THE MANHATTAN RUBBER MFG. DIVISION

OF

RAYBESTOS-MANHATTAN, INC.

Passaic, N.J.

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A study of the health hazards, if any, incident to the inhalation of dust and fumes at the plant of the Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc. at Passaic, N.J. was made between September 24, 1934 and November 1, 1934 by the Industrial Health Section of the Metropolitan Life Insurance Company.

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Exhibit A

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PLANT CONSTRUCTION

This plant consists of a number of buildings constructed of brick, concrete and steel. The ground floors are of concrete and the remaining floors are of wood.

Natural illumination is furnished by clear glass windows. Artificial illumination is furnished by incandescent electric lights equipped with reflectors.

PLANT PROCESSES

Products manufactured in this plant involving the use of asbestos are: brake lining, brake blocks, and clutch facings.

Three types of brake lining are made. These are lining made from woven asbestos cloth, dry process lining, and wet process lining.

The asbestos cloth is made outside of this plant. The cloth is treated with rubber, cut into strips and folded to the size desired. The folding is done in Department 36 on machine #1513. This lining is cut to length in Department 8 on machine #1382. The dry process lining is made from a mixture of asbestos, rubber, resin, litharge and cotton. The mixture is made up in Department 53T in a rotary mixer. Canadian asbestos is used. The asbestos as received is put through a hammermill and then through a picker and over a shaker screen. The other materials are kept in containers. After the mixture is completed, it is taken to Department 53. The mixture is weighed and pressed into sheets in a heated press. Several of these sheets are heated in a press for a given time. The sheets are then cut into strips to the desired width on a mill planer. The strips are ground to the desired thickness in Gardner surface grinders. They are then cut to length and formed to a given radius in a heated press. Holes are drilled in the lining on a gang drill machine. The ends are chamfered on abrasive wheels. The lining is inspected and packed for shipment.

The wet process lining is made from a mixture of asbestos, rubber, litharge and waste material from the finished product of Department 53. This mixture is made up in Department 53T. The different materials are kept in containers in stalls. A movable scale is equipped with an exhaust system so arranged that two stalls and the scale are exhausted at the same time. When the materials from the two stalls are weighed, the scale is moved to the next two stalls. The workman weighing out these materials is very careless in the handling of the lead used. He uses a hand scoop and manages to get the lead on his hands and clothes and on the floor. He wears a Willson silica respirator.

Gasoline is used as a solvent for the rubber. The mixing is accomplished in a mixer with rotating paddles. The material is then taken to Department 53 where it is formed into strips by means of an hydraulic press and a mold. The strips are dried in heated presses, ground to size in the Gardner Grinders and cut to length with an abrasive wheel. The lining is then formed on heated mandrels to the desired radius. Holes are drilled and the corners are chamfered. The lining is inspected and packed for shipment.

The brake blocks are made from a mixture of asbestos, rubber, resin, lead, etc. This mixture is made in Department 53T. The blocks are formed in heated molds and in a steam press in Department 52. The blocks are then turned to size on a lathe and cut to width on a band saw. They are finally put into a sandblast cabinet and the surfaces are blasted. Holes are drilled and the finished block is inspected before shipment.

Dry process clutch facings are made from a mixture of asbestos, rubber, lead, resin, sulphur, carbon black and waste from Department 39. These materials are mixed in Department 53T in a rotary mixer and the mixture is carted to Department 39. The material is weighed and the clutch facings are formed in heated molds and presses. The facings are then ground to the desired thickness, holes are punched, and the facings are inspected before shipment.

One cloth type clutch facing is made from woven asbestos cloth treated with rubber. The cloth is folded and circled on a coning machine. The folded cloth is cut and the ends are fastened together. The facing is then put into heated molds and pressed in a steam press. After coming from the molds, the facing is ground to the thickness desired and holes are punched.

The other type of cloth clutch facing is made by punching the rubber treated cloth to size and then putting several thicknesses into the molds. The separate pieces are molded together and then they follow the same processes as the other facings.

The base stock of the rubber used throughout the different departments is compounded in Department 1. The raw rubber is received in wooden boxes and stored on the third floor of the building. As the rubber is needed, the boxes are opened and the mass of rubber from each box is placed in a power cutter that cuts the rubber mass into six pieces. These pieces are carried on a conveyor to the second floor where they are weighed into mixes for different base stocks along with different compounding materials.

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In some of the products the rubber must be free from any foreign matter. The raw rubber is put through mills and then put through a machine to take out foreign matter.

The compounding materials such as litharge, zinc oxide, sulphur, rosin, clay, and oils are kept in a row of hoppers and tanks that discharge on the first floor. A traveling scale is mounted on a small track that runs under the length of the row of hoppers. The batches of compound are weighed into open containers as desired for the different bases.

The hoppers are filled from the second floor. Some of the materials are sifted through a shaker screen before entering the hoppers. The litharge (D-70) is received in metal drums. It is dumped from the drums through a grating into a bin. This dumping is done in a small corrugated iron shed located on the north side of the storage building and receiving department. An open belt conveyor carries the litharge to the second floor of Department 1 where it enters the hopper. A cloth screened box is used to allow the air to escape from the hoppers and keep the litharge dust from the atmosphere. One man does the dumping and wears a Willson Dustite respirator.

Two Banbury mixers and six compounding mills are used to make up the various base stocks. As the rubber comes from the compounding mills, it is placed on a conveyor and carried to the center of the building where two colored men remove it, dust it with soapstone and stack it onto skids. Each base is tagged and finally stacked into open racks until needed or taken directly to the department where it is to be used.

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Molded rubber products are made in Department 4. The base stock is reworked in rubber mills. It is cut into strips and put in tube machines that produce solid strips. These strips are cut into pieces and placed in metal molds. The molds are heated and pressed for a certain time, setting the rubber to the shape of the molds. The molds are stripped and the finished rubber is trimmed and inspected before packing for shipment.

Rubber bonded abrasive wheels are produced in Department 2. The base stock rubber is melted and mixed with asbestos, litharge, carbon, sulphur and abrasive materials in an open container. A colored man does the weighing and mixing. He does not wear a respirator while handling the dry materials. The mixture is molded to the desired sizes in molding machines. The molded wheels are then put into ovens where the solvents are driven off and the wheels set. The wheels are trued on lathes and grinders. These machines are exhausted. The smaller wheels have Babbitt centers. These centers are poured from a hand ladle. The Babbitt is melted in a pot under an exhausted hood.

Large rubber sheets used for flooring and floor protection are made up in Department 26. The base stock is rolled to the desired thickness and put into large heated presses where the rubber is cured or set. Mats of various designs and colors are made by cutting out sections and inserting or inlaying sections of different shapes and colors.

Rubber tubing is made in Departments 5, 51, 6, 21, and 74. Tubing is produced for various purposes and of various sizes. The base stock is usually reworked in each department before entering the tube machines where the tube is produced. The tubes are cured on metal rods to give the desired inside diameters. The tubing is dusted with soapstone, wheat flour or rice flour as it comes from the tube machines to keep it from sticking to adjacent tubing.

In some cases the tubing passes through braiders where a fabric covering is braided around it. Departments 7A and 6 do this type of work. Some types of tubing have various layers of fabric. This is accomplished by wrapping the tubing with cloth impregnated with rubber and allowing the rubber to set at the same time. The rubber of the cloth and tubing join together and the result is a solid tube with layers of fabric. This type of tubing is much stronger than plain rubber tubing.

The V type belts are made of a solid rubber core with a fabric covering. This fabric covering is applied to the core and cured in heated molds to assure the shape and size desired.

Flat belts are made of cloth impregnated with rubber. The cloth is folded mechanically and cured on heated mandrels, the edges being sealed together by a strip of rubber applied after the folding process. In the case of long belts the curing is accomplished in heated presses.

In Department 54 metal pipes, pipe joints and tanks are lined with rubber. The rubber is applied over a coating of rubber cement in thin layers to the desired thickness. This is uncured rubber and is applied with hand rollers. After the rubber is in place, it is cured in heated tanks making a solid rubber lining out of the several layers applied.

In Department 5 rubber tubing of various sizes is cut to length and placed on mandrels in lathe grinders. The outside diameter is ground to the size required. Other products are ground to size in this department also.

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Wool scouring rings and Minturn Vacuum dryer strips were ground at the time of the survey.

Grinding of rubber rolls of large dimensions, such as paper mill rolls, is done in department 28. The majority of these grinding machines have exhaust systems.

PERSONAL FACILITIES

Drinking water is supplied throughout the plant by bubbler fountains of the electrically cooled type. Wash rooms and toilets are adequate and are kept clean.

PLANT HOUSEKEEPING

Housekeeping is good in most departments. At the time of this survey portable vacuum cleaners were used in cleaning the rafters before painting.

METHODS OF SAMPLING AND ANALYSIS

Atmospheric dust and fume samples were taken with the impinger (1 & 2) at the breathing zone of the workmen at representative operations. This instrument, developed by the United States Public Health Service, is the standard method used in this country. Air is drawn in through a glass tube at the rate of one cubic foot per minute. The tube ends in a constricted orifice under the surface of distilled water contained in a flask. The air passes through the orifice and impinges upon a glass plate which breaks up the air stream, allowing the dust particles to be wet and entrapped in the water in the flask.

Alcohol is added to the sample as a preservative to inhibit the solution of the fine silica particles and also to prevent the formation of aggre-

(1) Comparative Tests of Instruments for Determining Atmospheric Dusts, Public Health Bulletin #144, U.S. Public Health Service, Treas. Dept. Wash. D.C. Jan. 1925.
(2) The Impinger Sampling Apparatus as Used by the U.S. Public Health Service, Public Health Reports, March 18, 1932, Vol. 47, U.S.P.H.S., Treasury Dept. Wash. D.C.

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ates of the fine particles by clumping.

Suction is supplied for drawing the air sample through the impinger y means of an ejector, or else an electrically driven pump where compressed air s not available to actuate the impinger.

The dust counts were made by the methods and technique developed and used by the United States Public Health Service. Particle size measurements were made of the dust by a direct projection method. The results are tabulated and appear in the graphs attached at the rear of the report. It will be noted that from 87 to 95.1% of the particles are less than 10 microns in greatest diameter.

The following table gives the results of analyses of air samples taken at representative points.

No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Millions of Dust Particles less than 10 microns in greatest diameter per cu. ft. air sampled	Milligrams of Lead per cu. ft. air sampled	Milligrams of Lead per cu. meter of air sampled	Lead Intake in Milligrams in 10-hour day on basis of workman breathing 10 cubic meters of air daily	Type of Dust	Remarks
1.	[illegible] surface [illegible] machine #2047	9/24/36	37.0	1.4	1.3	0.0009	0.03	0.3	Asbestos lead	Dry process brake linings; exhaust system
	At planer – cutting brake lining out of pressed sheet	"	38.4	1.4	1.3	0.0009	0.03	0.3	"	Exhaust system; one man
	Grinding dry process lining to width, side grinder, machine #1784	"	39.9	1.5	1.4	0.0010	0.04	0.4	"	Exhaust system; door open at time of sampling; one man
	Scouring at bending unit; wet process lining after taken from heated mandrel	"	3.5	16.0	14.4	0.0030	0.10	2.0	"	3 men
	General air; inspecting brake lining	"	38.4	1.8	1.6	0.0021	0.07	0.7	"	3 men
	Chamfering ends of brake lining with abrasive wheel	9/21/36	38.2	1.7	1.5	0.0009	0.03	0.3	"	1 man; exhaust system; machine
	Cutting wet process lining to length with abrasive wheel		38.0	1.8	1.6	0.0023	0.07	0.7	"	1 man; exhaust system
	At Gardner surface grinder #[illegible] machine #1318, dry process brake lining	"	35.0	2.9	2.6	0.0026	0.09	0.9	"	1 man; exhaust system
	Grinding inside surface of dry process lining	"	19.3	2.8	2.5	0.0020	0.01	0.3	"	Horizontal stands; one man; [illegible] system
	At surface grinder #1848 continuous process; wet process lining	9/23/36	39.5	1.9	1.7	0.00098	0.033	0.33	"	At discharge only exhaust system
	Gardner grinder #1277 wet process lining on rolls, grinding edges	"	38.0	2.7	2.4	0.0019	0.07	0.7	"	Lining goes through this grinder before going into grinder #18[illegible]; exhaust system
	Weighing and pressing dry process lining	9/24/36	34.0	1.7	1.5	0.0033	0.12	1.2	"	One man; exhaust hoods
	Dept. A: General air; trimming and inspection of molded rubber products	9/23/36	38.0	1.6	1.4	0.0009	0.03	0.3	Rubber lead	
	General air; steam press room	"	35.0	1.8	1.6				Rubber	Molding rubber products
	Pouring and cooling compounded rubber	"	33.2	2.4	2.2				Rubber	Two men
	Dept. 33: General air; typewriter platens	9/24/36	44.9	1.8	1.6	0.0021	0.07	0.7	Rubber	
	Dept. 34: Pouring rubber tubing from tubing machine	"	38.5	3.0	2.6				Soapstone	Two men
	At rubber compounding mill	9/23/36	38.3	2.9	2.6	0.0026	0.09	0.9	Sulphur, zinc, [illegible], wheat flour, hydrocarbons, zinc oxide, lead (at times)	
	Dept. 35: At sandblast cabinet blasting molds for clutch facing	9/24/36	37.3	1.8	1.6				Sand	Dust bag leaks from cabinet
	Grinding clutch facings, Badger grinder	"	39.4	1.9	1.7				Asbestos	Two-way exhaust system

Sample No.	Location	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Millions of Dust Particles less than 10 microns in greatest diameter per cu. ft. air sampled	Grams of lead cu. ft. air sampled	Milligrams of lead per cu. meter of air sampled	[illegible]	Dust	[illegible]
[illegible]	Grinding clutch facing, [illegible] machine	[illegible]	[illegible]	[illegible]	[illegible]				Asbestos, rubber	[illegible]
[illegible]	[illegible] clutch facing [illegible] of asbestos cloth [illegible] with rubber	*	[illegible]	[illegible]	[illegible]					[illegible]
[illegible]	[illegible]	*	[illegible]	[illegible]	[illegible]				*	
	[illegible] inspecting clutch facing	*	[illegible]	[illegible]	[illegible]				*	[illegible]
	[illegible] and [illegible] for clutch facing	*	[illegible]	[illegible]	[illegible]				*	[illegible]
[illegible]	Grinding clutch facing on surface grinder [illegible]	*	[illegible]	[illegible]	[illegible]				*	[illegible]
[illegible]	At operator's position on facing machine - cloth [illegible]	[illegible]	[illegible]	[illegible]	[illegible]				*	
30	Dept. [illegible] General air	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	Dept. [illegible] batch weighing and mixing for abrasive wheels, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	At [illegible] pots [illegible] for [illegible] of abrasive wheels	*	[illegible]	—	—	[illegible]	[illegible]	[illegible]	Lead	[illegible]
[illegible]	Grinding burrs on abrasive wheels, machine [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Truing outer diameter of abrasive wheels, lathe [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	*
[illegible]	Truing and smoothing sides of abrasive wheels, lathe [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	*
[illegible]	Truing abrasive wheels machine [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	*
[illegible]	[illegible] mixing for abrasive wheels	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Abrasive wheel molding machine [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]	Truing abrasive wheels machine [illegible]	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	General shop cut-off wheel room air conditioned	*	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
[illegible]	General shop mixing material for abrasive wheels and molding wheels	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	Dept. [illegible] dry mixture taken from mixer on chute and put into box cart	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Weighing up rubber for wet process mix	*	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
[illegible]	Weighing up asbestos for wet process mix	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	In mixing room during mixing up of mix for clutch facings dry process	*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	In small room of bottom- [illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
					[illegible]				[illegible]	
									[illegible]	

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Millions of Dust Particles less than 10 microns in greatest diameter per cu. ft. air sampled	Milligrams of lead per cu. ft. air sampled	Milligrams of lead per cu. meter of air sampled	Lead Intake in Milligrams in 8-hour day on basis of persons breathing 10 cubic meters of air daily	Type of Dust	Remarks
47	Between two bagging operations	10/20/31	39.4	3.3	3.1				Asbestos	Enclosed and exhausted cloth curtains on frames
48	Dept. 2: General air east end	"	30.0	2.6	1.7	0.0010	0.035	0.35	Lead rubber	Near bolting cloths
[illegible]	Cutting brake lining to length, power shear (#143)	"	30.9	3.2	3.0				Asbestos rubber	2 men, asbestos cords cloth treated with rubber
	General air second floor	10/27/31	31.4	1.9	1.8	0.0031	0.11	1.1	Lead	
51	Dept. 2-D: General air belt press room	10/20/31	39.4	2.0	1.7	0.0021	0.08	0.8	Lead asbestos rubber	
52	Grinding, cutting and scouring brake lining	"	38.4	2.0	1.1				Asbestos rubber	Machines (#[illegible]) and [illegible]
49	Dept. 25: General air tubes at press #16	"	40.0	4.0	4.3	0.0024	0.09	0.9	Lead rubber	
50	General air tubes at gum cutting tables east end	"	30.0	4.0	2.6	0.0030	0.11	1.9	Lead rubber	
[illegible]	General air near [illegible] (#127)	"	30.0	2.4	2.2				Soapstone	
90	Dept. 1: General air rubber mills, east end	"	40.1	3.3	3.2	0.0030	0.11	1.1	Talc rubber	Cleaning process for gum rubber, nothing added, machines #131 and 134
96	At rubber compounding mill #130	10/23/31	31.0	1.9	1.4	[illegible]	0.06	0.6	Lead, sulphur whiting, rubber — one man	
97	At rubber compounding mill #140	"	30.0	1.6	1.5	[illegible]	[illegible]	[illegible]	"	"
98	On platform of Banbury mixer #1	"	40.2	2.3	2.0	[illegible]	[illegible]	[illegible]	Lead, whiting, sulphur, soapstone, rubber	One man, intermittently, air charged by hand
99	On platform of Banbury mixer #2	"	41.9	2.2	1.9	0.0275	0.97	9.7	"	Mix charged from 3rd floor
60	Between compounding mills #129 and #130	"	31.6	3.2	2.9	0.0024	0.09	0.9	"	One man at each mill
61	Mixing batches of compound from hoppers	"	30.0	10.2	10.2	[illegible]	[illegible]	[illegible]	"	Travelling scale on track under hoppers; one man
62	General air in compound mixing room	"	39.1	5.0	5.3	[illegible]	[illegible]	[illegible]	"	Three men
63	Discharge of rubber conveyors from compounding mills	"	37.3	4.4	4.0	[illegible]	0.04	0.4	Soapstone lead	Two men dusting with soapstone and putting on skids
64	General air 2nd floor weighing stock for Banbury mixer	"	30.3	1.7	1.6	[illegible]	[illegible]	0.6	"	Dry sweeping
70	Cutting raw rubber, press room, 3rd floor, machine #1061	10/24/31	30.0	1.1	0.96				Rubber	One man
100	Dumping D-70 into hopper through gratings taken under respirator	11/6/31	10.4	--	[illegible]	[illegible]	[illegible]	[illegible]	Lead	Outside storage building in [illegible] from [illegible] Dustite respirator
101	2nd floor at discharge end of conveyors taken while bringing D-70 to hopper	"	30.0	--	—	[illegible]	[illegible]	[illegible]	"	[illegible]
66	Dept. 11: 18 rubber mill #14	10/20/31	31.6	2.0	1.9	[illegible]	[illegible]	[illegible]	Lead rubber	

Sample No.	[illegible]	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Millions of Dust Particles less than 10 microns [illegible] per cu. ft. air sampled	Milligrams of lead per cu. ft. air sampled	Milligrams of lead per cu. meter of air sampled	[illegible] one breathing 10 cubic meters of air daily	Dust	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.77					[illegible]
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Lead is present in most of the processes in combination with a number of other substances, but with the exception of lead, these substances are not in large enough quantities to be hazardous. Asbestosis will be discussed in general report.

TOXICITY OF LEAD

Lead poisoning is the commonest of the industrial intoxications. The toxicity of lead depends upon a number of factors such as: the form of lead taken into the body - vapor, dust or solid; the solubility of the lead compound in human tissues; the mode of entry of lead into the body - inhalation, ingestion or skin absorption; the extent of exposure; individual susceptibility which is heightened by numerous conditions particularly by previous attacks of poisoning.

Among the most readily toxic of the inorganic lead compounds are the oxides, the carbonate, the sulphate and the chromate.

Lead is a cumulative poison and, with a few exceptions, industrial lead poisoning is usually a chronic condition caused by the inhalation or ingestion of small amounts of soluble lead over long periods of time. This process of poisoning may go on slowly for a long period without manifesting any of the characteristic acute symptoms. Lead inhaled, however, is far more rapidly and surely toxic than lead ingested, since it reaches the blood stream more directly and comparatively little is eliminated unabsorbed.

There is little agreement in the estimates made by various authorities on the minimum amount of lead which can cause poisoning if taken into the body. For practical guidance, however, it can be assumed that from 1 to 2 milligrams taken in daily over a period of months or years may cause poisoning. A number of factors also enter into the estimation of the amount of air breathed by a man at active work during the working day. Ten cubic meters of air in a ten hour day is an estimate which very probably errs on the safe side for the average workman. On the basis of these calculations, the lead content of the air of workrooms where men are continuously exposed should be kept as low as 0.1 of a milligram per cubic meter of air or else strict measures for protection should be installed to prevent poisoning.

The symptoms of chronic lead poisoning are many and may manifest themselves through the gastro-intestinal tract as in the familiar "lead colic" or the neuro-muscular system or both. Among the symptoms most commonly noted are colic, metallic taste in the mouth, obstinate constipation and loss of appetite, muscular weakness, particularly of the hands and wrists, neuritis and joint pains, loss of weight, headache, dizziness, nausea or vomiting, gastric distress or fatigue are among the minor symptoms that may or may not be present.

The principal diagnostic signs for the detection of lead poisoning in its early stages or of lead absorption, which is essentially pre-clinical poisoning before the onset of symptoms, are ashen pallor of the skin, tremor, lead line on the gums, stippling or basophilic degeneration of the red blood cells, hematoporphyrin in the urine and mild secondary anemia. Other abnormalities in the blood which are characteristic of lead poisoning are polychromatophilia, changed relative proportions of lymphocytes and polymorphonuclear leukocytes, increased mononuclear cells and increased reticulocytes.

Repeated physical examinations should be made of workers exposed to lead at fairly short intervals of from two to six months, depending upon the severity of exposure. It is important to prevent the occurrence of lead poisoning, since, even though it is not often fatal under modern conditions, it frequently results in premature development of chronic degenerative conditions in the circulatory system.

The physiochemistry of lead poisoning and the treatment to be pursued have been the subject of intensive experimentation and study by Aub[3] and his associates at the Harvard School of Public Health and by Kehoe[4] and his colleagues of the University of Cincinnati.

(3)Lead Poisoning; J. C. Aub, et al; Williams and Wilkins, Baltimore, Md. 1926, pp. 265.
(4)On the Normal Absorption and Excretion of Lead, I-IV, R. A. Kehoe, F. Thamann, J. Cholak, Journal of Industrial Hygiene, Sept. 1933.

CONCLUSIONS AND RECOMMENDATIONS

The dust counts are low with the exception of sample #4 in Department 53. This concaving and bending unit is not exhausted. Although this operation is intermittent, precautions should be taken to eliminate any hazard by adequately entrapping and exhausting the arising dust.

Samples #26 and #34 in Department 2 and sample #61 in Department 1: these operations should be done under exhausted hoods to prevent the dispersion of dust throughout the rooms. The operator at these and all other batch mixing operations should be taught and compelled to handle the materials carefully to prevent the spilling of the materials on their clothing and on the floors.

Samples #87 in Department 5 and sample #88 in Department 6: careful handling of the soapstone and flours used and proper application of exhaust hoods over the pans and at the discharge ends of the tube machines would greatly reduce the dust concentration created at these points.

It will also be noticed that where there is an increase in dust counts and where lead compounds are present, as in samples #4, #26, #34, #61 and #88, there is a considerable increase in the concentration of lead compound in the air. The elimination of dust at these points would also tend to eliminate the lead compound concentration.

In addition to the samples listed in the preceding paragraph, the following were found to contain excessive amounts of lead: sample #41, Department 53; samples #30, #31 and #36, Department 2; samples #39 and #43, Department 53T; sample #76, Department 28; samples #82 and #84, Department 5. Although these operations are exhausted, they show an excess of lead concentration which may be due to the fact that the hoods are not properly placed or the suction is not adequate to remove the arising dust.

Sample #50, Department 26: If possible, exhaust should be applied to gum cutting operations to eliminate the lead concentration.

Samples #53, 57, 58, 59, 60 in Department 1: The Banbury mixers and rubber compounding mills where lead compounds are used should be exhausted to eliminate the lead compound dust generated. The pollution of the air at the east end of the department where the raw rubber is cleaned is probably due to the Banbury mixers and compounding mills located near this section. The operators should be warned to handle the lead carefully.

Sample #102, Department 1: This sample was taken under the respirator of the workman while he was dumping drums of litharge through a grate onto a belt conveyor which conveys the litharge to the hoppers. A mechanical means should be installed, if possible, for the dumping of litharge at this place or the workman should be supplied with a positive pressure respirator and an exhaust hood applied properly. It was noted that clouds of litharge were blown from the shed and platform and there is a possibility that this lead would be carried into adjoining buildings. This would create an unnecessary hazard.

Sample #103, 2nd floor, Department 1: The lead concentration at this point was excessive. An exhaust should be applied to the open belt conveyor and at the hopper end to prevent the pollution of the air in this room. The present method does not keep the finer particles from being dispersed into the atmosphere of the room.

Sample #68, 2nd floor, Department 8: This sample shows a slight excess of lead concentration. This may be due to the working of the belting material while the rubber is still in the uncured state or may be due to pollution from sources outside of this room. Exhaust hoods could be applied to the tables.

Sample #88, Department 6: The base stock is reworked in a mill and then put through the tube machines. The mill and the tube machines could be exhausted to eliminate the lead hazard at this point.

The workmen should be taught that lead compounds are harmful when the dust is breathed into the lungs and to handle it carefully. It was noticed that the workmen were careless in putting their hands into the lead compound and brushing it on their clothes.

Operations where there is an excess of lead and where exhaust systems are not practicable should be isolated and efficient respirators supplied to the workmen.

Lunch rooms should be maintained and separated from the departments where lead is used. Workmen should not be allowed to eat lunch in the departments.

Samples of material used in the different products were obtained and analyzed to determine harmful elements. The following results were obtained:

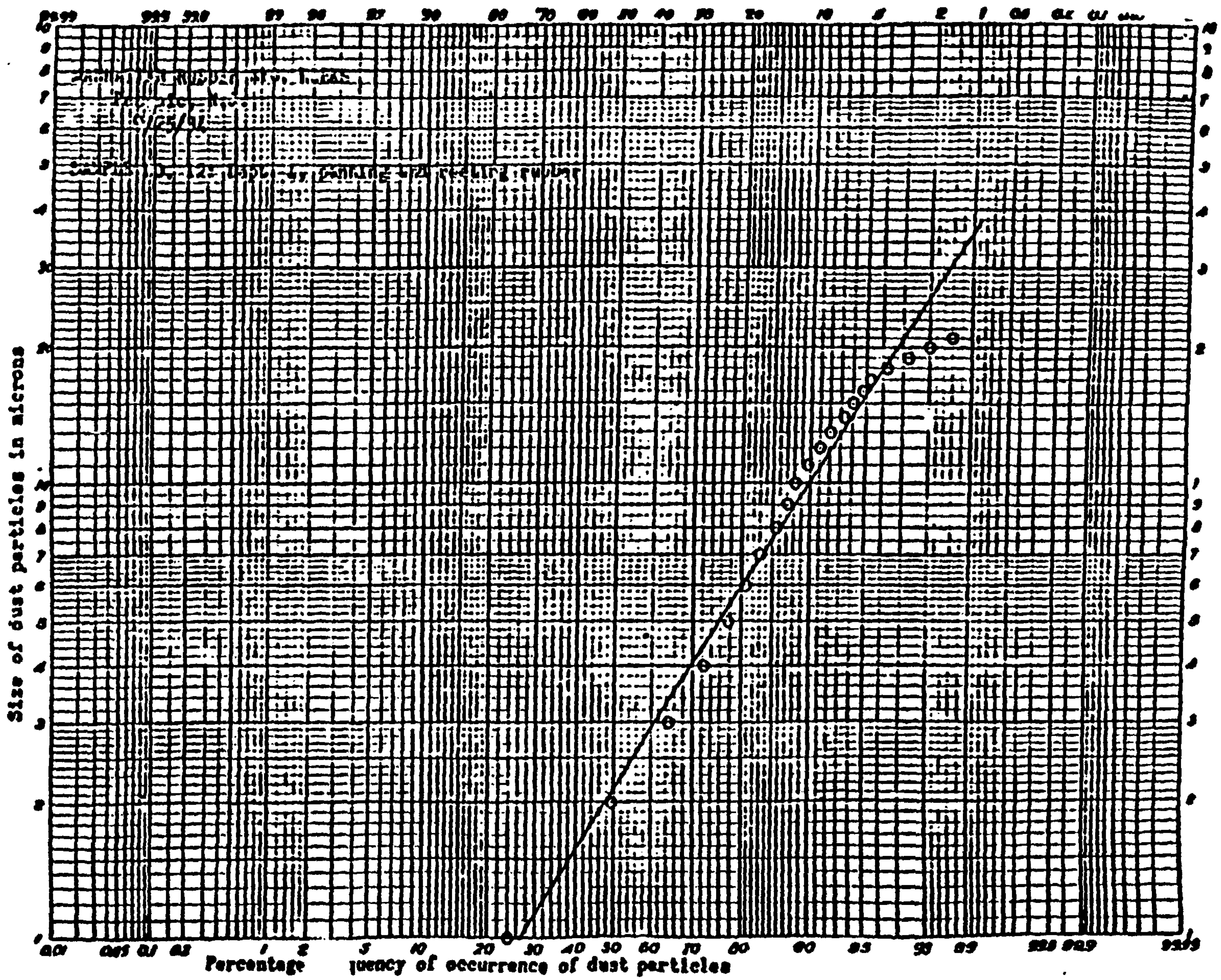
Lead compound	(D-70) -	93.45% lead
" "	(D-80) -	94.34% "
Waste material from Dept. 53	(R-56) -	24.65% lead; 13.91% total silica
" " " " "	(R-47) -	27.32% lead; 12.94% " "

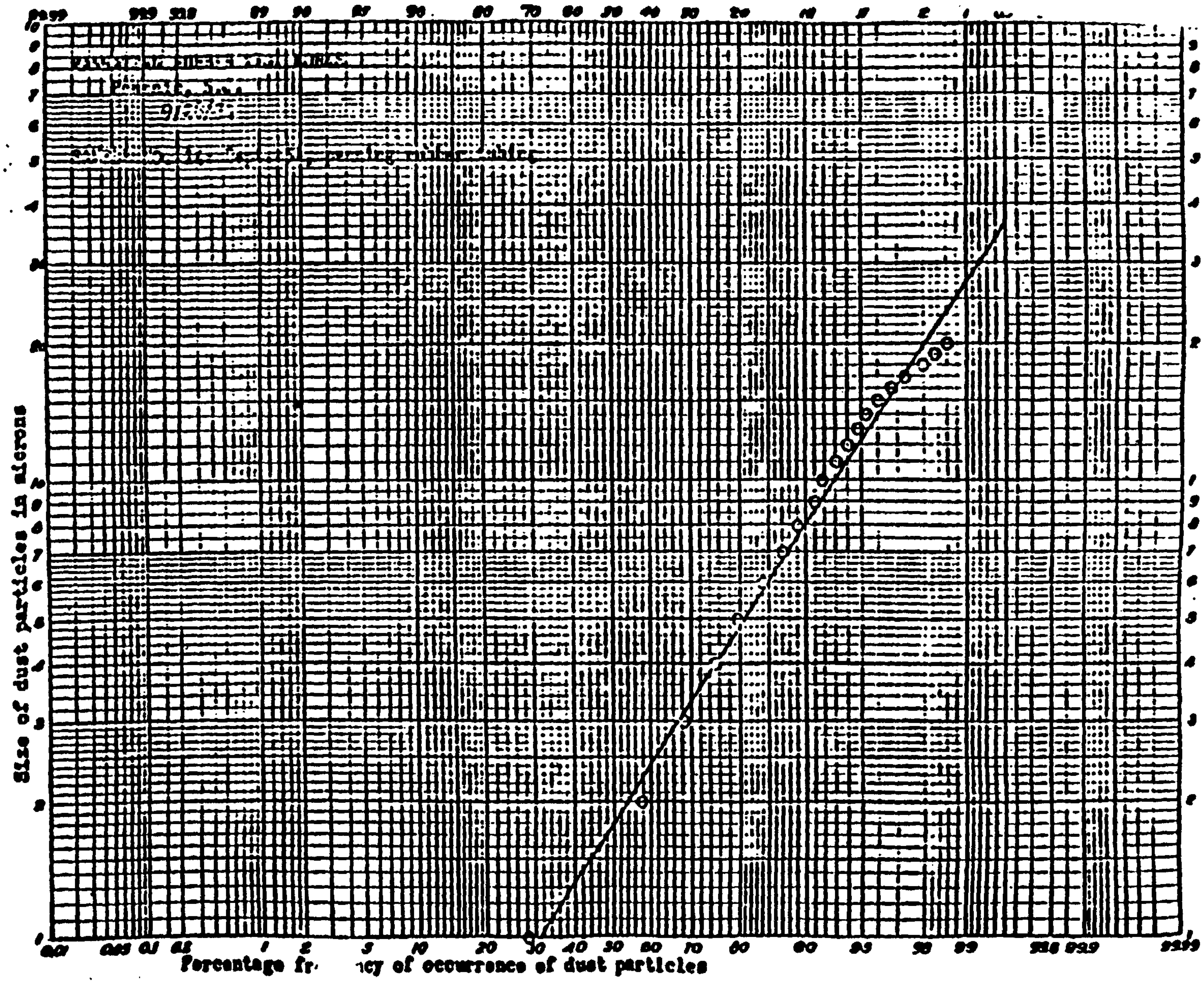
Samples of dust from three grinding operations were obtained and analyzed.

Dust from rubber grinding, Dept. 25, machine #M-746	- 7.85%	lead
" " black rubber, Dept. 5, machine #1240	- 1.15%	"
" " green rubber, Dept. 5, machine #1311	- 12.48%	"

Samples of dust from rafters were taken in various departments and analyzed. The following results were obtained:

Dept. 2, dust from over batch mixing operations - 5.48% lead
" 2, " " " grinders .60% "
" 53T, " " " weighing - 7.19% lead; 25.51% total silica
" 6, at end where tube machines were located - .38% lead
" 25-26, 55 (4th floor) - 1.13% lead
" 11 - 2.08% "
" 32 - 28.18% "
" 31 - 2.66% "
" 26 (1st floor) - 3.50% "


Size of dust particles in microns
Percentage [illegible]quency of occurrence of dust particles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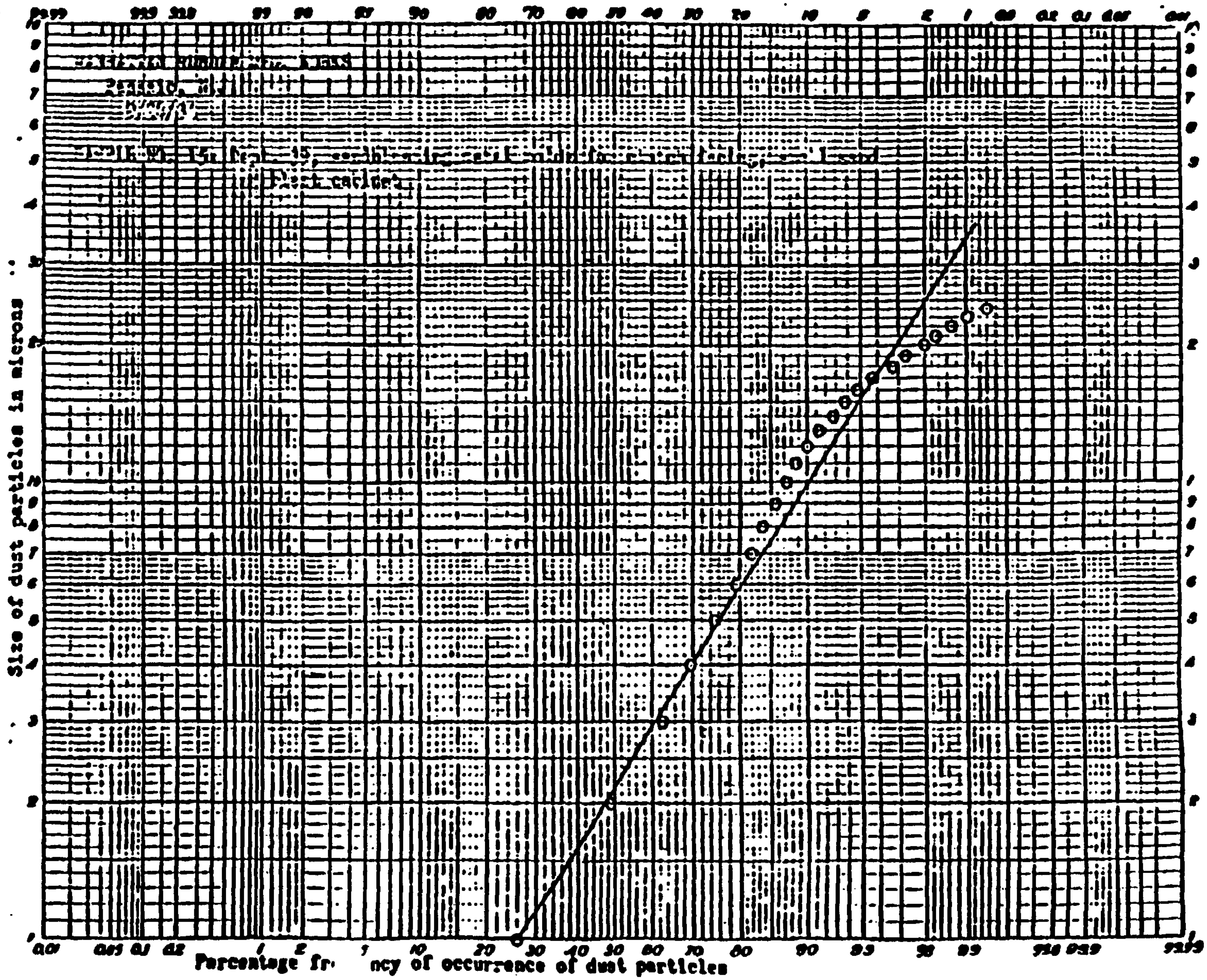
Percentage fr· ncy of occurrence of dust particles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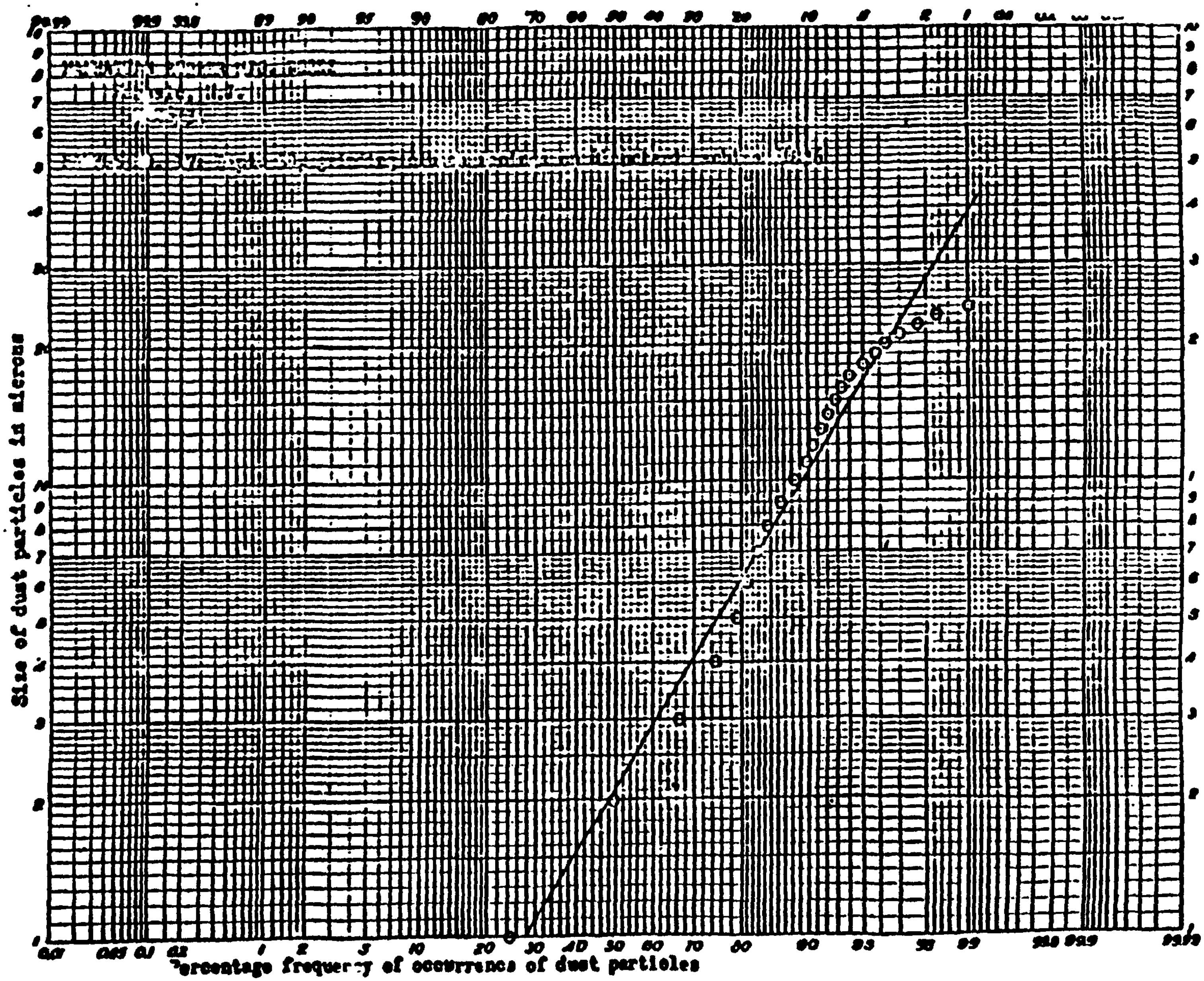
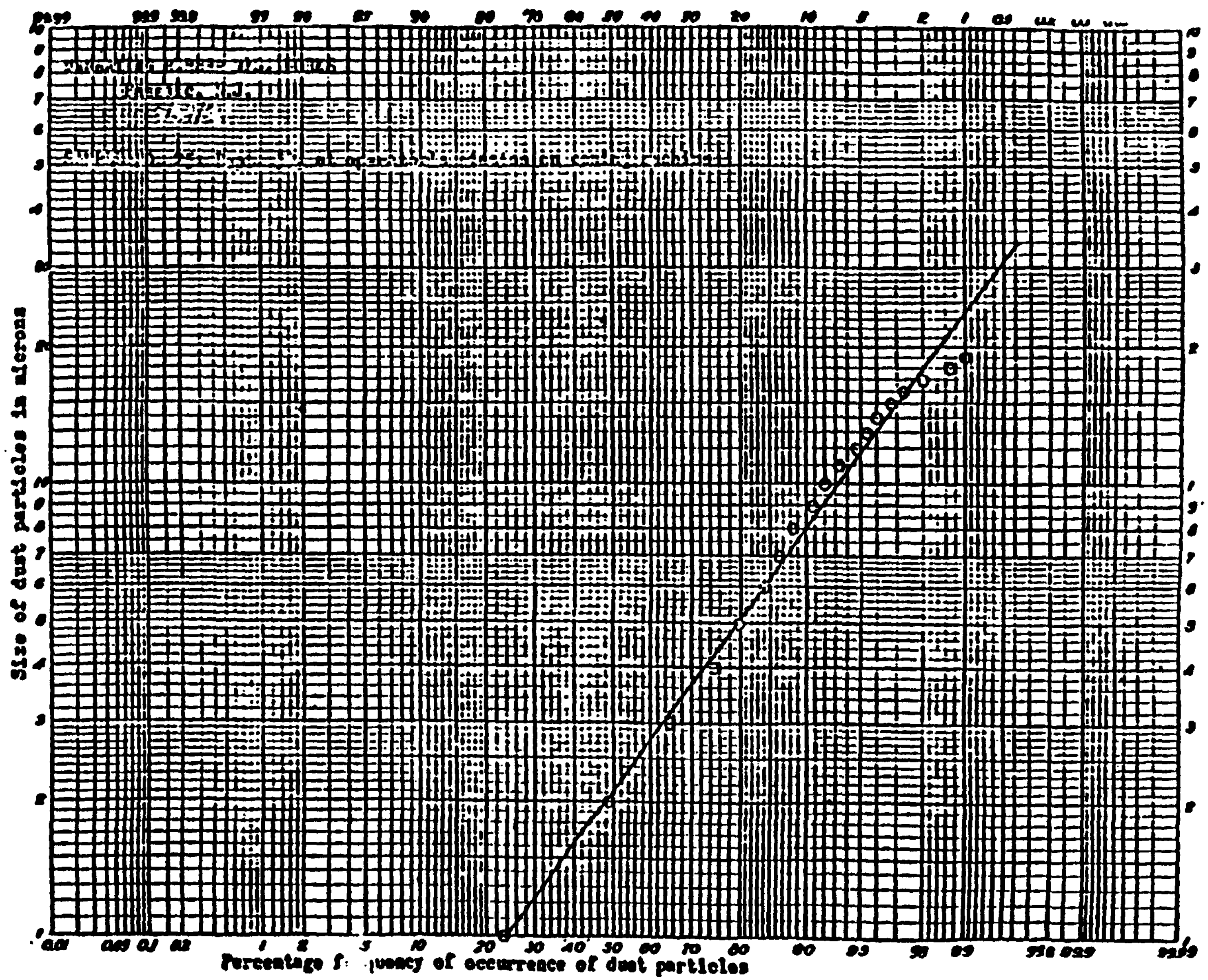
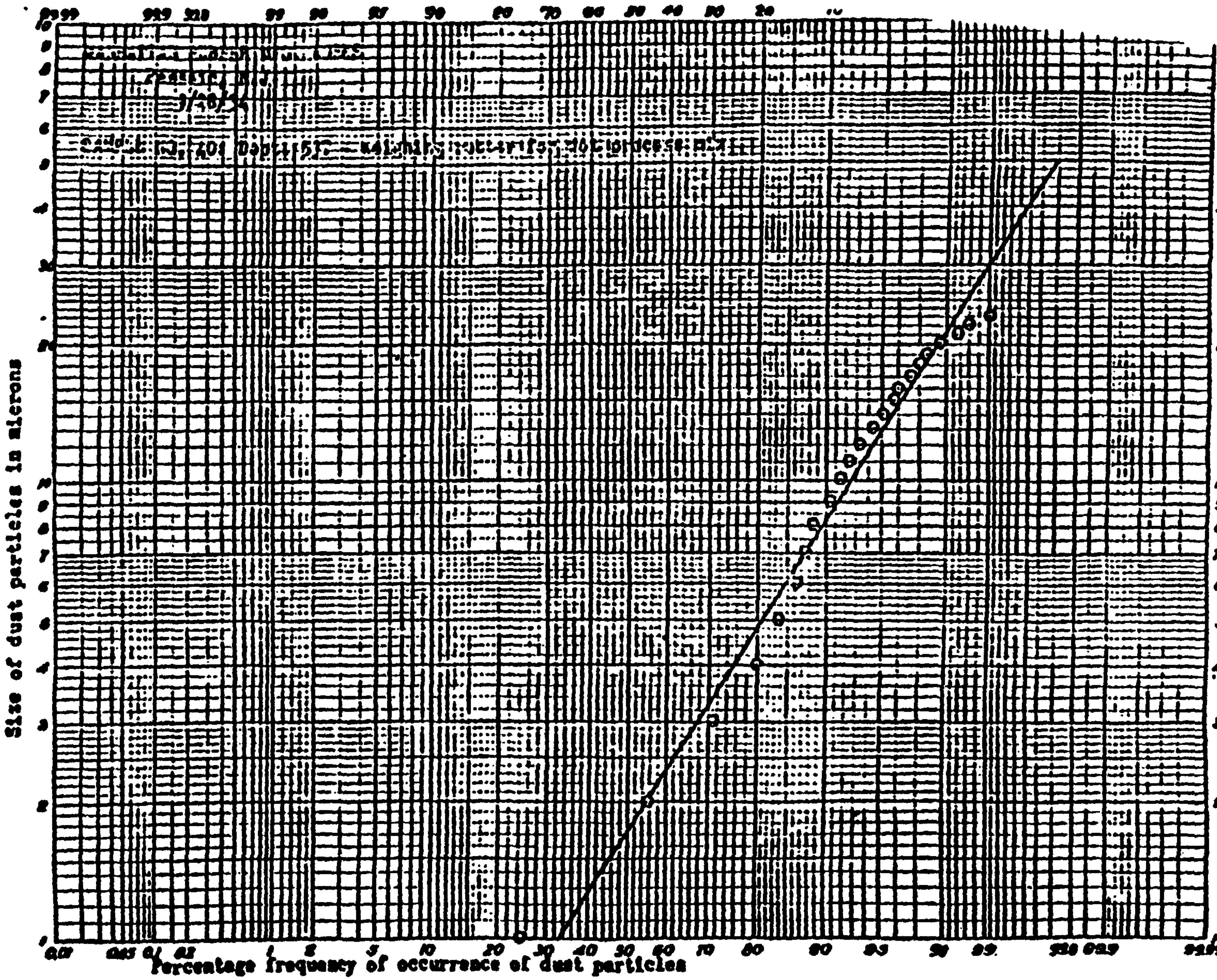
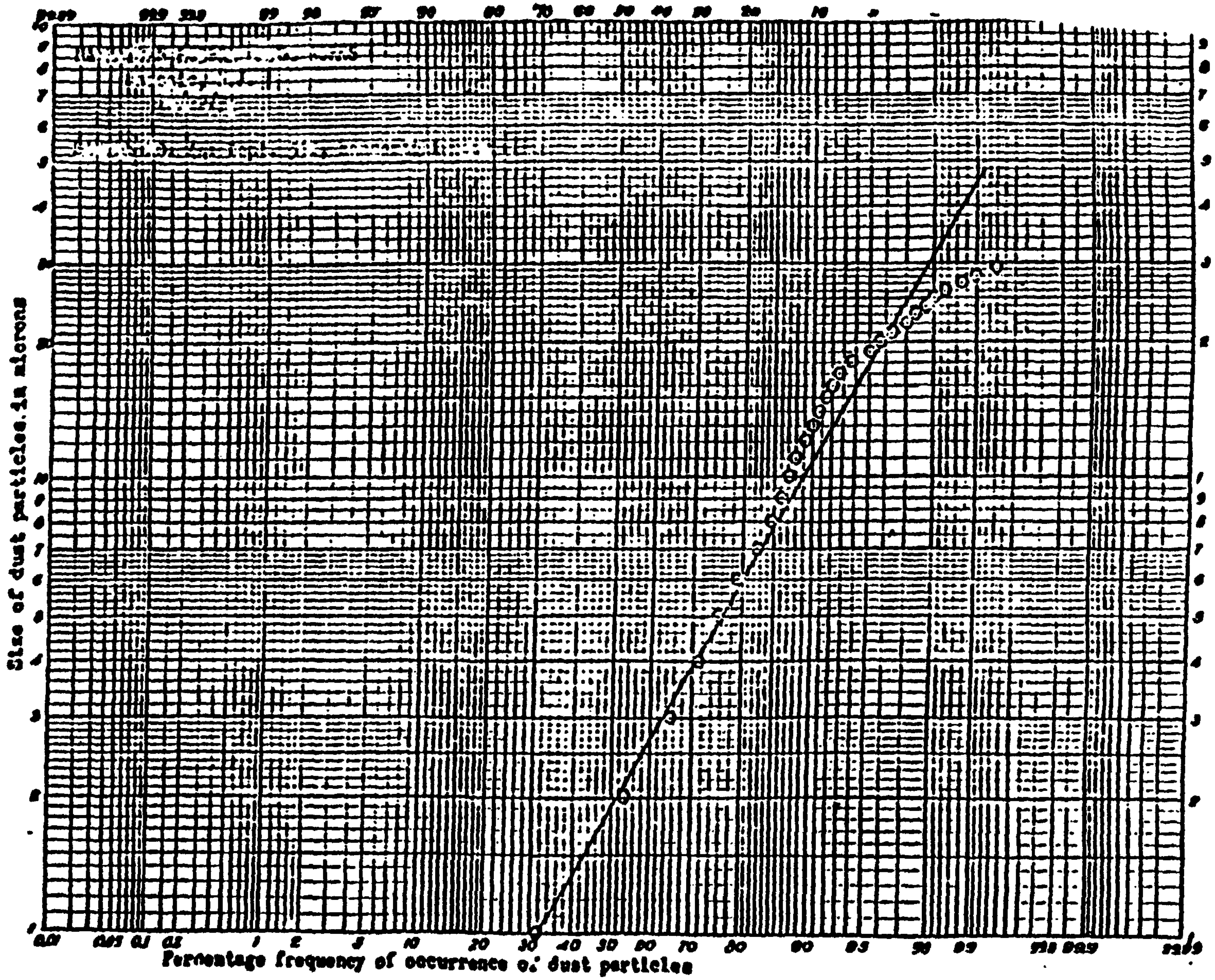
Percentage fr ncy of occurrence of dust particles

