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IDENTIFICATION: ____________

ADMITTED: ____________

April 6, 1951

Mr. W. G. Hazard
Owens-Illinois Glass Company
Industrial Relations Division
Toledo 1, Ohio

Dear Bill:

In accordance with your request of April 5, we are happy indeed to forward to you, under separate cover, three copies of the reprint on Experimental Studies of Asbestosis.

With every best wish,

Sincerely yours,

Arthur J. Vorwald, M.D.
Director

AJV:LB

CC: Miss Hagan:

Please mail 3 reprints to Mr. Hazard.

LRC

REPORT

KAYLO DIVISION PLANT

Owens-Illinois Glass Company

Sayreville, New Jersey

May 28, 1951

INDUSTRIAL HYGIENE SURVEY

by

The Saranac Laboratory

Saranac Lake, New York

Submitted by:

Arthur J. Vorwald, M.D.
Director, The Trudeau Foundation and
The Saranac Laboratory

In cooperation with:

Edward C. J. Urban
Thomas M. Durkan
Donald A. Bailey

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Report of Industrial Hygiene Survey
of
Kaylo Division Plant, Owens-Illinois Glass Company
Sayreville, New Jersey

A survey of the Kaylo Division plant of the Owens-Illinois Glass Company, located at Sayreville, New Jersey, was made on January 30, 19[illegible] by T. M. Durkan and E. C. J. Urban of The Saranac Laboratory in company with W. G. Hazard of the Owens-Illinois Company. The purpose of the survey was to observe the plant operations and to discover whether any hazards to health might be created by dust liberated from the raw materials handled or from the finished products manufactured. Dust counts of atmospheric samples taken at seven strategic locations with the midget impinger apparatus were made to determine the concentration of air-suspended dust to which the workmen were exposed. Seven samples of atmospheric dust sufficient for analysis were collected on paper filters with a vacuum cleaner device so that the amount of hazardous free silica and associated constituents in the air-floated material could be estimated. The filters were of a specially prepared paper which effectively retained dust particles as small as .01 microns in size. One of these filter paper samples was taken on January 30, while the dust survey was being made, but the other six were collected later by John Roades of the Owens-Illinois Company. The raw materials also were examined and their composition was determined approximately.

Composition of Raw Materials and Finished Product

The composition and particle size of the principal raw materials which are used in the manufacture of the product Kaylo are indicated in table 1. In addition to the materials listed, small amounts of kaolin and cement are required but these two items are not related to any dust hazard.

Of the six raw materials described in table 1, all except quick lime must be regarded as potentially hazardous and capable of causing a serious pneumoconiosis. Inhalation of amosite or chrysotile can produce asbestosis and inhalation of silica flour or tripoli can cause silicosis. Diatomaceous earth on inhalation is capable of producing a diffuse fibrosis which is unlike silicosis or asbestosis but which may be quite disabling.

The finding that the sample of amosite had a quartz content of 21 per cent is quite surprising. It is thus apparent that exposure to this commercial form of amosite may present a potential hazard not only from asbestos fibers but also from free-silica particles.

The finished product, Kaylo, appears to consist principally of a crystalline form of calcium silicate which yields a characteristic x-ray diffraction pattern. Petrographic and chemical examination revealed, however, that other constituents are present in the material. A sample of light grade Kaylo was shown by analysis to have a quartz content of about 8 per cent; for the heavy grade the value was about 5 per cent. Both grades also contained moderate amounts of asbestos. In a sample of the light grade the asbestos was in the form of chrysotile which comprised approximately 5 to 20 per cent of the sample. For a sample of the heavy grade the chrysotile content was estimated to be about 5 to 10 per cent but, in addition, about 3 to 5 per cent of amosite asbestos was seen. Carbonates made up about 1 per cent of each grade of Kaylo.

Concentration and Composition of Atmospheric Dust

The concentration of the atmospheric dust to which the workmen were exposed at various points is shown by the dust counts in table 2. Information pertinent to the operations or conditions at each sampling point are included in the table. A summary of the dust counts is as follows:

Sample		Particles per cu.ft. of air: Smaller than 10μ	Particles per cu.ft. of air: Larger than 10μ
1	Router machine	4.4 million	0.06 million
2	Center aisle	3.4	0.16
3	Batch weighing room	8.4	0.26
4	Asbestos unbagging room	6.9	0.14
5	East finishing line	6.3	0.45
6	Pre-hardener	2.2	0.49
7	Mixer balcony	5.2	0.03

