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Montello Exhibits
020000-020552

Asbestos Information Association/America

22 East 40th Street
New York, N. Y. 10016
(212) 661-8206

020410

June 15, 1972

The Editor
THE WALL STREET JOURNAL
22 Cortlandt Street
New York, New York 10007

Dear Sir:

It is incumbent upon any newspaper in this country, especially when reporting on an issue relating to occupational or environmental health, to present evidence that is factual, well-researched, and free from distortion, error and any possible taint of sensationalism. This is especially true when the newspaper in question enjoys the high reputation for fairness and accuracy of THE WALL STREET JOURNAL. Unfortunately, these basic precepts of sound journalism were not followed in a recent story in the JOURNAL.

By this we specifically refer to the article on asbestos by Barry Newman that appeared in your June 7 issue, beginning on the front page. The article contains many major errors of fact and interpretation, such that it presents a completely distorted and alarmist picture of the asbestos-health problem in the United States.

The simplest way to demonstrate the truth of this statement is to examine some of the major errors contained in the Newman article.

Mr. Newman began the article with a description of the supposed hazards faced by mechanics who blow asbestos-containing brake lining dust out of brake assemblies with an air hose before replacing the worn linings. Had your reporter investigated this matter with any degree of thoroughness, he would have discovered a number of well established facts, namely that (1) the U.S. Public Health Service conducted a study which showed that less than 1 per cent of the approximately 50 per cent of asbestos in brake linings remains as free fiber in the dust after wear, the rest being converted by the high heat of friction

to a non-fibrous non-toxic material called fosterite, and (2) a study by Hickish and Knight, published in the British "Annals of Occupational Hygiene" in January, 1970, established that men engaged in the blow-out procedure described by your reporter had a Time Weighted Average exposure of .68 asbestos fibers per cubic centimeter of air, a level far lower than either the current United States standard of five fibers per cc or the two fiber standard scheduled to go into effect in 1976.

While these studies in combination demonstrate quite conclusively the lack of a hazard for men employed in brake lining maintenance and replacement, of perhaps even more importance in evaluating your reporter's alarmist approach to the subject is the fact that to the best of my knowledge, there have been no published or unpublished studies indicating the existence or even the suspicion of a hazard for these men. The conclusion is inescapable that your reporter selected this example to lead off his story because of its colorful and alarmist nature rather than because of any factual evidence that an actual hazard existed.

In the fourth paragraph of the story, Dr. Irving Selikoff of Mount Sinai Hospital is quoted as predicting 95,000 deaths from asbestos related cancer among the approximately 250,000 men currently employed in the asbestos industry in this country. While Dr. Selikoff is obviously entitled to make whatever predictions he chooses, it is only reasonable to expect that a reporter seeking to write a balanced story would submit such a terrifying prediction to other experts in the field for their comment. Had he done so, your reporter would unquestionably have been told that Dr. Selikoff's prediction is quite exaggerated and without solid foundation. The reason why this is so is quite simple. The two studies upon which Dr. Selikoff's prediction is based were of men employed in the industry for a minimum of 20 years and at a time (the 1930s and 40s) when dust levels were many times higher than they are today. Thus to apply the death rates resulting from long term exposure to dust levels existing 25 and 30 years ago to today's working population is plainly illogical. Had your reporter sought additional comment on Dr. Selikoff's prediction, he would have discovered this fact.

-More-

In the next paragraph, it states that "ordinary people who have come into contact with asbestos in the atmosphere" could be subject to asbestos-related disease. This same idea of a general public hazard is contained in the headline of the story: "Tiny Asbestos Fibers Pose a Health Threat To Workers and Public." While there is some evidence that in years past there may have been some potential hazard to people living in close proximity to uncontrolled asbestos mines and mills, as technology was developed for the control of asbestos dusts in industry from escaping into the community air, these potential hazards have been eliminated. As far as the general public is concerned, there never has been nor is there today a public health hazard as a result of exposure to the very minute amounts of asbestos that have been shown to exist in the ambient air.

This was the basic conclusion reached by a panel of asbestos-health experts convened by the National Academy of Sciences to draft a report to serve as the medical basis for the Federal Environmental Protection Agency national emission standards on asbestos. The report, entitled "Asbestos: The Need for and Feasibility of Air Pollution Controls," states on page 19 that "there are levels of asbestos exposure that will not be associated with any detectable risk. What those levels are is not known, but there is no evidence that persons in the general population -- without occupational, household, or neighborhood exposures -- have any increased risk of neoplasm, even though there may be ferruginous bodies or fibers in their lungs," and in the Conclusion section on page 31 it states: "There is no evidence that the small numbers of fibers found in most members of the general population affect health or longevity."

This booklet has received wide distribution. Had your reporter researched his subject with any degree of thoroughness, he would certainly have been given copies of the report. If he was given a copy, he obviously completely disregarded it.

A little later on in the article your reporter states that "bits of asbestos used in filters for beverage making have been found in wine and beer, for instance, and could be dangerous if swallowed." This same question was raised in Great Britain a few years ago by writers also seeking the sensational rather than the scientific. The furor died

-More-

when it was shown that the total amount of asbestos fiber found in British beer added up to only two-one-thousandths of an ounce in the total United Kingdom beer production of over a thousand million gallons a year. This translates into about five parts per million-million by weight. The additional fact that there is not one shred of evidence that ingesting such infinitesimal amounts of asbestos is in any way hazardous helped allay the fears of the British beer drinking public.

The comment attributed to William Nicholson of Mount Sinai that shaking an asbestos-containing coat could result in "dust levels as high as in an asbestos factory" once again demonstrates your reporter's search for the sensational rather than the factual. Had he chosen to look into the matter of the 200,000 asbestos-containing coats more thoroughly, he would have discovered that the committee appointed by the Food and Drug Administration to investigate the problem concluded in its report that "this single episode of manufacture and sale of asbestos-containing garments did not constitute an 'imminent hazard' as defined by the Food and Drug Administration, and that a recommendation to recover all the garments from the individual purchasers was not warranted." Tests run on the coats by the National Institute of Occupational Safety and Health for the FDA were "deliberately designed to be many orders of magnitude more severe in terms of applying energy to the garments than would be expected in ordinary use by the public." In addition, "a build up of air-borne fibers was encouraged." Despite these severe wear and brushing tests, the amount of free fiber that became air borne was considered by the committee to provide "a wide margin of safety" for the wearer. Thus, while Mr. Nicholson's colorful quote makes attractive copy, it is not supported by sober, scientific fact.

One of the most serious breaches of journalistic ethics is to deliberately quote an individual out of context. This was done in the case of Mr. J. B. Jobe of Johns-Manville, who was quoted as stating at Occupational Safety and Health Administration hearings in Washington in March that it would be "socially irresponsible" to adopt a two fiber occupational standard in the asbestos industry. Mr. Jobe's full statement, which can be found in the official record of the hearing, was as follows: "Where there is no scientifically credible evidence

-More-

demonstrating the necessity of such low standards, it would be socially irresponsible to adopt them." By omitting the first part of Mr. Jobe's comment, the impression is given in the article that Mr. Jobe would be opposed to the two fiber standard on economic grounds, even if it were necessary to adopt such a standard in order to protect the lives of industry workmen. I need not point out the serious harm that could be done to Mr. Jobe's reputation by this out-of-context quote.

Your reporter's next major error is a relatively simple one of misunderstanding, yet had he made any efforts to discuss the situation with industry officials or to visit a manufacturing facility (both of which were offered to your reporter by Johns-Manville), the mistake would not have been made. By this, I refer to those paragraphs in the article in which your reporter states that "the curbing of asbestos contamination is more an exercise in good house-keeping than capital expenditure," and he then goes on to list a half-dozen "staples of such an operation, already in use in many plants." The mistake made by your reporter is that the "staples" he refers to, such as closed plastic bags for mixing cement, vacuum attachments on power saws, etc., are not used in plants where asbestos-containing products are manufactured, but in the construction industry, especially in the application of asbestos-containing insulations in buildings, power plants, etc. Asbestos dusts in manufacturing are controlled not by such devices but by highly sophisticated and expensive bag-house type dust collectors and other similarly costly equipment. One visit to an asbestos manufacturing plant would have clarified this point for Mr. Newman.

A similar error is made by your reporter when he reports that a Mount Sinai survey of 9,400 asbestos workers showed that there was only one dust count taken "in asbestos plants for every 20,000 man-days worked." Dr. Selikoff has reported on similar dust count frequencies for years, but always in reference to the construction industry, never to manufacturing plants, where dust counts are taken on a regular basis in most operations. Perhaps Mr. Newman's confusion arose out of the fact that the term "asbestos workers" when used by Dr. Selikoff refers not to men engaged in the asbestos manufacturing industry, but to those in the insulation application trades, who belong to a union called

the Heat, Frost, Insulation and Asbestos Workers (my underlining), which is commonly referred to as the Asbestos Workers Union. Once again, a more thorough research effort on your reporter's part would have provided him with this information.

Finally, I would like to register a very serious objection to a major error of omission in Mr. Newman's article, as contrasted to those of commission referred to thus far. In the entire article, your reporter makes only one or two passing references to industry efforts to solve its problems in this area, and leaves the distinct but erroneous impression that the industry is trying to get away with doing as little as possible and that it started its control efforts only very recently. Nowhere in the article can be found mention of the vast amount of medical research sponsored, co-sponsored or cooperated in by the industry over the past three or four decades, nor of the vast improvements in dust conditions achieved in manufacturing operations from coast to coast over the years. While information of this nature does not make for alarming headlines, it is as important a part of the overall asbestos-health story as case histories of disease and dire predictions of occupational deaths in the thousands.

In conclusion, I hope that this rather lengthy letter has demonstrated quite clearly to you the incomplete, erroneous, sensationalized and distorted manner in which your reporter presented the asbestos-health situation in his article. On behalf of the member companies of the Asbestos Information Association/North America, we request in the interests of fair and balanced journalism, that this letter be printed in its entirety in THE WALL STREET JOURNAL; that the WALL STREET JOURNAL print in its pages an apology for the incomplete and distorted nature of the article; and that you assign a competent writer untainted by the desire for sensationalism to write a balanced article on industry efforts and accomplishments in reducing asbestos-health hazards for workmen throughout the nation.

Very truly yours,

Matthew M. Swetonic

Matthew M. Swetonic
Executive Secretary



presents . . .

Super Visbestos

THE MOST VERSATILE DRILLING FLUID ADDITIVE

SUPER VISBESTOS

Economically Effective

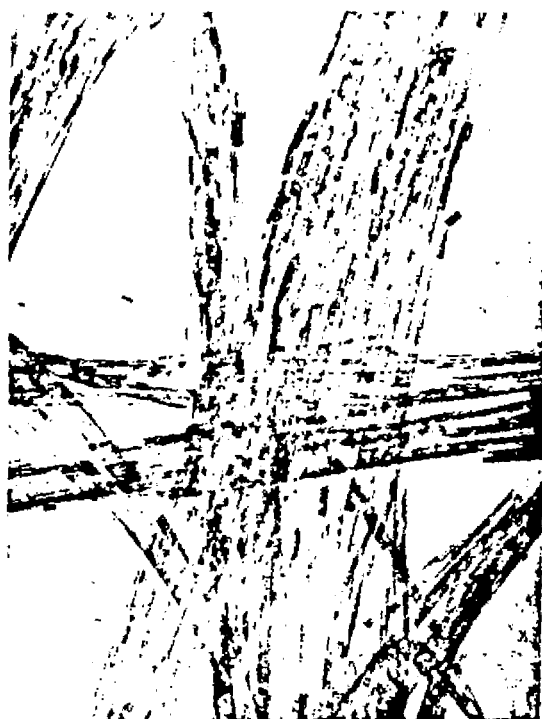
From . . .

Surface To Total Depth

In . . .

Fresh Water To Super Saturated

Nondispersed To Highly Dispersed



REGULAR ASBESTOS
(Dry Processed)



SUPER VISBESTOS
(Wet Processed -
Presheared Asbestos)

Super Visbestos is produced, exclusively for Montello, Inc., by chemically and hydraulically shearing a top-grade chrysotile asbestos, through a unique, proprietary, wet-process. This process produces a high degree of asbestos fiber separation.

A study of the micrographs above reveal that over 98% fiber separation has been achieved when processing Super Visbestos compared to less than 50% fiber separation with regular dry processed asbestos additives.

The high degree of fiber separation (i.e. yield) provided almost instantly with Super Visbestos is impossible to achieve using regular dry processed asbestos in the field even after days of circulation and mixing.

Plus high, & clean very good

A study of data below reveals the advantages of Super Visbestos.

1600 ct. Super SUPER VISBESTOS VS. REGULAR ASBESTOS
Test by Montello

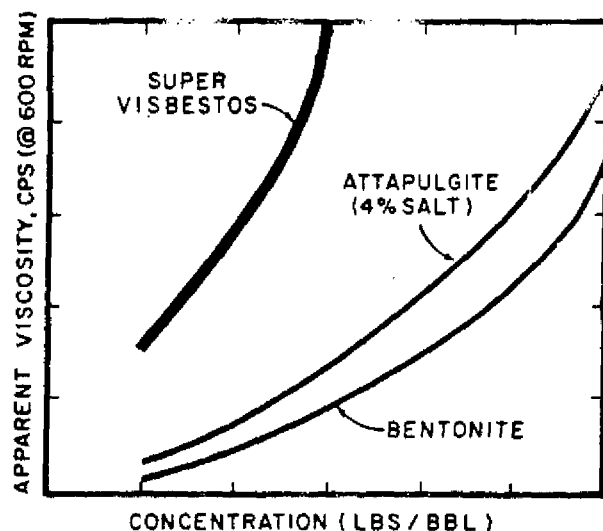
Fann VG Meter	Super Visbestos 5 LBS/BBL	Regular Asbestos 5 LBS/BBL
Apparent Viscosity	14.5	7
Plastic Viscosity	11	6
Yield Point	7	2
Initial Gel	5	3

(Tests Run By Major University)

1000 - 1/2" ROLLING - 1000

APPARENT VISCOSITY COMPARISON OF
 SUPER VISBESTOS, BENTONITE AND ATTAPULGITE IN WATER
 (TESTS RUN BY INDEPENDENT TEST LABORATORY, BUFFALO, NEW YORK)

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It takes considerable less SUPER VISBESTOS to build an adequate drilling fluid.

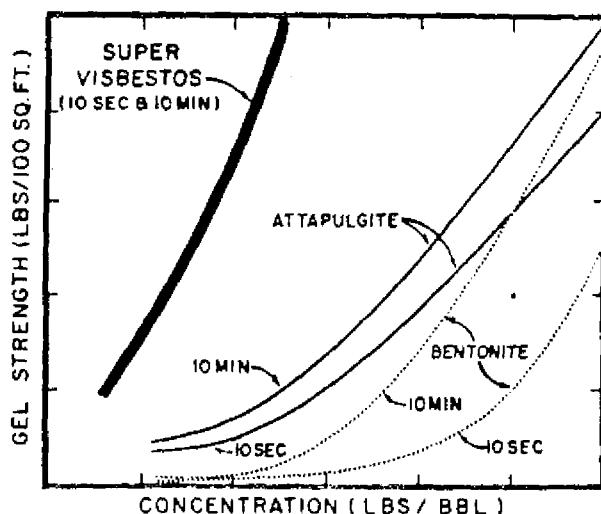
The curve compares the apparent viscosity obtained with different concentrations of SUPER VISBESTOS, bentonite and attapulgite.

Over 150 field wells have proved that SUPER VISBESTOS based drilling fluids produced better penetration rates than

bentonite or attapulgite based drilling fluids.

SUPER VISBESTOS drilling fluids drill faster.

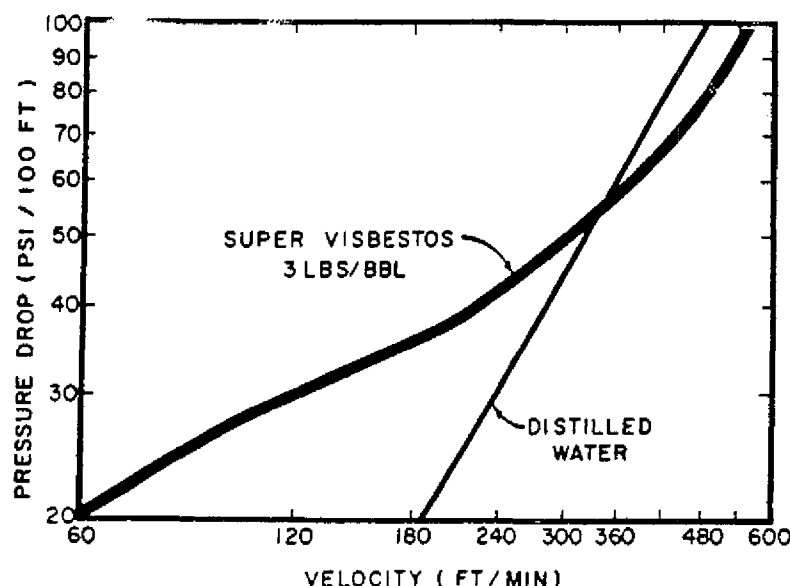
COMPARATIVE GEL STRENGTHS OF
 SUPER VISBESTOS, BENTONITE AND ATTAPULGITE IN WATER
 (TESTS RUN BY INDEPENDENT TEST LABORATORY, BUFFALO, NEW YORK)



The gel strength of a SUPER VISBESTOS Slurry is not progressive. (See graph -- 10 sec. and 10 min. gels of Super Visbestos slurry are equal).

Compare that with the progressive gel nature of attapulgite and bentonite.

This progressive nature of bentonite gel strength can be practically eliminated by using SUPER VISBESTOS in combination with bentonite.



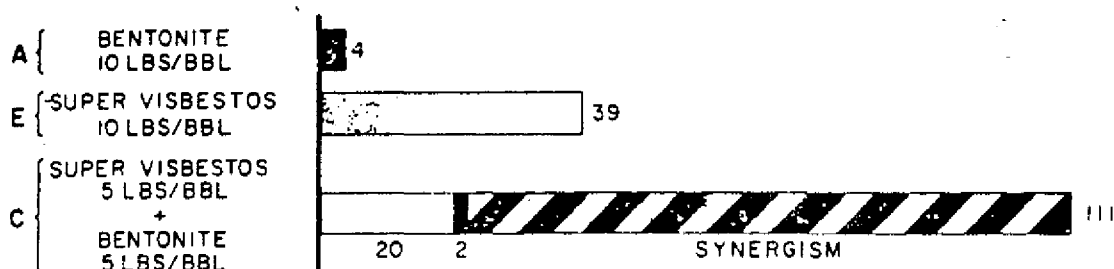
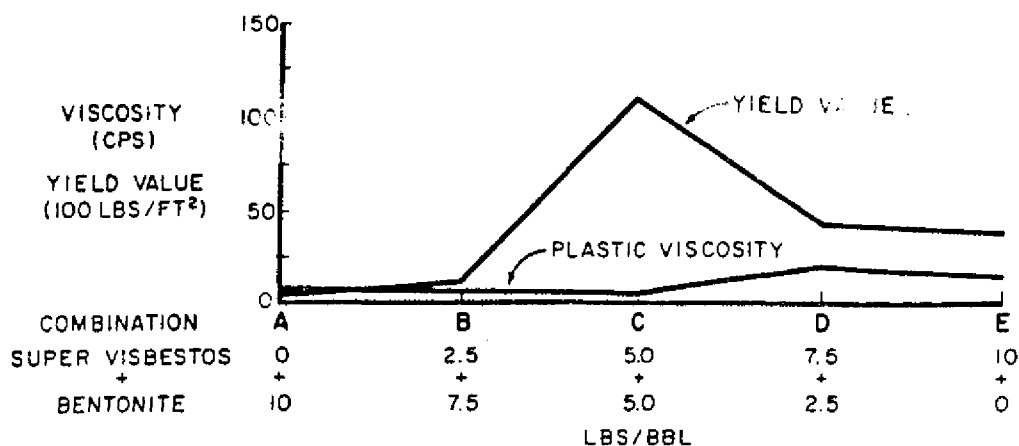
One of the most important characteristics of a drilling fluid is it's ability to shear thin. Shear thinning permits low viscosities at the bit and high viscosities in the annulus. This type of fluid combines high penetration rates with adequate lifting capacity in the annulus.

A study of the graph above reveals the following:

- Shear thinning capability of SUPER VISBESTOS based drilling fluids.
- That the viscosity of the SUPER VISBESTOS slurry is approximately equal to the viscosity of water at drill pipe velocity.
- That the viscosity of the SUPER VISBESTOS slurry is less than the viscosity of water at jet velocities.
- That the viscosity of the SUPER VISBESTOS slurry is considerably greater than the viscosity of water at annular velocities.

This is exactly what we want -- and when you get it with SUPER VISBESTOS you don't have to worry about bugs eating it -- temperature affecting it--progressive gels or excessive chemical treatments -- and in addition it is more economical to build and maintain with SUPER VISBESTOS than with polymers.

020-420



SUPER VISBESTOS is used primarily for hole cleaning in any drilling fluid. If adequate hole cleaning plus some fluid loss control is desired it can be obtained faster and cheaper with a combination of SUPER VISBESTOS and bentonite.

These graphs demonstrate the synergistic effect of SUPER VISBESTOS on bentonite. Webster defines synergism as the cooperative action of different products such that the total effect of the two used in combination is greater than the sum of the two effects taken independently.

Five different combinations of SUPER VISBESTOS plus bentonite were tested. The SUPER VISBESTOS concentrations were varied from 0 to 10 pounds per barrel, while and at the same time the bentonite concentrations were varied from 10 to 0 pounds per barrel. The total concentrations of SUPER VESBESTOS plus bentonite at any point was always equal to 10 pounds per barrel.

Maximum yield value occurred at combination C (5 LBS/BBL or SUPER VISBESTOS plus 5 LBS/BBL of bentonite). In actual field use combination C may not produce optimum yield value due to the hydrating character of the different drilled solids.

A comparison of the yield values of combinations A, E, and C can be more easily made by studying the bar graph above.

VARIES 300-500 Percent-

COMBINATION	YIELD VALUE
A { 10 LBS/BBL bentonite)	4
E { 10 LBS/BBL SUPER VISBESTOS)	39
C { 5 LBS/BBL SUPER VISBESTOS plus 5 LBS/BBL bentonite)	111

A closer look at combination C (bar graph) reveals that the synergistic action of SUPER VISBESTOS on bentonite for this concentration is 89. (That is 111-(20 plus 2)).

