PLAINTIFF'S EXHIBIT

DOW-474

1070

RESULTS OF SURVEY OF PIPE COVERERS' EXPOSURES FOR THE 8-HOUR DAY TO ASBESTOS AND FIBERGLAS CONTAINING DUSTS

ST0030684

PRESENT HEALTH STANDARD (THRESHOLD LIMIT VALUE) FOR ASBESTOS	5 MPPCF
PROPOSED HEALTH STANDARD (THRESHOLD LIMIT VALUE) FOR ASBESTOS	2 MPPCF
HEALTH STANDARD (THRESHOLD LIMIT VALUE) FOR FIBERGLAS	15 MPPCF
EXPOSURES TO ASBESTOS-CONTAINING DUSTS (INDOORS)	4.9 MPPCF
EXPOSURES TO ASBESTOS-CONTAINING DUSTS (OUTDOORS)	4.2 MPPCF
EXPOSURES TO FIBERGLAS-CONTAINING DUSTS (INDOORS)	0.5 MPPCF
EXPOSURES TO FIBERGLAS-CONTAINING DUSTS (OUTDOORS)	0.4 MPPCF

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OFFICE COPY

MAY 27 1955 D.D.J.

Biochemical Research Department
THE DOW CHEMICAL COMPANY

Noted E. E. D.
JUN 20 1955

SUBJECT: RESULTS OF AIR ANALYSIS MADE WHILE MIXING ASBESTOS - VINYL FLOOR TILE

File: T2.1-1-32 A)
Chg. 1219
Rec'd 10-23-54
Fin'd 5-5-55
Work S. R. Johann
Rep't S. R. Johann

Signed L. R. Johann Checked H. R. Hoyle

Date 5-6-55 Date 5-26-55

TO:

Ray McDonald, 433 Bldg.
Ralph Hand, 433 Bldg.
S. M. MacCutcheon, 401 Bldg.
H. H. Gay, M.D., 607 Bldg.

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ST0030577

CONCLUSIONS AND RECOMMENDATIONS

Air analysis showed that the presence of air borne materials near the operators was of sufficient concentration to create a health hazard for repeated eight hour exposure. The present equipment should be equiped with local exhaust ventilation if it is planned to operate continuously on this material.

Sufficient quantities of lead were found in the air samples in two of the operations, such that blood lead analyses were thought necessary. The results of the blood lead analyses showed the men had not been exposed for long enough periods of time to result in excessive exposure to lead.

ST0030578

PRESENTATION OF DATA

During the processing of experimental formulations of asbestos - vinyl tile, it was believed a health hazard existed due to the dustiness of the dry ingredients used. The Industrial Hygiene Laboratory was asked to investigate this hazard.

The 23rd of December 1954, samples were taken of the air while the men were operating the different pieces of mixing equipment on the 3rd floor of 433 building.

The amount of dry material found in the air during the different mixing operations was such that if these operations were run on a continuous basis a health hazard would exist. Any further large scale work should be done with improved ventilation. This ventilation should include exhaust ventilation hoods over each piece of equipment and the dry mixing with the electric mixer in the laboratory should be done in an approved hood.

The majority of dry materials in the air was assumed to be asbestos fibers and calcium carbonate. No specific tests were made at the time of sampling to determine the amount of each present. The two materials are reported as inerts. Any future work with this or similar material should be checked for the amount of asbestos in the air. An excess, that is more than 5 million particles per cubic foot of air, is a health hazard for repeated eight hour exposures.

Owing to the presence of lead-organic compounds in the dry mixtures, it was deemed necessary to have blood lead analyses made on the men concerned. The examinations showed the blood lead level was low. The men have not suffered any ill effects because they have operated the equipment for short periods of time only. Continuous eight hour operation would constitute a health hazard. This information is shown in Table I.

The amount of material found in the air as solid inert material, assumed to be calcium carbonate and asbestos, is shown in Table II, along with the samples that were analyzed for metals.

[redacted]

TABLE I

Blood lead content of men working with asbestos - vinyl tile

Name	Clock No.	Mg. Pg per 100 cc Blood
		0.024
		0.024
		0.016
		0.08

Samples drawn, 3-7-55 Recorded, 4-4-55

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TABLE II

Sample No.	Location of Sample	Analysis	Concentration Mg/m3
1	Man was mixing a batch of vinyl-asbestos tile on a differential speed 2 roll mill. Sample taken about 2 feet above the hot rolls. (285°F. & 235°F.) Odor of coconut oil present. Asbestos fibers could be seen in the air for a few minutes.	Pb cd Inert	3.47 <.66 102.00
2	Same operation as Sample #1, a different formulation used. No odor of coconut oil. Fumes or steam could be seen rising from the rolls.	cd Inert	<.66 93.00
3	Breathing zone sample of the operator while he was running a third batch of material on the same machine as in Samples 1 & 2. Man stated the odor was strong and disagreeable.	Ba cd Inert	4.00 <.66 16.00
4	Same as sample #3 but included cleaning the rolls after the run. Different formulation than in Sample #3.	Pb Ba Cd Inert	.98 4.90 <.445 Nil
5	Blending dry ingredients in a Baker-Perkins mixer. $CaCO_3$ being added to dry vinyl plus stabilizer. No asbestos fibers added at this stage. Material became plastic after mixing.	Inert	50.00
6	Same mixing operation as above but as the asbestos fiber is added. The material already in the mixer was soft. This and sample #5 are done about 20 runs per day when doing this particular experiment about 10 min. per run.	Inert	0.00
7	Breathing zone of the operator on the Bandbury Mill, as he added the dry filler material (asbestos & $CaCO_3$) to the molten mixture of vinyl. Dry filler material was visible in the air for several minutes but was dissapated by the room ventilation, operation takes about 3 min.	Inert	66.00

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Sample No.	Location of Sample	Analysis	Concentration Mg/m^3
8	Sample taken in the lab while the operator was mixing dry ingredients in a "Kitchen-aid" electric mixer. This is done about 10 times a day.	Inert	24.20
	Industrial Hygiene Standards for repeated eight hour exposures.	Pb	0.15
		Ba	0.50
		Cd	0.10
		Inert	15.00

glf

ST0030581

P.T.S. 433 Bldg.
Pilot Plant 8636
will plan on test 13-17

Tribase 90.1% pb O
Monohydrous Tribasic
lead sulfate

Plumb-O-Sil A 60 & 1% pb
Coprecipitate pb orthosilicate
& silica gel.