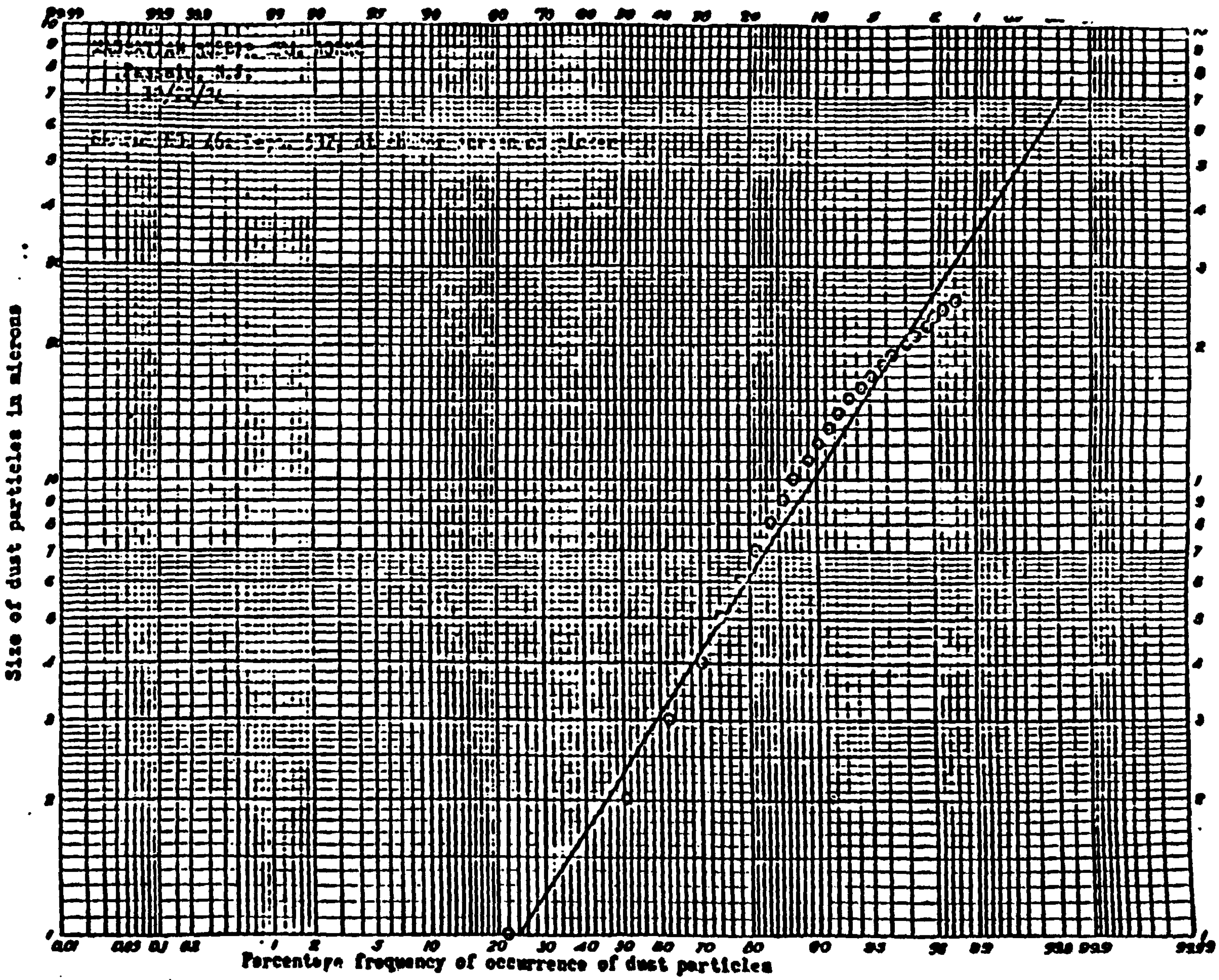

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

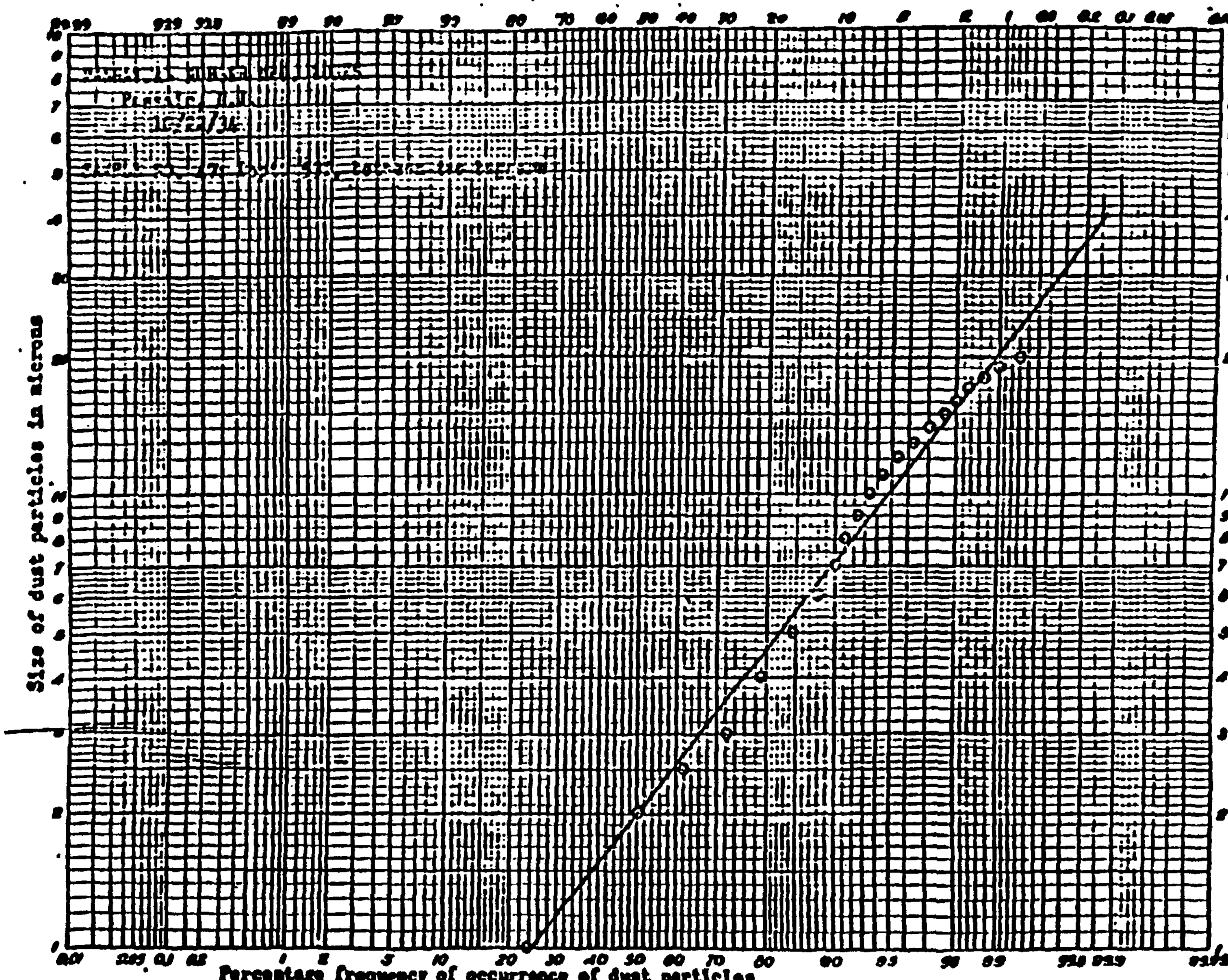

Size of dust particles in microns
Percentage f: quency of occurrence of dust particles

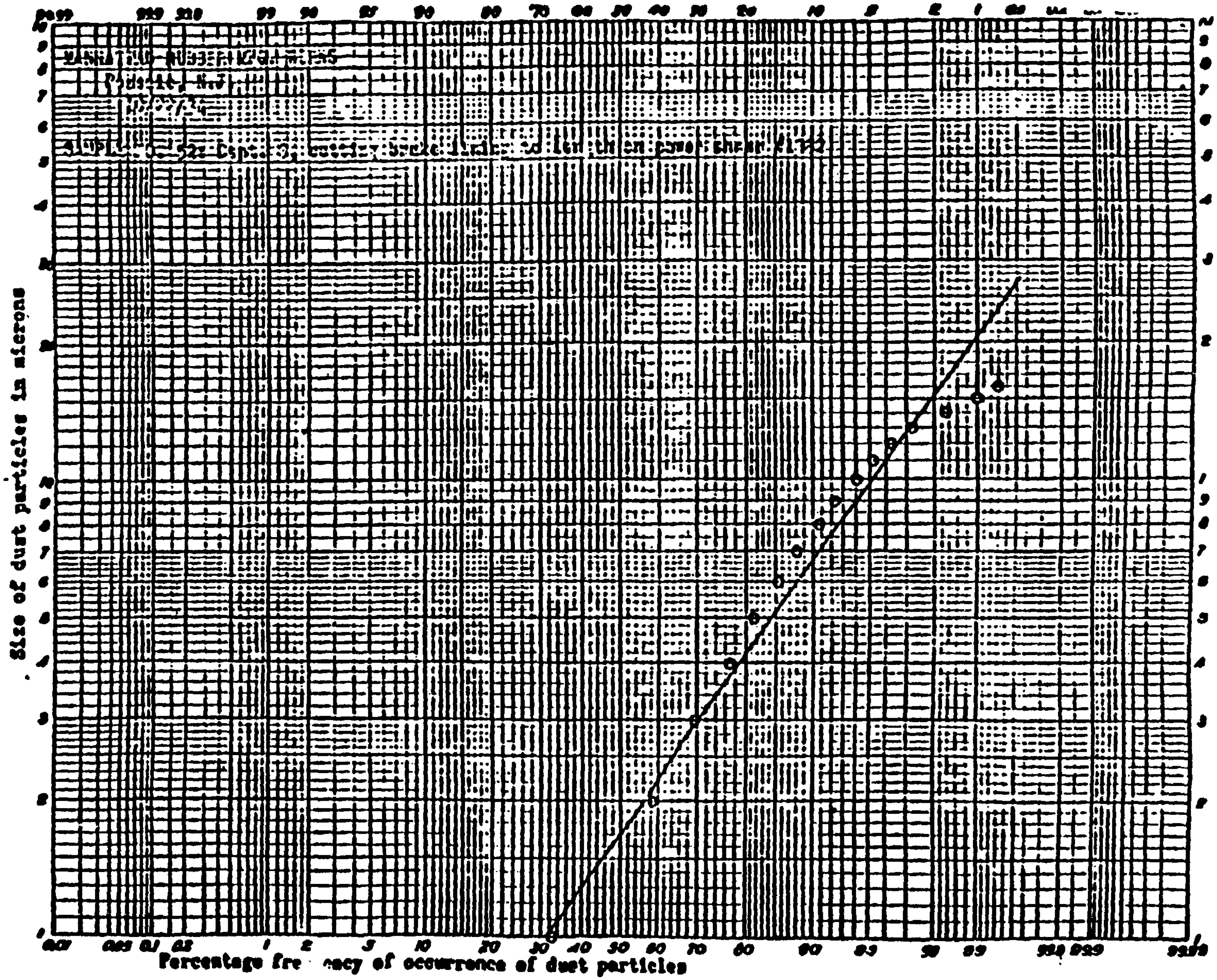

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

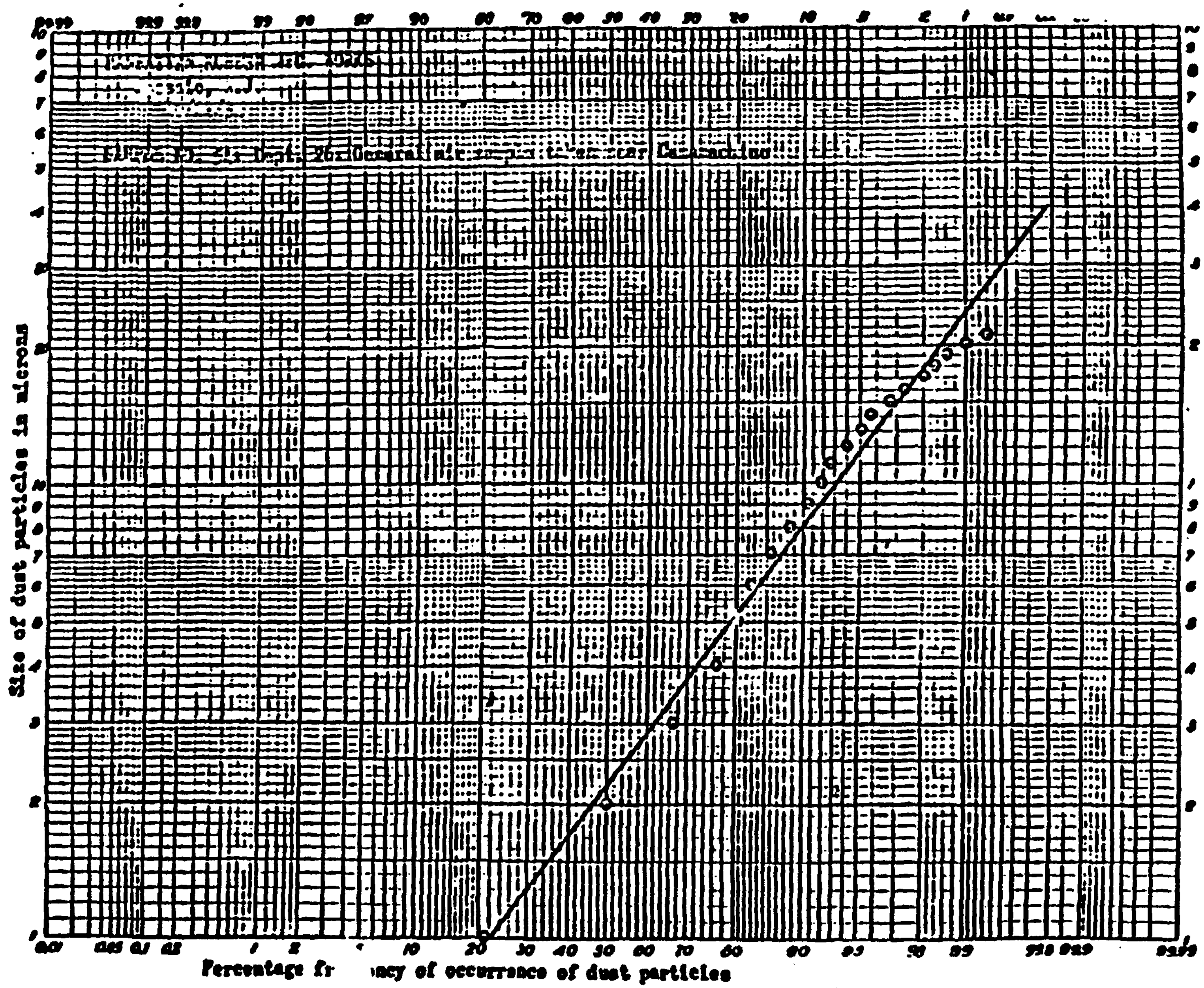


Size of dust particles in microns
Percentage frequency of occurrence of dust particles
0.01
0.1
0.2
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.99

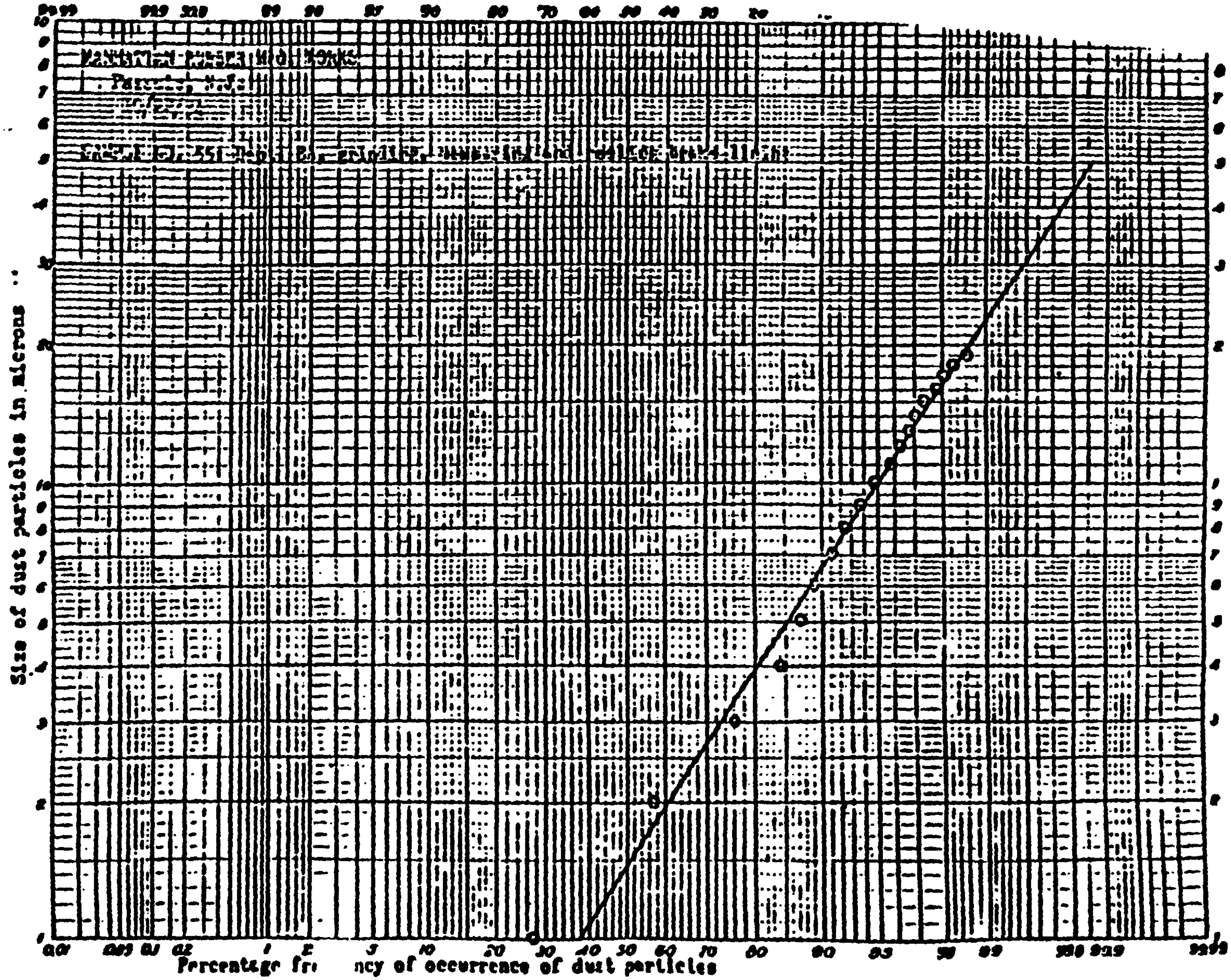

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

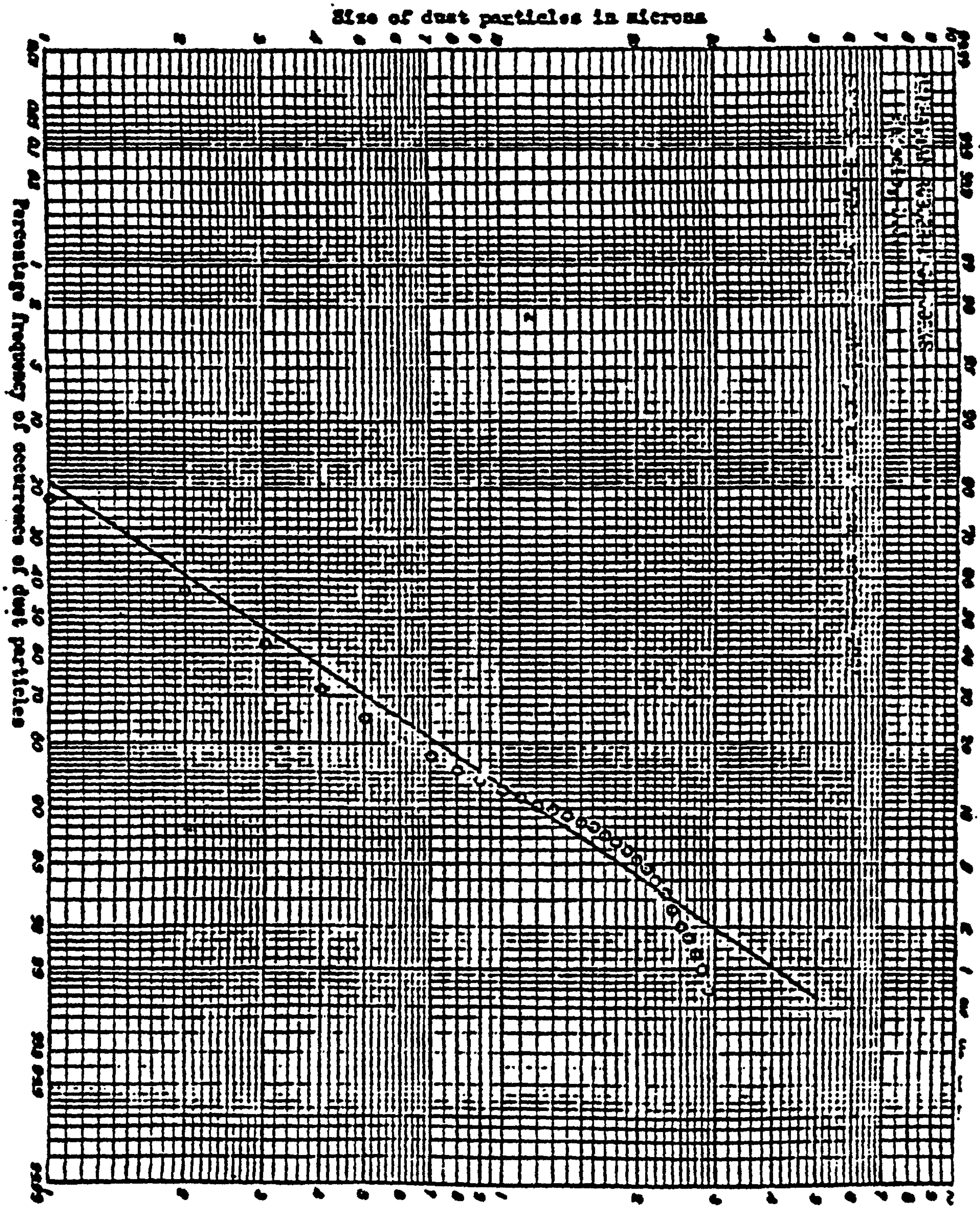

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

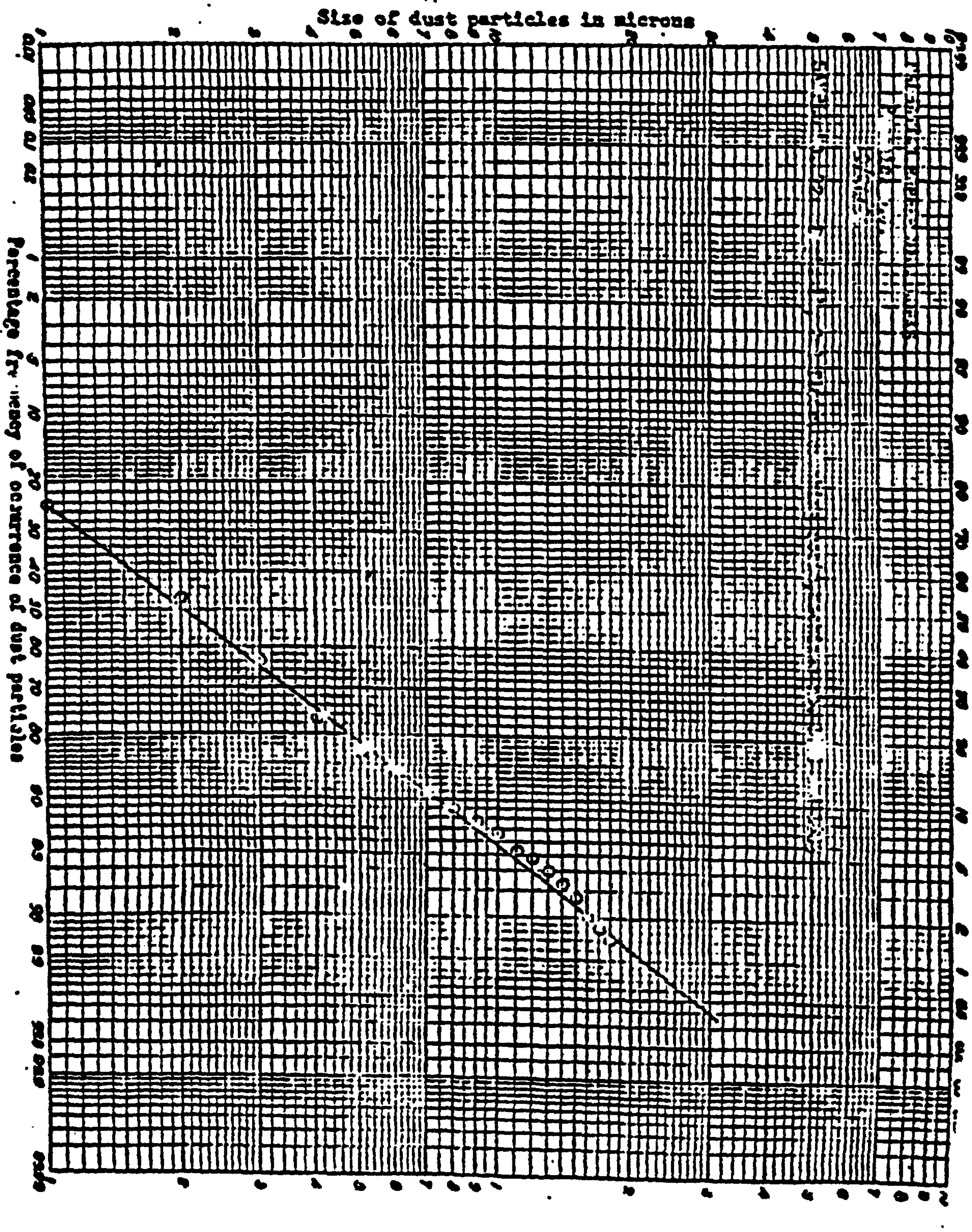

Size of dust particles in microns
Percentage fre ncy of occurrence of dust particles

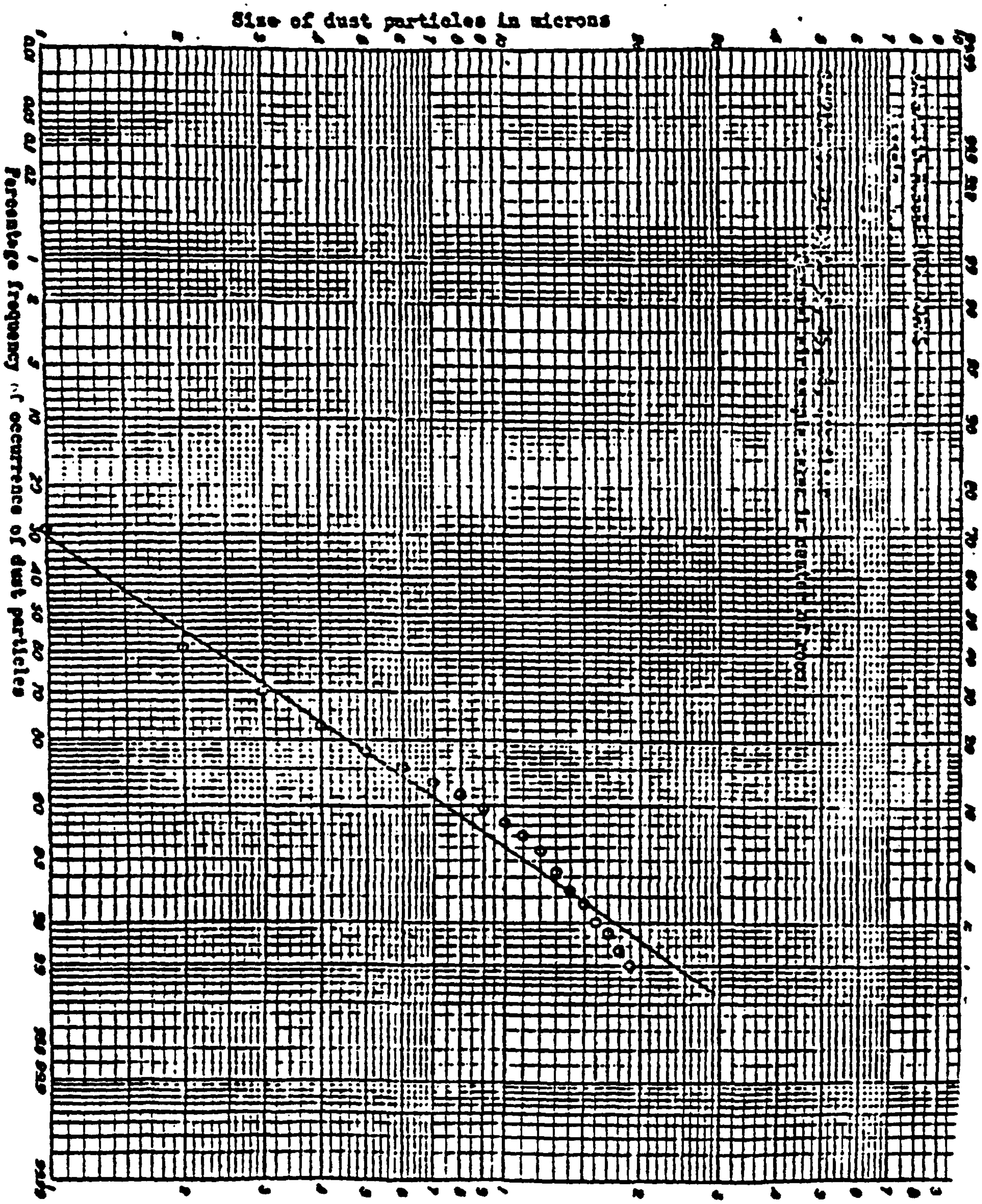


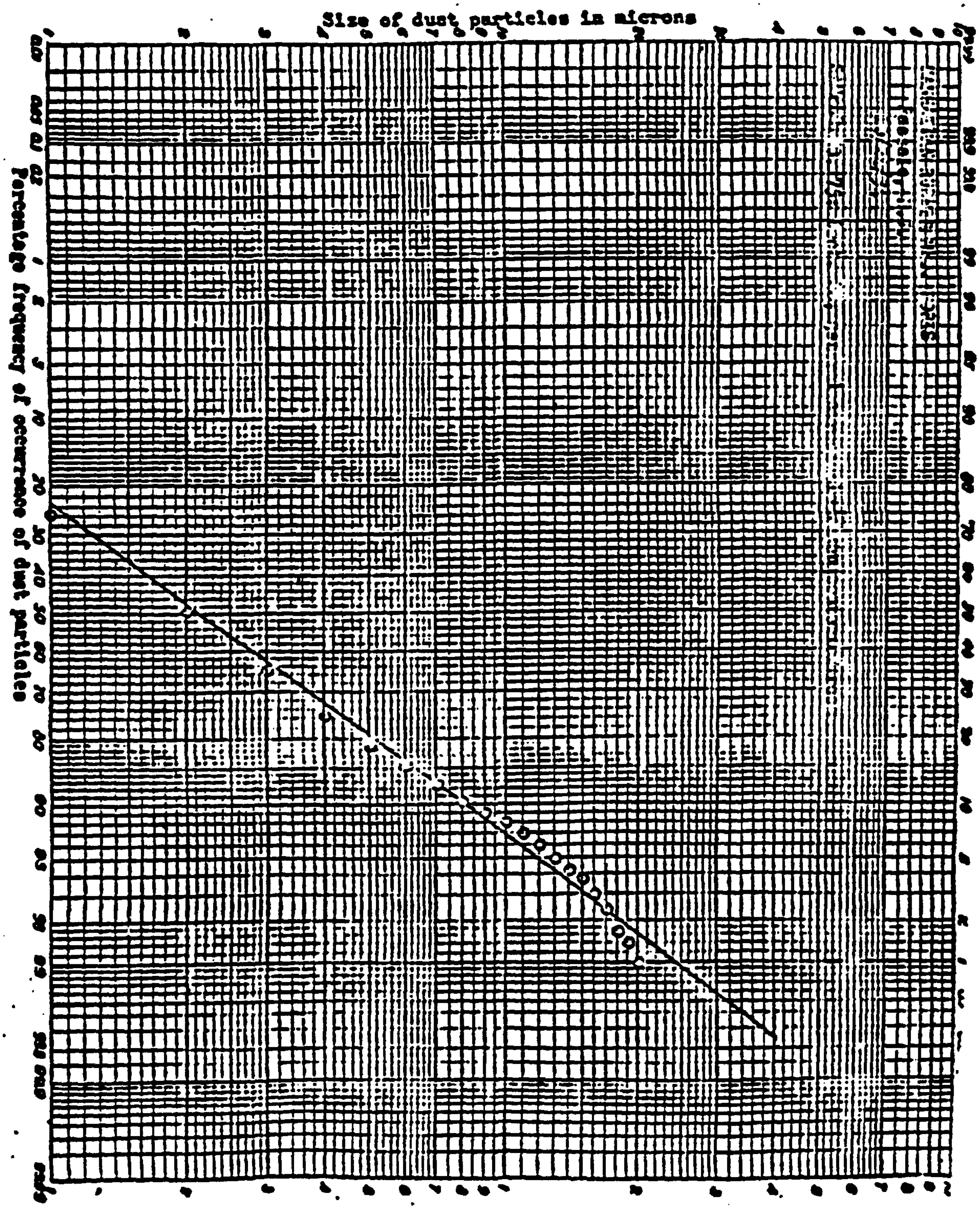
Size of dust particles in microns
Percentage fr ncy of occurrence of dust particles


Size of dust particles in microns
Percentage fr ncy of occurrence of dust particles

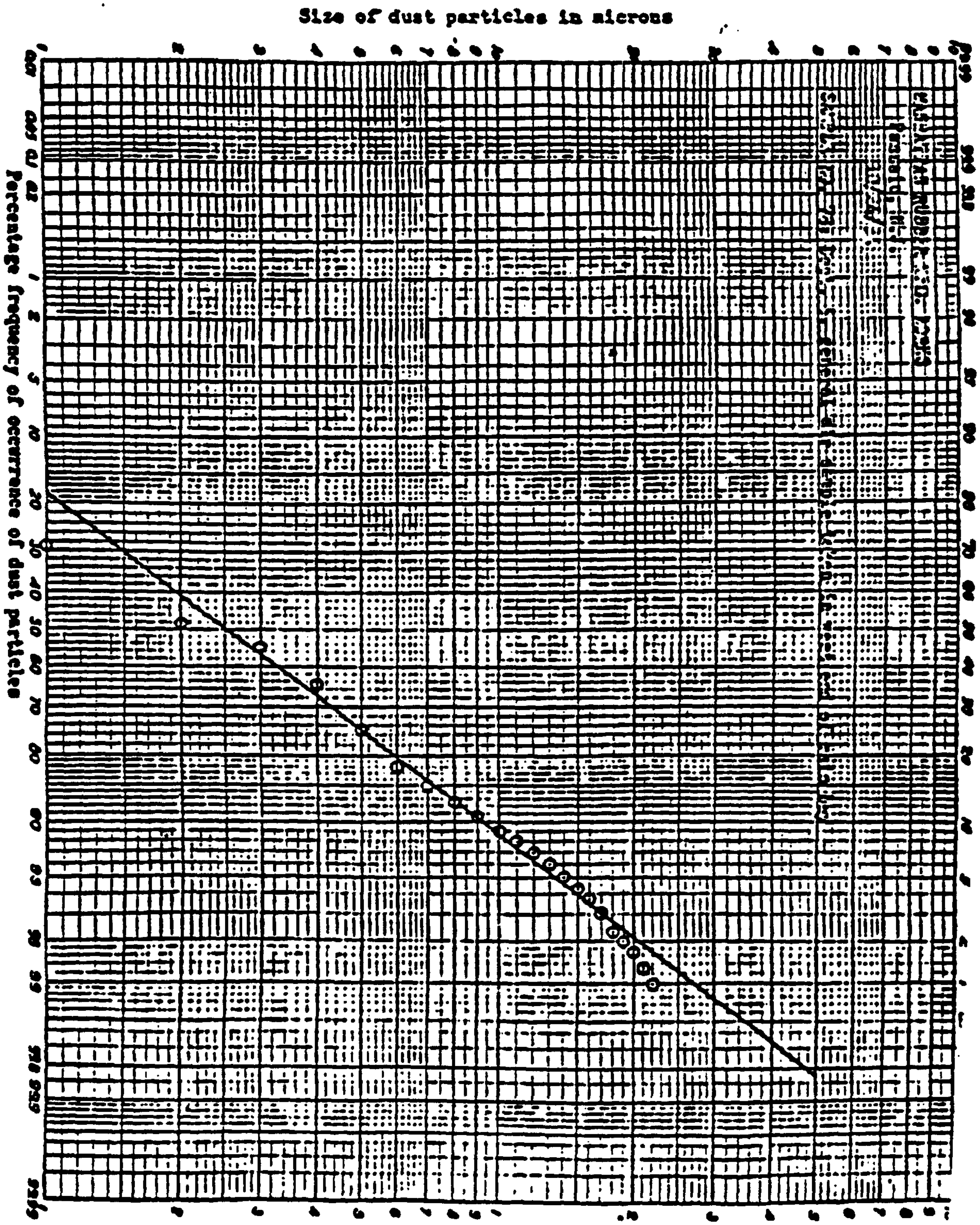

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

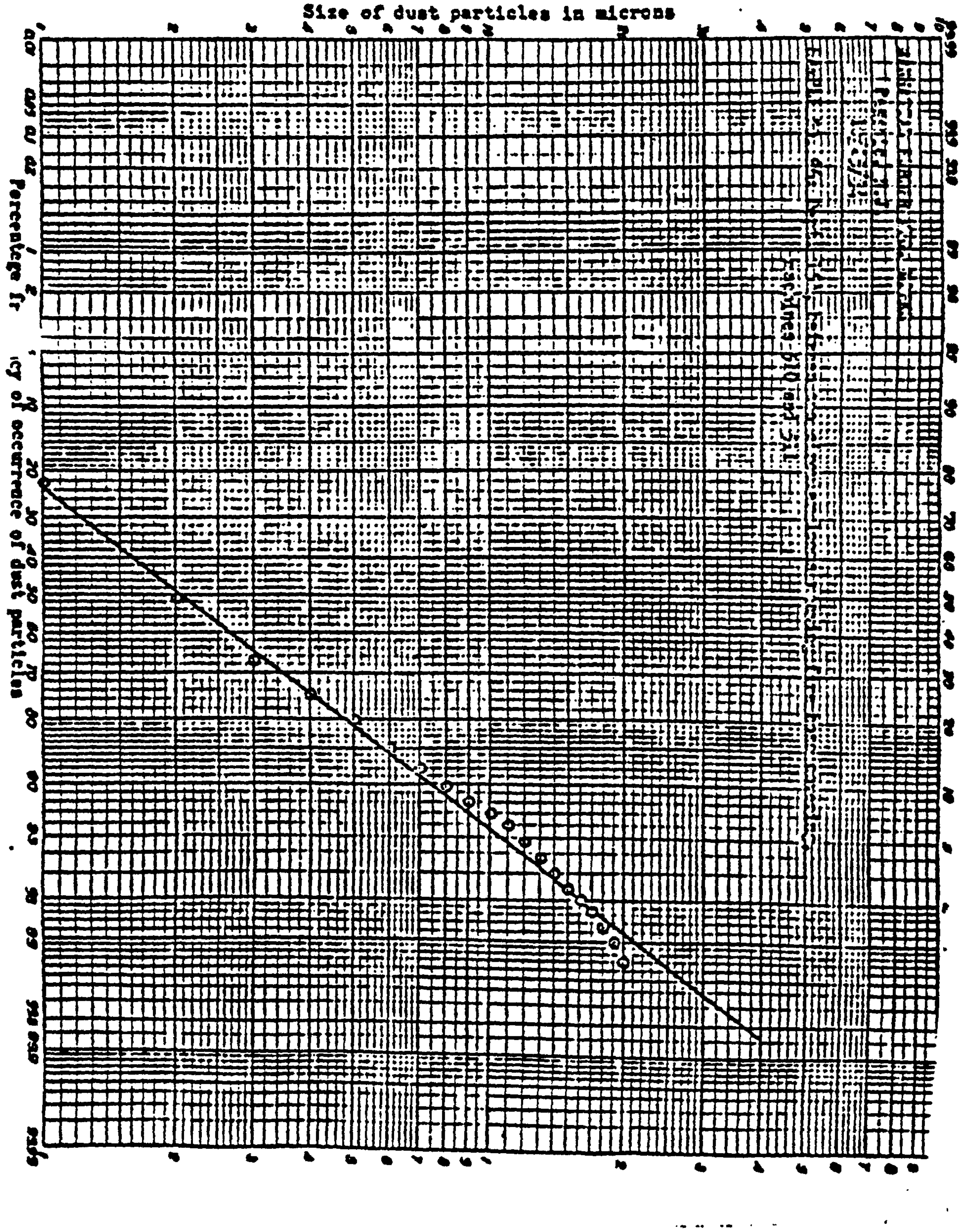

Size of dust particles in microns
Percentage fr uency of occurrence of dust particles


Size of dust particles in microns
Percentage frequency of occurrence of dust particles

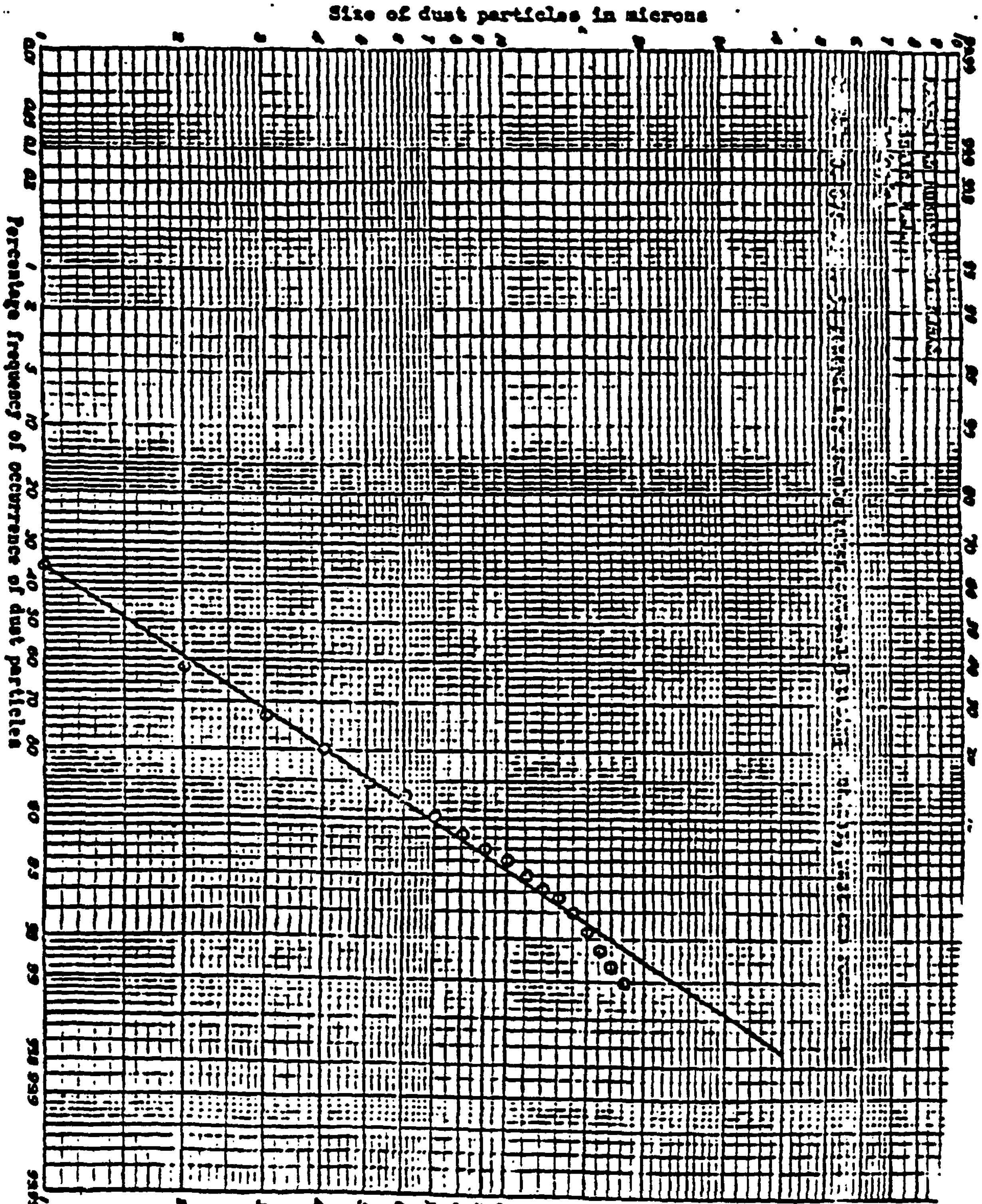


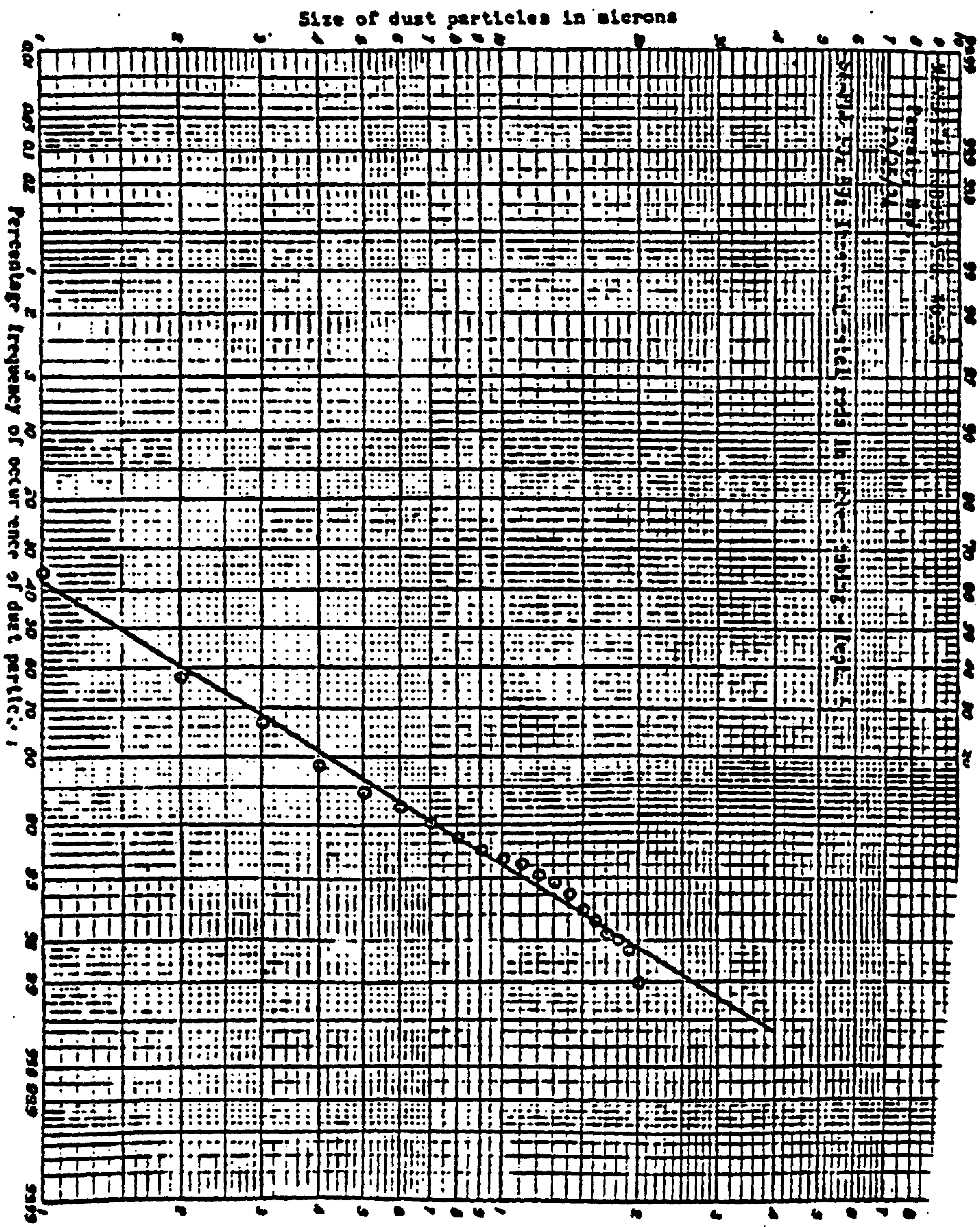
Size of dust particles in microns
Percentage frequency of occurrence of dust particles


Size of dust particles in microns
Percentage frequency of occurrence of dust particles

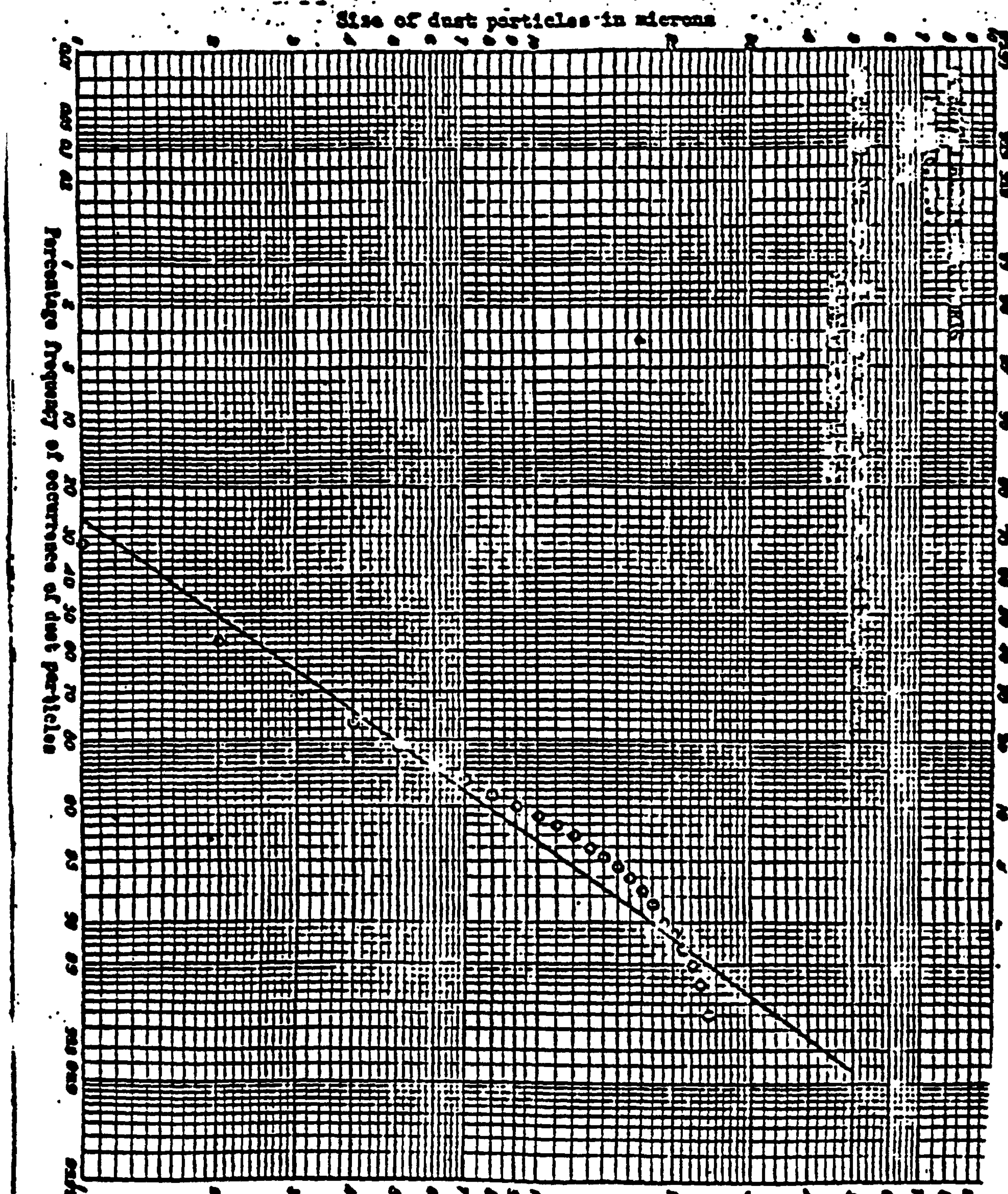


Size of dust particles in microns
Percentage frequency of occurrence of dust particles

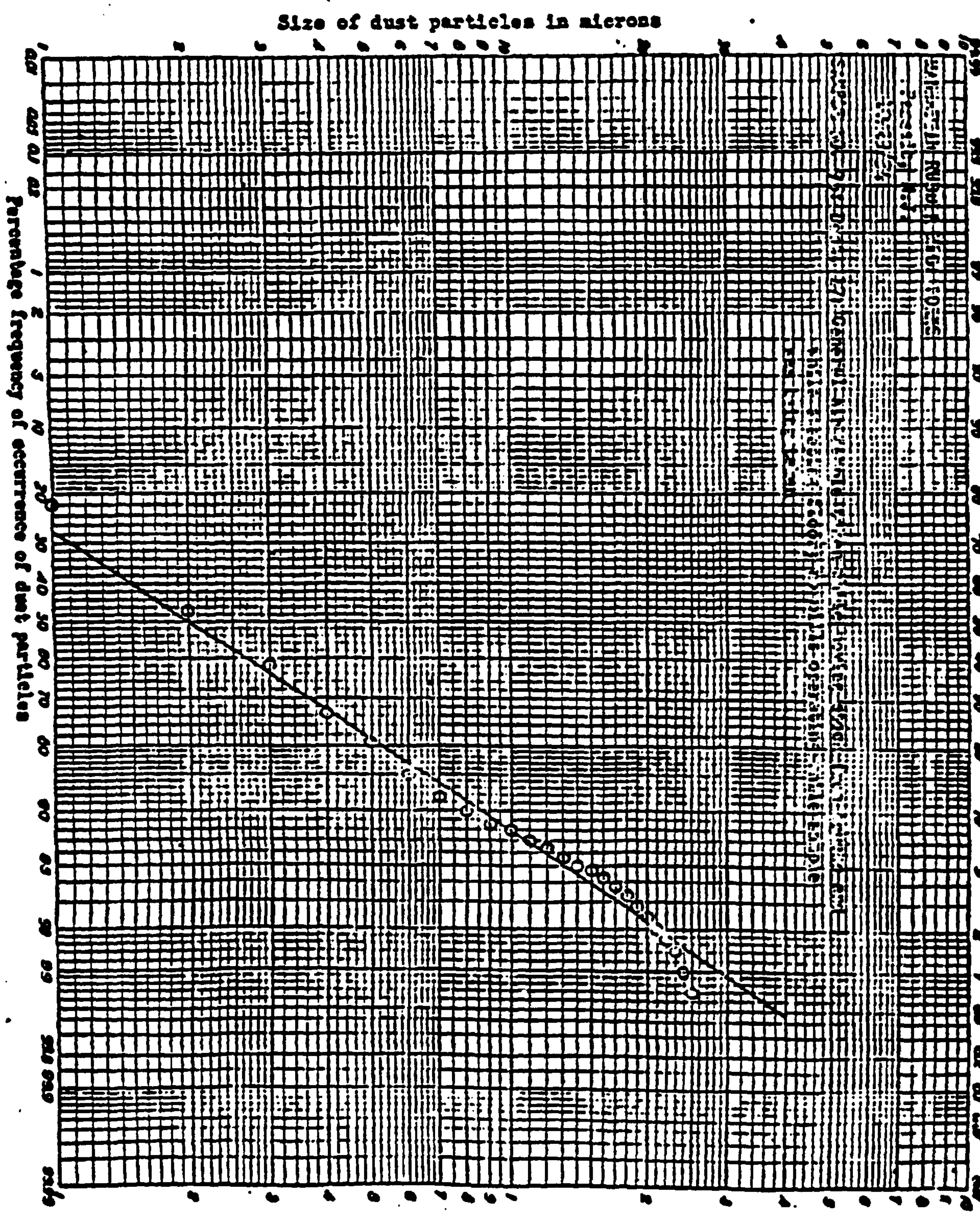

Size of dust particles in microns
Percentage frequency of occurrence of dust particles