The composition of the material suspended in the air at seven representative locations is revealed by the analyses in table 3; from the data in table 4 the weight of dust in the atmosphere at those seven locations can be calculated. Thus, the dust load of the general plant air (sample #3A) was 0.2 gram in about 17,000 cu. ft. of air or 0.01 mg. per cu. ft., while the dust load of the atmosphere at the other locations ranged from 0.06 to 0.4 mg. per cu. ft. The hazardous fraction of the dust consisted of the free silica components (quartz and diatomaceous earth) and the asbestos components (amosite and chrysotile). These hazardous constituents generally made up a large portion of each dust sample, as the following table reveals:

Sample		Free silica components per cent	Asbestos components per cent
1A	General weighing area	40-55	3-5
2A	Asbestos tank	10-20	40-50
3A	General plant air	18-30	32-40
4A	Finishing line	3-5	10-20
5A	Router machine	1-3	6-12
6A	Boxcar and truck	4-7	27-39
7A	Asbestos shredding room	22-24	40-50

By correlating the values for concentration and composition of the atmospheric dust at each sampling point a fair idea of the potential dust hazard at those points can be obtained:

		Atmospheric Dust at Sampling Point		
		Concentration	Composition	
Samples		Particles per cu.ft. of air	Free silica components per cent	Asbestos components per cent
1 and 5A	Router machine	4.4 million	1-3	6-12
2 " 3A	Center aisle	3.4	18-30	32-40
3 " 1A	Batch weighing room	8.4	40-55	3-5
4 " 7A	Asbestos unbagging room	6.9	22-24	40-50
5 " 4A	East finishing line	8.3	3-5	10-20
6 " 3A	Pre-hardener	2.2	18-30	32-40
7 " 2A	Mixer balcony; asbestos tank	5.2	10-20	40-50
- 6A	Boxcar and truck	-	4-7	27-39

Comment

The results of the dust survey, which included the analysis of raw materials and atmospheric dust and a limited number of dust counts, make it apparent that considerable attention had been given in this plant to the control of dust. Exhaust systems of removing the dust had been installed and the amount of dust suspended in the plant atmosphere was revealed by the survey to be at relatively low levels. Since, however, in many areas of the plant hazardous free silica and asbestos minerals comprised a large portion of the air-floated material, it is very important that effective dust control measures be maintained at all times so that the dissemination of unsafe amounts of dust into the atmosphere will be prevented.

A number of agencies have suggested threshold or maximum allowable limits for the concentration of dusts in industrial atmosphere. In 1948 the Department of Health for the State of New Jersey informed The Saranac Laboratory that the Department followed a "Sanitary Code" which recommends certain threshold limits for dust exposure. A somewhat similar code has recently been developed by the American Conference of Governmental Industrial Hygienists. Threshold values established by those codes are as follows:

(The threshold values are given on the next page)

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		Maximum Allowable Concentration (Particles per cu.ft. of air)	
		New Jersey code	Am. Conf. Gov. Ind. Hyg. code
Asbestos		5 million	5 million
Free silica:			
	more than 70%	5	—
	" " 50%	—	5
	40% to 70%	10	—
	5% to 50%	—	20
	5% to 40%	20	—
	less than 5%	50	50
Total dust		50	50

A review of the survey data discloses that in certain areas (such as the batch weighing room) free silica comprised a large portion of the dust to which the workers were exposed; in other areas (asbestos tank and boxcar) asbestos was the principal component of the air-suspended material; and in still other localities (center aisle and asbestos unbagging room) substantial amounts of both free silica and asbestos were present in the atmospheric dust. It is thus apparent that although the dust counts of the seven impinger samples were all below 10 million, and therefore relatively low, the rather high quartz or asbestos content of the air-suspended material tended to create in certain areas a condition which might be hazardous, or at least one which approached the maximum allowable limit established by code. Specific examples would be the exposure to free silica in the batch weighing room and to asbestos in the asbestos unbagging room. Also, the concentration of asbestos dust inside the boxcars probably exceeded safe limits. Although a dust count was not made during the survey

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for that sampling point, the weight of dust collected there with the vacuum cleaner device and filter paper indicates that the dust concentration inside the boxcar was possibly of the order of 50 million or more. Since about one-third of the dust was asbestos, it seems likely that a potentially hazardous condition existed.

Suggestions and Recommendations

1. It is suggested that minimum exhaust ventilation rates which will provide effective dust collection for each branch of the dust control system be determined, unless this has already been done, and that the suction of these branches be checked periodically. Static pressure measurements can be used to measure air flow.