That's synergism---the cooperative action of the combination is much much greater than the sum of the separate individual actions.

Not to be overlooked is the low value of plastic viscosity at combination C. This is a plus and just what we wanted because plastic viscosity being a function of type and amount of solids in a system will naturally increase when the system is loaded with cuttings.

So what does synergism mean. To you, the user, it simply means getting more than you planned for or paid for or getting all you needed with a lot less material.

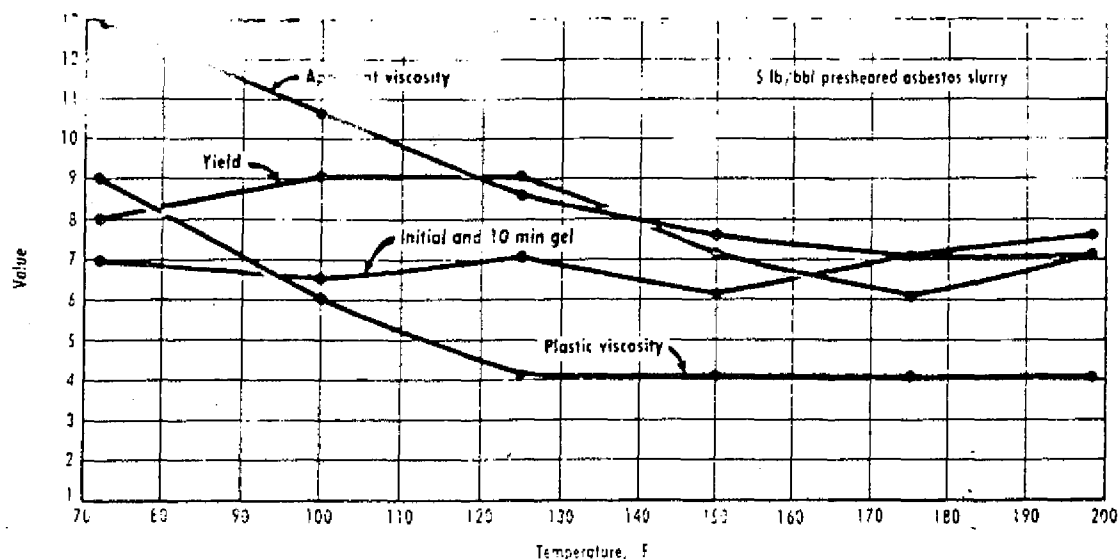
That's saving money either way--and only SUPER VISBESTOS can offer so much for so little amount of money.

SUPER VISBESTOS REDUCES SLIP VELOCITY 50 %

Dynamic tests were run to determine the actual slip velocity of a $\frac{1}{2}$ inch gravel sample from the North slope.

Slip velocity in plain water of $\frac{1}{2}$ inch gravel sample was 126.7 feet per minute.

Slip Velocity in plain water plus $2\frac{1}{2}$ LBS/BBL of SUPER VISBESTOS of same $\frac{1}{2}$ inch gravel sample was 62.5 feet per minute. Therefore $2\frac{1}{2}$ LBS/BBL of SUPER VISBESTOS reduced the slip velocity of cuttings by more than 50 percent.



Elevated temperatures in drilling fluids normally cause product deterioration -- increased viscosities -- higher gels -- all of which reduce penetration rates.

SUPER VISBESTOS is not adversely affected by elevated temperatures. The shape of this curve is similar to that of plain water and actually reflects a decrease in viscosity as temperature increases.

Therefore SUPER VISBESTOS when used with other drilling fluid additives tends to stabilize the temperature effect. The higher the percentage of SUPER VISBESTOS -- the more temperature stable the drilling fluid.

SUPER VISBESTOS (Pound Per Pound) costs no more than regular asbestos !!

ASBESTOS WET SCREEN TESTS

Concentration: 5 LBS/EBL Mixing: 15 Min. on Hamilton Beach
Test: All Materials Wet Screen Through 80 Mesh Screen

PRODUCT	PERCENT LOSS OVER 80 MESH SCREEN
Brand B	20.3 %
Brand F	25.0 %
Brand VQ	25.7 %

IF -- SUPER VISBESTOS LESS THAN 1 %

You are using a shale shaker -- and regular asbestos -- your cost per pound of regular asbestos left in system after one circulation is the same as the cost per pound of SUPER VISBESTOS.

It is not necessary to bypass desanders -- desilters -- or shale shakers when using SUPER VISBESTOS.

A SUPER VISBESTOS BASED SYSTEM

IS cheaper to build

IS cheaper to maintain

IS cheaper to drill with because

Less Material Costs

Less Mixing Costs

Less Hauling Costs

Less Water Requirements

Higher Penetration Rate

More Efficient Solids Removal

Reduced Chemical Treatment Cost

More Rapid Settling of Drilled Solids

SUPER VISBESTOS . . . THE WET PROCESS PRESHEARED ASBESTOS

Shear Thins

Chemically Stable

Doesn't Screen Out

Temperature Stable

Nonprogressive Gels

Reduces Slip Velocity

Best For Hole Cleaning

Synergistic Effect On Bentonite

Over Twice As Effective As Dry Processed Asbestos

Goes Into System Almost Immediately - One Circulation

SUPER VISBESTOS SYNERGISM ON BENTONITE

Major Operator in Libya.
Major U.S. Mud Service Company

Total Depth - 10,068 Feet
Hole - 18 5/8 inches to 156 Feet
13 3/8 inches to 3,272 Feet
12 1/4 inches to T.D.

Super Visbestos - Bentonite Low Solids Mud

Material Ratio:

Super Visbestos/bentonite Ratio used 1 / 2
(1 lb. Super Visbestos to 2 lbs. bentonite)
should be closer to a 1 / 1 ratio. Next Well
planned to a 1 / 1 ratio.

CMC Used For Fluid Loss Control

Mud Weight: 8.7 lbs/gal to 8.9 lbs/gal
Oil Content: 3 to 4 per cent
Funnell Viscosity: 40 Second
Solids: 4 to 7 per cent
Chemicals: Very Little (Caustic Soda Only)

Properties (Fann VG) Plastic Viscosity - 8
Yield Value - 4

Report - - Quote "Very Competitive System"

Advantages:

Fluid Properties - Easy to Maintain
Electric Logs Showed Excellent Gauge
No Problems - Hole Cleaning
Low Chemical Cost
Excellent Solids Removal (Desilter Efficiency
Very Good)
No Lost Circulation - (First in this Area Drilled
Without Losing Circulation)
Lower Water Requirements



020426

SUPER VISBESTOS
Pre-sheared, wet-processed asbestos

How Packaged:

Multi-wall paper sacks 50 pounds per sack.

Function:

To improve hole cleaning characteristics of all drilling fluids.

Effect on drilling fluid properties:

Increases yield quickly (one circulation).
Provides shear thinning
Increases viscosity

Where Used:

Drilling fluid: All types
Hole interval: From top to total depth

How to use:

Add one to three pounds per barrel through mud hopper as needed for desired hole cleaning. "Sweep the hole clean" by slugging approximately 30 barrels of slurry containing 3 pounds per barrel of Super Visbestos or flush 2 to 4 sacks of Super Visbestos through mud hopper.

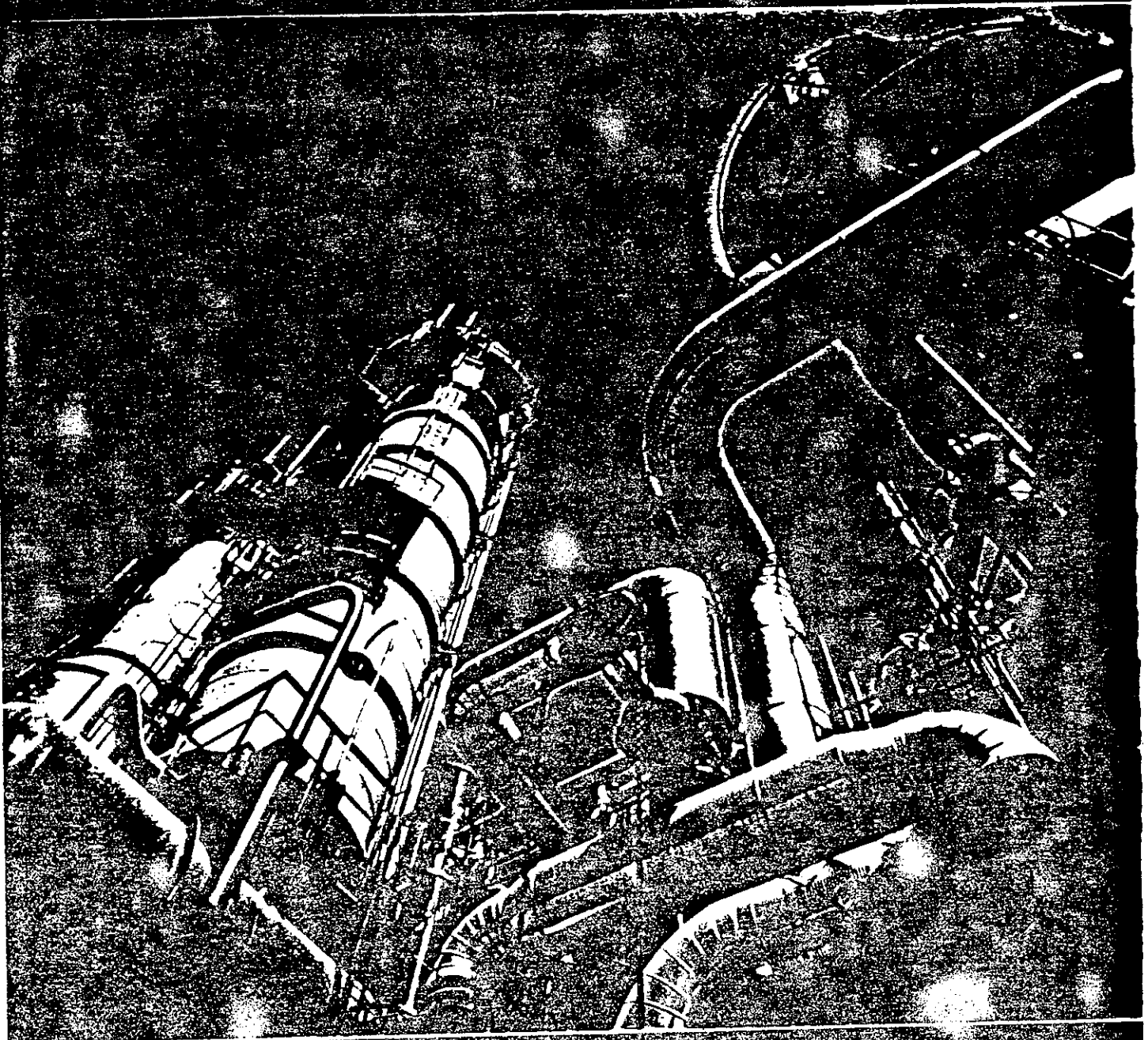
Advantages:

- Insensitive to contamination, temperature, bacteria, pressure -- you name it.
- Faster penetration - longer bit life (less re-drilling of cuttings).
- Not removed by shaker screens, de-sanders or de-silters.
- Highest and fastest yielding asbestos (one circulation).
- Desired hole cleaning with lower annular velocities.
- Lowest cost asbestos (per ton of cuttings removed).
- May be used in flocculated systems.
- Less washout.

MONTELLO, INC. - P.O. DRAWER 130, SAND SPRINGS, OKLAHOMA 74063
TELEPHONES: DAYS 918-245-6641, NIGHTS 918-743-3105

OIL & GAS JOURNAL

PUBLISHED WEEKLY



Presheared asbestos muds cut time, expenses

page 93

Reprinted from the June 8, 1970 edition

020427

Presheared asbestos muds help cut costs, rotating time

JOHN L. KENNEDY
Drilling Editor

RESULTS of drilling in widely separated areas indicate that the use of presheared asbestos in drilling fluids can help reduce mud costs and rotating time. These drilling fluids are designed as low-solids muds and appear to be finding increased application.

In one of these instances, presheared asbestos was used with bentonite and results were compared to drilling results using a straight bentonite system on an adjacent well. In this Okfuskee County, Okla., comparison, mud costs

for the presheared asbestos-bentonite system were 47.3¢/ft while the straight bentonite system cost 58.2¢/ft.

These two wells, located 660 ft apart, were drilled by the same operator using the same contractor and the same rig, the same mud company and the same mud engineer. Total depth of the two wells was slightly over 4,000 ft and mud-up depth was around 2,700 ft. Casing string in both wells was 8½-in.

A significant savings in drilling time resulted from using the presheared asbestos-bentonite mud over the straight bentonite system. The well using the combination fluid was drilled in 99 rig hr, compared to 140 hr to drill the well on which the straight bentonite system was used.

The bentonite-drilled well required six bits compared to five for the well drilled with the presheared asbestos-bentonite mud.

In Libya, a similar system proved to be competitive with straight bentonite fluids that had been used previously. And this particular well was drilled without any lost-circulation problems, something that had given operators considerable trouble in the past in this area.

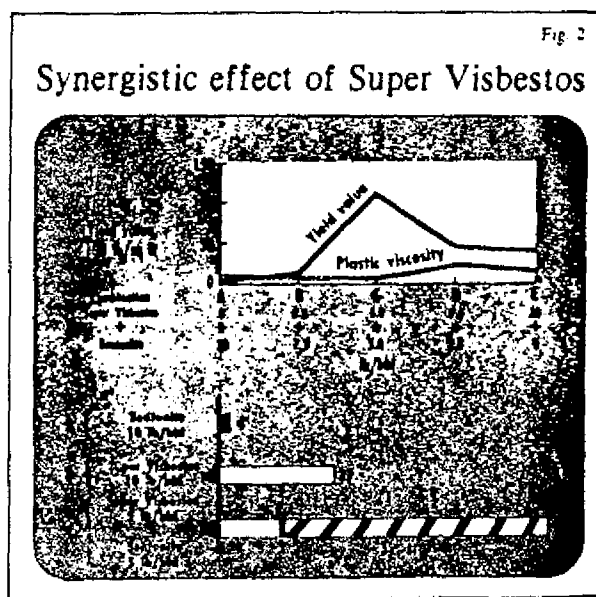
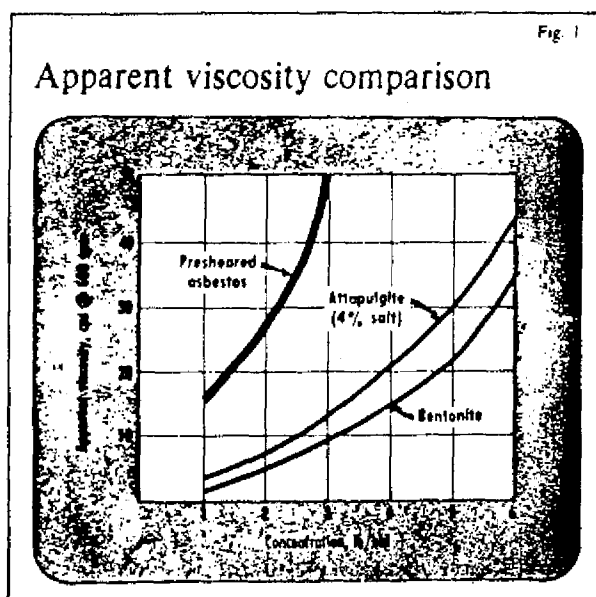
The Libya well was drilled to a total depth of 10,068 ft with mud weights varying from 8.7 to 8.9 lb/gal. After an 18½-in. surface string was set, 13½-in. was run to 3,272 ft and a 12¼-in. production string set at TD.

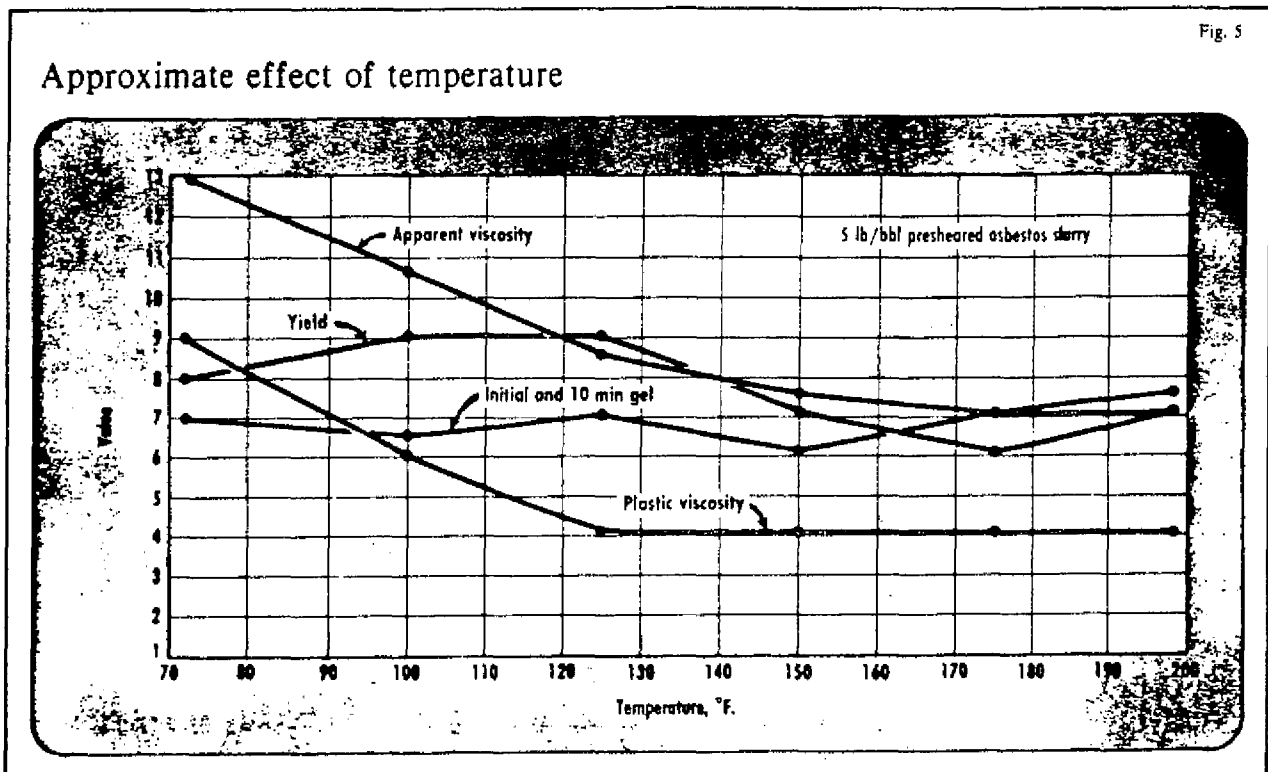
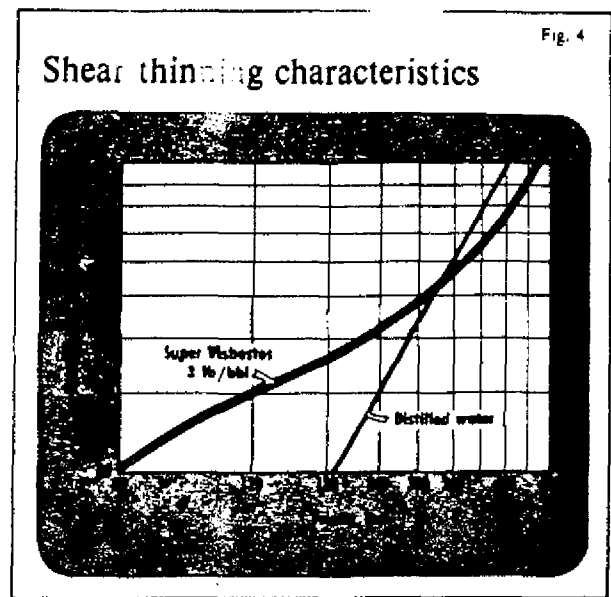
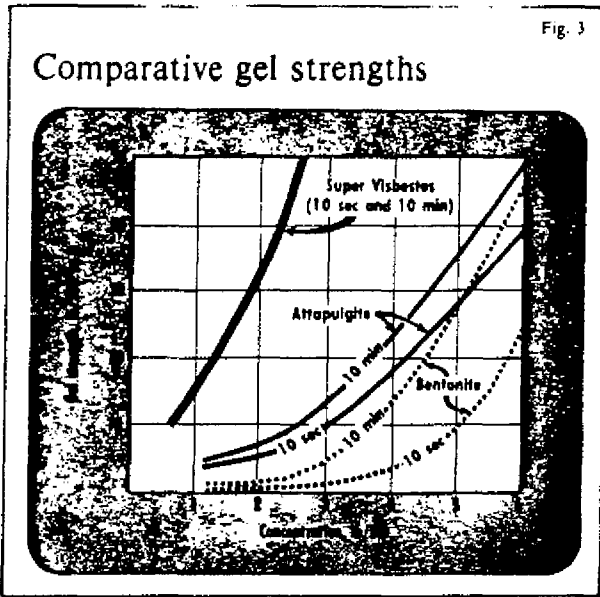
The presheared asbestos-bentonite low-solids mud system was built in a ratio of 1 lb of presheared asbestos to 2 lb of bentonite. But plans for the

next well included using a drilling fluid built in a ratio of these materials. In this instance, a fluid-loss control agent was used and the properties of the mud system included a plastic viscosity of 8; yield value of 4; funnel viscosity of 40 sec; and 4-7% solids.

For North Slope drilling, a presheared asbestos-bentonite extended system has been recommended from surface to total depth. In this case, this procedure applies:

1. Initial surface volume is prepared using freshwater treated with presheared asbestos and bentonite in a 50-50 ratio.
2. Surface volume is then treated with salt to lower the freezing point to the necessary level.
3. The system is then used to drill through the permafrost to the surface casing point. During this interval, presheared asbestos can be added directly to the system for viscosity and hole cleaning when needed. Bentonite can be prehydrated and added to the system when required, and filtration control can be obtained with salt-water fluid-loss agents.
4. Do not discard this fluid after drilling permafrost and setting surface casing—simply discontinue the addition of salt to the mud system and use freshwater for makeup.
5. This same system is used out from under surface to approximately 3,000 ft where casing is again set. Since no salt was added during this second interval and freshwater makeup was used, the system will be fresh enough to allow mixing of bentonite directly. For maximum yield, 50-50





concentrations of presheared asbestos and bentonite are used.

6. From second casing point to TD, the drilling fluid system is essentially a freshwater, low-solids, presheared asbestos-bentonite type. Filtration is controlled with a freshwater fluid-loss additive, and shale can be controlled using this same system but with the addition of powdered asphalt materials.

