and clarified by conventional methods and from which three 3.1 mm plugs were cut out to fit the diameter of the TEM gold grids. These plugs were created with a thin layer of carbon in the evaporator under vacuum, placed carbon coated side down on the TEM grids, exposed to methyl ethyl ketone fumes to soften clarified filter and fix asbestos fibers in situ. The filters fixed on the TEM grids were then placed in a reflux unit((cold finger) for about 20 minutes in the "cuff" zone of hot acetone fumes to remove organic material and leaving fibers fixed in place. The TEM grids were placed again in the evaporator for another thin coating of carbon for sandwich effect of fibers between two layers of carbon. The rudimentary parts of this technique and methods used in counting and varifying asbestos fibers are similar to Tentative Procedure for Detection and Evaluation of asbestos Fibers by C. Anderson, et al, EPA Research and Development Division, Athens, Georgia. The Philips EM-400 TEM unit was used in this study

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and magnifications from 1,500x up to 100,000x were used for cursory study (uniformity of distribution, artifacts, rips in carbon, if any, uniformity of carbon film depositions, and other check out procedures). The nominal magnification employed in traversing each grid opening completely was 18,000 X and each fiber was positively identified by either electron diffraction patterns and/or energy dispersive spectrometry for chemistry of ions of atomic number 11 and higher. In the Johns-Manville technique of the EPA procedure for grid preparation, the entire procedure takes 20 minutes rather than 8 to 16 hours by EPA methods and also fiber loss, if any, is negligible. During the entire handling and preparation technique, blanks are run to verify absence of fibers in refiltered Class 100 Clean Room and in filtered acetone and refiltered distilled water systems as well as washing and cleaning procedures of glass ware. Asbestos fibers were not detected in any of the blanks (20 openings traversed in each). Two grids from each sample, usually 10 openings each, were used in the quantification of asbestos except No. 27 which required only one grid due to uniformly heavy population in all grids prepared.

The transmission electron microscopy was performed by V. E. Wolkodoff and F. D. D'Ovidio who also did all of the analysis work. Their reports provided the primary basis for the text and data presented in this report.

Description of the Three Series Tests

The test set up was assembled in the 300,000 lb testing machine room located in the Product Development Building. Two ten ft lengths of 8 in. air/vent duct were used with a 90° elbow in between. Suction in the system was provided by a 15 H.P. centrifugal blower. Air was taken into the system within the room and evacuated through a roof vent. Air velocity in the system for all tests was approximately 4600 ft/min. Sampling within the duct was done through a 1-1/2 in hole cut in the side of the duct 5 ft from the end of the duct connected to the blower (length of pipe furthest from the air intake).

Test Series One

This series consisted of two tests. The first was with no holes cut in the duct. The system was purged for about 15 minutes. Sampling was then commenced for the 2 hour period. No ambient air background sampling was taken during this test.

For the second test two 3-1/2 in. holes were cut in the first duct (intake pipe). One hole was cut on the side of the duct 3 ft from the air intake; the other was cut in the top of the duct 4 ft from the intake. The holes were made by marking the size on the duct with a 3-1/2 in. template; drilling 1/4 in. holes around the perimeter, knocking the discs free with a hammer and then dressing up the holes with a coarse wood rasp. The TRANSITE discs were removed from the duct, the holes were cleaned with a rag to remove loose fiber and the interior of the duct vacuumed out. Making holes with a 1/4 in. drill, hammer, and wood rasp is recommended in the J-M TRANSITE air/vent duct installation guide.

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The line was then purged for about 15 minutes after which sampling was done for the 2 hour period. However, during this test the air ambient background was sampled at a location about six feet from the intake.

Test Series Two

This series consisted of two tests identical to the first series with the following exceptions:

The intake pipe with the holes was replaced by a pipe with no holes. The 90° elbow and second pipe remained the same.

A 3 ft length of PVC pipe was assembled onto the intake end of the TRANSITE duct. A 1-1/2 in. hole was cut 2-1/2 ft from the intake of the PVC pipe and on the side. This hole was used for air ambient background testing during both tests of the series.

Test Series Three

This series consisted of one test. The assembly with the holes cut in the duct from the second series of tests was purged for a period of one week and then samples taken for the 2 hour period both from the duct and from the PVC pipe for air ambient background.

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RESULTS

The results from the three series of tests follows. For the first series of tests the types of fiber encountered in each sample are enumerated. For the second and third series of tests this refinement was not done and all types of fibers are lumped into one category (fibers per cubic meter).

Test Series One - Results

A. Three 8 in. by 10 in. Millipore AA (0.8 um) filters were submitted for fiber quantification and characterization by TEM methods in connection with eight-inch TRANSITE pipe air duct testing at R&D Center. The three samples are identified as follows:

No. 1 - Pipe only; 68 cubic meters of air captured on Millipore AA.

No. 2 - Pipe with holes; also with 68 cubic meters of air through filter.

No. 3 - Ambient Area Background; 68 cubic meters on Millipore AA.

B. The types of fibers encountered in each sample are chrysotile, chrysotile clumps, crocidolite, amosite and glass. Percentages of fiber type follow:

	No. 1	No. 2	No. 3
Chrysotile Fibers	71.5	60.7	51.4
Chrysotile Clumps	1.8	14.7	7.6
Crocidolite Fibers	1.8	4.9	5.1
Amosite Fibers	24.0	11.5	23.1
Glass Fibers	0.9	8.2	12.8

C. Number of fibers or clumps per cubic meter

	No. 1	No. 2	No. 3
Chrysotile	3.3 million	146,000	79,000
Chrysotile Clumps	120,000	35,000	12,000
Crocidolite	79,000	12,000	8,000
Amosite	1.1 million	28,000	35,000
Glass Fibers	39,000	20,000	20,000
TOTAL	4,638,000	241,000	154,000

D. Fiber characterization: Refer to Appendix I.

Test Series Two - Results

1. Description of Samples (collected on Millipore AA filter media)

Number	Description	Volume, m^3	Test Date
1A	Test 1 - Ambient Air	64.6	7/11/79
1T	Test 1 - In air duct	64.6	7/11/79
2A	Test 2 - Ambient air	64.6	7/11/79
2T	Test 2 - In air duct with holes	64.6	7/11/79

2. Results and two sigma limits assuming Poisson's distribution and statistics apply.

Sample No.	Fibers per m^3	Two Sigma Limits Lower	Two Sigma Limits Upper	Asbestos[1] clumps/m^3
1A	15,500[2]	0	31,000	11,700[2]
1T	78,000	43,000	113,000	31,000
2A	43,000	17,000	69,000	19,000
2T	475,000	353,000	606,000	85,000

[1]Clumps are not taken into total calculation by EPA methods but are reported separately.