Plumb-O-Sil B 49-50% pb O

Plumb-O-Sil C 95-98% pb O

Normasal-76% pb O
Normal lead salicylate
soluble glycol & glycol ethers

Dythal-81.9% pb O
Dibasic lead phthalate

DS-207 59.9% pb O
Dibasic pb stearate

Tribase-E 69% pb O
Basic pb silicate sulphate

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← Dopeka 90.2 % pbt O
Dibasic lead phosphite

All above insoluble in common solvents

Ferro Stabilizers

NO
120 ← Barium Ricinoleate

200 ← Cadmium 2-Ethylhexoate

211 Cadmium Naphthenate
2-Ethylhexoate

221 Cadmium Ricinoleate

241 Sodium organo-phosphate

121 A Calcium Ricinoleate

130 Zinc 2-Ethylhexoate

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AVOID VERBAL ORDERS

MR. _____ DATE _____

mg Pt/100 cc blood.

Samples drawn 3-7-55 & recorded 4-4-55

.09 mg/100 CC allowable.

SIGNED _____

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ST00305584

INDUSTRIAL HYGIENE SAMPLE RECORD

SAMPLING METHOD	SAMPLE RATE	PROBLEM	BLDG.	DATE
Midget Impingers	3L/min.	72.1-1-32	433	12-23-54
TRAPPING MEDIUM	**ROTAMETER OR ORIFICE NO.**		**PROCESS**	
H_2O	Pump #4		Vinyl Tile fabrication	
ROTOMETER SETTING	**OUTSIDE TEMP.**	**INSIDE TEMP.**	**MATERIAL**	
3L.	25	75	# formulation	

VENTILATION: No special ventilation. Take room has a ceiling light roof & some heating & ventilation

SAMPLE	BOTTLE	DESCRIPTION	TIME START	TIME STOP	CONCENTRATION
#1	1	Man was mixing a batch	5 min	the	
		of vinyl tile on a		Pt.	347 mg/m³
		differential speed 2 roll mill		Cd.	<.66 "
		Taken about 2 feet above		Chart	102 "
		the hot rolls (285°F & 235°F)			
		Odor of cement oil present			
		asbestos fibers could be seen			
		in the air for a few minutes.			
2	2	Same operation as #1 but	5 min		
		more odor of cement oil fumes		Cd.	<.66 mg/m³
		or steam could be seen rising		Chart	93 mg/m³
		from the rolls. Different formulation			
		than #1.			
3	3	B.Z. sample while operator	5 min	Ba.	9 mg/m³
		was running a 3rd batch on		Cd.	<.66 "
		same mill. Strong odors. Stated		Chart	16 "
		odors were strong & disagreeable.			
4	4	Same as #3 but in the	7.5 min	Pb.	.98 mg/m³
		cleaning the rolls off after the		Ba.	9.9 "
		run.		Cd	<.995 "
				Chart	Nil

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INDUSTRIAL HYGIENE SAMPLE RECORD

SAMPLING METHOD	SAMPLE RATE	PROBLEM	BLDG.	DATE
Millipore filter	3l or 2l	T2.1-1-32	993	12-23-59
TRAPPING MEDIUM	ROTAMETER OR ORIFICE NO.	PROCESS		
—	Pump No 4	Vinyl tile mixing		
ROTOMETER SETTING	OUTSIDE TEMP.	INSIDE TEMP.	MATERIAL	
—	—	—	asbestos + others	

VENTILATION:
no special hoods or fans.

SAMPLE	BOTTLE OR filter no.	DESCRIPTION	TIME START	TIME STOP	CONCENTRATION
#5	1	3l/min Blending ingredient in a Baker-Perkins mixer no asbestos but some CaCO3	8 min		50 mg/m3
#6	2	3l/min dense material above but as the asbestos was added to the plasticized material mixed in sample #5 above. Normal operation 20 runs/day.	2 min		0.0 mg/m3
7	3	Banbury Mill 3l/min B.Z. operator to be added the dry filler material (asbestos + $Ba(OH)_2$) to the molten mix material was visible in the air but was soon dispersed by the room ventilation	3 min		66 mg/m3
8	4	On Lab while mixing dry ingredient in a Hobart mixer (2l/min) mixer was not visible but (done 10 times a day average)	2.75 min	S. P. Johnson	29.2 mg/m3

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CALCULATIONS RECORD

PROBLEM	RATE	MATERIAL	BUILDING	DATE
T2.1-1-52	3l/min.	Pb, Cd, Inert	733	3-1-55

MOL. WT. | CONVERSION HALOGEN TO TOTAL

ppm/mg/l | PROCESS: Vinyl tile formation

EXPLANATION OF CALCULATIONS:

SAMPLE	TIME	S. VOL.	ANALYSIS	Mg./l.	CONC.
1	5 min	15 l	Pb	.00347	347 mg/m³
			Ba	Nil	Nil
			Cd	<.00066	<.66 mg/m³
			Inert	.102	102 mg/m³
2.	5	15 l	Pb	Nil	Nil
			Ba	Nil	Nil
			Cd	<.00066	<.66 mg/m³
			Inert	.093	93 mg/m³
3.	5	15 l	Pb	Nil	Nil
			Ba	.004	4 mg/m³
			Cd	<.00066	<.66 mg/m³
			Inert	.016	16 mg/m³
4.	7.5	22.5 l	Pb	.00098	.98 mg/m³
			Ba	.0049	4.9 mg/m³
			Cd	<.000445	<.445 mg/m³
			Inert	Nil	Nil
allowable	Concentration		Pb		.15 mg/m³
8 hr exposure	5 days/week		Ba		.5 mg/m³
			Cd		.1 mg/m³
			Inert		15

ST0030587

397457

TO: S. Johann

THE DOW CHEMICAL COMPANY
MIDLAND MICHIGAN

MAIN LABORATORY

REPORT SHEET

DATE February 23, 1955 PROJECT 1219-26

MAIN LAB. NUMBER SSR 208-446

YOUR NUMBER 1-5

DESCRIPTION Atmosphere when making vinyl tile

ANALYSES OR TEST:

	P.P.M. per Sample			
Sample	Pb	Ba	Cd	Inert
1	5.2	nil	< 1.0	154
2	nil	nil	< 1.0	140
3	nil	6	< 1.0	24
4	2.2	11	< 1.0	nil
5	7.4	11	< 1.0	nil

ST0030588

BY CDP
jh

Phone 8879
S. A. Shrader
574 Bldg.