A typical system. A mud system like the one used in Libya is usually built around 2-3 lb/bbl of presheared asbestos and 3-5 lb/bbl of bentonite.

A 50-50 mix usually gives the best hole-cleaning results, but a higher proportion of bentonite is usually recommended when hole stability is a problem.

Using Super Visbestos, a presheared asbestos distributed by Montello, Inc., Sand Springs, Okla., a cost comparison indicates that such a fluid would run in the neighborhood of 52.5¢/bbl compared to a straight bentonite system at about 62.5¢/bbl.

These costs were based on the use of 2½ lb/bbl of presheared asbestos with 2½ lb/bbl of bentonite for the

combination system, and 25 lb/bbl of bentonite for the other fluid.

In addition to a lower initial cost, manufacturers of the presheared asbestos additives cite other possible savings including lower mixing costs; lower hauling costs; less water requirements; reduced chemical treatment cost; and higher penetration rates.

Presheared asbestos-bentonite systems will usually give some hole stabilization and a small amount of fluid-loss control. Then if necessary, a fluid-loss control agent can be used

to lower loss to required levels. Such a system is applicable in any area.

To get proper cleaning, a drilling fluid's yield point and plastic viscosity are important properties. Table 1 indicates the effect of these variables on the settling time of solids in a flocculated solids settling test. Another important consideration in cuttings transport is annulus flow profile. If this profile is turbulent, cuttings slippage is increased and cuttings can fall faster than the average annular rate causing a hole-cleaning problem.

If hole cleaning is critical and an adjustment of annulus flow does not help, yield value can be raised with asbestos. Montello recommends, however, when using their product that before raising the yield value too high the hole should be flushed clean with

a 25-bbl. slurry containing 1 lb/bbl of presheared asbestos. Or it can be done by adding 75-100 lb of the material directly into the mud system through the mud hopper. This flushing

operation can be repeated as needed with frequency ranging from once a day to twice a tour. And it should be done just before making a trip, according to Montello.

Of course, good solids removal techniques are essential to the performance of low-solids systems. Both chemical and mechanical means can be used to accomplish this.

Some properties. Presheared asbestos has grown in use recently, its advantages stemming from the fact that the carefully controlled shearing process at the point of manufacture provides a high degree of fiber separation quickly at the well (OGJ, Oct. 28, 1968). Properties of presheared asbestos compared with those of other mud-system additives are shown in Fig. 1-5.

END

Table 1

Settling tests					
Weight	Density of flocc lb/gal	Pv	Yp	Settling time for 50% solids settling (min/ft)	
8.3	10.4	1.0	0	1/2	
8.3	10.4	2.0	0.5	1	
8.3	10.4	2.0	1.0	2	
8.3	10.4	2.0	2.0	8	
8.3	10.4	4.0	4.0	27	
8.3	10.4	8.0	8.0	88	
9.0	11.0	4.0	4.0	30	
9.0	11.0	8.0	8.0	97	
10.0	11.8	4.0	4.0	34	
10.0	11.8	8.0	8.0	112	

SUPER VISBESTOS PROVIDES HIGH YIELDS ALMOST INSTANTLY

A message of special interest to drilling superintendents and those responsible for writing drilling mud programs, distributed courtesy of Montello, Inc. For more information and extra copies of the reprint, write Montello at P.O. Drawer 130, Sand Springs, Okla. 74063.



REGULAR ASBESTOS
(Dry Processed)
Only 50% Separation



SUPER VISBESTOS
(Wet Processed-Presheared Asbestos)
Over 98% Separation

Super Visbestos is produced, exclusively for Montello, Inc., by chemically and hydraulically shearing a top-grade chrysotile asbestos, through a unique, proprietary, wet-process. This process produces a high degree of asbestos fiber separation.

The high degree of fiber separation (i.e. yield) provided almost instantly with Super Visbestos is impossible to achieve using regular dry processed asbestos in the field even after days of circulation and mixing.

A study of data below reveals the advantages of Super Visbestos.

(Tests Were Run By A Major University)

SUPER VISBESTOS VS. REGULAR ASBESTOS

Fann VG Meter	Super Visbestos 5 LBS./BBL	Regular Asbestos 5 LBS./BBL
Apparent Viscosity	14.5	7
Plastic Viscosity	11	6
Yield Point	7	2
Initial Gel	5	3



P. O. DRAWER 130
SAND SPRINGS, OKLAHOMA 74063
Days: 918 245-6661 Nights: 918 743-3105



SUPER VISBESTOS EXTENDED
BENTONITE DRILLING FLUID SYSTEM

P. O. BOX 130

SAND SPRINGS, OKLAHOMA

Days: 918 245-6641

Nights: 918 743-3105

The Super Visbestos - bentonite drilling fluid system is the most versatile and economical low solids drilling fluid system available today.

This system is based upon the fact that Super Visbestos, when used in conjunction with bentonite, produces a synergistic effect: that is, Super Visbestos actually extends the bentonite. Pound for pound Super Visbestos and bentonite used together produce five hundred percent or five times as much drilling fluid as asbestos and bentonite used independently (see attached curves).

The presheared asbestos (Super Visbestos) - bentonite extended system has been field proven on the North Slope, in Libya, Indonesia, Offshore Gulf Coast and in the U. S. Midcontinent area.

For North Slope applications, this system is applicable from surface to total depth. The following procedure is followed:

1. Initial surface volume is prepared using fresh water treated with Super Visbestos and bentonite (50/50 for maximum synergism).
2. Surface volume is then treated with salt to lower the freezing point of the drilling fluid to the desired level.
3. The above system is then used to drill surface -- through the permafrost -- to the surface casing point. During this interval, Super Visbestos can be added directly to the system for viscosity and hole cleaning when required. Bentonite can be prehydrated and added to the system if needed. Filtration control, if required can be obtained with salt water fluid loss agents.
4. Do not throw away this system after drilling permafrost and setting surface casing - simply discontinue the addition of salt to the drilling fluid system -- use fresh water for makeup.
5. This same system was used out from under surface to approximately 3,000 feet where casing was again run. Since no salt was added during this second interval and since fresh water "makeup" was used, the system was fresh enough to allow mixing of bentonite directly to the system. To obtain maximum yield, Super Visbestos and bentonite at 50/50 concentrations are used.
6. From second casing point to total depth, the drilling fluid system was essentially of a fresh water, low solids, Super Visbestos - bentonite type. Filtration was controlled with a fresh water fluid loss additive. Shale was encountered and controlled using this same system but with the addition of powdered asphalt materials.

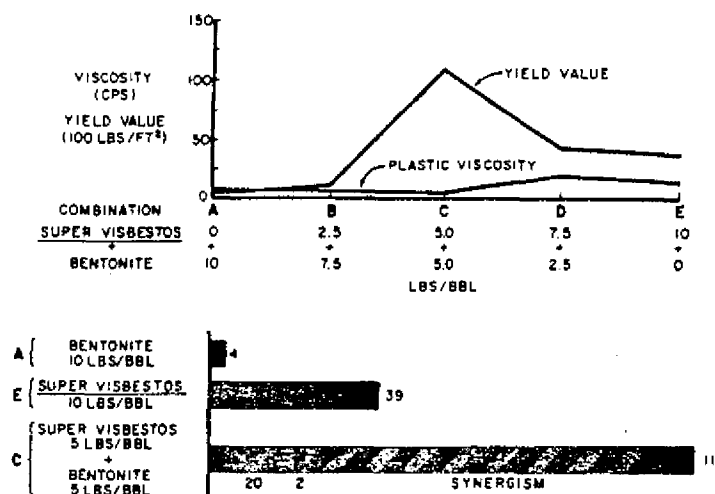
The efficiency of surface solids removing equipment is excellent when using the Super Visbestos - bentonite system. Super Visbestos will not screen out over shale shaker nor is Super Visbestos removed by desilters or desanders. Selective flocculants have also been used very successfully to assist in solids removal when required.

This system is very versatile because it can be used from surface to total depth regardless of salt contamination. Super Visbestos can be added directly to the system at any time regardless of salt content. The salt content of the drilling fluid will dictate whether the prehydration of bentonite is necessary, as well as what type of filtration control additives should be used.

This system is very economical. Due to high yield through synergism between the Super Visbestos and bentonite, the actual pounds of material required to build an adequate drilling fluid is drastically reduced. This combination of low priced materials plus lower handling cost (fewer pounds of material required) presents a drilling fluid system that has already proven its economic worth in difficult to service areas such as Libya, Indonesia and the North Slope.

Any area, where salt contamination (natural or manmade) is a factor, presents a made to order application for this type of system.

SYNERGISTIC EFFECT OF SUPER VISBESTOS ON BENTONITE
(TESTS RUN BY INDEPENDENT TEST LABORATORY)



Synergism is "the cooperative action of different products such that the total effect of the two used in combination is greater than the sum of the two effects taken independently." This is exactly what happens when Super Visbestos and bentonite are used together. Super Visbestos provides the hole cleaning and bentonite provides the fluid loss control.

Combinations of Super Visbestos and bentonite totaling 10 lbs/bbl. were tested for yield value and plastic viscosity. See the above graph. At point A, 10 lbs/bbl. of bentonite gave a yield of 4. With 5 lbs/bbl. you would expect a yield of 2. At point E, 10 lbs/bbl. of Super Visbestos gave a yield of 39. With 5 lbs/bbl. you would expect a yield of 20. Adding the expected yields from 5 lbs of bentonite and 5 lbs of Super Visbestos, the total should be 22.

Now for the synergism. The yield of 5 lbs/bbl. of Super Visbestos and 5 lbs/bbl. of bentonite is shown at point C on the graph. The value is 111. The bar chart above illustrates this even more graphically. Synergism brought about an unexpected increase in yield value of nearly 90 points. (By the way, don't overlook the low value of plastic viscosity at point C. This indication of low solids means faster penetration rates.) In field use, maximum synergism (yield) may occur slightly to the right of point C, depending on the amount of hydratable, drilled solids.

For you, the operator, synergism with Super Visbestos means better hole cleaning and faster penetration at lower cost.

PRODUCT TECHNICAL REPORT (PTR) NO. 0-09-1

SUBJECT: Effect of Super Visbestos (Preheated
Asbestos) in an invert oil emulsion
drilling fluid.

MC NTELO. INC.

P. O. BOX 130

SAND SPRINGS, OKLAHOMA

Days: 918 245-6041

Nights: 918 743-5110

Properties	Base Fluid 60/40 oil/water ratio invert drilling fluid	Base Fluid & 2 lbs. bbl. Super Visbestos mixed 20 min. 11,000 rpm., H.B. Mixer	Base Fluid & 2 lbs. bbl. Super Visbestos 20 min. at 11,000 rpm., H.B. Mixer Aged 1 wk., mix 20 min.
Fann 600	47	52	65
Fann 300	27	31	40
P.V. (CP)	20	21	25
Yield Point lb/100 sq.ft.	7	10	15
A.P. (CP)	23.5	26	32.5
Initial Gel	2	2.5	4
10 Min. Gel	3	2	5
Elec. Stab.	500v	200v*	250v

RESULTS: The addition of two pounds of Super Visbestos increased the yield value of base drilling fluid by approximately 43%, that is from 7 to 10. After aging for one week the yield value increased to 15 or approximately 114% increase over the base fluid.

No emulsion breaking was noted. The drop in Electrical Stability on adding the Super Visbestos does not mean that the stability of the emulsion is actually reduced. This stability change was due to the fact that the asbestos fibers are preferentially wet by the water phase and with each fiber in contact with the other a conductor was set up within the fiber structure rather than the electricity travelling from one water droplet to the next. No chemical change was noted. Any solids will plate out emulsifiers. The drilling fluid improved with age.

CONCLUSION: Super Visbestos can be successfully and economically used in an inverted oil emulsion drilling fluid to increase the carrying capacity of the fluid.

PREPARED FOR PRESENTATION AT SPE (SOC. PLAST. ENGINEERS)

"RETEC" meeting, in NY on 3/21/73.

020434

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Harry

OSHA STANDARDS AND THE SAFE USE OF ASBESTOS

John L. Myers
Union Carbide Corporation
January 1973

ABSTRACT

OSHA STANDARDS AND THE SAFE USE OF ASBESTOS

Asbestos is one of the first target hazards to be handled by the Occupational Safety and Health Agency of the U.S. Department of Labor. The unique properties of asbestos, a fibrous mineral, have resulted in its use in over 3000 applications. There is no reason to prohibit the use of chrysotile asbestos as fiber concentrations in the workplace and in the general environment can be readily and satisfactorily controlled.

Asbestos has received a great deal of attention and publicity in the last 10 years, especially after it was designated as a "target health hazard" by the EPA and a "hazardous air pollutant" by the EPA. Most of the media treatment of the subject has been emotionally oriented and distorted, and in some cases has bordered on the sensational. Little has been done to place the question of asbestos use and asbestos toxicity in a logical perspective. Many users of asbestos and products containing asbestos have been misled and confused by distorted reports, federal legislation, and locally-enacted rules and regulations. Some company news releases or advertising have even contained misleading or incomplete information.

It is an accepted fact that asbestos, like many other foreign bodies, can cause disabling lung damage, commonly referred to as asbestosis. It is important to note that asbestosis and statistical excess occurrences of bronchogenic carcinoma, the two most common asbestos-related diseases, have occurred only in workers with massive, long-term exposures to asbestos dust. The risk of this type exposure is normally limited to asbestos mines and mills, manufacturing operations using thousands of tons per year, and construction jobs using sprayed asbestos insulation. The latter operation has been essentially discontinued. Some epidemiological evidence indicates that asbestos fibers must be associated with cigarette smoking and/or the inhalation of other materials to cause a carcinogenic condition.

There is no evidence that the general public is in any danger from the amount of asbestos fiber in community air. The U.S. National Academy of Science states in an October 1971 publication, "Asbestos - The Need for and Feasibility of Air Pollution Controls":

"at present, there is no evidence that the small numbers of fibers found in most members of the general population affect health or longevity"

This does not, however, preclude the need for definition and control of man-made asbestos emissions into the atmosphere. There are several varieties of asbestos and there is considerable evidence that some are more harmful than others, especially with regard to development of mesothelioma, a very rarely found cancer of the pleura.

Asbestos is a commercial or generic term used to describe six naturally occurring minerals that are hydrated metal silicates. All are fibrous and can be separated into relatively soft, silky fibers. The six varieties are divided into two classes, serpentine and amphibole, based on crystal structure. Chrysotile is the only member of the serpentine class and the amphiboles include crocidolite, amosite, anthophyllite, tremolite and actinolite.

Chrysotile is by far the most used variety of asbestos and accounts for more than 95% of world production. It is the only variety produced in commercial quantities in the U.S. and Canada. Also of commercial importance are crocidolite, amosite and anthophyllite, obtained from Africa and Finland.

In the United States crocidolite is used almost exclusively to reinforce cement pipe. Amosite is used in insulating and packing materials while anthophyllite is used primarily as a chemical resistant filler in plastics. Chrysotile is used in over 3000 applications, the largest and most common include: asbestos-cement products, floor tile, asbestos paper, friction materials and gaskets, textiles, plastics, and insulation.

There is increasing evidence that crocidolite and amosite should be more

stantly controlled than chrysotile. Some data indicate that even a relatively short exposure to these amphibole minerals can result in the development of mesothelioma. A panel of experts in Britain concluded that other types of fiber should be substituted for crocidolite wherever possible. The use of crocidolite in Britain has been severely restricted since 1970 and its importation into the United States and Japan has steadily decreased since the middle 1960's.

Where there is a strong statistical relationship between mesothelioma and the inhalation of asbestos, crocidolite and amosite have been involved either alone or in combination. This is the case in crocidolite miners, asbestos-using insulation workers, asbestos textile manufacturing, and in a large asbestos products manufacturing plant. Until recently the insulation trade used much more amosite than chrysotile and large amounts of crocidolite were used in England. The insulation manufacturer is also exposed to silica and other pneumoconiosis producing dusts, as well as additional agents and materials in the particular work environment. These coexisting agents, such as coal tar and aromatic hydrocarbons, have been ignored in the reported studies of insulation and other workers.

When asbestos exposure has been limited to the serpentine class (chrysotile), as in Quebec asbestos workers, there is strong evidence that no excess mesotheliomas will occur. Additional data, as reported by Dr. J. C. McDonald, show that the Quebec miners have no excess of lung cancer unless they were very heavily exposed (probably to greater than 10 fibers per cc for forty years). Dr. McDonald is Professor of Epidemiology at McGill University in Montreal and has specialized in epidemiology for 25 years.

The Williams-Steiger Occupational Safety and Health Act of 1970 became effective on April 28, 1971. Based on congressional mail this law has stirred up more confusion and controversy than any other recent legislation. In spite of the interest it is estimated that 30% of the nation's employers are not aware of the law's existence and many others have no real idea of what it is all about.

The Congressional purpose of the Act is:

"to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources."

The Act established the Occupational Safety and Health Administration (OSHA) within the Department of Labor, which has responsibility for administration and enforcement. Research and related functions are handled by the Department of Health, Education and Welfare (HEW) through the newly created National Institute of Occupational Safety and Health (NIOSH).

Five million employers and 60 million of the nation's 80 million workers are covered by OSHA. Specifically excluded from coverage are government employees and operations, such as mining, which are protected under other Federal health and safety laws.

Most of the controversy originally surrounding OSHA was related to safety rules and the safety-oriented target industries program. Early efforts were aimed at eliminating hazards in the five industries whose safety record was especially bad:

- Longshoring
- Meat and Meat Products
- Lumber and Wood Products

In a news release issued January 4, 1972, OSHA announced a Target Health Hazards Program to parallel the Target Industries Program. The new program is aimed at improving health factors associated with working conditions. It was initiated by naming five substances to be the focus of initial and concerted efforts by OSHA and NIOSH:

Asbestos
Cotton Dust
Silica
Lead
Carbon Monoxide

Prior to this announcement, on December 7, 1971, an asbestos emergency standard was set at 5 fibers per ml. This replaced a prior threshold limit value (TLV) of 12 fibers per ml. originally established by the American Conference of Governmental Industrial Hygienists (ACGIH). This "emergency" action was prompted by an AFL-CIO request based on studies of insulation workers. The Act empowers the Secretary of Labor to establish emergency temporary standards, effective immediately upon publication in the Federal Register, where it is found that employees are exposed to "grave danger".

Continuing from the OSHA news release, following is a summary of the specifics on the five target substances:

Substance	Can Produce	No. Employees At Risk	Industries
Asbestos	Asbestosis, Cancer	200,000	Insulation, Ship building, construction, etc.
Cotton Dust	Byssinosis	800,000	Cotton Processing- all types
Silica	Silicosis	1,100,000	Abrasives, mineral processing, sand-blasting, etc.
Lead	Severe nervous system disabilities	1,600,000	Ammunition, paint, battery, auto, etc.
Carbon Monoxide	Brain damage, death	Uncountable Thousands	Metal processing, users of gasoline-powered equipment

At the present time, new standards have been established only for asbestos. Of the 8000 toxic substances on the NIOSH list, only 500 are covered by standards and many of them need updating. By some estimates, a new chemical goes into industrial use every 20 minutes; and the toxic effects of many of these chemicals are unknown.

A new Standard for Exposure to Asbestos Dust was published in the Federal Register, Volume 37, No. 110 on Wednesday, June 7, 1972. The basic exposure standard is an 8-hour time-weighted average (TWA) of 5 fibers, longer than 5 micrometers, per cubic centimeter of air. The fiber limit is to be reduced to 2 on July 1, 1976. A peak concentration of 10 fibers per cc is not to be ex-

ceeded at any time. All fiber concentrations are those to which an employee may be exposed without protective clothing or equipment.

The first basic requirement of the new standard is monitoring to determine whether or not fiber concentrations are in excess of the exposure limits. This was to have been completed within six months at "every place of employment where asbestos fibers are released". Obviously there are not enough industrial hygienists to enable compliance with this provision. Some asbestos suppliers provide a monitoring service to customers and several insurance companies have personnel trained in fiber counting. Many service companies have been formed and inexperience has resulted in several instances of inaccurate and misleading results. NIOSH sponsors training schools and each session is filled to capacity.

Improper interpretation of the regulations has created many misconceptions about the equipment and procedures needed to use asbestos. If exposure limits are not exceeded, there are no further compliance requirements except for medical examinations. Interpreted literally, medical examinations are required for all employees in any "occupation exposed to airborne concentrations of asbestos fibers". Some definition of "exposed" is necessary since evidence indicates that small amounts of asbestos fiber have existed in the atmosphere for millions of years. The source of these fibers would be from the weathering of naturally occurring surface outcrops. In its criteria document on asbestos, NIOSH recommended that "exposed to asbestos" be defined as "average exposures above one fiber per cc or peak exposures above five fibers per cc".

Respirators and special clothing are required in the construction trade for the spray application of insulation and fireproofing materials, and for the removal of such materials. This special protection is not required for any other use of asbestos unless exposure limits are exceeded. This is also true for other items such as specially equipped tools, product limitations, change rooms, clothes laundering and waste disposal.

Caution labels are required on products containing asbestos except where the fibers have been modified by a bonding agent or other material to prevent dusting during any normal subsequent use or handling. Besides raw asbestos fiber, products which require package labeling would include: dry acoustical spray products and joint cements, unsaturated roofing felt and textiles, various insulating products made without adequate binders. The labeling of a product does not prohibit its use.

Although the list could be endless, products containing up to 40% asbestos and not requiring a label could include: reinforced plastics (phenolic, nylon, polypropylene, polyester, etc.), roofing compounds, floor tile, reinforced rubber, ready-mix joint cements, flooring, coating and adhesives (polyester, epoxy, urethane, casein, etc.), paint (PVC, alkyd, acrylic latex), mineral board, lubricants and greases.

Soon after the asbestos standards were published, industry and OSHA representatives met to clarify a number of points with regard to interpretation and enforcement. Since these are the first set of standards it is expected that they will become guidelines for the other substances listed as target health hazards. There are several areas where literal interpretation is obviously not feasible. It was the consensus of the industry group after the meeting with OSHA that enforcement and citations would be reasonable provided that there was no attempt by industry to circumvent the spirit and intent of the

...ion to the OSHA standards. There are other regulations concerning asbestos which are being considered or which have been promulgated. Although expected six months earlier, as of the end of 1972 the Environmental Protection Agency (EPA) had not issued asbestos standards.

