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JOHNS-MANVILLE RESEARCH AND ENGINEERING CENTER

Report No. 425-T-1360

Date September 29, 1971

ST0095246

Title: TRANSITE PIPE TEST LINE - DETERMINATION OF ASBESTOS FIBER IN WATER

SUMMARY

A test line loop has been constructed specifically to determine the asbestos fiber content in water that has passed through thirty feet of three-inch TRANSITE water pipe. All water entering the TRANSITE line was filtered through a 40 plate Millipor filter utilizing 0.8 micron (1 micron = 1 millionth of a meter) filter paper which is capable of removing all asbestos fibers. After exiting the TRANSITE line, ten perce of the flow was filtered through a ten plate Millipore sampling filter also utilizir 0.8 micron filter paper in order to determine asbestos fiber removal from the pipe. The pH and hardness of the recirculating water were adjusted by a chemical injectior system and a water softener. A small amount of fresh water entered the system continuously, with an equal amount to the sewer, to prevent dissolved solids build-up. Flow volume normally was about 150 GPM and flow rate was 6-8 FPS. Tests were run weekly for a series of ten weeks minimum. Fiber determinations were by the Basic Chemistry Research Section.

The following summarizes the averages of each series of successful runs:

Series	C	D	E	F	G
No. of Runs	20	10	14	10	10
Avg. pH	7.2	7.3	7.3	6.0	4.9
Avg. Hardness (ppm $CaCO_3$)	105	51	24	25.6	12.1
Avg. Asb. Fiber Content (μg/gal.)	16.8×10^{-5}	12.3×10^{-5}	7.8×10^{-5}	1.4×10^{-5}	0.9

It should be noted that the fibers could only be detected by use of an electron microscope and that the amounts of fiber are reported as micrograms per gallon (1 microgram = 1 millionth of a gram). As an illustration of the extremely small quantity of fiber in the water, about 6,000,000,000 gallons of water from run "C" would be required to produce one gram of fiber.

Based on these trials, the amount of asbestos fiber entering the water system from the TRANSITE pipe test line was infinitesimally small. It is believed that the fib are securely held in place by the pipe wall matrix, even under aggressive condition The amount of fiber removed appeared to be independent of pH and hardness and the mechanism of removal was apparently due to physical erosion and not chemical corrosion. The amount of fiber removed appeared to decrease with time. Calculations indicate that for a lifetime of 30 years, and assuming two quarts of this type of water were consumed daily, the amount of fiber consumed would be about 0.0000025 grams.

Contents: Summary, Introduction, Discussion, Conclusions and Recommendations, Appendix, and Tables I - XI.

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INTRODUCTION

During 1968, a TRANSITE pipe test line was installed in a building situated adjacent to the Research filtration plant. The purpose of this installation was to determine the amount of asbestos fibers entering a potable water supply after passing through TRANSITE water pipe.

DISCUSSION

Originally, the system was constructed for 175 GPM to pass through the installation on a once-through basis. Trial runs revealed that a once-through system was not feasible due to almost immediate plugging of filters. Consequently, the system was converted to a semi-closed recirculating system with a small amount of filtered fresh water continuously entering the system, and an equal amount of system water to the sewer, in order to prevent dissolved solids buildup. (See Figure 1 of appendix for schematic and equipment list). (Refer also to Research Report No. 425-T-1345).

The most critical portion of the test involved two Millipore filters, one before the TRANSITE line and one after the TRANSITE line. The TRANSITE line was 30 feet of Class 200 RTPP from Waukegan Plant. The pre-TRANSITE filter was a 40 plate Millipore containing 40 sheets (293 mm diameter) of 0.8 micron filter paper. Before entering the TRANSITE line, all water passed through this filter. The 0.8 micron size was chosen based on chem lab tests showing that 0.8 micron filter paper would retain 100 percent of the asbestos. (See Research Report No. 425-Int-1301). After leaving the TRANSITE line, ten percent of the water was sampled by a ten plate Millipore filter also containing 0.8 micron filter paper. Hardness of the water was controlled by a water softener and pH was controlled by a chemical injection pump using dilute sulfuric acid. Water volume was about 150 GPM and flow rate was 6 - 8 FPS. A series consisted of a minimum of ten weekly runs at a chosen pH and hardness level. At the end of each weekly run, the ten papers from the sampling Millipore were delivered to the chemistry lab for fiber analysis. A fresh TRANSITE line was installed at the start of each series of runs.