397458

Milipore Filter.

Sample No

1. $\frac{12\ mg \times 1000}{8 \times 3} = 50\ mg/m^3$

2. $\frac{0.0\ mg \times 1000}{3 \times 2} = 0.0/m^3$

3. $\frac{0.6\ mg \times 1000}{3 \times 3} = 66\ mg/m^3$

4. $\frac{.2\ mg \times 1000}{2.75 \times 3} = 24.2\ mg/m^3$

ST0030589

397459

Roy McDonald

Ralph Lund

S1UU30590

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ABSTRACT OF ENVIRONMENTAL EXPOSURE DATA (CHEMICAL AGENTS) 665

Taken From Report (Number) 2-1-32 Survey Date 12/23/54

Chemical Surveyed Calcium Carbonate (Inert materials) Report Date: 5-5-55

K-Number Designation

Personnel Designation: Department Name* Plastics Development & Service
Department Index Number* 79310
Division/Plant Location Wilmington

Process Name Mixing Ingredients - Vinyl Floor Tile
Type of Process: Laboratory Scale [✓] Mini Plant [ ] Semi-Plant [ ]
Full Production [✓] Other [ ] Specify
Location of Process (Building Numbers) 433 Bldg.

Job Classification Designation*		Estimates of Exposure Parameters			
Name	Index Number	T.W.A.	Sample Range High	Sample Range Low	Nbr. of Samples
Lab Technician	278125	35.6	112.0	0	8

ST0030591

Type of Sampling: Area [✓] Continuous [ ] Breathing Zone [✓]
Units of Measurement: PPM by Vol. [ ] Mg/M^3 [✓] M of Particles/cu.ft. [ ]
Other [ ] Specify

Did process changes occur either since the last environmental survey or within the last two years which could have significantly affected exposure levels?
If "Yes", please specify.

Other Stresses Present (Chemical, Physical): Lead, Cadmium, & Uranium

*As shown on official Personnel Lists

397461

6-22-71

ABSTRACT OF ENVIRONMENTAL EXPOSURE DATA (CHEMICAL AGENTS)

Taken From Report (Number) 2-1-1-22 Survey Date 12/23/54

Chemical Surveyed Lead Report Date: 5-5-55

K-Number Designation ______

Personnel Designation: Department Name* Plastics Development + Service

Department Index Number*

Division/Plant Location Midland Division

Process Name Mixing Asbestos + Vinyl Floor Tile

Type of Process: Laboratory Scale [✓] Mini Plant [ ] Semi-Plant [ ]

Full Production [✓] Other [ ] Specify ______

Location of Process (Building Numbers) 433 Bldg.

Job Classification Designation*		Estimates of Exposure Parameters			
Name	Index Number	T.W.A.	Sample Range High	Sample Range Low	Nbr. of Samples
Technician		0.95	3.47	0.98	2

Type of Sampling: Area [✓] Continuous [ ] Breathing Zone [✓]

Units of Measurement: PPM by Vol. [ ] Mg/M^3 [✓] M of Particles/cu.ft. [ ]

Other [✓] Specify Mg. Pb per 100 cc blood

Did process changes occur either since the last environmental survey or within the last two years which could have significantly affected exposure levels? ______
If "Yes", please specify.

Other Stresses Present (Chemical, Physical): calcium carbonate + asbestos, cadmium, barium

*As shown on official Personnel Lists

397462

6-22-71

ST0030592

ABSTRACT OF ENVIRONMENTAL EXPOSURE DATA (CHEMICAL AGENTS)

Taken From Report (Number) 2.1-1-32 Survey Date 12/23/54

Chemical Surveyed Barium Report Date: 5-5-55

K-Number Designation ______

Personnel Designation: Department Name* Plastics Development + Service
Department Index Number* ______
Division/Plant Location Midland Division

Process Name Mixing Asbestos - Vinyl Floor Tile

Type of Process: Laboratory Scale [x] Mini Plant [ ] Semi-Plant [ ]
Full Production [x] Other [ ] Specify ______
Location of Process (Building Numbers) 433 Bldg.

Job Classification Designation*		Estimates of Exposure Parameters			
			Sample Range		
Name	Index Number	T.W.A.	High	Low	Nbr. of Samples
Technician			4.9	4.0	2

STD030593

Type of Sampling: Area [x] Continuous [ ] Breathing Zone [x]
Units of Measurement: PPM by Vol. [ ] Mg/M³ [x] # of Particles/cu.ft. [ ]
Other [ ] Specify ______

Did process changes occur either since the last environmental survey or within the last two years which could have significantly affected exposure levels? ______
If "Yes", please specify.

Other Stresses Present (Chemical, Physical): lead, calcium carbonate + asbestos, + cadmium

*As shown on official Personnel Lists

397463

6-22-71

ABSTRACT OF ENVIRONMENTAL EXPOSURE DATA (CHEMICAL AGENTS)

Taken From Report (Number) 2.1-1-32 Survey Date 12/23/54

Chemical Surveyed Cadmium Report Date: 5-5-55

K-Number Designation

Personnel Designation: Department Name* Plastics Development + Research

Department Index Number*

Division/Plant Location Midland Michigan

Process Name Mixing Asbestos - Vinyl Floor Tile

Type of Process: Laboratory Scale [✓] Mini Plant [ ] Semi-Plant [ ]

Full Production [✓] Other [ ] Specify

Location of Process (Building Numbers) 433 Bldg.

Job Classification Designation*		Estimates of Exposure Parameters			
Name	Index Number	T.W.A.	Sample Range		Nbr. of Samples
			High	Low	
Technician		<0.45			3

Type of Sampling: Area [✓] Continuous [ ] Breathing Zone [✓]

Units of Measurement: PPM by Vol. [ ] Mg/M^3 [✓] M of Particles/cu.ft. [ ]

Other [ ] Specify

Did process changes occur either since the last environmental survey or within the last two years which could have significantly affected exposure levels?

If "Yes", please specify.

