

Survey of the dust condition existing in the New Brighton plant of the U. S. Gypsum Co. Plant
at New Brighton, Staten Island

Made by the Saranac Laboratory
June 1 - 5, 1936



A survey of the dust condition existing in the New Brighton plant of the U. S. Gypsum Co. was made on June 1 - 5, 1936 by the Saranac Laboratory and the results are given in this report.

The products of the plant include land plaster (ground gypsum); calcined gypsum alone, as plaster of paris, or in mixtures such as cement plaster and sand plaster; gypsum building blocks; and gypsum wall board. The plant can produce approximately 300 tons of stucco (calcined gypsum) per day, of which about two-thirds would be calcined in long rotating kilns and one-third in ovens or "hot-beds". The block plant has a daily capacity of 30 tons of blocks and the board plant can make 100,000 feet of composition wall board each day.

The New Brighton plant extends along the Waterfront for one third of a mile and receives its raw materials (gypsum rock, sand) by boat. There are two kinds of raw gypsum rock : dark and white. The dark rock is discharged from the boat into storage silos from which it is withdrawn as needed and fed to a conveyor belt in a tunnel underneath the silos. After being carried to a crusher, where it is reduced to small size, the rock is passed through screens, calcined in long rotary kilns, ground fine in tube mills

and transported to the stucco bins for storage. From the bins the stucco is taken to the mixer and then to the stucco packer to be loaded into bags for shipment.

The silos are at the south end of the plant; near the north end are large bins for the storage of white rock. Farther on are the buhrstone grinders for grinding the rock fine and the "kettles" in which it is calcined. The "kettles" and rotary kiln calciners do not produce exactly the same type of calcined gypsum, because in the "kettles" the flame is generated from the charge while in the calciners the products of combustion and the charge are intimately mixed.

The warehouse occupies the middle portion of the plant on the side adjacent to the water. Here are located the machines for mixing and packing plaster, the stucco bins and the laboratory. Much of the warehouse floor space is used for storing bags of plaster. On the street side is the section of the plant in which are made building blocks and wall board.

Permissible Standards of Dustiness

It is generally conceded that the extent to which a hazard from silicosis or other form of pneumoconiosis might exist is indicated by the concentration in the industrial atmosphere of free silica or asbestos particles of respirable size. However, experience with mixed dusts, for instance silica and iron oxide, shows that the response of the body to inhaled silica is modified by the presence of the iron oxide. Animal experiments with artificial mixtures of quartz and calcined gypsum resulted in a delayed but typical reaction to the quartz. Apparently the protective action of the gypsum was a mechanical one, a clumping of quartz particles in-

to aggregates too large to be air-floated readily. Nevertheless, knowledge of the nature of mixed dusts is so limited that it is generally customary to make estimates of exposure on the amount of free silica in the air-floated dust and regard gypsum and other non-siliceous constituents as merely diluents. The evidence from the present and previous surveys in the gypsum industry strongly suggests that this assumption is not universally applicable.

A concentration of five million particles of free silica per cu. ft. of air has been tentatively suggested as a limit above which a silicosis hazard might exist. This value is for dust samples collected with the Greenburg-Smith impinger apparatus and counted by the standard light field technique of the U. S. Public Health Service. The light field method reveals particles which are larger than a minimum size estimated to lie between 0.7μ and 1.5μ . Since the impinger apparatus collects and retains the majority of particles much smaller than that limit, down to 0.2μ or smaller, a dark field method by which these smaller particles are made visible is also employed. There is no generally-accepted standard for safe dust concentration determined by the dark field method and it is used merely as an adjunct to the light field technique and as a guide in interpreting the general dust condition.

Good housekeeping standards demand that the amount of even apparently harmless non-siliceous dusts be kept within reasonable limits. A value of 100 million particles per cu.ft. of air (light field count) is sometimes given as a maximum concentration for any dust to which men are continuously exposed.

