PLAINTIFF'S EXHIBIT

BOND-166

Code 12002

WINDSOR MINERALS INC P.O. Box 630 Windsor, Vermont 05089

September 7, 1977

Bondex International
3616 Scarlet Oak Boulevard
St. Louis, Missouri 63122

Attn: Ms. Jeanette Garner
Purchasing Agent

Dear Ms. Garner:

In response to your letter of September 1, 1977, I am writing to assure you of the quality of our products regarding contamination with hazardous mineral species.

I am enclosing a copy of the Material Safety Data Sheet for our Grade TC-100 Talc and, in addition, a copy of a recent opinion conducted by NIOSH which concerned itself with the quality of our ores and products. This particular section of the NIOSH study was done by Harvard University, and I have taken the liberty of enclosing a copy of the final report which they presented. The report, as you will note, indicates the absence of hazardous fiberform minerals and, additionally, an extremely low level of quartz.

If we may be of further assistance in this regard, please do not hesitate to contact the writer.

Yours very truly,

WINDSOR MINERALS INC.

R. N. Miller
a.b.

R. N. Miller
President

RNM:ab
Encs.

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1187

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
Windsor Minerals, Inc.	802-484-7761
ADDRESS (Number, Street, City, State, and ZIP Code) P.O. Box 680, Windsor, VT 05089	
CHEMICAL NAME AND SYNONYMS: Magnesium Silicate-Hydrous	TRADE NAME AND SYNONYMS: Grade TC 100 Talc
CHEMICAL FAMILY: Silicates - Carbonates	FORMULA: $H_2Mg_3(SiO_3)_4$

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
DOES NOT APPLY		

SECTION III - PHYSICAL DATA

BOILING POINT (°F.) Does not apply		SPECIFIC GRAVITY (H_2O=1)	2.8
VAPOR PRESSURE (mm Hg.) Does not apply		PERCENT VOLATILE BY VOL. (%) Does not apply	
VAPOR DENSITY (AIR=1) Does not apply		EVAPORATION RATE (Butyl Acetate=1) Does not apply	
SOLUBILITY IN WATER Insoluble			
APPEARANCE AND ODOR			

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel
Does not apply	Does not apply		
EXTINGUISHING MEDIA: Does not apply			
SPECIAL FIRE FIGHTING PROCEDURES: Does not apply			
UNUSUAL FIRE AND EXPLOSION HAZARDS: Does not apply			

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(Continued on reverse side)

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE
20 Mg/M3

EFFECTS OF OVEREXPOSURE
Dust inhalation

EMERGENCY AND FIRST AID PROCEDURES
Leave dusty area

Wear approved respirator

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATABILITY *(Materials to avoid)*
Does not apply

HAZARDOUS DECOMPOSITION PRODUCTS
Does not apply

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Does not apply

Dry solid

WASTE DISPOSAL METHOD

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)*
Wear approved mask if above ACG1H exposure level

VENTILATION	LOCAL EXHAUST —	SPECIAL
	MECHANICAL *(General)* XXX	OTHER

PROTECTIVE GLOVES Not required	EYE PROTECTION Solid particulate

OTHER PROTECTIVE EQUIPMENT

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

WINDSOR MINERALS INC.

July 25, 1977

Dear Sir:

We have recently and cooperatively participated in a study by The National Institute for Occupational Safety and Health (NIOSH). In this study, environmental sampling was conducted in our mines and mills.

The samples taken in our operations were analyzed for their mineral content with particular reference to quartz (SiO_2) and asbestos.

A final report on this phase of the NIOSH study was presented at a meeting of The American Industrial Hygiene Association by Harvard University who was the contractor for NIOSH.

The study, while particularly concerned with dust exposure, verified the absence of contamination by undesirable mineral species in our ores.

I have enclosed a copy of the report for your records, and for use in responding to questions from regulatory agencies.

If you have any questions in this regard, please do not hesitate to contact the writer.

Yours very truly,

WINDSOR MINERALS, INC.

Roger N. Miller
President

RNM:rg
Enc.