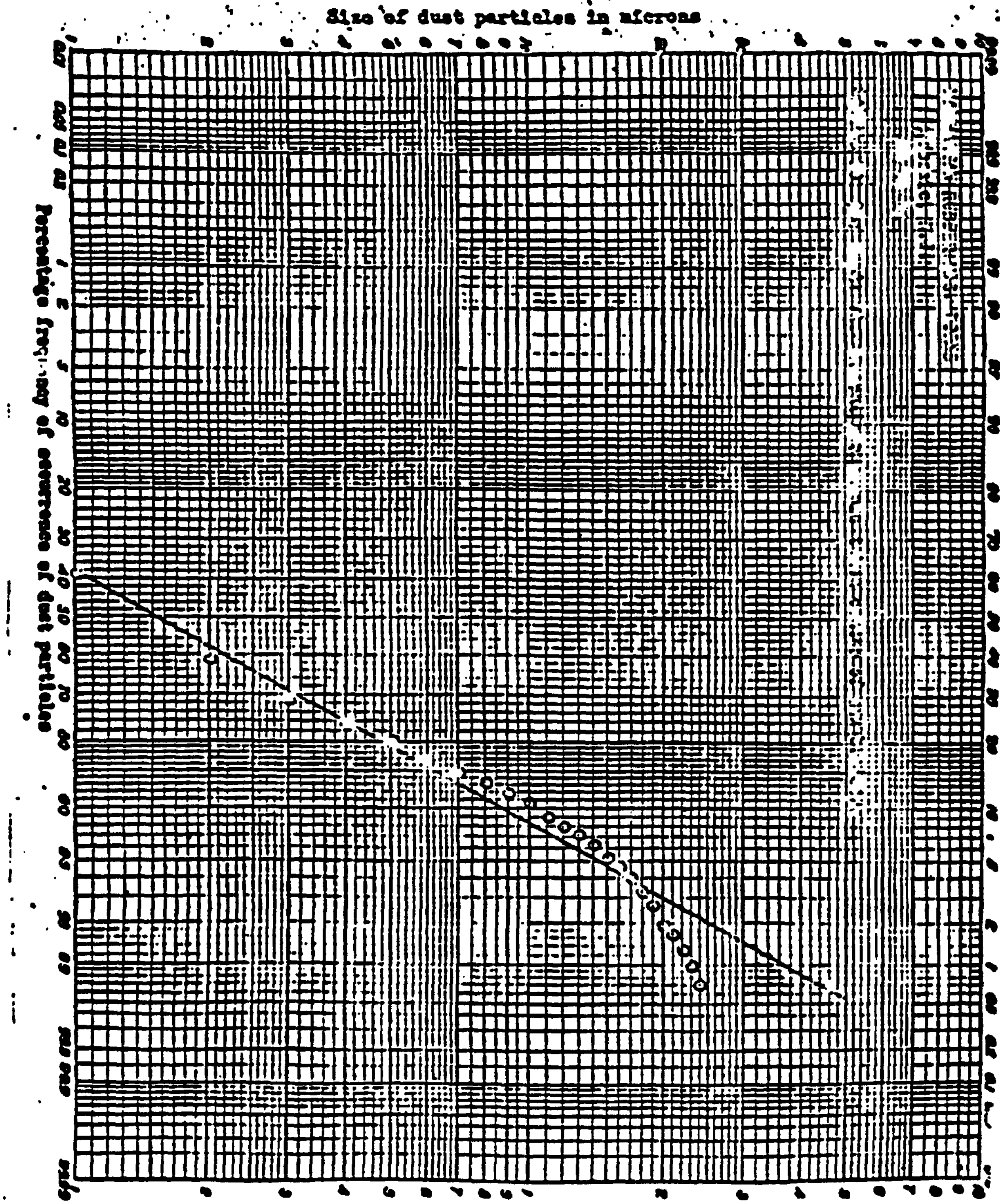


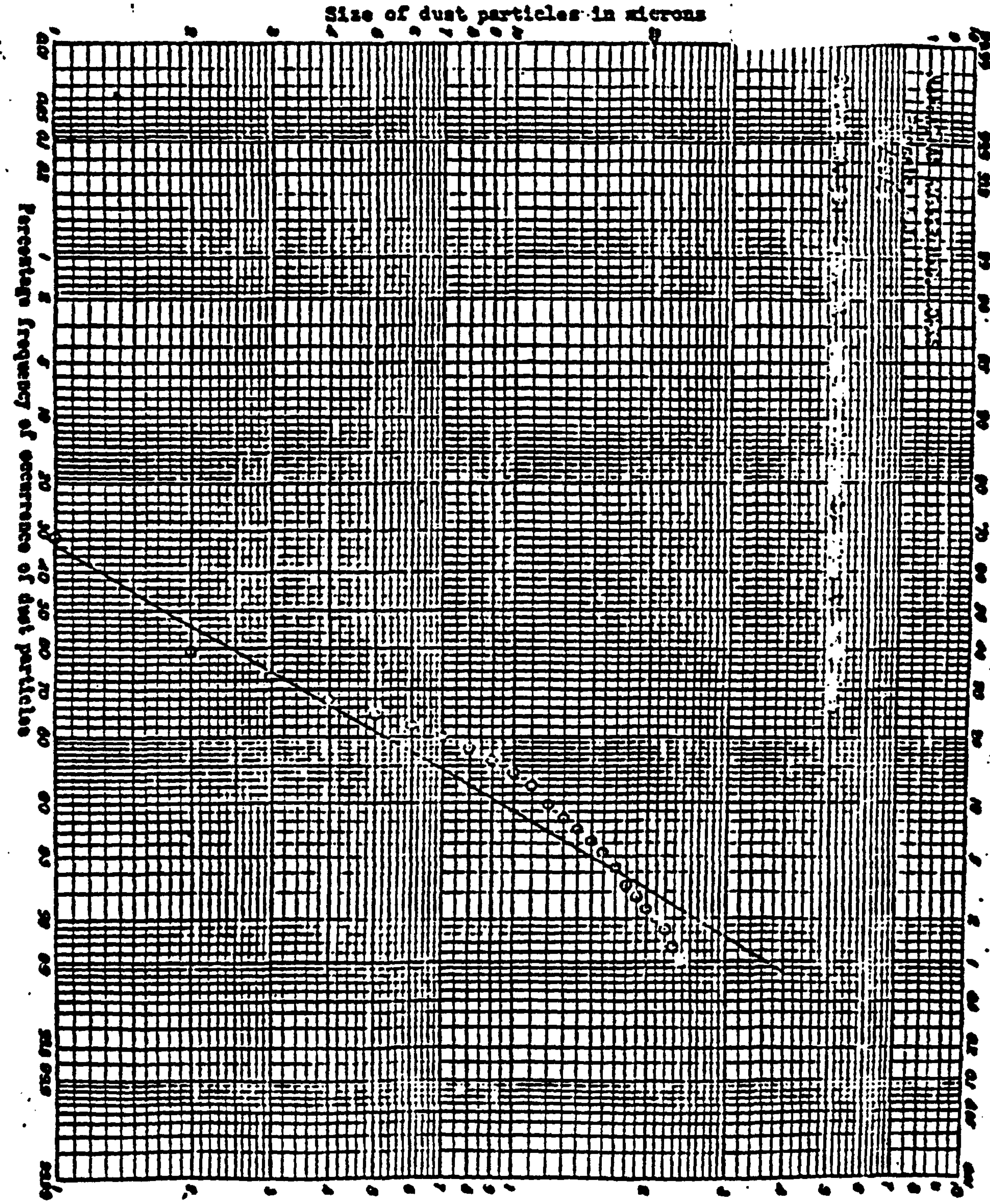
Size of dust particles in microns



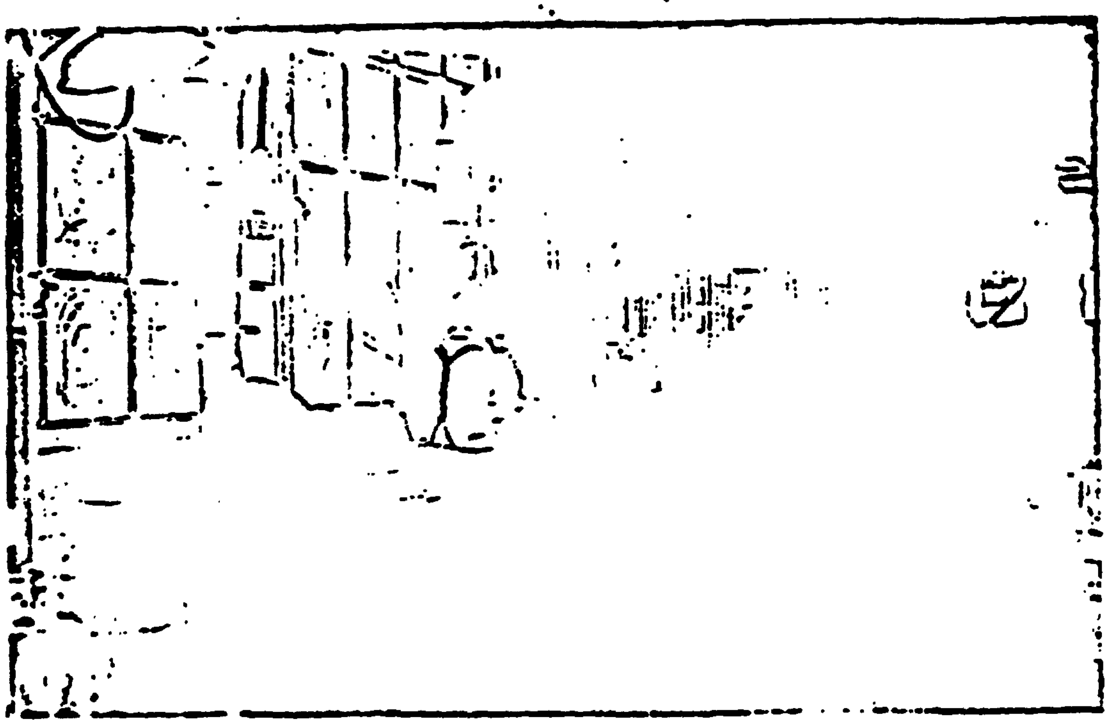
Size of dust particles in microns
Percentage frequency of occurrence of dust particles


Size of dust particles in microns
Percentage frequency of occurrence of dust particles


Size of dust particles in microns
Percentage frequency of occurrence of dust particles



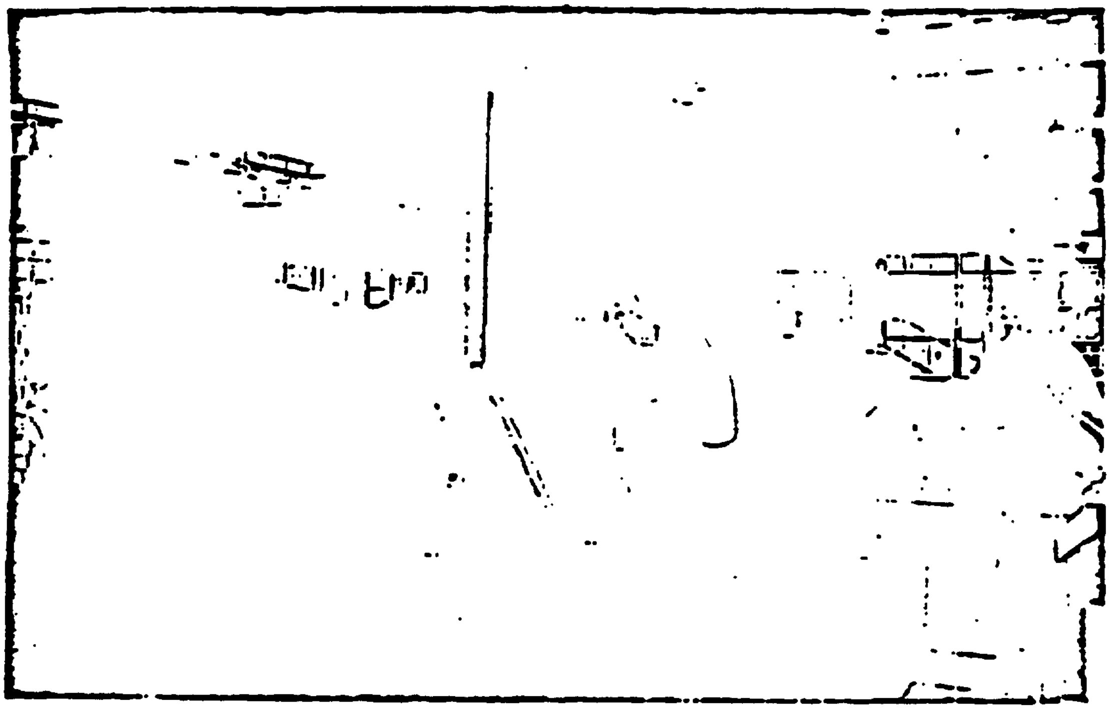
Size of dust particles in microns
Percentage frequency of occurrence of dust particles



SAMPLE NO. 6
Dept. 53

Grinding machine #2050, one man chamfering
ends of brake lining on emery wheel

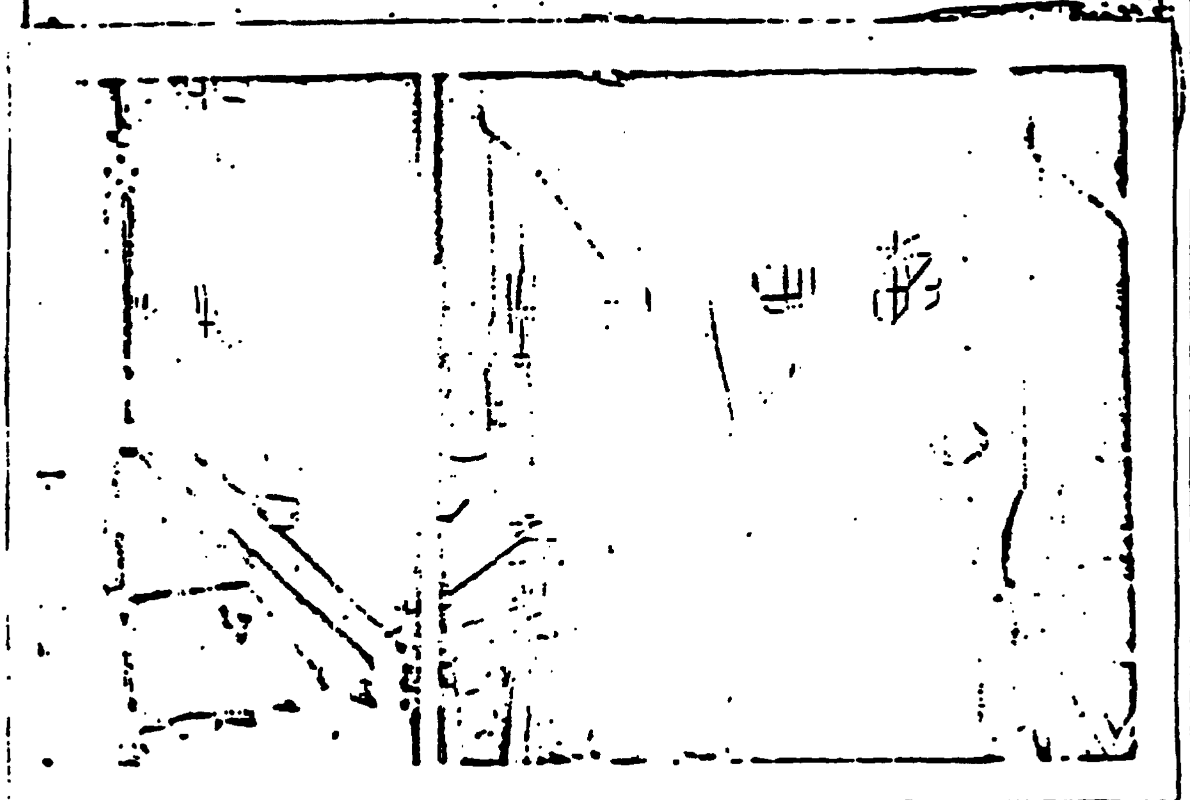
The Manhattan-Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



SAMPLE NO. 7
Dept. 53

Cutting operation with carborundum wheel;
cutting wet process brake lining to length

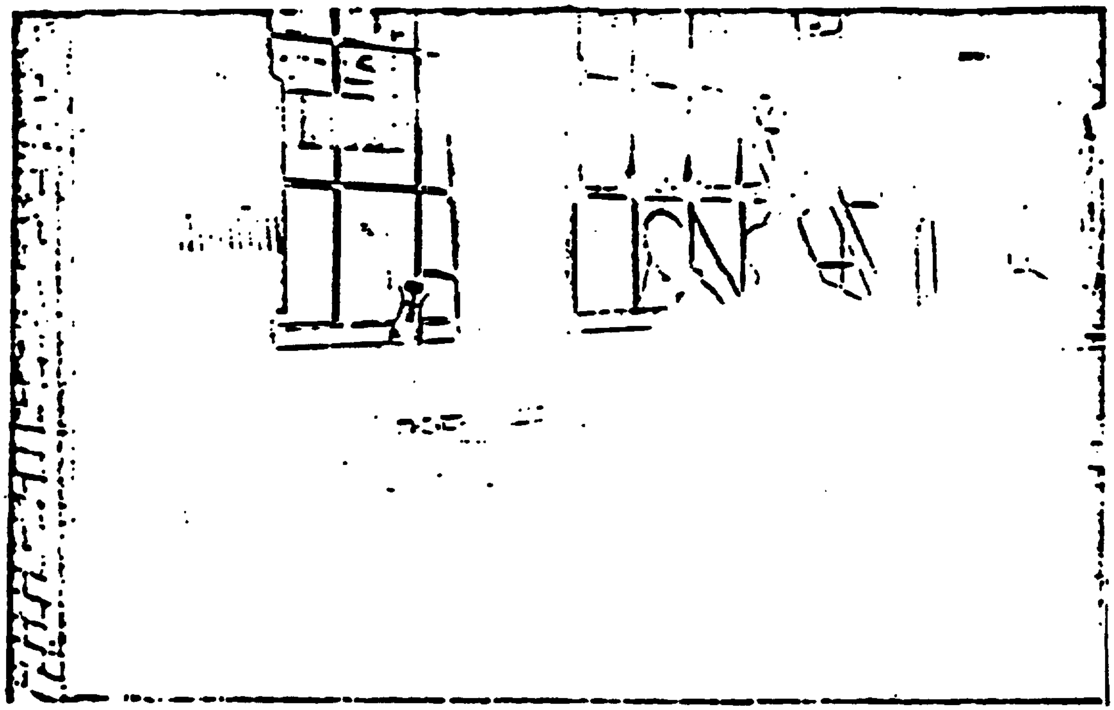
The Manhattan-Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



<u>SAMPLE NO. 8</u>
Dept. 53

Gardner surface grinder #2, machine #1510
dry process lining

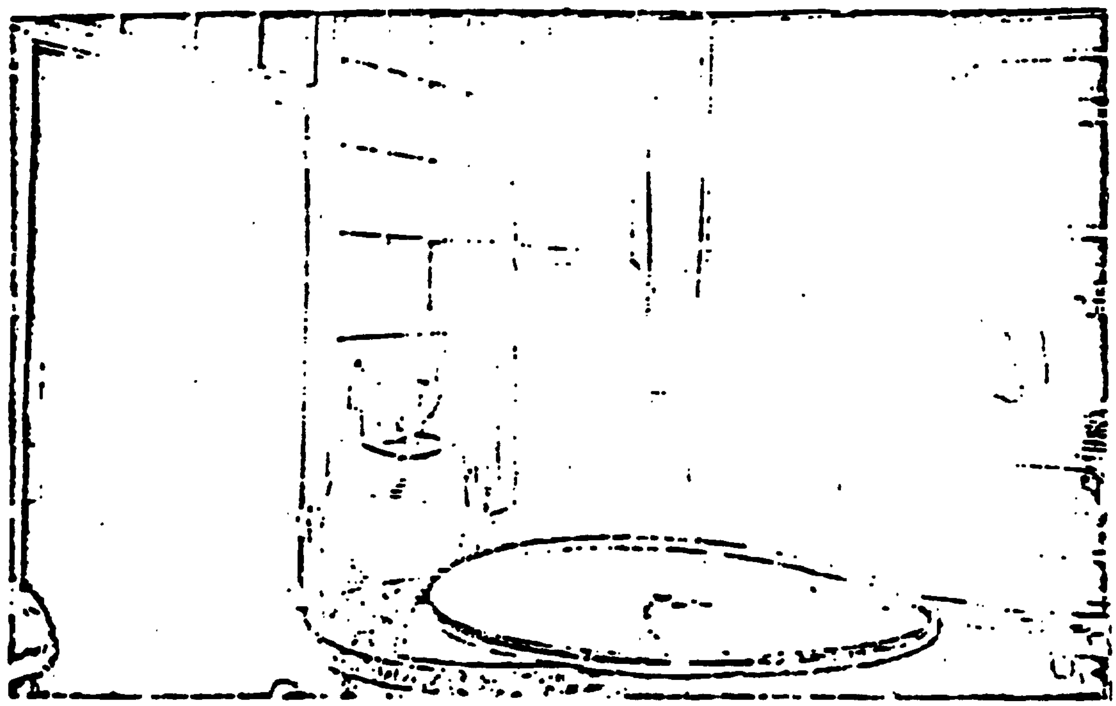
The Manhattan Rubber Mfg. Div.



SAMPLE NO. 9
Dept. 53

Circular grinder while grinding inside
surface of brake lining

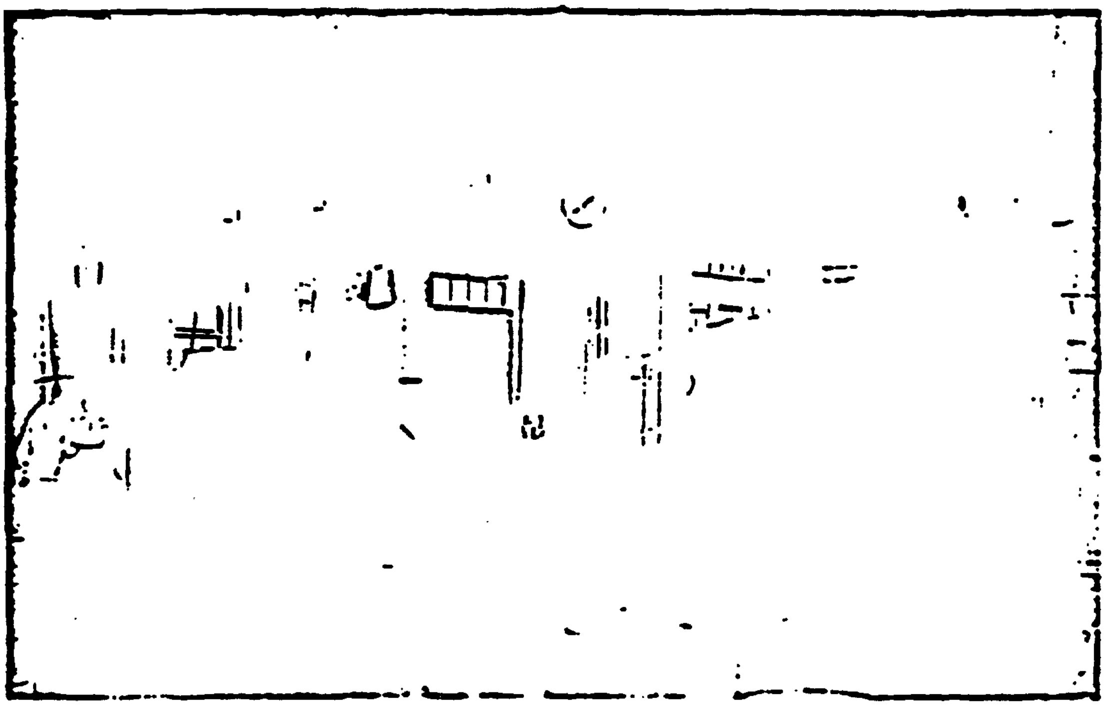
The Manhattan Rubber Mfg. Div.



SAMPLE NO. 14
Dept. 51

Panning rubber tubing

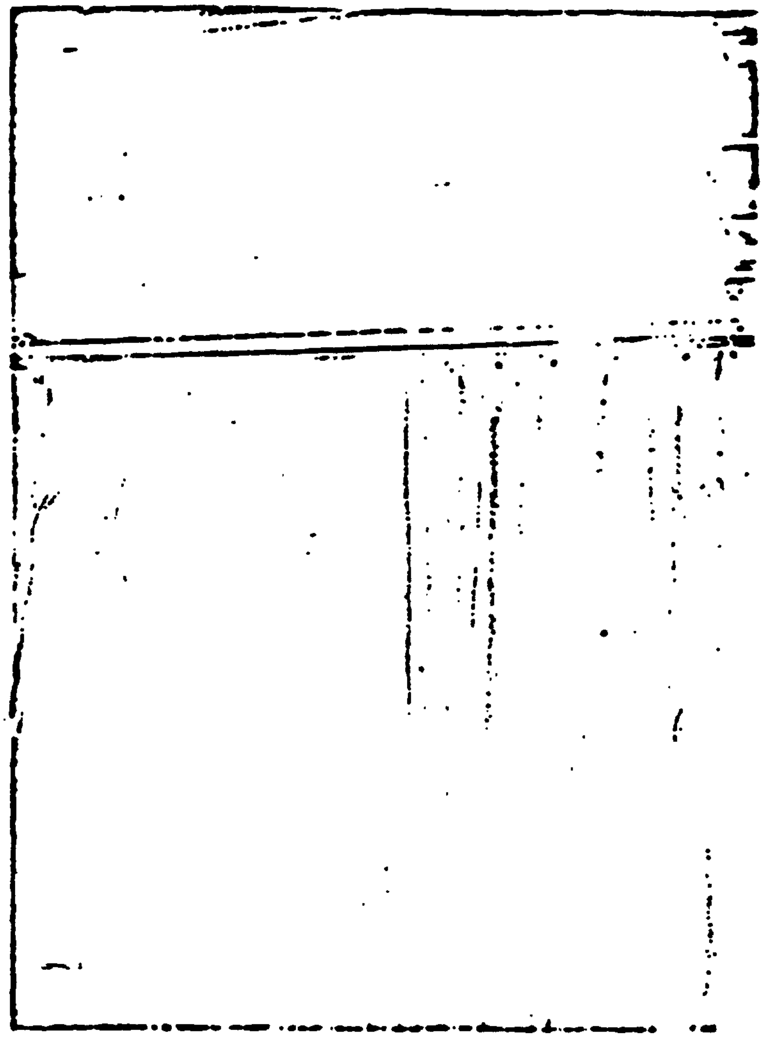
The Manhattan-Rubber Mfg. Div,
of Raybestos-Manhattan, Inc.



__SAMPLES NO. 16 and 17__
Dept. 39

Grinding clutch facing

The Manhattan-Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.

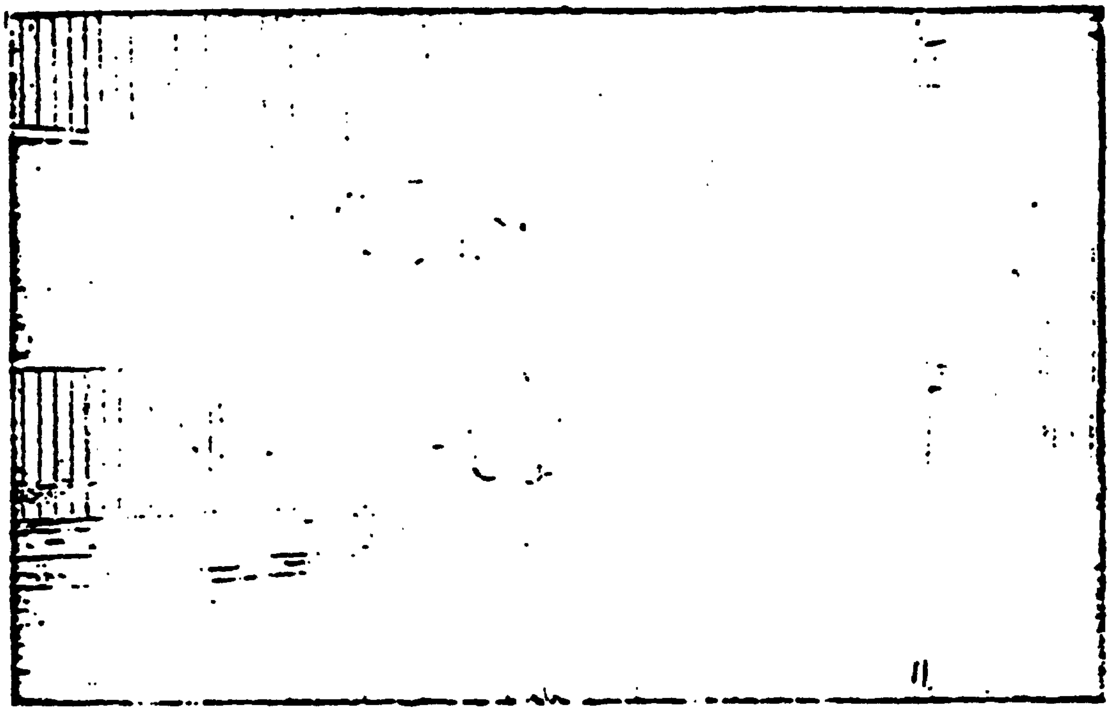


SAMPLE NO. 40

Dept. 53-T

Weighing rubber for wet process mixture

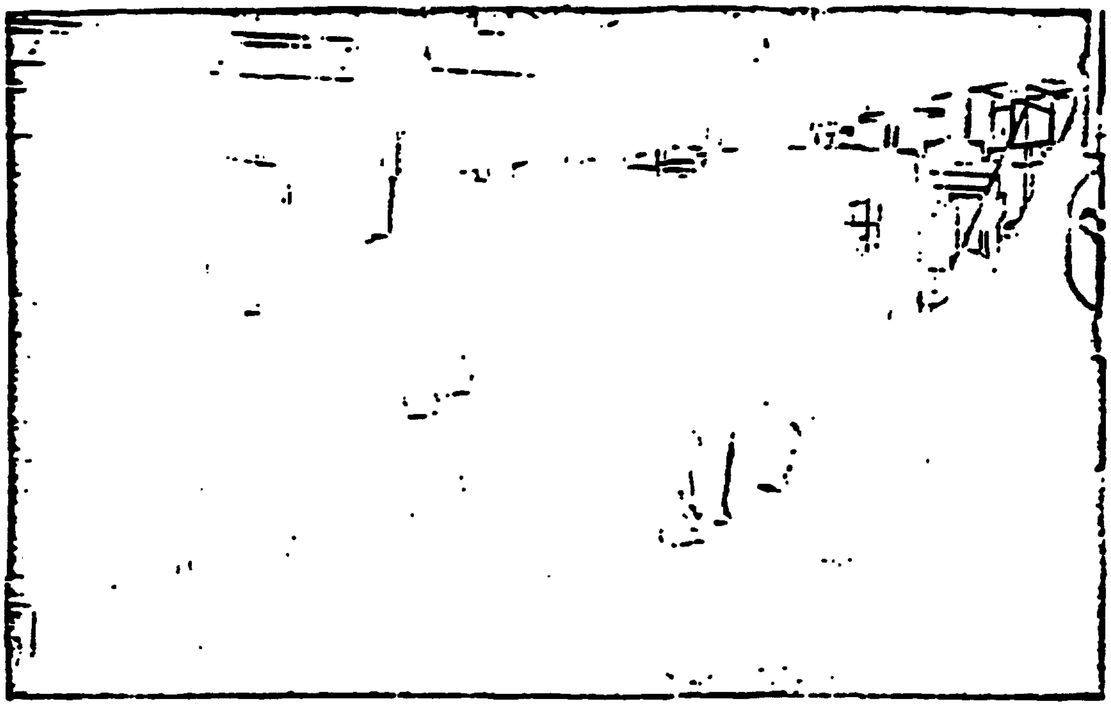
The Manhattan-Rubber Mfg. Div. of
Raybestos-Manhattan, Inc.



SAMPLE NO. 15
Dept. 39

Sandblasting molds for pressing clutch facings

The Manhattan Rubber Mfg. Div.

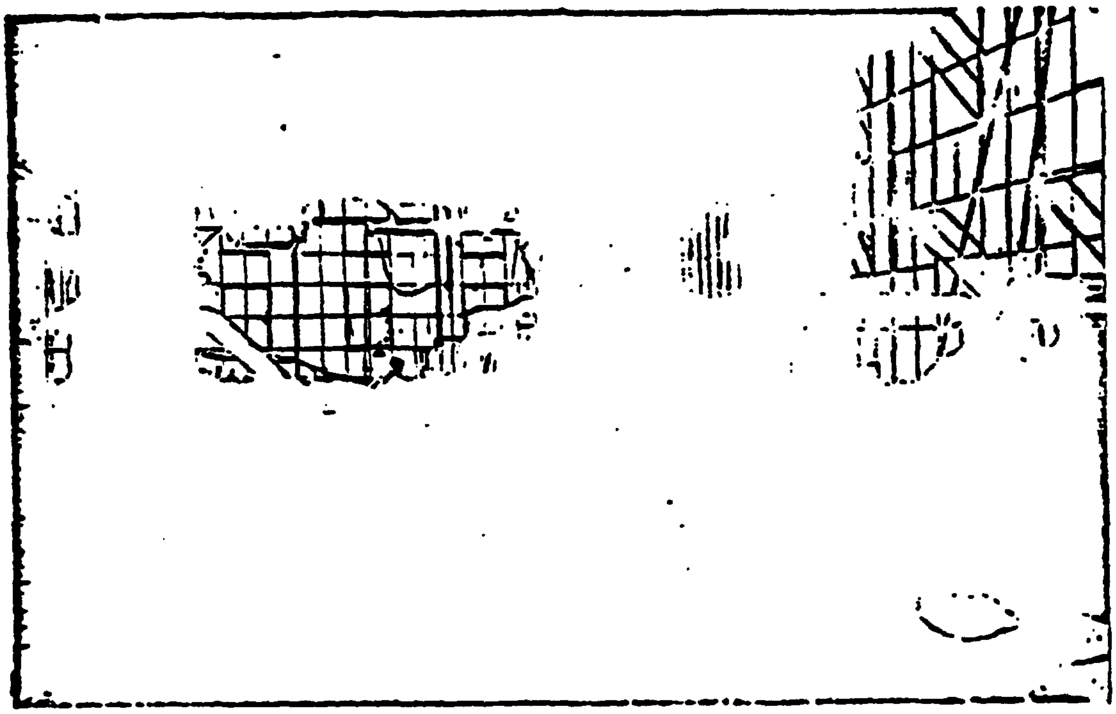


SAMPLES NO. 18 and 19
Dept. 39

Punching clutch-facing material out of
asbestos cloth

The Manhattan Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.

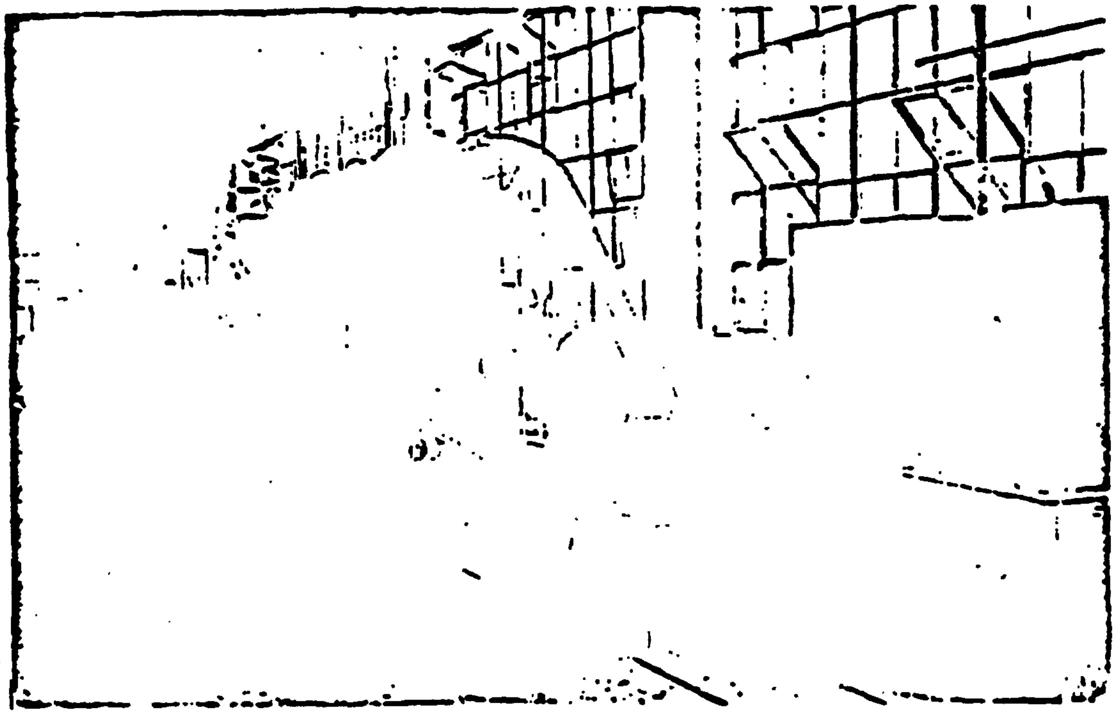
501.



SAMPLES NO. 31, 32,33
Dept. 2

Truing abrasive wheels

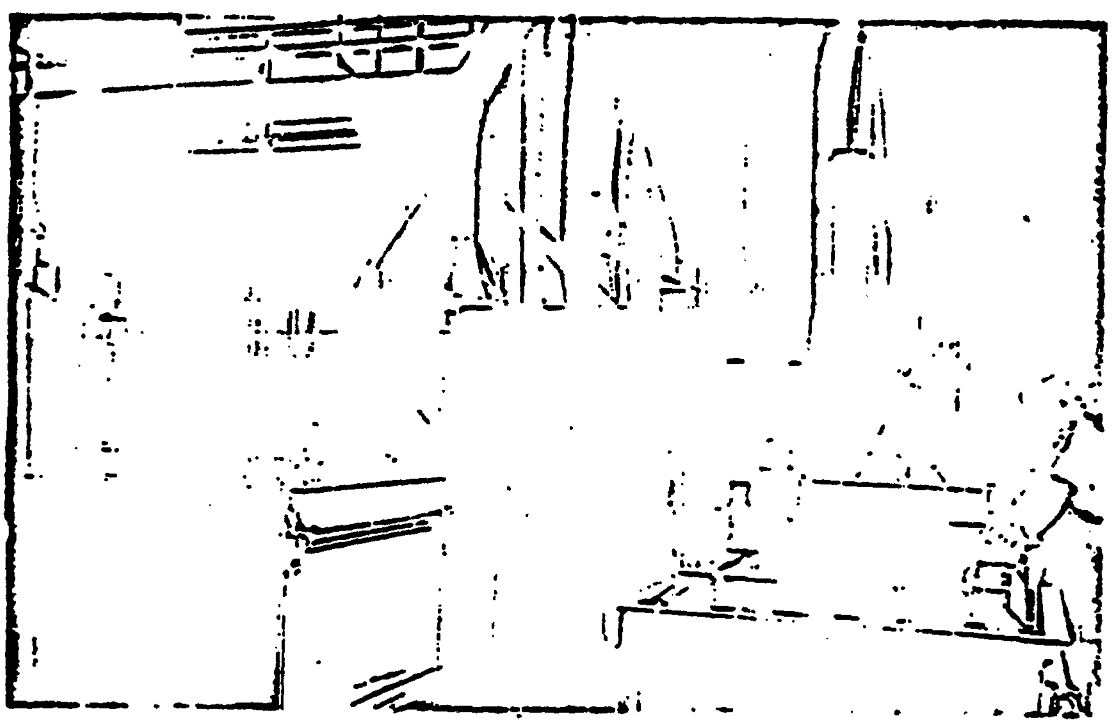
The Manhattan Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



SAMPLE NO. 34
Dept. 2

Batch mixing for abrasive wheels

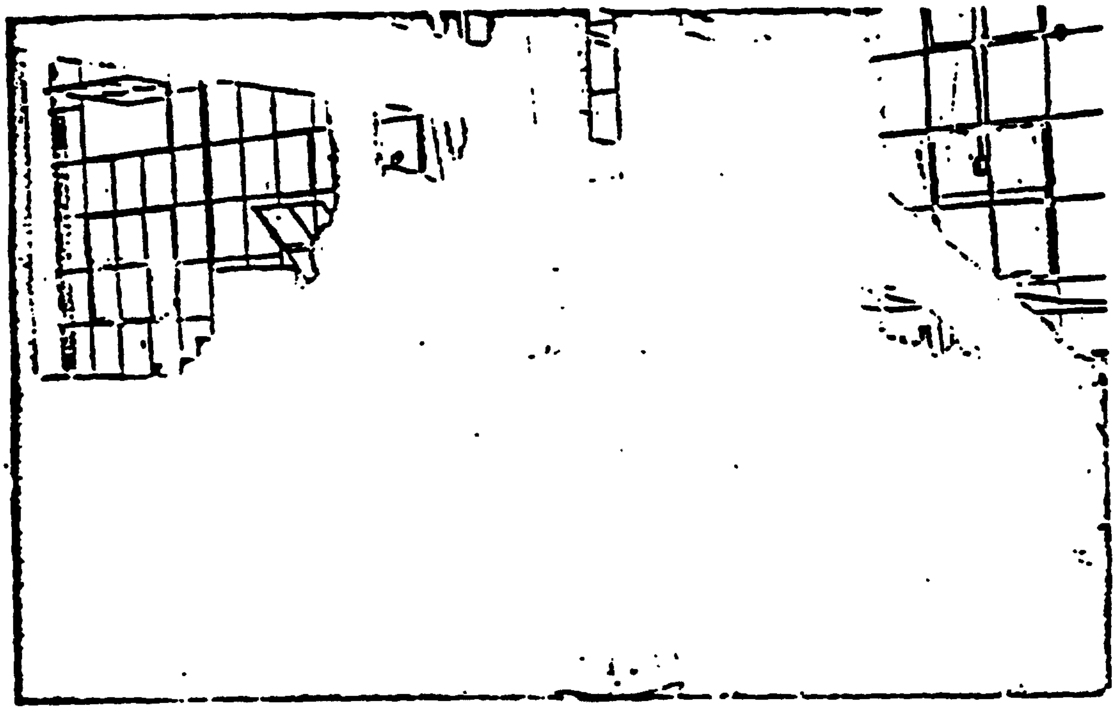
The Manhattan Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



SAMPLE NO. 41
Dept. 53

Weighing and pressing dry process brake lining

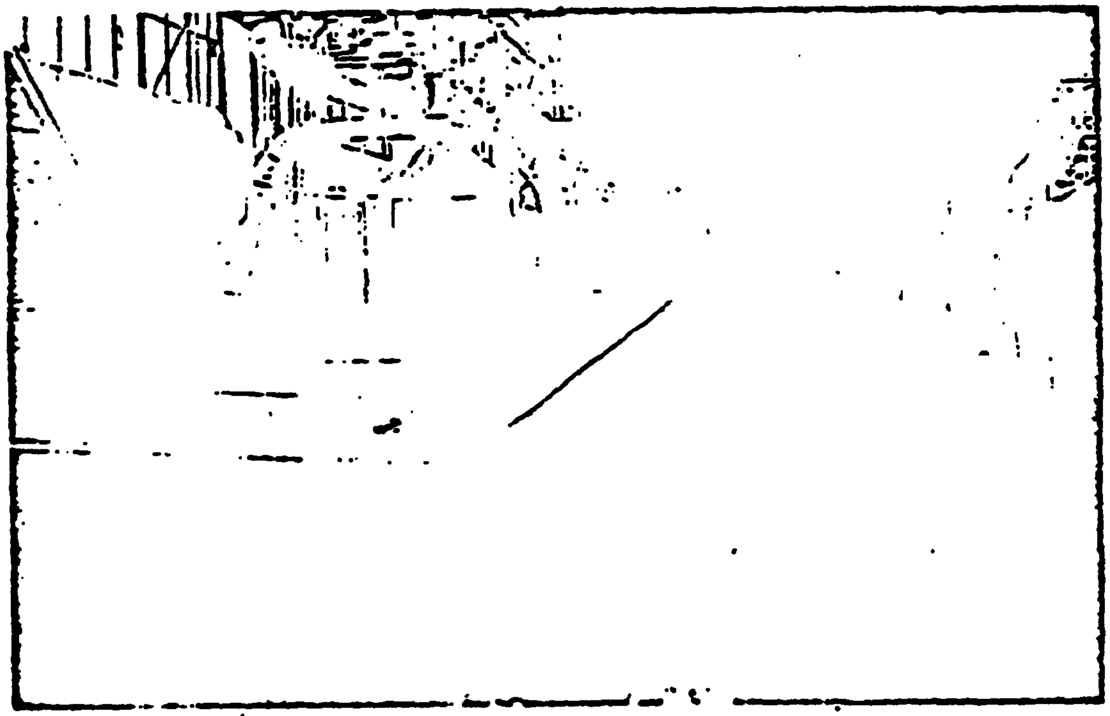
The Manhattan Rubber Mfg. Div.



SAMPLE NO. 30
Dept. 2

Grinding bores on abrasive wheels, machine #1558

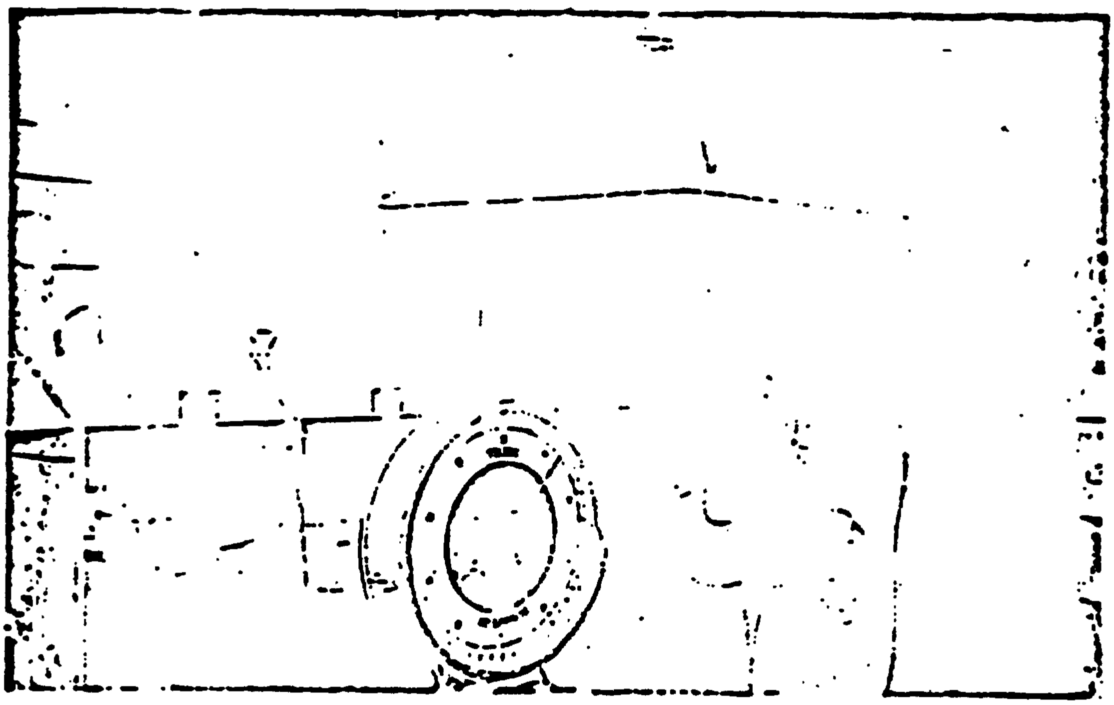
The Manhattan Rubber Mfg. Div.



SAMPLE NO. 42
Dept. 53-T

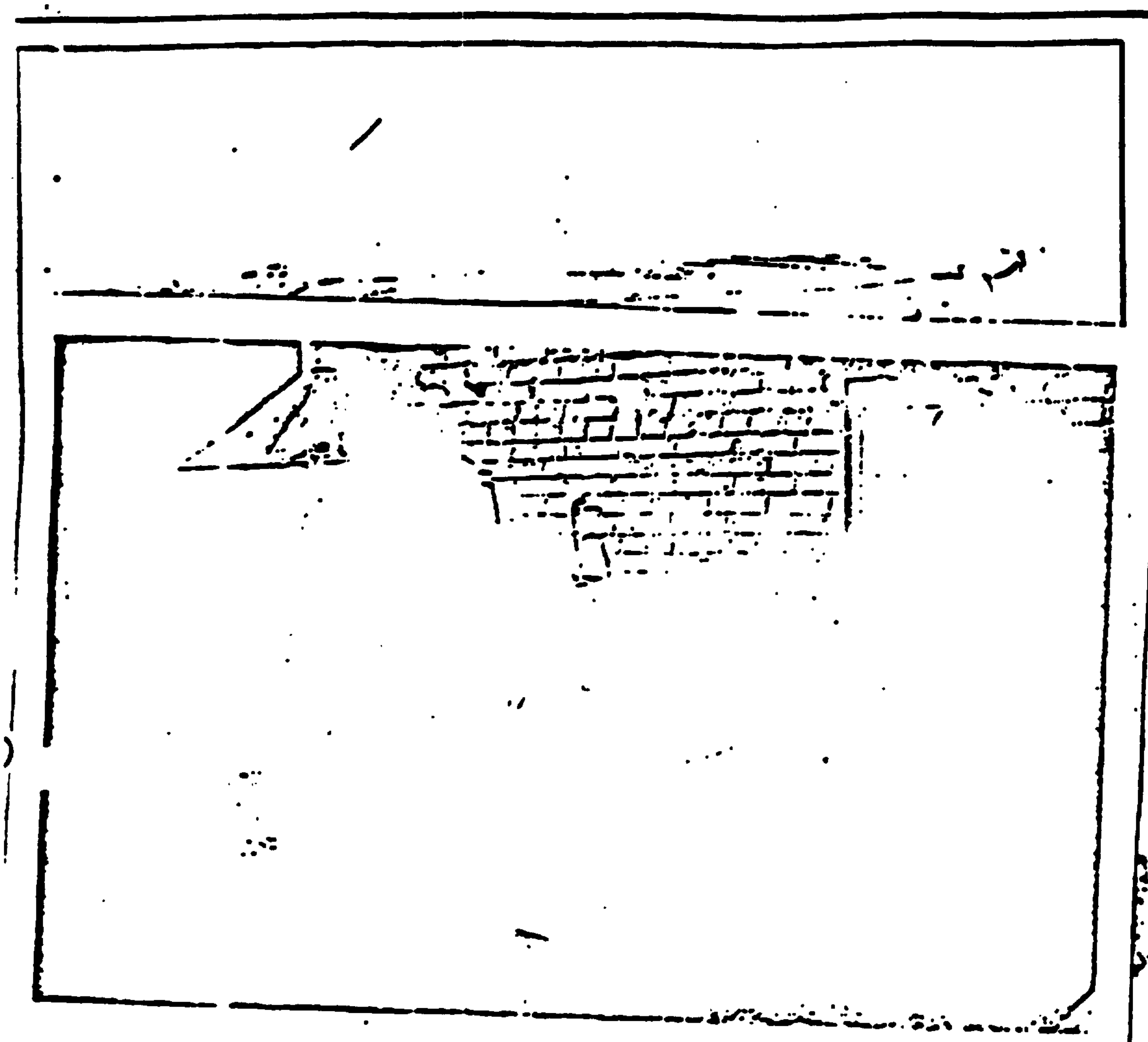
Weighing materials for wet process brake lining mixture

The Manhattan Rubber Mfg. Div.



SAMPLE NO. 43
Dept. 53T
In mixing room during time a mix was prepared and put into mixer. Clutch facing mix for Dept. 39

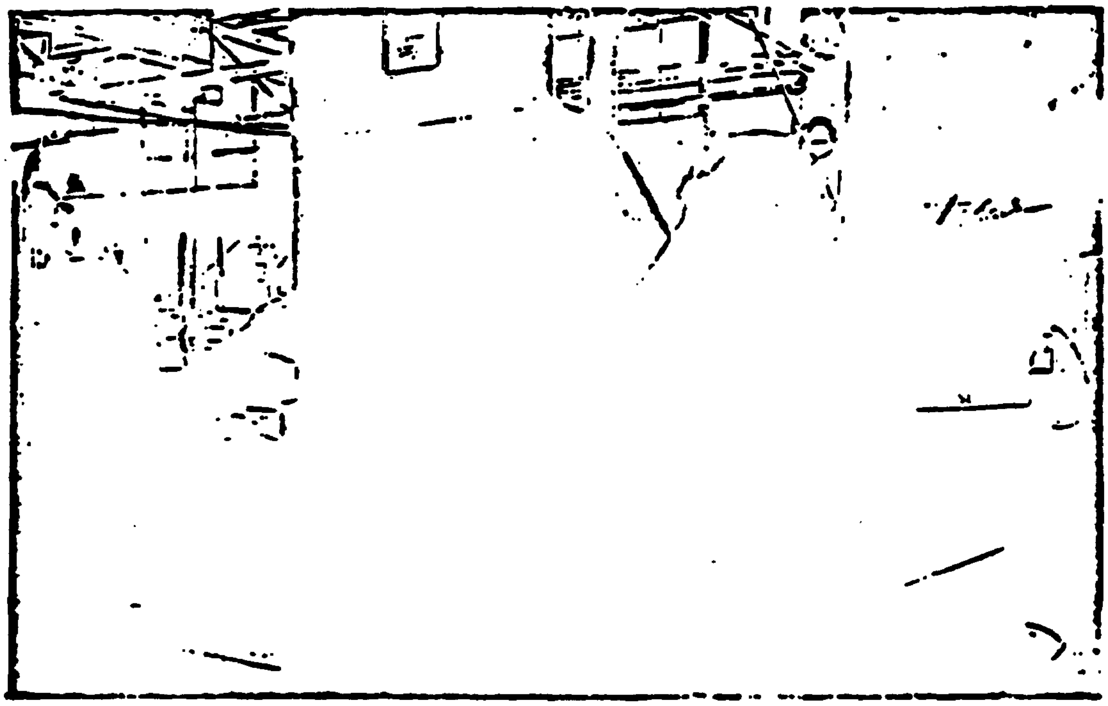
The Manhattan Rubber Mfg. Division
of
Raybestos-Manhattan, Inc.



SAMPLE NO. 44
Dept. 53T

At hammer mill

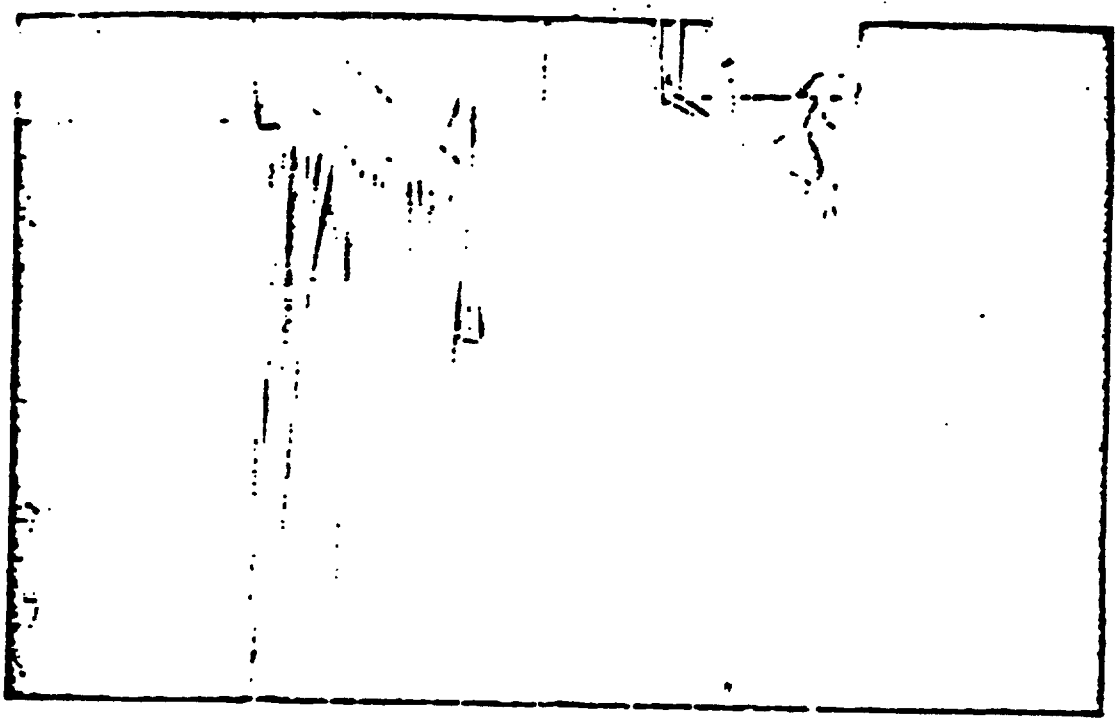
The Manhattan-Rubber Mfg. Div.