The EPA was founded by the Clean Air Act of 1970 to improve the environment to which the general public is exposed. On March 31, 1971, asbestos, along with beryllium and mercury, was identified as a "hazardous air pollutant" by Mr. William Ruckelshaus, Administrator of the EPA. Whereas OSHA is responsible for the protection of workers, the EPA regulations will be designed to protect the general public from harmful emissions which may be generated by plants and other industrial operations. In addition to requiring filters on certain plant ventilation equipment, it is expected that the spraying of certain materials will be prohibited. At this writing it is understood that the spraying on structures of fireproofing compounds containing more than 1% asbestos will be prohibited. This prohibition will not apply to insulating materials, roof coatings, auto undercoating, decorative paints and coatings, and similar products containing asbestos held with a suitable binder.

At least two states and local authorities have enacted "asbestos" regulations. Quoting from the New York State regulations: "No person shall engage in or allow surface coating by the spraying of asbestos or asbestos - containing materials". The intent was probably to restrict the spraying of insulation and fireproofing materials on structures, similar to the EPA provision, but a literal interpretation would eliminate many safe and necessary uses of asbestos.

Apparently much more thought and expert advice went into regulations enacted by the State of Illinois as they are feasible and workable without compromising public safety. However, the law enacted by the City of Chicago is similar to that of the State of New York which leaves much to be desired with regard to industry compliance and public safety. It is assumed that the EPA regulations will eventually be adopted or used as a pattern by state and local governments. Some proposed regulations are obviously based on misleading articles about asbestos.

Within the past year articles have been published about the hazard from asbestos in friction materials and to mechanics who blow dust from brake assemblies. The U.S. Public Health Service conducted a study which showed that less than 1% of the 40-50% asbestos in brake linings remains as free fiber after wear. The asbestos is converted by the high heat of friction to a non-fibrous, non-toxic material called forsterite. A study in England found that mechanics engaged in this activity had TWA exposures of 0.68 fibers per cc of air, much less than OSHA's 1976 standard. There is no known study which indicates any hazard to men employed in this occupation.

In another article, Dr. Irving Selikoff of Mount Sinai Hospital was quoted as predicting 95,000 deaths from asbestos - related cancer among 250,000 men currently employed in the U.S. asbestos industry. The two studies on which this dire prediction was based were of men employed in the industry for a minimum of 20 years during the 1930's and 1940's when dust levels were unfortunately many times higher than they are today. It is illogical to apply death rates resulting from long term exposure to dust levels existing some 30 years ago to today's working population.

Quoting from an article in the June 7, 1972 issue of the Wall Street Journal: "bits of asbestos found in filters for beverage making have been found in wine and beer, for instance, and could be dangerous if swallowed". A study in Great Britain showed that the total amount of asbestos fiber found in British beer added up to only 0.002 ounces in the total annual production of over one billion gallons. This is equivalent to about five parts per million-million by weight. There is not one shred of evidence that ingesting such small amounts of asbestos is hazardous.

Many stories refer to Dr. Selikoff and his studies at Mount Sinai Hospital. It should be noted that when Dr. Selikoff uses the term "asbestos workers" he is not referring to the men engaged in the general asbestos mining, milling or manufacturing industries. His studies have been on men employed only in the asbestos insulation trade who belong to a union called the "Heat, Frost, Insulation and Asbestos Workers", commonly referred to as the asbestos workers union. It was reported in one Mount Sinai survey that there was only one dust count taken for every 20,000 man-days worked by 9400 "asbestos workers". They have reported on similar dust count frequencies for years, but always in reference to the construction industry, never to asbestos milling and manufacturing plants.

Dust counts have been taken on a regular basis in most asbestos operations for years. With new and better counting techniques, pelletized asbestos, wet processing, and improved operating conditions, many industries are finding that OSHA compliance presents no major problem. In many cases dusty conditions are being caused by other raw materials. The new membrane filter technique for counting asbestos fibers precludes the inclusion of many dust particles as asbestos. The problem becomes one of nuisance dust control not a lengthy and usually unnecessary program to "get rid of asbestos". One large chrysotile asbestos user is now receiving pelletized asbestos in bulk hopper cars containing about 95 tons of product. With appropriate storage, transfer, and ventilation equipment, there is no asbestos dust released to the work or public atmosphere. The asbestos pellets flow freely from the car and there is no residual material. Plastic bags and repulpable paper bags are other means used to preclude container opening by personnel.

More is probably known about the potential health hazards of asbestos and the proper means for controlling or eliminating them than would be the case with possible substitute materials. It would be imprudent to use unproven materials, whose health effects are unknown, to replace asbestos which has proven its usefulness for the past 100 years.

Asbestos is used by the plastics industry for reinforcement, heat resistance and flow control. About 93% of the 250,000 tons used annually is chrysotile, normally chosen for most applications because of its plentiful supply and product uniformity. Sometimes the special advantages of another fiber are required.

Polypropylene has been reinforced with anthophyllite asbestos because it permits more effective heat stabilization. Recent work may overcome this shortcoming of chrysotile and permit its use in this large application. Chrysotile also has poor resistance to acids and an amphibole is usually chosen for this type application.

Chrysotile is set apart from the amphibole minerals by its positive surface charge, softness, flexibility, and low refractive index. Its fibril diameter is

than 0.1 micron, the smallest of the common fibers, and it has excellent mechanical strength. Wet processing of chrysotile has permitted chemically modified products with surface properties similar to pyrogenic silica for use in anti-sag and thixotropic applications. Compared to chrysotile, amphibole fibers are larger in cross-section, harsh, and hard. They are anionic in surface charge and more resistant to acids.

The unit chrysotile fibril is now recognized as a naturally occurring reinforcing whisker. Because of its high strength, stiffness and aspect ratio it provides excellent whisker reinforcement; assuming that it has a high degree of fiber liberation and has been specially processed to remove extraneous gangue material.

The largest uses for asbestos in plastics are in vinyl asbestos floor tile and in phenolic molding compounds. It is also used in numerous other compounds of polypropylene, polyester, nylon, melamine, epoxy, silicone, etc. It is used in many product types such as friction materials, heat resistant and electrical components, sealants, adhesives, coatings, mastics, etc.

Asbestos has been, is, and can be used safely in the plastics industry as well as most other areas of application. It is an important and necessary raw material and its use cannot and should not be prohibited. Medical, industrial and governmental personnel must continue to work together to establish reasonable exposure limits while, at the same time, providing safe work areas for employees.

020443



P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-2241
• Nights: 918 RI 3-3105

VISBESTOS

Availability and recommended treatment

VISBESTOS is available through your mud service company. If his stock is depleted, Montello, Inc. has back up stocks in your area which can be obtained by calling Montello's representative for your area or by calling Montello direct.

VISBESTOS has been used in brine muds, fresh water muds, emulsion muds, sample muds and work over muds. The treatment (#/BBL) of VISBESTOS depends upon the drilling fluid system and the amount of work that is done on the VISBESTOS during mixing. The more slowly the material is mixed, the higher the shear and the better your results.

Normal concentrations of VISBESTOS vary from 3# to 5# per barrel. A good sour mud was obtained by using 3#/BBL of VISBESTOS to 10#/BBL of Gel. Excellent sample muds have been prepared with as little as 2#/BBL of VISBESTOS. The exact concentration of VISBESTOS depends on the fluid system, the amount of mixing and the desired mud properties. Any mud engineer familiar with asbestos will have no difficulty using VISBESTOS. The only difference is that you will get the same results with less material.

VISBESTOS yields better in salt water than fresh water. VISBESTOS yields faster at the rig than competitive products due to extra shear during the manufacture of VISBESTOS. You will notice the larger size of VISBESTOS bags because of this.

Thank you for considering the best -----VISBESTOS.

5-3

VISBESTOS

Visbestos is a top grade chrysotile asbestos compound mined in Coalinga, California and processed under rigid quality control specifically for use as a drilling mud additive.

Visbestos, compatible with all drilling fluid systems, was designed primarily as a viscosity builder and is used successfully to increase the carrying capacity and suspending ability of drilling muds.

- Some of the first work with asbestos and drilling fluids was performed by Mr. David A. Rowe in the 1940's. Patents were assigned to a major oil company. Visbestos is covered under letters patent #2,727,001 and 2,732,343. These patents inclusively cover the use of chrysotile asbestos in drilling fluids, according to the opinion of very competent patent counsel.

There are six types of asbestos. Five types are charged negatively and one type, chrysotile, is charged positively. We will only discuss chrysotile asbestos since it is the only one of the six types that exhibits the desired properties.

Asbestos samples from Quebec, the East Coast, Arizona, Wyoming, California and other locations have been tested in order to determine the very best product from which to produce Visbestos. There was a tremendous variation in the performance of these samples. Most samples failed on the first test, that of building viscosity. After considering all the test indexes only the top grade chrysotile asbestos material proved to be acceptable.

What does Visbestos do? It builds viscosity and increases the carrying capacity of drilling fluid -- that is a fact!

The increase in viscosity of a drilling fluid caused by the addition of asbestos depends on the drilling fluid system, the concentration of asbestos and the amount of work that is done in mixing, (i.e. the amount of shear). As discussed above, the grade of asbestos also effects the viscosity yield.

020445

MONTELLI, INC.

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641

• Nights: 918 RI 3-3105

Low Solid Fresh Water Drilling

Visbestos muds have been prepared by adding as little as 2# of visbestos to a fresh water system. This small amount of material does not show an increase in the viscosity when measured with a marsh funnel, but there is an increase in the yield point, therefore giving an increase in carrying capacity. This mud provides characteristics to fresh water, but gives sufficient carrying capacity to keep the hole clean. The extenders have been very beneficial in flocculating the very fine cuttings from the visbestos mud using extenders as specified in clear water drilling information.

For instance, the manufacturers of powered extenders recommend that for an 8" hole with penetration rates of 100' per tour that it will require approximately 8# per tour.

We have had very good results using a liquid extender at the return lines and therefore flocculating ~~negative~~ solids in the mud pits. This product has proven very successful and more economical. When using any extender all contaminants must be treated from the mud.

slide
#10



020446

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

Other Applications

Wyoming Bentonite used with salt water and visbestos.

First method

- A. Mix visbestos with salt water.
- B. Mix Wyoming bentonite with fresh water.
- C. Feed Wyoming bentonite fresh water mixture to salt system.

Second method

Used in panhandle area

- A. Mix visbestos in salt system.
 - B. Mix Wyoming bentonite through mud hopper.
- Good results have been reported on the above procedure.

West Texas application

Major Oil Company drilling in West Texas

Highland Drilling Company - drilling at 14,000'.

Mud system consisted of 7# asbestos plus water loss control.

Contractor reported they were ahead on drilling program-no shale problem-situation very good

6/15/59
5-159



02-147

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

Visbestos Packer Fluid 16#

The following is a method that has been used in the Louisiana area for preparing an inexpensive packer fluid.

1. To fresh water blend approximately 2# per barrel of salt or magnesium sulphate.
2. Blend in 6# per barrel visbestos. Mix in at the rate of 15 minutes per sack.
3. Circulate 30-45 minutes after all visbestos has been added.
4. Add one ^{point} ~~pack~~ per barrel line for pH-corrosion control.
5. Mix weight material as fast as you want to.
6. If more corrosion protection is needed we have found **Borton** manufactured by Champlin Chemical to be very good.
7. If bacteria control is desired **Bacton** also manufactured by Champlin has proven to be most economical.

If a lighter packer fluid than 16# is desired more visbestos (6# per barrel) is used. We have found the optimum to be in the line of 10# per barrel.

This packer fluid was tested for 6 weeks with no setting at temperature to 375°F. No separation was noted. Gulf Coast seawater was used on one job without adding salt—results were very good.

*Tell Story on Lomax
Cosh Boy Allied.*

*5/15/61
11*



020448

TECHNICAL REPORT # VIS 66-8

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641

• Nights: 918 RI 3-3105

VISBESTOS

Problem: Drilling 3,000 feet of 17" surface hole.

Location: South Louisiana

Depth: Surface to 3,000 feet.

Temperature: Normal

Situation: Considerable trouble has been and is being experienced in this area when drilling surface hole. Difficulties are experienced in keeping hole clean. Cuttings are as big as a man's fist.

Tabulated below is a comparison of two surface holes cut with different types of mud - same depth - size and area.

Attapulgate Gel Mud

VISBESTOS + Gel
3# VISBESTOS to 10# Gel

Mud cost \$2,500.00 plus
Hole trouble all the way
Gauge very bad
Very bad cement job
Plug bit nearly every time
connection was made

Mud cost \$1,213.00
No hole trouble
Good gauge
Good cement job
Did not plug bit.

Conclusion: Due to poor carrying capacity of attapulgate gel mud difficulties were experienced with drill cuttings settling to bottom. Everytime a connection was made the cuttings would settle to bottom and plug bit. Also it was necessary to wash hole clean after connection was made which enlarged hole leading to poor cement job.

With a VISBESTOS mud settling did not occur, drilling was immediately continued after connection was made. The drilling contractor saved many hours which led to savings both to operator and drilling contractor.

5-15



020449

TELETYPE REPORT # VIB 66--

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISEESTOS

Problem: Quick viscosity and increased carrying capacity of mud required to keep hole clean.

Location: North Dakota

Depth: 9,700 feet

Drilling Fluid: Salt water and attapulgite

Temperature: Normal for area

Solution: A major oil company while drilling in North Dakota needed to build viscosity quickly and also to increase the cutting carrying capacity of the drilling fluid to help keep the hole clean.

VISEESTOS, (a high grade chrysotile asbestos compound), was added at pump suction through mud hopper to a concentration of approximately 3#/BBL.

The VISEESTOS was added slowly allowing about 15 minutes per 50# bag for maximum shear.

The desired viscosity was obtained in one round trip. Both the operator and mud service company were very pleased with the quick, economical results obtained using VISEESTOS.

Their only complaint -- "We could have done the job with less VISEESTOS!!!!!!"

5-14

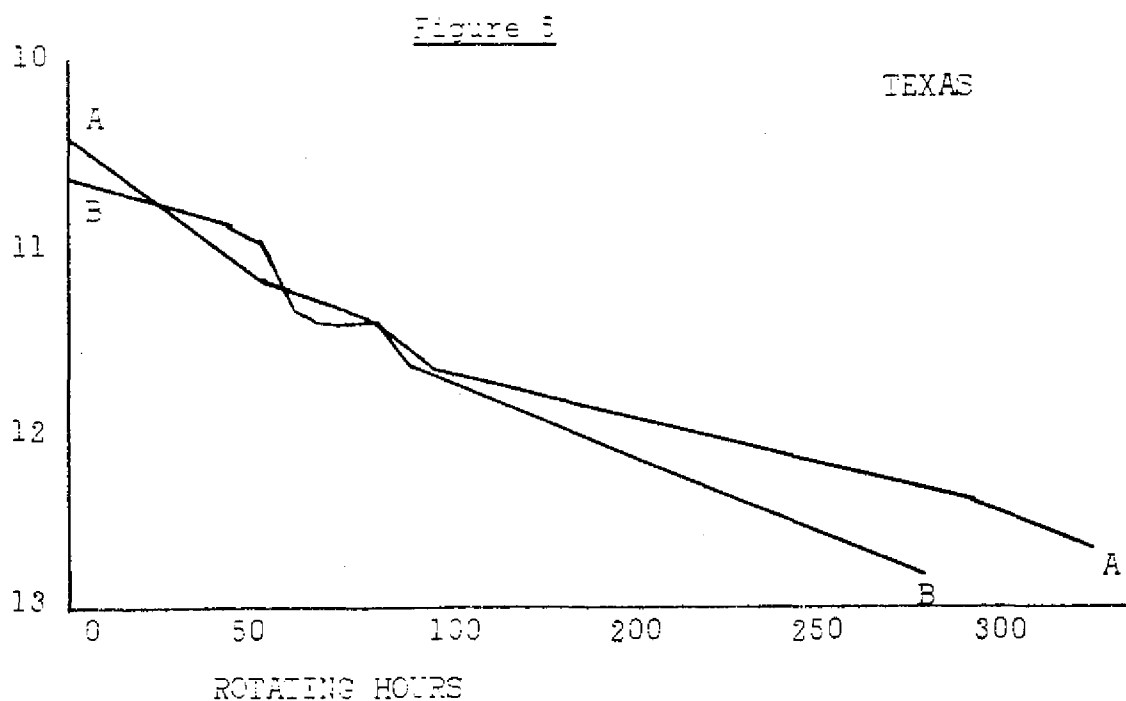
After this company started using asbestos the following advantages were noted.

- * Drilling time definitely decreased.
- * Cuttings were considerably larger.
- * Better gauge hole (no washing out while brushing or drilling up large, hand size rocks).
- * Better penetration.
- * Easier setting pipe.
- * Better cementing jobs (less fill required).

Louis

A study of figure 5 and figure 6 presents field evidence of the economy and advantages of Asbestos (Visbestos).

Figure 5: These wells were drilled by the same contractor, same rig, and same operator. Well A was drilled to 11,700 feet with water, 6-percent oil and emulsifier. At this depth a low viscosity sample mud with fluid loss control was added. Well B was drilled to 11,700 feet with water, 6-percent oil and asbestos. At depth a fluid loss control agent was added. For recovery of good samples, hold conditions required the introduction of asbestos. Fluid properties were 8.5 ppg, viscosity 34 to 40 seconds.

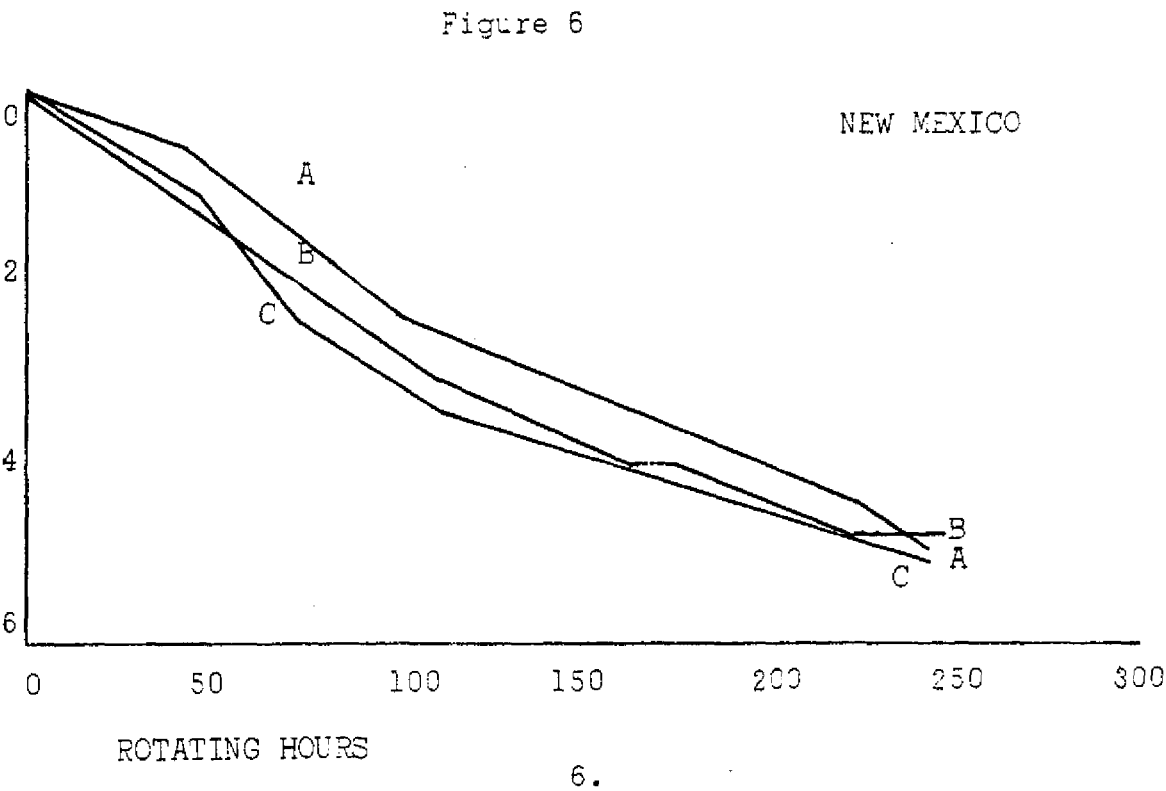


4-10

Comparative Penetration Rates

	Well A	Well B
Footage	2198	2407
no. of Bits	10	7
Rotating Hours	283	231
Avg. ft./bit	220	344
Avg. ft./hour	7.7	10.4
Bit size	7 7/8"	7 7/8"

Figure 6: Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 32 second viscosity was maintained as samples were desired from 900 feet.



COMPARATIVE PENETRATION RATES

	Well A	Well B	Well C
Footage	4847	4733	4908
Number of bits	8	10	7
Avg. ft./bit	606	473	701
Avg. ft./hour	19.9	19.6	19.9
Bit size	17½"	17½"	17½"
Rotating hours	243	241	247

In summary Asbestos has been economically and successfully used in:

Fresh water muds
Salt water muds (no gelling)
Low solids muds
Emulsion muds
Oil

The following advantages were realized:

- * Increased carrying capacity of mud.
- * Increased suspending ability of mud.
- * Stable at high temperature.
(no increase in viscosity due to temperature)
- * Larger samples.
- * Synergistic effect on polymers and starch.
- * Inhibits flocculation.
- * Better penetration rates.
(longer bit life)

Be sure the grade you use will do the job.

VISBESTOS IS THE BEST

5-12

COMPARATIVE PENETRATION RATES

	Well A	Well B	Well C
Footage	4'4"	4'4"	4'4"
Number of bits	8	8	8
Avg. ft./bit	0.55	0.55	0.55
Avg. ft./hour	1.10	1.10	1.10
Bit size	1 1/2"	1 1/2"	1 1/2"
Rotating hours	1.4	1.4	1.4

S-11

Shilco

In summary, Asbestos has been economical and successfully used in:

Handwritten scribble

Drill water made
Drill water made (no yellow)
Drill water made
Drill water made

WORK OUT — PACKED FLUIDS —

The following advantages were obtained:

- In a low carrying capacity mud.
- In a low suspending capacity mud.
- In a low high temperature.
- In a low viscosity due to temperature.
- In a low effect of polymers and starch.
- In a low erosion rates.
- In a low bit life.

Be sure the grade you use is the right one.