BON - 01524

EXPOSURE TO INDUSTRIAL TALC IN VERMONT TALC MINES AND MILLS

M. G. Boundy, K. Gold, and W. A. Burgess
Harvard University
Boston, MA

J. M. Dement
NIOSH
Cincinnati, OH

(For presentation at AIHA Conference at New Orleans, May 26, 1977)

Introduction

An environmental study of the Vermont talc mines and mills was undertaken in support of a concurrent epidemiological study of talc workers. Since geological studies dating to the early 1900's have shown that the Vermont talc deposits contain no asbestos and little quartz, this population represents a group of talc workers employed in mining and milling operations who have no association with these two fibrosis producing minerals. Therefore, the intent of this study was to verify these geological reports by quantitating the personal dust exposures of these talc workers and by identifying the mineral content of this "clean" talc ore.

Mineralogy

Pure talc mineral is a hydrous magnesium silicate with the theoretical formula $3MgO \cdot 4SiO_2 \cdot H_2O$ and consists of a brucite sheet containing magnesium ions sandwiched between two weakly held silica sheets. This mineral is extremely soft and slippery and has a hardness of 1 on the Mohs scale. However, as used industrially, the term "talc" refers to a mixture of minerals that meet certain physical requirements rather than one which has a fixed chemical composition. Industrial grades of talc usually contain chlorites which are sheet silicate minerals containing magnesium, iron, and aluminum, and carbonates which include

magnesite, dolomite, and calcite. Quartz, iron oxides, serpentine (one of the minerals from which talc evolved) and tremolite, may also be present. Therefore, since the constituents of industrial talc vary in their mineral and fiber content the ensuing product has a considerable range in hardness and particle shape which contributes to its versatility.

Field Study

The three major Vermont talc companies were surveyed in Summer 1975 and Winter 1976 and a total of 312 personal respirable mass samples were taken. Half of these samples were analyzed for free silica content by infra red spectrophotometry, and 20% by x-ray diffraction. Fifty-seven parallel fiber samples were taken using Millipore and Nuclepore filters. Fiber counts were performed on these samples using phase contrast at 437X, and scanning electron microscopy at 5000X magnification, respectively.

In addition, bulk samples from representative milling and mining operations were collected from each location. These specimens were analyzed qualitatively by x-ray diffraction for their mineral constituents.

The three Vermont companies obtain their talc ore, which occurs in compact lenses, by underground and surface mining. For the underground mines an inclined shaft (SLIDE) is sunk to the deposit and a heading is begun. Entry is via the same skip in which the ore is removed (SLIDE). The depth of the

mines ranges from 150-800 feet and the temperature is approximately 7°C yearround. The mines are always wet from the seepage of water from the surface and underground springs (SLIDE).

The tunnels are made by a track drill (SLIDE) through non-talc areas. This rock is wasted and this process was not in operation during our surveys.

A heading is mined by wet drilling, blasting, machine mucking, and stoping methods. A drilling crew of one or two men make the holes in the working face of the ore. At the end of a shift explosives are inserted and set off in the holes to break apart the mass of ore. The following morning mechanical muckers (SLIDE) or bobcat machines (3 SLIDES) are used to load the ore onto the haulage cars. Pneumatic jackhammers (pavement breakers) may be necessary to break up the large boulders. Stoping methods (SLIDE) are used to remove the ore from distant pockets via a series of horizontal or inclined workings in the ore veins. In such areas a "scraper" will operate a mechanical drag which is suspended from a cable and secured to a distant wall, to pull the blasted ore into an excavated chute (SLIDE). After filling the cars the trainman drives the locomotive to the shaft (SLIDE) where the ore is dumped into a skip, (SLIDE) hoisted to the surface or the 1st level by the skippy hoist operator. (SLIDE) The ore is then dumped and transferred again, hoisted to the surface, and transported by trucks to the mill.

In addition one company operates two walk-in mines and an open pit mine where the ore is mined by an automatic mining

operation. A diesel powered machine removes the rock from the face and loads it onto a truck via a conveyor in a continuous motion. An operator controls the location and movements of the cutting head which cuts away at the ore face in a circular motion. A gathering arm at the front of this machine draws the ore onto the conveyor which carries the ore to a diesel-powered dumptruck.