SAMPLES NO. 45 and 46
Dept. 53T

At hopper of picker and at shaker screen

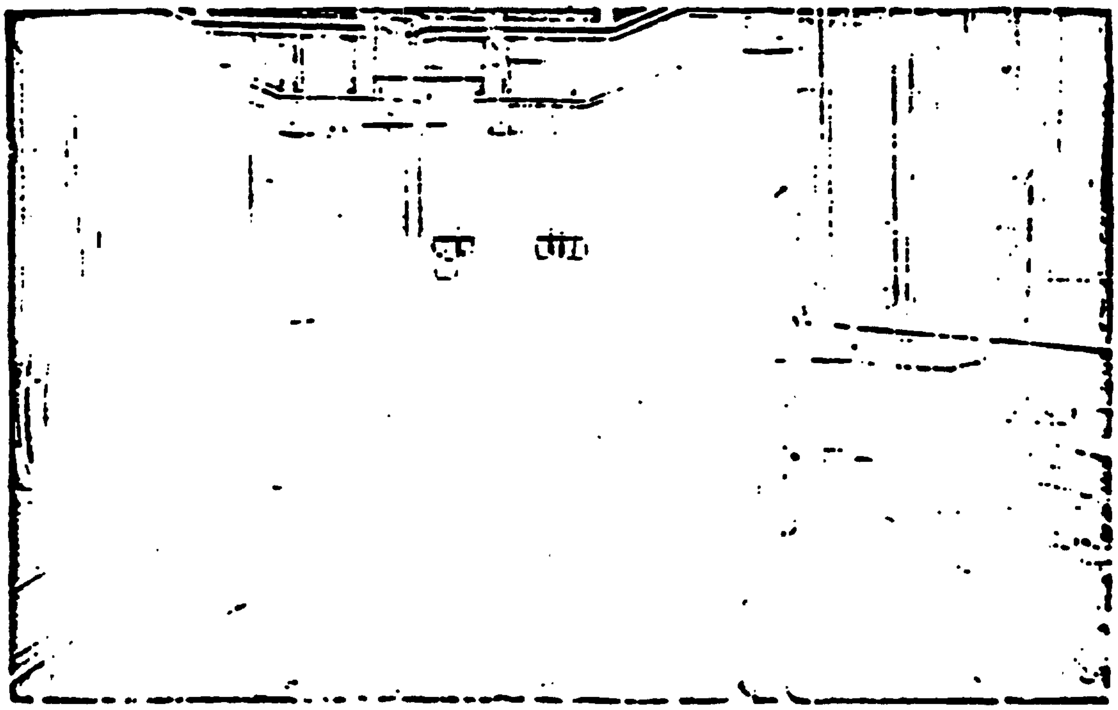
The Manhattan Rubber Mfg. Div.



<u>SAMPLE NO. 47</u>
Dept. 53-T

Between two baggers

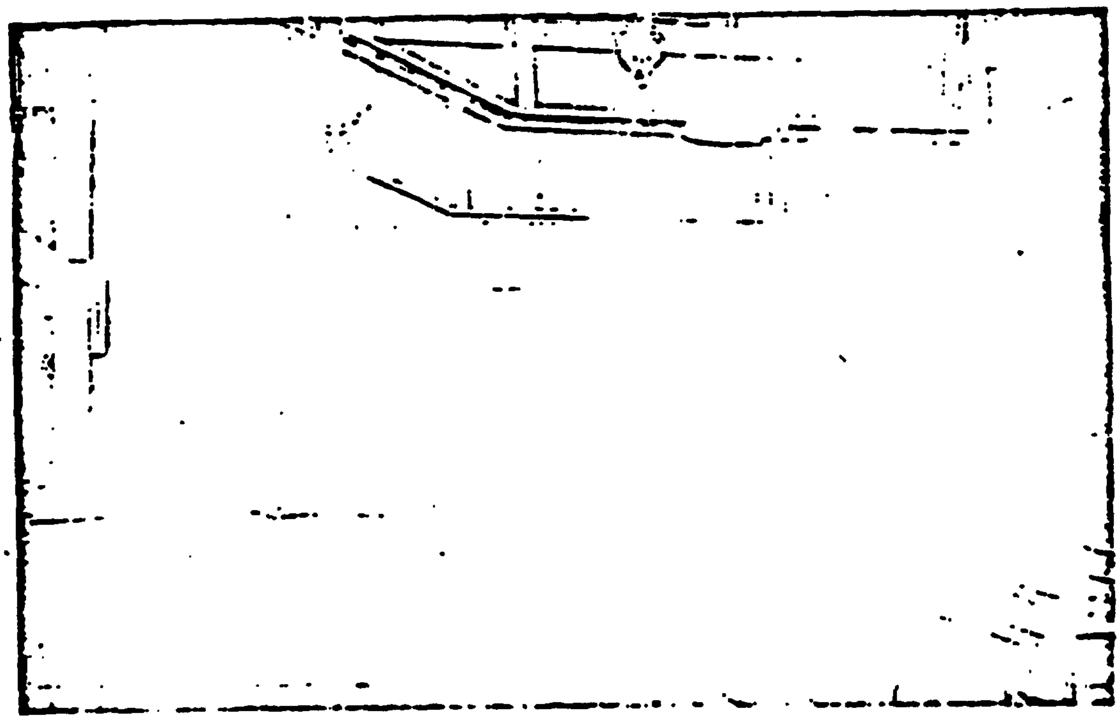
The Manhattan-Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



SAMPLE NO. 48
Dept. 8

General air - taken near belting winder - - east end

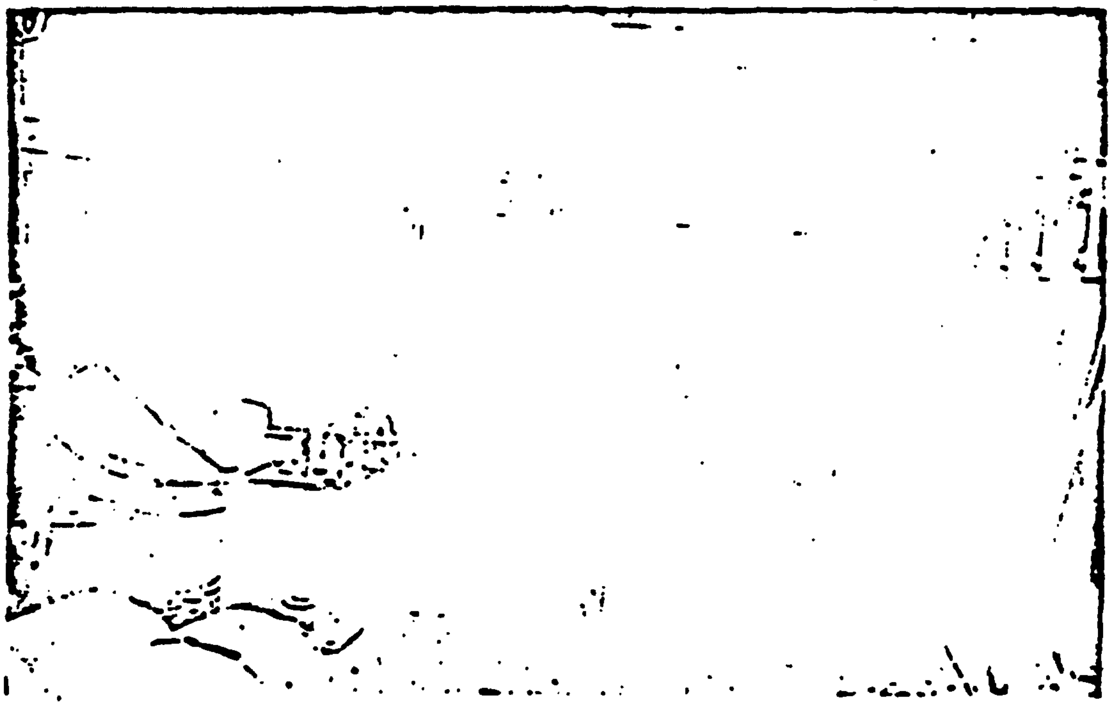
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.



SAMPLE NO. 49
Dept. 26

General air sample taken at Press #16

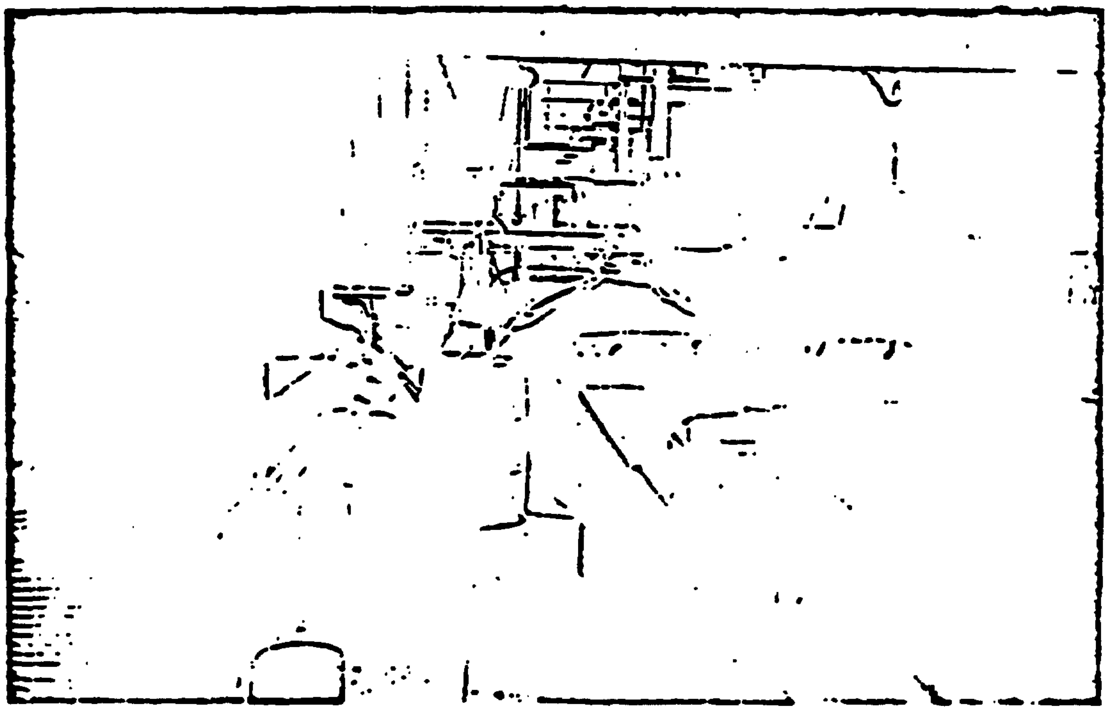
The Manhattan Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.



SAMPLE NO. 50
Dept. 26

General air sample taken at west end
of gum cutting table

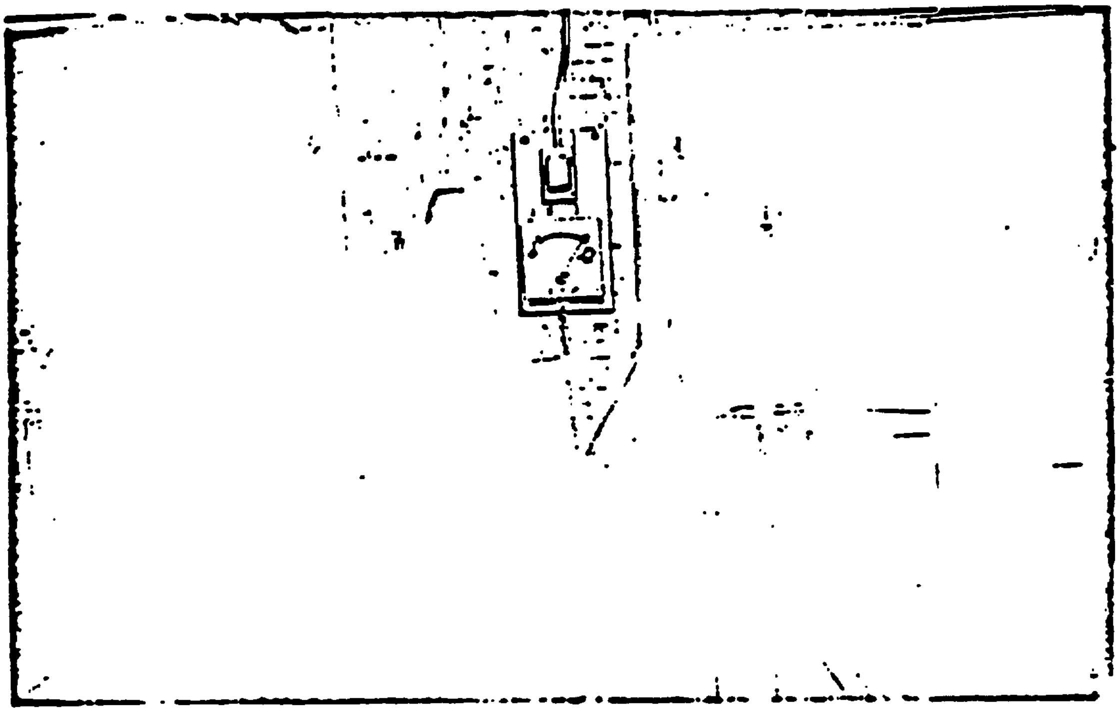
The Manhattan-Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.



SAMPLE NO. 51
Dept. 84

General air taken in belt press room

The Manhattan-Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.



SAMPLE NO. 52
Dept. 8

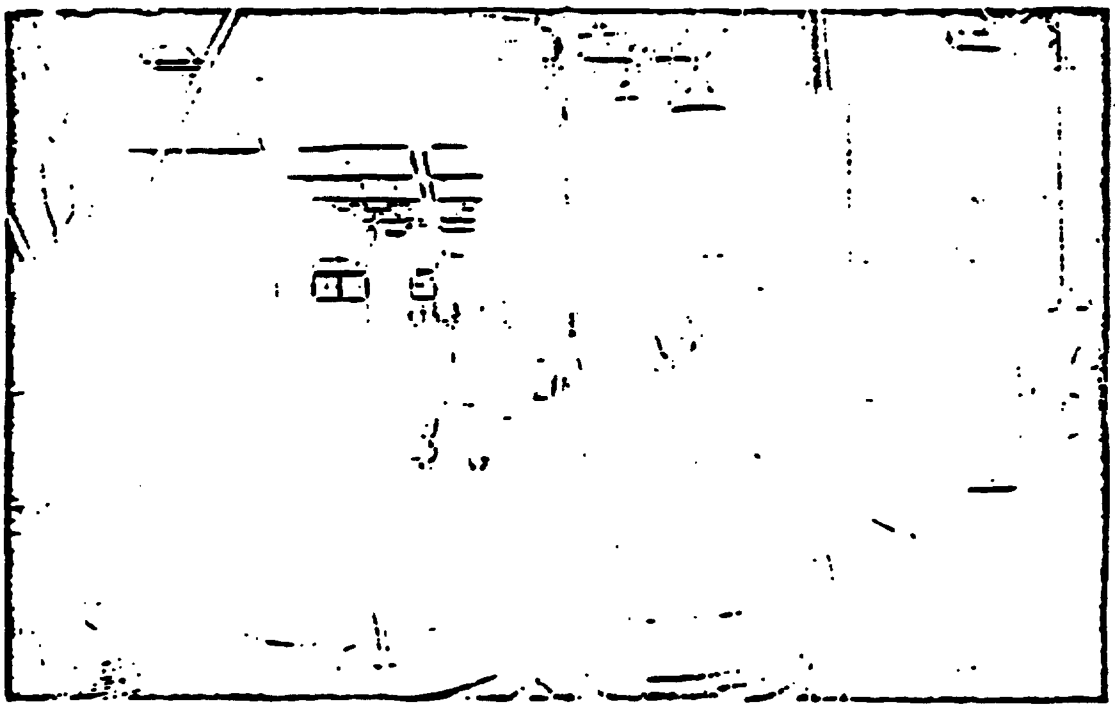
Cutting brake lining to length; power shear #1382

The Manhattan Rubber Mfg. Div.

SAMPLE NO. 53
Dept. 1

General air; rubber mills, east end, two mills #1343 and 1344 - cleaning process for raw rubber

The Manhattan Rubber Mfg. Div.
of Raybestos-Manhattan, Inc.

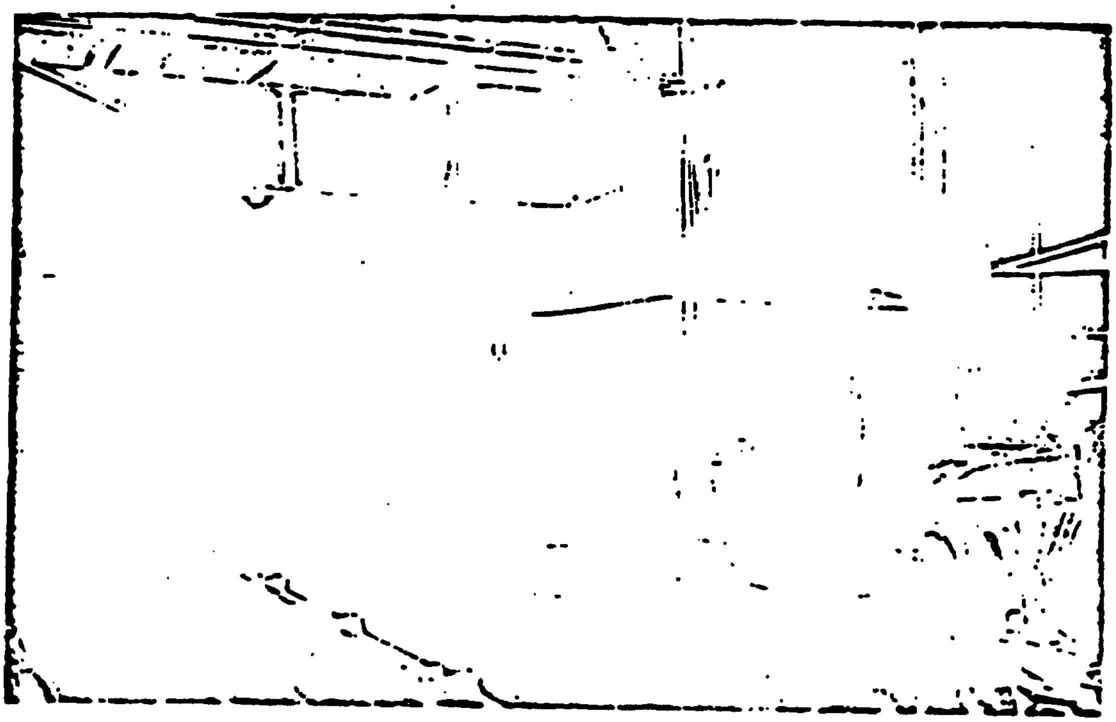


SAMPLE NO. 55

Dept. E-A

**Grinding, reeling and measuring brake lining,
machines #1689 and
#1690**

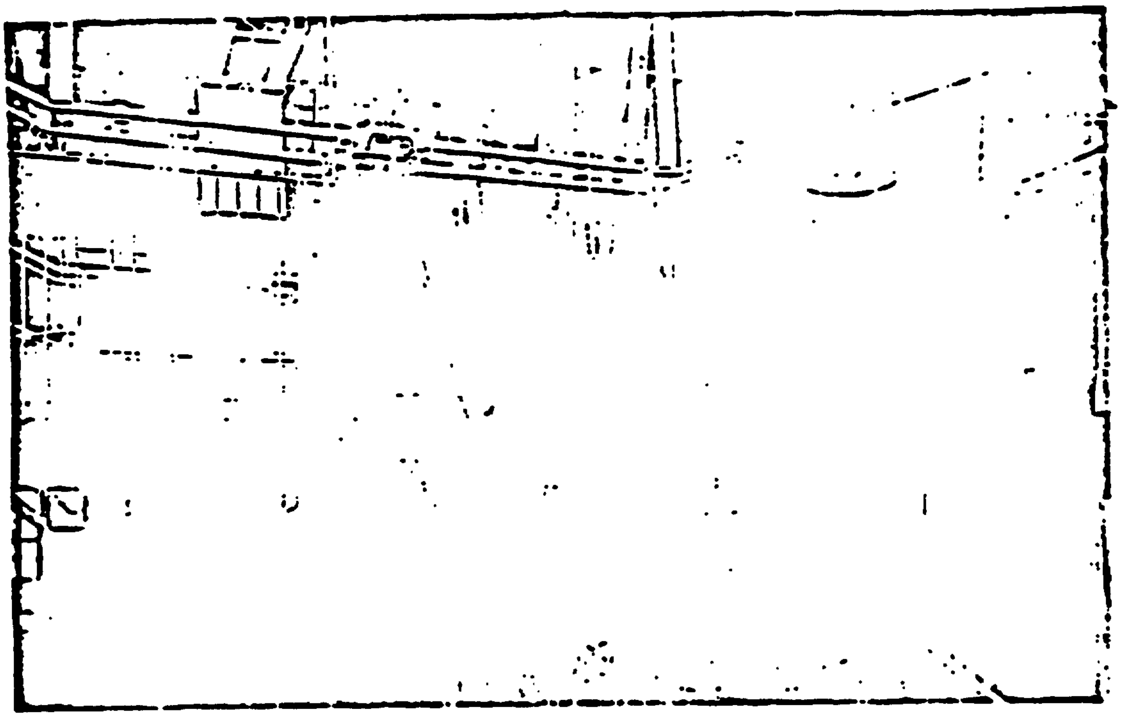
**The Manhattan-Rubber Mfg.
Div. of Raybestos-Manhattan, Inc.**



SAMPLES NO. 56 and 60
Dept. 1

Rubber compounding mills #128, 129 & 130

The Manhattan-Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.



<u>SAMPLE NO. 58</u>
Dept. 1

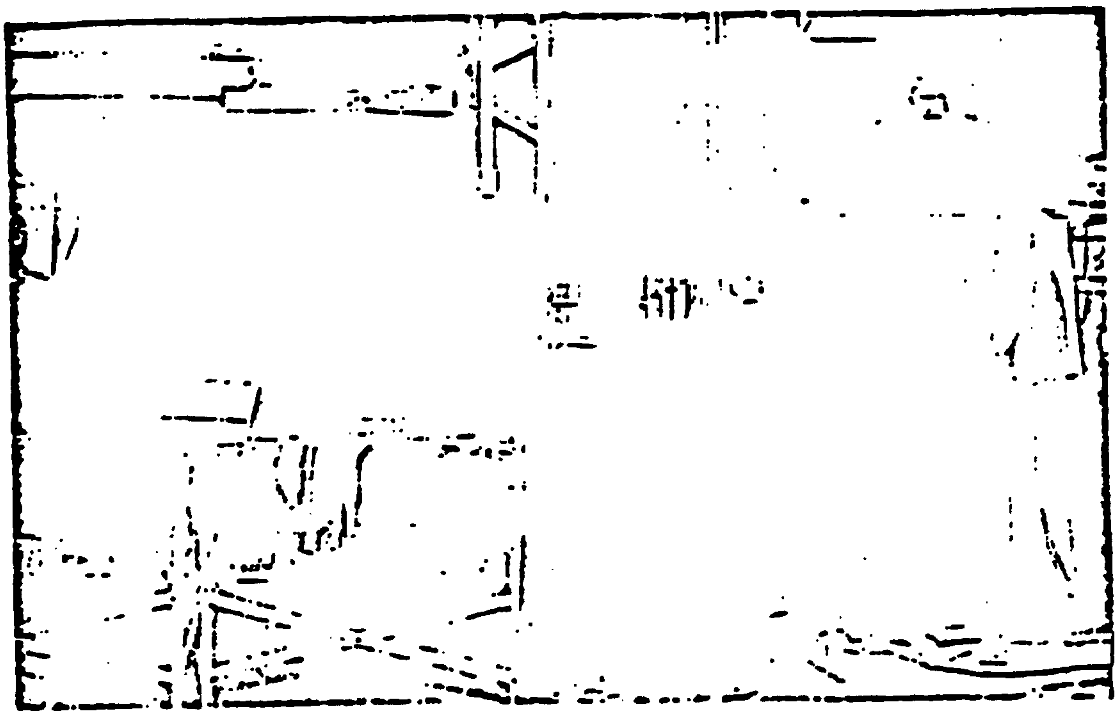
On platform of Banbury mixer #1

The Manhattan-Rubber Mfg. Division
of
Raybestos-Manhattan, Inc.

SAMPLE NO. 61
Dept. 1

Mixing batches of compound from hoppers

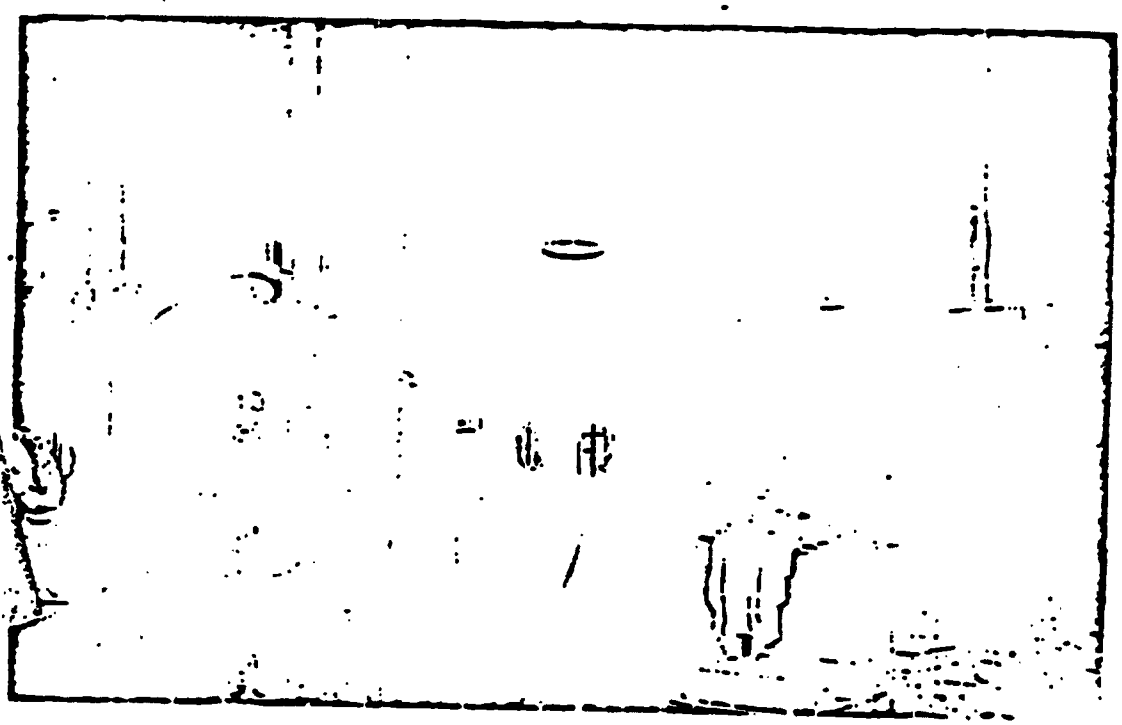
The Manhattan-Rubber Mfg. Division
of
Raybestos-Manhattan, Inc.



SAMPLE NO. 63
Dept. 1

At discharge end of conveyors from rubber
compounding mills. Two men taking
rubber off conveyor

The Manhattan-Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.



SAMPLE NO. 66
Dept. 11

Rubber compounding mill #74 and
friction calender

The Manhattan-Rubber Mfg.
Div. of Raybestos-
Manhattan, Inc.

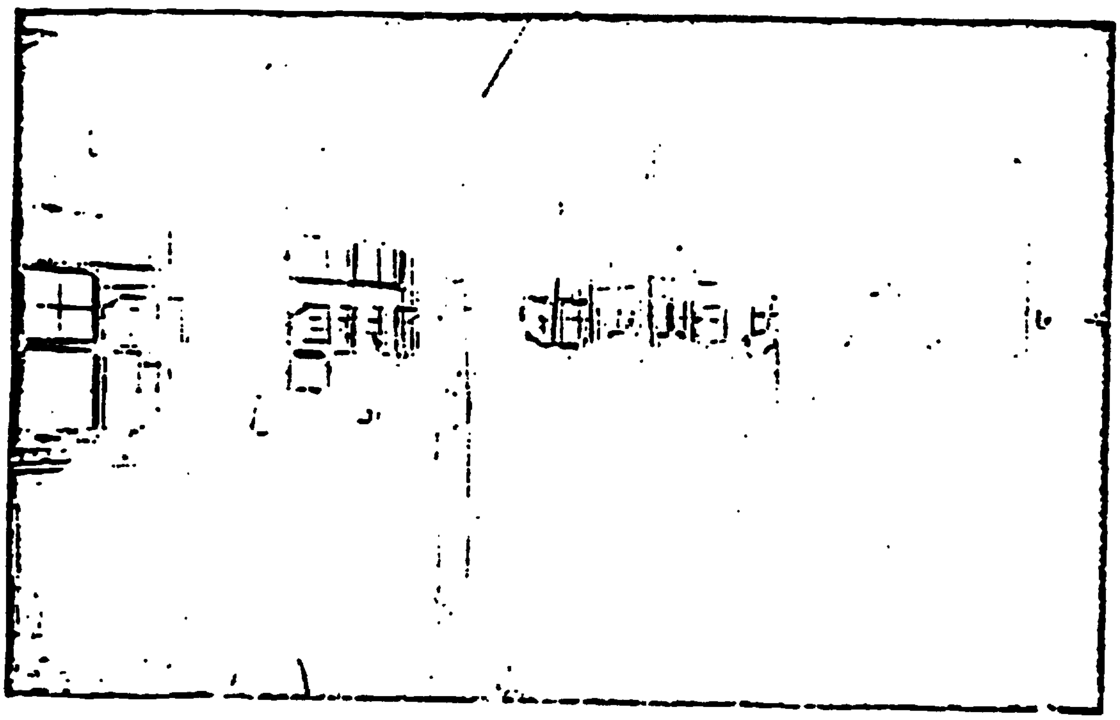
<u>SAMPLES NO. 80 - 84</u>

Dept. 5 - Balcony

Grinding and sanding, rubber

The Manhattan-Rubber Mfg.
Div. of Raybestos-Man-
hattan, Inc.

76 K



SAMPLE NO. 87
Dept. 5 West End Room

General air sample between three machines
panning and reeling rubber tubing

The Manhattan-Rubber Mfg. Div.
of
Raybestos-Manhattan, Inc.

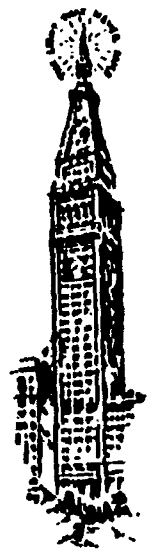
PLAINTIFF'S EXHIBIT

MET-296

Protection of Workers Exposed to Chromium & Its Compounds Edition 1921

(b) 4732 W

P|Pearson 33·C
11·4·83



METROPOLITAN LIFE INSURANCE COMPANY PRESS
NEW YORK, U.S.A.
(b) 4732 W

PROTECTION OF WORKERS EXPOSED TO CHROMIUM AND ITS COMPOUNDS

INDUSTRIAL HEALTH SECTION
METROPOLITAN LIFE INSURANCE COMPANY
HOME OFFICE, NEW YORK
Pacific Coast Head Office, San Francisco
Canadian Head Office, Ottawa

Protection of Workers Exposed to Chromium and Its Compounds

INTRODUCTION

The increasingly diverse and numerous industrial applications of chromium and its compounds have renewed interest in the troublesome, although not serious, effects of the action on the skin of exposed workers, and in studies to determine any harmful results following introduction into the body. Efforts have been directed particularly toward methods of protection for workers so exposed.

TOXICITY

All compounds of chromium are not equally toxic. Chromic acid (CrO_3) and the chrome salts, especially potassium and sodium bichromate, are far more toxic than the neutral salts and oxide. The bichromates (K_2CrO_4; Na_2CrO_4) are many times more poisonous than the soluble chromium oxide compounds, while chrome ironstone, native ferrous chromite ($FeCr_2O_4$), and pure chromium (Cr) are nonpoisonous.

It should be remembered that the chrome colors yellow, orange, green, and red—are lead chromates, and the chief danger lies in the lead content, which may cause chronic lead poisoning. These compounds may be known as lemon royal, Cologne and Paris yellow, or lead yellow.

USES

The development and rapidly increasing popularity of chromium plating have increased greatly the use of chromic acid in a variety of industrial operations. The process consists in the deposition of metallic chromium by passage of low-voltage electric

current through a solution having chromic acid as its principal constituent and is widely applied in the manufacture of automobile fittings, plumbing fixtures, and an assortment of small hardware. Important among other diverse industrial applications using chromates are the manufacture of batteries; chrome tanning; manufacture of safety matches—particularly Danish, Swedish, and "strike-anywhere" matches, which exposes the dippers rather than the mixers to chrome ulcers; photo-engraving and photography, especially in the "carbon-process"; wood coloring and hardening; textile printing; dyeing of leather gloves and mittens, fur, wool, and felt hats (usually in the steaming process), cotton, where chrome salts are required as "oxidizers" and "discharging" agents, and aniline dyeing; the bleaching of oils, fats, and wax; manufacture of colored glass, porcelain, and earthenware; steel making; manufacture of pigments, dyestuffs, and of various salts of chromic acid; manufacture of "pyroxydine" powder made from guncotton with bichromate of ammonium and potassium; ink making; zincolithography; cyanotype process of blueprints in which bichromate is the fixing agent; oxidation of alcohols, aldehydes, and other oxygenated compounds; manufacture of artificial flowers, linoleum, wallpaper, and colored crayons; in the rubber industry on secondary operations, such as paint pigments, welding molds, and tire rims, plating processes and large cleaning baths; in the leather industry (workers sometimes follow the practice of using their bare feet to soak the leather in tubs, in which case chrome sores develop between the toes); and in analytical chemistry.

MODES OF CONTACT

Chromic acid and its compounds are conveyed to the skin and mucous membranes:

First, through handling the dry material itself, either as crystals or in the form of a fine powder.

Second, through contact with solutions of the material.

Third, through exposure to the atmosphere containing the material in the form of a vapor, spray, or mist, or as a dust, in varying amounts, depending upon the technique practiced.

WEAVE ROOM

No.	Station	Date	Cu. Ft. Air Sampled	Millions of Particles per cu. ft. air sampled	Millions of Particles less than 10 microns per cu. ft. air sampled	Type of Dust	Remarks
	General air - west end of weave room	7/10/34	32.6	6.3	6.1	Asbestos	
	Same as #22	7/11/34	35.7	0.6	0.5	"	
	At inspection table woven cloth	"	27.3	2.6	2.5	"	Revolving brush - exhaust hood - two men
	General air - east end of weave room	"	27.9	5.5	5.3	"	
	Inspection table enclosed in beaver board two men - sample taken inside enclosure	"	20.2	3.2	3.0	"	Taken with revolving brush and exhaust running, Manhattan cloth 6815 and 140
	Taken just outside enclosure	"	19.0	9.5	9.3	"	Same time as #31
	Taken inside enclosure	"	20.2	23.2	21.9	"	Revolving brush - no exhaust two men
	Taken outside enclosure	"	18.8	1.5	1.5	"	Same time as #33
	Taken inside enclosure	"	20.2	1.5	1.4	"	Hand brushing - three men
	Taken outside enclosure	"	19.0	2.1	2.0	"	Same time as #35
	General air - west end of weave room	7/13/34	18.8	9.3	9.2	"	Before work started in morning, shut down from midnight
	General air - east end of weave room	"	18.6	6.0	5.9	"	" " "

- - - - - - - - - - - - - - - - - - - -

-- The dust counts of samples #43 and 44 were taken before work started in the morning. These counts are considerably higher than samples taken during operating periods. This may be due to closing of windows, shutting off of humidifiers and floor sweeping.

WEAVE ROOM (Continued)

Station	Date	Cu. Ft. Air Sampled	Millions of Particles per cu. ft. air sampled	Millions of Particles less than 10 microns per cu. ft. air sampled	Type of Dust	Remarks
General air - east end of weave room	7/13/34	27.0	2.6	2.6	Asbestos	Same time as #46 and 47; weave room started at 7 o'clock
General air - west end of weave room	"	27.9	2.7	2.7	"	Same time as #45 and 47
At inspection table for woven cloth, dry woven cloth 10P225	"	30.3	0.8	0.8	"	Revolving brush and exhaust; two men, same time as #45 and 46
Same location as #45	"	27.0	3.0	2.9	"	Same time as #49 and 50
Same location as #46	"	27.9	5.1	5.0	"	Same time as #48 and 50
Inspection table - hand brushing	"	30.3	0.8	0.8	"	Three men - at same time as #48 and 49
Same location as #45	"	18.9	4.9	4.8	"	At same time as #52 and 53
Same location as #46	"	20.5	0.9	0.9	"	Same time as #51 and 53
Table inspection woven cloth, revolving brush, no exhaust	"	21.2	1.8	1.7	"	Same time as #51 and 52; two men

General air samples, #22, 24 and 26, 45, 46, 48, 49, 51 and 52, averaged 3.5 million particles per cubic foot air, as compared with .6 found in survey of January 1930.

PACKING DEPARTMENT

Sample No.	Station	Date	Cu. Ft. Air Sampled	Millions of Particles per cu. ft. air sampled	Millions of Particles less than 10 microns per cu. ft. air sampled	Type of Dust	Remarks
20	General air - molded packing department	7/10/34	62.3	0.45	0.43	Asbestos	
23	General air - rubber compounding room	"	28.2	1.4	1.3	Clay lead talc sulphur	

- -

LEAD ANALYSES

Sample No.	Station	Date	Cu. Ft. Air Sampled	Milligrams of lead per cu. ft. air sampled	Type of dust	Remarks
21	Between two rubber compounding mills	7/10/34	33.8	Negative for lead	Clay lead talc sulphur	Exhaust hoods with cloth curtains
23	General air - rubber compounding room	"	28.2	Negative for lead	"	

CLOTH INSPECTION (WEAVE ROOM)

Table showing the results of special tests run at the cloth inspection table

	Millions of Dust Particles per cu. ft. air sampled	
	Inside enclosure (doors closed)	Normal conditions enclosure removed
Average general air - weave room during tests	3.5	3.8
Cloth inspection table - exhaust and revolving brush	3.2	0.8
Cloth inspection table - no exhaust but with revolving brush	23.2	1.8
Cloth inspection table - hand brushing, no exhaust	1.5	0.8

It was noted that only slight changes had been made in the preparation room since the survey in 1930. The method of oiling and conveying the fibre remains the same. As noted, the average dust count remained constant.

Extensive changes and increased methods of dust entrapping and removal in the card room were noted. The method of conveying the fibre from the preparation to the card room is the same and the fibre is carted from the storage bins to the feed hoppers on the cards in the same manner.

Natural ventilation is supplied by open windows which occupy approximately two thirds of the total wall space.

Samples No. 37 and 39 were taken before the fibre conveyors from the preparation room were running, while samples No. 40 and 42 were taken after the conveyors were put into operation. The increased count is evidently due to dust generated by the fibre conveyors and leakage from the storage bins in the card room.

In the test on the enclosed card, samples 37, 38, and 39 were taken before the fibre conveyors were operating and samples No. 40, 41 and 42 were taken after the conveyors were running. The muslin enclosure is not effective in keeping out the fine dust, as evidenced by the comparison of counts on samples taken simultaneously inside and outside the enclosure. The increased counts after the conveyor was operating should be noted.

The natural ventilation in the weave room is augmented by a forced air supply through the fan and distributing ducts used for heating in the winter months. The chance of dust pollution from this outside air supply is remote, as the dust collectors are located at a distance east of the weave room. Experimental work is in progress on entrapping and exhausting dust generated by the looms.

Attention is called to the tests run on the cloth inspection table, with the mechanically operated brush, which show that the exhaust system is effective in keeping the dust concentration down to the same count as under the system of hand brushing without exhaust.

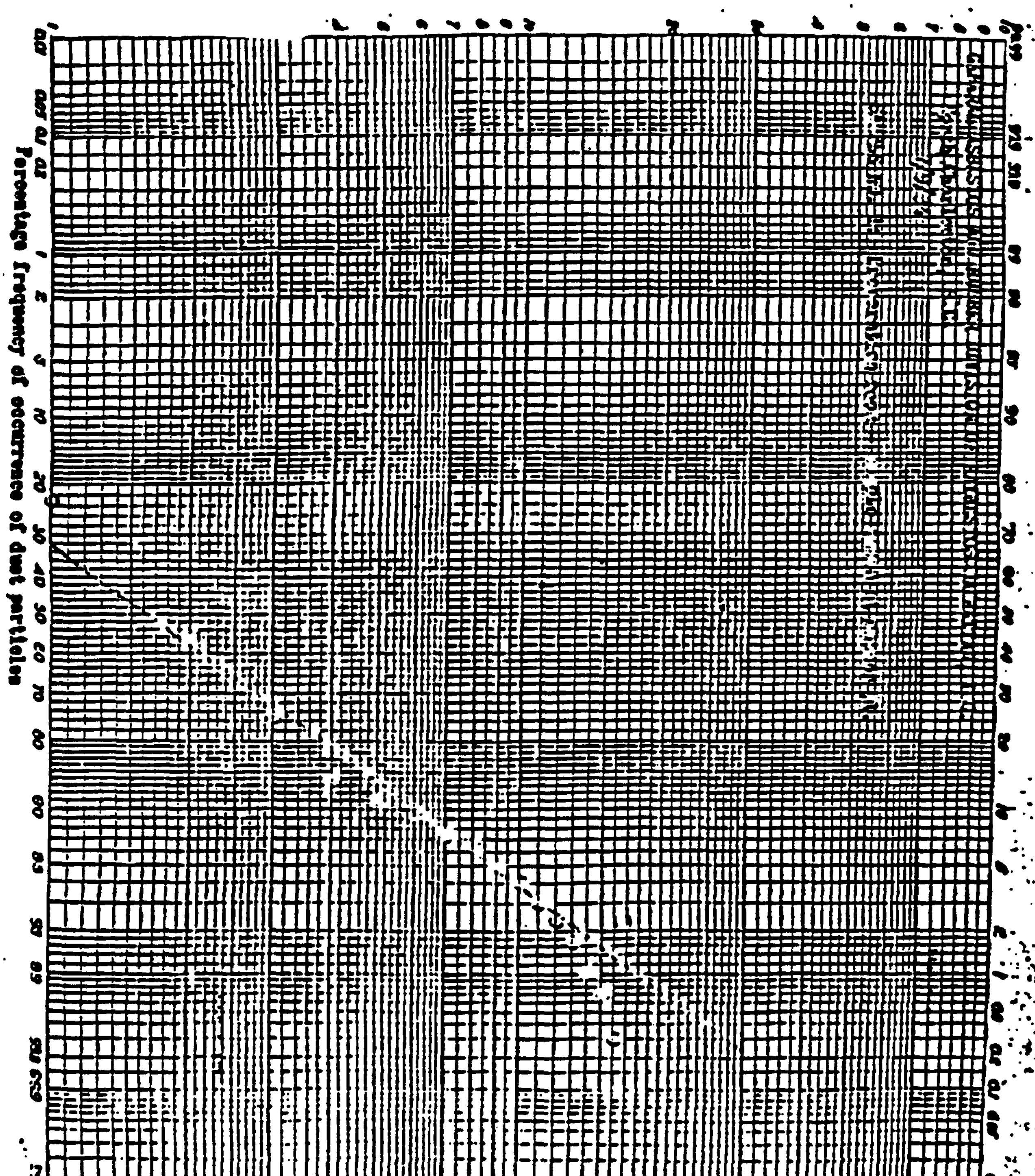
The lead pollution at the rubber compounding operations of the packing department has been corrected, as shown by the absence of lead in the air samples taken.

CONCLUSIONS AND RECOMMENDATIONS

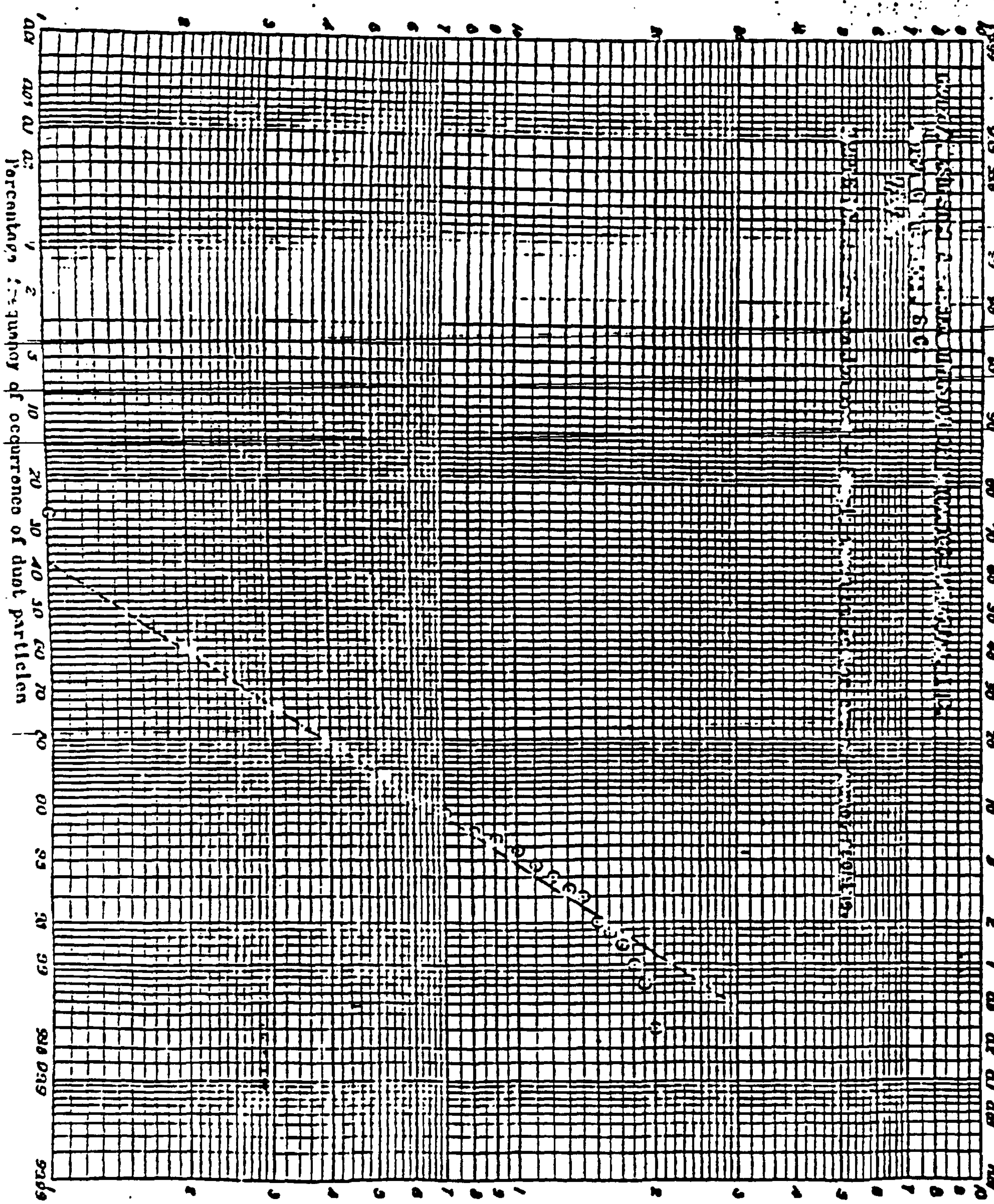
An exhaust system is under construction in the card room and experimental work is in progress for entrapping and exhausting dust generated by the looms in the weave room, and until this work is completed and checks run on the efficiency of the exhaust system, no other recommendations can be made.

Tests conducted in the card room show that there is an increase in the general air dust content when the fibre conveyors are in operation. This is due to leakage of dust from the fibre storage bins in the card room and efforts should be made to seal this leakage.