Dusts encountered in Plant

Although there is some variation in the composition of air-borne dust in the plant, the principal constituent is generally

raw or collated gypsum. The typical dusts up most of the dust at the work places, the equipment and tube mills, and the vibratory grinders. Collated gypsum dust predominates in the warehouse, the block plant and the board plant. Also suspended in the air of the warehouse are particles of sand, coal fiber, jute fiber, lime, organic materials employed as a retarder, and occasionally small amounts of substances such as asbestos and talc used in special plasters. Much of the dust set up when sand is unloaded from the boat is undoubtedly quartz, since that mineral is in excess in the sand. In the operation of shipping buhrstone a dust which is almost pure quartz is generated.

Quartz and sand (owing to its quartz content) can be classed as definitely hazardous. Asbestos also falls in the same category but so little is used that it can be neglected. Clinical and experimental evidence has led to the conclusion that the inhalation of gypsum dust is relatively harmless; in fact, there is some basis for the belief that it has a protective action by engulfing quartz particles into clumps which settle out of the breathing zone. The other kinds of dust mentioned are regarded as unlikely to cause any type of pneumoconiosis.

Dust Concentrations in Plant

Dust samples were collected with the Greenburg-Smith impinger apparatus used in previous dust surveys for the U. S. Gypsum Co. The dust particles were counted by the light field method of the Public Health Service and also with dark field illumination as recommended by some investigators. Counts for both methods are tabulated at the end of this report. Most of the samples were collected in 95 per cent alcohol; for a few 25 per cent alcohol was substituted so that only quartz and other insoluble particles would

remain undissolved.

Unloading raw material

Both gypsum and sand are received by boat. Dust samples for the unloading of gypsum could not be taken because no shipment of rock arrived during the survey. However, any dust raised would be principally gypsum and should not be harmful. Sand is unloaded by means of a bucket elevator which lifts the sand from the boat and discharges it on a conveyor belt in a small room. The dust concentration inside the room is quite high, being 160 million particles per cu. ft. of air. Since this dust is derived from sand which contains a large amount of quartz (by chemical analysis 50 per cent), it is dangerous. Therefore the man working in this vicinity should wear a respirator when inside the room; on the outside he is exposed to little dust because it is dissipated by the wind.

Transporting and calcining raw rock

Underneath the raw rock storage silos is a tunnel in which is the conveyor belt that transports raw rock to the crusher. The dust concentration in the tunnel was 30 million particles per cu. ft. of air. After being crushed the rock is lifted to the top of #3 building and then passes down through screens. One man works around these screens and the average concentration to which he is exposed was found to be 34 million particles per cu. ft. of air. The crushed rock is then calcined. There was only a moderate amount of dust around the calciners, the counts being 14 million for the calciner feed man, 13 million for the calciner fireman and 19 million for the tube mill operator.

Next to the "kettles" the dust concentration was 25 million

particles per cu. ft. of air. Much of this dust was from dust (ground gypsum) which was being loaded into cars nearby. Near the buhrstone grinders, where the rock to be calcined in the "hot-blow" is ground, the concentration of dust was less than 7 million particles per cu. ft. of air.

Chipping buhrstones

Buhrstones are nearly pure quartz and the chipping of them creates a dust that is definitely hazardous. The dust count for that operation was more than 17 million particles, a value which is above the safe limit. An exhaust system of dust removal was installed after the dust samples had been taken and it is believed that the concentration has now been reduced to a safe value.

Block and board plant

At the machine making gypsum blocks the dust concentration was 26 million particles per cu. ft. of air. For the board plant the dust counts were 9 million on the platform where the upper paper rolls are unwound and terra alba accelerator added; 19 million on the floor below where the semi-fluid gypsum is poured on the paper sheet; and 7 million near the machine cutting rocklath boards. Since the dust in these localities is principally gypsum, the foregoing concentrations cannot be regarded as hazardous.

Mixing and packing plaster

The mixing and packing of plaster produce concentrations of dust that are quite high, as shown below. (Cement plaster is nearly 99 per cent calcined gypsum and sanded plaster is about 78 per cent calcined gypsum and 21 per cent sand.)

Dust Concentration Produced by the Mixing and Packing of Plaster

Kind of Plaster	Light Field Dust Count	
	Mixing Plaster	Packing Plaster
Cement Plaster	431.9 million	448.1 million
Sanded Plaster	443.1 million	598.1 million

It appears that an exhaust system of dust removal reduces the dust concentration in the room by nearly one-half. Thus, the above counts of 443 and 598 million were for a packer with exhaust ventilation; counts for samples taken at the Oakfield plant near a motor packer without an exhaust system were 941 and 1025 million.