Talc Milling

The milling processes at the three companies are rather similar. With only one exception, the Vermont mills are large, drafty barn-like structures. The ore arrives at each mill from the mine by truck and is dumped into a pit or an ore storage bin (SLIDE). A crusher operator, (3 SLIDES) using a conveyor system or the same type of mechanical scraper as in the mine stopes, draws the ore into a jaw crusher. The ore may pass through a series of screens or a secondary crusher before being dried and proceeding to the mills. Depending on the final particle size and grade of the product, the ore may be further ground in a pebble mill or pulverized in a roller mill (SLIDE) where spring-loaded rollers rotate against a horizontally fixed steel ring. An air classifier system then separates the ore according to particle size, and this material is either bagged directly or held in storage silos.

Two of the companies further purify and grind the ore using a flotation process to separate the mineral talc from the magnesite and non-talc minerals. A slurry of the ore in water fills

flotation cells in which bubbles are created by reagents and an air injection system. The talc becomes attached to the air bubbles and rises to the surface as a mineralized froth. Rotary blades gently push the bubbles into troughs. The recovered talc is thickened, dried, and stored in bins until bagging or shipment in bulk.

Most of the product is shipped in 50-60 pound bags. (2 SLIDES) The bags are hand placed on support holders and are automatically filled, sealed and discharged onto a conveyor. The conveyor leads to a palletizing area (SLIDE) where two men stack the bags on pallets which are then loaded onto railroad cars or trucks by a fork lift operator (SLIDE). Usually the bagger and palletizers form a three-man team and rotate jobs on a half-day cycle. In addition, some talc may be shipped in bulk form by rail or truck.

Bulk Samples

Bulk samples consisting of ore chunks from the mines or crushing operations at the mill and mineral mixtures or products from the mills were obtained from each company. Each bulk sample was ground, dried, and scanned qualitatively by x-ray diffraction. For all the samples, talc and magnesite are found in major amounts, chlorite and/or dolomite are minor constituents, and dolomite, calcite, quartz, biotite, ankerite, chromite, oligoclase, or phlogopite may be found in trace quantities. (Table

Quartz was present in trace amounts in 15% of these samples and petrographic microscope analysis, analytical transmission electron microscopy, and x-ray diffraction with step-scanning revealed no asbestos in these samples.

Over 300 personal respirable mass samples were taken using 10 mm 2-stage Nylon cyclones at a flow rate of 1.7 liters per minute. The respirable dust exposures of underground miners are shown in Table 2 (SLIDE). These exposures are classified by job and company and the highest dust concentrations occur at Company B. The ore in this mine is relatively hard and the extensive drilling and jackhammering operations required to break apart the large boulders may account for the higher dust levels.

Jobwise, the highest concentrations are experienced by the drillers, scraper, bobcat, and mucker operators, and laborers. Scraper, bobcat and mucker operators are involved in the movement of blasted ore into an excavated area or directly into the haulage cars. The confinement of their work areas and the necessity of using pneumatic jackhammers may contribute to their exposures. Maintenance men and laborers are the "trouble-shooters" and their work and dust exposures may change on a daily basis.

The average respirable mass dust exposures for workers in the open-pit and walk-in mines are presented in Table 3 (SLIDE). The automatic mine operator who controls the movements of the mine scraper had the heaviest average exposure (5.8 mg/m^3). The machinery in these mines was diesel-powered and the amount of diesel fume in the respirable mass fraction was not determined.

Table 4 presents the average respirable mass concentrations of the millers according to job and company. The highest dust exposures in all the plants are seen by the dry mill operators,

utility men, and crushers in the mill area, and by the baggers and palletizers in the shipping area. The small sized operation at Company A is reflected by the limited number of samples. Most of these millers rotate jobs depending on the production cycle and therefore their exposures are in the miscellaneous category.

Company B has the highest dust concentrations with major contributions by the dry mill operator and utility man who works the night shift in the mill area. The age of this milling equipment and may have added to their dust exposures.