Other Stresses Present (Chemical, Physical): Lead, Calcium Carbonate + asbestos, Barium

*As shown on official Personnel Lists

397464

6-22-71

ST0030594

Use this form for historical data only.

Industrial Hygiene Chemical Exposure Data Entry Log
Field Survey TWA Exposure And Excursion Exposure Data

ST0030595

Report no. 21-1-32/665 Date 1254

Building no. 433 Index no.

Units of Data M Respirator Worn?

Master no.

Job Classification	Job No.	Chemical Name: lead DR# 162005 TWA/Exc.	Chemical Name: cadmium DR# 21987 TWA/Exc.
Operator	336755	0 / 3.47	0 / < .66

397465

Use this form for historical data only.

Industrial Hygiene Chemical Exposure Data Entry Log
Field Survey TWA Exposure And Excursion Exposure Data

Report no. 2.1-1-32/665 Date 1254

Building no. 433 Index no. _____

Units of Data M Respirator Worn? _____

Master no. _____

ST0030596

Job Classification	Job No.	Chemical Name: barium DR# TWA/Exc.	DR# TWA/Exc.
operator	336755	0/4.9	/
		/	/
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		/	/
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X FEB 7 1958 D.C.I.
Noted E. E. D.
FEB 07 1958

Biochemical Research Laboratory
The Dow Chemical Company

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EVALUATION OF CHEMICAL EXPOSURES
RECEIVED BY OF
COATINGS TECHNICAL SERVICE,
433 BUILDING

File: T2.1-1-32 (F)
Chg.: 1219
Date: 1-22-58
By: J. E. Peterson

Signed J E Peterson Checked H R Hoyle

Date 1-29-58 Date 1-30-58

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PROBLEM

Recently, has become ill. The Environmental Research Laboratory was requested to determine chemical exposures received by him, and to assess these data.

CONCLUSIONS

1. Exposures to airborne materials during the formulation, mixing, and calendering of vinyl asbestos tile in 433 Building were evaluated on 12-23-54 and on 1-15-58. Results of these evaluations are used to assess exposures received by during his work with this material.

2. From December 1953 to December 1954, worked with vinyl asbestos tile formulations, and in the course of that work was occasionally exposed to somewhat excessive concentrations of airborne asbestos.

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ST0030598

During this period of time exposure to lead occurred, but his blood lead level on 3-7-55 was only 0.024 mg./100 cc. blood, a normal figure. Exposures to cadmium during this period were to airborne concentrations of "< 0.7 mg./m^3" at intermittent periods. No effect is expected as a result of these exposures.

3. From the first part of 1955 to late 1956 worked mostly with latex in concrete, and exposures to vinyl-asbestos tile ingredients were reduced accordingly.

4. From the last part of 1956 until the present he has been working with vinyl-asbestos tile formulations in a supervisory capacity. During this work he was probably exposed a maximum of 1-2 days per week to airborne dust concentrations of less than 3 mppcf of a material analyzing 20-30% asbestos, less than 5% SiO_2, and about 0.02% cadmium. No effect can be expected from such exposure.

5. If difficulty is the result of chemical exposure, the causitive agent is unknown at present. Further air analyses are to be made during a time when chlorinated polyethylene is used as the resin binder in the tile formulations.

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ST0030599

PRESENTATION OF DATA

has been ill with a lung difficulty, and overexposure to chemicals encountered during the formulation, mixing, and calendering of vinyl-asbestos tile formulations was suspected to be the cause of his illness. The Environmental Research Laboratory was requested to determine and evaluate his exposures.

On 12-23-54 an environmental survey of the vinyl-asbestos tile formulating operation was made by S. R. Johann; the results of this work were reported on 5-5-55 (File Number, T2.1-1-32). This survey found that air concentrations of "inerts" (asbestos plus calcium carbonate), barium, and lead were too high for repeated 8-hour exposures, and even though exposures were not that prolonged, recommended the installation of local exhaust ventilation. Cadmium was determined in the air samples, but in all cases the amount present was below the limit of sensitivity of the analytical technique employed, leading to air concentration figures of "less than" 0.56 mg./m^3 and "less than" 0.45 mg./m^3.

As a result of this investigation several changes were made. First, the use of lead and barium compounds in the formulation was sharply curtailed. Second, operational techniques were changed so that each batch was completely formulated before mixing in the Banbury or Baker-Perkins machines, and mixing in these enclosed machines was always to be done prior to

397469

compounding on the 2 roll mill

Third, canopy hoods were installed over the large 2-roll mill and over the calender, but not over the small 2-roll mill usually used for preliminary compounding of these formulations. Finally, the Building Products group recently moved into new quarters where a bench-type hood is always available to control dust from dry mixing.

ST0030600

In connection with the environmental survey of December 1954, samples were taken for blood-lead determinations for the men involved on this project. blood lead concentration was found to be 0.024 mg./100 cc. of blood, a normal figure, indicating insignificant exposure to lead. The other two men involved also had normal blood lead values.

On 1-15-58 a second environmental survey of the vinyl-asbestos tile operations was made, partly to assess the value of indicated changes in reducing exposures of personnel, and partly to gain more insight into the chemical exposures that may have received recently.

The ingredients used in vinyl-asbestos tile formulations have adhered quite well to the same basic recipe for over a year.

The recipe is as follows:

Material	Weight Ratio
Resin - May be chlorinated polyethylene or resin 2716, the copolymer of 15% vinylidene chloride, 85% vinyl chloride.	17.5
Dioctyl phthalate or tricresyl phosphate	2.25
Monoplex S-38 - An epoxidized oil purchased from Rohm and Haas.	2.25
Metasap 624 - Contains cadmium laurate	1.5
Aluminium stearate	0.1
Paraffin wax	0.1
Lesimit - Calcium carbonate	39.8
No. 18 graining sand - A very fine sand	12.5
Titanox RA50- Titanium dioxide	5.0
Asbestos shorts, type 7M	19.0

With the exception of dioctyl phthalate and monoplex S-38, which are liquids, all of these materials are dry powders, and normally are weighed into a stainless steel mixing bowl in the open. This operation takes about 5 minutes. The mixing bowl is then placed under a mixer within a hood, mixed for a few minutes, and then the two liquids are added. After further mixing, the batch (which is still a dry powder) is poured into a paper bag held within the hood.