When dust is put in suspension when packing jute bags with land plaster, the light field count for that operation being 321 million and the dark field count having the extremely high value of 3317 million. The packing machine is equipped with exhaust ventilation but it is probably rather ineffectual because an opening in the back, left uncovered to allow weights to be changed, interferes with effective suction. This condition should be remedied and the full value of the exhaust system realized.

When packing 5 pound paper bags with plaster of paris is exposed to a concentration of 45 million particles per cu. ft. of air. This dust (calcined gypsum) as well as the land plaster (ground gypsum) packed in jute bags is not considered to be dangerous.

In a report of a recent survey made at the Oakfield plant on March 19 - 20, 1936 attention was directed to the dust condition associated with the mixing and packing of sanded plaster. It was observed that the hazard presented by those operations was less serious

than the total dust concentration alone would indicate because the proportion of particles in the air-Plaster dust is not the same as in the original mixture. The same condition has been found to prevail at the New Brighton plant. This is revealed by comparing samples collected in 25 per cent alcohol and in 95 per cent alcohol. In the former gypsum dissolves leaving only quartz and other insoluble particles, but in 95 per cent alcohol the gypsum particles do not dissolve. Counts for these samples are as follows;

Relative Dust Counts for Samples Collected
in 95 per cent and in 25 per cent Alcohol

Operation	Night Field Dust Count	
	25 per cent Alcohol Sample	95 per cent Alcohol Sample
Mixing Sanded Plaster	438.3 million	42.3 million
Packing Sanded Plaster	396.1 million	1.7 million

The count for mixing sanded plaster, 25 per cent alcohol sample, is higher than one would expect and may be due to the presence of many organic particles, such as animal fibers, in the air near the mixer. Weight is given to this explanation by the chemical analyses below, which show a higher ignition loss for the mixer sample than for the packer sample.

In order to obtain accurate knowledge of the composition of air-borne dust generated when sanded plaster was being mixed and packed, a suction motor equipped with a dust collecting bag was operated as described below.

Mixing Sanded Plaster

Motor was placed on top of scales, at breathing level, and operated for 40 minutes. Wt. of dust collected = 1.157 gr.

Packing sanded plaster

Lotor was suspended at breathing level, 4 ft. from man at Bates packer, and operated for 20 min. Wt. of dust collected = 0.150 gr.

Chemical analyses of the dust collected and also of sanded plaster ready for shipment were then made. The results are tabulated below.

Chemical Analyses of Sanded Plaster and Sanded Plaster Dust

	Sanded Plaster	Air-borne Dust	
		near mixer	near packer
Acid soluble material	33.6%	78.7%	78.4%
Acid insoluble material	62.5	5.0	10.8
Ignition loss below 210°	1.9	4.5	0.9
Ignition loss above 210°	2.0	11.3	9.9
	100.0	100.0	100.0
Total insoluble SiO ₂	56.8	3.5	5.4
Estimated free SiO ₂ (quartz)	50	2	3

These analyses of air-borne dust show that only a small fraction of the quartz in the sanded plaster mixture diffuses an appreciable distance into the surrounding air, either at the mixer or at the packer. This condition may be due to the large size of quartz particles or to the tendency of gypsum to form aggregates with the quartz. In either case the quartz would not be air-floated readily but would settle out.

From the above data it is evident that the mixing and packing of sanded plaster are operations which are not nearly so hazardous as they would appear to be. But neither can they be said to be entirely without danger. Packing sanded plaster produced a dust concentration of 596 million particles per cu. ft. of air; and about 3 per cent of the dust was quartz. If all particles were the same size there would be nearly 18 million quartz particles in a cubic foot of air. This would be a dangerous concentration. Undoubtedly the particles of quartz are larger than those of gypsum and therefore at concentration

tion of dust is less than 100,000. The low count of approximately 100 million insoluble particles for the 75 percent alcohol sample taken at the Bates pucker confirms this conclusion. Furthermore, the slumping action of gypsum probably reduces to a very low figure the number of quartz particles actually inhaled. This explanation may account for the apparent lack of silicosis among men mixing and packing sand plaster.