In the shipping area of Company B, the respirable mass filters of the three-man team were changed at mid-day to assess the actual dust load from the bagging and palletizing operations. Dust exposures in the shipping areas of Company B were found to be dependent on the work habits of the men and the grade and particle size of the talc being bagged. The palletizers' exposure (2.7 mg/m^3) may be explained by the manual handling and tossing of the 50 pound dusty bags onto the pallets and the lack of any local exhaus ventilation at transfer points. These bags may have had an ineffi seal which may have caused leakages and dust exposures to the palletizers. The lower dust levels of the baggers and palletizers at Company C may be attributed to a better seal of the bags and a more officient ventilation system.

Quartz Analysis

Seventy percent of the respirable mass samples from each company were randomly selected and analyzed for free silica. Fifty percent were analyzed by infrared spectrophotometry and 10% by x-ray diffraction performed at Harvard and 10% by x-ray diffraction performed at NIOSH. The limit of detection by infrared spectrophotometry is 5 µg SiO_2 and by x-ray diffraction is 10 µg (HSPH) and 20 µg (NIOSH).

Less than ten percent of the filters examined had measurable quartz concentrations and these jobs and exposures are listed in Table 5 (SLIDE). All quartz exposures were below the present threshold limit value (TLV) of 100 µg/m^3. In the underground mine at Company C a maintenance worker had a considerable exposure (63.6 µg/m^3). During the winter survey a driller experienced 94.7 and 70.2 µg/m^3 quartz on two days. On both occasions he was doing some drilling in an uncharted area and may have found a quartz vein. The ore from this underground mine is processed at Mill #1, and free silica was found in only one of the eighteen respirable mass samples analyzed from this plant. Table 5 shows that a palletizer received a quartz exposure of 92.3 µg/m^3.

In the summer survey the automatic miner operator at the open pit was exposed to 26.0 µg/m^3 free silica. This ore was brought to Mill #2 and a maintenance/baggerman received a respirable quartz dose of 41.8 µg/m^3.

Fiber Counts

The carcinogenic potential and the hazards of asbestos exposures have been well documented. Also, several types of asbestos are known to be geological contaminants in talc ore. Since the accepted best index of exposure to asbestos requires counting the respirable fibers in the worker's breathing zone, the problem arises in the methodology of distinguishing asbestos fibers from talc. Characteristically, talc has a tendency to curl and stand on its edge which may result in many erroneous counts (SLIDE).

The latest USPHS/NIOSH method for counting asbestos fibers requires phase contrast microscopy at 400-500 X and thus arbitrarily defines a fiber as a particulate with a length to width ratio of 3:1 or greater, and a maximum width and minimum length of 5 micrometers. This method is a crude determination of total fiber exposure because of the resolution limitations of optical microscopy. Most airborne asbestos fibers are less than 5 μm in length and those that are longer may have diameters too small to be detected by phase contrast microscopy.

To compensate for the many controversies our sampling protocol involved taking parallel fiber samples on Millipore (0.8 μm) and Nuclepore (0.4 μm) filters and quantitating the

fibers by phase contrast microscopy and Scanning Electron Microscopy. The fiber samplers were placed in the immediate vicinity of the worker and a breathing zone sample was obtained without having the man wear the pumps. The Millipore filters were counted using the latest USPHS/NIOSH method at 437 X magnification.

The evaluation of the corresponding Nuclepore filter by Scanning Electron Microscopy at 5000 X allows one to morphologically distinguish rolled talc particles and talc shard from actual fibers. Fibers less than five micrometers in length may be counted by the higher magnification of this instrument, and the sample stage may be rotated to view a specific particle at various angles.

The following series of slides are scanning electron micrographs of some of Nuclepore filter samples.

1. Counting field at 400 X which is the magnification recommended for fiber counting by phase contrast microscopy. Notice the number of elongated particles that fit the definition of a fiber.

2. However, at 7000 X this elongated particle is morphologically not a fiber.

3. One rolled talc particle at 12000 X which has curled on both sides to form a tube. At a lower magnification this particle would be counted as a fiber.

