

Memorandum to Messrs. G. L. Dickson
P. W. McDaniel
J. L. Myers
C. M. Offenhauer
H. B. Rhodes
H. F. Wendt

Subject: Experimental Results - Airborne Asbestos

Date: February 29, 1972

From: M. A. Peters

Copy to: Messrs. J. W. Rawlings
R. G. Woolery
R & D File

I. INTRODUCTION

The need for data on the concentration of airborne asbestos during certain operations was pointed out at the January 12 asbestos meeting in Niagara Falls. A series of experiments were discussed at that meeting and were later outlined in a January 17 letter from Mr. W. N. Johnson.

Experiments assigned to the author were completed and the results and conclusions presented in this memorandum. The concentrations of airborne asbestos during dumping of various grades of asbestos and the sanding of asbestos-containing products were determined. A relationship between the asbestos concentrations expressed as fibers/c.c. of air sampled and the Mg concentration was established. Hopefully, this will give us an alternate method of asbestos determination. In addition, the thermal properties of RG-244 and RG-144 asbestos were determined by thermogravimetric analysis (TGA).

II. DETERMINATION OF AIRBORNE ASBESTOS

A. Experimental Procedures

Experiments were completed in which the airborne asbestos concentrations during the dumping of various grades of asbestos and the sanding of asbestos-containing products were determined. All dust samples were taken, under the direction of Mr. Paul McDaniel, by drawing a measured amount of air through a millipore filter. The sampling device was worn in the breathing zone of the operators at chest level during the dumping and sanding operations. Prior to each operation, background samples were taken. The number of asbestos fibers collected were determined by Mr. McDaniel's group by manually counting at 400 X with a phase contrast microscope.

Each experiment will be discussed separately as follows:

1. Dumping Experiments

The bags of asbestos fiber were opened and dumped into a 5 ft. x 5 ft. x 6 ft. deep hopper. The top edge of the hopper was at the waist-level of the operator. The bags were placed on the top edge of the hopper, slit open, dumped into the hopper, and shaken to completely empty the bags. In each experiment the bags were dumped in 5 minutes ±20 seconds with the operator remaining at the hopper edge for the remaining 5 minutes of the sampling period. In each test, 500 pounds of asbestos were dumped.

New hoppers were used for each test and sufficient time elapsed between dumping tests to ensure low background. The dumping tests were carried out in Building 88, Niagara Falls. This is a large building with neither general nor local exhaust in operation. The movement of air in the building was minimal during these tests.

a. Dumping Test #1 - Pellets

Dump, in random order, 5 bags of SG-100, 2 bags of SG-200, and 3 bags of HPP. Each bag contained 50 pounds of asbestos.

b. Dumping Test #2 - Canadian 7R

Five bags of Canadian 7R standard open fiber (100 lb./bag) were dumped.

c. Dumping Test #3 - Open

Dump, in random order, two bags of RG-110 (30 lb./bag), 5 bags of HP open (40 lb./bag), 8 bags of SG-210 (30 lb./bag).

2. Sanding Tests

The sanding experiments were conducted in Rooms 114 and 116 in Building 166. The volumes of these rooms are similar to the volume of a typical room found in a home. No general or local exhaust was in operation during the sanding experiments. All sanding was done on a vertical surface. Hand sanding was performed with a 4 x 7 inch No. 120 sandpaper fastened to a block of wood. Electric sanding was performed with a Black and Decker oscillating sander without a vacuum attachment (local exhaust); (~4-1/2 x 9 inch, No. 120 sandpaper). Sanding with a belt sander equipped with local exhaust could not be tested because of the unavailability of this type of sander. A local plasterer (Mirabelli) assured us that TJC is never machine sanded; only hand sanding is used in this business. Therefore, any data from machine sanding of TJC will not be representative of industry practice. Fresh sandpaper was used for each experiment but was not changed during the air sampling period.

a. Sanding of Tape Joint Compound (TJC)

A thick layer of tape joint compound was applied to a section of plasterboard and allowed to dry. The TJC contained ~5% asbestos and was manufactured by U.S.Gypsum, Chicago, Illinois, and is an all-purpose wallboard compound.

1) Hand Sanding - TJC (Tests #4 and #6)

2. Sanding Tests (Contd.)

a. Sanding of Tape Joint Compound (TJC) (Contd.)