2. The exhaust system for the asbestos unbagging room should be redesigned so that the suction hoods will be located close to the points where the dust is produced to collect it before it contaminates the general air. It might be feasible to dump the asbestos bags into a small hopper and chute rather than on to an open platform. The hopper could have a rotary feeding device for moving the asbestos on to the riffle tables. The tables should be partly enclosed by plastic hoods and should be exhausted. Housekeeping in the area should be improved by periodically cleaning the room of the accumulated dust.

3. Housekeeping practices could be improved in a number of areas of the plant. At the router machine the dust should be removed from the machine carriage regularly and a sufficient number of containers provided for the proper disposal of the waste material. On the mixer balcony care should be taken to avoid spilling dry dust and the area

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should be cleaned periodically.

4. Special attention should be given to housekeeping in those areas where silica flour, tripoli, diatomaceous earth and asbestos are handled. It was noted during the survey that bags of these materials were stored in large piles throughout the plant area where space was available. Some of the bags were broken and covered with dust. Dust arising from this source would tend to contaminate the atmosphere of the entire plant.

5. It is recommended that a suction hood be installed in front of the operator who manually turns over the Kaylo tiles on the conveyor belt.

6. All employees working at points where dust is created should be educated in good dust suppression practices. As an added safeguard, it is suggested that those who work at dusty jobs be required to change their work clothing frequently.

7. Since it appears that men loading box cars are probably exposed to a hazardous concentration of air-suspended asbestos fibers, it is recommended that the men wear U.S. Bureau of Mines approved respirators during that operation. It would be preferable, of course, to reduce the dust concentration by exhaust ventilation or some other practicable method if at all possible.

8. Dust count surveys should be made in the plant at regular monthly intervals until a low level of dustiness in each potentially-hazardous area is established. The surveys can then be done less frequently.

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9. The maintenance of the working environment in a condition which conforms to regulations promulgated by local health agencies or which is in accord with accepted standards of good practice should not be considered as a complete protection for a worker from acquiring a disease as the result of his occupation. It is strongly recommended that at the Kaylo plant a medical program be maintained which would require a pre-employment examination, including a roentgenogram of the chest, of all prospective employees and a routine chest roentgenogram of all regular workers at intervals of once each year. Such a program should reveal those individuals who are unfit for employment in a dusty trade. Of most importance, any case of disease which might develop in the regularly employed workers would be found early, before it became a serious health problem to the individual and a liability to the management.

Table 1

ANALYSIS OF RAW MATERIALS USED IN THE MANUFACTURE OF KAYLO

Material	Composition	Size of Particles
Amosite	The bulk of the material was fibrous. Many of the fibers were separated; they did not possess the high degree of flexibility of chrysotile. Grains of chlorite or serpentine were adhering to some of the fibers. The sample of the amosite brought back from the Kaylo plant had a quartz content of 21 per cent.	Most of the fibers were several hundred microns to several cm. in length; relatively few were shorter than 50 microns. Many of these short fibers were 1 micron or less in diameter and, unlike chrysotile, were generally straight or only slightly curved. About 5 per cent of the material (by weight) would pass through a 100 mesh screen; in this smaller-than-100 mesh fraction about one-third of the fibers were longer than 20 microns and for every fiber there were about 6 particles.
Chrysotile	More than 90 per cent fibrous chrysotile. Adhering to some of the fibers were grains of chromite (?), carbonates, a few grains of massive serpentine and a trace of olivine. About 0.5% quartz also was present.	The fibers were well separated. Many were several hundred microns long and some were several mm. in length. About 10 per cent of the material (by weight) would pass through a 100 mesh screen; in the smaller-than-100 mesh fraction about one-fourth of the individual fibers were longer than 20 microns and for every fiber there were about 12 particles. In this fraction unopened bundles were about as numerous as the separated fibers.
Diatomaceous earth	Principally natural diatomaceous earth with a trace of quartz. Probably some clays were present. Diatoms were the fresh water variety (?).	Probably more than 90 to 95 per cent of the particles were smaller than 1 micron.
Quick lime	Nearly all lime, with 0.2% quartz and traces of carbonates, feldspar and glass.	Mostly smaller than 2 microns and rarely larger than 10 microns. Many clumps larger than 30 microns were seen.
Silica flour	Almost entirely pure, finely-ground quartz.	Probably more than 95 per cent of the particles were smaller than 5 microns.
Tripoli	Almost entirely cryptocrystalline quartz.	Probably more than 95 per cent of the particles were smaller than 5 microns; only rarely were any larger than 40 microns seen.