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S 1003060 2

When it is done, weighing and blending of the ingredients takes place at a maximum frequency of about 3-half-days per week; an average frequency is difficult to establish because two or three weeks may pass with no activity in this area at all. normally would be involved in about 10% of this work which is usually done by a lab technician.

Dry powder from the paper bag is poured directly into the Baker-Perkins or Banbury mixer - usually the Banbury. Here the material is forced into a heated mixing chamber with an air-powered ram and is mixed for about two minutes. The resulting mass is semi-plastic, and is removed (sometimes with difficulty) from the mixer and carried to the differential speed heated (200-300°F.) 2-roll mill. On this mill it is further blended and occasionally marbilizing chips are added. Such blending may take from 2 or 3 minutes to a half-hour depending upon the difficulties encountered.

After being thoroughly mixed on the 2-roll mill the plastic mass is carried to the calender (basically a cooler heated 2-roll mill) a few feet away. Here the material is squeezed to a pre-determined thickness by a pass through the rolls; the surface of the resulting strip is improved by a second pass through this machine. The strip of tile material is then cut into pieces of the correct size for testing with a shear. From Banbury mixer to finished pieces of tile may take from 15 minutes to an hour or so for a single batch

The maximum frequency of this job is about the same as for weighing and blending, 3 half-days per week, and again, an average frequency is almost impossible to establish. For reasons of safety, two men always work together in these operations;

has been associated with about 80% of this work since the latter part of 1956.

ST0030603

On 1-15-58 several air analyses were made during vinyl-asbestos tile manufacture. Air sampling equipment used was the Bausch and Lomb dust counting microscope and the electrostatic precipitator. Results of these air analyses are presented in Table I. Samples 1-11 were taken with the B and L dust counting microscope and the concentrations are expressed in terms of millions of particles per cubic foot of air. (mppcf). Samples 12-14 were taken with the electrostatic precipitator, and normally concentrations would be expressed as milligrams of air contaminant per cubic meter of air ($mg./m^3$), but the samples were unfortunately of too short duration to obtain weighable quantities of dust.

ST0030604

Table I

Sample No.	Description	Dust Concentration, mppcf
1	An air sample taken directly over a paper bag of dry materials shaken to produce dust. This sample was mainly to establish the size range of the airborne particles.	Most particles ≤ 5μ in diameter, average about 2-3 μ
2	Breathing zone sample as a paper bag of formulation was dumped into the Banbury mixer.	3.2
3	Sample of fume from the hot semi-plastic mass as it was withdrawn from the mixer, not a breathing zone sample.	0.7
4	Breathing zone of a man removing the semi-plastic mass from the Banbury mixer with steel picks.	1.0
5	Breathing zone while working the material on the 2-roll mill.	0.9
6	Breathing zone while working the material on the 2-roll mill.	0.2
7	Breathing zone of man as he put the material through the calender.	0.7
8	Breathing zone while cutting the tile to size on the shear.	0.5
9	Room air in the office.	0.2
10	Breathing zone of lab technician as he added dry asbestos fiber to the mixing container on a scale in the laboratory.	1.4

ST0030605

Sample No.	Description	Length of Time of Sample	Dust Concentration, MPPCF / Dust Conc. mg./m.^{3}
11	Immediately outside of the bench hood where the dry batch of material was being mixed.		0.5
12	Electrostatic precipitator sample in the breathing zone while formulation being mixed in the Banbury.	2 min.	Too little to weigh
13	Breathing zone while working the formulation on the 2-roll mill.		Too little to measure.
14	Sample taken in bench hood over the container where the dry mixture was being stirred. This sample was taken only to determine the relative proportions of the dust constituents in air.		$CaCO_3$ - Main Constituent Asbestos - 20-30% SiO_2 <5% Cd 0.02%

The resin used for the tile formulation involved in the work described in Table I was resin 2716, consisting of the polymer made from 15% vinylidene chloride, 85% vinyl chloride. Analysis of Sample 14 was by x-ray diffraction and emission spectrograph; the organic materials are not "seen" by this method.

The dust concentrations shown in Table I may be compared with the appropriate Industrial Hygiene Standards, listed in Table II. Industrial Hygiene Standards are concentrations which may be inhaled as much as 8 hours per day, 5 days per week indefinitely without ill effect.

Table II

Industrial Hygiene Standards

Material		Standard
Asbestos		5.0 mppcf
Silica (quartz)		5.0 mppcf
Cadmium		0.10 mg./m^3
Calcium Carbonate		15.0 mg./m^3
Resin 2716	probably	15.0 mg./m^3

An examination of Tables I and II readily shows that at no time were the standards for asbestos or silica exceeded. Since the dust counting microscope determines the number, not the weight of particles in the air some assumptions must be made before the cadmium exposure can be evaluated: (1) assume that the dust encountered near the Banbury mixer, 2-roll mill and calender had the same particle-size distribution as the dust of the dry mixture (confirmed by dark-field microscopic examination); (2) assume the dust particles were spherical with an average diameter of 2.5 μ; (3) assume the density of the particles was approximately 2.0 g./cc.

S1003606

ST0030607

Using these assumptions, the weight concentration of dust corresponding to the highest observed particle concentration (3.2 mppcf) would be 1.85 mg./m.^{3}. Then, assuming that the particles were 0.02% cadmium, the air concentration of cadmium was about 0.0004 mg./m.^{3}, well below the 0.10 mg./m^3 Standard, especially considering that all of the assumptions made were conservative.

Thermal decomposition products of the resin and plasticizers used could conceivably be the cause of trouble except that a great amount of experience at Dow and at other companies with these materials has shown that no adverse effects are to be expected even under much worse conditions than have been prevalent in 433 Building.

Remaining as a possibility is the dust and/or thermal decomposition products from chlorinated polyethylene, a new material. A survey will be made when this material is again used in vinyl-asbestos tile formulations in order to determine what materials are inhaled, and in what concentrations. Also, this dust, along with the dust of other materials, is soon to be investigated by the Toxicology Laboratory to determine the degree of irritation caused by sub-dermal injections. This investigation should help to decide whether or not lung injury could have been caused by the resins used in vinyl-asbestos tile formulations.

The bench hood used in the laboratory for dry mixing was evaluated by measuring air velocities at the face of the hood with an Anemotherm Air Meter. The attached "Hood Survey Data Sheet" is self explanatory regarding findings and recommendations.