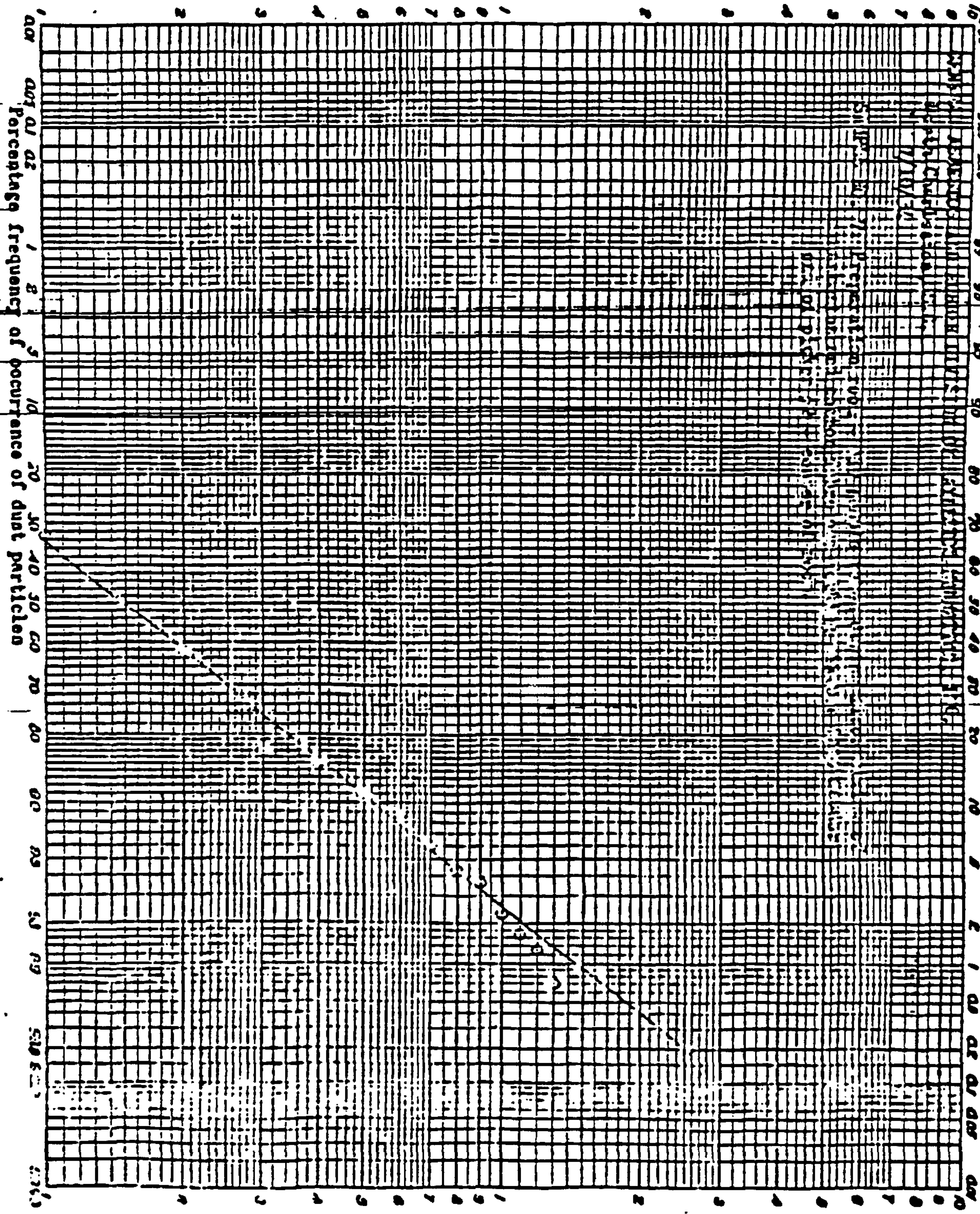
Dust particle sizes in microns



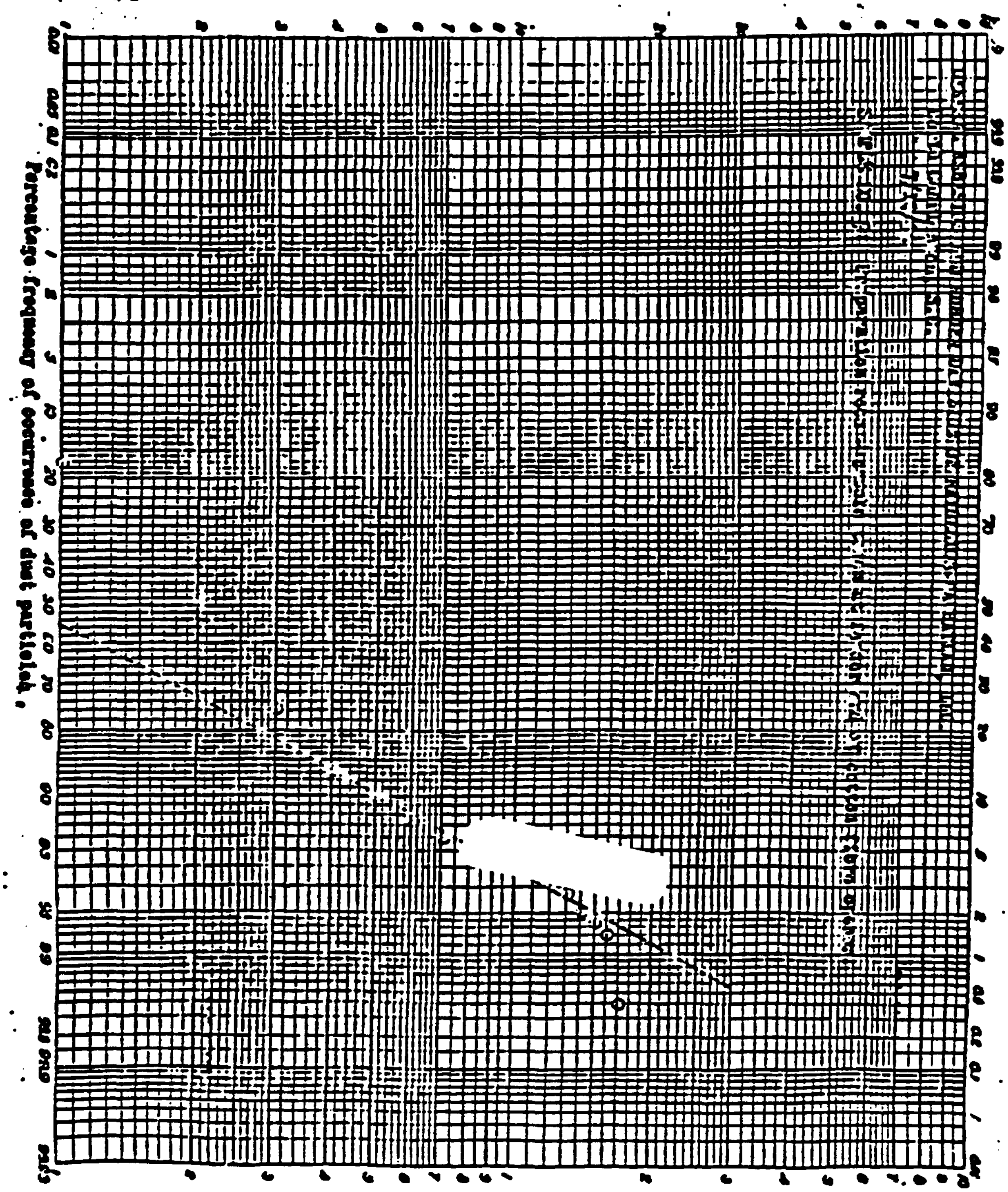
Dust particle sizes in microns

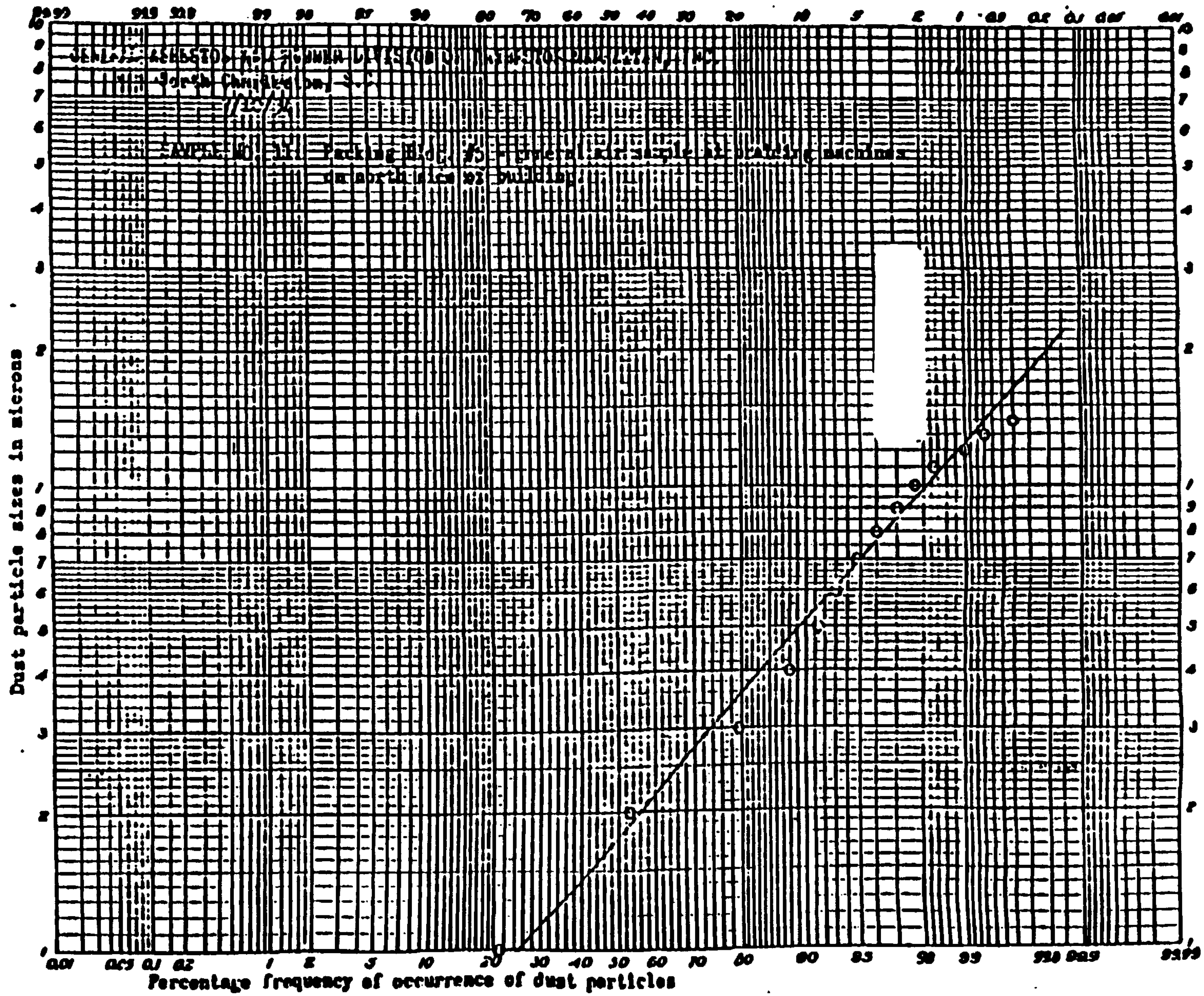


Dust particle sizes in microns

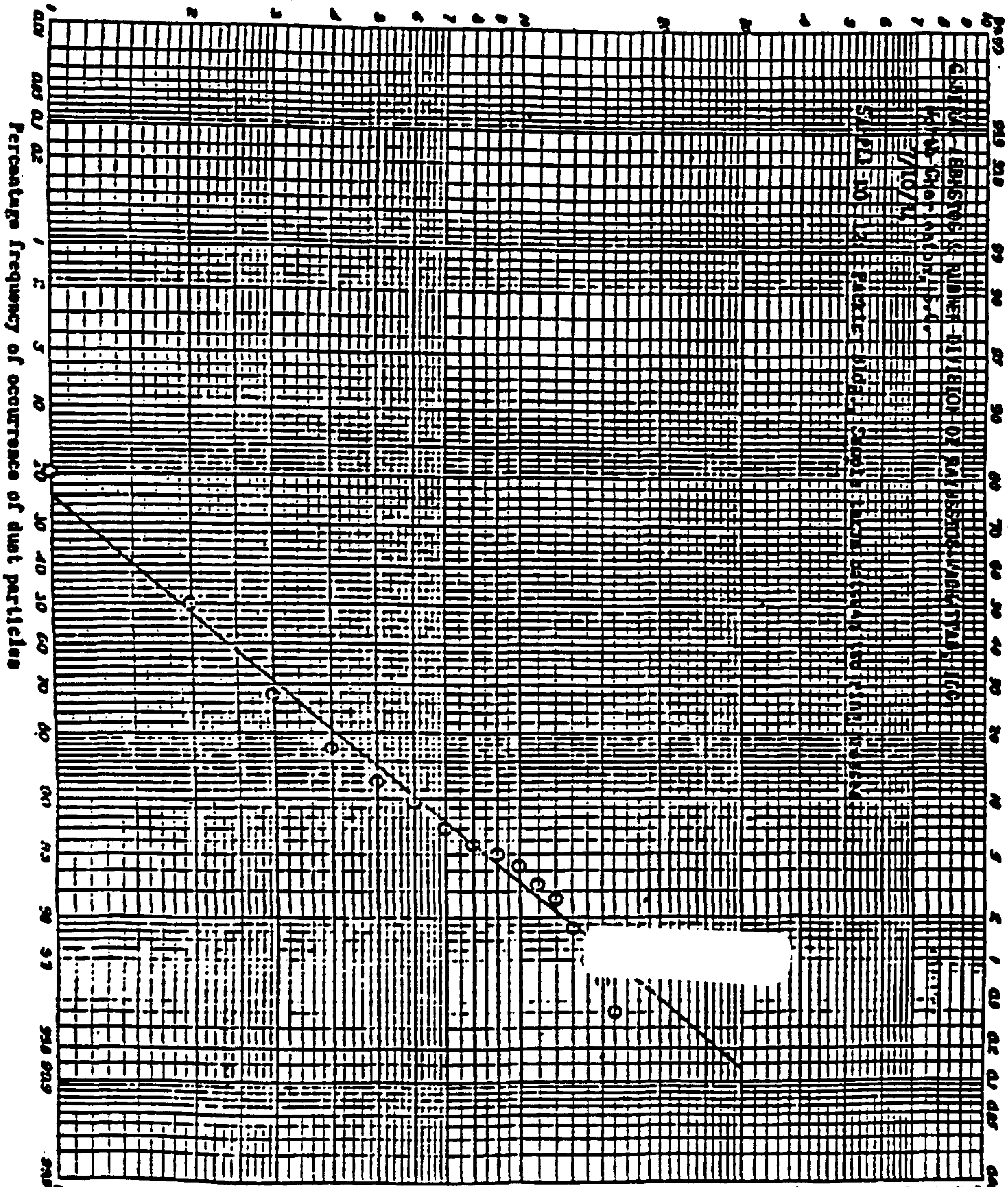


Dust particle sizes in microns

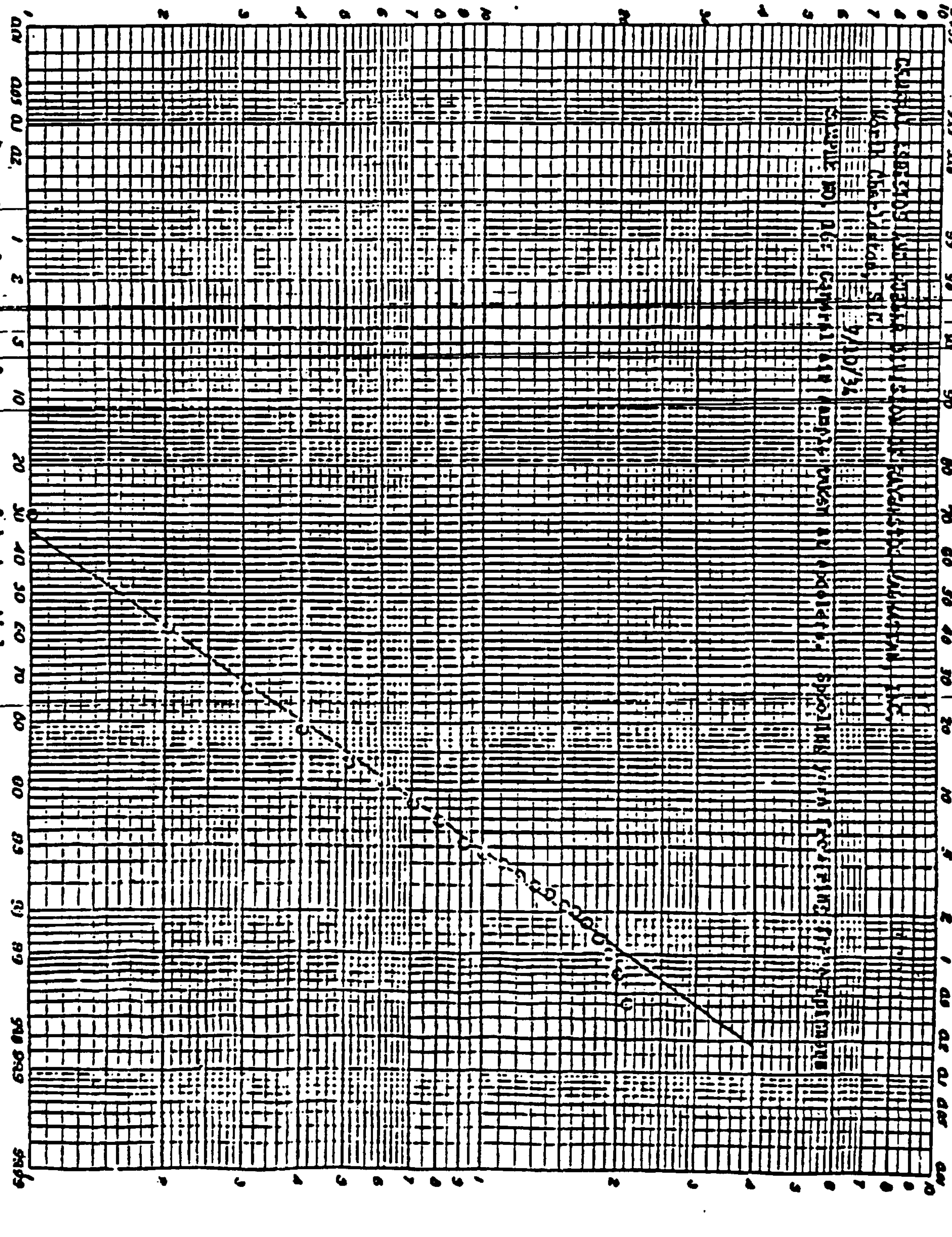



Dust particle sizes in microns
Percentage frequency of occurrence of dust particles

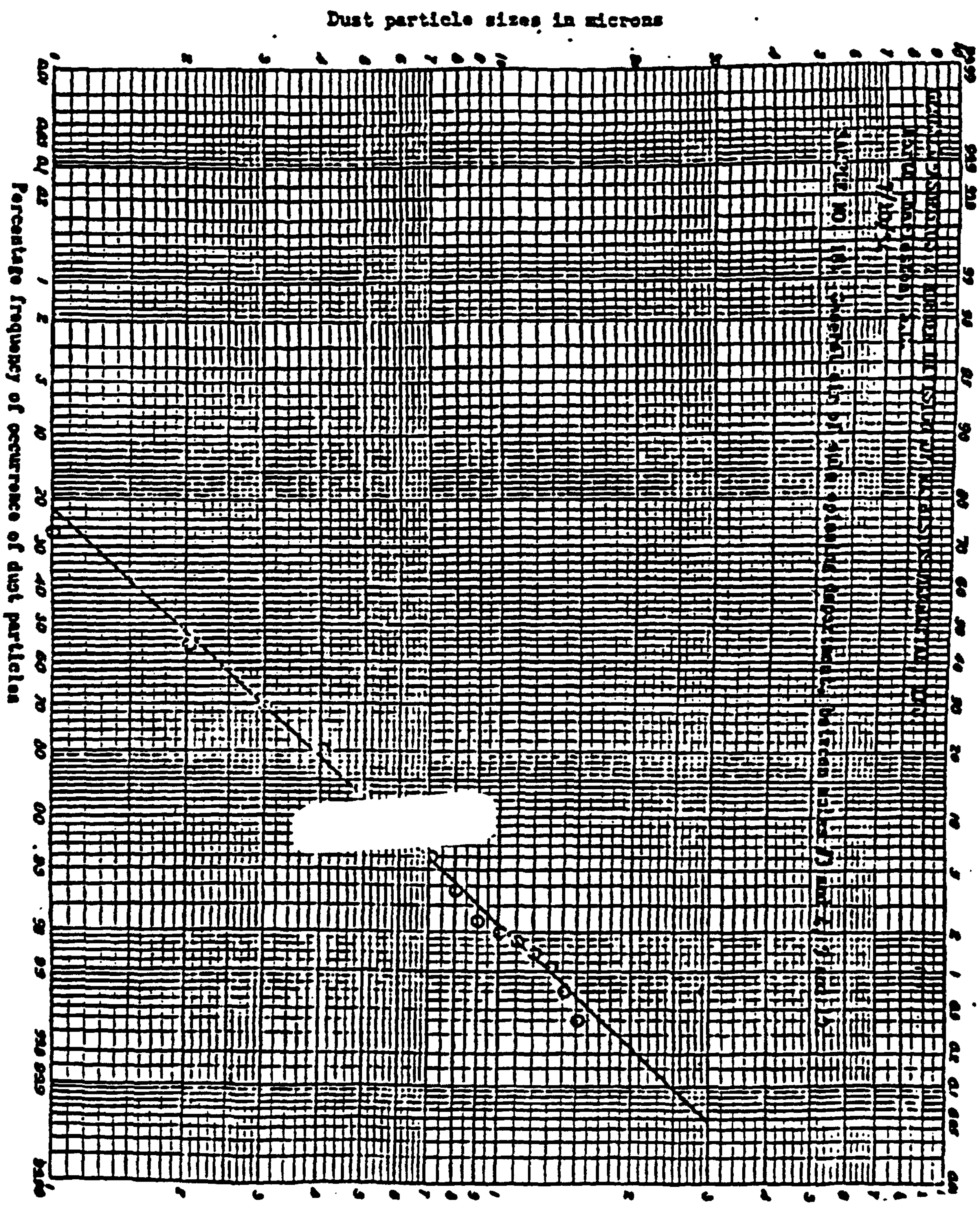
Dust particle sizes in microns



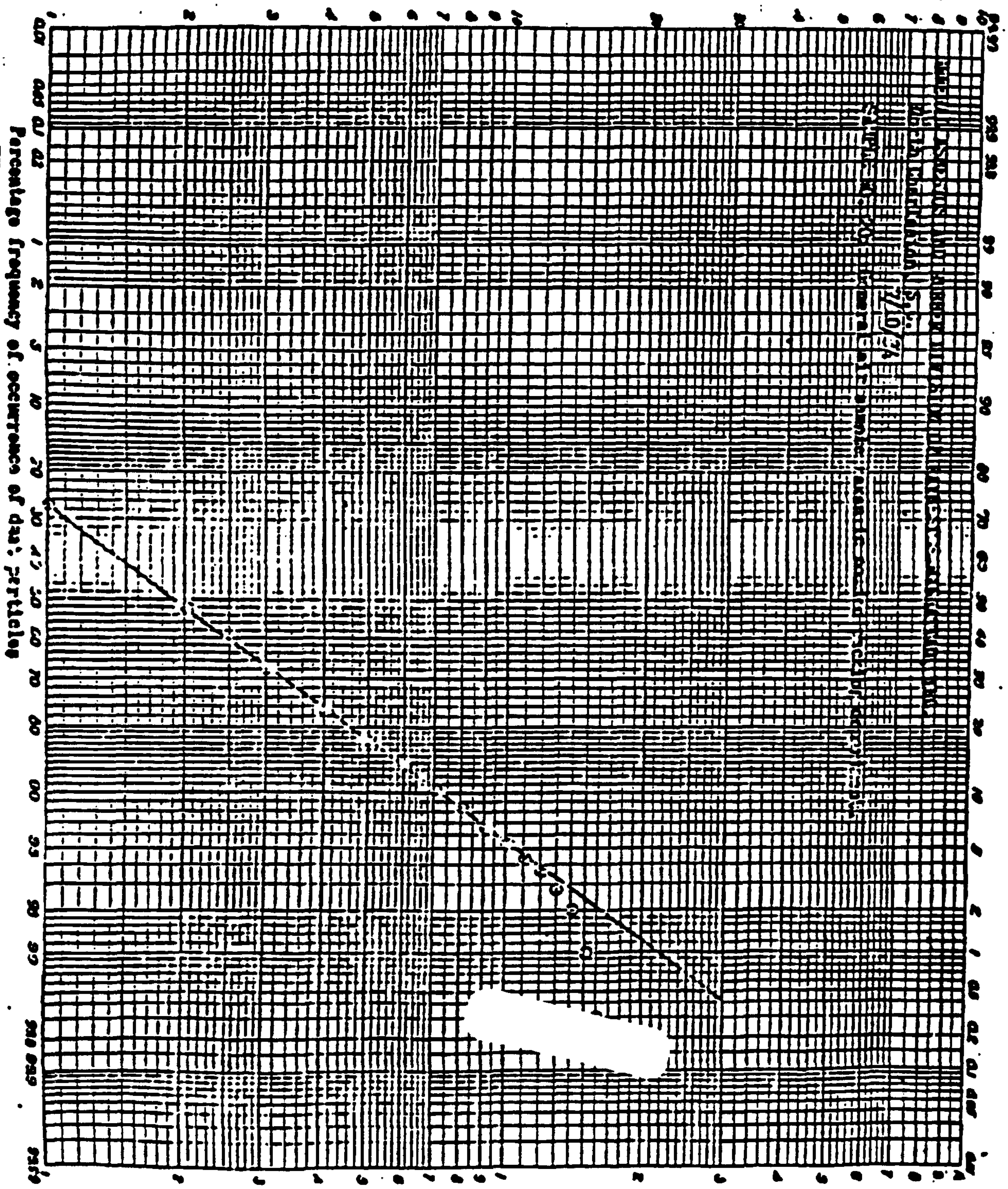
Dust particle sizes in microns



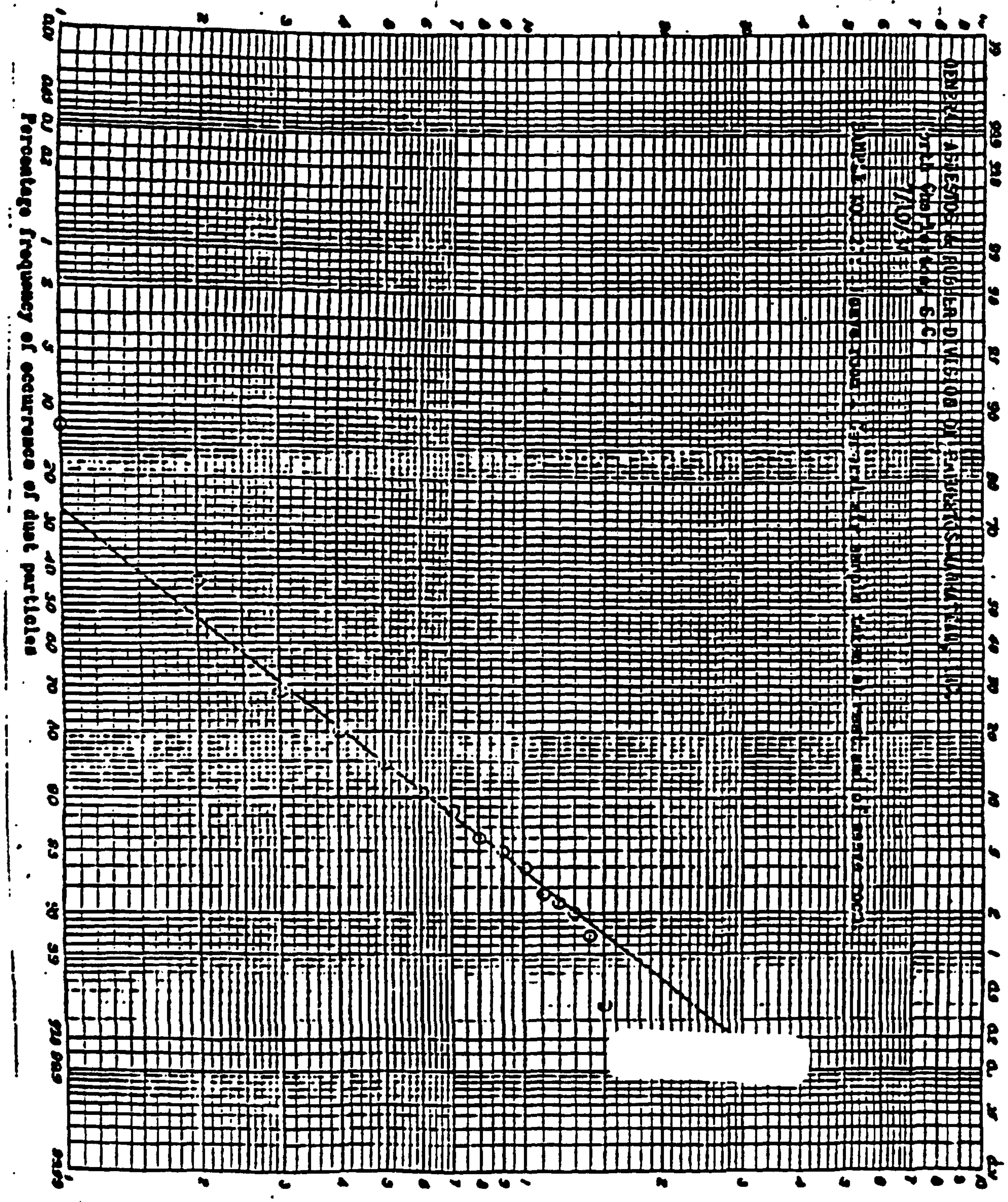
Percentage frequency of occurrence of dust particles

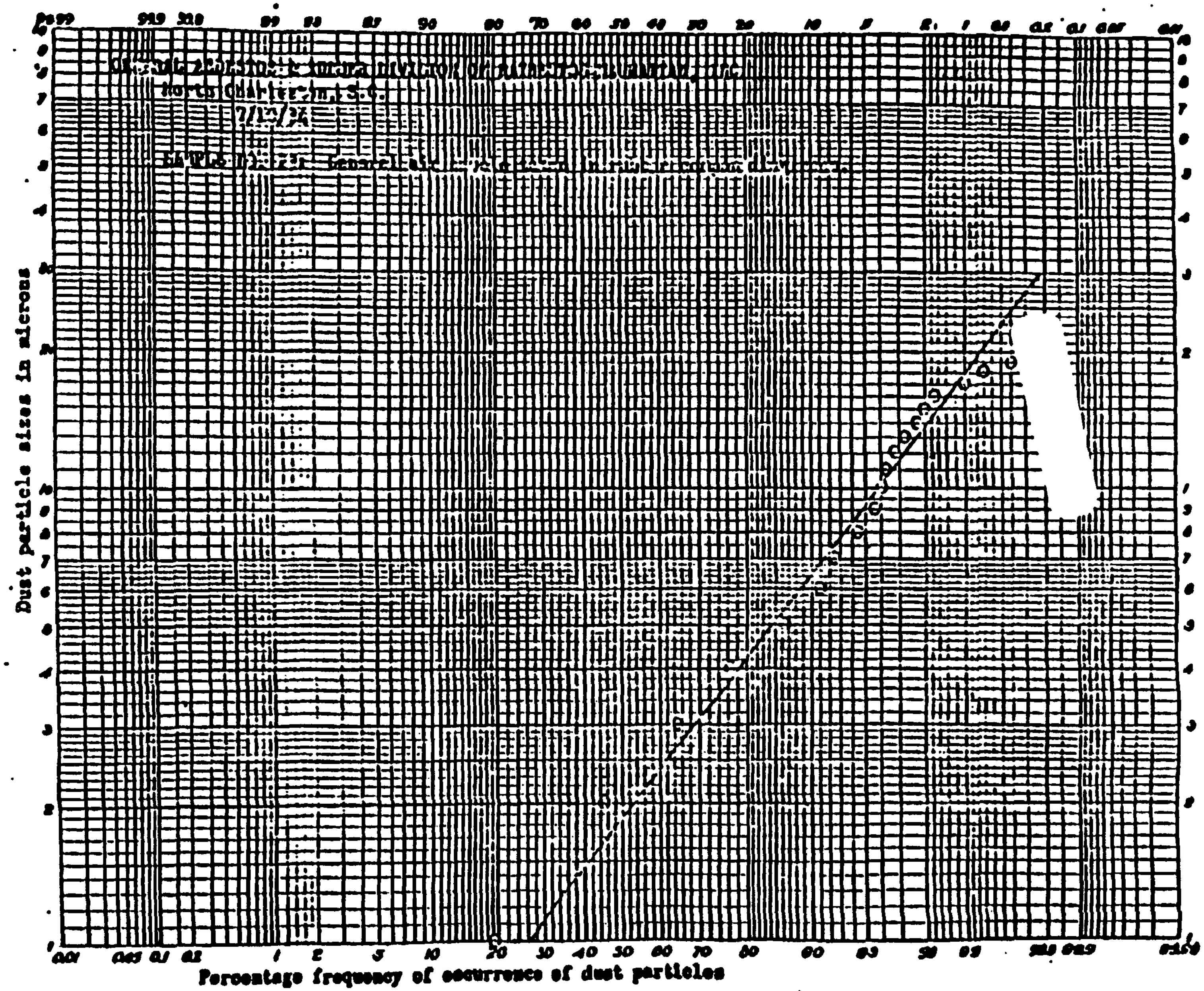

Dust particle sizes in microns
Percentage frequency of occurrence of dust particles

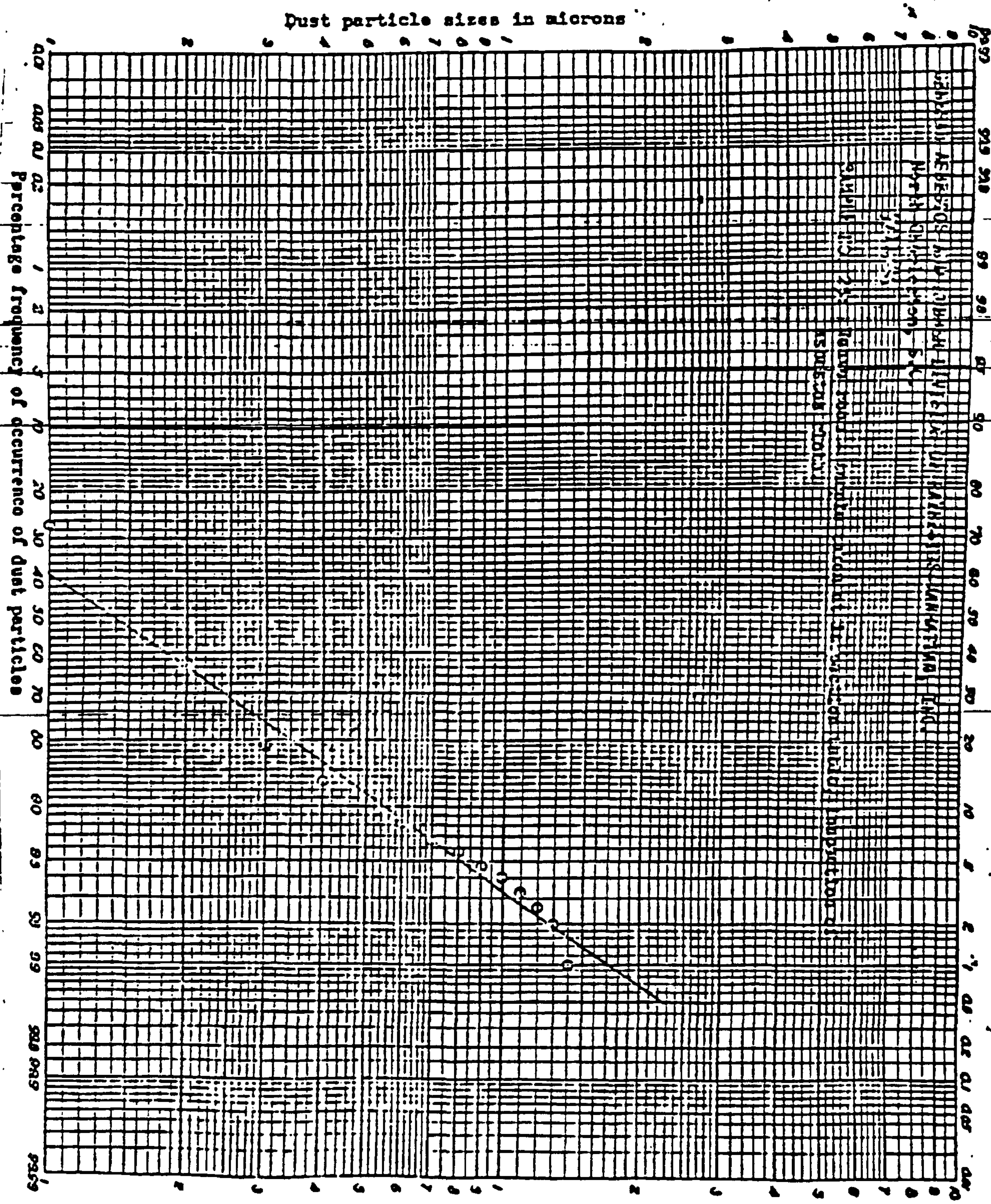
Dust particle sizes in microns



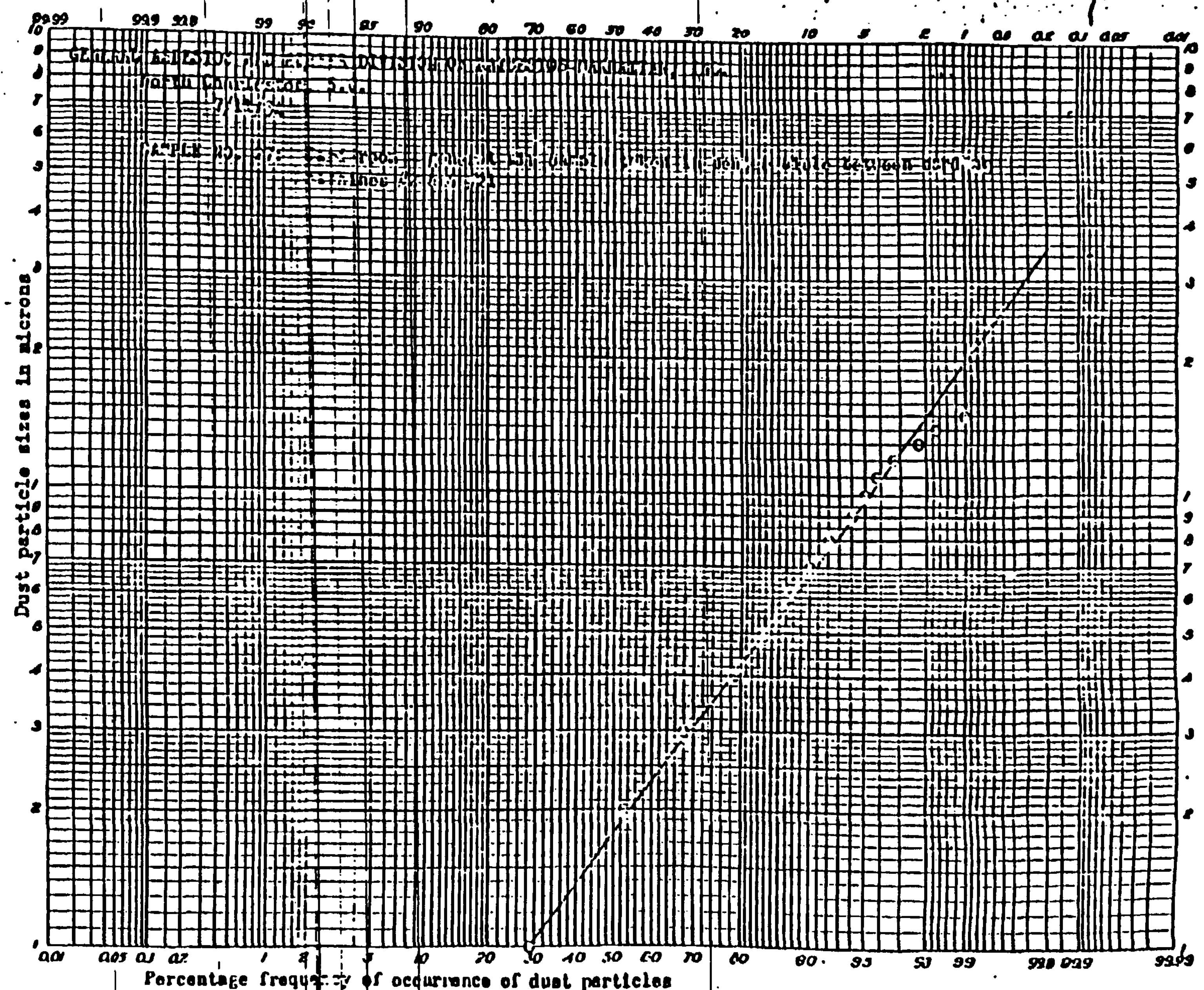
Dust particle sizes in microns



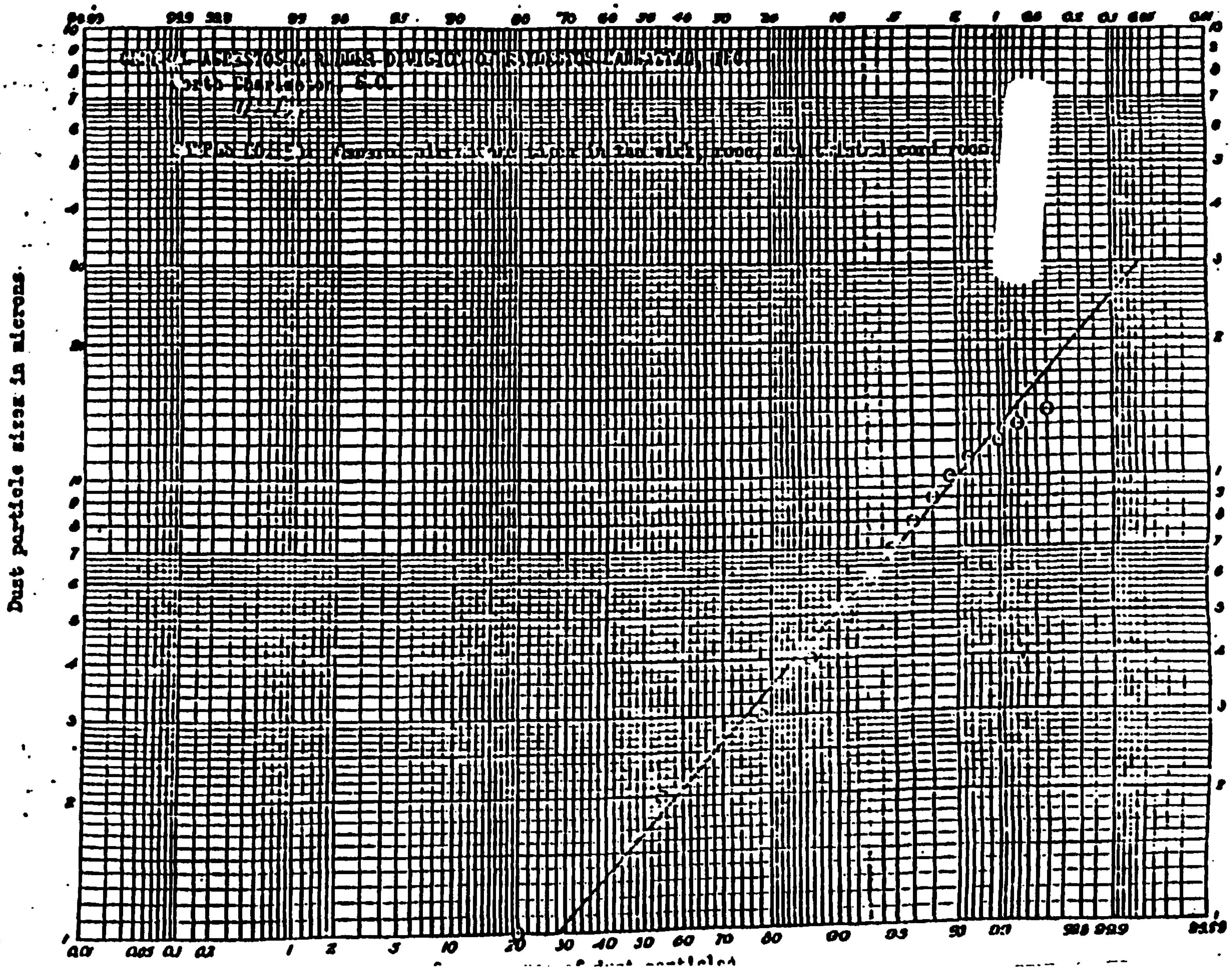

Dust particle sizes in microns
Percentage frequency of occurrence of dust particles
North Charleston, S.C.

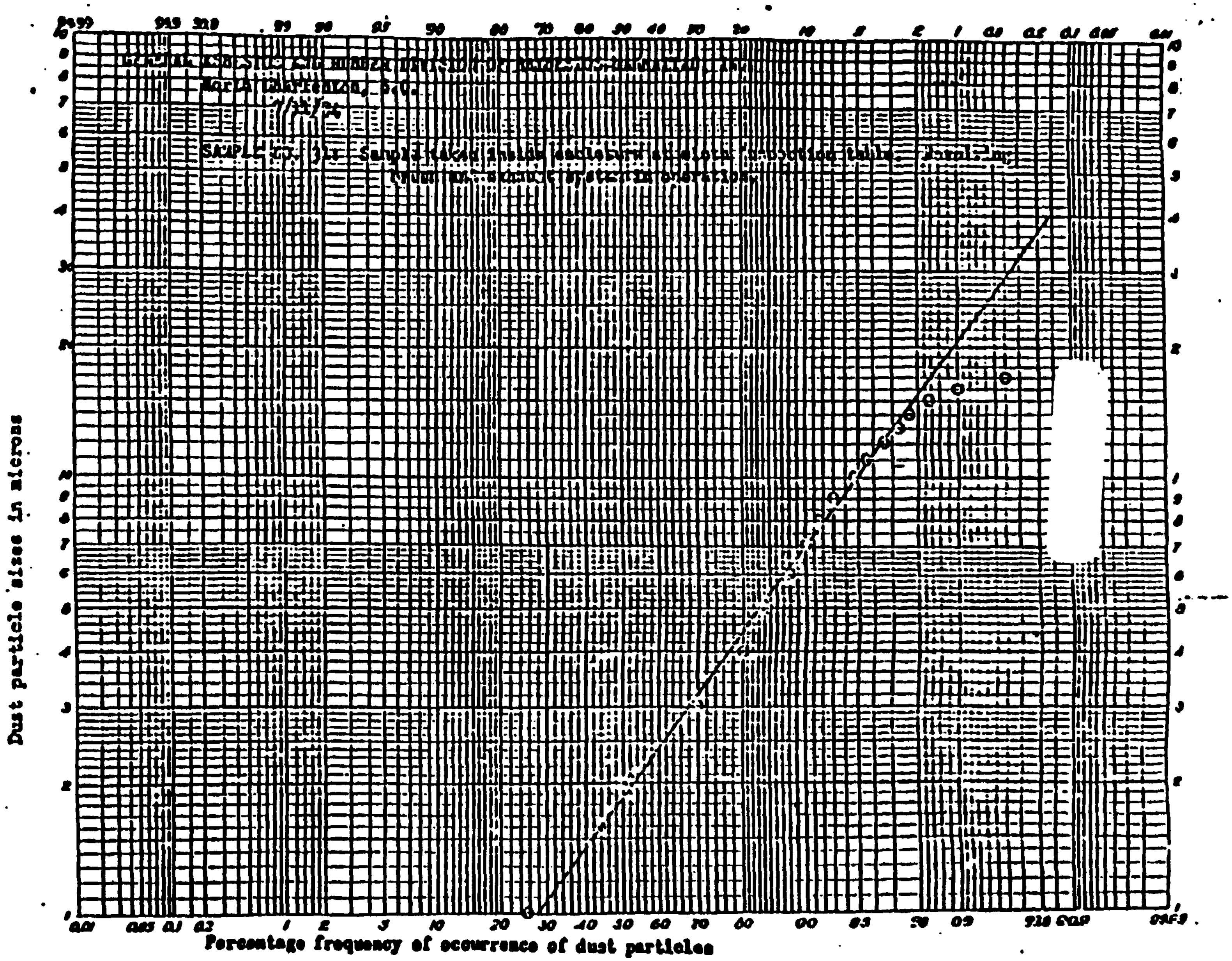


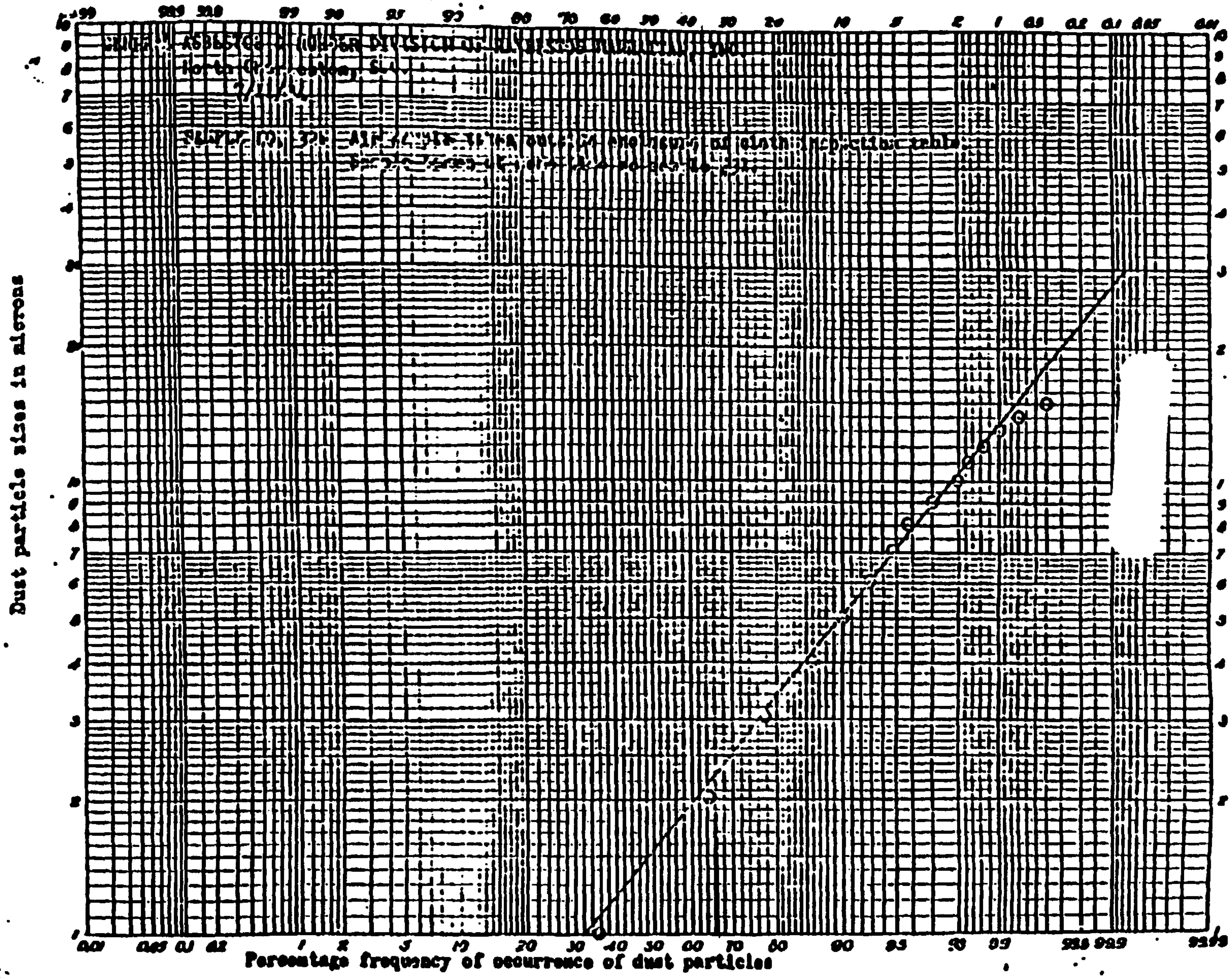
Dust particle sizes in microns
Percentage frequency of occurrence of dust particles



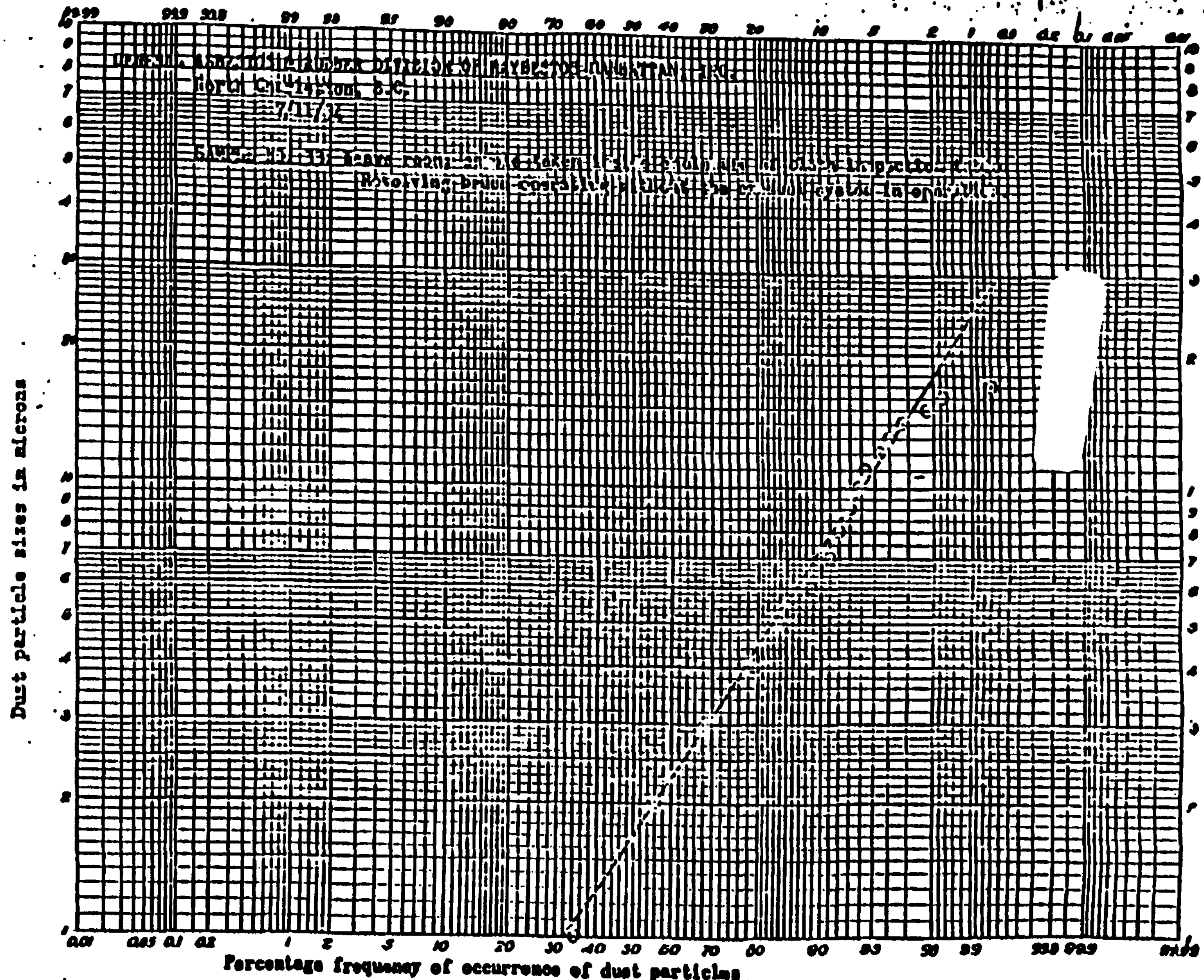
Dust particle sizes in microns
Percentage frequ... of occurrence of dust particles

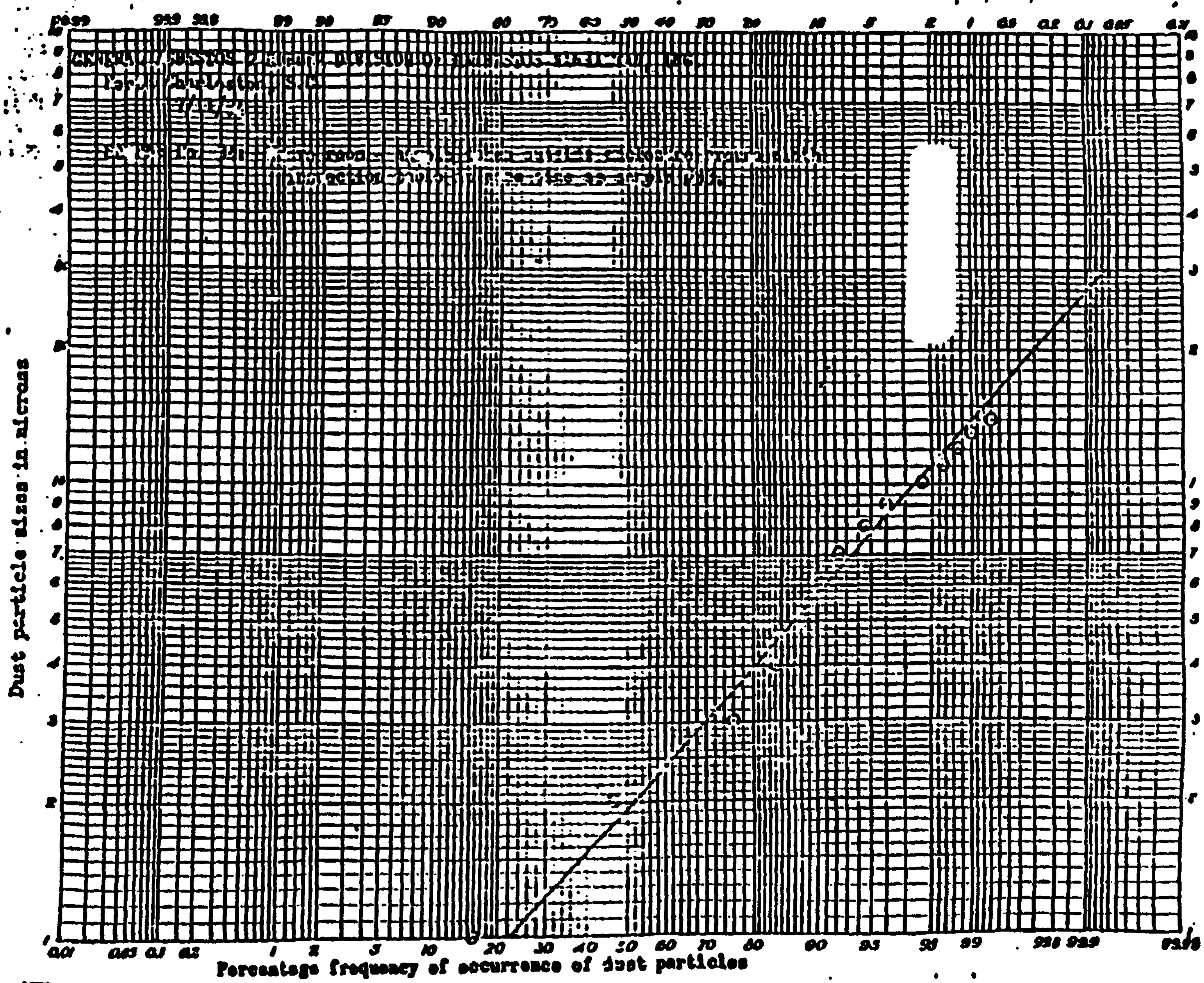

Dust particle sizes in microns
North Charleston, S.C.