Table 2

CONCENTRATION OF ATMOSPHERIC DUST AT VARIOUS SAMPLING POINTS IN PLANT

All samples were taken with the midget impinger. The collecting fluid was 95% ethyl alcohol.

Sample #1: Router machine. Taken at 2:45 P.M.; 10 min. sampling time.

Router machine cutting Kaylo blocks into pipe insulation forms. Sample represented exposure of two men at router machine outlet removing pipe insulation forms and applying cloth coatings. A light glue was sprayed on the forms with compressed air spray guns to make the cloth adhere to the Kaylo. The cutting parts of the machine were enclosed by sheet metal housings which were exhausted by a central suction system. The exhaust points were checked by smoke tests and were found to have strong suction. This same central exhaust system also served the west finishing line, which was not in operation at the time. Since the exhaust points of the west line were closed off by dampers, the volume of exhaust at the router machine was substantially increased.

The router unit was located in the open plant area. Moderately heavy accumulations of Kaylo dust covered the undercarriage of the machine. The operators discarded broken pieces of insulation by throwing them into open containers. Several containers were filled in a short time and the excess discards fell to the floor. Housekeeping in the machine area was only fair.

Dust concentration: particles per cu. ft. of air
4.4 million smaller than 10μ. (Nearly all of these particles appeared to be 5μ or less in length.)
0.08 million larger than 10μ. (10 to 20μ in length.)

Sample #2: Center aisle. Taken at 3:10 P.M.; 10 min. sampling time.

General air sample along center aisle between direct-fired driers and indurator units. The units were of a completely enclosed construction. Only a slight volume of steam was noted escaping into the general air. Housekeeping was good.

Dust concentration: particles per cu. ft. of air
8.4 million smaller than 10μ. (Most of the particles were 5μ or less in length.)
0.16 million larger than 10μ. (10 to 20μ in length.)

Sample #3: Batch weighing room. Taken at 3:30 P.M.; 8 min. sampling time.

General air sample in batch weighing room area. No weighing was being done as time of sampling was close to the changing of shifts. Other normal activity was going on. Housekeeping in the area was in fair to good order and the general ventilation conditions were good. The dumping points of the dust storage bins into the weighing containers were each provided with exhaust systems. These exhaust points were checked by smoke tests and the suction was found to be only fair. During an inspection made earlier in the day visible amounts of dust were seen to escape into the general room air from the dumping points during weighing.

Dust concentration: particles per cu. ft. of air
8.4 million smaller than 10μ. (Most of the particles were 5μ or less in length.)
0.26 million larger than 10μ. (Near 10μ in length.)

Table 2 (Continued)

Sample #4: <u>Asbestos unbagging room</u>. Taken at 4:00 P.M.; 8 min. sampling time.
Exposure of workman in asbestos unbagging room. A complete cycle of work was done including opening a 200 lb. bag of amosite long-fiber asbestos, dumping it on a platform, feeding the riffle table and feeding asbestos into the hammer mill. The room was completely enclosed and was exhausted from two points in the ceiling. The door was open to admit bags of asbestos and intake air for ventilation. A visible cloud of dust in the air was present during the unbagging operation. Moderately heavy accumulations of fiber were present on the machine surfaces and walls throughout the room. During the unbagging operation the operator, who was stationed in the stream of air coming into the room, wore a filter-type respirator approved by the U.S. Bureau of Mines.

Dust concentration: particles per cu. ft. of air
6.9 million smaller than 10μ. (Most of the particles were 5μ or less in length.)
0.14 million larger than 10μ. (Near 10μ in length.)

Sample #5: <u>East finishing line</u>. Taken at 4:15 P.M.; 5 min. sampling time.
Exposure of workman while turning Kaylo structural tiles by hand on a conveyor belt located in the center of the finishing line. All adjacent tile smoothing operations were enclosed and were provided with exhausts. Moderate quantities of dust were raised when the man turned the tiles. The finishing line was located in the open plant area. Housekeeping was good.

Dust concentration: particles per cu. ft. of air
8.5 million smaller than 10μ. (Most of the particles were 5μ or less in length.)
0.46 million larger than 10μ. (Mostly 10 to 15μ in length; one was 100μ long.)