Fiber analysis was originally intended to be based on the magnesium content found on the sampling Millipore. However, due to the extremely small amounts of fiber and because of traces of magnesium from cement in the pipe and magnesium in the water, this approach was abandoned. The results from the first few runs were, therefore, considered invalid and are not reported. Runs "C" through "G" results were considered to be as accurate as possible and are reported as valid runs. (See Tables 1 - 11). Fiber analysis was performed by the chemistry lab using particle and fiber counts of magnified electron microscope photographs combined with a radioactive tracer technique. Observation of the data showed that in all series of runs, the amount of fiber in the water is extremely small. For instance, calculating the numbers of gallons needed to produce one gram of fiber results in the following:
(See next page).

Run	No. Gallons Required for 1.0g Fiber
C	5,950,000,000
D	8,130,000,000
E	12,800,000,000
F	71,400,000,000
G	11,200,000,000

Regression analysis and variance analysis of the data was performed by D. H. Hamer and S. E. Lawrence. (See Research Report No. 425-T-1357). Their report states that, "This analysis shows that in all cases the rate of removal of fiber decreases with time. Comparison of data from one test run to another revealed no apparent relationship between the rate of removal and changes in the pH/hardness combination.

CONCLUSIONS AND RECOMMENDATIONS

Based on these test series, it may be concluded that:

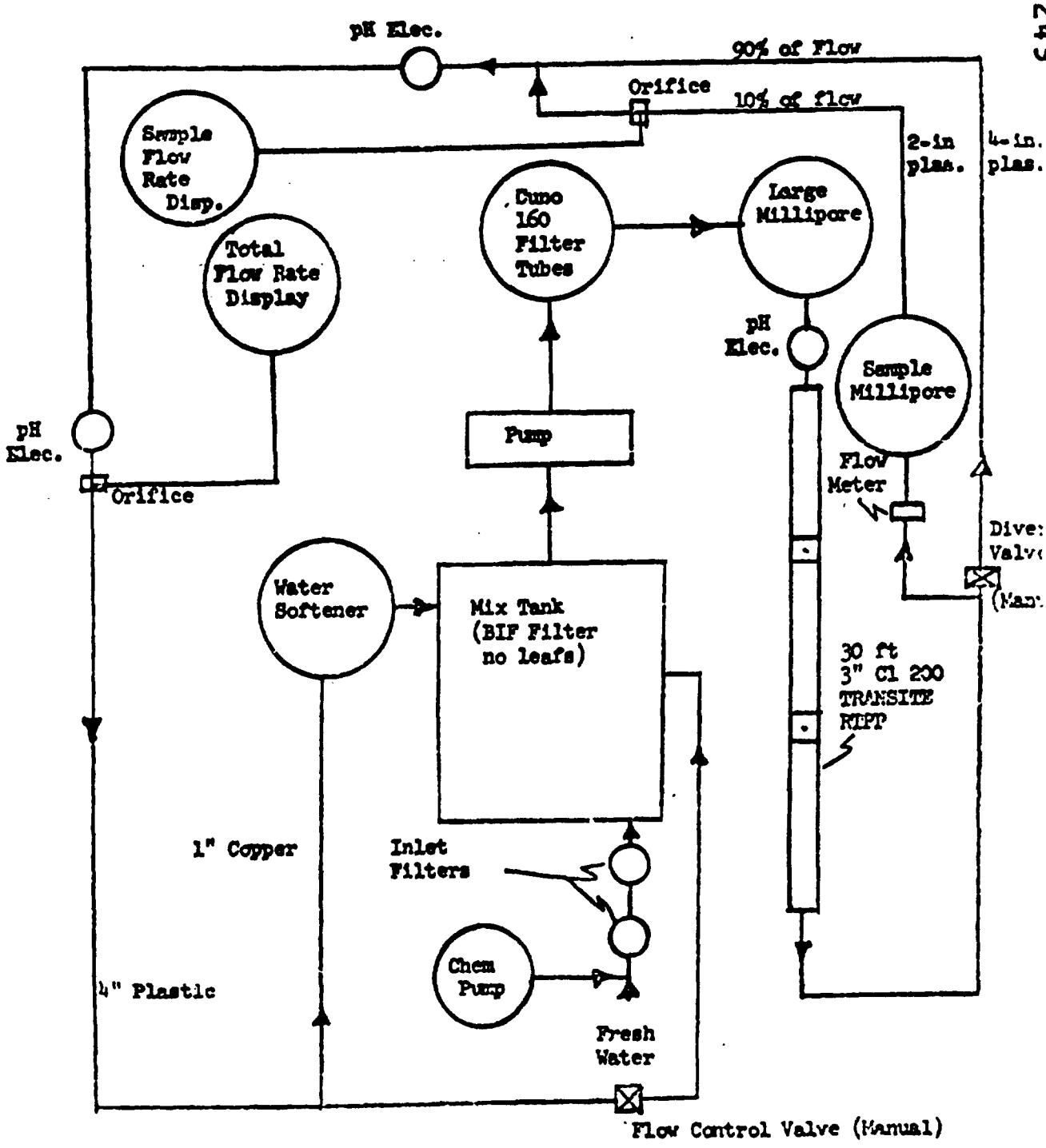
1. The rate of removal of asbestos fibers from the TRANSITE pipe test line by conveyed water was infinitesimally small and required electron microscopy techniques for measurement.