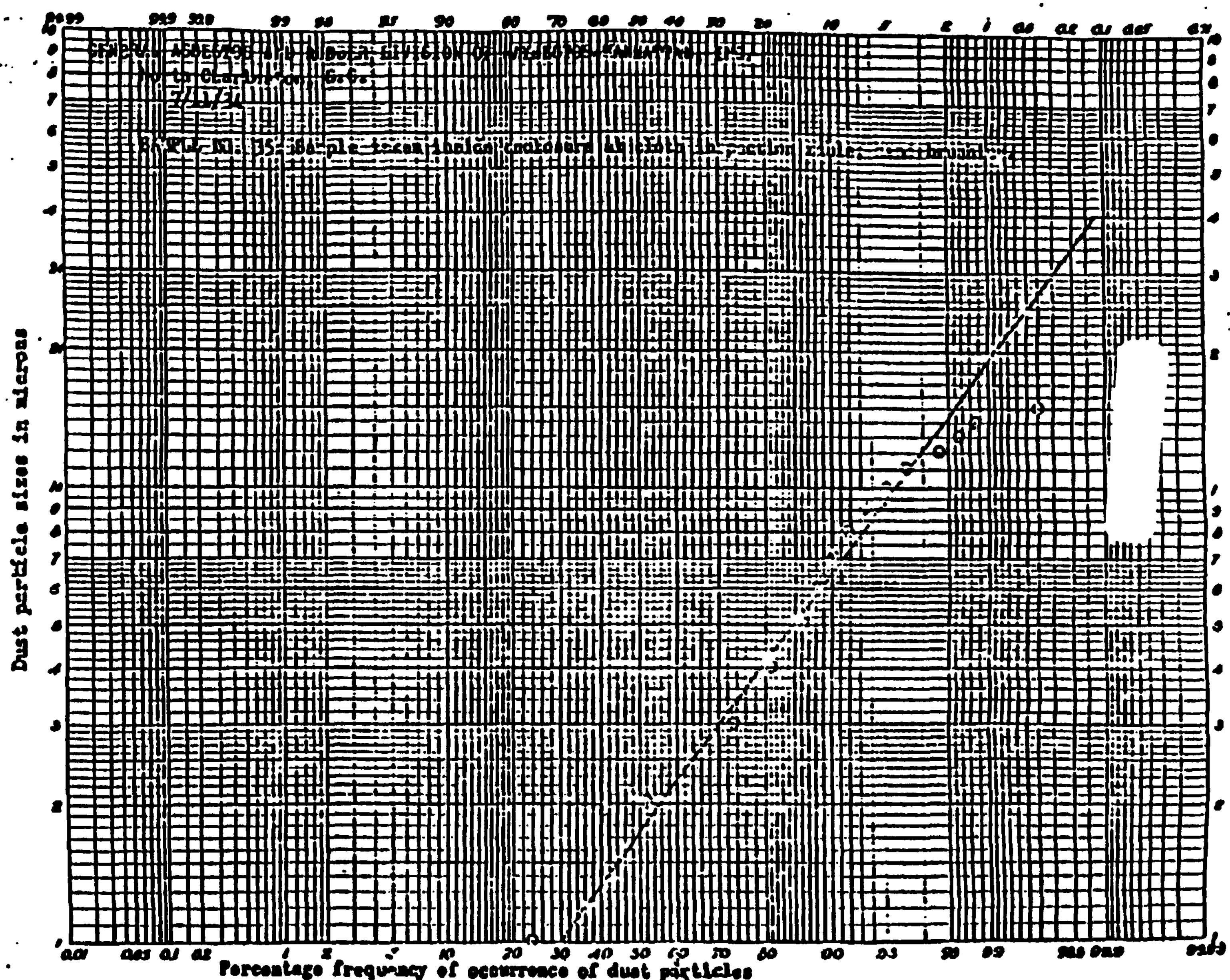

Dust particle sizes in microns
Percentage frequency of occurrence of dust particles

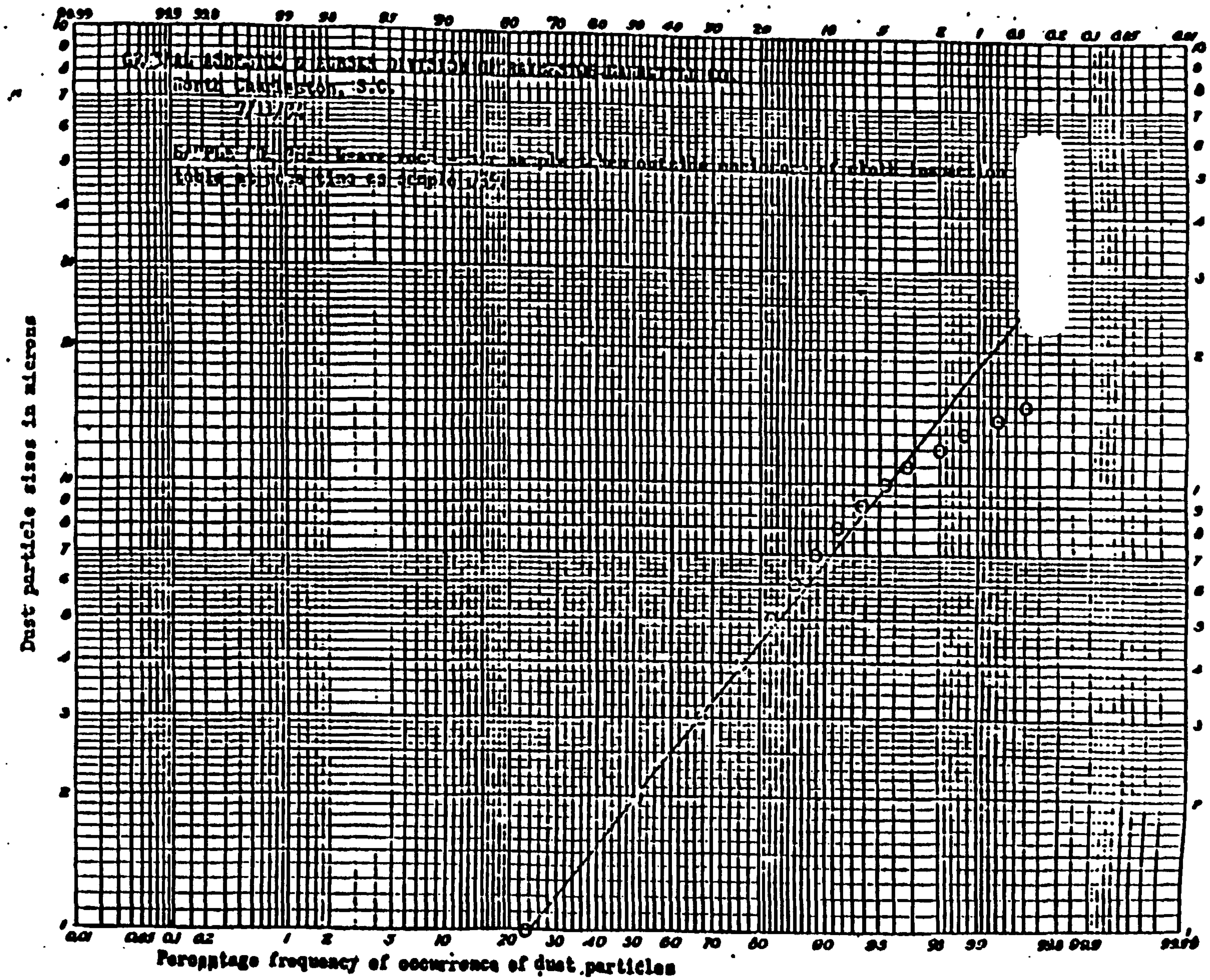


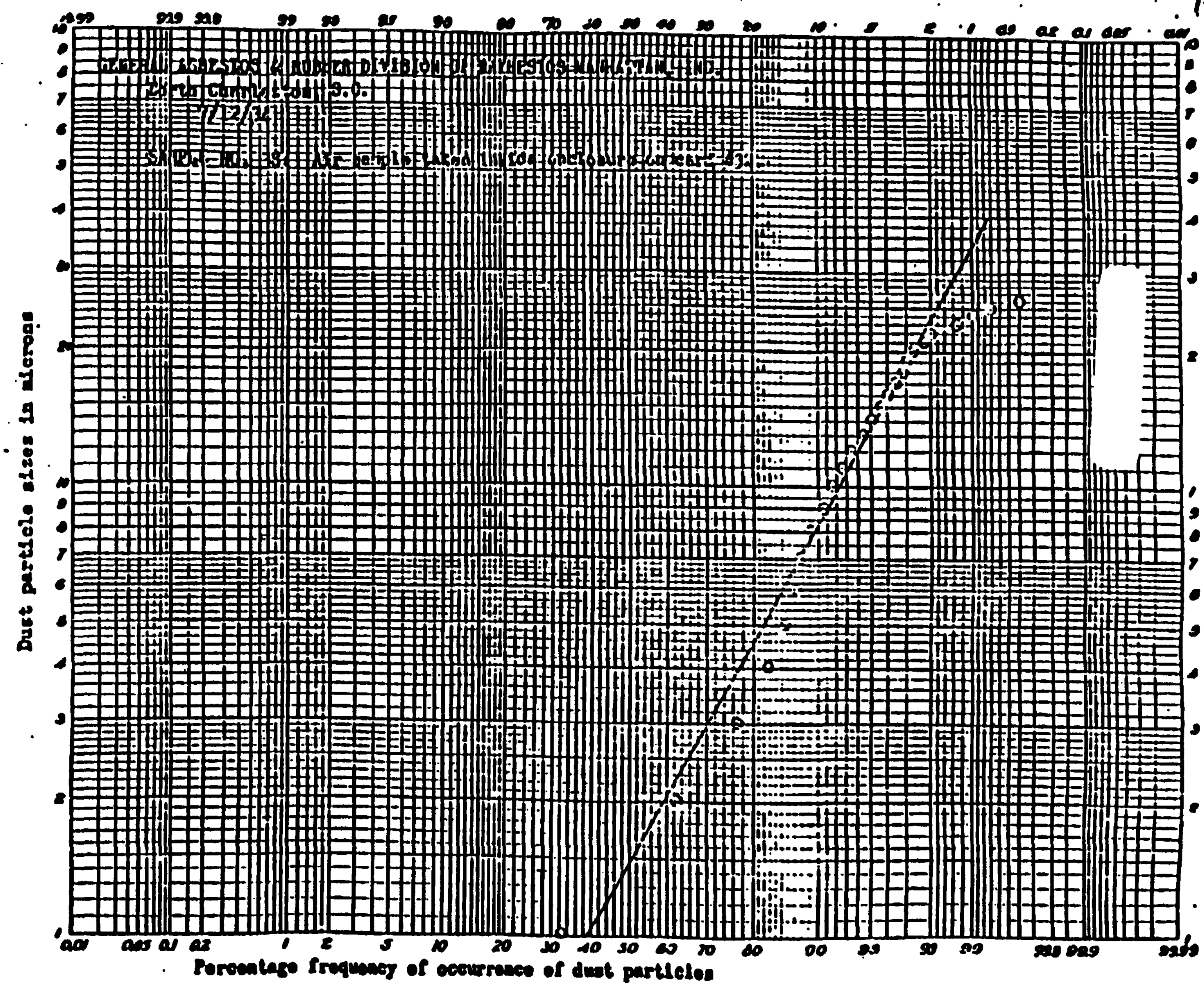
Dust particle sizes in microns
Percentage frequency of occurrence of dust particles


Dust particle sizes in microns
Percentage frequency of occurrence of dust particles

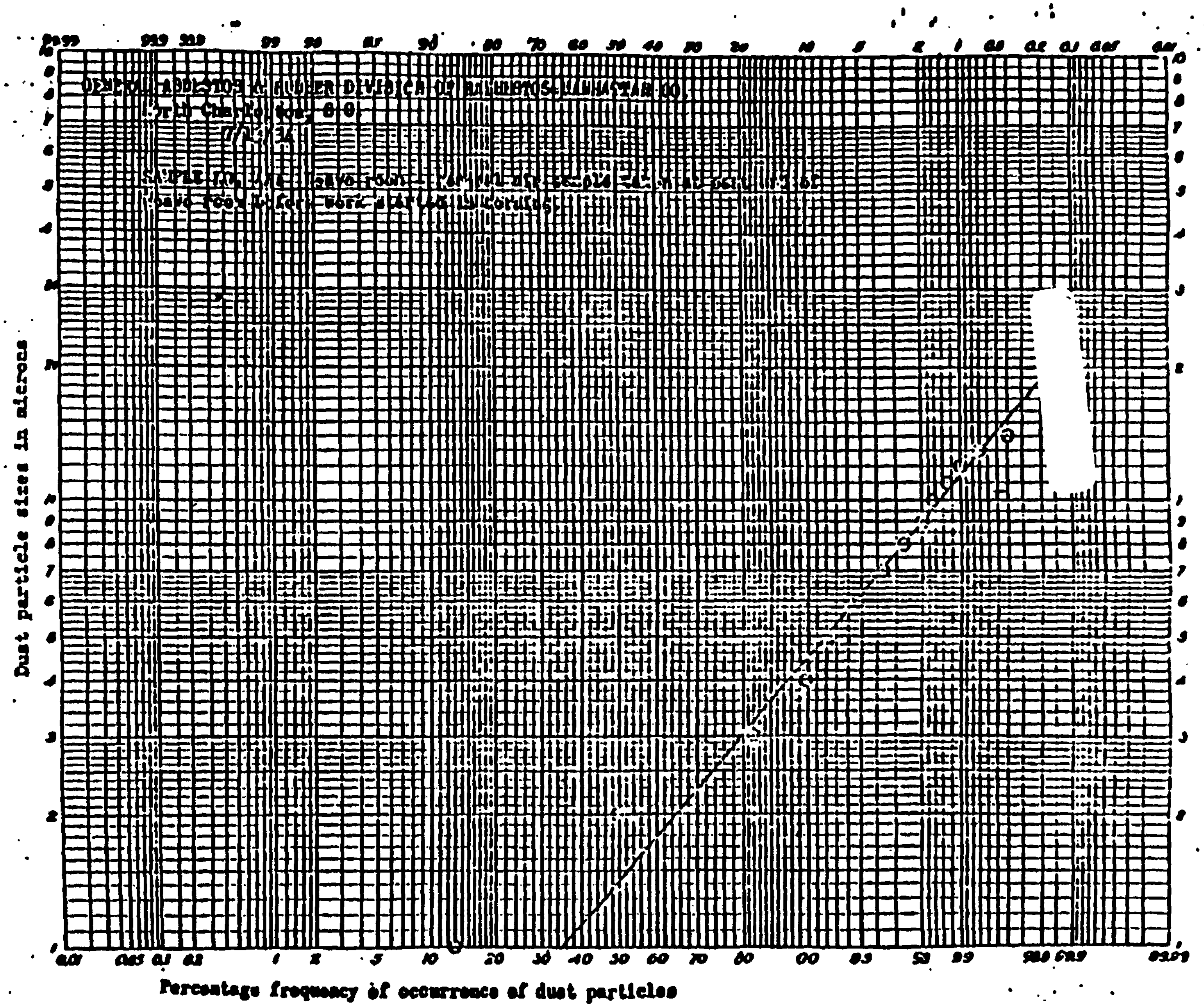

Dust particle sizes in microns
Percentage frequency of occurrence of dust particles


Dust particle sizes in microns
Percentage frequency of occurrence of dust particles


Dust particle sizes in microns
Percentage frequency of occurrence of dust particles



7/12/34
Dust particle sizes in microns
Percentage frequency of occurrence of dust particles


Dust particle sizes in microns
Percentage frequency of occurrence of dust particles

12-B

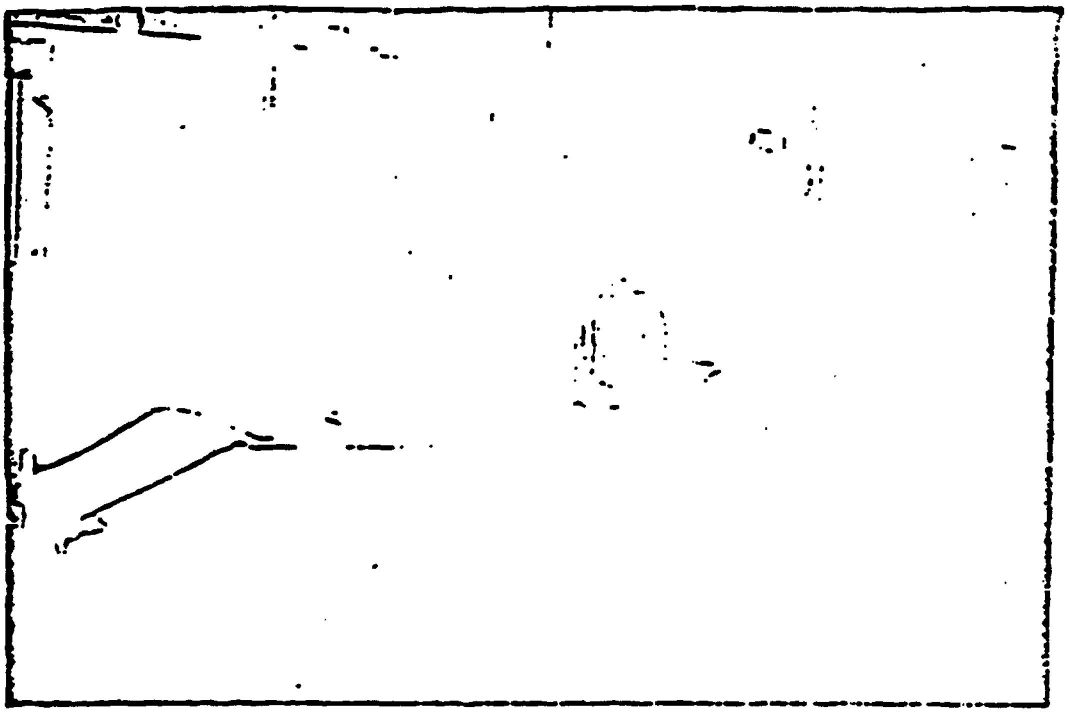
12-B

Card Room.

General Asbestos & Rubber Division
Raybestos-Manhattan, Inc.
Charleston, S.C.

13-B

13-B



SAMPLES NO. 25, 47, 50 and 53

At inspection table — woven cloth

General Asbestos & Rubber Division
Raybestos-Manhattan, Inc.
Charleston, S.C.

17-12

14-B

SAMPLES NO. 31, 32, 33, 34, 35 and 36

Enclosure built around table inspection
of woven cloth in weave room

General Asbestos & Rubber Division
Raybestos-Manhattan, Inc.
Charleston, S.C.

GENERAL ASBESTOS & RUBBER DIVISION

OF

RAYBESTOS-MANHATTAN, INC.

No. Charleston, S. C.

* * *

This survey was conducted on April 20, 21, and 22, 1936 and is supplementary to the survey made in July, 1934.

This survey was made to determine the extent of dust removal accomplished by the installation of new exhaust equipment and the redesigning of old exhaust equipment.

* *

MAX GLAUBACH, C.S.R.
CERTIFIED IN
NEW JERSEY & NEW YORK

[illegible] 1983 P. PIG/Cons.-14

Exhibit No. For Id. In Evid.

COMPARATIVE DATA

Preparation Room

21 The average count in this room at the time of the 1934 survey was 3.6 million particles per cubic foot of air. The average count at the time 16 of the 1936 survey was 2.7 million particles per cubic foot of air.

Card Rooms

21 The average count in this department at the time of the 1934 survey was 3.5 million particles per cubic foot of air. The average count at the time 9 of the 1936 survey was 1.2 million particles per cubic foot of air.

Spinning Department

17 The average count in this department at the time of the 1934 survey was 2.68 million particles per cubic foot of air. Samples 14 to 19 inclusive were averaged. The average count at the time of the 1936 survey was 20 4.4 million particles per cubic foot of air.

Weave Room

21 The average count in this room at the time of the 1934 survey was 3.5 million particles per cubic foot of air. The average count at the time of 14 the 1936 survey was 2.3 million particles per cubic foot of air.

Comparison of Dust Counts of Surveys

Sample No.	July, 1934 Millions of Dust Particles per cu. ft. air sampled	Sample No.	April, 1936 Millions of Dust Particles per cu. ft. air sampled
PREPARATION ROOM			
1	1.9	1A	1.2
2	8.2 · .80	2A	1.3
4	1.2	4A	2.2
5	1.5	5A	2.1
6	0.87	6A	1.5
7	7.8	7A	6.6 · .39
8	8.1	8A	2.8
9	1.3	9A	5.0
10	1.9	10A	1.9
CARD ROOMS			
27	5.5	27A	1.0
28*	15.9 · .05	28A	1.2
29*	13.2	29A	1.3 · /
30	2.7	30A	1.3
SPINNING DEPARTMENT			
11	1.6	11A	2.4
12	2.1	12A	1.4
13	1.1	13A	0.93
14	0.99	14A	4.9
15	2.3	15A	9.9 · .59
16	0.93	16A	6.0
17	8.1 · .97	17A	3.1
18	2.5	18A	1.1
19	1.1	19A	1.5
[illegible]			
20	0.45	20A	0.82
23	1.4	23A	1.8

*Built on blower break while these tests were running in 1936.

Comparison of Dust Counts of Surveys

July, 1934		April, 1936	
Sample No.	Millions of Dust Particles per cu. ft. air sampled	Sample No.	Millions of Dust Particles per cu. ft. air sampled
WEAVE ROOM			
22	6.3	22A	1.2
24	0.6	33*	1.4
26	5.5	34*	2.3
45	2.6	35*	6.6
46	2.7	36*	2.7
48	3.0	37*	1.2
49	5.1	38*	1.6
51	4.9	39*	1.3
52	0.9		

*Samples 33 to 39 in the 1936 survey do not compare as to location with samples in the 1934 survey.

The following tables show the results of analyses of samples taken in April, 1935. Methods of sampling and analysis are identical to those used in 1934.

GENERAL ASBESTOS & RUBBER CO.
No. Charleston, S.C.

	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Type of Dust	Remarks
[illegible] ROOM						
1A	At #1 chaser	4/20/36	37.4	1.2	Asbestos	
2A	At #4 chaser	"	35.8	1.3	"	
3	Feeder end of #1 picker exhaust hood	"	44.6	1.1	Asbestos cotton	One man supplied respirator
4A	Feeding end of Garnet machine	"	36.4	2.2	Asbestos	
5A	At fly shaker exhaust	"	49.8	2.1	"	
6A	Vertical fibre opener	"	44.0	1.5	"	Exhaust
7A	Floor mixing of cotton and asbestos - exhaust hoods	"	9.6	6.6	Asbestos cotton	2 men - supplied respirators.
8A	At shaker screen - loading hand trucks with fibre	"	39.0	2.8	Asbestos	Exhaust
9A	At feeder end of cotton fibre opener	"	23.3	5.0	Cotton	Exhaust - one man
[illegible]	At conveyor end of #2 picker	"	24.2	1.9	Asbestos	Exhaust on machine conveyor
[illegible] DEPARTMENT						
11A	General air - braiders Building #5	4/21/36	37.2	2.4	"	Large machines
12A	Between 2 ring presses Bldg. #5	"	34.5	1.4	Asbestos graphite	
13A	General air - small braiders - Bldg. #5	"	43.2	0.93	Asbestos graphite cotton	Making stock for presses
14A	General air - ring frame spinning	"	20.4	4.9	Cotton asbestos	
15A	General air - twister	"	38.5	9.9	Asbestos	
16A	General air - spoolers	"	33.5	6.0		Yarn from ring spinning, near W. north side.
17A	General air - spoolers near partition wall, east side	"	33.1	3.1	"	Yarn from mule on four means.
18A	General air - mule spinning	"	39.5	1.1	"	Between machines #9 and #10
[illegible]	General air - mule spinning	"	34.6	1.6	"	Between machine #15 and #16.
20A	General air - 4 spooler machines	"	30.0	1.3	"	Exhaust system.

GENERAL ASBESTOS & RUBBER CO.
No. Charleston, S.C.

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Dust Particles per cu. ft. air sampled	Type of Dust	Remarks
D ROOM						
25	South aisle - between cards #21 and 22	"	27.5	1.6	"	Hopper and finis ends - exhaust west of bins.
26	North aisle - between cards #9 and 10	"	26.3	1.1	"	" "
27A	Center aisle - between cards #2 and #21	"	40.0	1.0	"	Camel-back ends cards - exhaust west of bins.
28A	Center aisle - between cards #10 and #29	"	34.6	1.2	"	" " "
29A	Between cards - #16 and #35	"	32.2	1.3	"	East of bins - "
30A	General air - wick, rope, and twisted card room	"	32.1	1.9	"	
VE ROOM						
32A	General air - west end of weave room	4/22/36	39.0	1.2	"	
33	At inspection table - woven cloth	"	28.8	1.4	"	Two men - exhau
	At Broadloom #4 - west end of room	"	27.4	2.3	"	Exhaust on bulk warp and slay
35	At loom #17 - brake bands dry weaving	"	33.2	6.6	"	North east corn weave room.
36	General air - east end of weave room	"	36.4	2.7	"	
37	At broadloom #10 - north east side of room	"	35.9	1.2	"	Exhaust only on warp, not on sl
38	Between looms #15 and #16, broadlooms - #15 and warp	"	32.9	1.6	"	#15 - exhaust o warp and slay #16 - exhaust north side of r
39	At two tape looms #4 and #5, south side of room	"	34.7	1.3	"	Looms face east dry weaving.
DEPARTMENT						
20A	General air - molded packing department	"	48.7	0.82	"	
23A	General air - rubber compounding room	"	41.7	1.8	Clay, talc lead, sulphur	
31	At Pratt & Whitney grinder	"	43.5	1.1	Asbestos	Brake lining -
	At drill press	"	47.1	1.1	"	"

GENERAL ASBESTOS & RUBBER CO.

No. Charleston, S.C.

LEAD ANALYSES

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Milligrams of Lead per Cubic Foot of Air Sampled	Milligrams of Lead per Cu. Meter Air Sampled	Lead Intake in 10-hr. day on basis of workmen breathing 10 cubic meters air	Remarks
21A	Between two rubber compounding mills	4/22/36	36.0	0.000389	0.0137	0.137	Exhaust
23A	General air - rubber compounding room	"	41.7	000	000	000	
31	At Pratt & Whitney grinder	"	45.5	000	000	000	
32	At drill press	"	47.1	000	000	000	

CONCLUSIONS AND RECOMMENDATIONS

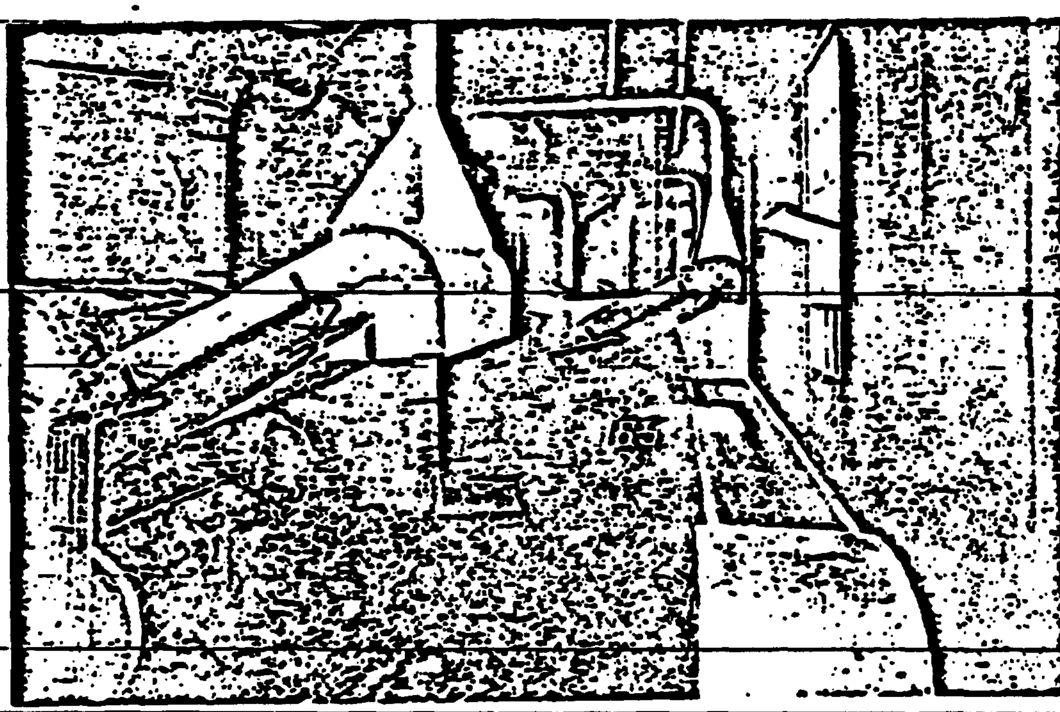
At the time of the 1936 survey the exhaust systems in the Card Room were completed, including exhaust on the storage bins. These exhaust systems were not completely finished in July, 1934.

The Spinning Department showed a slight increase over the 1934 survey. The rate of production at the time of the 1936 survey was much higher than at the time of the previous survey with more twisters in operation.

In other departments the variation is no greater than that encountered in the outside atmosphere.

It is evident from the results of this 1936 survey that the general air pollution of the Preparation Room has been decreased, but it is questionable if the exposure of the individual workmen at the floor mixing operations has been decreased.

9-c



__Preparation Department__

View showing exhaust arrangement on discharge ends
of picker machines

General Asbestos & Rubber Division
No. Charleston, S.C.

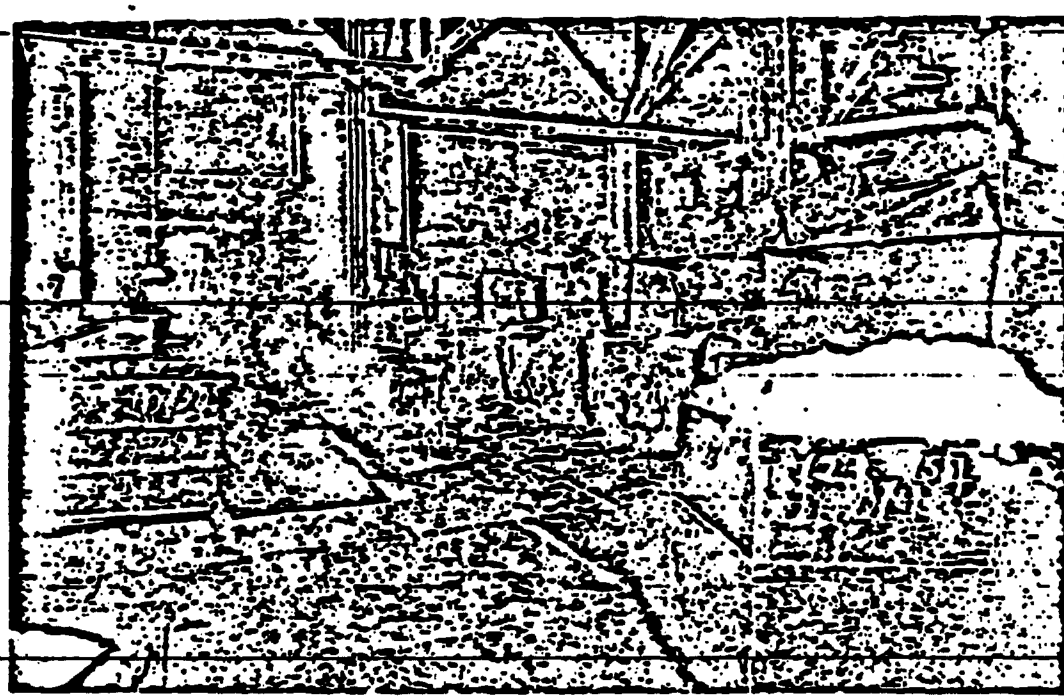
10-c

__Preparation Department__

View showing exhaust hoods on fibre opener machines

General Asbestos & Rubber Division
No. Charleston, S.C.

11-c

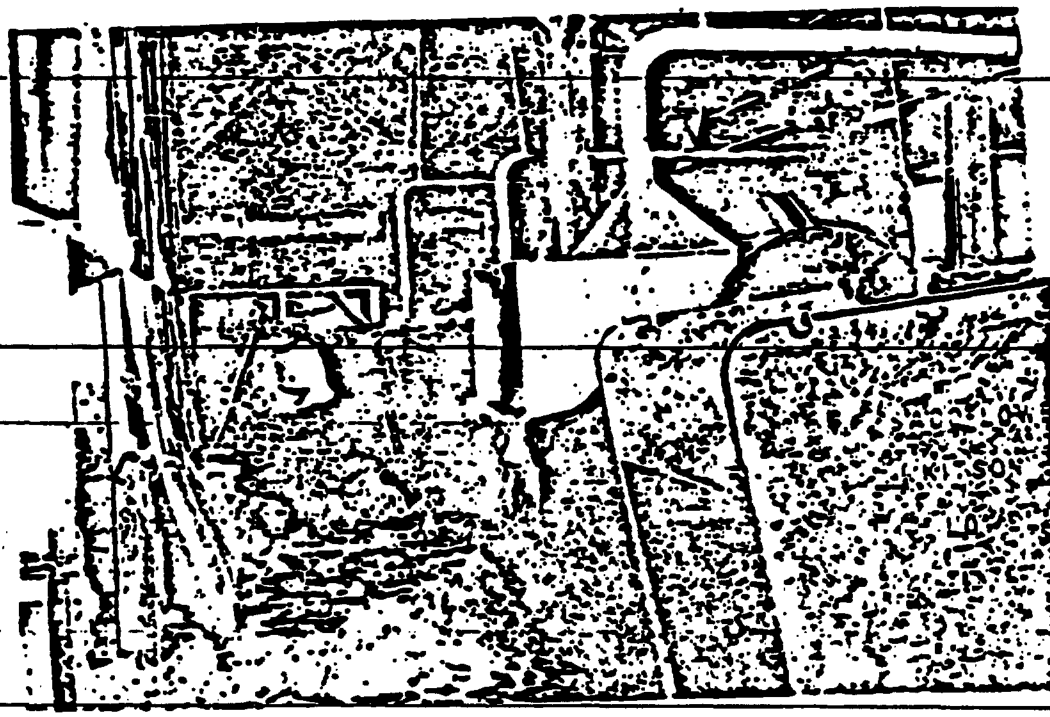


Preparation Department

View showing [illegible] as a mixing bin

General Asbestos & Rubber Division
No. Charleston, S.C.

12-c

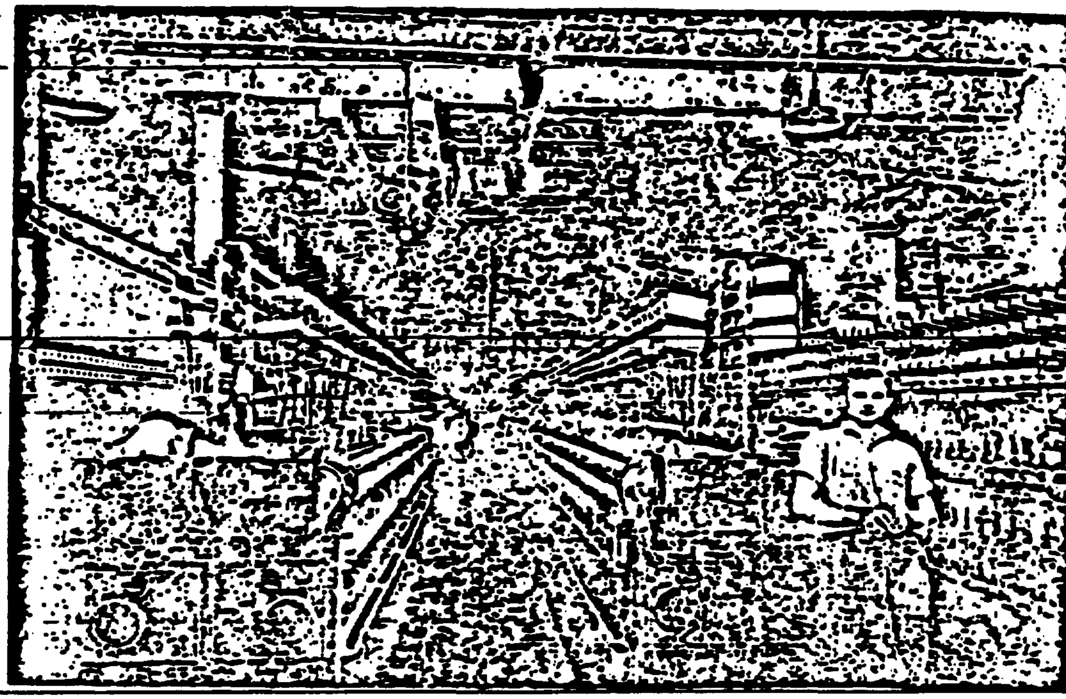


Preparation Department

View showing exhaust hood on hopper of picker machine

General Asbestos & Rubber Division
No. Charleston, [illegible]

13-c



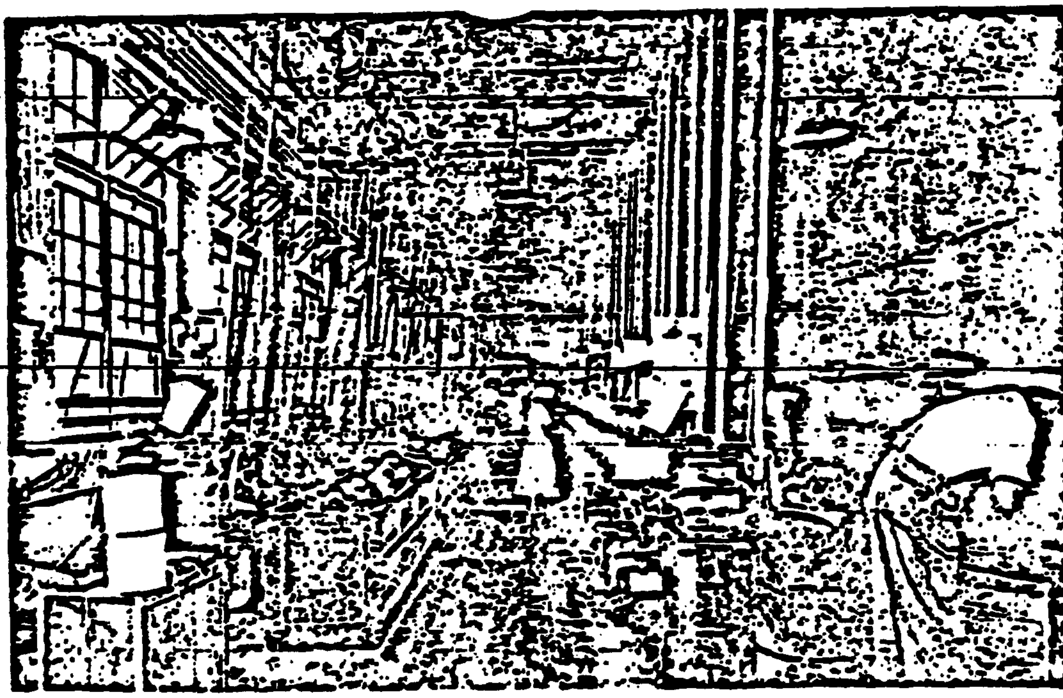
Twisting Department

Sample 15A

General air sample taken in center of twisting machines

General Asbestos & Rubber Div.
No. Charleston, S.C.

14-e



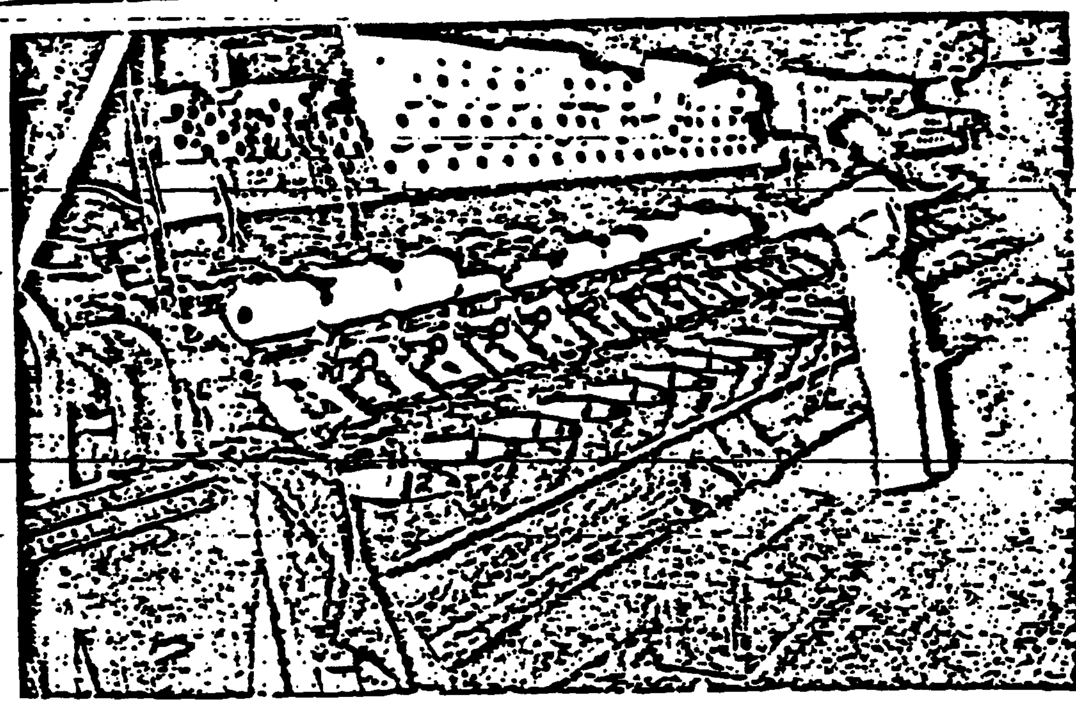
Spinning Department

Sample [illegible]

General air sample taken at spoolers on north side of room

General Asbestos & Rubber Div.
No. Charleston, S.C.

15-C

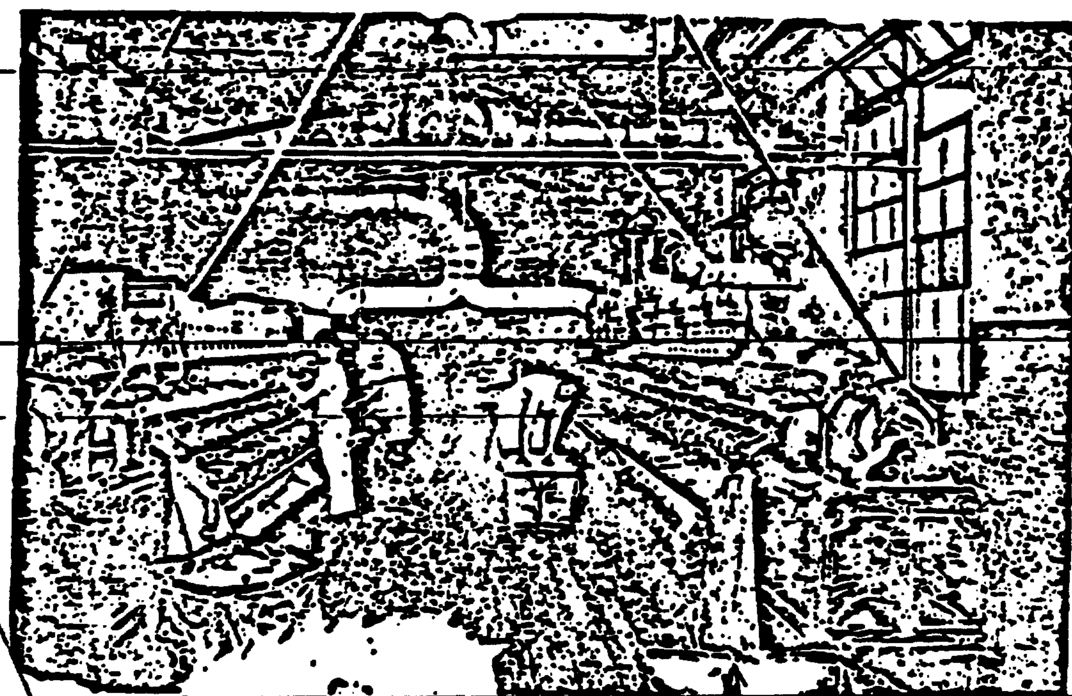


[illegible]

View of spooler machine with exhaust equipment

General Asbestos & Rubber Div.
No. Charleston, S.C.

16-C



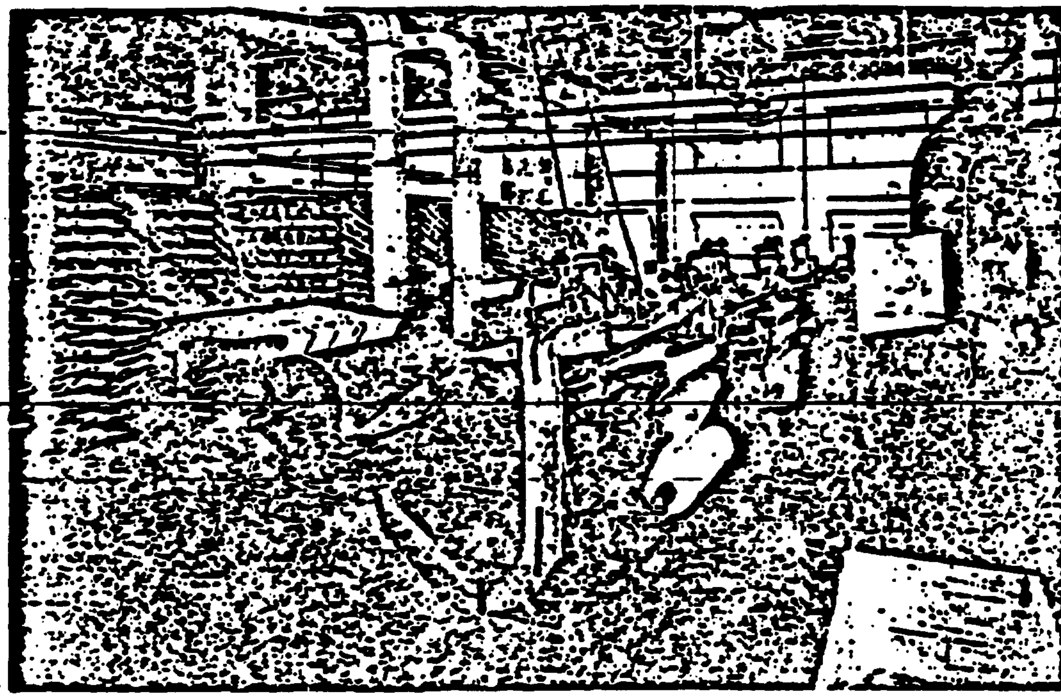
[illegible] Department

Sample [illegible]

General air sample taken between four spooler machines with exhaust equipment

General Asbestos & Rubber Co.
No. Charleston, S.C.

17-c

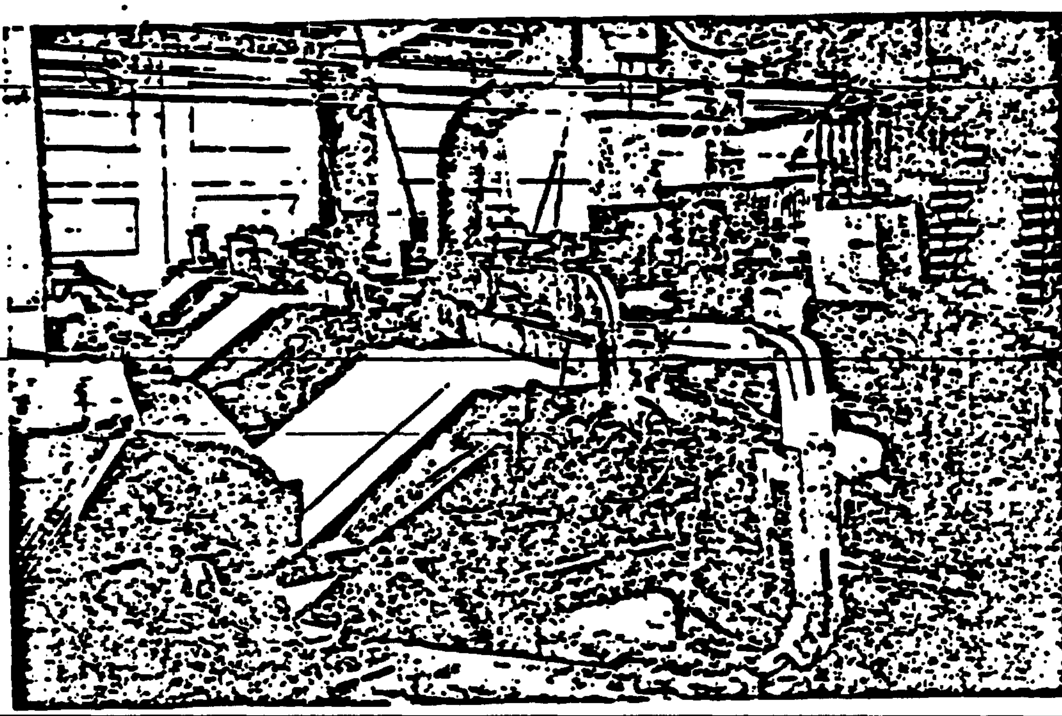


[illegible]

View of broadloom showing exhaust equipment on clay

General Asbestos & Rubber Div.
No. Charleston, S.C.

18-c

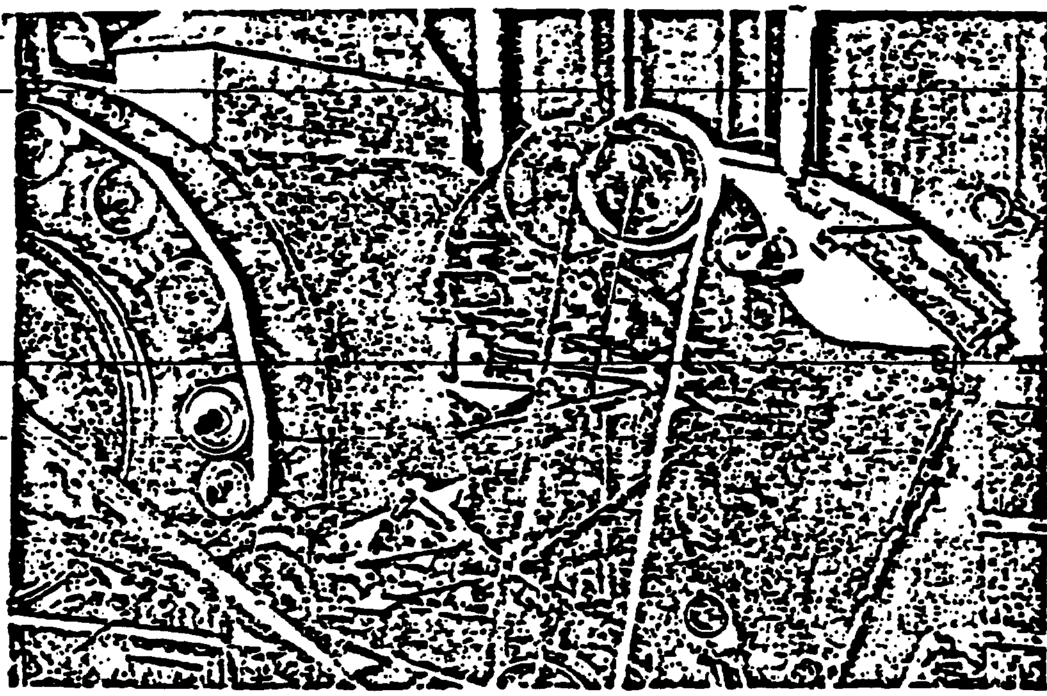


Weave Room

View of broadlooms showing exhaust equipment under warp and on slay

General Asbestos & Rubber Div.
No. Charleston, S.C.

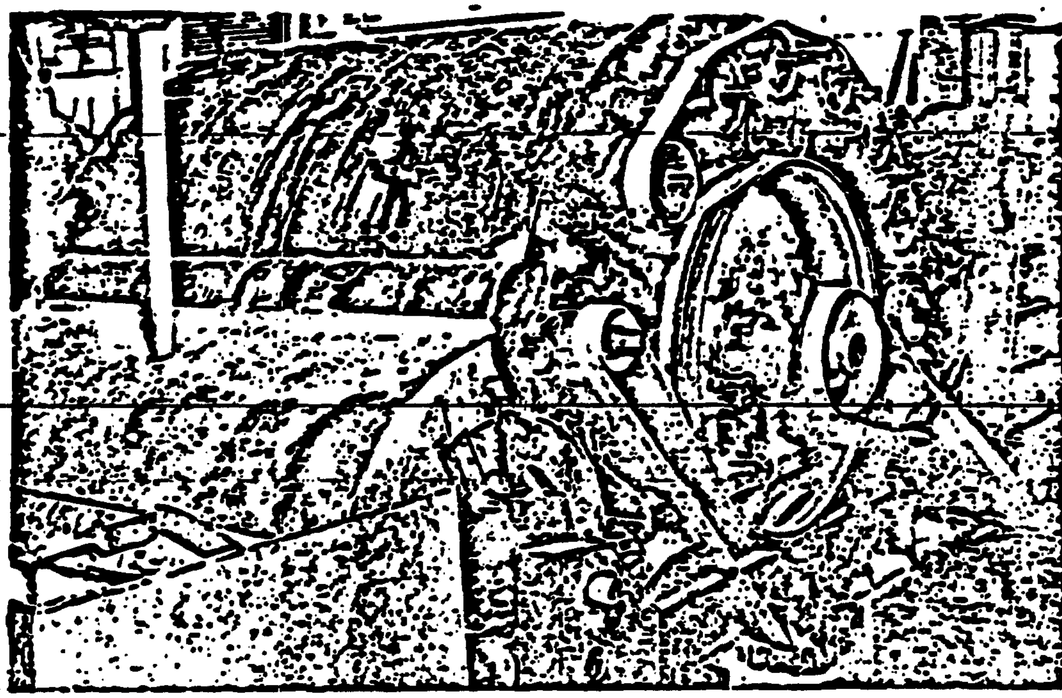
19-c



Card Room

Close-up view of card showing part of exhaust enclosure

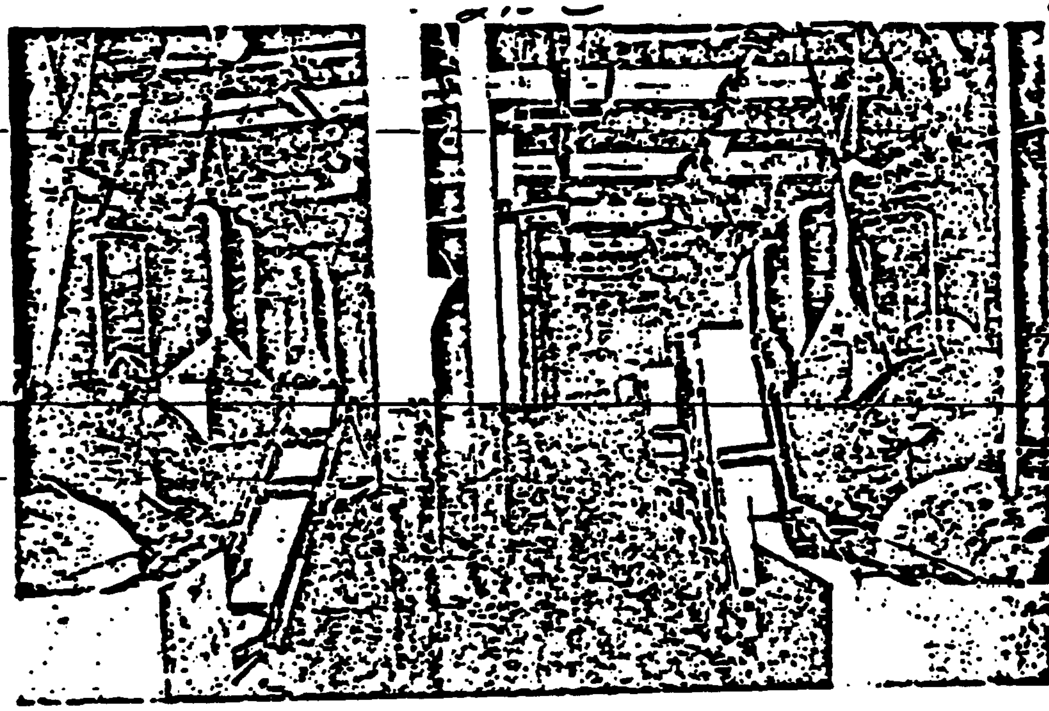
General Asbestos & Rubber Div.
No. Charleston, S.C.



Card Room

Close-up view of card showing part of exhaust enclosure

General Asbestos & Rubber Division
No. Charleston, S.C.



Card Room

General view - center aisle - card room - camel back ends of cards

General Asbestos and Rubber Division
No. Charleston, S.C.

A STUDY OF DUST CONDITIONS

in the Manheim Plant

of the

UNITED STATES ASBESTOS & RUBBER DIVISION OF THE RAYBESTOS-MANHATTAN,

INC.

* * * *

1930

MAX GLAUBACH, C.S.R.
CERTIFIED IN
NEW JERSEY & NEW YORK

Exhibit No. P-P Ecul 30 [illegible] 15

Exhibit J

R-M 261 a-Rh 5-12-77

The following report is a study of dust conditions in the Manheim plant of the United States Asbestos & Rubber Division of the Raybestos-Manhattan, Inc. This study was carried on during February, 1930, by the Industrial Health Service of the Metropolitan Life Insurance Company.

It is the third unit in a series of studies of the asbestos industry in the United States and Canada for the purpose of determining the extent and nature of atmospheric pollution to which asbestos workers are exposed and whether there can be demonstrated any harmful effect to such workers.

This study differs from the two preceding ones in that there were included physical examinations of employees, hence it is more complete and informative.

* * * * *

APPARATUS AND METHODS OF SAMPLING:

The impinger method[1] was used for collecting samples of dust in the air. This is accomplished by aspirating the air to be sampled, and impinging it upon a flat surface under a liquid of either distilled water or alcohol. In general whenever the dust collected is of a siliceous nature an alcohol-water mixture is used to prevent any silica going into solution. Pyrex flasks are used as containers to collect the samples, as experience has shown that this glass is, for all purposes, practically insoluble. The volume of air is measured by means of a flow meter or else a vacuum gauge and the air sample is aspirated by suction supplied either by an electrically driven pump or else by an ejector actuated by compressed air. Each dust sample collected represented a volume of air of from 50 to 80 cubic feet.

Due to the high concentrations of dust in the departments of this plant this size sample was found to be representative and of sufficient size for analysis. The impinger was placed in close proximity to and at the breathing level of the workmen.

Air samples were also taken with the electric precipitator[2] for dust particle measurements. This instrument is designed upon the principle of the Cottrell precipitator. Air is drawn through an electrostatic field, where the dust particles are deposited upon a celluloid foil, by means of a small electrically driven pump. The volume of air sampled is measured by means

(1) "Comparative Tests of Instruments for Determining Atmospheric Dusts", - Public Health Bulletin, No. 144, Treasury Dept., Washington, D.C.
(2) "Determination of Suspensoids by Alternating Current Precipitators", - Philip Drinker and Robert T. Thomson, Journal of Industrial [illegible]iene, Vol. VII, No. 6, June, 1925.

of a flow meter. From 10 to 50 cubic feet of air were taken for a sample.

The collected dust samples were transported to the laboratory where total dust counts were made, and particle size measurements were taken. The results are tabulated and appear in graphs attached. The percentages of the various sized particles may be interpolated from these graphs.

Microphotographs of these dust particles were taken under high power and were further enlarged by being projected upon a screen by means of a lantern slide projector. The enlarged particles were then measured with a ruler. Knowing the entire enlargement (by actual measurement) it was possible to calculate the original particle size.[3] By the use of Hazen's[4] logarithmic probability paper, the logarithms of the function to be measured - in this case microns - are plotted as ordinates against the probability of occurrence as abscissae. Since the line is straight, exterpolation and interpolation of any desired region is facilitated.