Sample #6: <u>Pre-hardener</u>. Taken at 4:45 P.M.; 10 min. sampling time.
Pre-hardener and tile pouring machine, B unit. General air sample of the area in which three men operated the unit. A wet slurry of Kaylo was poured into molds and then passed through a steam chest into the pre-hardener. A moderate amount of steam was in the atmosphere around the machine.

Dust concentration: particles per cu. ft. of air
2.2 million smaller than 10μ. (Most of the particles were less than 5μ in length.)
0.45 million larger than 10μ. (Up to 15μ in length.)

Sample #7: <u>Mixer balcony</u>. Taken at 4:55 P.M.; 10 min. sampling time.
General air sample in west end and center of the mixing balcony. Two men were doing their normal work. One man added lime, silica and cement to a mixer unit from several portable containers. All the mixer units were covered. Accumulations of dust from spillage were present on all the mixer units and on parts of the floor area.

Dust concentration: particles per cu. ft. of air
5.2 million smaller than 10μ. (Most of the particles were less than 5μ in length.)
0.00 million larger than 10μ.

Table 3

ANALYSIS OF SAMPLES OF ATMOSPHERIC DUST

Sample number	1A	2A	3A	4A	5A	6A	7A
	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Quartz	5-10	5-10	3-5	3-5	1-3	4-7	[illegible]
Diatomaceous earth	35-45	5-10	15-25	-	Tr.		[illegible]
Amosite	3-5	40-50	30-40	5-10	5-10	[illegible]	45-[illegible]
Chrysotile	-	?	2-3	5-10	1-2	2-4	
Chlorite	2-3	5-10	2-3	Tr.	1-2	Tr.	[illegible]
Carbonates	5-10	1-2	5-10	15-25	3-5	20-30	[illegible]
Kaylo (?)*	30-40	25-35	10-20	55-65	10-20	30-40	
Goethite	-		-	Tr.	-	Tr.	[illegible]
Ferric oxide	-	Tr.	Tr.	-	-	-	Tr.
Opaque	1-2	Tr.	5-10	-	Tr.	-	-
Organic fiber	-	Tr.	3-5	-	Tr.	-	-

*Clay-like masses like those found in the finished product Kaylo.

Notes: Sample 1A. Sample contained considerable diatomaceous earth.

2A. Fibers and bundles of amosite up to several cm. long.

3A. Much of the amosite was between 10 and 100 microns in length.

4A. The amosite occurred mostly as 20 to 100 micron fibers; a few bundles of amosite were noted. The chrysotile was present as partially opened bundles several hundred microns long.

5A. The bulk of sample #5 was an unidentified isotropic material with a low index of refraction. Possibly it was amorphous silica or a less porous form of Kaylo. Much of it occurred as rosette-like masses.

6A. The bulk of the fibrous material appeared to consist of fibers mostly 20 to 100 microns long; some were several hundred microns long.

7A. The amosite occurred as flexible fibers 20 to 100 microns long, also as bundles several hundred microns to several mm. long. Fibers shorter than 20 microns appeared less flexible than chrysotile. It is doubtful that much or any chrysotile was present in this sample.

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Table 4

DATA FOR SAMPLES OF ATMOSPHERIC DUST

Sample number	Weight of dust collected	Description of sample
1A	1.0	Collected in general weighing area from 10:00 A.M. to 4:30 P.M. (6.5 hrs.) on Jan. 31, 1951.
2A	2.9	Collected at asbestos tank from 10:15 A.M. to 4:30 P.M. (6.25 hrs.) on Feb. 1, 1951.
3A	0.2	General plant air sample collected from 8:25 A.M. to 3:30 P.M. (7.1 hrs.) on Feb. 2, 1951.
4A	2.4	Collected at finishing line from 10:30 A.M. to 4:30 P.M. (6 hrs.) on Feb. 5, 1951.
5A	2.9	Collected at router from 9:00 A.M. to 3:00 P.M. (6 hrs.) on Feb. 6, 1951.
6A	5.4	Collected in box car from 8:50 A.M. to 12:40 P.M. (3.8 hrs.) on Feb. 12, 1951 and while loading truck from 1:00 P.M. to 3:00 P.M. (2 hrs.) on Feb. 15, 1951.
7A	1.3	Collected in asbestos shredding room from 1:00 P.M. to 4:00 P.M. (3 hrs.) on Jan. 30, 1951.

NOTE: The samples of atmospheric dust for analysis were collected on a paper filter with a vacuum cleaner. The volume of air sampled was about 2400 cu. ft. per hour.