ST0030608

HOOD SURVEY DATA

FILE NUMBER	BUILDING NUMBER	DATE	TYPE OF HOOD
T21-1-32	433	1/15/52	LAB BENCH

HOOD LOCATION, DESIGNATION: BUILDING PRODUCTS LAB, PTS

INTERNAL BAFFLE?	EXTERNAL BAFFLE?	CHEMICALS HANDLED IN THIS HOOD
YES	NO	ASBESTOS, PVC, PLASTICIZERS, RTC, CEMENT, SOLVENTS

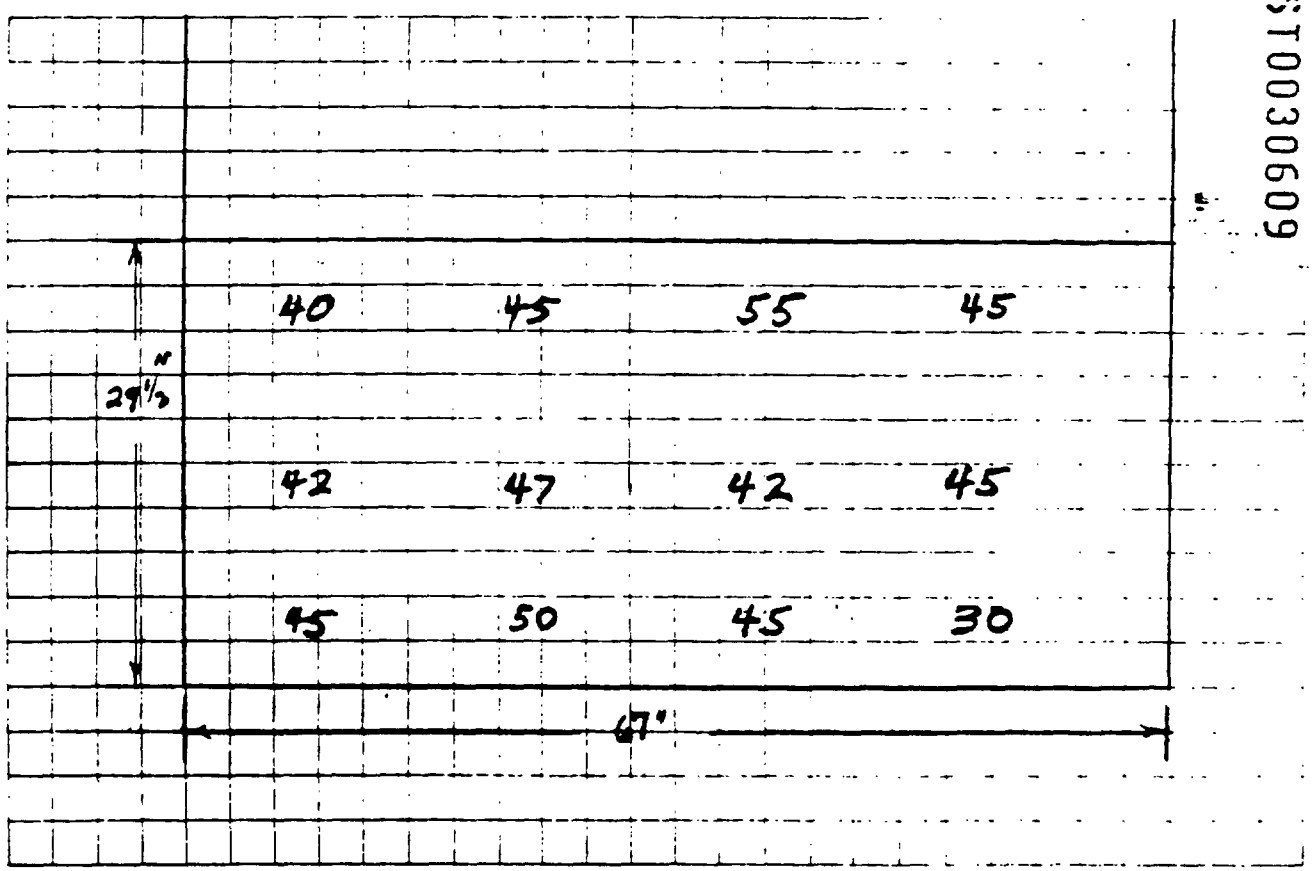
OTHER HOODS CONNECTED TO THE SAME EXHAUST SYSTEM: SOVENS

SOURCES OF AIR DISTURBANCE EXTERNAL TO THIS HOOD: AIR DIFFUSER INLET ABOUT 8 FEET FROM FRONT OF HOOD

REMARKS:

RECOMMENDED MEAN FACE VELOCITY FOR THIS HOOD 80 F.P.M. DOOR OPEN 29½ IN.

RECOMMENDED EXHAUST RATE FOR THIS HOOD 1100 C.F.M.



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HOOD CONDITIONS DURING THE SURVEY

	SUCTION	CENTER	MEAN	VARIANCE (s.d.²)
ACTUAL FACE VELOCITIES	55 F.P.M.	32 F.P.M.	44 F.P.M.	33

HOOD FACE AREA DURING SURVEY: 13.7 SQ. FT.

EXHAUST RATE DURING SURVEY: 605 C.F.M.

MAXIMUM OPENING: HEIGHT 29½ IN. WIDTH 67 IN. MAXIMUM HOOD FACE AREA 13.7 SQ. FT.

INSTRUMENT USED FOR AIR VELOCITY MEASUREMENTS	SERIAL NUMBER	SURVEYOR
ANEMOTHERM AIR METER	5259	J.E.P.