2) Electric Sanding - TJC (Tests #5, #7, #7-1)

The sampling period was reduced to 10 minutes for this experiment because of the high dust level.

b. Sanding of Painted Surfaces

A thick coat of paint was applied to a section of plasterboard and allowed to dry thoroughly. The paint contained 1/2 pound asbestos per gallon of paint or approximately 4.6% asbestos. The paint was manufactured by A-1 Oil and Lead Company and is an acrycite latex house paint.

1) Hand Sanding Paint (Tests #8 and #10)

Sampling period = 15 minutes.

2) Electric Sanding Paint (Tests #9, #9-1, #11)

Two samples were taken simultaneously during 2/4/72 tests. Each sample was 10 minutes. One sample was taken with the samplers fastened to the operator at chest level, as usual, and the other sample was positioned ~4 ft. from the edge of the plasterboard and ~4 ft. above the floor. The sample for the 2/9/72 test was taken as usual.

3. Florida Samples

Samples were collected during various operations in small Florida companies during the week of January 31. Two sets of samples were collected simultaneously; one was a low-volume air sample used for fiber counting (Mr. E. G. Brown's letter to Dr. H. B. Rhodes, February 23, 1972) and the other was a high-volume air sample used for Mg determinations (Mr. E. G. Brown's letter to Dr. H. B. Rhodes, February 15, 1972).

4. Mg Determination - Alternate Method for Asbestos Determination

The concentration of airborne asbestos is presently determined by drawing a measured volume of air through a millipore filter (MF). The asbestos fibers, collected on the MF, are then counted at 400 X with a phase contrast microscope. Any fiber with a length > 5μ and a length to diameter ratio > 3 is counted as an asbestos fiber. This procedure is time consuming and may be subject to error. Clearly, an alternate method for the determination of asbestos would be desirable.

Asbestos contains ~25% Mg. The Mg concentration of the air sample could be used as a measure of the asbestos concentration if the background air is low in Mg and the process which is being tested (dumping, sanding) does not produce any Mg-containing airborne dust other than asbestos. The weight of asbestos collected on the MF, however, is low (0-100μg) and may contain high levels of matrix dust. An analytical procedure is required that is sensitive and relatively interference free. Atomic Absorption Spectroscopy (AAS) satisfies these requirements.

4. Mg Determination (Contd.)

The analytical procedure for Mg determination on MF briefly is: A measured portion of the MF containing the sample was wet ashed with HF, HNO_3, and $HClO_4$, eliminating most organics and silica from the sample solution. After adding HCl and $LaCl_3$ to the sample solution and diluting to 100 ml., the solution was aspirated into the flame of the AAS. The absorption due to the Mg in the sample solution was compared to a series of standards and the concentration of Mg calculated.

With the sensitivity of the AAS set at maximum, a meaningful Mg absorption signal was produced with 0.2 μg Mg/100 ml. solution (2 ppb). Because of the variable Mg concentration in the added reagents, 1.0 $\pm$ 0.2 μg. Mg/100 ml., and in the MF, 1.0 $\pm$ 0.2 μg.Mg/25 mm. diameter MF, the Mg sensitivity becomes slightly less favorable and each Mg determination will have an uncertainty of at least $\pm$ 0.4 μg.Mg/100 ml. This means that if 18 l. of air was sampled, 0.01 μg. Mg per liter of air would produce a measurable signal and that the uncertainty in any determination would be $\pm$ 0.02 μg.Mg/l. air sampled.

B. Results and Discussion

The number of asbestos fibers/cc. and the Mg concentration/l. for the various tests are presented in Table I. A comparison of the fiber count vs. Mg concentration is shown in Figure 1. A reasonable correlation exists between these two measured parameters and suggests that the Mg concentration may be a valid measure of airborne asbestos concentration. More data points, however, are required to validate this suggestion.

One factor becomes evident from Figure 1; the straight line does not go through the origin. Samples containing no Mg (that is <0.01 μgMg/l. air sampled) were reported to have asbestos fibers present (0.2-1.2 fibers/cc.) by the microscope fiber counting technique. This indicates that the fiber counting technique may be biased on the high side with an average bias of $\sim$+0.6 fibers/cc. If, however, the straight line in Figure 1 is repositioned so that it does go through the origin but maintains its original slope, a bias of $\sim$+1.9 fibers/cc. is suggested. The true bias probably varies with the process being tested and may never accurately be determined; however, the existence of a positive bias should be recognized.

The numbers of asbestos fibers $<5\mu$ in length must be nonexistent in these tests. If a substantial number were present, the straight line of Figure 1 would intercept the X-axis at a Mg concentration >0 μgMg/l.