[2]Fibers detected in 20 grid openings, 4 or less, are so low that EPA would not quantify but rather assign NSS designation acronym for not significant statistically.

3. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos.

Sample No.	Grid Openings	Fibers Verified	Clumps Verified
1A	20	4	3
1T	20	20	8
2A	20	11	5
2T	10	61	11

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4. Characteristics of Asbestos Fibers in um.

Sample No.	Average Diameter	Range in diameter	Average Length	Range in Length
1A	0.3536	0.0166 to 1.1440	6.604	0.520 to 14.476
1T	0.0520	0.0166 to 0.3744	0.856	0.104 to 2.912
2A	0.1492	0.0166 to 0.4160	5.956	0.104 to 31.616
2T	0.0465	0.0104 to 0.4160	0.924	0.104 to 14.768

Test Series Three - Results

1.

Number	Description	Volume, m^3	Test Date
3A	Test 3, Ambient Air	64.6	8/8/79
3T	Test 3, In Air Duct with holes	64.6	8/8/79

2. Results and two sigma limits for asbestos fibers assuming Poisson's distribution and statistics apply.

Sample No.	Fibers per m^3	Two Sigma Limits Lower	Two Sigma Limits Upper	Asbestos[1] clumps/m^3
3A	62,000	31,000	93,000	19,000
3T	307,000	233,000	376,000	35,000

Note: Fibers refer to unattached end free fibers of asbestos (all types).

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3. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos (raw data).

Sample No.	Grid Openings	Fibers Verified	Clumps Verified
3A	20	16	5
3T	20	79	22
Blank	20	ND	ND

4. Characteristics of Asbestos Fibers in Micrometers.

Sample No.	Average Diameter	Range in Diameter	Average Length	Range in Length
3A	0.1167	0.016 to 0.374	1.99	0.42 to 11.85
3T	0.0782	0.011 to 1.352	2.07	0.10 to 48.75

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COMMENTS

A. All asbestos fibers were verified by electron diffraction patterns and/or energy dispersive spectrometry for chemistry of elements of atomic number 11 and higher.

B. Glass fibers (amorphous) were not counted.

C. Fibers, neither asbestos or glass, were encountered but not identified and are not included in the counts.

D. If optical methods were to be employed under the best possible conditions, e.g., 1000X oil immersion lens of very high numerical aperture, green light source just above ultra violet wavelength and Kohler or Nelsonian type illumination, on these samples the asbestos fibers in Sample No. 3A would not be detected (resolvability dependent on diameter and not length) and an estimated 1 percent of the total could be detected in Sample No. 3T and these would be of the amphibole asbestos type. In no case, optically, would any of the chrysotile type asbestos be detected since these are fibrillar in nature.

E. By our studies over the last five years, it can be demonstrated that for every fiber (in samples of this type) that is detected optically there are at least 10,000 fibers which can only be detected and verified by transmission electron microscopy.

F. Examination by light microscopy using the NIOSH recommended method revealed no detectable fibers.

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APPENDIX I

FIBER CHARACTERIZATION, 8-INCH A/C PIPE

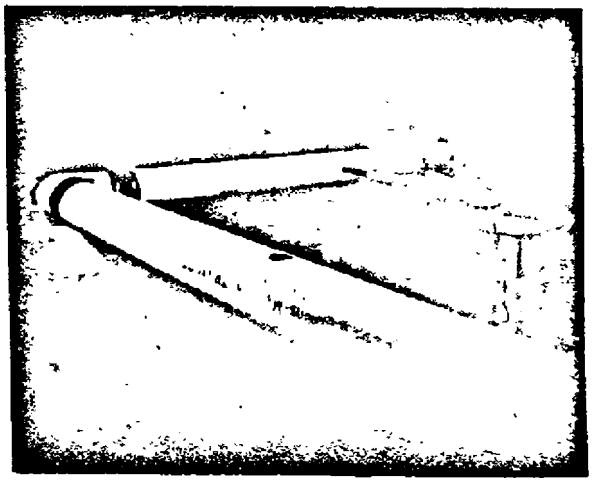
FROM TEST SERIES ONE

Sample No.	Chrysotile				Amosite				Fiber			
	Average Diameter, D	Diameter Range, D	Avg Length, L	Length Range, L	Average Diameter, D	Diameter Range, D	Avg Length, L	Length Range, L	Average Diameter, D	Diameter Range, D	Avg Length, L	Length Range, L
1	0.0260	0.0115 to 0.0323	0.603	0.104 to 1.333	0.0080	0.0033 to 0.0115	0.425	0.121 to 0.333	0.2084	0.0819 to 1.3662	2.262	0.433 to 21.411	0.6655	0.2060 to 1.9490	14.222	0.329 to 25.174
2	0.0454	0.0104 to 0.2129	1.213	0.164 to 11.838	0.0260	0.1072 to 0.2129	2.288	1.906 to 2.458	0.3468	0.0788 to 0.3125	4.188	0.720 to 13.536	0.6655	0.1606 to 1.1588	10.852	2.288 to 22.292
3	0.0256	0.0104 to 0.0323	1.511	0.104 to 5.368	0.0082	0.0044 to 0.0156	2.303	1.089 to 3.236	0.2936	0.1044 to 0.3398	6.902	0.720 to 17.422	0.6658	0.1606 to 1.1588	10.852	2.288 to 22.292

* Used for fibers for statistic characterization.