WISCONSIN IS THE BEST

Comparative Penetration Rates

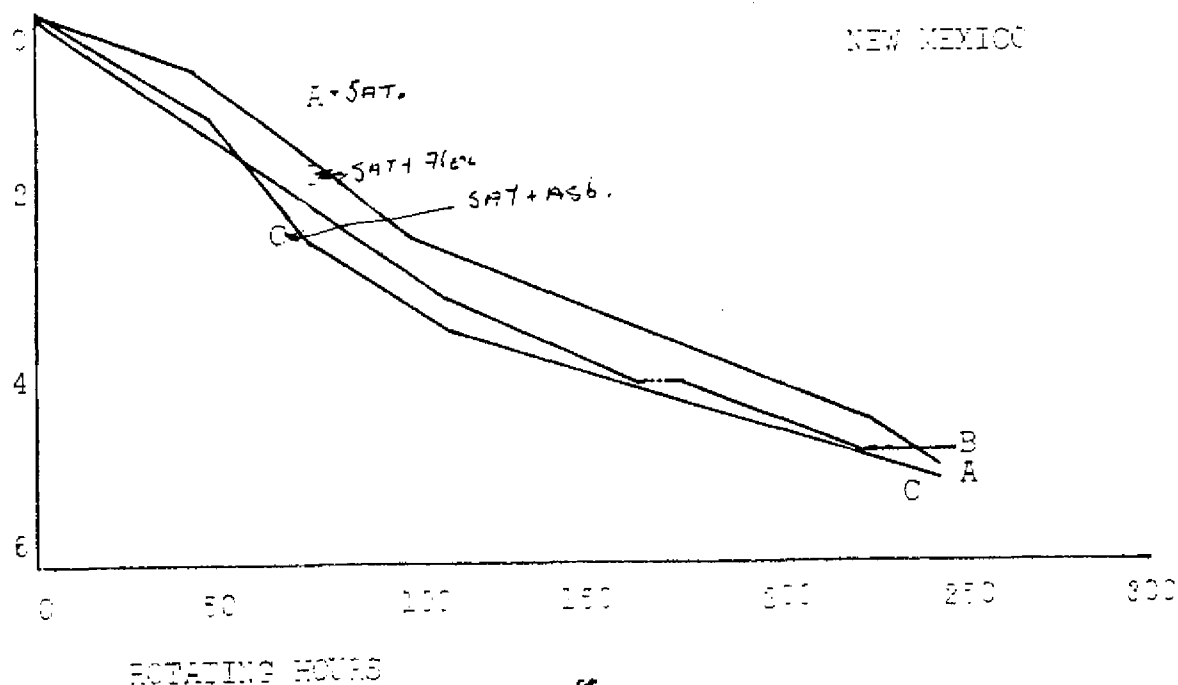
	Well A	Well B
Footage	2138	2437
no. of Bits	10	7
Rotating Hours	288	231
Avg. ft./bit	220	344
Avg. ft./hour	7.4	10.4
Bit size	7 7/8"	7 7/8"

Slide #10

Figure 6: Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 50 second viscosity was maintained as samples were desired from 800 feet.

Slide 11

Figure 6



Continued

Slide I &

020455

(Grades lower one effect)

*minimum
can be
reduced*

For instance the same concentrations of a first and second grade asbestos were checked with the following results:

Fann V G
2 800

Grade #1
82

Grade #2
47

Have you told Biggat sack is Best
This is very important -- do not become partial to a certain brand name that may look like "Visbestos" but does not perform like a top grade asbestos. Require performance runs to indicate which material is the best buy.

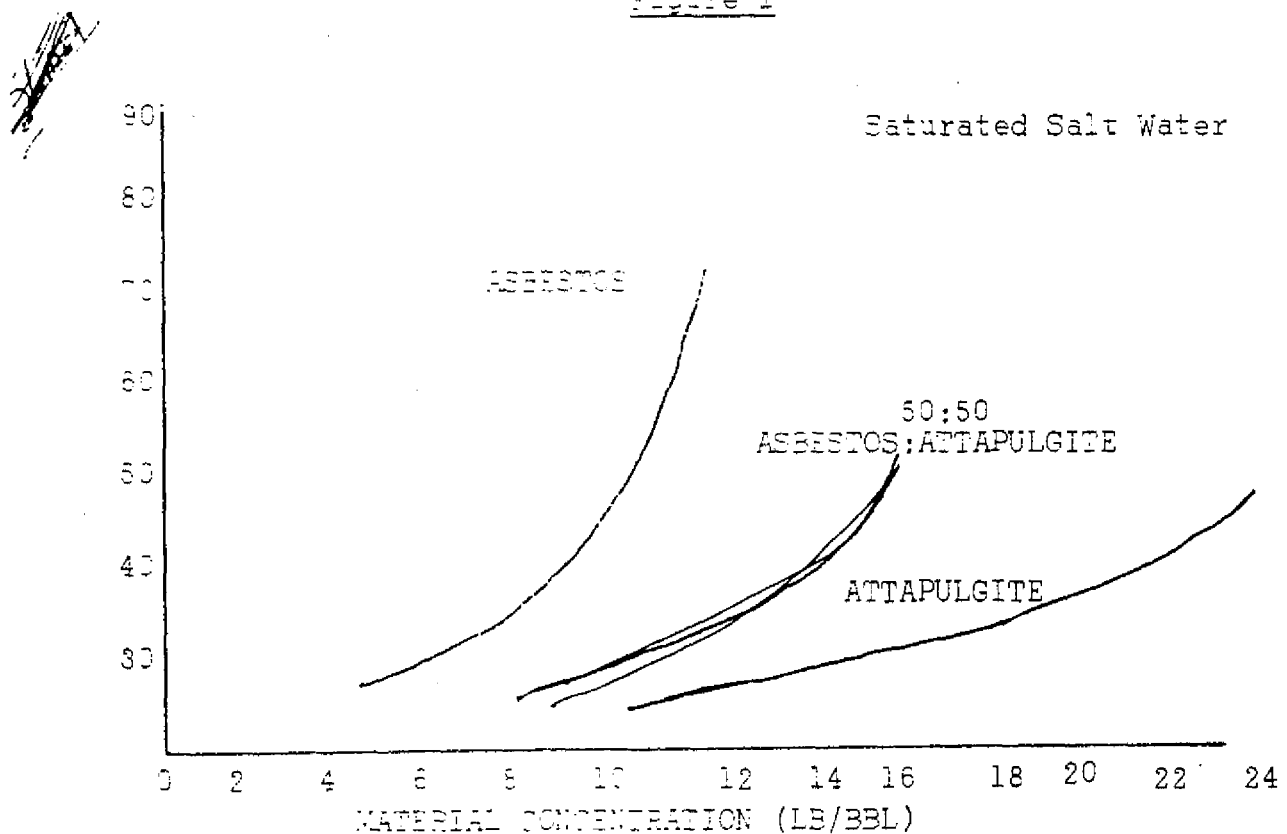
#1 is correct

35 Vol is

Visbestos (asbestos) definitely has a place in the drilling industry and has proven its economy numerous times in many areas.

Figure 1 - indicates the viscosity building characteristics of Visbestos in saturated salt water. The values shown are an average of laboratory test runs. Similar results are obtained when tested in fresh water.

Figure 1

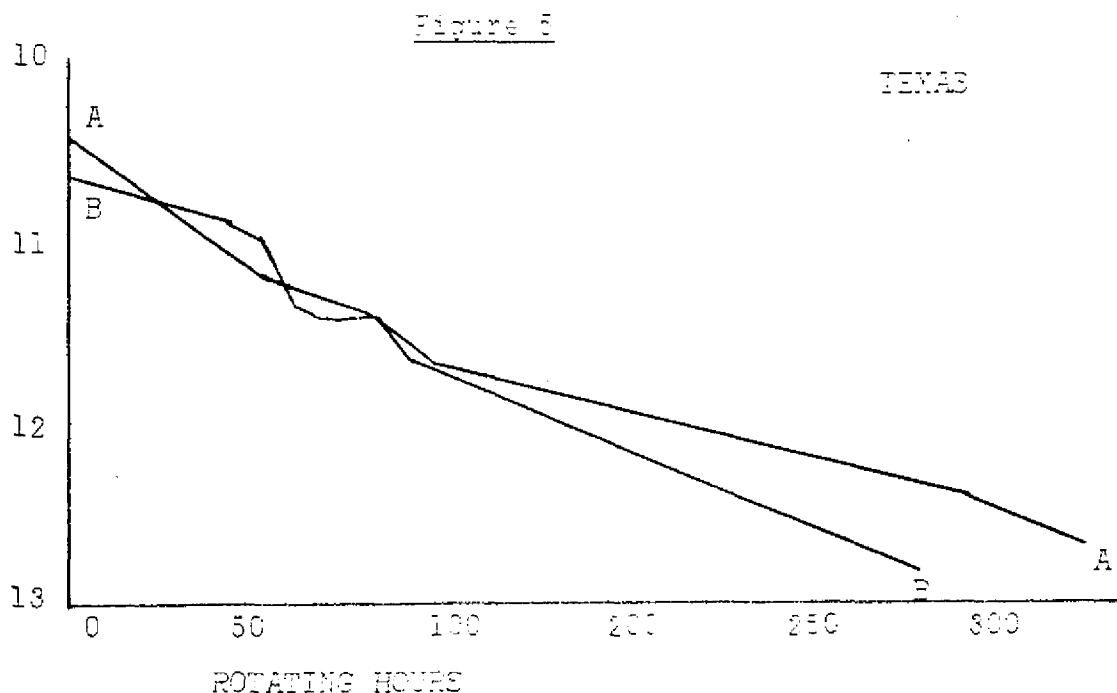


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A study of figure 5 and figure 6 presents field evidence of the economy and advantages of Asbestos (Visbestos).

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over 5-10 contours

5-10

For instance the same concentrations of a first and second grade asbestos were checked with the following results:

Fann V G
@ 600

Grade #1
82

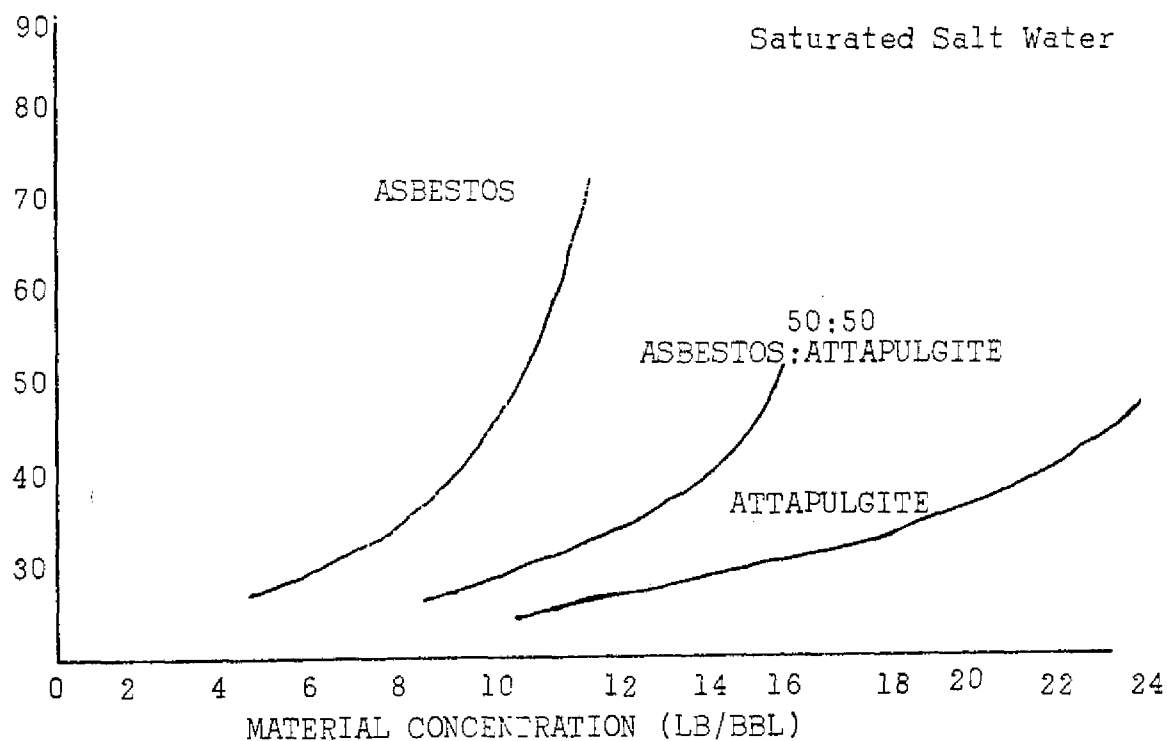
Grade #2
47

This is very important -- do not become partial to a certain brand name that may look like "Visbestos" but does not perform like a top grade asbestos. Require performance runs to indicate which material is the best buy.

Visbestos (asbestos) definitely has a place in the drilling industry and has proven its economy numerous times in many areas.

Figure 1 - indicates the viscosity building characteristics of Visbestos in saturated salt water. The values shown are an average of laboratory test runs. Similar results are obtained when tested in fresh water.

Figure 1



Visbestos (asbestos) also builds viscosity in oil emulsion mud. For instance Visbestos was tested using Kerosene @ 70° F with the following results:

Fann V G	Kerosene	3% Visbestos Low	3% Visbestos High
600	3	14	24

Why does Visbestos (asbestos) react in this manner? A study of the data given in Figures 2 and 3 below gives us a good hint as to the reason for the viscosity building characteristics of asbestos.

Figure 2

COMPARISON OF FIBRE DIAMETERS

Type of Fibre	Dia. - Inches
Human Hair	.00158
Wool	.0008 to 0.0011
Nylon	.0003
Glass	.00026
Asbestos (Chrysotile)	.000000706 to 0.00000118

Figure 3

SURFACE AREA OF FIBRES

Type of Fibre	Surface Area by N ₂
Nylon	3,100
Cotton	7,200
Wool	9,600
Asbestos (Chrysotile)	130,000 to 220,000

Please note the fibre diameter of asbestos compared to other fibres. Also note the extremely high surface area of asbestos compared to nylon, cotton and wool. The tremendous strength of the asbestos fibres (figure 4) reveals why the asbestos fibres are not destroyed by mixing and agitation of the drilling fluid system.

5-4

Figure 4

COMPARISON OF TENSILE STRENGTH

Type of Material	Strength - psi
Wrought Iron	48,000
Carbon Steel	155,000
Rock Wool	60,000
Asbestos (Chrysotile)	100,000 to 300,000

Laboratory tests and field applications proved that a top grade chrysotile asbestos (Visbestos) is compatible to all mud systems and can be used economically in the following systems.

Brine
Fresh Water
Emulsion Muds
Sample Muds
Spud Muds
Work Over Muds

Some advantages of Visbestos are:

- *Lower solids mud.
- *Replaces or complements bentonite and attapulgate clays.
- *Increases carrying capacity and suspending ability of drilling fluids.
- *Larger formation samples and cuttings are removed from well.

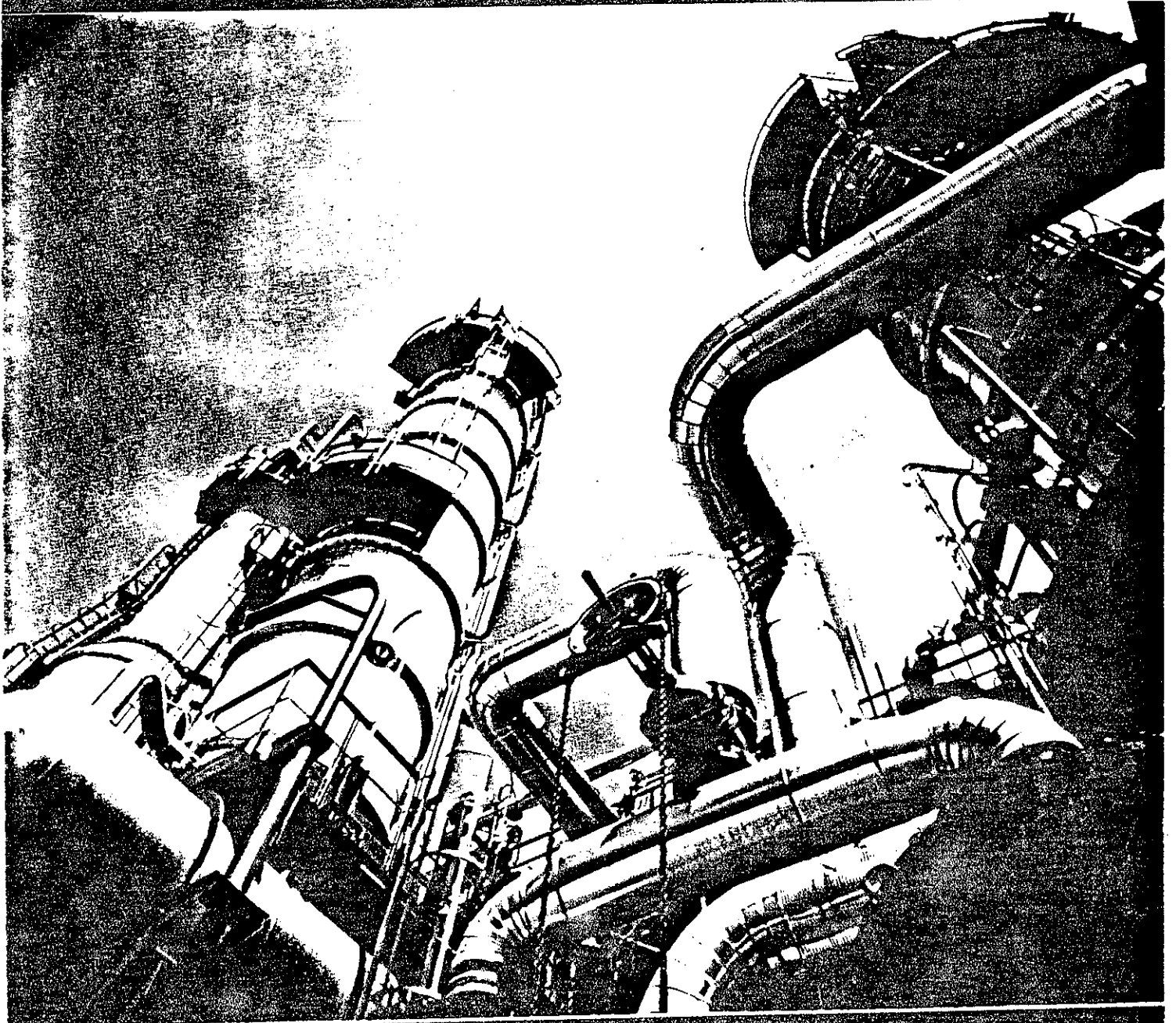
A recent report from South Louisiana revealed that a major mud company was using asbestos in 80 - 85 % of the wells they are servicing.

Outstanding results were reported when using 50 to 100 sacks of asbestos and some clay while drilling surface hole.

9
24

OIL & GAS JOURNAL

PUBLISHED WEEKLY



Presheared asbestos muds cut time, expenses

page 93

Reprinted from the June 8, 1970 edition

020460

Presheared asbestos muds help cut costs, rotating time

JOHN L. KENNEDY
Drilling Editor

RESULTS of drilling in widely separated areas indicate that the use of presheared asbestos in drilling fluids can help reduce mud costs and rotating time. These drilling fluids are designed as low-solids muds and appear to be finding increased application.

In one of these instances, presheared asbestos was used with bentonite and results were compared to drilling results using a straight bentonite system on an adjacent well. In this Okfuskee County, Okla., comparison, mud costs

for the presheared asbestos-bentonite system were 47.3¢/ft while the straight bentonite system cost 58.2¢/ft.

These two wells, located 660 ft apart, were drilled by the same operator using the same contractor and the same rig, the same mud company and the same mud engineer. Total depth of the two wells was slightly over 4,000 ft and mud-up depth was around 2,700 ft. Casing string in both wells was 8 5/8-in.

A significant savings in drilling time resulted from using the presheared asbestos-bentonite mud over the straight bentonite system. The well using the combination fluid was drilled in 99 rig hr, compared to 140 hr to drill the well on which the straight bentonite system was used.

The bentonite-drilled well required six bits compared to five for the well drilled with the presheared asbestos-bentonite mud.

In Libya, a similar system proved to be competitive with straight bentonite fluids that had been used previously. And this particular well was drilled without any lost-circulation problems, something that had given operators considerable trouble in the past in this area.

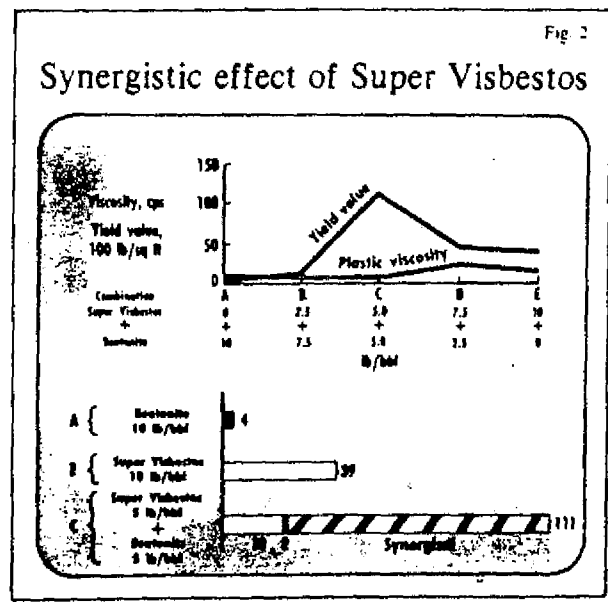
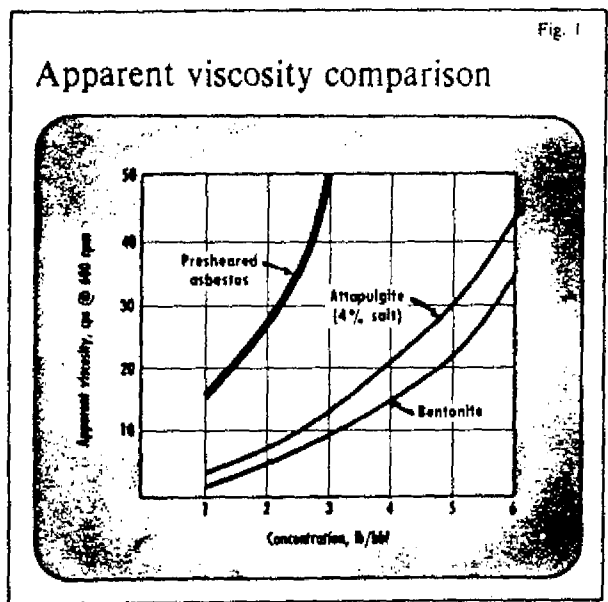
The Libya well was drilled to a total depth of 10,068 ft with mud weights varying from 8.7 to 8.9 lb/gal. After an 18 5/8-in. surface string was set, 13 3/4-in. was run to 3,272 ft and a 12 1/4-in. production string set at TD.