4. This is an elongated particle standing on edge at 3500 X which might be considered a fiber.

5. However, by rotating the sample stage 60°, one can see the laminated features of this talc particle.

6-7. Even some "fibers" are not immune from closer scrutinization. When this sample stage is rotated 50°, this so-called "fiber" now has this appearance. These magnifications are 5000 X and 15000 X respectively.

Table 6 represents a partial list of fiber samples and shows that by phase contrast microscopy the counts range from 0 to 60 fibers/cc. The parallel filters counted by SEM are greatly reduced and range from 0 to 1.0 fiber/cc. These concentrations are below the present TWA of asbestos which is 2 fibers/cc greater than five micrometers in length based on the phase contrast method. If the minimum length restriction is released, then the total fiber concentration for some of these samples changes slightly and ranges from 0 to 2.0 fibers/cc. Thus, this SEM method provides a more realistic approach to fiber counting in the talc industry.

To further correlate these data, half-filter samples of the heaviest fiber samples by phase contrast microscopy were sent to NIOSH for analytical transmission electron microscopy. The samples were prepared by using heavy carbon coating which allows analysis by electron diffraction and microprobe techniques.

Each of the samples contained elongated particles meeting the definition of a fiber (3 to 1 aspect ratio). However, most elongated particles were identified as talc based on their selected area electron diffraction patterns. Several of these particles were identified as antigorite. No asbestos fibers were seen in any of the other samples.

Conclusions

The Vermont talc industry was selected by NIOSH for both epidemiological and environmental surveys to establish a TWA dust exposure because this talc was believed to contain minimum amounts of quartz and asbestos. This environmental study characterized bulk samples from the three companies and quantitated the talc workers' dust exposures. X-ray diffraction studies showed that the bulk samples contained major amounts of talc, and only trace amounts of quartz were found in 15% of these samples. Petrographic microscopy analyses, analytical transmission electron microscopy, and x-ray diffraction with step-scanning revealed no asbestos in the bulk samples.

Respirable mass sampling provides a more realistic method to determine personal dust exposures than midget impinger samples. In addition, the amount of respirable quartz in the respirable dust sample may be determined by infrared spectrophotometry or x-ray diffraction. Thus, the overall picture of the quartz and dust concentrations to which the workers are exposed may be obtained with reasonable confidence.

The study further showed that scanning electron microscopy should be considered as an adjunct to the NIOSH/USPHS method when counting fibers in a dust environment. Phase contrast microscopy may suffice in an asbestos environment, but the resolution limitations of optical microscopy and the inability to distinguish rolled talc particles and talc "shards" from actual asbestos fibers will allow only a crude determination of the total fiber exposure.

Some Chemical and Physical Properties of Talc

Talc $3MgO \cdot 4SiO_2 \cdot H_2O$

Refractive indices: 1.54 - 1.6

Specific Gravity: 2.6 - 2.8

Hardness (Mohs scale): 1

Color: White or Gray to Apple Green

Morphological varieties: Laminated and Fibrous

Some Minerals Found in Industrial Talc

Chlorite	$(MgFe)_5\ Al(AlSi_3)\ O_{10}(OH)_8$
Magnesite	$MgCO_3$
Dolomite	$Ca\ Mg(CO_3)_2$
Calcite	$CaCO_3$
Serpentine	$Mg_6(Si_4O_{10})(OH)_8$
Quartz	SiO_2
Tremolite	$Ca_2\ Mg_5\ Si_8O_{22}(OH)_2$

TABLE 1

QUALITATIVE ANALYSIS OF BULK SAMPLES
BY X-RAY DIFFRACTION

SOURCE	MAJOR (20-100%)	MINOR (5-20%)	TRACE (<5%)
MINE (37)	TALC MAGNESITE	CHLORITE (DOLOMITE)	DOLOMITE CALCITE QUARTZ BIOTITE ANKERITE CHROMITE PHLOGOPITE OLIGOCLASE
MILL (20)	TALC MAGNESITE	CHLORITE (DOLOMITE)	CALCITE QUARTZ PHLOGOPITE BIOTITE DOLOMITE