APPENDIX II

Figure 1

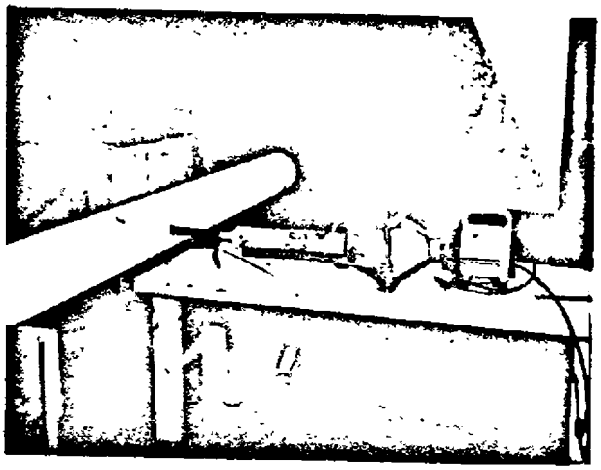


Two-ten foot lengths of 8 in. TRANSITE air/vent duct with 90° elbow; 8 in. stevenson couplings used through out; note 3-1/2 in. hole in duct; second hole is in far side of duct.

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APPENDIX II

Figure 2



Equipment used to sample air stream inside the duct; Note centrifugal blower in background.

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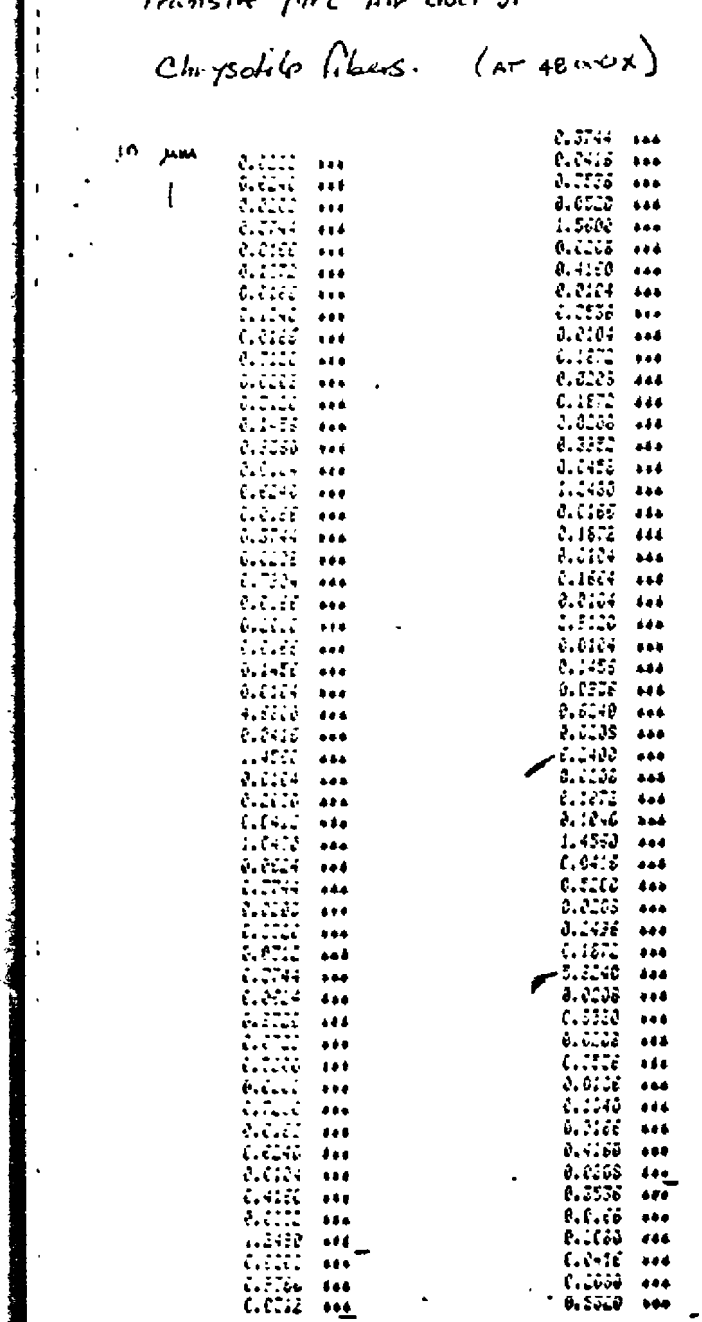
Fiber Characterization

Transite pipe air duct 3T

Chrysotile fibers. (AT 48 mm X)

10 μm

1



Fiber Characterization

Transite pipe Air duct Sample 3A

Chrysotile Fibers

in μm

0.0416 ***
0.0250 ***
0.0333 ***
0.7500 ***
0.1624 ***
0.0250 ***
0.0624 ***
1.2400 ***
0.0250 ***
1.5000 ***
0.1250 ***
0.0333 ***
0.1458 ***
0.0250 ***
0.1042 ***
0.0250 ***
0.0333 ***
1.0540 ***
0.0166 ***
1.0200 ***
0.1040 ***
1.7500 ***
0.0250 ***
0.1250 ***

Diam. range: 0.0166 *** – 0.0666 ***

Length range: 0.0100 *** – 11.7500 ***

Avg. Diam — 0.0777 ***

Avg length — 1.2273 ***

STD Diam — 0.0522 ***

STD length — 2.0251 ***

Amphibole Fibers

in μm

0.1458 ***
1.2400 ***
0.0333 ***
1.7500 ***
0.1250 ***
0.4160 ***
0.3744 ***
1.2480 ***

Diam. range: 0.1458 *** – 0.3744 ***

Length range: 0.4150 *** – 1.7500 ***

Avg. Diam — 0.2340 ***

Avg length — 1.1700 ***

STD Diam — 0.0936 ***

STD length — 0.5095 ***

All measurements AT 46,000x

Fiber Characterization

Transite Pipe Air duct 3T

Amphibole fiber: (AT 48,000X)

In μm

Diam Range	0.0202	fib
	1.3520	fib
Length Range	0.3360	fib
	42.3720	fib
Avg. Diam	0.6231	fib
Avg length	14.5252	fib
SD Diam	0.4624	fib
SD length	10.2208	fib

Johns-Manville

Internal Correspondence

To HANK GOODSFELD R&D

Date MAY 7, 1979

From D.R. CHRISTENSEN R&D

From G.L. HALLOW 1-06

Subject ASBESTOS EMISSIONS
TRANSITE AIR DUCT

Following is a brief outline, including basic equipment and facilities, of the testing program for Transite Air Duct for asbestos emissions.