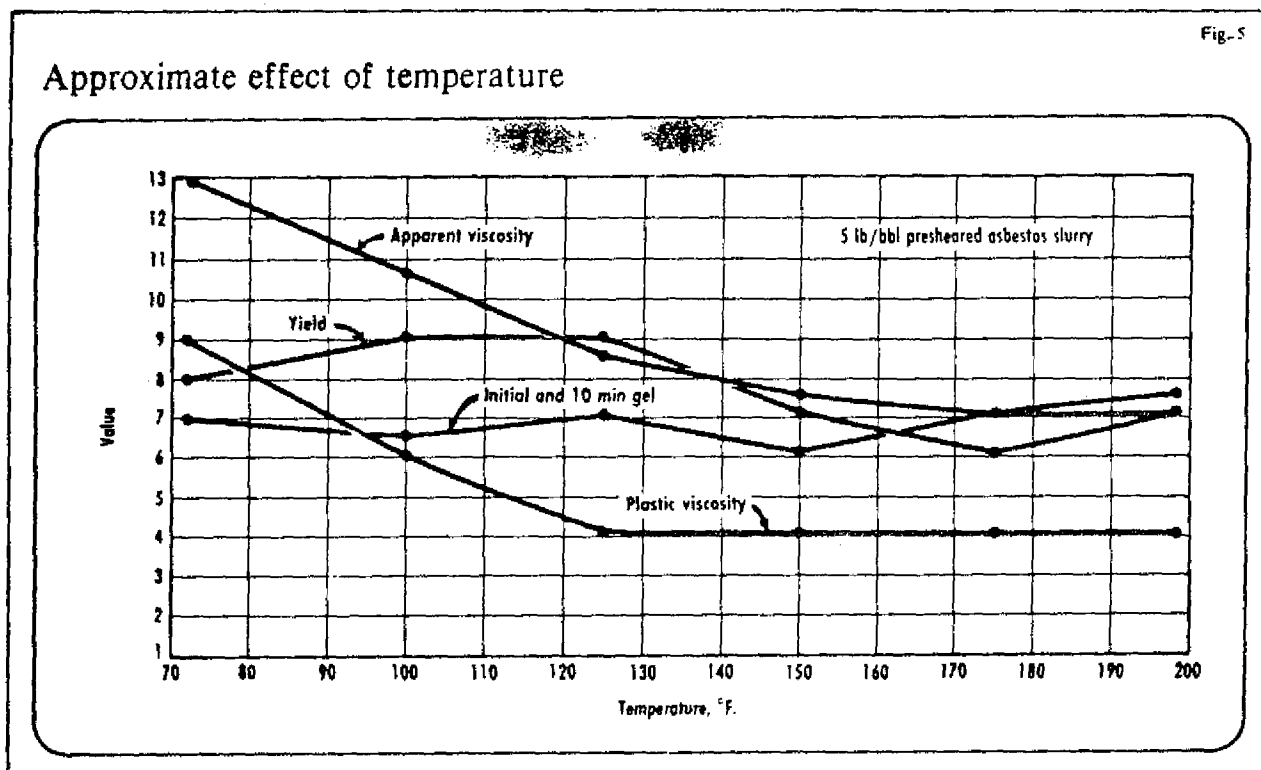
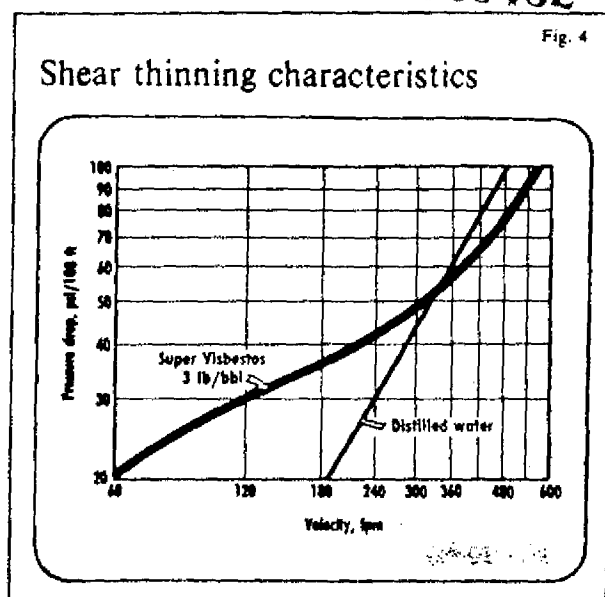
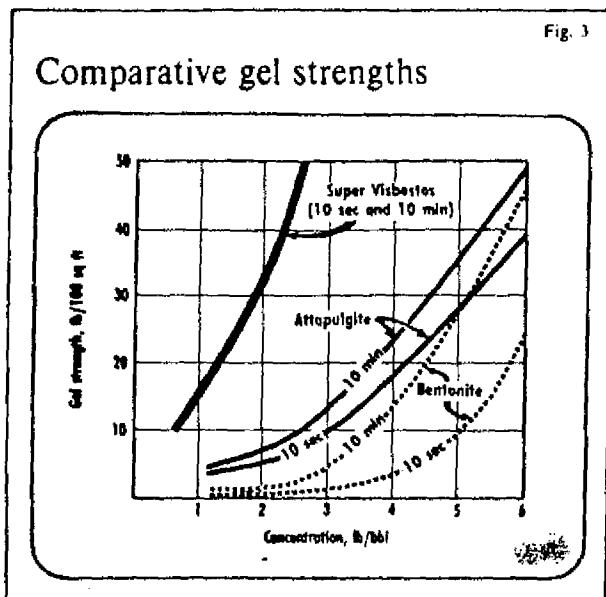
The presheared asbestos-bentonite low-solids mud system was built in a ratio of 1 lb of presheared asbestos to 2 lb of bentonite. But plans for the

next well included using a drilling fluid built in a 1/1 ratio of these materials. In this instance, a fluid-loss control agent was used and the properties of the mud system included a plastic viscosity of 8; yield value of 4; funnel viscosity of 40 sec; and 4-7% solids.

For North Slope drilling, a presheared asbestos-bentonite extended system has been recommended from surface to total depth. In this case, this procedure applies:

1. Initial surface volume is prepared using freshwater treated with presheared asbestos and bentonite in a 50-50 ratio.
2. Surface volume is then treated with salt to lower the freezing point to the necessary level.
3. The system is then used to drill through the permafrost to the surface casing point. During this interval, presheared asbestos can be added directly to the system for viscosity and hole cleaning when needed. Bentonite can be prehydrated and added to the system when required, and filtration control can be obtained with salt-water fluid-loss agents.
4. Do not discard this fluid after drilling permafrost and setting surface casing—simply discontinue the addition of salt to the mud system and use freshwater for makeup.
5. This same system is used out from under surface to approximately 3,000 ft where casing is again set. Since no salt was added during this second interval and freshwater makeup was used, the system will be fresh enough to allow mixing of bentonite directly. For maximum yield, 50-50





concentrations of presheared asbestos and bentonite are used.

6. From second casing point to TD, the drilling fluid system is essentially a freshwater, low-solids, presheared asbestos-bentonite type. Filtration is controlled with a freshwater fluid-loss additive, and shale can be controlled using this same system but with the addition of powdered asphalt materials.

A typical system. A mud system like the one used in Libya is usually built around 2-3 lb/bbl of presheared asbestos and 3-5 lb/bbl of bentonite.

A 50-50 mix usually gives the best hole-cleaning results, but a higher proportion of bentonite is usually recommended when hole stability is a problem.

Using Super Visbestos, a presheared asbestos distributed by Montello, Inc., Sand Springs, Okla., a cost comparison indicates that such a fluid would run in the neighborhood of 52.5¢/bbl compared to a straight bentonite system at about 62.5¢/bbl.

These costs were based on the use of 2½ lb/bbl of presheared asbestos with 2½ lb/bbl of bentonite for the

combination system, and 25 lb/bbl of bentonite for the other fluid.

In addition to a lower initial cost, manufacturers of the presheared asbestos additives cite other possible savings including lower mixing costs; lower hauling costs; less water requirements; reduced chemical treatment cost; and higher penetration rates.

Presheared asbestos-bentonite systems will usually give some hole stabilization and a small amount of fluid-loss control. Then if necessary, a fluid-loss control agent can be used

to lower loss to required levels. Such a system is applicable in any area.

To get proper cleaning, a drilling fluid's yield point and plastic viscosity are important properties. Table 1 indicates the effect of these variables on the settling time of solids in a flocculated solids settling test. Another important consideration in cuttings transport is annulus flow profile. If this profile is turbulent, cuttings slippage is increased and cuttings can fall faster than the average annular rate causing a hole-cleaning problem.

If hole cleaning is critical and an adjustment of annulus flow does not help, yield value can be raised with asbestos. Montello recommends, however, when using their product that before raising the yield value too high the hole should be flushed clean with

a 25-50-bbl slurry containing 3 lb/bbl of presheared asbestos. Or it can be done by adding 75-100 lb of the material directly into the mud system through the mud hopper. This flushing

operation can be repeated as needed with frequency ranging from once a day to twice a tour. And it should be done just before making a trip, according to Montello.

Of course, good solids removal techniques are essential to the performance of low-solids systems. Both chemical and mechanical means can be used to accomplish this.

Some properties. Presheared asbestos has grown in use recently, its advantages stemming from the fact that the carefully controlled shearing process at the point of manufacture provides a high degree of fiber separation quickly at the well (OGJ, Oct. 28, 1968). Properties of presheared asbestos compared with those of other mud-system additives are shown in Fig. 1-5.

END

Table 1

Settling tests				
Weight	Density of floc lb/gal	Pv	Yp	Settling time for 50% solids settling (min/ft)
8.3	10.4	1.0	0	1/2
8.3	10.4	2.0	0.5	1
8.3	10.4	2.0	1.0	2
8.3	10.4	2.0	2.0	8
8.3	10.4	4.0	4.0	27
8.3	10.4	8.0	8.0	88
9.0	11.0	4.0	4.0	30
9.0	11.0	8.0	8.0	97
10.0	11.8	4.0	4.0	34
10.0	11.8	8.0	8.0	112

SUPER VISBESTOS PROVIDES HIGH YIELDS ALMOST INSTANTLY

A message of special interest to drilling superintendents and those responsible for writing drilling mud programs, distributed courtesy of Montello, Inc. For more information and extra copies of the reprint, write Montello at P.O. Drawer 130, Sand Springs, Okla. 74063.



REGULAR ASBESTOS
(Dry Processed)
Only 50% Separation



SUPER VISBESTOS
(Wet Processed-Presheared Asbestos)
Over 98% Separation

Super Visbestos is produced, exclusively for Montello, Inc., by chemically and hydraulically shearing a top-grade chrysotile asbestos, through a unique, proprietary, wet-process. This process produces a high degree of asbestos fiber separation.

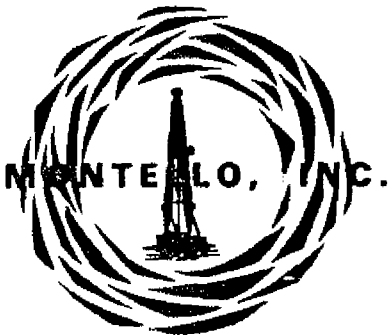
The high degree of fiber separation (i.e. yield) provided almost instantly with Super Visbestos is impossible to achieve using regular dry processed asbestos in the field even after days of circulation and mixing.

A study of data below reveals the advantages of Super Visbestos.

(Tests Were Run By A Major University)

SUPER VISBESTOS VS. REGULAR ASBESTOS

Fann VG Meter	Super Visbestos 5 LBS./BBL	Regular Asbestos 5 LBS./BBL
Apparent Viscosity	14.5	7
Plastic Viscosity	11	6
Yield Point	7	2
Initial Gel	5	3



P. O. DRAWER 130
SAND SPRINGS, OKLAHOMA 74063
Days: 918 245-6661 Nights: 918 743-3105

Test	<u>Bentonite</u>		<u>Visbestos</u>		<u>Visbestos/Bentonite</u>	
	lbs./bbl.		lbs./bbl.		1:1 ratio-lbs./bbl.	
	5	10	5	10	5(total)	10(total)
Fresh Water:						
1. API Funnel Viscosity (Average, 3 runs)	27.5	29.1	26.5	29.9	26.6	28.8
2. Apparent Viscosity (CP)	2.0	2.5	5.0	12.5	2.0	4.5
3. Plastic Viscosity (CP)	2.0	2.0	3.0	5.0	1.0	1.0
4. Yield Point/100 s.f.	0.0	1.0	4.0	10.0	2.0	4.0

Test	<u>Attapulqite</u>		<u>Visbestos</u>		<u>Visbestos/Attapulqite</u>	
	lbs./bbl.		lbs./bbl.		1:1 ratio-lbs./bbl.	
	5	10	5	10	5(total)	10(total)
Salt Water:						
1. API Funnel Viscosity (Average, 3 runs)	28.7	31.1	29.0	34.4	29.1	36.7
2. Apparent Viscosity (CP)	4.0	8.0	11.5	22.0	9.0	21.0
3. Plastic Viscosity (CP)	3.0	4.0	6.0	14.0	3.0	5.0
4. Yield Point/100 s.f.	2.0	8.0	11.0	16.0	12.0	24.0

Companies in the Drilling Industry

Re: The SAFE use of asbestos in drilling fluids

On June 7, 1972, stringent Federal regulations went into effect on the commercial use of asbestos. The impact of these regulations on the drilling industry has been a source of concern and confusion to suppliers and users, alike.

Because of this, we at Montello determined to ascertain how our unique, wet-refined Super Visbestos would perform, in the context of the OSHA regulations, under the widely varying conditions found on-drilling rigs. With the invaluable cooperation and assistance of several companies, four on-site tests and their evaluation have now been completed.

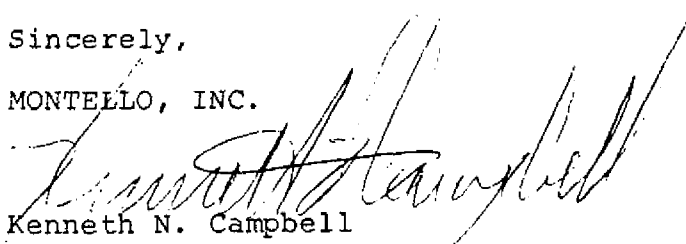
You will find attached, a recap of the more important points found in this study. We'll be pleased to send you a complete, complimentary copy of an extensive report which gives a detailed interpretation of the results from these four on-site tests. Site selection was based on a desire to evaluate the broadest possible range of dumping environments. Three different forms of our asbestos were checked to determine the effects of fine grinding, coarse grinding (i.e. crushing) and granulating, on air entrained dust concentrations.

We believe interested readers will find this report informative. In substance, the results lead us to believe that there is no reasonable expectation of exceeding the limit values imposed by the regulations, when using either Crushed Super Visbestos or the much cleaner New Granular Super Visbestos.

Please contact our Sand Springs office for your copy of the report. We'll respond as quickly as possible.

Sincerely,

MONTELLO, INC.



Kenneth N. Campbell

KNC/jd

Attachment (1)

Montello

P.O. BOX 130, SAND SPRINGS, OKLAHOMA 74063 / (918)-245-6661/TWX 910-840-3007

A study covering airborne dust concentrations in drilling fluid operations using wet-refined asbestos has been completed. The following are some of the more important points to consider:

1. All tests were performed using Montello's exclusive wet processed asbestos products. The findings cannot be safely applied to any of the several dry ground products on the market.
2. Fiber counts were highest on fine ground material and lowest on granular material, with coarsely ground (crushed) material falling between these two.
3. Crushed Super Visbestos, which has been used in the field for several years, consistently fell well below the OSHA regulations as to maximum ceiling limit and 8 hour, time weighted average, (TWA).
4. New Granular Super Visbestos, now available in the field at no extra cost, proved to be from 20% to 50% cleaner than Crushed Super Visbestos.
5. Neither form of Super Visbestos exceeded even the much more stringent TWA level which will become effective in 1976.
6. Based on this test series, Super Visbestos in either form offers a safety margin of 5 to 1 or more, in complying with the limits set by the regulations. Therefore, we believe there is no reasonable expectation of exceeding the legal limits, when using Crushed or New Granular Super Visbestos.

To: Companies in the Drilling Industry

Re: The SAFE use of asbestos in drilling fluids

On June 7, 1972, stringent Federal regulations went into effect on the commercial use of asbestos. The impact of these regulations on the drilling industry has been a source of concern and confusion to suppliers and users, alike.

Because of this, we at Montello determined to ascertain how our unique, wet-refined Super Visbestos would perform, in the context of the OSHA regulations, under the widely varying conditions found on drilling rigs. With the invaluable cooperation and assistance of several companies, four on-site tests and their evaluation have now been completed.

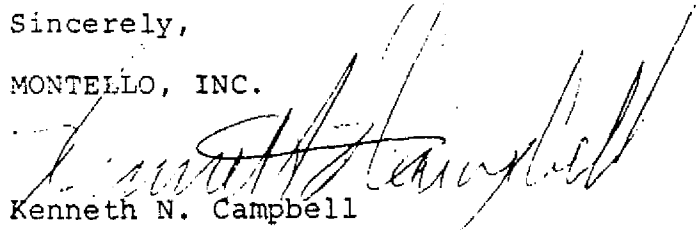
You will find attached, a recap of the more important points found in this study. We'll be pleased to send you a complete, complimentary copy of an extensive report which gives a detailed interpretation of the results from these four on-site tests. Site selection was based on a desire to evaluate the broadest possible range of dumping environments. Three different forms of our asbestos were checked to determine the effects of fine grinding, coarse grinding (i.e. crushing) and granulating, on air entrained dust concentrations.

We believe interested readers will find this report informative. In substance, the results lead us to believe that there is no reasonable expectation of exceeding the limit values imposed by the regulations, when using either Crushed Super Visbestos or the much cleaner New Granular Super Visbestos.

Please contact our Sand Springs office for your copy of the report. We'll respond as quickly as possible.

Sincerely,

MONTELLO, INC.



Kenneth N. Campbell

KNC/jd

Attachment (1)

Montello

P.O. BOX 130, SAND SPRINGS, OKLAHOMA 74063 / (918)-245-6661/TWX 910-840-3007

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**OIL & GAS
JOURNAL**

**Presheared asbestos muds
help cut costs, rotating time**

JOHN L. KENNEDY
Drilling Editor

Reprinted from the June 8, 1970 edition
Compliments of
MONTELLO, INC.

Presheared asbestos muds help cut costs, rotating time

JOHN L. KENNEDY
Drilling Editor

RESULTS of drilling in widely separated areas indicate that the use of presheared asbestos in drilling fluids can help reduce mud costs and rotating time. These drilling fluids are designed as low-solids muds and appear to be finding increased application.

In one of these instances, presheared asbestos was used with bentonite and results were compared to drilling results using a straight bentonite system on an adjacent well. In this Okfuskee County, Okla., comparison, mud costs

for the presheared asbestos-bentonite system were 47.3¢/ft while the straight bentonite system cost 58.2¢/ft.

These two wells, located 660 ft apart, were drilled by the same operator using the same contractor and the same rig, the same mud company and the same mud engineer. Total depth of the two wells was slightly over 4,000 ft and mud-up depth was around 2,700 ft. Casing string in both wells was 8½-in.

A significant savings in drilling time resulted from using the presheared asbestos-bentonite mud over the straight bentonite system. The well using the combination fluid was drilled in 99 rig hr, compared to 140 hr to drill the well on which the straight bentonite system was used.

The bentonite-drilled well required six bits compared to five for the well drilled with the presheared asbestos-bentonite mud.

In Libya, a similar system proved to be competitive with straight bentonite fluids that had been used previously. And this particular well was drilled without any lost-circulation problems, something that had given operators considerable trouble in the past in this area.

The Libya well was drilled to a total depth of 10,068 ft with mud weights varying from 8.7 to 8.9 lb/gal. After an 18½-in. surface string was set, 13½-in. was run to 3,272 ft and a 12¼-in. production string set at TD.

The presheared asbestos-bentonite low-solids mud system was built in a ratio of 1 lb of presheared asbestos to 2 lb of bentonite. But plans for the

next well included using a drilling fluid built in a 1/1 ratio of these materials. In this instance, a fluid-loss control agent was used. The properties of the mud system included a plastic viscosity of 8; yield value of 4; funnel viscosity of 40 sec. and 4-7% solids.

For North Slope drilling, a presheared asbestos-bentonite extended system has been recommended from surface to total depth. In this case, this procedure applies:

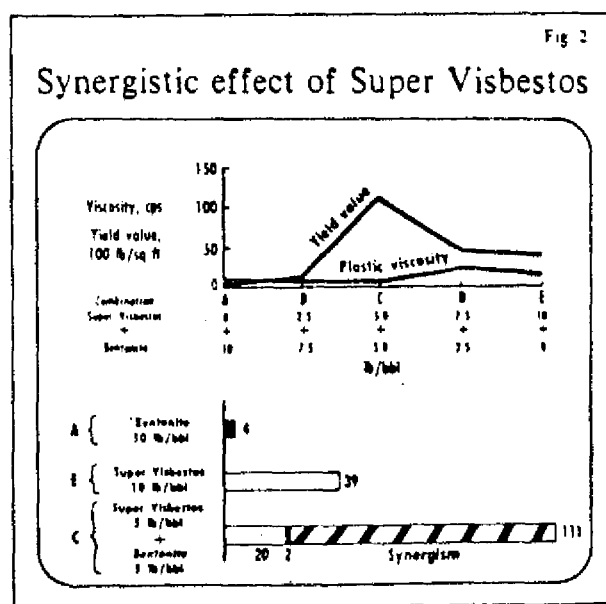
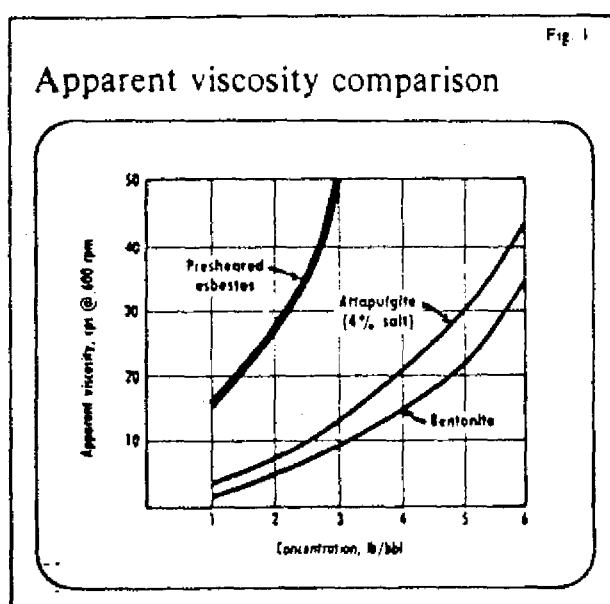
1. Initial surface volume is prepared using freshwater treated with presheared asbestos and bentonite in a 50-50 ratio.