397479

HOOD SURVEY DATA

FILE NUMBER	BUILDING NUMBER	DATE	TYPE OF HOOD
T2.1-1-32	433	1/15/58	LAB BENCH

HOOD LOCATION, DESIGNATION: BUILDING PRODUCTS LAB, PTS

INTERNAL BAFFLE?	EXTERNAL BAFFLE?	CHEMICALS HANDLED IN THIS HOOD

OTHER HOODS CONNECTED TO THE SAME EXHAUST SYSTEM:

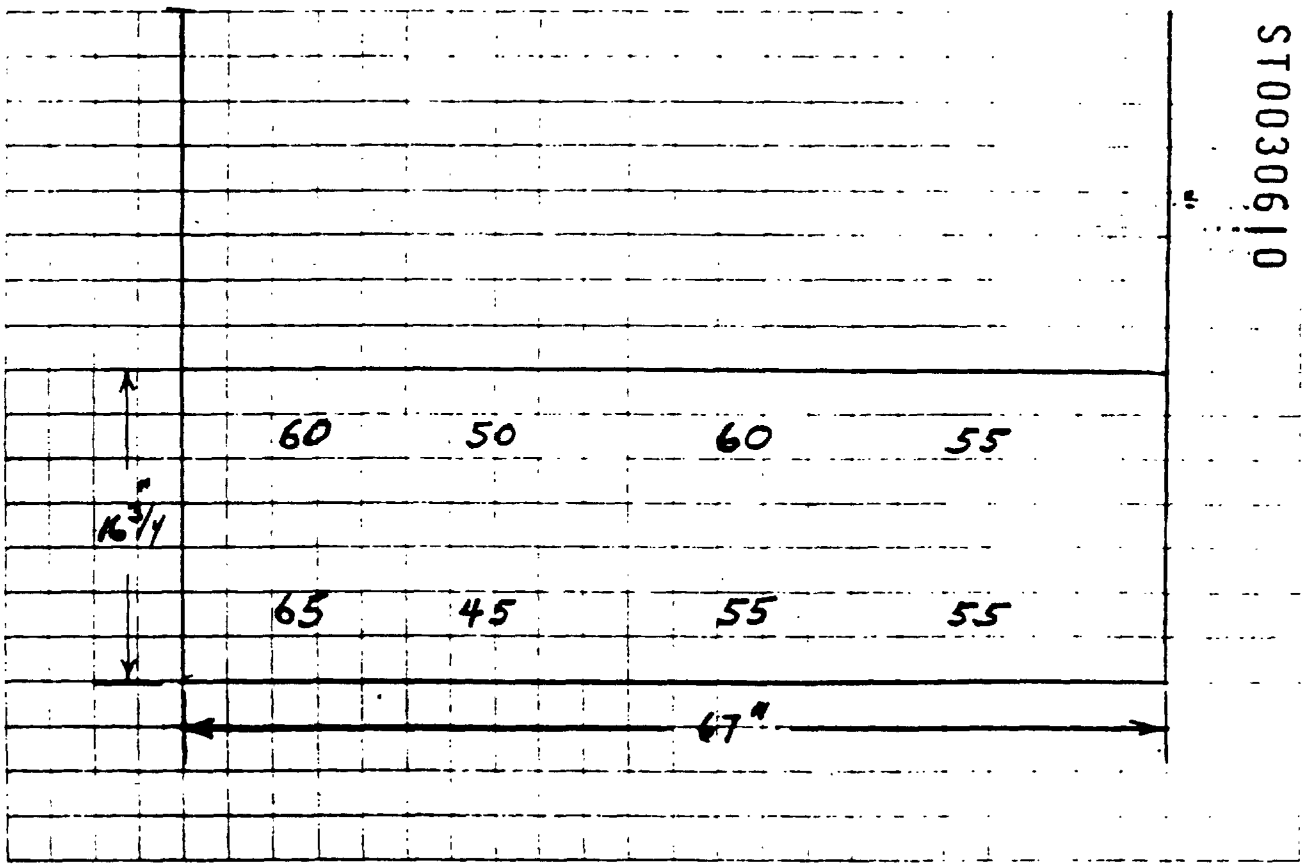
SOURCES OF AIR DISTURBANCE EXTERNAL TO THIS HOOD:

REMARKS:

RECOMMENDED MEAN FACE VELOCITY FOR THIS HOOD 80 F.P.M., DOOR OPEN WIDE, 29½ IN.

RECOMMENDED EXHAUST RATE FOR THIS HOOD 1100 C.F.M.

ST0030610



HOOD CONDITIONS DURING THE SURVEY

	MAXIMUM	MINIMUM	MEAN	VARIANCE (s^2)
ACTUAL FACE VELOCITIES	60 F.P.M.	45 F.P.M.	56 F.P.M.	45

HOOD FACE AREA DURING SURVEY 7.8 SQ. FT.

EXHAUST RATE DURING SURVEY 434 C.F.M.

MAXIMUM OPENING: HEIGHT 29½ IN., WIDTH 67 IN. MAXIMUM HOOD FACE AREA 13.7 SQ. FT.

INSTRUMENT USED FOR AIR VELOCITY MEASUREMENTS	SERIAL NUMBER	SURVEYOR
ANEMOTHERM AIR METER	5259	J.E.P

[illegible] PRINTED IN U.S.A. [illegible]

397480

I am an author of and have read this report comprising 13 pages with 2 pages of drawings, photographs, graphs, and checked the data herein against the original entries under Biochemical Laboratory File Number T2.1-1-65

Signature J E Peterson Date 2/6/58

Signature _____ Date _____

I finished typing this report on 1-29-58 comprising 13 pages and placed therewith 2 pages of drawings, photographs, graphs from an original draft given me by J. E. Peterson on 1-27-58.

I have placed in the plant mail 5 copies of this report for transmittal to Please refer to the Distribution list of this report.

Signature Sheldon Klotzman Date 2-6-58

ST0030611

ST00306 12

UNIT INDEX

Possible chemical exposures received by of Coatings Technical Service while working with vinyl-asbestos tile formulations are evaluated as possible causes of his lung injury. No evidence leading to the determination of a causitive agent was found, but plans were made for another survey to be performed when chlorinated polyethylene is used as the resin in a tile formulation, and dust of this material will also be investigated further by the Toxicology Laboratory.