1. LOCATION
   A. Prime canidate for the location is the Research and Development Center. Ambient air sampling must be done prior to our Duct evaluation to determine if the background is suitable.
   B. Alternate site - to be determined from the ambient air sampling. A garage or outside environment may be needed.

2. TEST SET-UP (Open to atmosphere, not closed system)
   A. To consist of two 10' sections of Air Duct.
      1. One set up to contain a 90° elbow properly installed as it would be in the field.
      2. Possibly a second set-up with a straight section of duct only.
   B. Obtain a blower assembly capable of producing the necessary air velocities (some type of damper to flow).
      1. Check with Dick Himes, he may know of a blower that could be used for this project.
   C. Possibility of some cuts should be made in the duct system as it would have been done in the field application. (?)

3. ANALYSIS
   A. Transmission Electron Microscope (TEM)
      1. Fiber sizing
         A. Length
         B. Diameter
   B. Optical Microscope
      1. Fiber count (F/cc)

Johns-Manville

PIPE FIELD TESTS

Internal Correspondence

To E. M. Fenner - 1-06

Date: August 14, 1979

From V. E. Wolkodoff - R&D

Copies: See End of Correspondence

Subject: IPD SALES/SERVICE 3104. TRANSITE PIPE AIR DUCT EVALUATION FOR AIRBORNE ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPY. TESTING DONE IN PD BUILDING. M79-168

1. Please refer to my letter-report of July 30, 1979 (M79-153) to J. P. Leineweber on similar subject and in which the filter media and direct transfer technique for TEM grid preparation are described. Samples were collected by D. R. Christensen and are identified as follows:

Number	Description	Volume, m^3	Test Date
3A	Test 3, Ambient Air	64.6	8/8/79
3T	Test 3, In Air Duct with holes	64.6	8/8/79

2. Results and two sigma limits for asbestos fibers assuming Poisson's distribution and statistics apply

Sample No.	Fibers per m^3	2 sigma limits		Asbestos clumps/m^3
		Lower	Upper	
3A	62,000	31,000	93,000	19,000
3T	307,000	238,000	376,000	85,000

Note: Fibers refer to unattached and free fibers of asbestos (all types).

3. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos (raw data).

Sample No.	Grid Openings	Fibers Verified	Clumps Verified
3A	20	16	5
3T	20	79	22
Blank	20	ND	ND

4. Characteristics of Asbestos Fibers in Micrometers

Sample No.	Average Diameter	Range in Diameter	Average Length	Range in Length
3A	0.1167	0.016 to 0.374	1.99	0.42 to 11.8
3T	0.0782	0.011 to 1.352	2.07	0.10 to 48.7

5. TEM Negatives on File

Sample No.	Negative Nos.
3A	0694 (22,000x) 0695 (48,000x) 0696 (6,000x)
3T	0697 (8,000x) 0698 (48,000x)

Other negatives are on file for Sample No. 3T but were being developed or washed at time of writing this letter-report. However, these negatives will be logged in the TEM Negative NB and will be available for your use if you so wish.

6. Comments

a. All asbestos fibers were verified by electron diffraction patterns and/or energy dispersive spectrometry for chemistry of elements of atomic number 11 and higher.

b. Glass fibers (amorphous) were not counted.

c. Fibers, neither asbestos or glass, were encountered but not identified and are not included in the counts.

d. If optical methods were to be employed under the best possible conditions, e.g. 100x oil immersion lens of very high numerical aperture, green light source just above ultra violet wavelength and Kohler or Nelsonian type illumination, on these samples the asbestos fibers in Sample No. 3A would not be detected (resolvability dependent on diameter and not length) and an estimated 1 percent of the total could be detected in Sample No. 3T and these would be of the amphibole asbestos type. In no case, optically, would any of the chrysotile type asbestos be detected since these are fibrillar in nature.

6. (cont'd)

e. By our studies over the last five years, it can be demonstrated that for every fiber (in samples of this type) that is detected optically there are at least 10,000 fibers which can only be detected and verified by transmission electron microscopy. Confirmation of our observations are in a publication by Ontario Research Foundation but not issued at this time due to political sensitivity of the subject — EPA techniques by electron microscopy vs NIOSH techniques relying on phase contrast or optical mineralogy techniques.

f. If you need more information for your report not covered in this letter, please let me know as soon as possible.

V. E. Wolkodoff

V. E. Wolkodoff

F. D'Ovidio

F. D'Ovidio

km

cc:
J. P. Leineweber - 1-06
G. L. Swallow - 1-06
D. R. Christensen - R&D
H. Goodspeed - R&D
J. F. Herr - R&D
C. J. Sulewski
P. E. Dix
S. Speil
S. B. Spencer
R&D Information Center
File 259

NB 5059 pgs 17,23,&24
TEM tally sheets on file
NB TEM 7801 pgs 24-25, 26-27

(Please Type - Please Rush!)

JM Johns-Manville — Internal Correspondence

(Pipe)

To D.F. Christenson R+D — Date 6/26/79

From: V.E. Volkodoff

Copies: H. Goodgame R+D; S. Spoil R+D; E.M. Fraser 1-66; Attn S.E. Spencer; J.P. Lemmerhirt 1-66

Subject: Transite Pipe Air Duct Tests at R+D Complex. Analyses by TEM. JPD Sales/Service 3104. M79-114

A. Three 8" by 10" Millipore AA (0.8 μm) filters were submitted for fiber quantification and characterization by TEM methods in connection with a TRANSITE (eight-inch) Pipe air duct testing at Raw D Center. The three samples are identified as follows:

No. 1. Pipe only; 68 cubic meters of air ruptured on Millipore AA

No. 2. Pipe with holes; also with 68 cubic meters of air through filter

No. 3. Ambient Area Background, 68 cubic meters on Millipore AA

B. The types of fibers encountered in each samples are chrysotile, chrysotile clumps, crocidolite, amosite and glass. Percentages of fiber types follow.

	No. 1	No. 2	No. 3
Chrysotile fibers	71.5	60.7	51.4
Chrysotile clumps	1.8	14.7	7.6
Crocidolite fibers	1.8	4.9	5.1
Amosite fibers	24.0	11.5	23.1
Glass fibers	0.9	8.2	12.8

C. Number of fibers or clumps per cubic meter

	No 1	No 2	No 3
Chrysotile	3.3 million	144,000	79,000
Chrysotile clumps	120,000	35,000	12,000
Crocidolite	79,000	12,000	8,000
Amosite	1.1 million	28,000	35,000
Glass fibers	39,000	22,000	20,000
Totals	4,633,000	241,000	154,000

D. Fiber Characterization

Refer to Table 1.