How Many Dust Particles

While moving Burlap sacks work in a high concentration of dust - 100 million particles per cu. ft. of air - which remains fairly constant. The dust is set free when the heavy doors are opened to an air lock which is the count for a 100 million per cu. ft. of air. The dust is 100 million. The dust is exposed to that high concentration of dust for a short time because there is much less dust in suspension while the bag wall is being filled. The dust is mostly gypsum with some jute fibers.

Miscellaneous

At intervals a man must go inside the stucco bins and scrape stucco into holes in the floor. Clouds of dust are raised by this operation, producing an exceedingly high concentration of 2,100 million particles per cu. ft. of air. Although the dust is all contained gypsum and therefore relatively harmless, it would appear desirable to work outside of feeding stucco which would not require a man to work inside the bin.

The count for a dust sample collected in a passageway on the third floor of the warehouse was about 14 million. This sample represents an average exposure of men trucking plaster.

Considerable dust is raised when motors are blown out

with compressed air, the light field dust count for the shop was about 2 million particles per cu. ft. of air. The dust count in the laboratory was about 1 million particles per cu. ft. of air. The men who blow out motors wear respirators and the dust count emphasizes the necessity of his continuing to do so, especially since the dust may contain many quartz particles.

The dust concentration in the machine shop was about 2 million particles per cu. ft. of air and in the laboratory it was about 1 million.

Summary and Conclusions

1. It is recommended that the concentration of free silica (quartz) dust to which men are exposed be kept less than 5 million particles per cu. ft. of air. It is urged that a serious effort be made to meet "good housekeeping" requirements so that no man will be exposed continuously to dust of any kind in concentrations greater than 100 million particles per cu. ft. of air. These values refer to light field counts.

2. The man helping unload sand from the boat should wear a respirator when he is inside the house over the conveyor belt.

3. Limestone chipping without an exhaust system appears to be hazardous. It is believed that the suction device recently installed may eliminate the hazard.

4. Mixing and packing plaster produce dust concentrations far above "good housekeeping" limits. When the plaster is a hard plaster, large amounts of quartz are used. An analysis of the air-floated dust shows that 15% to 20% quartz is suspended in the atmosphere. However, owing to the high dust concentration, even the

small percentage of quartz may be sufficient to control the dust. It is suggested that the person who is working in the area of the dust concentration, say 50 per cent, should be provided with an efficient exhaust system. If this is impracticable, the person should wear respirators.

5. The rates packer at which sand plaster is packed should be adjusted so that the filling of the bags to be changed without rendering the exhaust system ineffective.

6. The high concentration of dust encountered by people working in the vicinity of the bag should be reduced. More ventilation would help.

7. The men carrying sand should be provided with a mask to protect them from an extremely high dust concentration. It would seem possible to change the way of doing this work from carrying the bag.

8. Moving sand motors which are considered as dust, some of which may be quartz particles. A suction method of removing the dust will be preferable because then it would not be put in suspension in the air.

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Sample No.	Operation Represented	Location	Date and Sampling Time	Collecting Fluid	Remarks	Particles per cu. ft. of air - in millions		
						Light Field 7607e 10p	Dark Field 6070e (Condenser)	
1	Unloading sand from boat	Chute taken inside house where chute fed by elevator from boat discharges sand on conveyor belt	June 1, 1936 P 3:30 p.m. S 3:30 min.	90% Alcohol	Man in inside house about one-third of time; when outside for a little exposure because dust is blown away. dust. Man on boat not exposed to much dust. Good ventilation inside house; door 6 feet away open.	0.01	169.7	333.3
2	Working in tunnel under silos	Sample collected at breathing level 30' inside tunnel and next to conveyor belt	June 4, 1936 P 10:08 p.m. S 10:00 min.	"	Hook was being disconnected from chute 30' further on in tunnel. Moderate draft of air.	0.30	22.0	61.2
3	Working over rock screens at top of ID building	Sample taken at breathing level in middle of floor to represent average location; near place where man shovels crushed rock into chute	June 2, 1936 P 11:36 p.m. S 11:30 min.	"	Man is on this floor most of time; on floor below near line some of the time. Good ventilation.	0.86	31.9	71.6
4	Celestine feed man	Sample taken at bin at end of onlifter; this represents an average location for man	June 3, 1936 P 11:10 p.m. S 11:00 min.	"	Good ventilation	0.20	14.2	23.3
5	Celestine fireman	Sample held at breathing level on platform in front of celestine cages.	June 2, 1936 P 10:26 p.m. S 10:20 min.	"	Celestine fireman here hourly all of the time. Good ventilation.	0.03	13.3	34.7