2. Surface volume is then treated with salt to lower the freezing point to the necessary level.

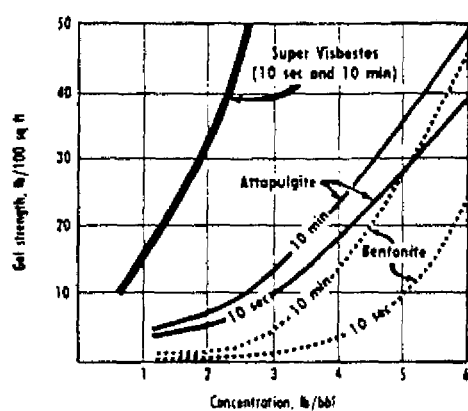
3. The system is then used to drill through the permafrost to the surface casing point. During this interval, presheared asbestos can be added directly to the system for viscosity and hole cleaning when needed. Bentonite can be prehydrated and added to the system when required, and filtration control can be obtained with salt-water fluid-loss agents.

4. Do not discard this fluid after drilling permafrost and setting surface casing—simply discontinue the addition of salt to the mud system and use freshwater for makeup.

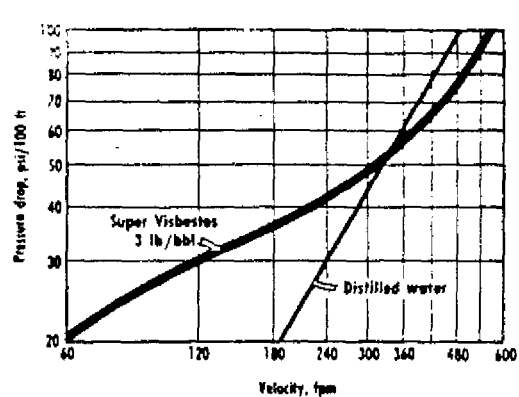
5. This same system is used out from under surface to approximately 3,000 ft where casing is again set. Since no salt was added during this second interval and freshwater makeup was used, the system will be fresh enough to allow mixing of bentonite directly. For maximum yield, 50-50



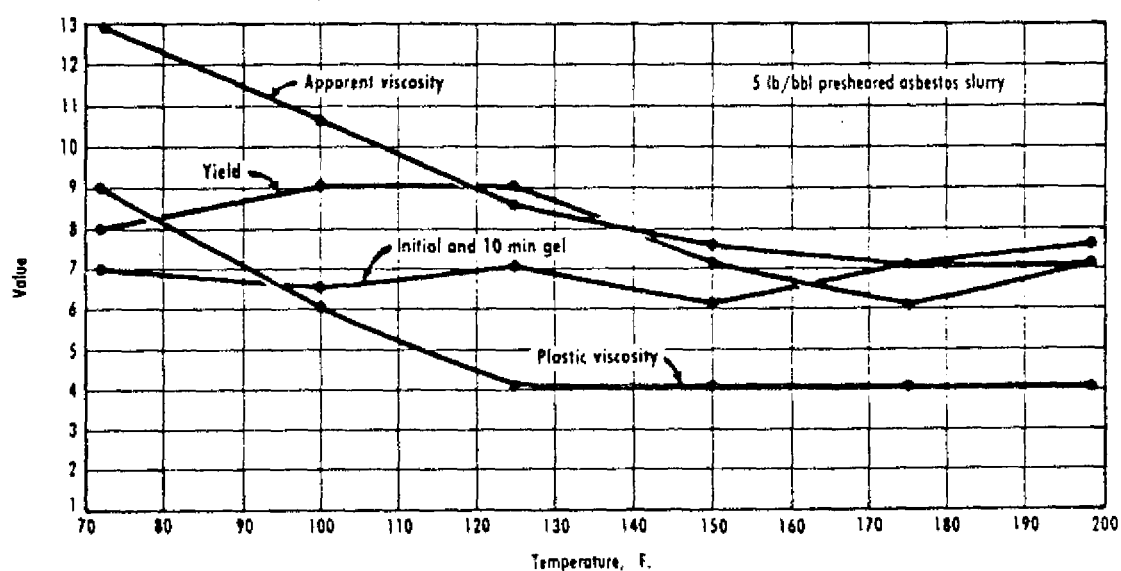
Comparative gel strengths



Shear thinning characteristics



Approximate effect of temperature



concentrations of presheared asbestos and bentonite are used.

6. From second casing point to TD, the drilling fluid system is essentially a freshwater, low-solids, presheared asbestos-bentonite type. Filtration is controlled with a freshwater fluid-loss additive, and shale can be controlled using this same system but with the addition of powdered asphalt materials.

A typical system. A mud system like the one used in Libya is usually built around 2-3 lb/bbl of presheared asbestos and 3-5 lb/bbl of bentonite.

A 50-50 mix usually gives the best hole-cleaning results, but a higher proportion of bentonite is usually recommended when hole stability is a problem.

Using Super Visbestos, a presheared asbestos distributed by Montello, Inc., Sand Springs, Okla., a cost comparison indicates that such a fluid would run in the neighborhood of 52.5¢/bbl compared to a straight bentonite system at about 62.5¢/bbl.

These costs were based on the use of 2½ lb/bbl of presheared asbestos with 2½ lb/bbl of bentonite for the

combination system, and 25 lb/bbl of bentonite for the other fluid.

In addition to a lower initial cost, manufacturers of the presheared asbestos additives cite other possible savings including lower mixing costs; lower hauling costs; less water requirements; reduced chemical treatment cost; and higher penetration rates.

Presheared asbestos-bentonite systems will usually give some hole stabilization and a small amount of fluid-loss control. Then if necessary, a fluid-loss control agent can be used

to lower the yield value. Such a system is applicable in any area.

To get proper cleaning, a drilling fluid's yield point and plastic viscosity are important properties. Table 1 indicates the effect of these variables on the settling time of solids in a flocculated solids settling test. Another important consideration in cuttings transport is annulus flow profile. If this profile is turbulent, cuttings slippage is increased and cuttings can fall faster than the average annular rate causing a hole-cleaning problem.

If hole cleaning is critical and an adjustment of annulus flow does not help, yield value can be raised with asbestos. Montello recommends, however, when using their product that before raising the yield value too high the hole should be flushed clean with

a 20-50-bbl slurry containing 3 lb/bbl of presheared asbestos. Or it can be done by adding 75-100 lb of the material directly into the mud system through the mud hopper. This flushing

operation can be repeated as needed with frequency ranging from once a day to twice a tour. And it should be done just before making a trip, according to Montello.

Of course, good solids removal techniques are essential to the performance of low-solids systems. Both chemical and mechanical means can be used to accomplish this.

Some properties. Presheared asbestos has grown in use recently, its advantages stemming from the fact that the carefully controlled shearing process at the point of manufacture provides a high degree of fiber separation quickly at the well (OGJ, Oct. 28, 1968). Properties of presheared asbestos compared with those of other mud-system additives are shown in Fig. 1-5.

END

Table 1
Settling tests

Weight	Density of floc lb/gal	Pv	Yp	Settling time for 50% solids settling (min/ft)
8.3	10.4	1.0	0	1/2
8.3	10.4	2.0	0.5	1
8.3	10.4	2.0	1.0	2
8.3	10.4	2.0	2.0	8
8.3	10.4	4.0	4.0	27
8.3	10.4	8.0	8.0	88
9.0	11.0	4.0	4.0	30
9.0	11.0	8.0	8.0	97
10.0	11.8	4.0	4.0	34
10.0	11.8	8.0	8.0	112

SUPER VISBESTOS PROVIDES HIGH YIELDS ALMOST INSTANTLY

A message of special interest to drilling superintendents and those responsible for writing drilling mud programs, distributed courtesy of Montello, Inc. For more information and extra copies of the reprint, write Montello at P.O. Drawer 130, Sand Springs, Okla. 74063.



REGULAR ASBESTOS
(Dry Processed)
Only 50% Separation



SUPER VISBESTOS
(Wet Processed-Presheared Asbestos)
Over 98% Separation

Super Visbestos is produced, exclusively for Montello, Inc., by chemically and hydraulically shearing a top-grade chrysotile asbestos, through a unique, proprietary, wet-process. This process produces a high degree of asbestos fiber separation.

The high degree of fiber separation (i.e. yield) provided almost instantly with Super Visbestos is impossible to achieve using regular dry processed asbestos in the field even after days of circulation and mixing.

A study of data below reveals the advantages of Super Visbestos.

(Tests Were Run By A Major University)

SUPER VISBESTOS VS. REGULAR ASBESTOS

Fann VG Meter	Super Visbestos 5 LBS./BBL	Regular Asbestos 5 LBS./BBL
Apparent Viscosity	14.5	7
Plastic Viscosity	11	6
Yield Point	7	2
Initial Gel	5	3

MONTELLO, INC.
P.O. DRAWER 130
SAND SPRINGS, OKLAHOMA 74063
24 HOURS: 918 245-6661

ASBESTOS DRILLING FLUID ADDITIVE'S EFFECT ON PRODUCING FORMATIONS

The following report is respectfully submitted in answer to questions which have arisen concerning what effect asbestos fibers as used in drilling or workover fluids might have on production zones, and of equal importance, what effect 15% hydrochloric acid has on these same asbestos fibers. There are six general types of asbestos fibers: chrysotile, amosite, actinolite, crocidolite, anthophyllite and tremolite. All of the above asbestos fibers carry a negative charge with the exception of chrysotile, which carries a positive charge.

Until recently, chrysotile asbestos products as used in drilling and workover fluids were dry processed and most available data has been accumulated on such materials. With the introduction of wet processed, presheared Super Visbestos, there is a new innovation in asbestos processing. Most of the chrysotile asbestos used in drilling fluids today is produced from California asbestos ore. This ore assays at approximately 60% pure asbestos with the remaining 40% being a white serpentine type rock.

Dry processing of asbestos fibers consists of grinding dry ore and cleaning the asbestos through screens, cyclones and dust collectors. the purity of dry processed asbestos drilling fluid additives varies from 58% to approximately 90%.

Wet processing of asbestos fibers consists of repeated washing and opening of asbestos ore, with rock and dust removal through floatation. This produces a finished product with a purity of approximately 99%. While still wet the asbestos is then presheared or defiberized to produce Super Visbestos, with 98% open fiber as compared with 50% open fiber for dry processed asbestos materials.

A detailed study on the effect of acids on dry processed asbestos materials entitled "Fibrous Silicates" was made in 1966 by Mr. A. A. Hodgson of the Royal Institute of Chemistry at 30 Russell Square in London, England. This study revealed that chrysotile asbestos possesses such little resistance to acid that it may be decomposed by strong acetic acid, also that dry processed chrysotile asbestos refluxed in 4.0N hydrochloric (HCL) acid would rapidly decompose. Weight losses amounted to approximately 60% in the first 15 minutes of immersion. The higher the normality of acid, the more complete and the faster the chrysotile fiber is decomposed. As reported by an oilfield acidizing company, a 15% hydrochloric acid, which is normally used in oil well and gas well acidizing, is equivalent to a 4.4N.

It should be added that the rate of decomposition of chrysotile asbestos fibers by HCL acid is a direct function of the exposed surface area of the fibers. There are structural differences between the major

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Page 2:

groups of asbestos fibers which account for the rapid decomposition of the chrysotile asbestos by acids.

When a chrysotile fiber reacts with strong acid, the whole of its (MgOH) layer is rapidly removed leaving at most a very porous skeleton of the individual fiber.

Recent tests performed by a major mud service company on a Berea sandstone core subjected to salt water containing chrysotile asbestos fibers showed "0" permeability damage after being treated with a 15% solution of hydrochloric acid.

"Summary"

1. Deposition of chrysotile asbestos fibers in the bore hole of a well is reversible. It can be decomposed and removed with a 15% HCL solution. Only chrysotile asbestos is used in the manufacturing of Super Visbestos.
2. The rate of the decomposition of chrysotile asbestos in HCL is a direct function of the surface area of the asbestos fibers. Super Visbestos (the only wet processed, presheared chrysotile asbestos drilling fluid additive) has 300 to 400% greater surface area than the other materials which are dry processed.
3. Some asbestos drilling fluid additives contain impurities which are not soluble in HCL. Super Visbestos is approximately 99% pure chrysotile. Dry processed asbestos drilling mud additives purity varies from 58% to approximately 90%.
4. Greater fiber liberation means greater efficiency and correspondingly fewer pounds per barrel required when treating drilling fluids. Super Visbestos with 98% fiber liberation as compared to 50% fiber liberation of the dry processed materials simply means that only one-half as much material is needed to produce the desired results when using Super Visbestos. Therefore, the wall cake of a Super Visbestos drilling fluid system contains only one-half as much chrysotile asbestos as the dry processed asbestos drilling fluid.

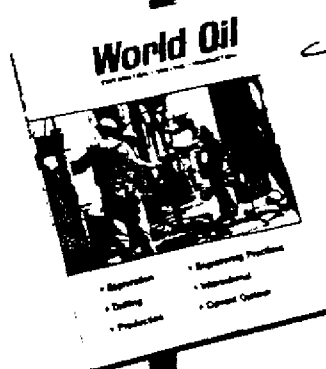
Conclusions:

Therefore, due to Super Visbestos'

- Greater fiber separation, 98% versus 50%
- Greater surface area, 3 - 4 times more
- Higher purity, 99% versus 90%
- Higher efficiency, (only one-half as much required)

Super Visbestos should be used instead of dry processed asbestos material as a drilling or workover fluid additive.

Harry M. Wyatt
 MONTELLO, INC.
 P. O. Box 130
 Sand Springs, Oklahoma 74063
 A.C. (918) 245-6661



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020477

Asbestos in drill water helps cut drilling costs

Reprinted from
September 1965

World Oil



A GULF PUBLISHING
COMPANY PUBLICATION

3301 Allen Parkway
Houston, Texas

William C. Smith, Drilling Superintendent,
Capitan and Highland Drilling Companies,
Odessa, Texas

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Asbestos in drill water helps cut drilling costs

Capitan and Highland Drilling Companies have increased penetration rates in West Texas

William C. Smith, Drilling Superintendent, Capitan and Highland Drilling Companies, Odessa, Texas

20-second summary

Asbestos added to drill water has been found effective in retaining good water penetration rates along with recovery of good samples. The asbestos can be added to fresh or salt water directly through the mud hopper. The asbestos has been found compatible with all mud additives used in West Texas drilling operations.

CAPITAN AND HIGHLAND DRILLING COMPANIES of Odessa, Texas, have achieved water penetration rates along with good samples by adding an asbestos material to the drill water (Figure 1).

Asbestos, an inorganic material, increases the carrying capacity and suspending ability of drill water. It can be used in fresh, salt or a mixture of both with a minimum of solids. Since it is chemically inert, it does not control water loss or cause water to gel. The material requires no new equipment at the rig for handling. It is added to the mud system through the mud hopper.

To continue reducing drilling costs, it is essential that every means possible be used to increase rock bit penetration rates. After analyzing each foot of hole to be drilled and applying optimum drilling technique, it is

possible, in many cases, to lower the footage price. This can be done in cooperation with the operator by reducing the amount of hole that is drilled with mud to recover good samples.

Since 1958 the West Texas drilling industry has been able to increase over-all penetration rates about 20 percent. This has been done by using improved hydraulic programs, correct bit selection, more drill collar weight, and using clean water or brine as drilling fluid.

Results of a recent McElroy Field study of wells drilled with a chemical mud from 1958 to 1960 compared with wells drilled in 1963 and 1964 with brine, or very low solid muds, showed the later wells had a 15-18 percent higher penetration rate. Clean water as a drilling fluid, of course, produces the fastest hole.

Although water cannot always be used as a drilling fluid because of hole conditions, much footage drilled today with mud could be water drilled if good formation samples could be obtained.

Since most wells are contracted on a footage basis to total depth, the upper, or faster drilled, part of the hole is where the contractor usually makes the most money.

The top hole is almost always drilled with water, but the lower part of the hole is where the most improvement can be made in penetration rates. Too many times—just because only a few hundred feet or at most a thousand feet are involved—a contractor does nothing about trying to improve the drilling fluid program.

Capitan and Highland Drilling Companies had drilled some 9,300-foot wells in Ector County, Texas, and were



FIG. 1—Samples in this photograph on the right were taken while drilling with water, and the larger samples on the left were after adding asbestos to the water.

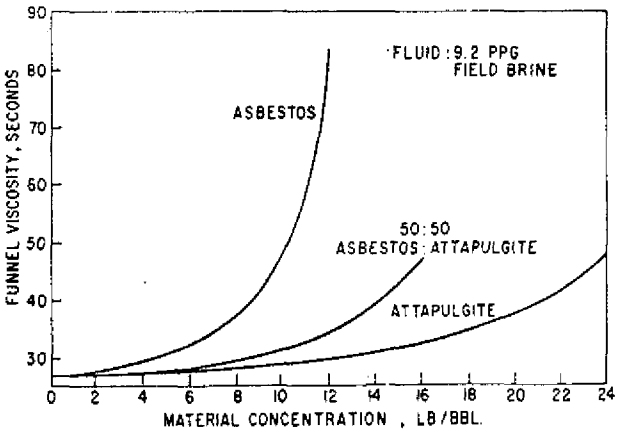


FIG. 2—Funnel viscosity vs. various material requirements.

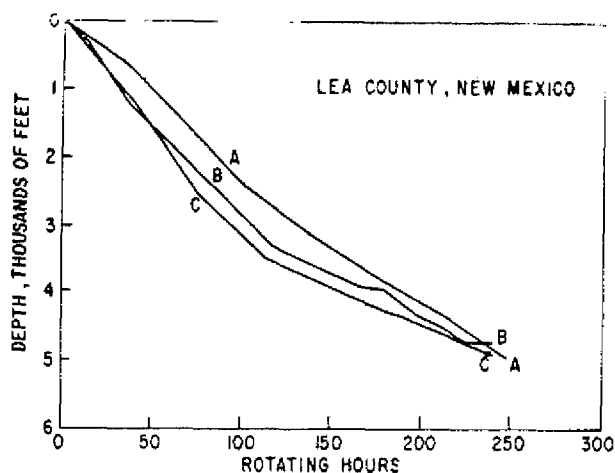


FIG. 3—Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 32-second viscosity was maintained as samples were desired from 900 feet.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B	WELL C
Footage	4,847	4,733	4,908
No. of bits	8	10	7
Avg. ft./bit	606	473	701
Avg. ft./hour	19.9	19.6	19.9
Bit size	17½"	17½"	17½"
Rotating hrs.	243	241	247

required to mud-up at 6,900 feet so the geologist could recover good samples. After study of the problem and discussions with mud and bit company engineers, it was decided that water could be used to safely drill to 8,500 feet.

Drilling bids were recalculated assuming that from 6,900-7,900 feet the increase in penetration with water versus mud would be 90 percent, and that from 7,900 to 8,500 feet the increase would be 75 percent, not considering savings in bit cost. The operator then was offered a choice of price reductions on the bid of 15 cents per foot if the mud-up point was lowered to 7,900 feet and 20 cents per foot if lowered to 8,500 feet. This is a savings per well, to the operator, of \$1,395 and \$1,860, respectively. To the contractor, this meant an added profit of 5 to 10 cents per foot.

To allow recovery of good samples while drilling with water, a new long fiber asbestos material was tested. Addition of this asbestos material to the drilling fluid was designed to allow good sample recovery and still maintain penetration rates near that of water. Capitan and Highland Drilling Companies added this asbestos material at 6,700 feet to the drilling fluid and achieved penetration rates about 95 percent of those expected with water.

In many cases, the same funnel viscosity can be achieved with as little as 25 percent of the material requirements as when bentonite or attapulgit is used. Figure 2 indicates the funnel viscosity versus material requirements.