V.E. Wolkodoff

F. D'Ovidio

NB 5059 pgs 6-15 plus TEM Tally Sheets

TABLE 1

FIBER CHARACTERIZATION, 8-inch A/C PIPE

Sample no.	Chrysotile				Crocidolite				Amosite				Avg. Diameter, μm
	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm	
1	0.0248	0.0125 to 0.0833	0.615	0.104 to 3.333	0.0989	0.0833 to 0.145	0.635	0.521 to 0.729	0.2864	0.0833 to 1.6667	5.362	0.625 to 15.411	1)
2	0.0456	0.0104 to 0.3120	1.715	0.146 to 11.856	0.4160	0.1872 to 0.8320	2.288	2.080 to 2.496	0.3962	0.0728 to 0.8320	4.160	0.728 to 13.936	0.6656
3	0.0356	0.0104 to 0.0832	1.573	0.104 to 9.568	0.2912	0.2080 to 0.3744	2.392	2.080 to 2.704	0.3995	0.1664 to 0.5200	6.702	0.728 to 17.472	0.6698

1) Too few fibers for realistic characterization

$$0.4t = \frac{4}{w \cdot 1.8}$$

.08

TABLE 1

BFR CHARACTERIZATION, 8-inch A/C PIPE

	Crocidolite				Amosite				Glass			
Length Range, μm	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm	Avg. Diameter, μm	Diameter Range, μm	Avg. Length, μm	Length Range, μm
04 to 3.333	0.0989	0.0833 to 0.145	0.625	0.521 to 0.729	0.7864	0.0833 to 1.6667	5.162	0.625 to 35.411	1/	1/	1/	1/
166 to 856	0.4160	0.1872 to 0.8320	2.928	2.080 to 2.496	0.3962	0.0728 to 0.8320	4.160	0.728 to 13.936	0.6656	0.2080 to 1.0400	14.227	4.576 to 35.776
104 to 568	0.2912	0.2080 to 0.3744	2.392	2.080 to 2.704	0.2995	0.1664 to 0.5200	6.762	0.728 to 17.472	0.6698	0.1664 to 1.2480	19.062	2.288 to 35.776

for respirable characterization

Johns-Manville

Note FIELD TEST

Internal Correspondence

To: D. R. Christensen - R&D

Date: July 3, 1979

From: V. E. Wolkodoff - R&D

Copies: E. M. Fenner - 1-06
J. P. Leineweber - 1-06
H. Goodspeed - R&D
S. Speil - R&D
attn: S. Spencer - R&D

Subject: TRANSITE PIPE AIR DUCT TESTS AT R&D COMPLEX
ANALYSES BY TEM. IPD SALES/SERVICE 3104
M79-114

A. Three 8 in. by 10 in. Millipore AA (0.8 μm) filters were submitted for fiber quantification and characterization by TEM methods in connection with eight-inch TRANSITE pipe air duct testing at R&D Center. The three samples are identified as follows:

No. 1 - Pipe only; 68 cubic meters of air captured on Millipore AA.

No. 2 - Pipe with holes; also with 68 cubic meters of air through filter.

No. 3 - Ambient Area Background; 68 cubic meters on Millipore AA.

B. The types of fibers encountered in each sample are chrysotile, chrysotile clumps, crocidolite, amosite and glass. Percentages of fiber type follow:

	No. 1	No. 2	No. 3
Chrysotile Fibers	71.5	60.7	51.4
Chrysotile Clumps	1.8	14.7	7.6
Crocidolite Fibers	1.8	4.9	5.1
Amosite Fibers	24.0	11.5	23.1
Glass Fibers	0.9	8.2	12.8

C. Number of fibers or clumps per cubic meter

	No.1	No. 2	No. 3
Chrysotile	3.3 million	146,000	79,000
Chrysotile Clumps	120,000	35,000	12,000
Crocidolite	79,000	12,000	8,000
Amosite	1.1 million	28,000	35,000
Glass Fibers	39,000	20,000	20,000
TOTAL	4,638,000	241,000	154,000

D. Fiber Characterization

Refer to Table I.

V. E. Wolkodoff

V. E. Wolkodoff

F. D'Ovidio

F. D'Ovidio

km

NB 5059 pgs 6-15 plus TEM tally sheets.

TABLE 1

FIBER CHARACTERIZATION, 8-INCH A/C PIPE

Sample No.	Chrysotile				Crocidolite				Amosite				Glass			
	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m
1	0.0248	0.0125 to 0.0833	0.693	0.104 to 3.333	0.0989	0.0833 to 0.1145	0.625	0.521 to 0.729	0.2864	0.0833 to 1.6667	5.262	0.625 to 35.411	1*	1*	1*	1*
2	0.0456	0.0104 to 0.3120	1.715	0.166 to 11.856	0.4160	0.1872 to 0.8320	2.288	2.080 to 2.496	0.3462	0.0728 to 0.8320	4.160	0.728 to 13.936	0.6656	0.2080 to 1.0400	14.227	4.576 to 35.776
3	0.0356	0.0104 to 0.0832	1.513	0.104 to 9.568	0.2912	0.2080 to 0.3744	2.392	2.080 to 2.704	0.2935	0.1664 to 0.5200	6.702	0.728 to 17.472	0.6698	0.1664 to 1.2480	19.052	2.288 to 25.792

*Too few fibers for realistic characterization.