Sample No.	Operation Represented	Location	Date and Sampling Time	Collecting Fluid	Remarks	Particles per cu. ft. of air (in millions)		
						Light field	Dark field	(plankton counter)
6	Tube mill operator	Sample collected at breathing level, 4 min. on tube mill floor and 4 min. on conveyor floor, over area covered by tube mill operator.	June 1, 1936 P 10.35 p.m. S 10.38 10 min.	90% Alcohol	Both tube mills and belt mill in operation Good ventilation	0.14 above 10μ below 10μ	18.0	71.6
7	Working at battery	Flask held at breathing level, in front of furnaces	June 2, 1936 P 11.50 p.m. S 11.40 10 min.		7 report of early use of dust mask in stream of lead plaster for plaster into cans, such dust reduced by this. Good ventilation.	0.07 above 10μ below 10μ	5.3	4.4
8	Turning buhrstone grinders	Sample taken off-sette and 2' from the middle one in a row of buhrstone grinders	June 2, 1936 P 9.45 p.m. S 9.40 8 min.		Good ventilation; open window 10' away	0.03 above 10μ below 10μ	6.0	2.0
9	Chipping buhrstones	Flask held 1' from men chipping buhrstones	June 2, 1936 P 3.00 p.m. S 2.40 10 min.		Strong drafts of air through open door 6' away and open window 10' away. Exhaust from air heater blows chips away from men. Ten chips buhrstone 1/4 of time, rest of time tends buhrstone grinders.	0.04 above 10μ below 10μ	17.0	6.0
10	Working at block machine	Sample collected at breathing level, 1' from block machine, between men working at machine.	June 2, 1936 P 8.30 p.m. S 8.10 10 min.		Poor ventilation	0.05 above 10μ below 10μ	24.0	10.4

Sample No.	Operation Represented	Location	Date and Sampling Time	Collecting Fluid	Remarks	Particles per cu.ft. of air (in million)		
						Light fluid	above 10μ	below 10μ
11	Torking in board plant at paper rolls	Sample taken on platform belt, 4' from upper paper rolls, at positions near paper roll and 4' from belt to represent an average condition.	June 3, 1936 P 10.30 a.m. S 10.30 10 min.	90% Alcohol	Take air (hand plaster) added to the mix in small lots on this floor. Good ventilation	0.04	0.0	0.0
12	Feeding semi-fluid green to board machine	Sample collected at breathing level, 1' from operator, at place where semi-fluid gypsum is poured on paper sheets.	June 1, 1936 P 3.00 p.m. S 3.00 10 min.	"	Good ventilation; open window away.	0.12	19.7	7.0
13	Cutting off rocklike boards	Sample taken 2' from machine cutting rocklike boards in two, 2' from stand on which boards are stacked.	June 3, 1936 P 11.40 a.m. S 11.30 10 min.	"	Miner man working in this vicinity. Very good ventilation; open window away.	0.04	6.5	15.1
14	Mixing cement plaster (filled)	Flask held at breathing level 4' from hopper at about middle of area covered by men.	June 1, 1936 P 9.40 a.m. S 9.40 10 min.	"	Two men working near mixer. Fair ventilation; open window and door 30' away.	1.0	431.0	770.3
15	Mixing sand plaster	Sample collected at position occupied by men filling mixer (near hopper and scales)	June 1, 1936 P 11.40 a.m. S 11.40 10 min.	"	Cover on hopper open most of time. Floor is below floor level. Little ventilation.	1.90	323.1	942.7
16		Sample taken in front of hopper	June 3, 1936 P 3.40 p.m. S 3.40 10 min.	"	Little ventilation.	1.10	360.5	600.0
17			June 3, 1936 P 3.00 p.m. S 3.00 10 min.	90% Alcohol	There is sample #14 except that collecting fluid was 90% alcohol	0.1	7.0	35.0