2. The extremely small amount of fiber removed from the TRANSITE pipe test line appeared to be independent of the pH and hardness of the water being conveyed. Apparently, the fiber removal mechanism was by physical erosion rather than chemical corrosion.

3. The extremely small amount of fiber removed appears to decrease with time, probably because of the formation of a "mat" which holds the fibers in place even after binder removal.

4. Calculations show that for an 80 year lifetime, the amount of fiber consumed would be 0.0000025 grams assuming two quarts of this type of water were consumed daily.

Figure 1. Schematic Diagram of Test Line Installation



APPENDIX

Figure 1 (cont'd) - List of Equipment - Test Line Installation

Inlet Water Flowmeter - Fischer & Porter No. 10A3535SY - 9.5 GPM max.

Inlet Water Filter - Pall Trinity Micro Corp. filter housing No. MCS1002UX16 utilizing two pleated paper filter cartridges No. MCY1001UX rated for 100 percent removal of 0.8 microns.

Chemical Pump on Inlet Water - Chemcon Pump - Model No. L24 "Raider"

Diatomite Filter - BIF Model No. 1865-03 vacuum diatomite filter, 240 square feet, flow rate 175 GPM at five psig. Operated with leafs removed and no diatomite in system.

Pump - Weirman Model 2KB (Centrifugal) capacity 175 GPM at 220 feet TDH, 2-inch discharge, 3-inch suction flanged, 20 HP 3500 RPM motor 460-3-60.

Cuno Filter - "Micro-Wynd" cartridge type filter, type CG 40 S-4 for 175 GPM at 1.0 micron filter density, 95 psig inlet - five psig pressure drop. Cartridges used are 160 each of JM 2E7P or equivalent.

Large Millipore - Millipore 20 set multi plate filter unit complete in 30 set plate capacity bell housing. 0.8 micron filter papers.

Sample Millipore - Millipore five set multi-plate filter unit complete in five set capacity bell housing. 0.8 micron filter papers.

Sampling Flowmeter - Schutte & Koerting Figure No. 18410 size 6HCF6 type SK W/S.F. fittings, 17.5 GPM at 65 psig one-inch connections.

Sampling Orifice & Recorder - Beckman model No. 153062, capacity 17.5 GPM with one pair 1-1/2-inch PVC orifice flanges.

pH Meters - Beckman Model No. 900.

Water Softener - Sears Roebuck Model No. 625.3474 - capacity 8.5 GPM.

Total Flow Orifice & Display - Foxboro, serial No. 423484, capacity 300 GPM (model No. unknown).

Water Testing - Hach portable engineers kit - Model No. DR 1834B.