Fiber Characterization

Transite pipe air duct 3T

Chrysotile fibers: (AT 48000X)

10 μm

1

0.0232 ***
0.0240 ***
0.0232 ***
0.3744 ***
0.0166 ***
0.1872 ***
0.0166 ***
0.1040 ***
0.0166 ***
0.3120 ***
0.0208 ***
0.7200 ***
0.1456 ***
0.5200 ***
0.0104 ***
0.6240 ***
0.0166 ***
0.3744 ***
0.0208 ***
2.7904 ***
0.0166 ***
0.2080 ***
0.0166 ***
0.1456 ***
0.0104 ***
4.6800 ***
0.0416 ***
1.4560 ***
0.0104 ***
0.2080 ***
0.0416 ***
1.0400 ***
0.0624 ***
0.3744 ***
0.0208 ***
0.5200 ***
0.0312 ***
0.3744 ***
0.0624 ***
0.3328 ***
0.8320 ***
0.5200 ***
0.0208 ***
0.7280 ***
0.0166 ***
0.6240 ***
0.0104 ***
0.4160 ***
0.0832 ***
1.2480 ***
0.0208 ***
0.3360 ***
0.0312 ***

0.3744 ***
0.0416 ***
0.3536 ***
0.0520 ***
1.5600 ***
0.0208 ***
0.4160 ***
0.0104 ***
0.3536 ***
0.0104 ***
0.1872 ***
0.0208 ***
0.1872 ***
0.0208 ***
0.3328 ***
0.1456 ***
1.2480 ***
0.0166 ***
0.1872 ***
0.0104 ***
0.1664 ***
0.0104 ***
2.9120 ***
0.0104 ***
0.1456 ***
0.0936 ***
0.6240 ***
0.0208 ***
0.2400 ***
0.0208 ***
0.1872 ***
0.1040 ***
1.4560 ***
0.0416 ***
0.5200 ***
0.0208 ***
0.2496 ***
0.1872 ***
5.2240 ***
0.0208 ***
0.5200 ***
0.0208 ***
0.3536 ***
0.0166 ***
0.1040 ***
0.3166 ***
0.4160 ***
0.0208 ***
0.3536 ***
0.0166 ***
0.2080 ***
0.0416 ***
0.2080 ***
0.6320 ***

3 fibers

2.4960 ***
0.0208 ***
1.4560 ***
0.0208 ***
0.3120 ***
0.3744 ***
4.5760 ***
0.1248 ***
0.3328 ***
0.1040 ***
0.6240 ***
0.0208 ***
0.6240 ***
0.0208 ***
0.6240 ***
0.0208 ***
4.8880 ***
0.0520 ***
[illegible] ***
1.3520 ***
0.5200 ***
0.1248 ***
0.3120 ***
0.1248 ***
2.3120 ***
0.0624 ***
2.0800 ***
0.0416 ***
0.6240 ***
0.0208 ***
0.2080 ***
0.0208 ***
0.6240 ***
0.0624 ***
0.2288 ***
0.0208 ***
0.5200 ***
0.0416 ***
2.0800 ***

Diameter Range — 0.0104 *** / 0.0520 ***

Length Range — 0.1040 *** / 6.3200 ***

Average Diameter — 0.0536 ***

Average Length — 1.2235 ***

STD Diameter — 0.1121 ***

STD Length — 1.7795 ***

Fiber Characterization

Transite pipe Air duct sample 3A

Chrysotile Fibers

in μm

0.0416 ###
0.0240 ###
0.0208 ###
0.1200 ###
0.1664 ###
0.0200 ###
0.0624 ###
1.0400 ###
0.0520 ###
1.0560 ###
0.1976 ###
0.1456 ###
0.0250 ###
1.1040 ###
0.0520 ###
0.2080 ###
1.0640 ###
0.0156 ###
0.0240 ###
0.1040 ###
0.0416 ###
0.0156 ###

Diam. range: 0.0156 ### – 0.2080 ###

Length range: 0.4160 ### – 11.7520 ###

Avg. Diam — 0.0777 ###

Avg length — 4.3673 ###

STD Diam — 0.0571 ###

STD length — 2.0851 ###

Amphibole Fibers

in μm

0.1456 ###
1.2480 ###
0.2288 ###
1.7680 ###
0.1872 ###
0.4160 ###
0.3744 ###
1.2480 ###

Diam. range: 0.1456 ### – 0.3744 ###

Length range: 0.4158 ### – 1.7680 ###

Avg. Diam — 0.2240 ###

Avg length — 1.1700 ###

STD Diam — 0.0956 ###

STD length — 0.5593 ###

All measurements AT 40,000×

Fiber Characterization

Transite pipe Air duct 3T

Amphibole fiber: (AT 48,000X)

In μm

0.0020 ###
-0.6720 ###
0.0022 ###
0.3360 ###
1.3520 ###
16.2240 ### ?
[illegible] ###
0.6240 ###
0.6240 ### ?
1.7040 ###

Diam Range 0.2280 ### < 1.3520 ###

Length Range 0.3360 ### < 45.5720 ###

Avg. Diam — 0.6531 ###

Avg length — 14.5352 ###

STD Diam — 0.4634 ###

STD length — 20.2206 ###

Johns-Manville

Internal Correspondence

RE FIELD TEST

To E.M. FENNER 1-06

Date AUG 10, 1979

From D.R. CHRISTENSEN R&D

Copies J.P. LEINEWEBER 1-06
G.L. SWALLOW 1-06
H. GOODSPEED R&D

Subject:
TRANSITE AIR DUCT - ASBESTOS FIBER EMISSIONS
FIBER CONCENTRATION DETERMINATION VIA OSHA P&CAM 239 (OPTICAL)

Three tests consisting of two samples each have been analyzed via the P&CAM 239 OSHA/NIOSH method for the determination of fiber concentration. These six samples are taken from the same filters as those analyzed by V.E. Wolkodoff in his EM work.

IDENTIFICATION	CONCENTRATION, F/cc	RESULTANT F/cc in AIR DUCT
1A (ambient air blank)	0.02	
1T (in air duct)	0.02	0.00
2A	0.11	
2T	0.07	(0.00)*
3A	0.07	
3T	0.11	0.04

* Actually a negative number

D.R. CHRISTENSEN

Field Test.....

Please Type - Please Rush!