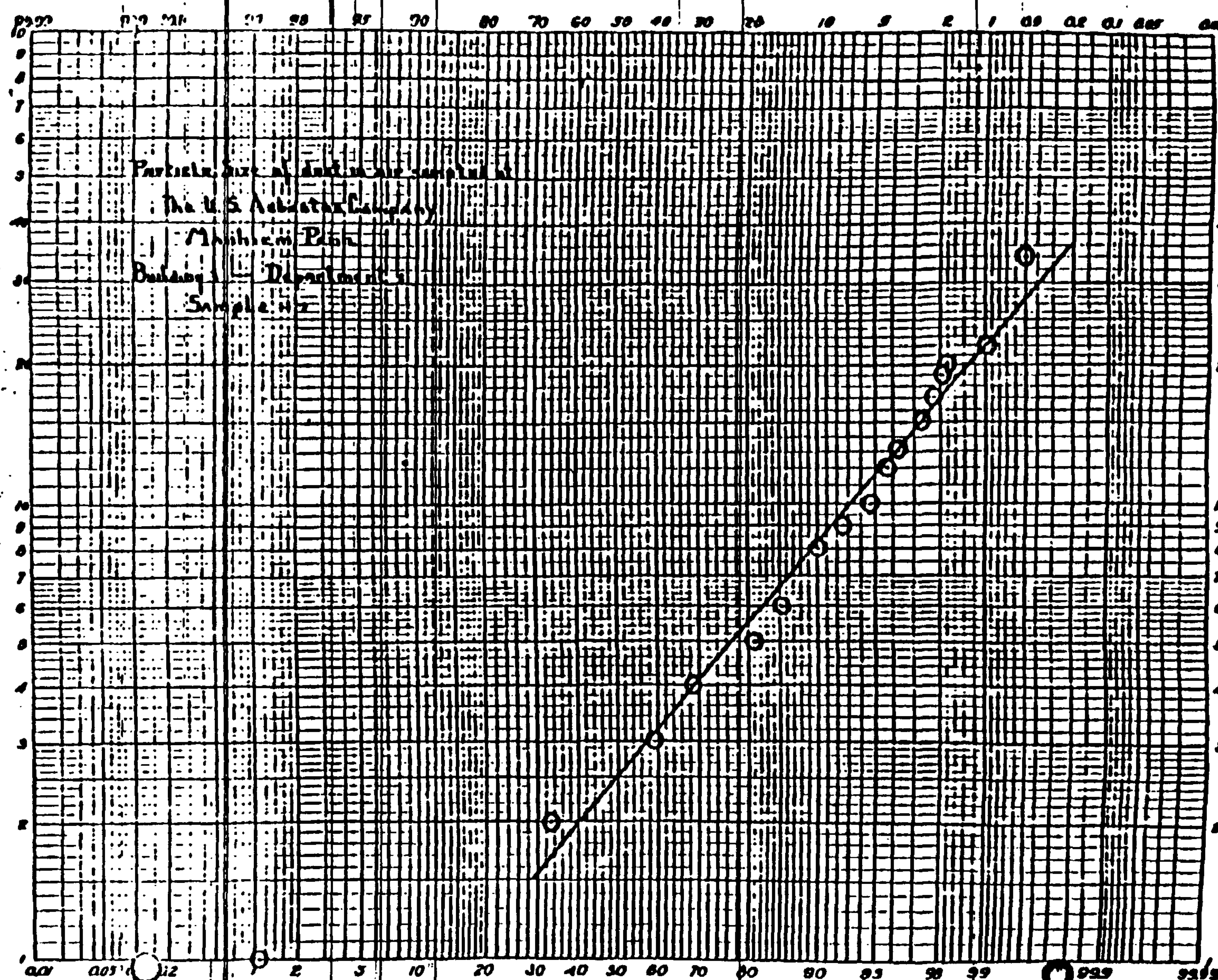
It will be noted from these curves that from 86 to 99% of the particles are less than 10 microns in their greatest diameter.

The analyses are reported in total particles per cubic foot, and also in the corresponding weight of the dust in milligrams. There is no indicated relationship between the dust counts and the corresponding weights.

DESCRIPTION OF PLANT:

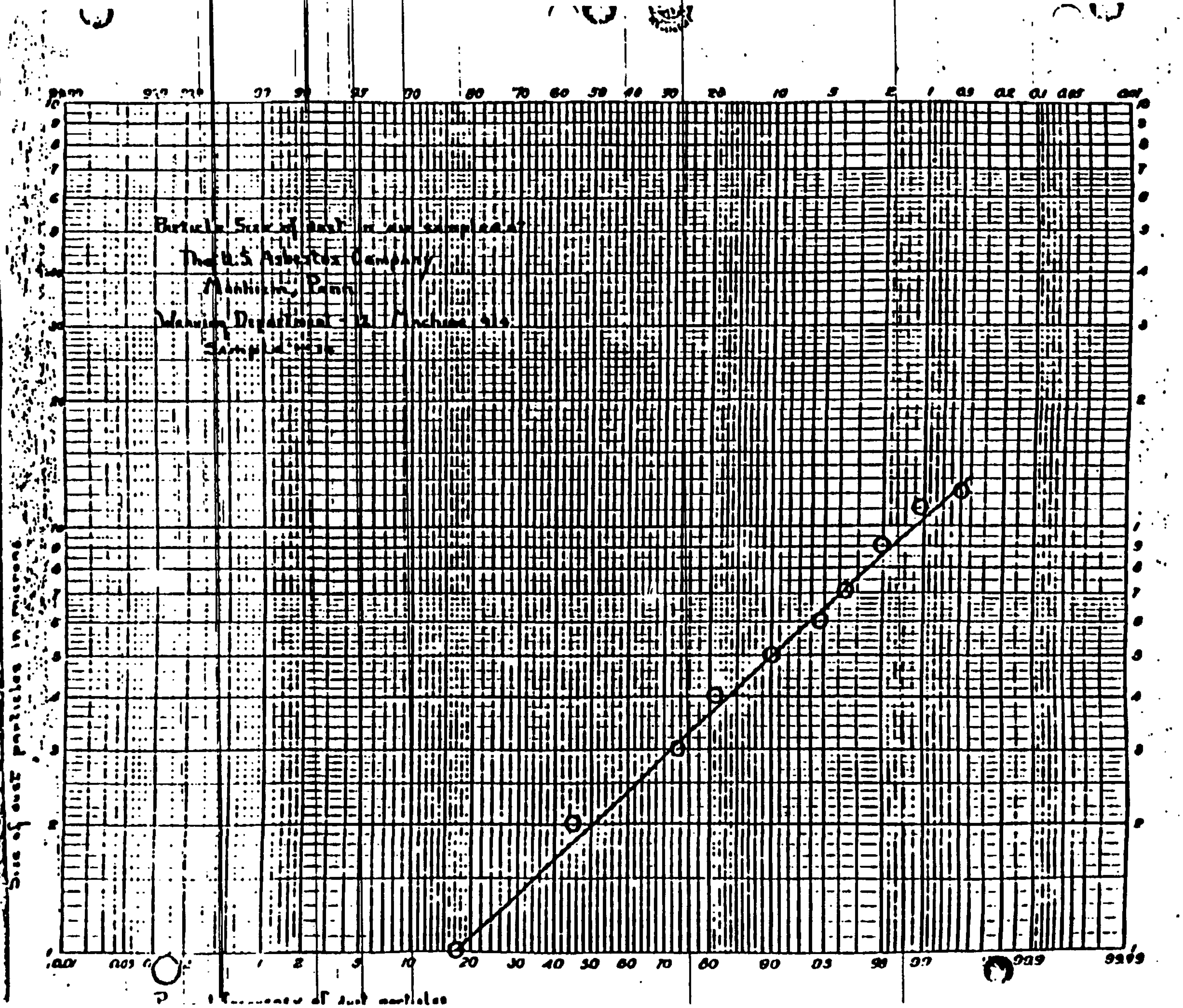
The plant at Manheim consists of a number of one-story and two two-story buildings. One of the two-story buildings houses the offices, laboratories, dispensary and store room, while the other is devoted to the preparation

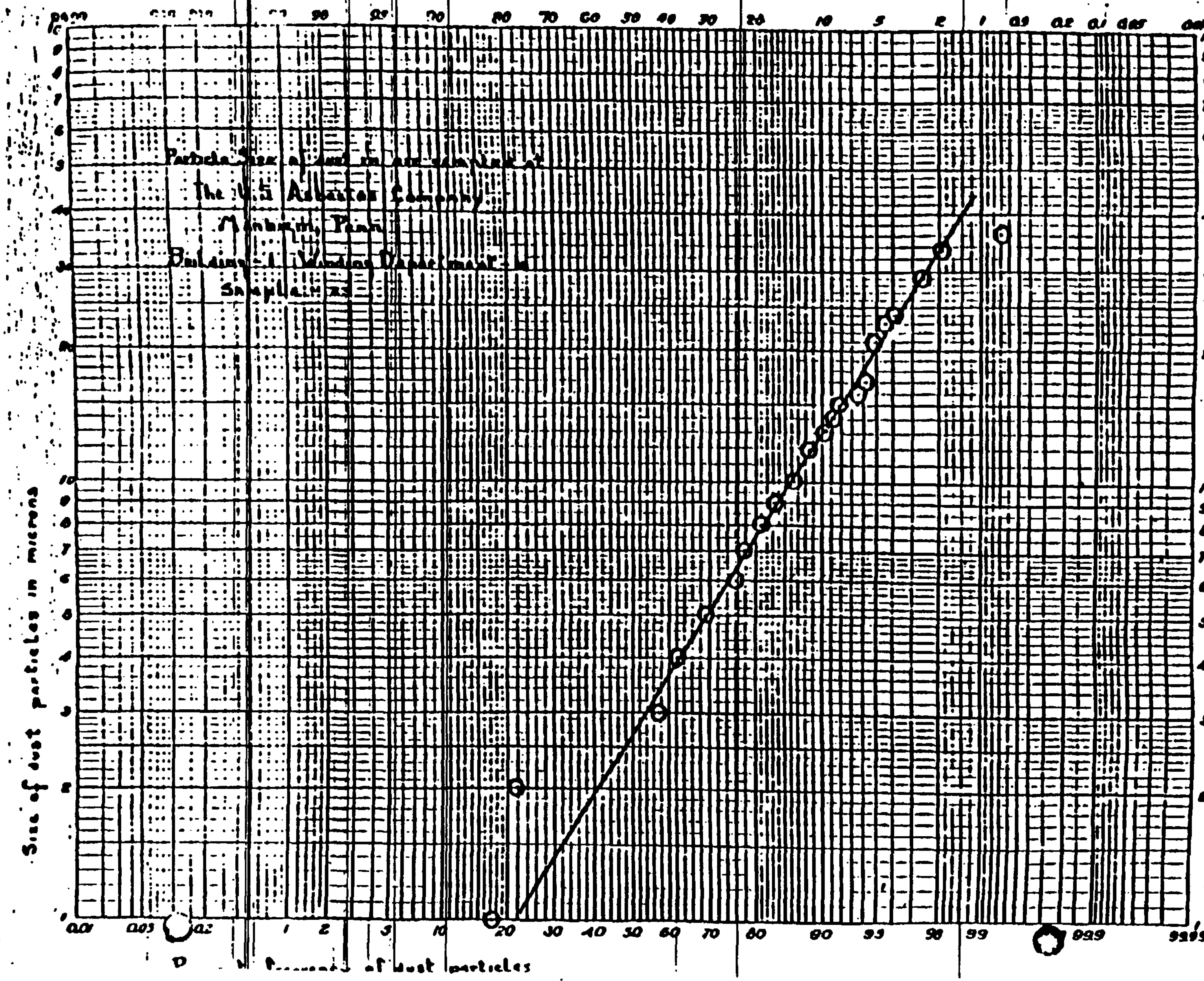
(3) Green, H. "A Photomicrographic Method for the Determination of Particle Size of Paint and Rubber Pigments", Journal Franklin Institute, 1921, 192, 657.
(4) Whipple, G.C. Vital Statistics, N.Y. John Wiley & Sons, Inc. 1925, p. 451

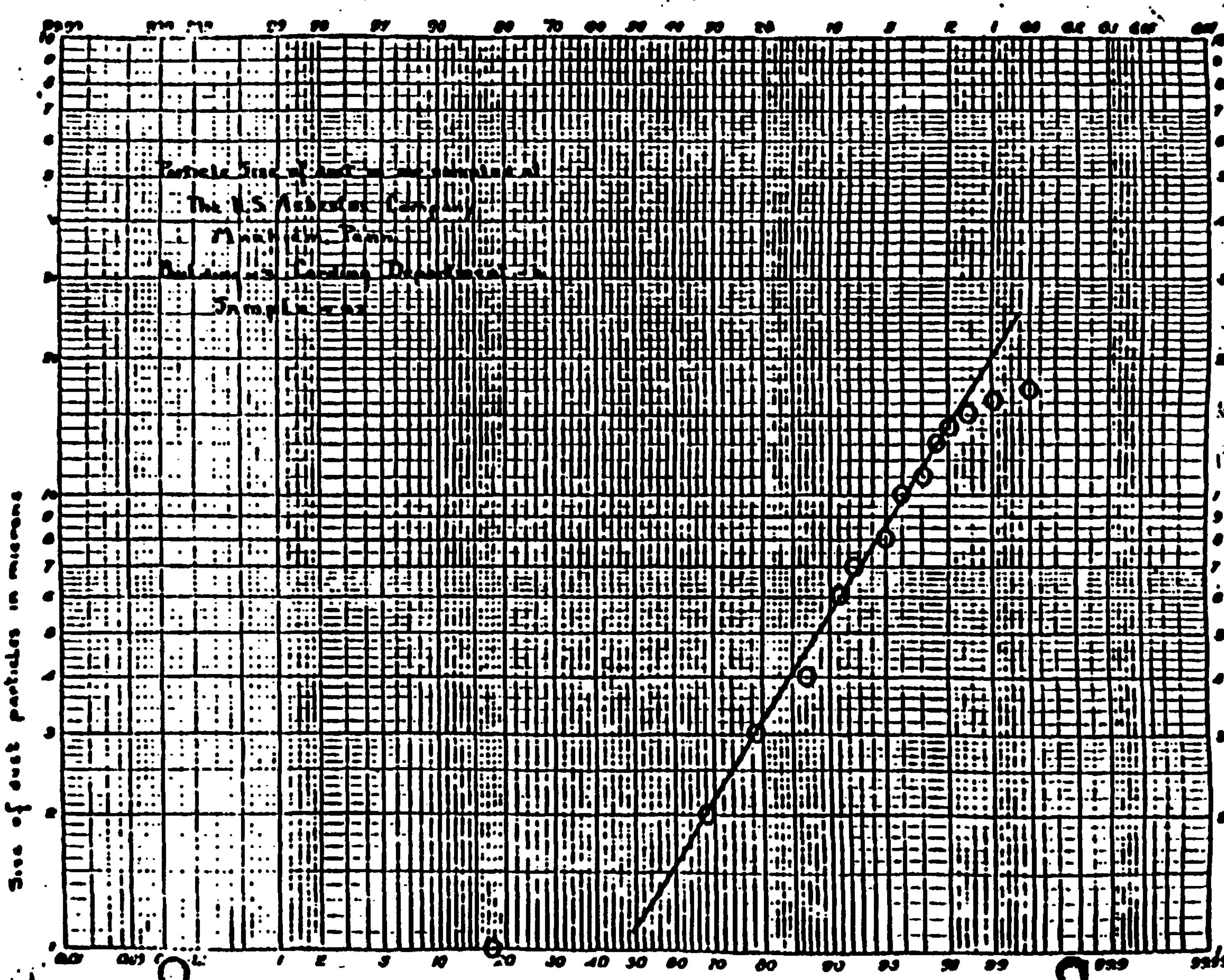


Size of dust particles in microns

Per cent frequency of dust particles


Particle Size of dust in air sample at
The U.S. Asbestos Company
Manheim, Penn.
Weaving Department
Sample
Size of dust particles in microns
Frequency of dust particles


The U.S Asbestos Company
Manheim, Penn.
Size of dust particles in microns
Percent of dust particles


The U.S. Asbestos Company
Manheim, Penn.
Size of dust particles in microns

room and brake-band weave room on the first floor and the carding, spinning and spooling operations are performed on the second floor.

The other one-story buildings are occupied by spooling, twisting and broad loom operations, brake-band treating and packing manufacturing, shops and shipping department.

PREPARATION DEPARTMENT:

The asbestos is received in bags and emptied upon the floor. It is then shoveled into pug mills or chasers from which it is passed into an opener and on a shaker sieve. Here it is piled on the floor to made up into mixtures with proportionate amounts of cotton which has already been passed through an opener. The batches of mixed cotton and asbestos are passed through a mixer picker and carried by suction through a pipe to bins in the card room on the second floor. In this suction pipe oil is applied to the mixture of cotton and asbestos by means of sprayers. Judging from the high dust counts found in the card room, as compared with those found at similar locations in the plant at Charleston, the method of applying the oil does not appear to be as effective.

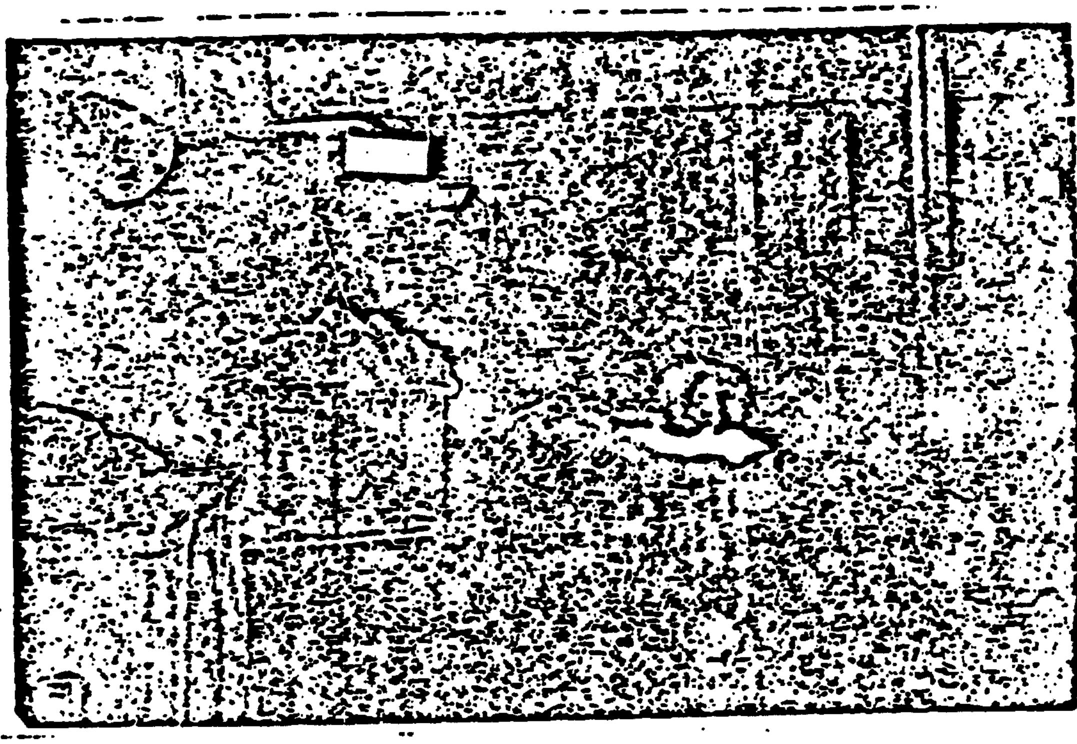
Two card machines working on waste material are making wicking in this department. One loom is operating on brake-bands.

The exhaust systems at the various machines were only in partial operation due to relocation of machines. No humidifying system was in operation. The temperature of this department at the time of visit was 67° F. with a relative humidity of 37%, as compared with outdoor temperature of 30° F. and a relative humidity of 67%. The high incidence of dust in this department is partly due to the alterations being made.

TABLE NO. 1

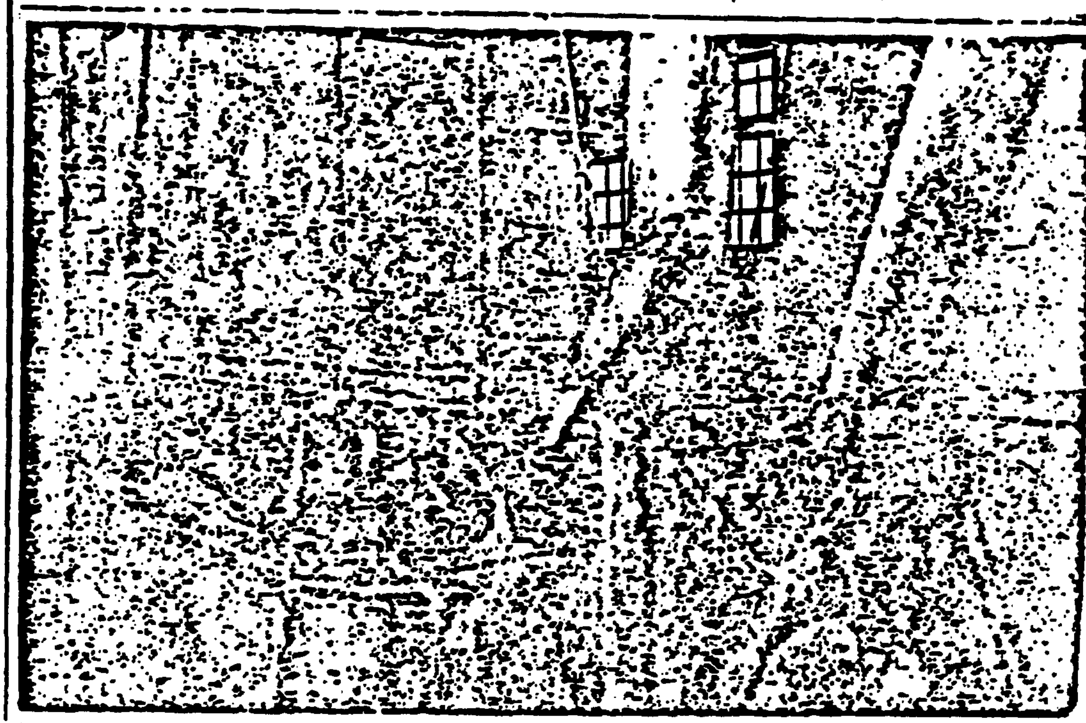
PREPARATION ROOM

Sample No.	Building No.	Dept. No.	Location of Sampling	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
1	3	1	Alongside exhaust pipe from vertical opener discharging on to shaker sieve	43,289,154	2.5
3	3	1	Alongside loom 946. Only one loom in preparation room	2,201,597	.46
4	3	1	Alongside chasers #1 and 2	3,135,214	.47
5	3	1	At the side of shaker sieve	23,809,525	1.37
6	3	1	Floor mixing center of room	3,457,660	.45
8	3	1	Alongside feeder end of wick card working waste material, machine 136	3,067,129	.40
9	3	1	Machine #18, feeder hopper of breaker card	29,219,145	3.4
11	3	1	At the take off end of wick card machine #136	4,904,515	.65

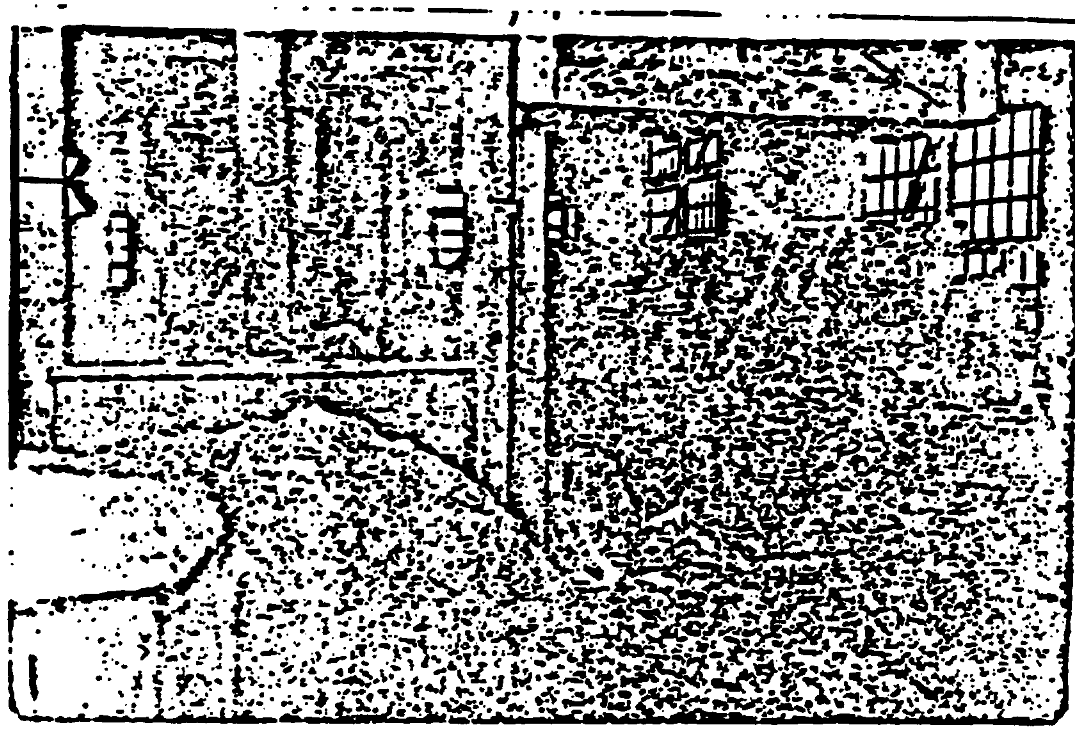


Storage and Batch Mixing Bins
in
Preparation Room

Feeder End of Shaker Sieve
in
Preparation Room



Take-off End of Shaker Piers
Preparation Room



Floor Mixing in Preparation Room.
Chaser or Pug Mill Visible at the Right

It will be noticed that the dust count is high in places and exceeds 10,000,000 particles, the standard adopted by the U.S. Public Health Service in their study of the granite industry.[5]

BRAKE-BAND WEAVING DEPARTMENT:

This process is conducted in a room adjacent to the preparation department. This room is equipped with hand controlled water sprays for humidifying. The temperature in this department was found to be 69° F. and the relative humidity was 78%.

Artificial illumination is furnished by Cooper Hewitt lamps.

Dust counts were collected in close proximity to the workers and are as follows:

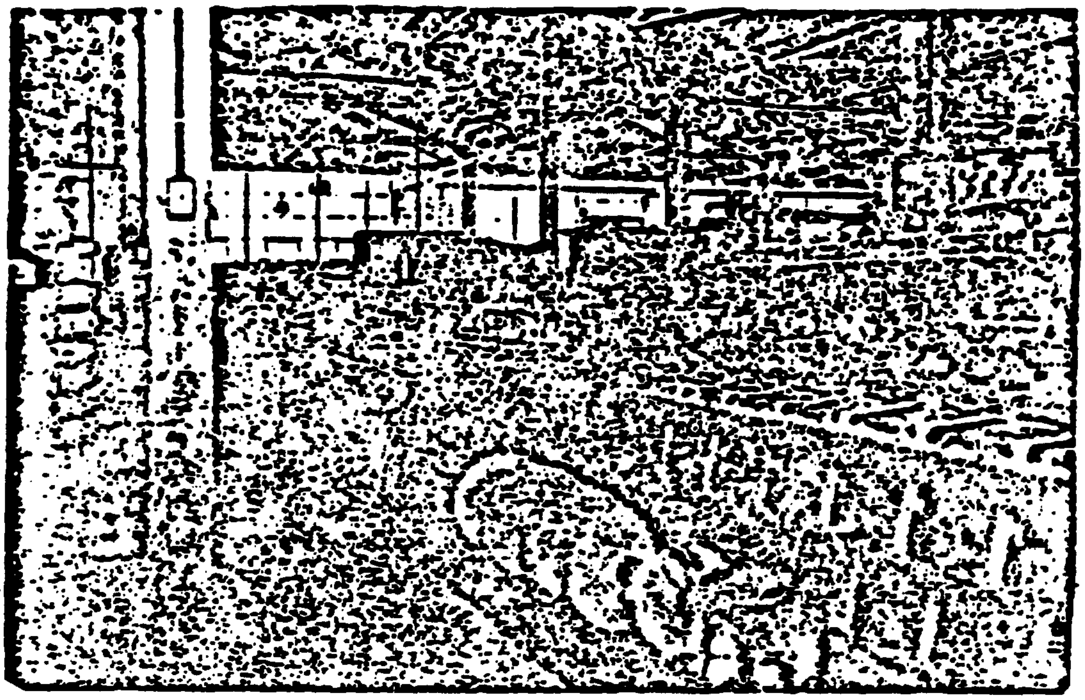
(5) Public Health Bulletin No. 187 "The Health of Workers in Dusty Trades II. Exposure to Siliceous Dust (Granite Industry)" - U.S.P.H.S., Treasury Dept., Washington, D.C. 1929.

TABLE No. 2

WEAVE ROOM (BRAKE BAND)

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
12	1	12	Alongside loom 9 space 8. Machine #916	8,101,852	.60
15	1	12	Alongside loom 6 space 8. Machine #915	6,074,858	1.1
16	1	12	Alongside loom 5 space 12. Machine #925	4,824,606	.60
17	1	12	Front of loom 20 space 8. Machine #926	5,705,705	—
18	1	12	Front of loom 57 space 4. Machine #944	9,982,656	1.1
19	1	12	Front of loom 19 space 2. Machine #925	9,076,765	1.5

6-1



Brake-Band Reeving

The number of particles per cubic foot of air in this room are considerably less than in the preparation room, and slightly under the standard quoted above.

SPOOLING, TWISTING AND BROAD LOOM WEAVING:

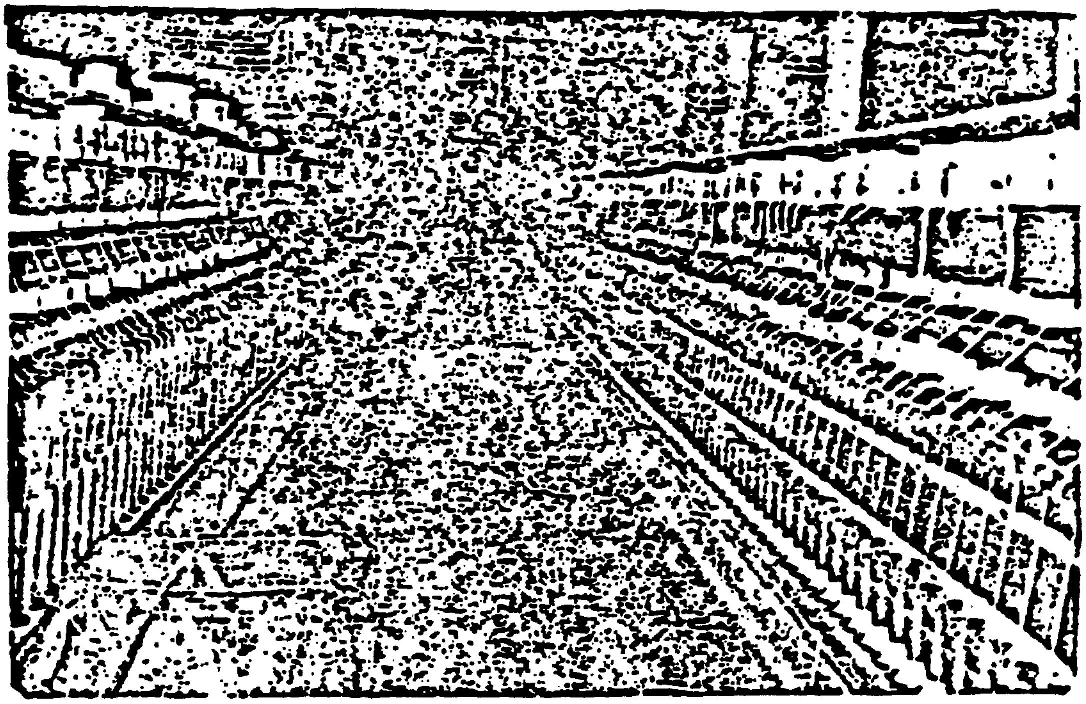
These processes are likewise carried out on the first floor of building number one. This department is equipped with the Carrier Air Conditioners which furnish ample humidification. The temperature was found to be 74° F. and the relative humidity was 80%.

TABLE No. 5

SPOOLING, TWISTING AND WEAVING

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
20	1 N.E. corner	6	Between spoolers 605 and 602	2,979,901	.65
21	1	6	Front of spooler #605	1,150,175	.25
22	1	10	Between universal winders 701 and 702	1,322,751	.30
24	1	7	Between twisters 660 and 661	3,732,838	.60
25	1	10	Alongside loom #1016 weaving broad cloth	2,270,469	.28
26	1	6	Alongside machine #451. Ring spinning	1,469,320	.35
28	1	10	Alongside loom #1017. (dry weaving)	3,182,870	.30
30	1	10	Between looms 5, 21 and 20 dry weaving on wide material	2,704,201	.30

First floor of building #1 equipped with the Carrier system.



Twisting Machines

The dust counts as shown in the table indicate a relatively small number of particles.

SPINNING DEPARTMENT:

This department is located on the second floor of building No. 1 at one end of the main card room.

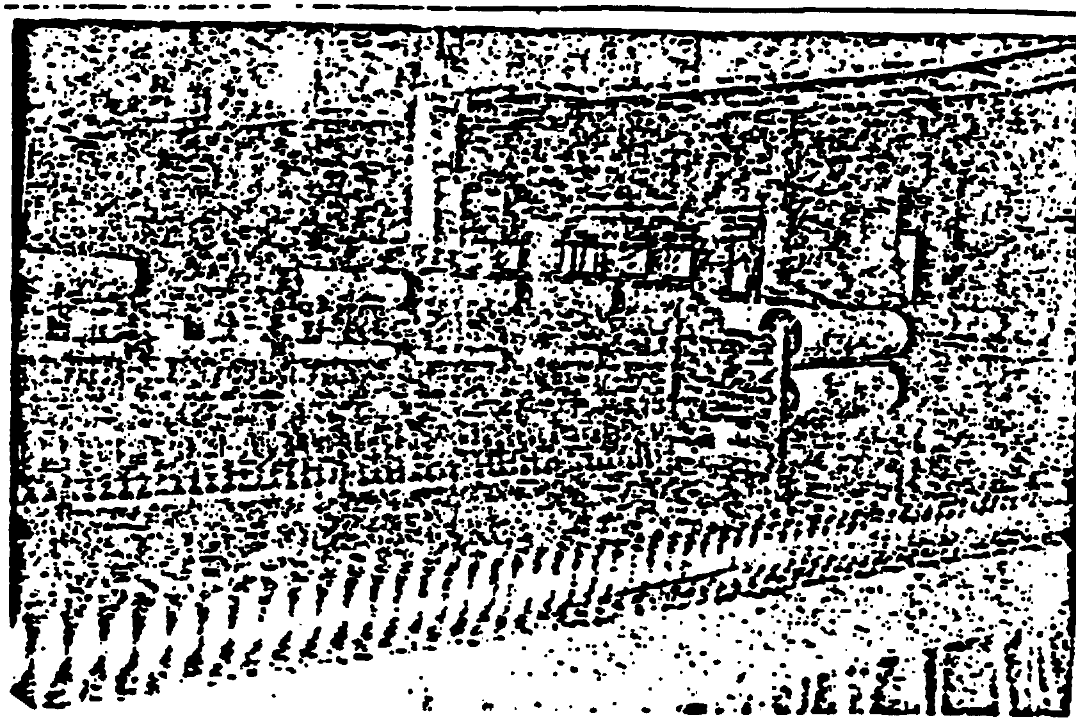
Mule spinning and some spooling operations are carried on here. The department is provided with the Carrier System. No ring frame spinning is done.

TABLE No. 4

SPINNING

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
32	1 2nd floor	4	Between mules 405 and 406 at S.E. corner of room	2,314,814	.49
33	1 2nd floor	4	Between mules 405 and 406 at the N.E. corner of room	4,578,810	.40
34	1 2nd floor	4	At the end of spooler 457	1,254,164	——

These counts are comparatively low and indicate effective control.



Mule Spinning

CARDING ROOM:

This room consists of two connecting departments occupying the second floors of building No. 1 and No. 3, except for a portion in building No. 1 devoted to spinning.

The section located in building No. 1 is equipped with the Carrier System. No form of humidification is used in building No. 3.

The carding machines in building No. 1 are totally enclosed by canvas covered wooden frames and each enclosure is equipped with an exhaust to remove the dust. That section located in building No. 3 is not totally enclosed. The exhaust on these machines is connected with the hood covering the comb of the card.

TABLE No. 5

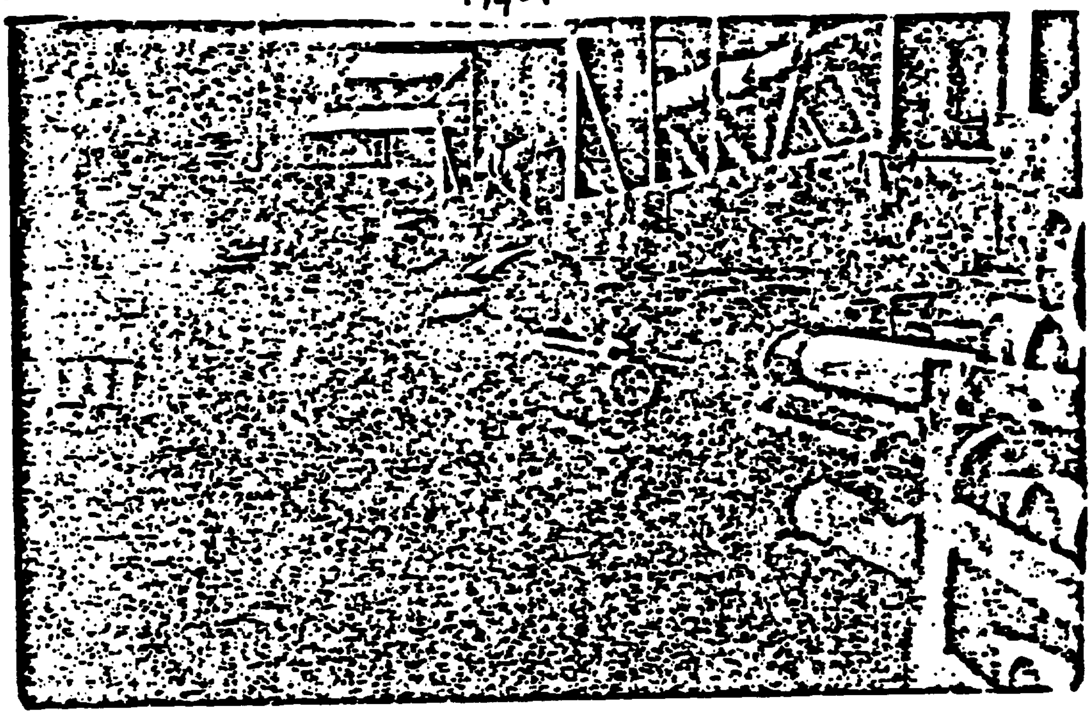
CARD ROOM

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
36	1 2nd floor	2	Between cards #101 and 102	10,127,314	1.58
37	1 2nd floor	2	Alongside of card #201	5,519,228	.70
38	1 2nd floor	2	On spooler #459	5,825,518	.89
39	5 2nd floor	5	Alongside card #184	7,520,950	1.28
40	5 2nd floor	5	Alongside card #172	15,677,052	1.55
41	5 2nd floor	5	Between carders #162 and 195	6,221,064	.57

It will be noticed that the counts vary considerably and in two instances are quite high. No marked difference is noticed where the machines are totally enclosed and only partially enclosed.

14-1

114-1

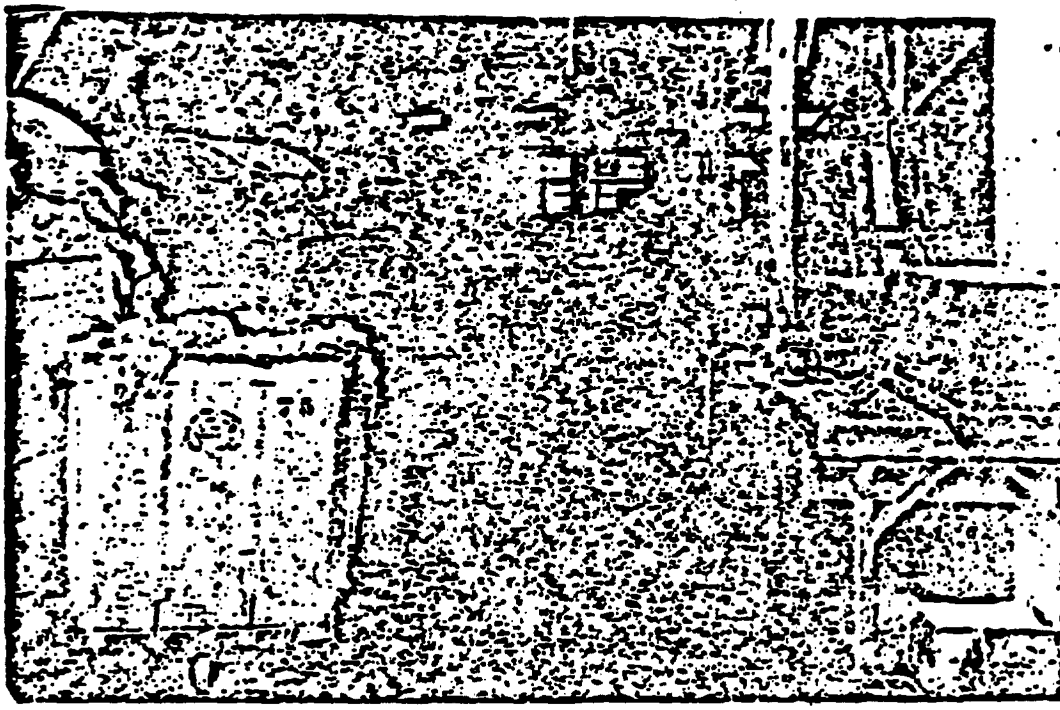


Main Card Room, Second Floor
Bldg. #1
Showing totally enclosed card machine

14-✓

Card Room, Second Floor
Bldg. #1

14-3



Card Room, Second Floor
Building #3

14-4

Card Room, Second Floor
Building #3

PLANT HOUSEKEEPING:

The floors are dry swept almost continuously throughout the working period. Each Friday the dust is removed from the ceilings, walls, and machines by means of an air hose during the working period. The dust counts during this period of cleaning would be increased considerably. It is recommended that cleaning be accomplished by means of a vacuum system. There are portable units on the market designed for this kind of work.

PHYSICAL EXAMINATIONS:

Physical examinations were made on fifty-four employees. All who worked in an asbestos industry three years or longer were included in this group. These employees were examined for symptoms usually associated with what English authorities term "asbestosis". These include anorexia, leaden hued complexion, emaciation, dyspnoea, cyanosis, cough, expectoration, "asbestos corns", decrease in chest expansion, clubbing of fingers, swelling of skin at the nails, and history of chest trouble. The chests of these employees were then examined for friction rubs, râles, dullness, diminished breath sounds, increased voice sounds, and where the symptoms and findings suggested further examination, X-ray pictures of the lungs were taken.

X-ray examinations were made of 20 employees; of these 10 showed definite evidence of asbestos dust injury to the lungs; one showed tuberculosis without dust injury, and nine were negative.

The action of inorganic dust upon the lung tissue is such as to cause the development of fibrous tissue - fibrosis. Such dust fibroses are classified under the general term pneumoconiosis. The various types of pneumoconiosis are further differentiated by more specific titles which define themselves, such as silicosis, anthracosis, and asbestosis.

On page 2 of the first unit report of this series of studies it was stated, in relation to the action of asbestos dust on the lungs, "We are confronted with three alternatives:

(1) Asbestos dust does not cause pulmonary damage.

(2) Asbestos dust does cause pulmonary damage akin to silicosis, but of a milder nature.

(3) Asbestos dust itself does cause pulmonary damage, but in a manner and of a type entirely distinct from silicosis."

The X-ray films of this study definitely inform us that individuals exposed to the inhalation of asbestos will in time show structural changes in their lungs - pneumoconiosis. Our studies have not progressed sufficiently for us to construe this type of pneumoconiosis in term of disability or of increased susceptibility to tuberculosis. This type of pneumoconiosis, to which the term asbestosis may properly be applied, is quite distinct in its X-ray film appearance from true silicosis and an experienced technician would have no difficulty in distinguishing the two conditions. The evidence so far would indicate that the action of asbestos dust is in accord with the second alternative quoted above.

Four films showing definite asbestosis also showed old tuberculous lesions, apparently inactive, 3 of the films negative for asbestosis also showed such lesions; this would lend support to the contention that asbestosis does not tend to activate quiescent tuberculous lesions which is in accord with the meagre evidence so far available from animal experimentation and with the limited clinical experience.

The following table summarizes the X-ray examinations.

No.	Sex	Age	Occupational History	Diagnosis
1	F	35	Weaving 21 yrs. off & on, 4 yrs. U.S. Asbestos Co.	Negative
2	F	37	Twisting 15 years	Late first degree asbestosis
3	M	32	Weaving 12 years	Early first degree asb old tubercu-lous lesion
4	M	53	Spooling 6 years	Negative
5	M	47	Spooling 3 yrs. U.S.As.Co. 14 yrs. elsewhere	Negative
6	M	68	Warping 12 years	Negative; old tuberculous lesion
7	M	50	Weaving 10 years	Early first degree asbestosis
8	M	44	Carding 5 years	Early first degree asbestosis; heart lesion
9	M	58	Spooling 5 years	Beginning asbes-tosis
10	M	37	Weaving 6 years	Negative
11	M	32	Weaving 9 years	Negative. Old tuberculous lesion
12	M	38	Weaving 22 years	First degree as-bestosis. Old tuberculous lesion
13	M	45	Weaving 7 years U.S. As. Co. 11 yrs. elsewhere off & on	Negative
14	M	64	Warping 12 years	Negative

No.	Sex	Age	Occupational History	Diagnosis
15	M	30	Weaving 5 years	Negative. Old tuberculous lesion active(?)
16	M.	32	Weaving 18 years	Early asbestosis
17	F	41	Spinning 3 years	Negative
18	M	35	Carding 7 years	First degree asbestosis
19	M	48	Foreman 22 years	Early second degree asbestosis
20	M		Worked in asbestos 20 years, out of plant 10 years	Late second degree asbestosis. Old tuberculous lesion

In the foregoing cases the length of exposure with the resultant degree of pneumoconiosis and the general appearance of the films all support the second alternative mentioned above.

Sputum analysis was made of ten of the individuals X-rayed, and "asbestos bodies" were found in one case.

SUMMARY:

Dust counts in the preparation room and carding room were high, several counts higher than ten million.

Individuals exposed to this dust showed definite pneumoconiosis. Their occupation and length of exposure were as follows (omitting 19 and 20 whose histories were not clear):

Twisting	Spooling	Carding	Weaving
15 years	5 years	5 years	10 years
		7 "	12 "
			18 "
			22 "

The number of these cases is too small to draw any final conclusions. They indicate a possible variation of hazard in the four processes listed, but further study will be needed to establish the facts.

RECOMMENDATIONS:

1. The method of application of the oil used in the preparation room at the Charleston plant is more effective than that used at Kanheim. Therefore, the Charleston method is preferred.

2. That the humidification and air conditioning system be continued

and extended wherever possible.

3. The dust counts indicate little difference between the two systems of exhausting dust arising from the carding machines. The canvas covers have no advantage in exhausting the dust, and have the disadvantage of making it more difficult to clean the machines. They also offer a larger surface for dust to settle. The exhaust system connected with the metal hood covering the comb of the card is recommended.

4. That the exhaust system attached to the machines in the preparation room be repaired and maintained, especially those connected with the shaker sieve and the wick carding machines.

5. That cleaning be done by means of a vacuum system instead of the present method of blowing with compressed air.

6. That all employees be given an initial physical examination and periodically thereafter. X-ray examinations should be made when indicated.

U.S. ASBESTOS & RUBBER DIVISION OF RAYBESTOS-MANHATTAN, INC.

Manheim, Pa.

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A second survey of dust conditions in the Manheim plant of the U.S. Asbestos & Rubber Division of Raybestos-Manhattan, Inc. was made on April 16, 17, 18, 22, and 23, 1935. This is supplementary to the survey conducted in February, 1930 and the methods of sampling and analysis are the same as in the first survey.

The first survey included only those departments involving textile operations, whereas this survey includes all departments of the plant.

The processes in the Preparation Department, Carding Department, Brake Band Weave Room, and twisting, spinning, spooling, and broad cloth weaving departments are the same as at the time of the first survey. The exhaust equipment has not been changed.

The following tables show results of dust counts and comparative data of the two surveys:

- Exhibit K

R-M 261B 5-15-77

U.S. ASBESTOS & RUBBER DIVISION OF RAYBESTOS-MANHATTAN, INC.

Manheim, Pa.

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air Sampled	Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled		Type of Dust	Remarks
PREPARATION DEPARTMENT, DEPT. #1								
1	Beside discharge pipe from vertical opener discharging fibre onto screen	4/16/35	20.0	6.2	5.15	30	Asbestos cotton	Stock 22¼ 116 special
2	At loom #39 - wet warp	"	27.9	20.9	17.4	10	"	Only loom in Prep. Dept.
3	Between chasers #1 and #2	"	15.0	21.8	18.1	10	Asbestos	Shoveled fibre #2, one man
4	Beside truck under discharge pipe from hopper on second floor	"	9.5	33.7	28.0	11	Asbestos cotton	One man, clothes covered with fibre
5	Floor mixing of asbestos and cotton between chasers and vertical opener	"	15.0	30.4	25.2	10	"	Three men
6	At discharge end of small fibre opener	"	20.5	10.2	8.5	51	Asbestos	Conveyor belt; one man, fibre from crusher
7	General air in preparation room	"	22.0	14.2	11.8	[illegible]	Asbestos cotton	Center of room
8	At hopper of mixing picker	"	15.0	21.8	18.1	11	"	One man, forking mixture into hopper from floor

Relative humidity in Preparation Dept. (1935) 20% -- (1930) 37%
The average of these counts is 19.9 million particles per cu. ft. air sampled.
The average count in this department in 1930 was 14.13 million particles per cu. ft. air.
The analysis of rafter dust from this department showed 36% SiO_2.
Relative humidity outside (1935) 50% -- (1930) 67%.

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air Sampled	Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled	Type of Dust	Remarks
CARD ROOMS							
9	At take-off end of breaker card #1, Dept. 2, 2nd floor	4/16/35	41.0	9.0	7.7 46	Asbestos cotton	
10	Taken between cards #9 and #16, Dept. 2, 2nd floor	"	20.5	13.7	11.7 70	"	129 min - cards enclosed and exhausted
11	Between storage bins and cards #31 and #32 at operator's positions	"	31.1	18.8	16.0 86	"	Cards partially exhausted but not enclosed #32 - 130 stock #31 - 116 special
22	Same location as #11 just after stock from mixing picker had been blown into storage bins	4/17/35	36.5	16.2	13.8 82	"	Bin door opens on this floor
12	Between cards #1 and 2 and #7 and 8 operator's station, Dept. 3, second floor, 3 cards running 22¢ stock; 1 card running 12¢ stock	4/16/35	22.5	16.7	14.2 85	"	Cards partially enclosed and exhausted; operator wore gauze strip with cotton pad under nose.
13	Between cards #7 and #8 on saddle side; saddles extend out from enclosure	"	10.0	36.8	31.4 119	"	Dept. #3, second floor
14	Between cards #18 and 19 and #25 and 26 in aisle where operator works	"	20.0	28.4	24.2 115	"	Cards partially enclosed and exhausted; 3 cards running 22¢ stock 1 card running 60/40 stock
19	Between cards #20 and 21 and #27 and 28 in aisle where operator works; cards partially enclosed and exhausted	4/17/35	30.0	8.8	7.5 42	"	2 cards running 60/40 stock; 1 card running 23¢ stock; 1 card running 22¢ stock

Relative humidity 20%.
The average of these counts is 18. Million particles per cu. ft. air sampled

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air sampled	Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled	Type of Dust	Remarks
SPINNING DEPT. #4, 2nd floor							
15	Between speeders twisting wire and yarn, 2 men	4/16/35	20.0	20.0	17.0	Asbestos cotton	Machines #464, 463, 462, 459, 229 stock - 224 stock
16	Between mules #417 and 402 where operators work	"	27.5	29.6	25.2	"	
17	Between mules #404 and 405 where operators work	"	20.0	12.4	10.5	"	
18	Between mules #406 and 407 where operator works	"	20.0	17.6	15.0	"	

Relative humidity 20%.
The average of these counts is 19.9 million particles per cu. ft. air sampled.
The average count in this department in 1930 was 2.72 million particles per cu. ft. air sampled

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air Sampled		Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled	Type of Dust	Remarks
BRAKE ROOM (BRAKE BAND) DEPT. #12								
20	Between looms #3 and #23 dry weaving	4/17/35	30.0	14.9	59	12.7	Asbestos cotton	Ring steel and brake lining 224 stock, one man
23	At operator's position of loom #17	"	23.3	14.8	58	12.6	"	Pontiac brake lining 224 stock
24	In aisle between looms #33 and #19, wet weaving	"	32.5	8.85	5v	7.5	"	#33 - 224 stock #19 - 310 stock
25	In aisle between looms #14 and #26, and #7 and #12	"	23.0	7.3	44	6.2	"	#14 and #26 - truck lining - wet #7 and 12 dry - 224 stock
26	Inspection of brake lining and ring stock	"	30.0	6.15	34	5.2	"	Material goes thru revolving brushes - exhaust system

Relative humidity (1935) 47% - (1930) 76%
The average of these counts is 10.4 million particles per cu. ft. air sampled.
The average count in this department in 1930 was 6.96 million particles per cu. ft. air.

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air Sampled	Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled	Type of Dust	Remarks
SPOOLING, TWISTING & WEAVING							
27	Between looms #1 and 2 and #3 and 4; broad looms, #1 not running	4/17/35	49.0	8.8	7.55	Asbestos cotton	Air-water spray for humidifying, Dept. 10.
28	At looms #22 and 24, cloth	"	26.0	16.3	14.0	Asbestos cotton	#24 warp wet with a hose; #22 dry.
29	At loom #10 - wet weaving, 890 cloth, 3 ply for clutch facing	"	22.0	10.3	8.8	"	210 - 224 mix, warp passes through 63% emulsion
30	Between twisters #657 and 658	"	24.0	13.7	11.8	"	2 women, dept. 7.
31	Between twisters	"	26.6	18.0	15.4	"	2 women, dept. 7.
32	Between spoolers #3 and 4, dept. 6	"	20.8	25.0	21.4	"	6 women, dust on machines blown off with cardboard used as fans.

Relative humidity (1935) 41% - - - (1930) 50%
The average of these counts is 15.35 million particles per cu. ft. air sampled.
The average count in this dept. in 1930 was 2.35 million particles per cu. ft. air sampled.

CONCLUSIONS AND RECOMMENDATIONS

TEXTILE DEPARTMENTS

The dust counts in the Preparation Department are high. All counts, but one, show more than ten million particles per cubic foot. The raw fibre is handled carelessly and piled on the floor at various places. The average dust counts are higher than those of the survey made in 1930. No improvements have been made since the first survey was made. The relative humidity is lower than at the time of the previous survey.

It is recommended that a mechanical method of handling the fibre be installed. Exhaust equipment, properly designed and applied, be installed at the chasers, pickers, and shaker screens and it should be properly maintained. The one loom should be removed from this department. A humidifying system should be used, if practicable. A vacuum sweeping system for sweeping and cleaning machines should be installed throughout the plant.

The average counts in the broad band weave room are higher than those of the 1930 survey. No exhaust equipment is in use on the looms. The relative humidity is lower than at the time of the first survey.

It is recommended that wet warp weaving be done whenever possible. The humidity should be kept as high as possible without causing discomfort to the workmen.

The average dust counts in the spooling, twisting, and weaving departments are much higher than those of the first survey. The relative humidity is lower than at the time of the first survey.

It is recommended that the broad looms be exhausted and the humidity be kept higher.

The average dust counts in the spinning department are much higher than those of the first survey. This may be attributed to pollution of the air from the carding machines located in the same room and to the low humidity. A check of the records will show the grade of fibre used at the time of the two surveys and the rate of production.

It is recommended that the spinning department be isolated from the carding department. A humidifying system should be installed.

The average dust counts in the carding departments are higher than those of the first survey. A check of the records would show the grade of fibre used at the time of the two surveys and the rate of production. The exhaust equipment does not seem to be effective in removing the dust generated.

It is recommended that exhaust equipment, similar to that in operation at the Charleston plant, be installed on the carding machines. Fibre storage bins opening into the card room should be exhausted.

BRAKE LINING AND CLUTCH FACING

PROCESSES

Two types of brake lining are made. One type is made from woven narrow bands of asbestos. The bands are saturated in an emulsion or a rubber solution according to specifications. They are cured in heated presses or on heated mandrels. If they are cured on heated mandrels, they are cut to length before being cured. The mandrels also shape them into arcs. They are ground to the thickness desired and rivet holes are drilled or punched into them. They are inspected and packed for shipment.

The second type of brake lining is the extruded type. This type is produced from a mixture of asbestos fibre, litharge, sulphur, zinc oxide, whiting, sizes, and rubber dissolved in gasoline. This wet mixture is put into an hydraulic press and is extruded through a die into long narrow strips. The strips are cured in heated presses. They are ground to the thickness and width desired and formed on heated mandrels. Holes for rivets are drilled or punched into them. The ends are chamfered. The lining is then inspected and packed for shipment.

Clutch facing is made from asbestos cloth and narrow bands of woven asbestos. The wide cloth is cut into squares on a band saw. Solid rings are cut from these squares after they have been saturated in an emulsion and dried. The rings are cured in heated presses. They are then ground to the thickness desired. Holes are drilled into them on gang drill presses. The inside and outside diameters are ground on Gardner grinders. The clutch facing is then inspected before shipping.