Sample No.	Operation Represented	Location	Date and Sampling Time	Collecting Fluid	Remarks	Particulate per cu. ft. of air (in millions)		
						Light	Violo	Dark Violo (Plankton Condenser)
18	Packing cement plaster (filled)	Plank held at breathing level midway between two men packing cement plaster at Bates packer.	June 1, 1936 P 9.08 a.m. S 9.00 10 min.	95% Alcohol	Machine has exhaust system of dust removal. Two men each loading 3 bags work at packer. Good ventilation; open door 30' away.	2.33	440.1	1067.0
19	Packing sanded plaster	Plank held about 1' from head of man operating Bates packer.	June 1, 1936 P 1.30 p.m. S 1.30 10 min.	"	Machine has exhaust system of dust removal. Little ventilation; open door 40' away.	3.04	536.1	2004.7
20	"	"	June 1, 1936 P 2.00 p.m. S 2.00 10 min.	25% Alcohol	Same, as sample #19 except that collecting fluid was 25% alcohol.	0.14	6.7	24.4
21	Packing sand plaster in jute bags	Sample collected at breathing level 1 - 2' from man at Bates packer.	June 3, 1936 P 1.00 p.m. S 1.46 10 min.	95% Alcohol	Machine has exhaust system. Open door at back for convenience of operator in changing bags; random system rather ineffectual. Little ventilation.	5.00	1021.7	2117.2
22	Packing plaster of paris in 5 lb. bags	Sample taken between machine packing 5 lb. bags with plaster of paris and machine sewing them.	June 6, 1936 P 1.05 p.m. S 1.50 10 min.	"	Four men work here. Good ventilation.	0.11	40.2	172.2
23	Sewing burlap bags	Plank held at breathing level 2' from girl sewing bags. Girl 8' away, stamping and wiring bags, exposed to less dust.	June 1, 1936 P 10.30 a.m. S 10.30 10 min.	"	No exhaust system of dust removal. Fair ventilation; open window 10' away	1.31	400.8	244.0

Sample Operation No. Represented	Location	Date and Sampling Time	Collecting Fluid	Remarks	Particles per cubic foot of air (10:1 dilution)		
					Light field above table top	Dark field (Fluorescence)	Dark field (Fluorescence)
24 Working at Bag wheel.	Sample taken in passageway 18' from closed room where bag wheel was shaking burlap sacks.	June 2, 1936 P 4.30 p.m. S 4.48 10 min.	95% Alcohol	Can work part of time filling bag wheel, part of time in passageway when bag wheel is running. Little ventilation; some circulation of air through open door.	0.00	0.00	400.0
25 Working in stucco bin.	Plank held at breathing level, 5' inside stucco bin, close to men scraping stucco into holes in floor.	June 3, 1936 P 1.10 p.m. S 1.15 10 min.	"	Heavy clouds of dust r lead occasionally by falling stucco. No ventilation. Very hot.	8.07	2,171.0	17,617.0
26 Trucking on 3rd floor of warehouse	Sample taken in passageway where electric trucks carrying sacks are passing.	June 4, 1936 P 6.38 p.m. S 6.30 10 min.	"	Latex packer 20' away loading burlap bags. Good ventilation.	0.11	15.7	90.6
27 Blowing dust out of rotors with compressed air.	Plank held close to men blowing out rotors (1' away for one-third of sample, 3' away for remainder).	June 4, 1936 P 2.33 3/4 p.m. S 2.30 3 3/4 min.	"	One small and one large motor blown out. Men wore respirator.	10.30	327.7	300.3
28 In machine shop.	Sample collected at breathing level in middle of machine shop near planer.	June 1, 1936 P 1.54 p.m. S 1.40 14 min.	"	Fair ventilation	0.01	2.4	9.1
29 In laboratory	Sample taken inside laboratory 5' from door which was nearly closed.	June 4, 1936 P 4.05 p.m. S 4.15 10 min.	"	Good ventilation; open window in opposite wall 20' away.	0.07	6.1	20.3