No matter what measure of airborne asbestos concentration we use, a number of facts are evident from the data of Table I. The measured airborne asbestos concentration during the dumping of UCC pellets is significantly less than during the dumping of Canadian 7R and UCC open fiber. The measured airborne asbestos concentration during the dumping of Canadian 7R is slightly higher than UCC open fiber.

A visible asbestos cloud was evident during all three dumping tests. The dumping of UCC pellets and Canadian produced about the same observable airborne dust density while the UCC open fiber seemed to produce the greatest dust density. These observations are not consistent with the data of Table I and demonstrate the limits of visual observation.

B. Results and Discussion (Contd.)

The sanding experiments show that a very small amount of asbestos, if any, becomes airborne. No asbestos health hazard is present during the sanding operations. An apparent exception appears to be the machine sanding of TJC; however, this operation is not typical of the industry.

The lack of correlation between fiber count and Mg determination for the Florida samples is disappointing. The reason for the poor correlation may have been caused by the simultaneous sampling procedure. The low-volume sample, which was used for fiber count, was positioned near the breathing zone of the man dumping the RG-244. The high-volume sample, which was used for Mg determinations, was positioned slightly back from the dumping operation approximately 3-4 feet from the low-volume samples. The Mg content of the low-volume sample will be determined in order to prove whether the lack of correlation is real or was caused by the 3-4 foot separation in sampling points.

III. THERMOGRAVIMETRIC ANALYSIS (TGA) OF ASBESTOS

Proper waste disposal of asbestos by incineration requires a prior knowledge of the thermal properties of asbestos. Some of these properties were determined on the Stanton thermogravimetric balance and are shown in Figure 2. Two grades of UCC asbestos were examined: RG-144 (highly purified) and RG-244 (SiO_2-treated). Both grades dehydroxylate between 650-800°C. Because of the rather rapid rate of temperature rise (7°C/min.), the dehydroxylation temperature range may be slightly biased on the high side. An incinerator operating at 650°C., therefore, would probably be hot enough to achieve complete dehydroxylation of RG-144 and RG-244. The total weight loss of RG-244 is less than that of RG-144. This is reasonable since the RG-244 contains $\sim$8% SiO_2 and may contain a lower concentration of ^{-}OH groups.

M. A. Peters

MAP:et/rvg
Attach.

TABLE I

Determination of Airborne Asbestos Concentration During Dumping of Asbestos and Sanding of Asbestos-Containing Materials

Volume of Air Sampled: 18 or 27 liters
Air Sampling Rate: 1.8 or 2.7 liters/min.

Test No.	Experiment Description	Exp. Date and Time	Building, Room	Asbestos Fibers >5[c] μ in Length per ml. of Air Sampled	μg. Mg Found per Liter of Air Sampled
	Background	2/4/72, 8:55 A.M.	88	0.2	0.05
1	Dumping-Pellets	" 9:05 A.M.	"	2.40	0.145
	Background	" 10:35 A.M.	"	0.25	0.03
2	Dumping-Canadian 7R	" 10:45 A.M.	"	4.20	0.63
	Background	" 1:45 P.M.	"	0.25	0
3	Dumping-Open	" 1:55 P.M.	"	3.90	0.49
4	Hand Sanding-TJC[a]	2/4/72, 9:25 A.M.	166, 114	0.65	0
	Background	" 11:30 A.M.	" "	0.25	0.13
5	Electric Sanding-TJC	" 11:40 A.M.	" "	2.70	0.23
6	Hand Sanding-TJC	2/9/72, 10:08 A.M.	" "	0.50	0
	Background	" 1:30 P.M.	" "	0.10	0
7	Electric Sanding-TJC	" 2:15 P.M.	" "	2.10	0.10
7-1[b]	" " "	" "		-	0.60
8	Hand Sanding-Paint	2/4/72, 10:05 A.M.	166, 116	0.90	0
	Background	" 11:40 A.M.	" "	0.20	-
9	Electric Sanding-Paint	" 11:50 A.M.	" "	1.20	0.0056
9-1[b]	" " "	" "	" "	0.41	0.011
10	Hand Sanding-Paint	2/9/72, 10:32 A.M.	" "	0.50	0.019
	Background	" 1:34 P.M.	" "	0.20	0
11	Electric Sanding-Paint	" 2:00 P.M.	" "	0.75	0
12	Florida Sample A Dumping 23 Bags of RG-244	Week of 1/31/72	Marco Plant, Bartow	4.4) 11.5) 5.77 1.4)	0.0048[d]
13	Florida Sample B Dumping 5 Bags of RG-244	" " "	Alpha Chem., Kathleen	2.8	0.006[d]
14	Florida Sample C Power grinding outdoors on boat sections	" " "	Irwin Yacht, St. Petersburg	3.0) 2.3) 2.47 2.1)	0.024[d]