The narrow bands of woven asbestos are put through a coning machine to be formed into spirals. These are then put through a rubber solution and wound onto a mandrel. The rings are cut and the ends fastened together with brass wire. They are cured in heated presses and ground to the dimensions required. They are then inspected before shipping.

FOLDED GASKETS AND PACKING

Asbestos cloth is impregnated with a solution of rubber and gasoline. The cloth is then cut into strips. The strips are folded by hand roughly to form the gasket or packing. The rough forms are then placed in forming molds and pressed and cured in steam heated presses. The edges are trimmed and the product is then inspected.

Rubber used in the various products is compounded in building #2. The raw rubber is mixed with zinc oxide, lithopone and barytes in a rubber compounding mill. The compounded rubber is dissolved in gasoline in tumbler barrels.

The emulsions used in the various products are made in building #35. The materials used are litharge, lampblack, mica, Gilsonite, linseed oil, kerosene, and water. These materials are weighed and put into an electric mixer. After the emulsion is mixed, it is put into pails and carried to the different departments where it is used.

ANALYSES OF BLOOD SPECIMENS

Name	Age	Occupation	Years of Exposure	Hemoglobin %	Punctate Basophiles	Remarks
Leo F. Blesch		Emulsion preparation	2	50	Frequent	Poor teeth
Harry L. Bullock		Grinding brake lining	5 (approx.)	88	Negative	
Samuel Wright		Mixing for extruded brake lining	1½	65	"	Stomach trouble
Charles Mathews		Cutting brake bands	6½	40	Occasional	Formerly mixing for extruded brake lining, changed because of sickness, had lead poisoning 2 years ago, treated by doctor
LeRoy Gelb	26	Roll grinder	1½	94	Negative	Complains of nervous disorders and stomach trouble, claims to have high blood pressure
Robert Guider	22	Extruder	3	60	"	
Louise Winger	20	Label and stamp segments	1½	70	"	
Mark Mohr	26	Segment grinder	2½	85	"	
R. F. Walter	40	Supt. of molded brake lining dept.	4½	55	"	
Olive Bauer	22	Label and stamp segments	1 1/3	70	"	
Annette Shocke	23	Label, stamp and skip segments	1 1/3	80	"	
Malcolm Shaeffer	23	Braider	1	65	"	
R. Spengler	20	Mandrels	2	95	"	
John Miller	29	Rubber mixer	1½	97	"	
Homer Miller	30	Segment grinder	6 wks.	90	"	Worked 10 years previously as silk weaver
Paul H. Hollinger	25	Supervisor of molded	1	100	"	

Sample No.	Station	Date of Sampling	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft. Air Sampled	Millions of Particles less than 10 microns in greatest diameter per cu. ft. Air Sampled	Type of Dust	Remarks
SPOOLING, TWISTING & WEAVING							
27	Between looms #1 and 2 and #3 and 4; broad looms, #1 not running	4/17/35	49.0	8.8	7.55	Asbestos cotton	Air-water spray for humidifying, Dept. 10.
28	At looms #22 and 24, cloth	"	26.0	16.3	14.0	Asbestos cotton	#24 warp wet with a hose; #22 dry.
29	At loom #10 - wet weaving, 890 cloth, 3 ply for clutch facing	"	22.0	10.3	8.8	"	210 - 224 mix, warp passes through 634 emulsion
30	Between twisters #657 and 658	"	24.0	13.7	11.8	"	2 women, dept. 7.
31	Between twisters	"	26.6	18.0	15.4	"	2 women, dept. 7.
32	Between spoolers #3 and 4, dept. 6	"	20.8	25.0	21.4	"	6 women, dust on machines blown off with cardboard used as fans.

Relative humidity (1935) 41% - - - (1930) 50%
The average of these counts is 15.35 million particles per cu. ft. air sampled.
The average count in this dept. in 1930 was 2.35 million particles per cu. ft. air sampled.

CONCLUSIONS AND RECOMMENDATIONS

TEXTILE DEPARTMENT

The dust counts in the Preparation Department are high. All counts, but one, show more than ten million particles per cubic foot. The raw fibre is handled carelessly and piled on the floor at various places. The average dust counts are higher than those of the survey made in 1930. No improvements have been made since the first survey was made. The relative humidity is lower than at the time of the previous survey.

It is recommended that a mechanical method of handling the fibre be installed. Exhaust equipment, properly designed and applied, be installed at the chasers, pickers, and shaker screens and it should be properly maintained. The one loom should be removed from this department. A humidifying system should be used, if practicable. A vacuum sweeping system for sweeping and cleaning machines should be installed throughout the plant.

The average counts in the brake band weave room are higher than those of the 1930 survey. No exhaust equipment is in use on the looms. The relative humidity is lower than at the time of the first survey.

It is recommended that wet warp weaving be done whenever possible. The humidity should be kept as high as possible without causing discomfort to the workmen.

The average dust counts in the spooling, twisting, and weaving departments are much higher than those of the first survey. The relative humidity is lower than at the time of the first survey.

It is recommended that the broad looms be exhausted and the humidity be kept higher.

The average dust counts in the spinning department are much higher than those of the first survey. This may be attributed to pollution of the air from the carding machines located in the same room and to the low humidity. A check of the records will show the grade of fibre used at the time of the two surveys and the rate of production.

It is recommended that the spinning department be isolated from the carding department. A humidifying system should be installed.

The average dust counts in the carding departments are higher than those of the first survey. A check of the records would show the grade of fibre used at the time of the two surveys and the rate of production. The exhaust equipment does not seem to be effective in removing the dust generated.

It is recommended that exhaust equipment, similar to that in operation at the Charleston plant, be installed on the carding machines. Fibre storage bins opening into the card room should be exhausted.

BRAKE LINING AND CLUTCH FACING

PROCESSES

Two types of brake lining are made. One type is made from woven narrow bands of asbestos. The bands are saturated in an emulsion or a rubber solution according to specifications. They are cured in heated presses or on heated mandrels. If they are cured on heated mandrels, they are cut to length before being cured. The mandrels also shape them into arcs. They are ground to the thickness desired and rivet holes are drilled or punched into them. They are inspected and packed for shipment.

The second type of brake lining is the extruded type. This type is produced from a mixture of asbestos fibre, litharge, sulphur, zinc oxide, whiting, size, and rubber dissolved in gasoline. This wet mixture is put into an hydraulic press and is extruded through a die into long narrow strips. The strips are cured in heated presses. They are ground to the thickness and width desired and formed on heated mandrels. Holes for rivets are drilled or punched into them. The ends are chamfered. The lining is then inspected and packed for shipment.

Clutch facing is made from asbestos cloth and narrow bands of woven asbestos. The wide cloth is cut into squares on a band saw. Solid rings are cut from these squares after they have been saturated in an emulsion and dried. The rings are cured in heated presses. They are then ground to the thickness desired. Holes are drilled into them on gang drill presses. The inside and outside diameters are ground on Gardner grinders. The clutch facing is then inspected before shipping.

The narrow bands of woven asbestos are put through a sewing machine to be formed into spirals. These are then put through a rubber solution and wound onto a mandrel. The rings are cut and the ends fastened together with brass wire. They are cured in heated presses and ground to the dimensions required. They are then inspected before shipping.

MOLDED GASKETS AND PACKING

Asbestos cloth is impregnated with a solution of rubber and gasoline. The cloth is then cut into strips. The strips are folded by hand roughly to form the gasket or packing. The rough forms are then placed in forming molds and pressed and cured in steam heated presses. The edges are trimmed and the product is then inspected.

Rubber used in the various products is compounded in building #2. The raw rubber is mixed with zinc oxide, lithopone and barytes in a rubber compounding mill. The compounded rubber is dissolved in gasoline in tumbler barrels.

The emulsions used in the various products are made in building #35. The materials used are litharge, lampblack, mica, Gilsonite, linseed oil, kerosene, and water. These materials are weighed and put into an electric mixer. After the emulsion is mixed, it is put into pails and carried to the different departments where it is used.

ANALYSES OF BLOOD SPECIMENS

Name	Age	Occupation	Years of Exposure	Hemoglobin %	Punctate Basophiles	Remarks
Leo F. Blanch		Emulsion preparation	2	90	Frequent	Poor teeth
Harry L. Bullock		Grinding brake lining	5 (approx.)	88	Negative	
Samuel Wright		Mixing for extruded brake lining	1½	65	•	Stomach trouble
Charles Mathews		Cutting brake bands	6½	40	Occasional	Formerly mixing for extruded brake lining, changed because of sickness, had lead poisoning 2 years ago, treated by doctor
LeRoy Geib	26	Mill grinder	1½	94	Negative	Complains of nervous disorders and stomach trouble, claims to have high blood pressure
Robert Snider	22	Extruder	3	60	•	
Louise Winger	20	Label and stamp segments	1½	70	•	
Mark Mohr	26	Segment grinder	2½	85	•	
R. F. Walter	40	Supt. of molded brake lining dept.	4½	95	•	
Olive Bauer	22	Label and stamp segments	1 1/3	70	•	
Annette Shenk	23	Label, stamp and ship segments	1 1/3	80	•	
Malcolm Shaeffer	23	Braider	1	65	•	
E. Spangler	20	Mandrels	2	95	•	
John Miller	29	Rubber mixer	1½	97	•	
Homer Miller	30	Segment grinder	6 wks.	90	•	Worked 10 years previously as silk weaver
[illegible]	[illegible]	[illegible] of molded	1	100	•	

CONCLUSIONS AND RECOMMENDATIONS

CLUTCH FACING, BRAKE LINING AND PACKING DEPARTMENTS

Several dust counts in these departments are high and in almost all cases show that there is lead present in the air. Samples #14, 36, 38 and 55 show large quantities of lead present. Chemical analyses of rafter dust samples from these departments also show presence of lead. These analyses show that there is a definite health hazard present due to the use of lead. There is another health hazard present due to the use of benzol in the treating of brake bands.

Blood specimens were taken from sixteen employees and the results of these tests are shown in tabular form. Only two specimens showed punctate basophiles (stippled cells), but several other specimens showed low hemoglobin percentage.

It is recommended that a vacuum sweeping system be installed to do away with dry sweeping.

All machines in these departments should be equipped with efficient exhaust systems to carry away harmful dusts.

Employees engaged in handling lead should be supplied with positive pressure or cartridge type respirators and cautioned to handle the lead carefully. These operations should be isolated from the remainder of the departments. Female help work in the same room in which litharge is mixed for unmolded brake lining. Empty litharge drums should be removed from the departments.

The use of benzol should be eliminated, if practicable, or such operations should be isolated so that the least number of employees would be exposed to the fumes, or the benzol should be handled in a closed system.

The employees exposed to benzol fumes should be supplied with positive pressure respirators. All employees in these departments should be watched carefully and examined periodically for signs of lead or benzol poisoning.

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HEALTH HAZARDS OF ASBESTOS AND OTHER DUSTS

Asbestos dust gives rise to a pneumoconiosis or fibrosis of the lungs which has been discussed in the previous report made on the asbestos industry. Developments in our knowledge of asbestosis are continually taking place and a summary of new facts discovered will be added to the general composite report of the asbestos plant survey which is to be brought out later.

Mica dust. Very little is known of the effect of mica dust on the lungs, but such evidence as there is would tend to place it in a class with the less harmful silicate dusts such as talc and clay. If inhaled in sufficiently high concentrations, these dusts would have to be considered potentially harmful, however, until the contrary is proved, although they apparently do not have the specific injurious effect of the dusts high in uncombined silica.

With the exception of litharge, or lead, an extremely toxic dust, the other dusts generated in the compounding of rubber and brake linings such as zinc oxide, sulphur, and lithopone are probably relatively harmless in the quantities present and in any event proper protection against the lead or litharge dust which is essential would protect against these also.

TOXICITY OF LEAD

Lead poisoning is probably the most common of the industrial poisonings. Practically all forms of lead are toxic, the degree of toxicity depending upon their solubility in human tissues. The oxides and basic lead carbonate are among the most soluble and therefore the most readily toxic forms.

Lead inhaled is more rapidly and more surely toxic than lead ingested. When lead enters the digestive tract some or most of it may be eliminated unchanged from the body and it is only when it is absorbed in greater quantities than are eliminated that poisoning occurs. When lead is taken into the lungs, it reaches the blood stream rapidly and directly and comparatively little is eliminated. While lead is circulating in the body poisoning may occur. Lead absorbed in excess of lead eliminated is accumulated in various organs and is finally deposited in the bones in insoluble form in a manner similar to the deposition of calcium. It is somewhat controversial at the present time whether or not under ordinary circumstances changes in bodily metabolism can later render the lead thus stored in the bones soluble again and set it free into the circulation causing poisoning without further exposure. It has been demonstrated by Aub and his associates,[1] however, that this stored lead can be released by medication with weak acids and low calcium intake. Aub's studies on the subject eight or ten years ago revolutionized the treatment of lead poisoning. Extensive studies on lead poisoning have also been made recently by Kehoe and his associates[2] who have made valuable contributions to the knowledge of the subject.

Lead absorption does not necessarily mean lead poisoning, but there is probability of lead poisoning wherever lead is being absorbed into the body. Individuals vary considerably in their ability to take in and eliminate lead. It is generally considered that negroes, women, and children are more highly susceptible and that those who have had attacks of poisoning are more liable to future attacks than those who have not.

With a few notable exceptions, industrial lead poisoning is of the chronic type due to prolonged exposure to minute quantities of lead taken in daily. Owing to the above-mentioned differences in the toxicity of lead compounds, in the methods of entrance into the body, and in individual susceptible

(1) Aub, J.C., Fairhall, L.T., and others, Lead Poisoning, Medicine Monographs, Vol. VII, The Williams & Wilkins Co., 1926, Baltimore, Md.
(2) Kehoe, R.A., Thamann, Fred, and Cholak, Jacob, Lead Absorption and Excretion in Certain Lead Trades, Journal of Industrial Hygiene, Sept. 1933, Vol. XV, No. 5, pp. 306-319, Balt. Md., another article pp. 320-340.

ity, there is little agreement in the numerous attempts that have been made to estimate the minimum amount of lead which can cause chronic poisoning if taken in over long periods of time. The various estimates range from one-tenth of a milligram to two milligrams daily. Probably one to two milligrams daily represents a fairly safe limit.

In a study made by the United States Public Health Service[3] in a storage battery plant, for instance, it was concluded that for the conditions of exposure in that plant, 1.5 milligrams per 10 cubic meters of air appeared to be a safe limit.

It is also impossible to determine exactly the amount of air taken into the lungs daily, owing to individual differences and to differences in degree of activity. For practical purposes only, therefore, it is roughly estimated that a man at moderately heavy work inhales about 10 cubic meters of air in a ten-hour day. Where possible, it is recommended that the working atmosphere should be kept below one-tenth of a milligram per cubic meter of air or the workers should be protected by suitable respirators and other precautions. Removing lead at its source of origin is by far the best method for prevention of poisoning.

Evidence of lead absorption is shown by an ashen pallor of the skin, a lead line on the gums, stippling of the red blood cells, and a secondary anemia or other indication of damage to the blood-forming organs. Upon evidence of lead absorption workers should be removed from exposure until all signs have disappeared.

If lead exposed workers are under very careful and experienced medical control, it is possible to catch early cases of poisoning in the absorption

(3) U.S. Public Health Service, Treasury Dept., Public Health Bulletin No. 205, Lead Poisoning in a Storage Battery Plant, Gov. Print. Off. Wash. D.C., 1933.

stage or in the early stages of intoxication and, by taking appropriate measures, to prevent the occurrence of any acute or sub-acute attacks of poisoning. It is not easy, however, to diagnose lead in its early stages without laboratory studies of the blood, and there will generally be cases which will present symptoms unexpectedly and in an unusual manner.

The symptoms of lead poisoning are numerous and it manifests itself in a great variety of ways. The most common characteristic symptoms noted are colic, constipation, weakness, especially of the extensor muscles of the hands and feet, muscular pains, nausea and vomiting, loss of appetite, bad taste in the mouth, nervousness and irritability. The prominent objective signs of lead poisoning are pallor or jaundice, tremor, reflex changes, changes in the blood picture, excessive amount of lead in the excreta.

Lead intoxication brings in its train a great many sequelae, including paralysis, optic atrophy, encephalitis, and premature old age. It causes early degenerative changes such as arterio-sclerosis and nephritis. The mortality from chronic lead poisoning is not high, but this is absolutely no indication of the extent to which cases are occurring since cases treated early have a fairly good prognosis and since many deaths are recorded as due to the final sequelae such as arterio-sclerosis rather than to the original cause.

Among the measures for control of lead poisoning recommended by the industrial physician of a large rubber manufacturing plant in Akron, Ohio are (1) monthly medical examinations of exposed workers, (2) separate lockers for work and street clothing, (3) provision of two sets of work clothing and arrangements for laundering weekly, (4) two respirators, one of them to be cleaned and sterilized each day, (5) provision of clean towels, soap and nail brushes, hot running water, and time allowance for thorough washing, (6) wet sprinkling and sweeping or vacuum cleaning of the floor daily, (7) exclusion of all other workers except those engaged in operating lead processes from the room, and (8) rules strictly enforced against eating in the workrooms.

TOXICITY OF BENZOL, ITS HOMOLOGUES, TOLUOL AND XYLOL, AND OF PETROLEUM DISTILLATES

Benzol is by far the most hazardous of the solvents commonly used in industry. It was at one time quite widely employed in many processes and especially in paints and lacquers used for coating by air guns, but because of its recognized danger to the health of operatives, its use has been largely supplanted by less toxic substances. The higher homologues of benzol such as toluol and xylol have been substituted in some cases with and in some cases without success from the health standpoint. These substances are more poisonous than benzol in high concentrations such as would result in acute accidents, and, experimentally, animals die in a shorter time and with lesser concentrations than is the case with benzol. However, their lower volatility gives toluol and xylol an advantage over benzol for industrial practice with respect to health of the workers and the effects of chronic poisoning by toluol not containing any benzol seem to be less serious and not so lasting.

The Benzol Committee of the National Safety Council (4) found that benzol would cause signs of poisoning at concentrations of only 100 parts per million in the atmosphere. Slight effects are possible with even far lower concentrations. It should be borne in mind that benzol can also be absorbed into the system through the skin and that it is extremely dangerous to spill it on the skin or clothing.

~~The symptoms of chronic benzol poisoning resulting from inhalation~~

(4) National Safety Council, Final Report of the Committee on Benzol, Chemical and Rubber Section, Chicago, 1926, pp. 117-118.

over a period of time to low concentrations of benzol vapor are well known and consist of headache, dizziness, weakness, loss of appetite and weight, sore gums, shortness of breath, and, sometimes, abdominal pain, nausea and vomiting. The signs, with due allowance for atypical cases, generally consist of a marked reduction in the number of white blood cells, a changed relationship between the percent of polymorphonuclear cells and the lymphocytes, and later on pallor, due to aplastic anemia, oxygen want or internal asphyxiation, prolonged coagulation time, bleeding from the mucous membranes, purpura, and sometimes tremor and visual disturbances.

Besides the serious systemic effects, benzol, in common with many other solvents, may cause a dermatitis of the skin.

Individual susceptibility to poisoning by benzol appears marked. The fact that cases of poisoning are not being reported from workers in a given process is no guarantee of safety unless physical examinations with blood counts are carried out on employment and regularly during exposure. The symptoms are vague, the worker frequently is not aware of his exposure, and the family physician is usually not familiar with the manifestations of chronic benzol poisoning.

The National Safety Council committee has recommended that a 25% reduction in the white cell blood count should be considered as evidence of poisoning. The color index of the blood is not a reliable criterion, since destruction of red blood cells usually occurs fairly late in the picture after serious or fatal damage has been done to the blood forming organs. Other conditions may be present which could cause a picture somewhat similar to that of benzol poisoning, in which case detailed study and observation are indicated.(5)

(5) McCord, Carey P., M.D., The Present Status of Benzene (Benzol) Poisoning, Journal of the American Medical Association, July 27, 1929, pp. 280-283.

The National Safety Council committee found that 32% of the exposed workers who were examined in various factories had leukopenia (decreased white blood cells) in mild or pronounced degree even when benzol concentration in the air was low and exhaust ventilation was good.

Preventive measures in handling so dangerous a substance logically consist of completely enclosing processes or containers and in providing carefully designed downward-draft ventilation, the results of which should be checked by air sampling. The method of choice, however, is to substitute some other less harmful substance where possible.

TOXICITY OF GASOLINE AND KEROSENE

In the presence of heavy fumes from these petroleum solvents, an acute anesthetic poisoning occurs with headache, blurring of vision, mental confusion, dizziness, nausea, and loss of consciousness. Permissible maximum concentrations(6) in the air breathed are estimated to be from 1000 to 3000 parts per million for short exposures and 1000 parts per million or less for prolonged exposure.

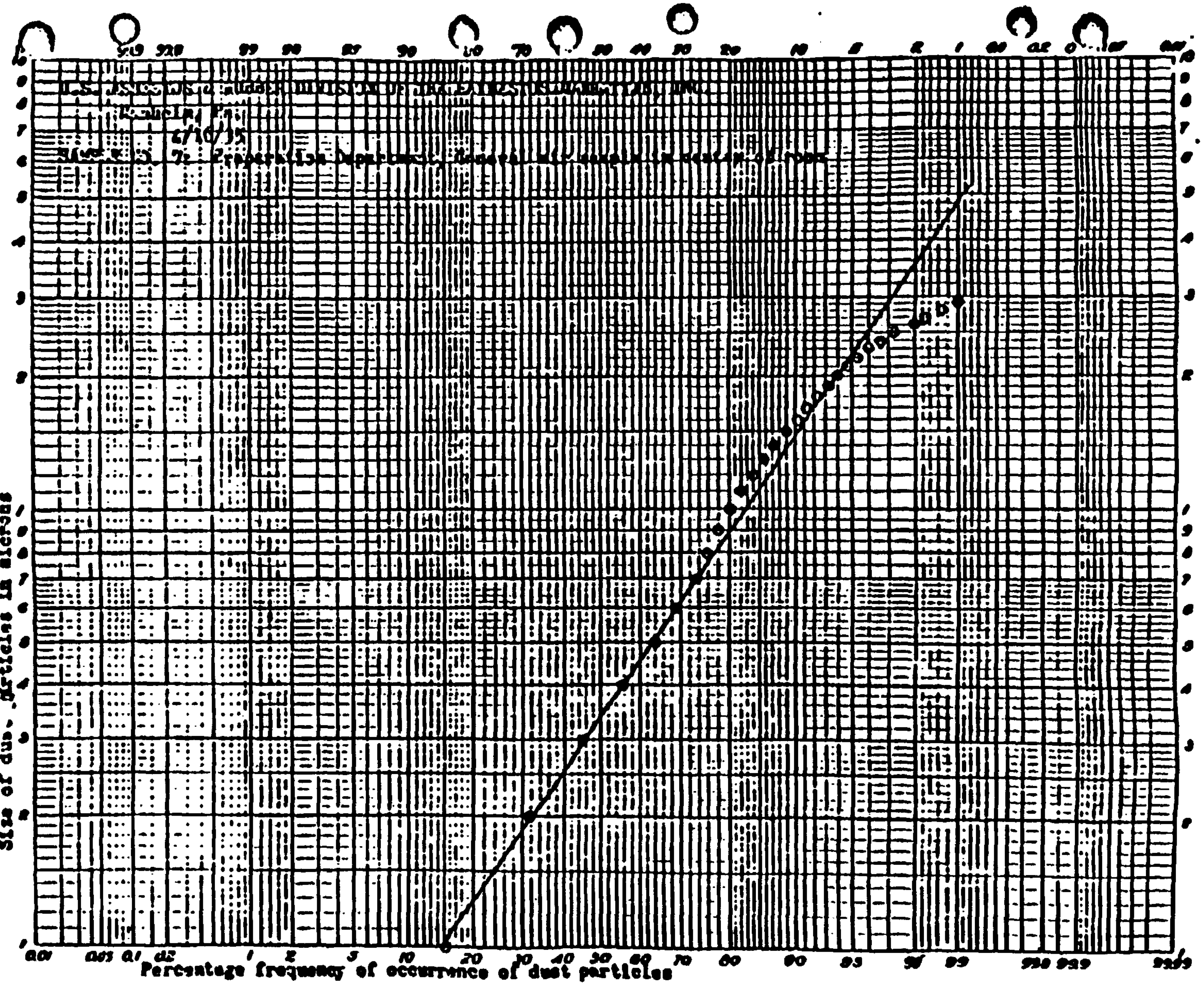
These substances are fat-solvent and skin trouble is frequently caused in those who come into continuous contact with them. Gloves are apt to aggravate the difficulty since without free evaporation, burns are caused by the gasoline getting inside the gloves. A booklet describing precautions to be taken against oil dermatitis is enclosed.

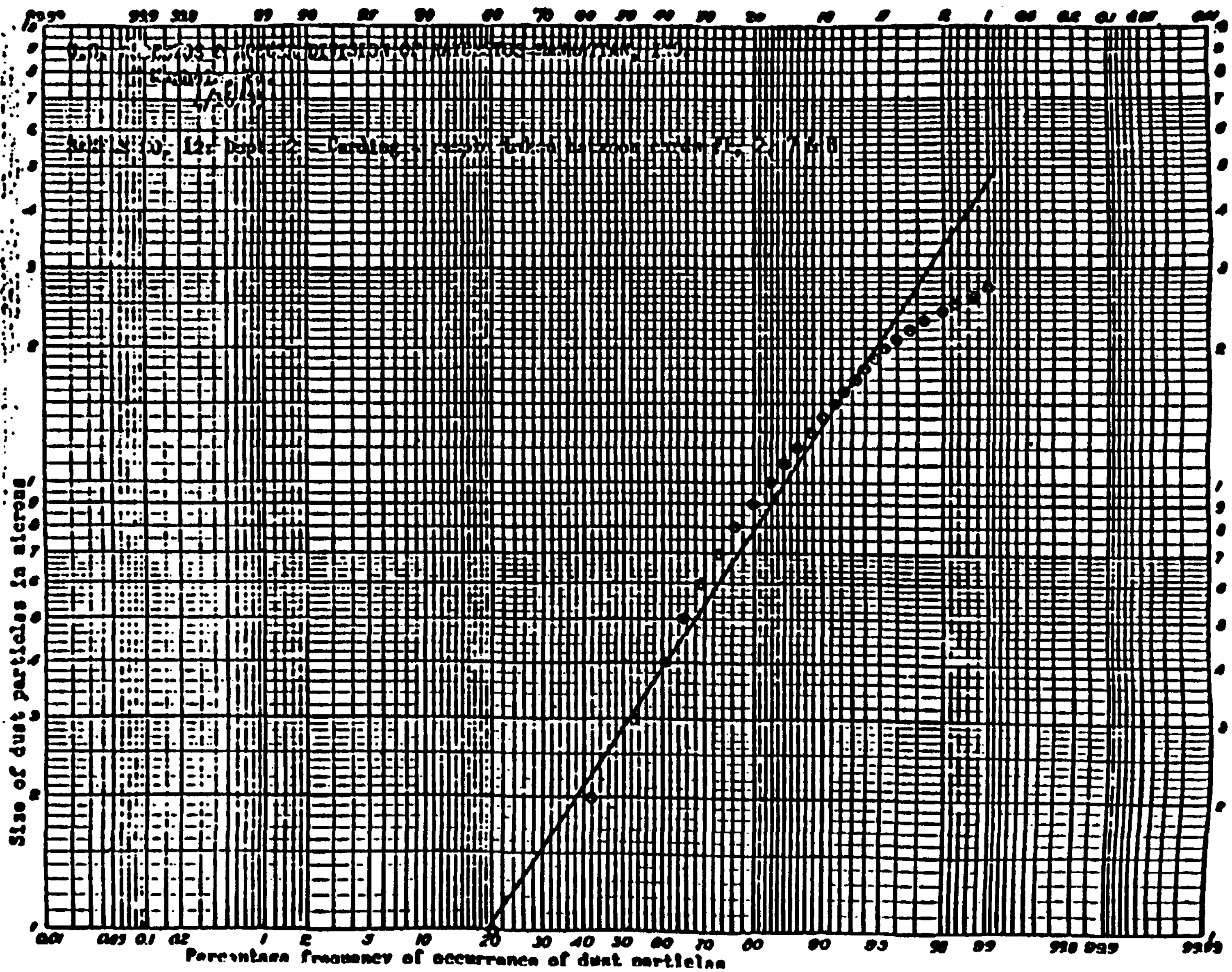
TOXICITY OF LINSEED OIL

In addition to the danger of spontaneous combustion, linseed oil, when heated gives off irritating fumes of acrolein which may be acutely toxic in concentrations of more than 30 parts per million of air, while for prolonged

(6) U.S. Bureau of Mines

exposures 3 parts per million is considered the maximum permissible by the United States Bureau of Mines. No chronic ill-effects have been noted from this substance as used in industry, though it is irritating to the eyes, nose and throat. In addition dermatitis or infections of the skin are common among workers handling these oils. Those showing hypersensitivity are best removed from contact with them.


6/10/75
Size of dust particles in microns
Percentage frequency of occurrence of dust particles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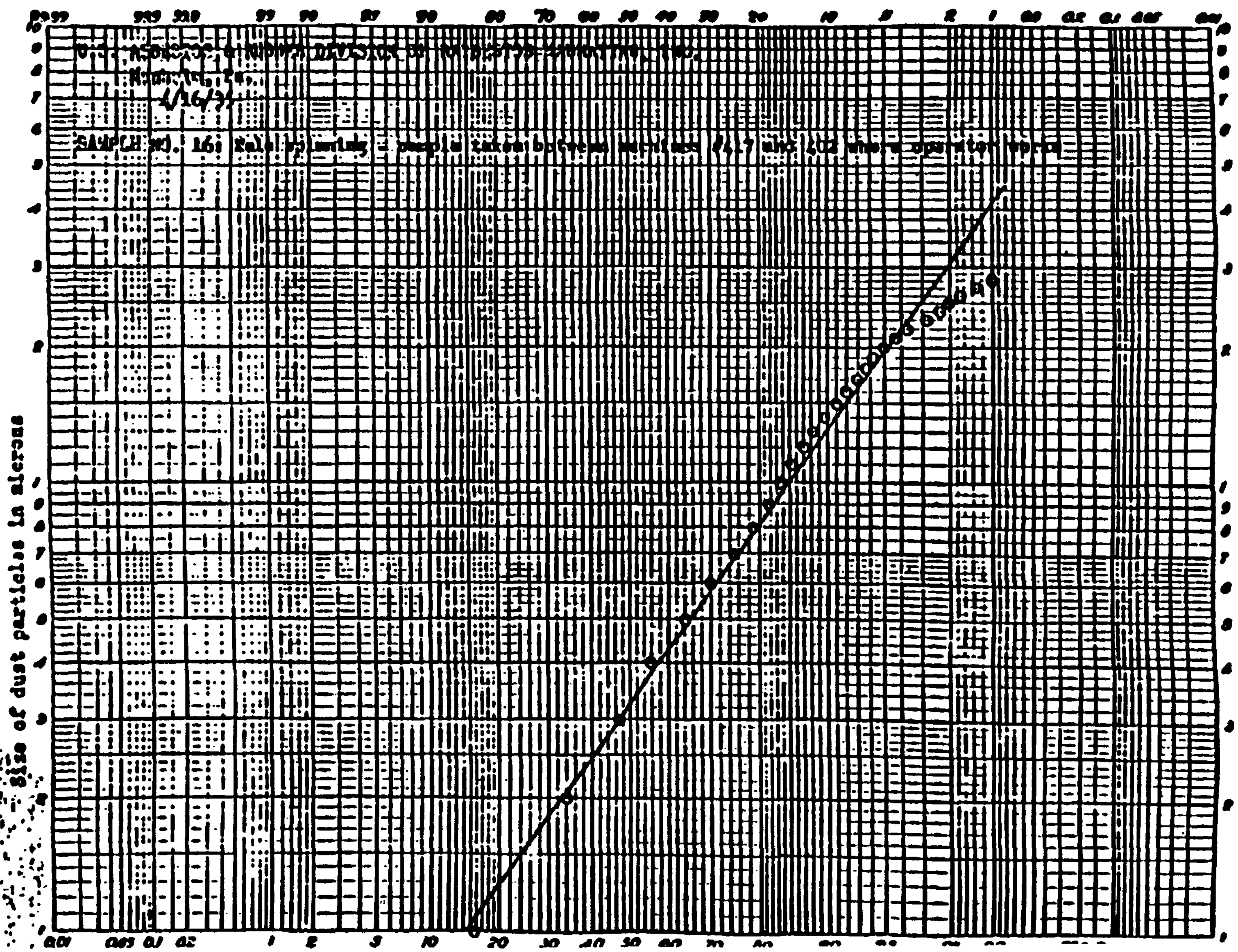
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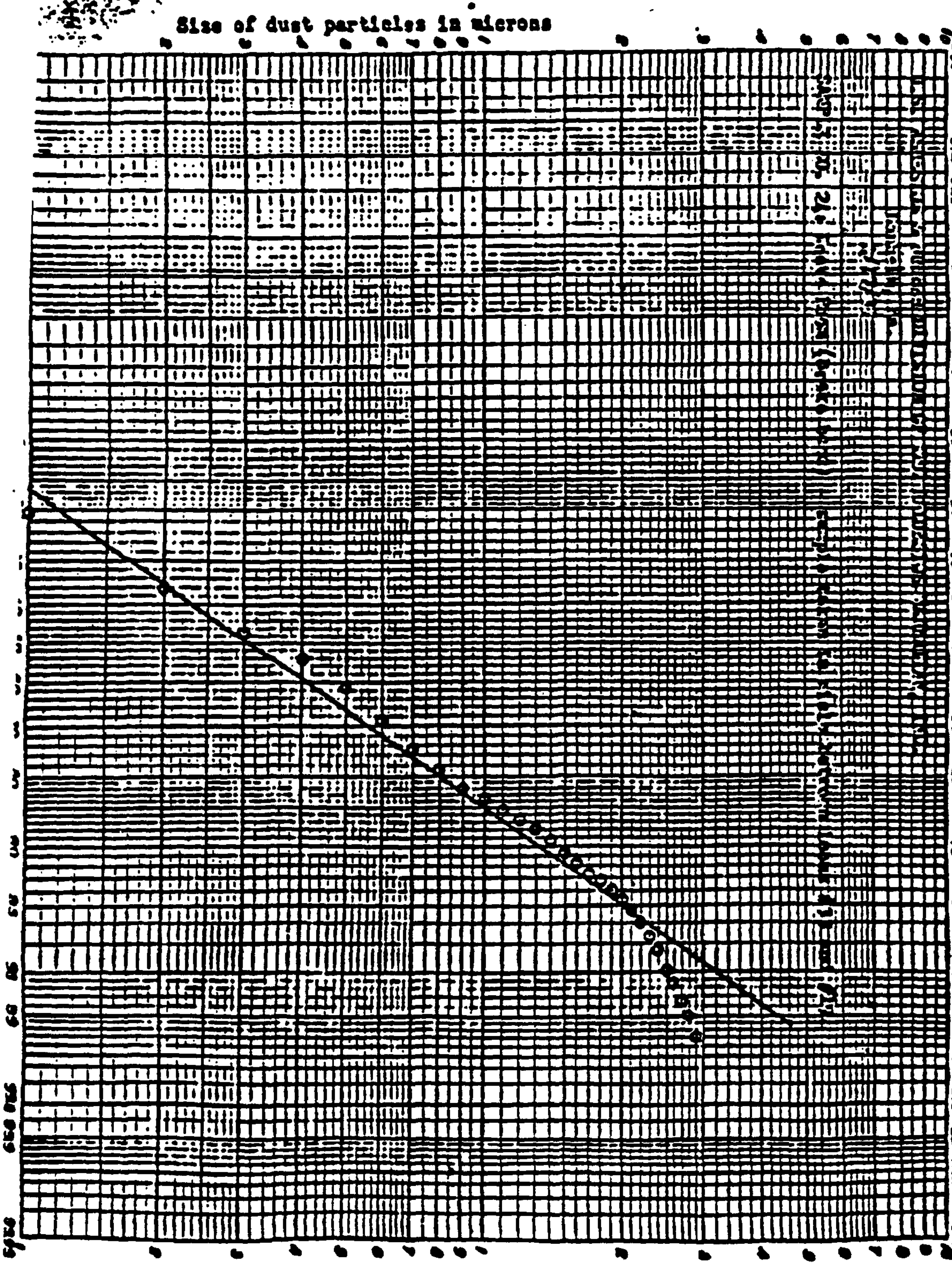
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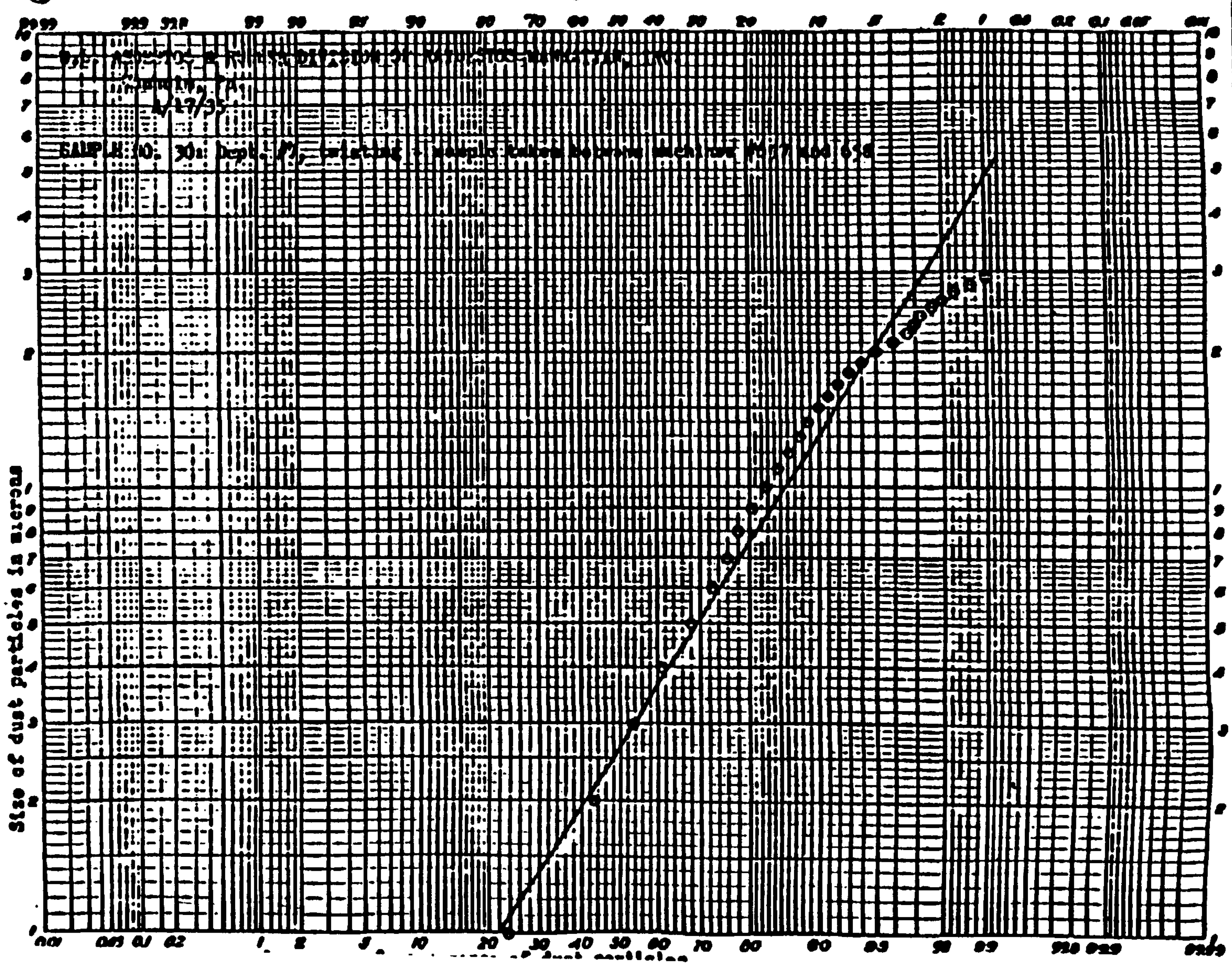
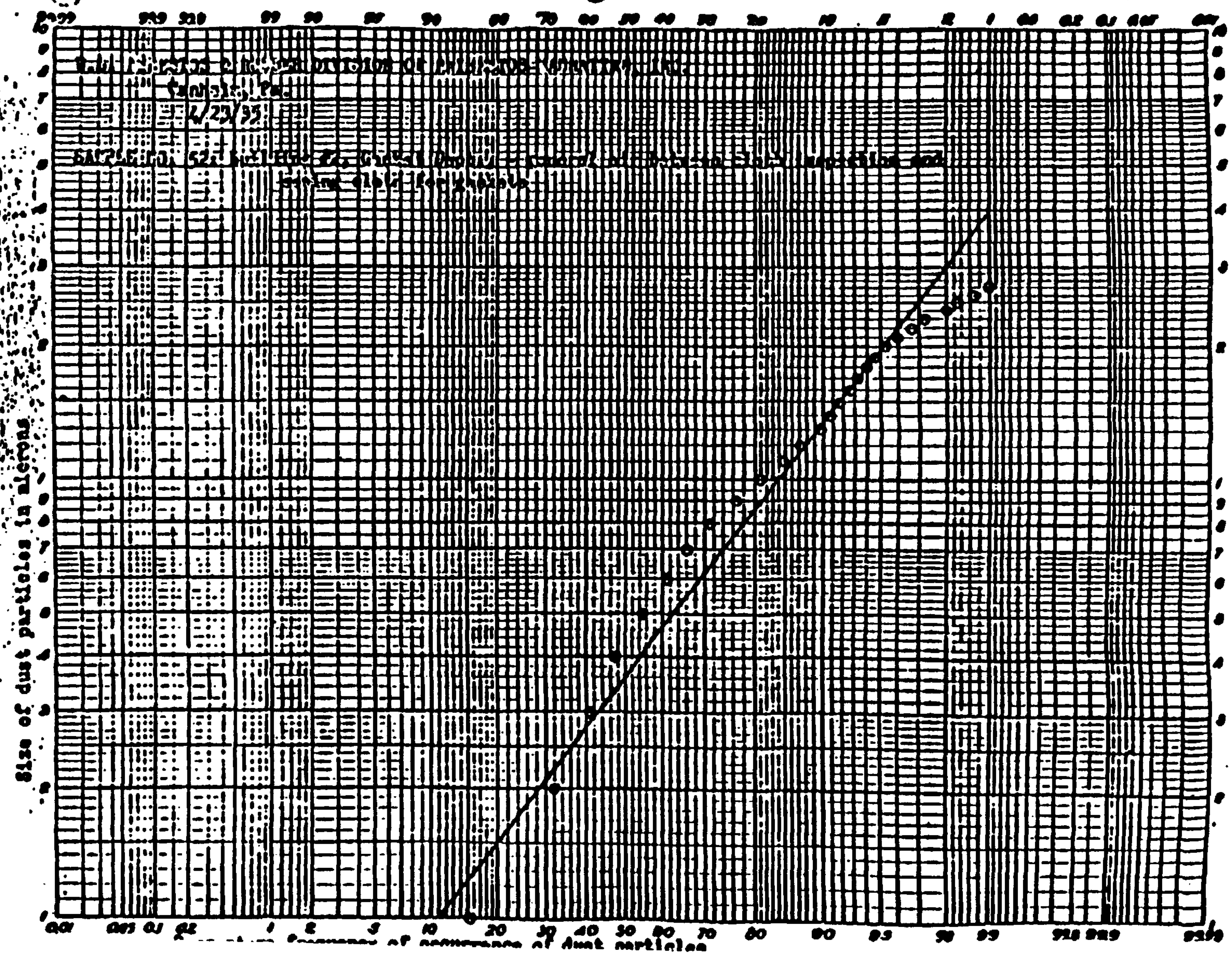

SAMPLE NO. 30: Dept.
Size of dust particles in microns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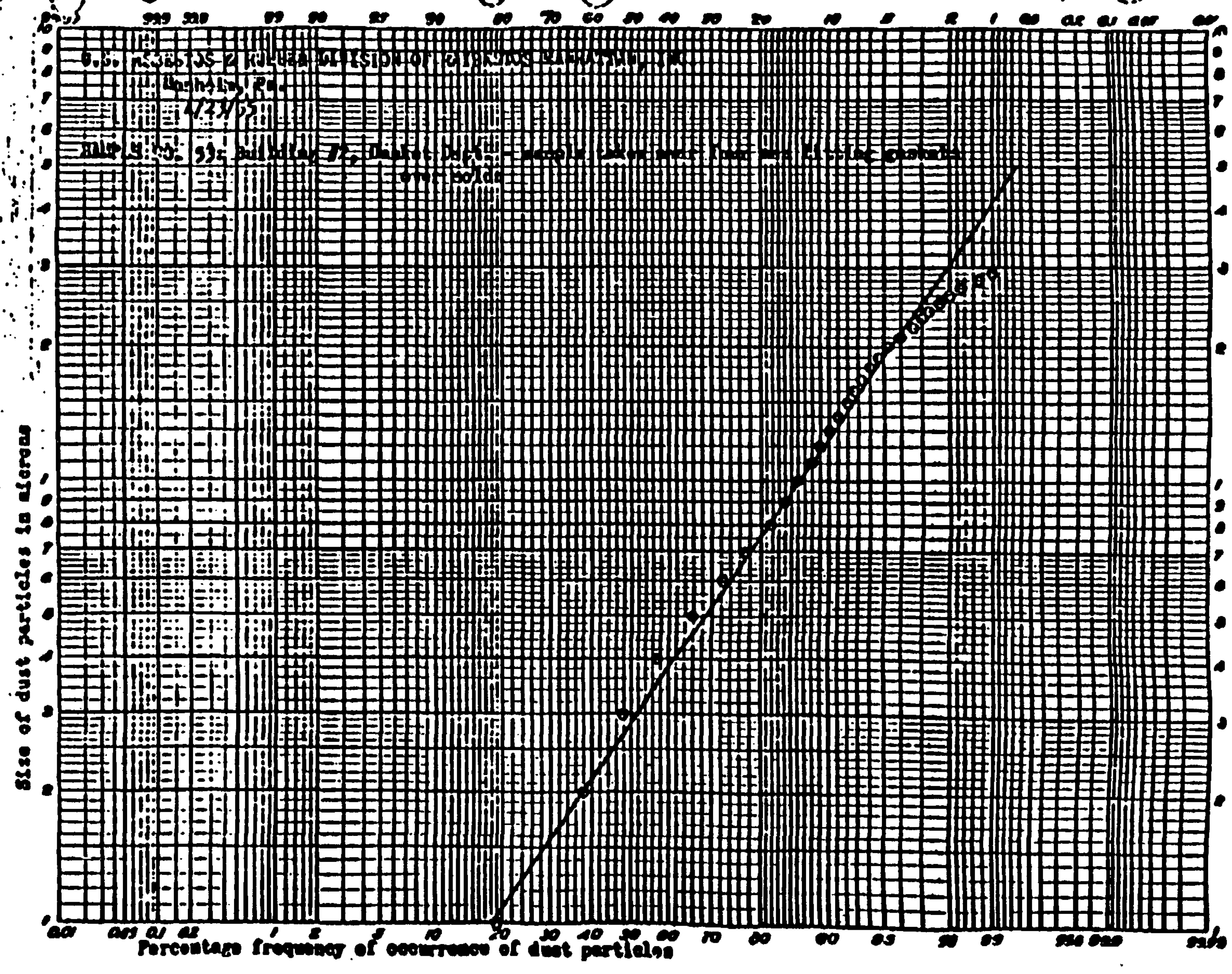

Percentage frequency of occurrence of dust particles
Size of dust particles in microns

UNITED STATES ASBESTOS DIVISION

of Raybestos-Manhattan, Inc.

Manheim, Penna.

• • •

A survey was made of this plant on March 14, 15, 16, 17, 20, 21 and 22, 1939. This report supplements reports made on similar surveys conducted in 1930, 1935, and 1938.

The manufacturing operations at the time of this survey were the same as in the previous surveys. A few changes have since been made in the relocation of machines and in the application of exhaust systems for the collection and removal of generated dusts. Such changes are noted in the remarks column in the following tables of results.

The same sequence of sample numbers has been followed as in the previous reports.

MAX GLAUBACH, C.S.R.
CERTIFIED IN
NEW JERSEY & NEW YORK

P. Pearson

Exhibit L

U. S. ASBESTOS DIVISION OF RAYBESTOS-MANHATTAN, INC.

Manheim, Penna.

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Total Count of Millions of Particles per cubic foot of air sampled		Type of Dust	Remarks
1	Preparing or opening room area of vertical opener and shaker screens; machines #19 and 39	3/15/39	38.0	8.0	41	Asbestos	The exhaust fa[n] window under h[ood] has been lower[ed] to 4 feet from floor and its capacity incre[ased]. Approximately [...] the batch mi[x]i[ng] is done outsid[e] hood.
2	At operator's position on loom #346	3/16/39	46.0	5.2	31	Asbestos and cotton	This position [is] near the chase[rs] which are bein[g] enclosed and exhausted.
4	Between #1 and 2 chasers; machines #2 and 3	3/14/39	56.0	4.0	24	Asbestos	These chasers [are] being provided [with] exhaust hoods.
6	At loading end of tandem vertical opener; machine #15	3/15/39	56.0	5.2	31	Asbestos and cotton	
3	At discharge end of tandem vertical opener; machine #46	3/15/39	45.0	2.5	15	"	The exhaust hoo[d] has been exten[ded] to cover the co[n]veyor and truc[k] into which the material drops.
5	General air sample taken at center of the opening room	3/15/39	44.0	1.6	10	"	The additional looms placed i[n] this departmen[t] were not in op[era]tion when this sample was tak[en].
7	At Williams crusher	3/15/39	38.0	2.6	16	"	No waste mater[ial] on the floor a[t] the time this sample was tak[en].
9A	At Giant cutter	3/15/39	36.0	3.0	11	"	Sample #9 was at the picker which has since been eliminate[d]. No exhaust app[lied] to this machin[e]. The material discharges ont[o] the floor.

ple	Location of Sample	Date	Cu. Ft. Air Sampled	Total Count of Millions of Particles Per cu. ft. air sampled		Type of Dust	Remarks
	Card rooms - 2nd floor, dept. 3 At operator's position, cards 1, 2, 7 &&	3/21/39	42.0	1.5	4	Asbestos and cotton	The exhaust system on the cards is the same as in 1938.
	Condensing machine #360	"	44.6	2.5	15	"	No bagging of material at time this sample was taken. Exhaust hood applied over loading trucks.
	Dept. 2						
	Between cards 1 and 7, machines #232 and 242, at take-off side.	3/20/39	42.0	1.7	8	"	
	Between cards 7 and 13, machines #232 and 242, saddle side.	"	44.0	2.6	16	"	
	Between cards 3 and 9, machines #255 and 261, at take-off side	"	42.0	3.0	18	"	
	Between cards 9 and 15, machines #234 and 248, saddle side	"	43.5	1.7	8	"	
	Between cards 5 and 12, machines #257 and 263, take-off side.	"	43.5	2.3	14	"	
	Between cards 12 and 18, machine #264, saddle side	3/21/39	43.5	1.8	10	"	
7	Between cards 16 and 22, machines #266 and 270, take-off side.	3/20/39	35.6	1.8	10	"	
	Between cards 13 and 20, machines #258 and 267, take-off side.	"	36.0	2.2	14	"	
	Between cards 17 and 23, machines #271 and 276, take-off side.	3/21/39	51.5	1.1	7	"	
	Mule Spinning Dept.						
	Between mules 1 and 2	3/17/39	29.0	2.7	16	"	
	Between mules 5 and 6	"	34.0	2.7	16	"	
2	At Whitin spoolers, machine #418	"	34.0	3.2	32	"	Both Whitin spoolers now enclosed and exhausted.
				3 | 8.6			
				2.9			

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Total Count of Millions of Particles per cu. ft. air sampled	Type of Dust	Remarks
	Spooling, Twisting and Weaving 1st floor					
26	Between twisters, machines #657 and 658	3/16/39	34.0	2.6		
27	Between twisters, machines #651 and 652	"	44.0	2.6		
40	At spoolers, machines #603 and 613	"	42.0	3.6		
28	At Universal winders	"	36.0	1.8		
29	At looms 4 and 2; machines #1026 and 1021, operator's position	3/17/39	43.5	3.4		
30	At looms 11 and 10, machines #1031 and 1028	"	34.0	1.4		Loom #10 not operating.
31	At looms 6, 7, 8 and 9; machines #1013, 1032, 1040 and 1041	3/16/39	43.5	3.3		Loom #8 not operating; water sprays shut off; dry weaving.

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Total Count of Millions of particles per cu. ft. air sampled	Type of Dust	Remarks
Brake band weave room.						
32	At looms #7 and 10	3/17/39	20.0	4.9		Warp is treated with emulsion.
33	At loom #2, machine #322	"	46.5	2.5		Wet warp weaving.
34	Between #33 and 19 looms; machines #339 and 323.	3/14/39	44.0	1.1		Loom #19 – warp is treated with emulsion loom #33 not operating.
35	Between #14, 26, 7 and 12 looms	3/17/39	63.0	4.7		Only #12 loom operating with warp passing through water.
35	At inspection table	3/14/39	42.0	2.3 15.5?		Inspecting regular brake band lining, exhaust over brush.

[illegible]

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Milligrams of Lead per Cu. Meter	Lead Intake per 10-hr. day	Remarks
35A	At inspection table	3/17/39	42.0	0.148	1.48	
33A	At loom #24	3/14/39	44.0	0.126	1.26	

LEAD ANALYSES

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft.	Milligrams of Lead per Cu. Meter	Lead Intake per 10-hr. day	Remarks
	Brake lining finishing dept.						
42	At calendering machine	3/21/39	33.6	1.7	0.095	0.95	
44	At sanding machine	"	34.6	2.6	0.102	1.02	
47	At drill press	3/22/39	37.4	5.3	0.074	0.74	
43	Machine shop - general air	3/21/39	43.5	1.5	0.07	0.7	
37	Emulsion mixing dept.	3/21/39	17.0	2.4	NEGATIVE		

LEAD ANALYSES

Sample No.	Location of Sample	Date	Cu. Ft. Air Sampled	Millions of Particles per Cu. Ft.	Milligrams of Lead per Cu. Meter	Lead Intake per 10-hr. day	Remarks
	[illegible]ing Dept.						
50	At Campbell cutter, machine #2321	3/22/39	36.0	4.3	NEGATIVE		
51	At Campbell clutch facing segment cutter, machine #1196	"	35.6	2.5	0.06	0.6	Exhaust appli to this opera tion.
52	Hand sanding tables	"	27.0	5.0	0.261	2.61	9 women now working as compared with 5 in 1938.
53	Dept. 859 - center of mandrels	"	31.0	2.2	0.07	0.7	
54	Pratt and Whitney surface grinder, machine #2340	"	34.2	5.6	0.124	1.24	This machine exhausted.
57	At Gardner grinder #14, machine #1566	"	39.6	8.8	0.07	0.7	This machine exhausted; a times pieces being ground are too larg for hood and the operator then raises hood, defeat the purpose.
[illegible]	At Blanchard grinders machines #1579 and 1675	"	27.3	9.3	0.459	4.59	
60	Between Gardner grinder #7½ and #2 drill, machine #1598	"	42.0	3.1	0.233	2.33	The dust collector ar located out- side the department.
62	Drilling machine #2346 and 1654	"	48.0	1.8	0.089	0.89	This machin exhausted.
63	Segment grinding, machine #2257	"	42.0	2.8	0.304	3.04	This machin has been re ated and exhausted : 1938 survey Formerly sample #49
64	Yates sander, machine #783	"	40.8	2.9	0.138	1.38	This machi exhausted.

CONCLUSIONS AND RECOMMENDATIONS

The dust concentrations are comparable to those found in the 1938 survey.

Lead concentrations in general are lower. This may be due to increased efficiency of exhaust systems or the material being worked may have a lower lead content.

It is suggested that the present program of extending and improving exhaust equipment be continued.