TABLE 1 - "C" SERIES OF RUNS - TEST LIFE DATA (SEE RESEARCH REPORT NO. 404-56)
WATER NOT TREATED DURING THIS SERIES

Run No.	Hours of Test	Water Flow (gal.) Total x 10^3	Sample x 10^3	Avg. Rate (CPM)	Avg. pH	Avg. Total Hardness*
1	99.0	1031	106.1	174	7.5	120
2	93.5	996	97.5	178	7.3	125
3	96.0	965	91.4	168	7.2	109
4	95.0	941	89.8	165	6.8	101
5	72.0	737	65.3	168	7.3	105
6	95.3	1004	103.3	175	7.3	111
7	96.0	821	74.2	140	6.9	95
8	96.0	979	89.9	170	7.0	102
9	96.0	914	82.1	159	7.2	103
10	95.0	714	62.2	125	7.3	76
11	96.3	953	89.5	165	7.1	78
12	75.0	745	70.0	110	6.8	95
13	96.0	893	74.9	155	7.0	100
14	72.0	698	61.2	160	7.3	102
15	96.0	850	75.6	148	7.5	113
16	96.3	938	81.4	163	7.1	123
17	72.0	706	61.2	163	7.5	122
18	96.3	852	74.1	148	7.6	119
19	97.0	945	90.2	163	7.0	108
20	96.0	857	82.1	190	6.9	102
					avg. 7.	avg. 109

* As ppm $CaCO_3$
Run Dates - January 6, 1969 - July 25, 1969

TABLE 2 - "C" SERIES OF RUNS - FIBER DATA (SEE RESEARCH REPORT NO. 404-56)

Run No.	Water Sampled (gal.)x10^3	Ashed Solids (mg)	Fiber in Ashed Solids (%)	Fiber in Water (µg/gal.)*
1	106.1	21.4	0.0337	6.8×10^{-5}
2	97.5	41.5	0.0140	6.0×10^{-5}
3	91.4	51.0	0.135	75.0×10^{-5}
4	89.8	47.2	0.0506	27.0×10^{-5}
5	65.3	118.5	0.0112	20.0×10^{-5}
6	103.3	53.6	0.0040	2.1×10^{-5}
7	74.2	228.5	0.0168	52.0×10^{-5}
8	89.9	130.0	0.0001	0.14×10^{-5}
9	82.1	152.5	0.0061	11.0×10^{-5}
10	62.2	106.3	0.0030	5.1×10^{-5}
11	89.5	47.6	0.0025	1.3×10^{-5}
12	70.0	32.0	0.0242	11.0×10^{-5}
13	74.9	116.1	0.0075	12.0×10^{-5}
14	61.2	38.6	0.0043	2.7×10^{-5}
15	75.6	70.3	0.0115	11.0×10^{-5}
16	81.4	26.0	0.0251	8.0×10^{-5}
17	61.2	83.5	0.0061	8.4×10^{-5}
18	74.1	27.2	0.0648	24.0×10^{-5}
19	90.2	27.5	0.162	49.0×10^{-5}
20	82.1	17.7	0.0138	3.0×10^{-5}
			avg.	15.8×10^{-5}

* Micrograms/gal. (1 microgram = 1 millionth of a gram)
See Research Report No. 404-37 for method

TABLE 3 - "D" SERIES OF RUNS - TEST LINE DATA (SEE RESEARCH REPORT NO. 404-63)
TREATED WATER - GOAL: pH-7, HARDNESS - 50

Run No.	Hours of Test	Water Flow (gal.) Total x 10^3	Sampled x 10^3	Avg. Rate (GPM)	Avg. pH	Avg. Total Hardness*
1	96.0	806	64.8	140	7.4	54
2	96.0	900	73.4	156	7.4	53
3	95.5	958	91.0	168	6.8	50
4	96.0	878	86.4	153	7.2	39
5	96.0	943	91.4	164	7.4	44
6	96.0	743	71.3	130	7.3	54
7	96.0	950	90.7	165	7.2	57
8	96.0	842	84.6	146	7.3	55
9	71.0	499	49.2	117	7.4	56
10	95.5	939	91.4	164	7.2	48
					avg.	51

* As ppm $CaCO_3$
Run dates - January 19, 1970 - March 30, 1970

TABLE 4 - "D" SERIES OF RUNS - FIBER DATA (SEE RESEARCH REPORT NO. 404-63)