To: E. M. Fenner 1-06 August 12, 1979
From: V. E. Wolkodoff R+D

Copies: C. Sulewski R+D
J. P. Leineweber 1-06
G. L. Swallow 1-06
D. R. Christensen R+D
H. Goodspeed R+D
P. Dix R+D
J. F. Heer R+D
S. Speil R+D
S. B. Spencer R+D
R+D Information Center File 259

Subject: IPD SALES/SERVICE 3104, TRANSITE PIPE AIR DUCT EVALUATION FOR AIRBORNE ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPY. TESTING DONE IN PD BUILDING. M79-168

1. Please refer to my letter-report of July 30, 1979 (M79-153) to J. P. Leineweber on similar subject and in which the filter media and direct transfer techniques for TEM grid preparation are described. Samples were collected by D. R. Christensen and are identified as follows:

Number	Description	Volume, m^3	Test Date
3A	Test 3, Ambient Air	646	8/8/79
3T	Test 3, In Air Duct With Holes	646	8/8/79

2. Results and two sigma limits for asbestos fibers assuming Poisson's distribution and statistics apply.

Sample No.	Fibers per m^3	Two sigma limits Lower	Two sigma limits Upper	Asbestos clumps/m^3
3A	62,000	31,000	93,000	19,000
3T	307,000	238,000	376,000	85,000

Note: Fibers refer to matrixed and free fibers of asbestos (all types).

3. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos (raw data).

Sample No.	Grid Openings	Fibers verified	Clumps Verified
3A	20	16	5
3T	20	79	22
Blank	20	ND	ND

4. Characteristics of Asbestos Fibers in Micrometers.

Sample No.	Average Diameter	Range in Diameter	Average Length	Range in Length
3A	0.1167	0.016 to 0.374	1.99	0.42 to 11.84
3T	0.0782	0.011 to 1.352	2.07	0.10 to 40.72

5. TEM Negatives on File

Sample No.	Negative Nos.
3A	0694 (23,000X)
	0695 (48,000X)
	0696 (6,000X)
3T	0697 (8,000X)
	0698 (48,000X)

Other negatives are on file for Sample No. 3T but were being used, developed or washed at time of writing this letter-report. However, these negatives will be logged in the TEM Negative NB and will be available for your use if you so wish.

6. COMMENTS

-> a. All asbestos fibers were verified by electron diffraction patterns and/or energy dispersive spectrometry for chemistry of elements of atomic number 11 and higher.

-> b. Glass fibers (amorphous) were not counted.

-> c. Fibers, neither asbestos or glass, were encountered but not identified and are not included in the counts.

-> d. If optical methods were to be employed under the best possible conditions, e.g. 100X oil immersion lens of very high numerical aperture, green light source just above ultra violet wavelength and Kohler or Nelsonian type illumination, on these samples the same asbestos fibers in in Sample No. 3A would not be detected (resolvability dependent on diameter and not length) and an estimated 1 percent of the total would be detected in Sample No. 3T and these would be of the amphibole asbestos type. In no case, optically, would any of the ~~chrysotiles~~ chrysotile type asbestos be detected since these are fibrillar in nature.

-> e. By our studies over the last five years, it can be demonstrated that for every fiber (in samples of this type) that is detected optically there are at least 10,000 fibers which can only be detected and verified by transmission electron microscopy. Confirmation

5

of our observations are in a publication by Ontario Research Foundation but not issued at this time due to political sensitivity of the subject — EPA techniques use by electron microscopy vs NIOSH techniques relying on phase contrast or optical mineralogy techniques. Also, the ORF publication refers only to fibers 5 micrometers or more in length.

→ f. If you need more information for your report not covered in this letter, please let me know as soon as possible.

V. E. Wolkodoff

F. D'Ovidio

NB 5059 pgs 17, 23 and 24.
TEM tally sheets on file.
NB TEM 7801 pgs 24-25, 26-27.

FIELD TESTS

Johns-Manville

Internal Correspondence

To J. P. Lucineweber - 1-06 Date July 30, 1979

From V. E. Wolkodoff - R&D

Copies E. Fenner - 1-06
H. Goodspeed - R&D
D. Christensen - R&D
S. Speil
attn: S. Spencer
R&D Information Center - File 259 7/31

Subject IPD SALES/SERVICE 3104. TRANSITE PIPE AIR DUCT EVALUATION FOR AIRBORNE ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPY M79-153

1. Description of Samples (collected on Millipore AA filter media)

Number	Description	Volume, m^3	Test Date
1A	Test 1 - Ambient Air	64.6	7/11/79
1T	Test 1 - In air duct	64.6	7/11/79
2A	Test 2 - Ambient air	64.6	7/11/79
2T	Test 2 - In air duct with holes	64.6	7/11/79

2. Filter Media

The Millipore AA filters measure 8 by 10 inches and on which the actual area of deposition for each filter measures 175.5 mm by 227.5 mm.

3. TEM Grid Preparation

Gold 200-mesh TEM grids were used throughout the study and individual grid openings measured 89.9 by 89.9 µm. From the center of each filter, a 22 mm diameter cut-out was taken as a representative area. The 22 mm cut-out filter was collapsed and clarified by conventional methods and from which three 3.1 mm plugs were cut out to fit the diameter of the TEM gold grids. These plugs were created with a thin layer of carbon in the evaporator under vacuum, placed carbon coated side down on the TEM grids, exposed to methyl ethyl ketone fumes to soften clarified filter and fix asbestos fibers in situ. The filters fixed on the TEM grids were then placed in a reflux unit (cold finger) for about 20 minutes in the "cuff" zone of hot acetone fumes to remove organic material and leaving fibers fixed in place. The TEM grids were placed again in the evaporator for another thin coating of carbon for sanduich effect of fibers between two layers of carbon. The rudimentary parts of this technique and methods used in counting and varifying asbestos fibers are similar to Tentative Procedure for Detection and Evaluation of Asbestos Fibers by G. Anderson, et al, EPA Research and

Development Division, Athens, Georgia. The Philips EM-400 TEM unit was used in this study and magnifications from 1,500x up to 100,000x were used for cursory study (uniformity of distribution, artifacts, rips in carbon, if any, uniformity of carbon film depositions, and other check out procedures). The nominal magnification employed in traversing each grid opening completely was 48,000 X and each fiber was positively identified by either electron diffraction patterns and/or energy dispersive spectrometry for chemistry of ions of atomic number 11 and higher. In the Johns-Manville technique of the EPA procedure for grid preparation, the entire procedure takes 20 minutes rather than 8 to 16 hours by EPA methods and also fiber loss, if any, is negligible. During the entire handling and preparation technique, blanks are run to verify absence of fibers in refiltered Class 100 Clean Room and in filtered acetone and refiltered distilled water systems as well as washing and cleaning procedures of glass ware. Asbestos fibers were not detected in any of the blanks (20 openings traversed in each). Two grids from each sample, usually 10 openings each, were used in the quantification of asbestos except No. 2T which required only one grid due to uniformly heavy population in all grids prepared.