[a] TJC - Tape Joint Compound

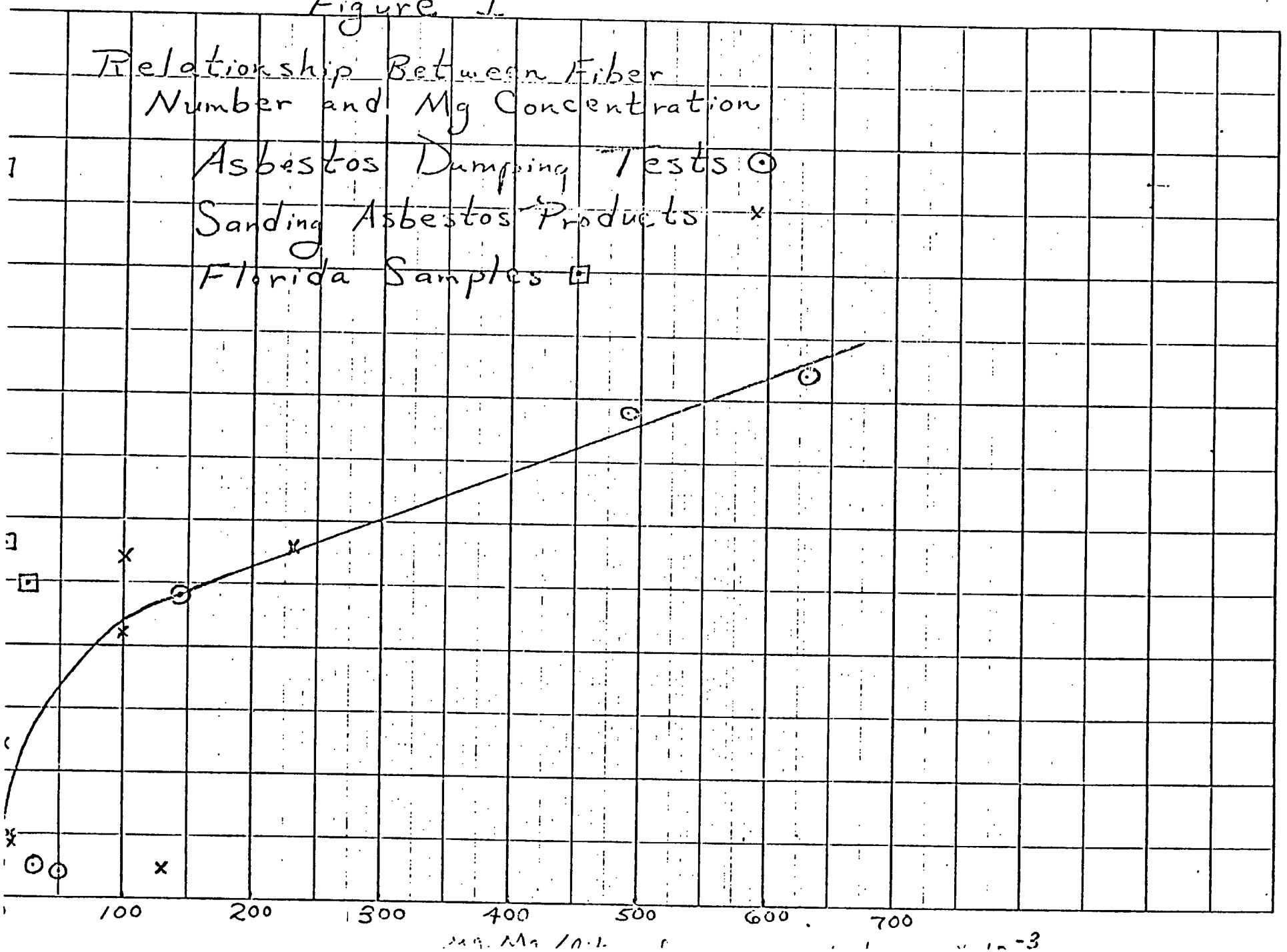
[b] Air Sampler ~4 feet from sanding area and ~4 ft. from the floor

[c] Data taken from letter to Mr. J. L. Myers from Mr. P. W. McDaniel, 2/11/72

[d] See letter from Mr. E. G. Brown to Dr. H. B. Rhodes, 2/15/72. Volume of air sampled in Tests 12 and 14 is 600 l. and in Test 13 is 200 l. for the Mg determination.