Run No.	Water Sampled (gal.)x10^3	Ashed Solids (mg)	Fiber in Water (μc/gal.)*
1	64.8	58.1	9.6×10^{-5}
2	73.4	55.0	37.6×10^{-5}
3	91.0	34.0	19.2×10^{-5}
4	86.4	31.7	12.5×10^{-5}
5	91.4	31.4	4.7×10^{-5}
6	71.3	26.5	10.3×10^{-5}
7	90.7	34.8	6.8×10^{-5}
8	84.6	37.4	4.8×10^{-5}
9	49.2	37.0	5.8×10^{-5}
10	91.4	41.4	11.7×10^{-5}
		avg.	12.3×10^{-5}

* Using radioactive tracer method, D-G series

TABLE 5 - "E" SERIES OF RUNS - TEST LINE DATA (SEE RESEARCH REPORT NO. 425-Int-1361
TREATED WATER GOAL - pH-7, HARDNESS - 25

Run No.	Hours of Test	Water Flow (gal.) Total x 10^3	Sampled x 10^3	Avg. Rate (GPM)	Avg. pH	Avg. Total Hardness*
1	96.0	828	77.0	144	7.1	25
2	95.5	917	83.9	160	7.4	24
3	96.0	763	72.0	130	7.8	17
4	74.3	727	74.2	163	7.8	26
5	94.0	853	86.1	151	7.5	26.5
6	96.0	792	82.8	137.5	7.1	24
7	71.5	708	70.8	165	7.3	26
8	96.0	922	93.6	160	7.4	24
9	97.0	941	96.0	160	7.4	23
10	94.5	907	93.6	160	7.5	26
11	95.0	905	90.5	159	7.2	24
12	95.0	862	88.4	151	7.1	23.5
13	95.0	855	87.7	150	7.2	21
14	96.0	547	56.2	95	7.1	23
				avg.	7.35 avg.	24

* As ppm $CaCO_3$
Run Dates - April 6, 1970 - November 6, 1970

TABLE 6 - "E" SERIES OF RUNS - FIBER DATA (SEE RESEARCH REPORT NO. 404-75)

Run No.	Water Sampled (gal.)x103	Ashed Solids (mg)	Fiber in Ashed Solids (%)	Fiber in Water (µg/gal.)
1	77.0	58.3	0.0783	59.0×10^{-5}
2	83.9	58.9	0.0120	8.0×10^{-5}
3	72.0	46.8	0.0065	2.0×10^{-5}
4	74.2	73.1	0.0023	2.3×10^{-5}
5	88.1	37.7	0.0231	9.9×10^{-5}
6	82.8	39.2	0.0054	2.1×10^{-5}
7	70.8	46.6	0.0126	8.4×10^{-5}
8	93.6	43.0	0.0061	2.7×10^{-5}
9	96.0	44.8	0.0003	0.1×10^{-5}
10	93.6	39.2	0.0253	11.0×10^{-5}
11	90.5	42.7	0.0032	1.5×10^{-5}
12	88.4	39.4	0.0001	0.05×10^{-5}
13	87.7	37.1	0.0034	1.4×10^{-5}
14	56.2	39.0	0.0010	0.7×10^{-5}
			avg.	7.8×10^{-5}

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TABLE 7 - "F" SERIES OF RUNS - TEST LINE DATA (SEE RESEARCH REPORT NO. 425-Int-13(
TREATED WATER COAL - pH-6, HARDNESS - 25

Run No.	Hours of Test	Water Flow (gal.) Total x 10^3	Sampled x 10^3	Avg. Rate (GPM)	Avg. pH	Avg. Total Hardness*
1	144.0	1,311	134.0	152	6.0	26.0
2	95.0	855	85.9	150	6.1	26.5
3	96.0	871	87.1	151	6.1	28.0
4	96.0	868	87.1	151	5.3	21.5
5	96.0	864	87.1	150	6.0	24.5
6	96.0	857	85.7	150	6.0	24.0
7	95.0	827	82.0	145	6.0	32.0
8	96.0	806	80.3	140	6.3	31.0
9	96.0	893	92.2	155	5.7	20.0
10	95.5	876	91.5	152.5	6.0	23.0
				avg.	6.0 avg.	25.7

* As ppm $CaCO_3$
Run Dates - November 16, 1970 - March 19, 1971

TABLE 8 - "F" SERIES OF RUNS - FIBER DATA (SEE RESEARCH REPORT NO. 425-T-1357)