4. Results and two sigma limits assuming Poisson's distribution and statistics apply.

Sample No.	Fibers per m^3	Two Sigma Limits		Asbestos[1] clumps/m^3
		Lower	Upper	
1A	15,500[2]	0	31,000	11,700[2]
1T	78,000	43,000	113,000	31,000
2A	43,000	17,000	69,000	19,000
2T	475,000	353,000	606,000	85,000

[1] Clumps are not taken into total calculation by EPA methods but are reported separately.

[2] Fibers detected in 20 grid openings, 4 or less, are so low that EPA would not quantify but rather assign NSS designation acronym for not significant statistically.

5. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos.

5. (cont'd)

Sample No.	Grid Openings	Fibers Verified	Clumps Verified
1A	20	4	3
1T	20	20	8
2A	20	11	5
2T	10	61	11

6. Characteristics of Asbestos Fibers in μm.

Sample No.	Average Diameter	Range in diameter	Average Length	Range in length
1A	0.3536	0.0166 to 1.1440	6.604	0.520 to 14.476
1T	0.0520	0.0166 to 0.3744	0.856	0.104 to 2.912
2A	0.1492	0.0166 to 0.4160	5.956	0.104 to 31.616
2T	0.0465	0.0104 to 0.4160	0.924	0.104 to 14.768

7. TEM Negatives on File

Samples No.	Negative Nos.
1A	0681 (8,000x)
1T	0682 (6,000x), 0683 (17,000x)
2A	0684 (6,000x), 0685 (17,000x) (0686(10,500x)
2T	0687 (28,000x), 0688 (22,000x) 0689 (17,000x), 0690 (48,000x) 0691 (48,000x), 0692 (8,000x)

V. E. Wolkodoff
V. E. Wolkodoff

F. D'Ovidio by VEW
F. D'Ovidio

km

NB 5059 pgs 16-21 plus TEM tally sheets
NB TEM 7801 pgs 24-25

#				

Johns-Manville R&D

Internal Correspondence

To J. P. Leineweber - 1-06

Date July 30, 1979

From V. E. Wolkodoff - R&D

Copies L. Fenner - 1-06
H. Goodspeed - R&D
D. Christensen - R&D
S. Speil
attn: S. Spencer
R&D Information Center - File 259 7/31

Subject C & S
IPD SALES/SERVICE 3104. TRANSITE PIPE AIR DUCT EVALUATION FOR AIRBORNE ASBESTOS BY TRANSMISSION ELECTRON MICROSCOPY
M79-153

1. Description of Samples (collected on Millipore AA filter media)

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5. Number of grid openings, selected at random, and number of fibers and clumps verified as asbestos.

5. (cont'd)

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V. E. Volkodoff
V. E. Volkodoff

F. D'Ovidio by IEW
F. D'Ovidio

km

NB 5059 pgs 16-21 plus TEM tally sheets
NB TEM 7801 pgs 24-25

Johns-Manville

Internal Correspondence

To: D. R. Christensen - R&D

Date: July 3, 1979

From: V. E. Walkodoff - R&D

Copies: E. M. Fenner - 1-06
J. P. Leinweber - 1-06
H. Goodspeed - R&D
S. Speil - R&D
attn: S. Spencer - R&D

Subject: TRANSITE PIPE AIR DUCT TESTS AT R&D COMPLEX
ANALYSES BY TEM. IPD SALES/SERVICE 3104
479-114

A. Three 8 in. by 10 in. Millipore AA (0.8 μm) filters were submitted for fiber quantification and characterization by TEM methods in connection with eight-inch TRANSITE pipe air duct testing at R&D Center. The three samples are identified as follows:

No. 1 - Pipe only; 68 cubic meters of air captured on Millipore AA.

No. 2 - Pipe with holes; also with 68 cubic meters of air through filter.

No. 3 - Ambient Area Background; 68 cubic meters on Millipore AA.

B. The types of fibers encountered in each sample are chrysotile, chrysotile clumps, crocidolite, amosite and glass. Percentages of fiber type follow:

	No. 1	No. 2	No. 3
Chrysotile Fibers	71.5	60.7	51.4
Chrysotile Clumps	1.8	14.7	7.6
Crocidolite Fibers	1.8	4.9	5.1
Amosite Fibers	24.0	11.5	23.1
Glass Fibers	0.9	8.2	12.8

C. Number of fibers or clumps per cubic meter

	No.1	No. 2	No. 3
Chrysotile	3.3 million	146,000	79,000
Chrysotile Clumps	120,000	35,000	12,000
Crocidolite	79,000	12,000	8,000
Amosite	1.1 million	28,000	35,000
Glass Fibers	39,000	20,000	20,000
TOTAL	4,638,000	241,000	154,000

D Filter Characterization

Refer to Table 1.

V. E. Volkodoff

V E Volkodoff

F. D'Ovidio

F. D'Ovidio

km

SB 5059 pgs 6-15 plus TEM tally sheets.

TABLE I

FIBER CHARACTERIZATION, 8-INCH A/C PIPE

Sample No.	Chrysotile				Crocidolite				Amosite				Glass			
	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m	Average Diameter m	Diameter Range m	Avg Length m	Length Range m
1	0.0248	0.0125 to 0.0833	0.693	0.104 to 3.333	0.0989	0.0833 to 0.1145	0.625	0.521 to 0.729	0.2864	0.0833 to 1.6667	5.262	0.625 to 35.411	1*	1*	1*	1*
2	0.0456	0.0104 to 0.3120	1.715	0.166 to 11.856	0.4160	0.1872 to 0.8320	2.288	2.080 to 2.496	0.3462	0.0728 to 0.8320	4.160	0.728 to 13.936	0.6656	0.2080 to 1.0400	14.227	4.576 to 35.776
3	0.0356	0.0104 to 0.0832	1.513	0.104 to 9.568	0.2912	0.2080 to 0.3744	2.392	2.080 to 2.704	0.2935	0.1664 to 0.5200	6.702	0.728 to 17.472	0.6698	0.1664 to 1.2480	19.052	2.288 to 35.792

*Too few fibers for realistic characterization.