NO. 4520-L 20X20 TO THE INCH

Figure 1.



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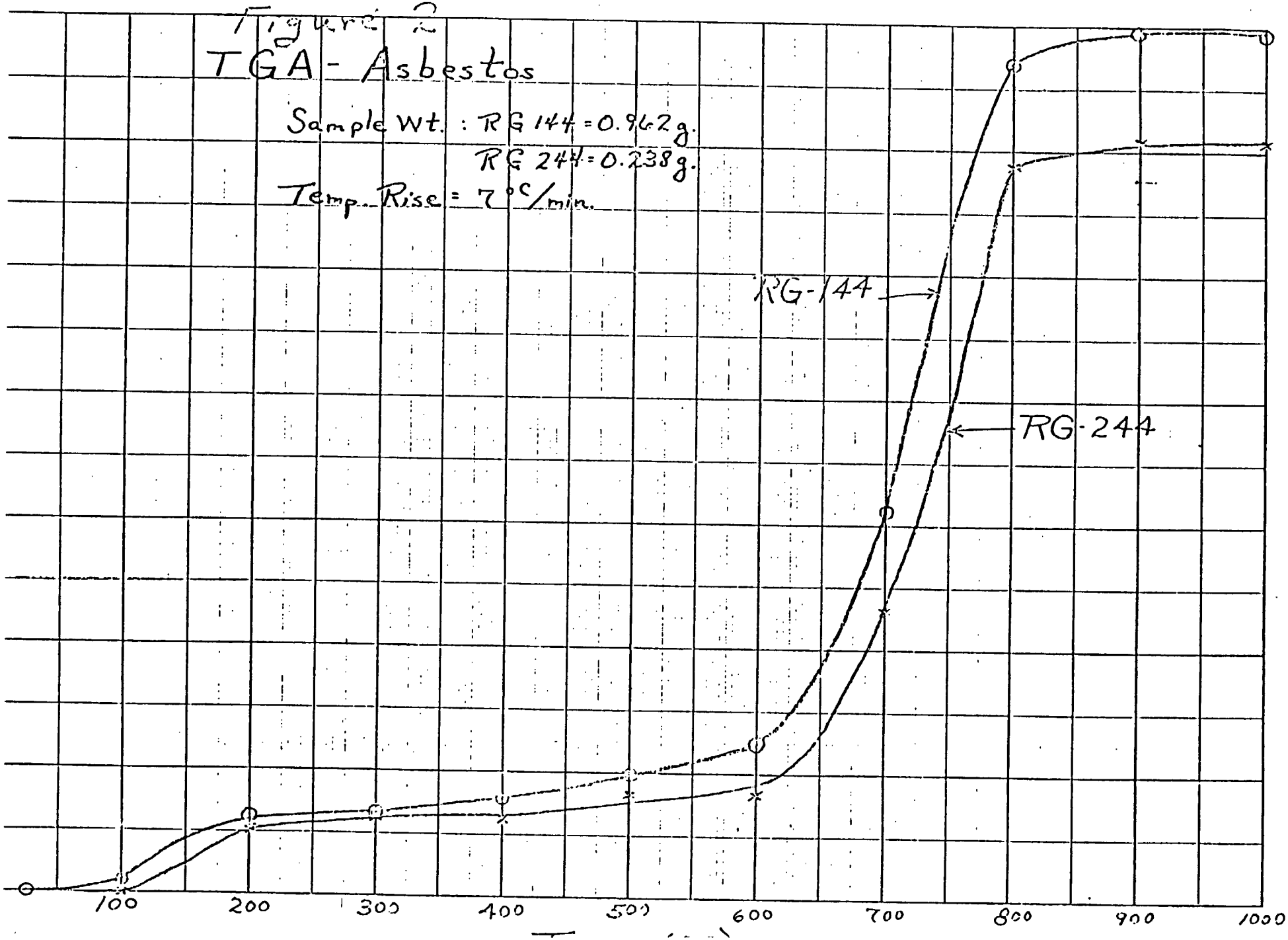
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ACL Doc 15670 · Page 8 of 8

NO 4520-L 20X20 TO THE INCH

Figure 2

TGA - Asbestos

Sample Wt. : RG 144 = 0.962 g.
RG 244 = 0.238 g.
Temp. Rise = 7 °C/min.



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