Run No.	Water Sampled (gal.)x10^3	Ashed Solids (mg)	Fiber in Ashed Solids (%)	Fiber in Water (µg/gal.)
1	1,311	42.2	0.0061	0.1×10^{-5}
2	855	37.0	0.011	4.8×10^{-5}
3	871	33.6	0.0095	3.6×10^{-5}
4	868	28.7	0.0017	0.5×10^{-5}
5	864	28.7	0.0017	0.5×10^{-5}
6	857	35.4	0.0004	0.1×10^{-5}
7	827	32.8	none detected	none detected
8	806	36.9	0.0062	2.8×10^{-5}
9	893	32.1	0.0005	0.1×10^{-5}
10	876	35.2	0.0040	1.5×10^{-5}
			avg.	1.4×10^{-5}

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TABLE 9 - "G" SERIES OF RUNS - TEST LINE DATA (SEE RESEARCH REPORT NO. 425-Int-136)
TREATED WATER GOAL - pH-5, TOTAL HARDNESS - 0

Run No.	Hours of Test	Water Flow (gal.) Total x10^3	Sampled x10^3	Avg. Rate (GPM)	Avg. pH	Avg. Total Hardness*
1	96.0	864	88.9	150	5.1	11.5
2	72.0	648	65.2	150	4.3	12
3	96.0	814	83.9	140	5.1	10
4	95.0	670	71.7	120	5.0	16
5	95.0	857	88.6	150	5.0	13
6	96.0	814	83.2	140	4.8	12.5
7	96.0	742	78.1	130	4.8	13
8	96.0	662	67.3	115	5.1	11
9	96.0	835	85.3	145	5.15	12
10	72.0	605	58.3	140	4.9	12
				avg.	4.9 avg.	12

* As ppm $CaCO_3$
Run Dates - March 29, 1971 - June 4, 1971

TABLE 10 - "G" SERIES OF RUNS - FIBER DATA (SEE RESEARCH REPORT 425-T-1357)

Run No.	Water Sampled (gal.)x10^3	Ashed Solids (mg)	Fiber in Ashed Solids (%)	Fiber in Water (µg/gal.)
1	88.9	40.3	0.020	9.0×10^{-5}
2	65.2	35.6	0.0025	1.3×10^{-5}
3	83.9	46.5	0.054	30.2×10^{-5}
4	71.7	40.3	0.0021	1.1×10^{-5}
5	88.6	67.3	0.018	14.0×10^{-5}
6	83.2	39.0	0.0004	0.1×10^{-5}
7	78.1	33.4	0.043	18.4×10^{-5}
8	67.3	34.1	0.015	7.6×10^{-5}
9	85.3	43.3	0.012	6.2×10^{-5}
10	58.3	59.4	0.0010	1.0×10^{-5}
				avg. 8.9×10^{-5}

TABLE 11 - EXAMINATION OF PIPE FROM TEST SERIES D THROUGH G

Method - Sections were cut from pipe from test series D through G. Interiors were probed and scraped with a knife blade to determine extent of I.D. softening. Results were:

Run	Estimated Softening Depth	Comments
D	1 mil	Appears normal
E	1 mil	Appears normal
F	1 mil	Appears normal
G	3-5 mils	I.D. stained brown*, slight softening

* Due to rust in system

TABLE 9 - "C" SERIES OF RUNS - TEST LINE DATA (SEE RESEARCH REPORT NO. 425-Int-136
TREATED WATER GOAL - pH-5, TOTAL HARDNESS - 0

Run No.	Hours of Test	Water Flow (gal.) Total x 10^3	Sampled x 10^3	Avg. Rate (GPM)	Avg. pH	Avg. Total Hardness*
1	96.0	864	88.9	150	5.1	11.5
2	72.0	648	65.2	150	4.3	12
3	96.0	814	83.9	140	5.1	10
4	95.0	670	71.7	120	5.0	16
5	95.0	857	88.6	150	5.0	13
6	96.0	814	83.2	140	4.8	12.5
7	96.0	742	78.1	130	4.8	13
8	96.0	662	67.3	115	5.1	11
9	96.0	835	85.3	145	5.15	12
10	72.0	605	58.3	140	4.9	12
				avg.	4.9 avg.	12

* As ppm $CaCO_3$
Run Dates - March 29, 1971 - June 4, 1971