DISTRIBUTION

R. B. Drubel, Coatings Technical Service, 433 Building
N. R. Peterson, Coatings Technical Service, 433 Building
H. H. Gay, M.D., Medical Department, 607 Building
W. L. Tisdale, Safety Department, 401 Building
G. E. Bolstead, Compensation Department, 256 Building
W. Snodgrass, Maint. Service Admin., 49 Building (7/9/71)

gck

INDUSTRIAL HYGIENE SAMPLE RECORD

SAMPLING METHOD	SAMPLE RATE	PROBLEM	BLDG.	DATE
B & L MICROSCOPE	—	T2.1-1 [redacted] 32	433	1/15/58

TRAPPING MEDIUM	ROTAMETER OR ORIFICE NO.	PROCESS
—	—	CTS VINYL-ASBESTOS TILE

ROTOMETER SETTING	OUTSIDE TEMP.	INSIDE TEMP.	MATERIAL
—	—	—	OVET- ASBESTOS, METALAP,

VENTILATION:

SAMPLE	BOTTLE SLIDE	DESCRIPTION	TIME START	TIME STOP	CONCENTRATION mppf
1	1	Sample of dust in paper bag			too hi to count all (4 5-7)
2	12	Breathing zone on mixture was dumped in the mixer	12:25		3.2
3	11	Fumes from hot mixture as it was withdrawn from mixer	12:28		± 0.7
4	10	Breathing zone - near mixer, removing hot formulation with pails	12:30		1.0
5	9	Breathing zone while working the formulation on the 2-roll mill	12:31		0.9
6	8	Same as sample 5	12:37		0.2
7	7	Breathing zone while putting formulation thru calender	12:40		0.7
9	6	Breathing zone while cutting tile to size	12:41		0.5

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ST00306613

INDUSTRIAL HYGIENE SAMPLE RECORD

SAMPLING METHOD	SAMPLE RATE	PROBLEM	BLDG.	DATE
B & L microscope	—	T2.1-1-32	433	1/15/58

TRAPPING MEDIUM	ROTAMETER OR ORIFICE NO.	PROCESS (Ts - Using asbestos tile
—	—	

ROTOMETER SETTING	OUTSIDE TEMP.	INSIDE TEMP.	MATERIAL Dust - ASBESTOS, METASAP

VENTILATION:

SAMPLE	BOTTLE stick	DESCRIPTION	TIME START	TIME STOP	CONCENTRATION mppcf
9	2	Room air (office)			0.3
10	5	Breathing zone while adding dry asbestos to container on scale			1.4
11	4	Just outside bench hood where dry batch was being mixed Jack L Peterson 1/15/58			0.5

ST0030614

397484

INDUSTRIAL HYGIENE SAMPLE RECORD

SAMPLING METHOD	SAMPLE RATE	PROBLEM	BLDG.	DATE
ELECTROSTATIC PRECIPITATION	3.0 CFM	TJ.1-1-32	433	1/15/57

TRAPPING MEDIUM	ROTAMETER OR ORIFICE NO.	PROCESS
	—	VINYL ASBESTOS TILE

ROTOMETER SETTING	OUTSIDE TEMP.	INSIDE TEMP.	MATERIAL
			DUST

VENTILATION:

ST0030615

SAMPLE	~~BOTTLE~~ TYPE	DESCRIPTION	TIME START	TIME STOP	CONCENTRATION mg/m³
12	60-1	Breathing zone of operator mixing the formulation in the hot mixer	2 min 13:55		< 2.9
13	60-2	Breathing zone while working the formulation on the 2-roll mill	14:00 2.25 min		< 9.4
148	60-2	Sample taken in hood over container of dry blend being stirred.			0.1508 g.

Jack E. Peterson 1/15/58

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CALCULATIONS RECORD

PROBLEM	RATE	MATERIAL	BUILDING	DATE
T2.1-1-65	3.0 CFM	T2.1-1-32	~~432~~	1/15/58

MOL. WT.	CONVERSION MILLIGRAM TO TOTAL
ppm/mg/l	PROCESS

EXPLANATION OF CALCULATIONS:

SAMPLE	TIME	S. VOL. ~~ft³~~	ANALYSIS	mg/l.	mg/m³ CONC.
12	2 min	6.0	0.5 mg.		2.9
13	2.25 min	6.75	1.8 mg.		9.4
		Jack T Peterson 1/16/58			
14	analysis by x-ray diffraction and emission spec. show the following				
		Calcium Carbonate - main constituent			
		asbestos		20-30%	
		Silica (quartz)		< 5%	
		Calcium		0.02%	

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particle diameter = 2.5μ = 2.5×10^{-3} mm.

particle volume = $\frac{4}{3}\pi (1.25 \times 10^{-3})^3 = 8.2 \times 10^{-9}$ mm^3

density = 2.0 g/cc = 2.0 mg/mm^3

∴ particle weight = $2.0 \times 8.2 \times 10^{-9} = 16.4 \times 10^{-9}$ mg/particle.

$16.4 \times 10^{-9} \frac{mg}{particle} \times 3.2 \times 10^{6}$ particle/ft^3 = 52.5×10^{-3} mg/ft^3

$52.5 \times 10^{-3} \times 35.3 = 1.85$ mg/m^3

.0002

.000370

ST00306617

2716 - vinyl - vinyltile

resin	17.5 p by weight
DOP	2.25
...oplex S-38	2.25 epoxidized oil Rohm + Haas
mitosap 424	1.5
al stearat	0.1
paraffin wax	0.1
leskmit	39.8 $CaCO_3$
NO.18 graining sand	12.5
TiO_2	5.0
asbestos short 7M type	19.0

max dry mixing 1½ days/week [3 work days
avg - Banbury + calendering time 1½] in 3 days

~~10% of total~~

80% of total

ST0030618

397488

1-29-58

T2.1-1-32

THE DOW CHEMICAL COMPANY Report No. 101978
SPECTROSCOPY LABORATORY

To J. R. Peterson - Biochem. Res. By H. W. Rinn

Subject Analysis of Dust Sample 60-2. X-Ray Diffraction, X-Ray Fluorescence and Spectroscopy.

Charge No. 1219-26 Signed H. W. Rinn

Date Rec'd 1-16-58 Date

X-Ray Diffraction Analysis:

$CaCO_3$ -- chief constituent
Asbestos (serpentine variety) -- 20-30%
Quartz -- Trace (<5%)
There also appears to be a clay type material present.

Emission Spectroscopy and X-Ray Fluorescence Analysis:

Cd -- .01-.02%

1-21-58
HWR:vsr
2

ST00306 19

397489

Industrial Hygiene Chemical Exposure Data Entry Log
Field Survey TWA Exposure And Excursion Exposure Data

Report no. 2-1-1-32/670 Date 0157

Building no. 433 Index no. _____

Units of Data X Respirator Worn? _____

Master no. _____

ST0030620

Job Classification	Job No.	Chemical Name: asbestos DR# 270713 TWA/Exc.	DR# _____ TWA/Exc.
Operator	336755	0 / 3.2	/
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		/	/
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