The asbestos material was found compatible with all

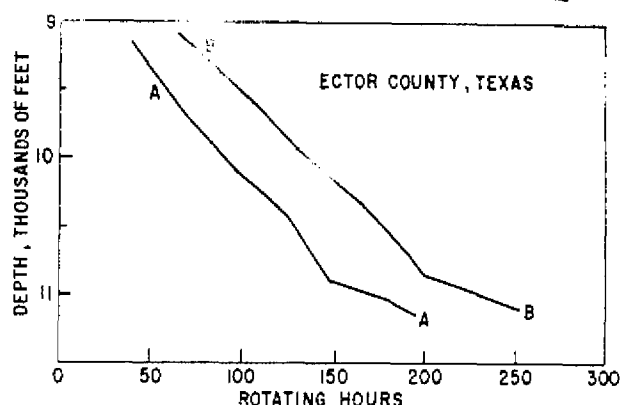


FIG. 4—These wells were drilled in the same field with comparable rigs but by different contractors. Well A drilled this interval with water, 6-percent oil and emulsifier. Well B drilled this interval with water and asbestos to secure good samples. Fluid properties were 8.5 ppg, with a viscosity of 35-38 seconds.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B
Footage	2,649	2,955
No. of bits	8	8
Rotating hrs.	194	252
Avg. feet/bit	331	369
Avg. feet/hour	13.6	11.7
Bit size	8¾"	8¾"

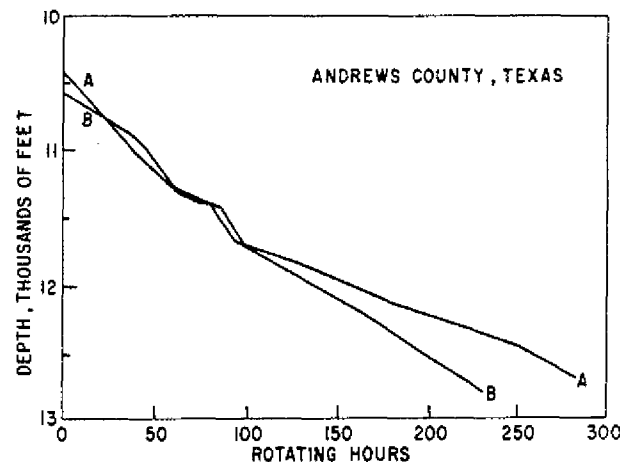


FIG. 5—These wells were drilled by the same contractor, same rig, and same operator. Well A was drilled to 11,700 feet with water, 6-percent oil and emulsifier. At this depth a low viscosity sample mud with fluid loss control was added. Well B was drilled to 11,700 feet with water, 6-percent oil and asbestos. At depth a fluid loss control agent was added. For recovery of good samples, hole conditions required the introduction of asbestos. Fluid properties were 8.5 ppg, viscosity 34-40 seconds.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B
Footage	2,198	2,407
No. of Bits	10	7
Rotating hrs.	283	231
Avg. ft./bit	220	344
Avg. ft./hour	7.7	10.4
Bit size	7⅞"	7⅞"

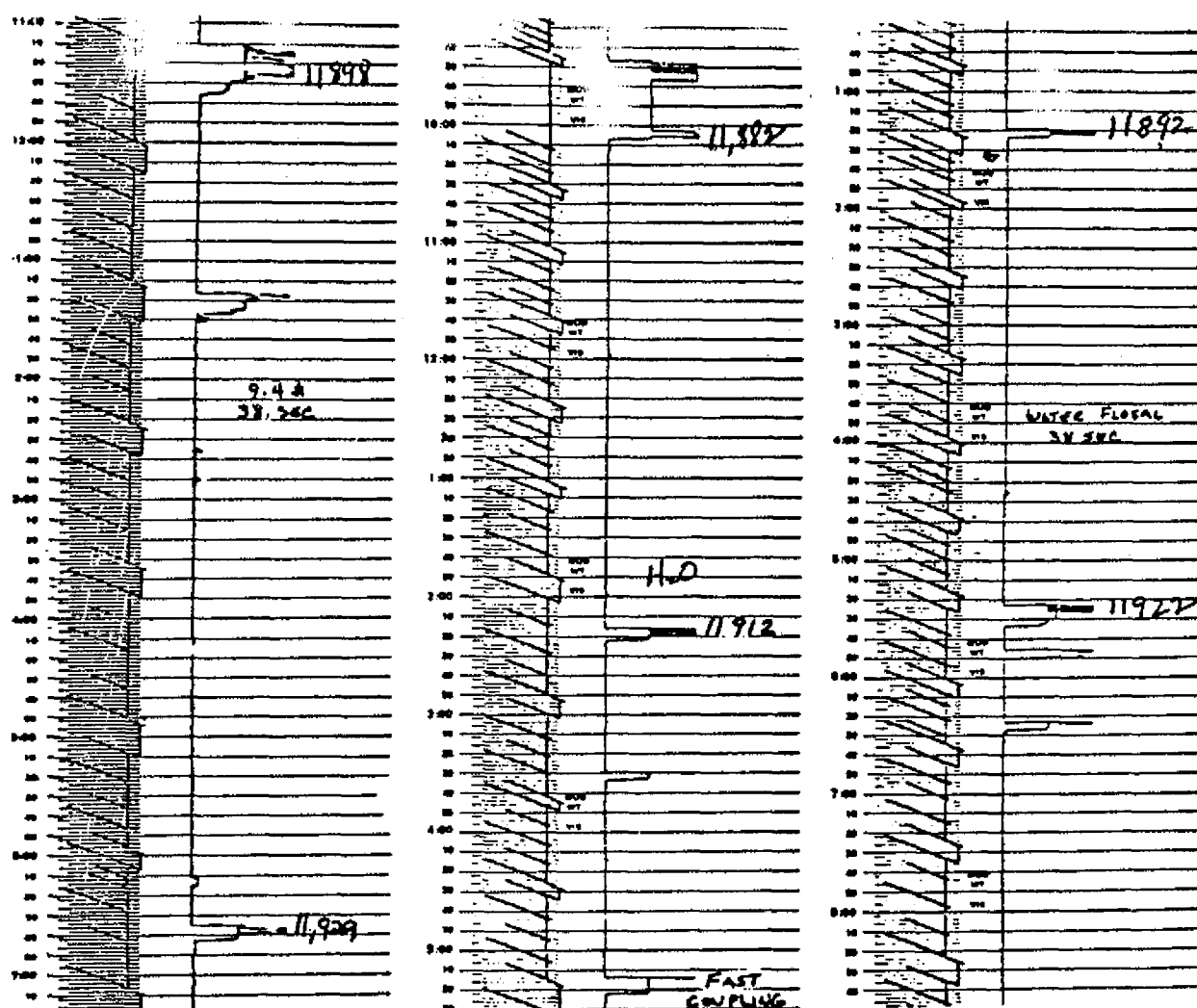


FIG. 6—These wells were drilled by the same contractor, same rig, same operator. Well A was drilled with bentonite sample mud, no water loss control. Well B was drilled with water and 6-8 percent oil. The increase on penetration over mud was

about 27 percent for the interval shown. Well C was drilled with water and asbestos. The increase on penetration over mud was about 39 percent for the interval shown. Asbestos was added to obtain good samples.

mud additives used in West Texas drilling operations. However, in lost circulation zones such as the San Andres, the asbestos material can be dangerous in wall sticking, if not used along with a water loss control agent.

Figures 3, 4, and 5 indicate comparative penetration rates for water and brine versus water and brine with asbestos added.



About the author

WILLIAM C. SMITH is drilling superintendent for Capitan and Highland Drilling Companies in Odessa, Texas. He was graduated from Texas A & M University in 1945 with a B.S. degree in chemical engineering. Prior to joining Capitan and Highland Drilling Companies, he worked 11 years with Baroid Division of The National Lead Company. Smith is an active member of the API, AIME and AAODC.

Figure 6 compares three drilling rate charts of development wells drilled in the same field in San Andrews County, Texas. This is a case where the operator needed samples for the interval. A bentonite sample mud without water loss control was used in Well A. In an attempt to reduce cost, water and oil were substituted for mud in Well B. The drilling rate increased about 29 percent, but samples recovered were not satisfactory.

In Well C, use of the asbestos material and water increased the drilling rate about 37 percent and did produce good samples. The operator is continuing to use this drilling fluid program in development work.

It is through research and development of specialized techniques and continued cooperation of service companies, contractors and operators that drilling prices can be kept in line.

This article is based on a paper titled "Good Samples with Water Penetration Rates," presented at the Spring Meeting of the Southwestern District Meeting of API in Dallas, March 10-12, 1965. ■



TECHNICAL REPORT # VIS 66-6

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISBESTOS

Problem: Quick viscosity and increased carrying capacity of mud required to keep hole clean.

Location: North Dakota

Depth: 9,700 feet

Drilling Fluid: Salt water and attapulgite

Temperature: Normal for area

Solution: A major oil company while drilling in North Dakota needed to build viscosity quickly and also to increase the cutting carrying capacity of the drilling fluid to help keep the hole clean.

VISBESTOS, (a high grade chrysotile asbestos compound), was added at pump suction through mud hopper to a concentration of approximately 3#/SSL.

The VISBESTOS was added slowly allowing about 15 minutes per 50# bag for maximum shear.

The desired viscosity was obtained in one round trip. Both the operator and mud service company were very pleased with the quick, economical results obtained using VISBESTOS.

Their only complaint -- "We could have done the job with less VISBESTOS!!!!!!"



020482

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

Visbestos and Super Visbestos

are just like love—
you must ask for it
by brand name to get it

Specify Visbestos or Super Visbestos by brand name on your next location . . . We guarantee they are better—our customers say much better—than competitive priced asbestos products.

- ★ Adequate stocks in your area
- ★ 24-hour service through your favored mud service company

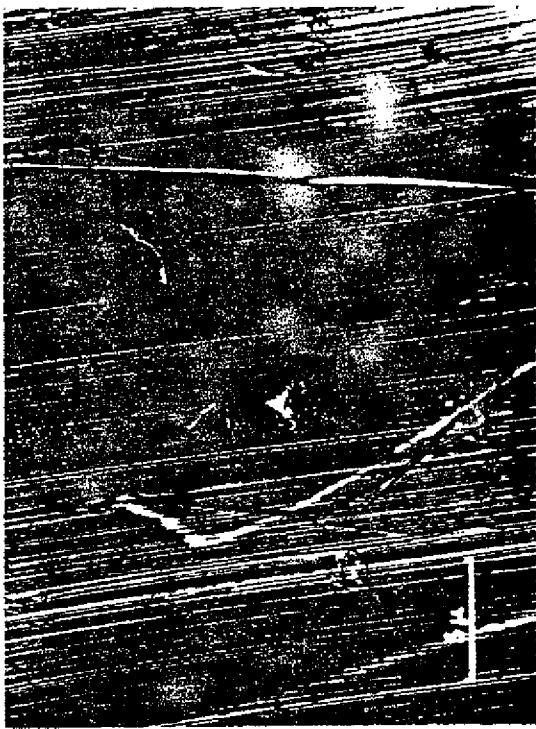
OR CALL

Monahans, Texas—943-4781—Montello, Inc.
Sweetwater, Tex.—BE 4-2498—Glasgow Trucking

FOR

**PICK UP, WAREHOUSE OR DELIVERED
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Visbestos and Super Visbestos are produced from Calidria asbestos,
the best asbestos that money can buy.



Typical Canadian asbestos fiber structure



Typical Calidria asbestos fibers



Dry processed asbestos fibers



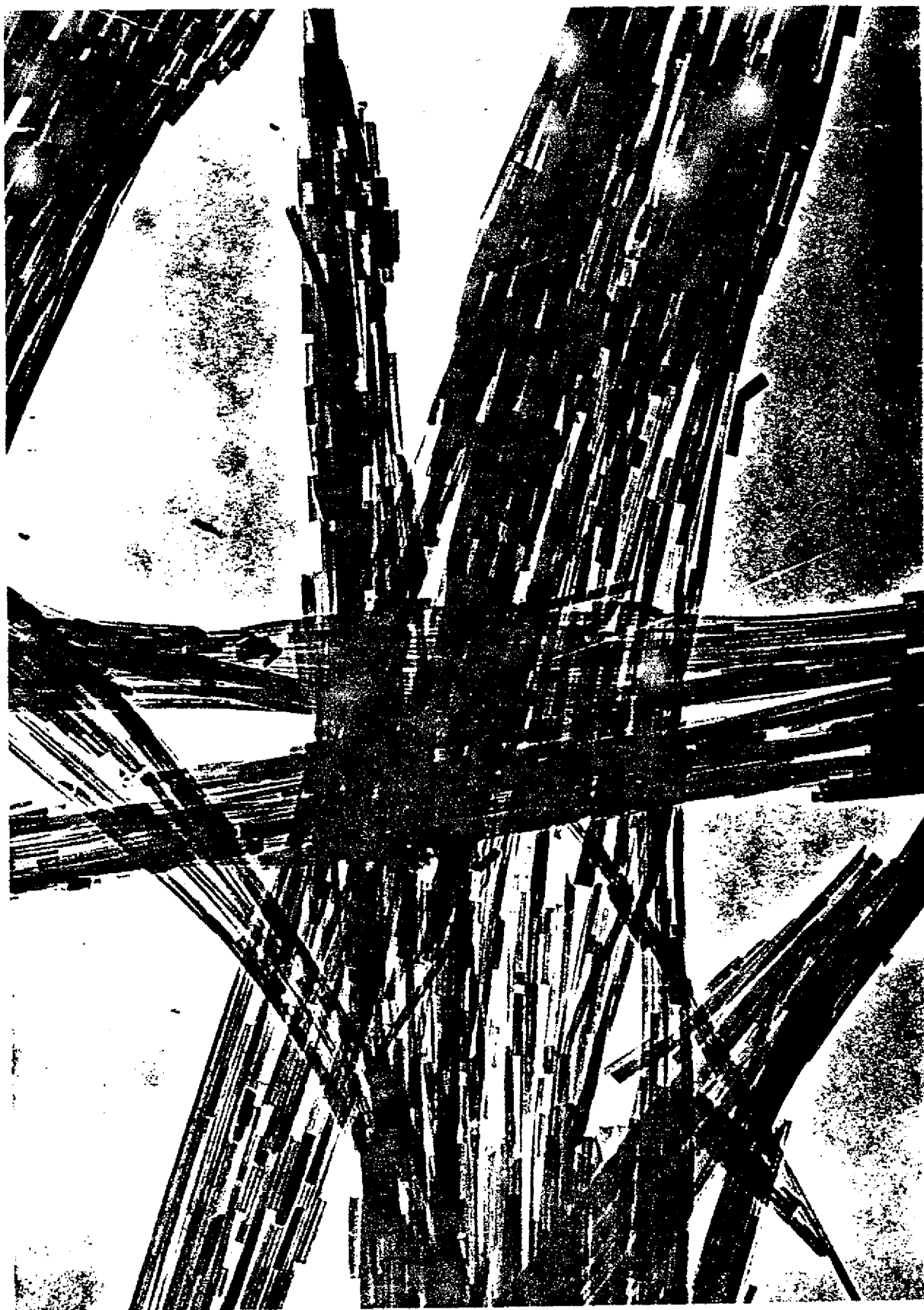
Wet processed Calidria asbestos fibrils



Electron Micrograph of typical Canadian asbestos fiber structure



Electron Micrograph of typical Calidria asbestos fibers



Electron Micrograph of dry processed asbestos fibers



Electron Micrograph of wet processed Calidria asbestos fibrils

020488

To: Companies in the Drilling Industry

Re: The SAFE use of asbestos in drilling fluids

On June 7, 1972, stringent Federal regulations went into effect on the commercial use of asbestos. The impact of these regulations on the drilling industry has been a source of concern and confusion to suppliers and users, alike.

Because of this, we at Montello determined to ascertain how our unique, wet-refined Super Visbestos would perform, in the context of the OSHA regulations, under the widely varying conditions found on drilling rigs. With the invaluable cooperation and assistance of several companies, four on-site tests and their evaluation have now been completed.

You will find attached, a recap of the more important points found in this study. We'll be pleased to send you a complete, complimentary copy of the five reports which document the tests. The first is an interpretation of the overall results of the series. The next four cover the details of each of the on-site tests. Site selection was based on a desire to evaluate the broadest possible range of dumping environments. Three different forms of our asbestos were checked to determine the effects of fine grinding, coarse grinding (i.e. crushing) and granulating, on air entrained dust concentrations.

We believe interested readers will find this report both detailed and informative. In substance, the results lead us to believe that there is no reasonable expectation of exceeding the limit values imposed by the regulations, when using either Crushed Super Visbestos or the much cleaner New Granular Super Visbestos.

Please contact our Sand Springs office for your copy of the report. We'll respond as quickly as possible.

Sincerely,

MONTELLO, INC.

Kenneth N. Campbell

KNC/jd

Attachment (1)

Montello

P.O. BOX 130, SAND SPRINGS, OKLAHOMA 74063 / (918)-245-6661/TWX 910-840-3007

A study covering airborne dust concentrations in drilling fluid operations using wet-refined asbestos has been completed. The following are some of the more important points to consider:

1. All tests were performed using Montello's exclusive wet processed asbestos products. The findings cannot be safely applied to any of the several dry ground products on the market.
2. Fiber counts were highest on fine ground material and lowest on granular material, with coarsely ground (crushed) material falling between these two.
3. Crushed Super Visbestos, which has been used in the field for several years, consistently fell well below the OSHA regulations as to maximum ceiling limit and 8 hour, time weighted average, (TWA).
4. New Granular Super Visbestos, now available in the field at no extra cost, proved to be from 20% to 50% cleaner than Crushed Super Visbestos.
5. Neither form of Super Visbestos exceeded even the much more stringent TWA level which will become effective in 1976.
6. Based on this test series, Super Visbestos in either form offers a safety margin of 5 to 1 or more, in complying with the limits set by the regulations. Therefore, we believe there is no reasonable expectation of exceeding the legal limits, when using Crushed or New Granular Super Visbestos.

AIRBORNE ASBESTOS DUST CONCENTRATIONS

in

DRILLING FLUID OPERATIONS

using

WET-REFINED ASBESTOS

This report provides a general interpretation of the overall results from four on-site evaluations. Individual reports on each are appended for reference.

H. B. Rhodes

&

E. J. Kleber

PLEASE NOTE: Companies co-operating in these tests are customers of Montello and conducted the tests to ascertain that their use of the product complies with standards set forth in the Federal Occupational Safety and Health Act. Results of these tests are made available to other companies solely for their use in making their own evaluations of procedures to be followed in using the material. No representations are made, nor are to be implied, from this report as to the safety of this material no matter how it is used.

UNION CARBIDE CORPORATION
Mining & Metals Division
Niagara Falls, New York

February 22, 1973

A survey has been made to examine the levels of asbestos dust that may occur when wet-refined asbestos is used as an ingredient in drilling fluids. Both open-air and enclosed dumping operations were checked. A range of dumping rates from 10 to 80 sacks per hour was used.

Tests were run with three types of wet-refined asbestos:

1. A fine-ground hydrophobic asbestos known commercially as Arcovis 953. (2)
2. A coarse-ground asbestos known commercially as Super-Visbestos.
3. A new version of Super-Visbestos in the form of 1/8" granular pellets.

It is important to emphasize that the dust levels reported herein are specific for the wet-refined asbestos types described and do not apply to dry-processed California or Canadian asbestos.

The reports giving the details of the dumping and sampling at four locations and the raw data obtained are appended for reference. This report provides a more general interpretation of the overall results.

SUMMARY AND CONCLUSIONS

The highest dust level measured during any of the nine dumping operations tested was 5.5 fibers/cc. greater than 5 micrometers in length⁽¹⁾ which is over 55% of the allowable ceiling concentration. This level occurred during the dumping of the fine-ground product in a small enclosed area to simulate North Slope conditions and is not typical of routine mud operations. The more representative tests gave results below 2 fibers/cc. which is less than 20% of allowable.

Time-weighted average values were calculated for all dumps on the basis of one dumping period per shift and a background exposure of 0.3 fiber/cc. during the time asbestos was not being handled. The highest value found in any of the dumps was 0.7 fibers/cc. for North Slope conditions with 0.3-0.4 fibers/cc. typical of normal operations. The latter values are less than 10% of the current allowable value of 5 fibers/cc. and 20% of the projected value of 2 fibers/cc. in 1976.

As would be expected, the new-granular product gave much less dust, i.e., 20-50%, than the coarse-ground Super-Visbestos.

CALCULATION PROCEDURES

The OSHA regulations permit exposure to a ceiling concentration of 10 fibers/cc. and an 8-hour time-weighted average exposure of 5 fibers/cc. In this work, the ceiling concentration occurred in the breathing zone of the operator during the dumping of the asbestos and is reported directly as measured.

(1) For convenience, in this discussion the term "fibers/cc." will be taken to mean the entire term, "fibers/cc. greater than 5 micrometers in length."

(2) Use of this product is covered by U.S. Patent No. 3,618,680.

020432

The 8-hour time-weighted average is basically a simple concept that can be expressed as:

$$\text{T.W.A.} = \text{Time-Weighted Average} = \frac{\left\{ \begin{array}{l} \text{Fibers/cc. in a} \\ \text{particular sample} \end{array} \right\} \left[\begin{array}{l} \text{Time in hours over which the} \\ \text{particular sample was collected} \end{array} \right]}{8}$$

Where: Σ = Summation of samples collected over the 8-hour period.

In order to be strictly correct, it is necessary to sample over the entire 8-hour period to define the TWA. In these tests, however, only a short post-dump sample was obtained. Normally, at a well, an operator dumps for a short period once a shift (or tour) and spends the remainder of the time out of the immediate dump area. It is thus reasonable to estimate the TWA for the operator as a combination of the ceiling concentration (measured) exposure during the dump and a background exposure for the remainder of the shift. The data obtained in this work indicate a reasonable and probably conservative (high) value for the background of 0.3 fibers/cc. This number will be used in the calculation of 8-hour TWA values.

REVIEW OF DATA

Dust counts have been obtained at four locations: three by Union Carbide and one by [REDACTED]. Complete reports are appended for reference.

In this section, the data are reviewed and the technical basis for the background level assumption just described is provided. An 8-hour time-weighted average value is also calculated for each dump.

[REDACTED] Central Oklahoma Well Location

In this test, 20 sacks of regular Super-Visbestos were dumped over a 21-minute period. After a wait of about 10 minutes, 20 sacks of the New Granular Super-Visbestos were dumped over a 26-minute period.

The fiber count data for the airborne dust samples obtained is shown graphically in Figure 1. The figure gives fiber count as a function of elapsed time.

The ceiling concentration sample taken in the breathing zone of the operator during the dump of regular Super-Visbestos gave a count of 1.9 fibers. When granular Super-Visbestos was dumped 10 minutes later, the count was down to only 0.4 fibers. During these same periods, the downwind counts were 0.51 and 0.31 fibers, respectively, while upwind values of <0.1 and 0.15 fibers were found. The wind was a light, somewhat variable breeze so all of these values seem reasonable and internally consistent.

Note that the highest environmental sample found (Position 3, downwind) was only 0.5 fiber and this occurred during the dumping of the ground Super-Visbestos. With granular Super-Visbestos the maximum seen was 0.3 fiber or less. The assumed value of 0.3 fiber for the background level when no asbestos is being handled thus seems reasonable.

Note that both environmental samples (Positions 1 and 3) were 0.3 fiber or below during the granular Super-Visbestos dump. The assumed value of 0.3 fiber for the background level when no asbestos is being handled thus seems reasonable.

The data in Figure 1 can be used to estimate TWA values for both types of asbestos dumped. For the regular Super-Visbestos, consider the exposure to be 1.9 fibers for the 30-minute period covering both the dump and subsequent time until the lower reading was obtained. For the remaining 7-1/2 hours of the shift, it is assumed that the operator dumps no more asbestos and is exposed to a background level of 0.3 fibers.

Thus:

$$TWA = \frac{(1.9 \text{ fibers}) (0.5 \text{ hours}) + (0.3 \text{ fibers}) (7.5 \text{ hours})}{8 \text{ hours}}$$

$$TWA = \frac{3.21}{8} = 0.4 \text{ fibers}$$

This is only $(0.4) (100)/5 = 8\%$ of the allowable exposure level.

For the granular Super-Visbestos, consider the exposure to be 0.4 fibers for 0.5 hour and the assumed background of 0.3 fibers for 7.5 hours. Thus:

$$TWA = \frac{(0.4) (0.5) + (0.3) (7.5)}{8} = 0.3 \text{ fibers}$$

This is 6% of the allowable TWA.

Location Near Houston, Texas

The next series of tests to be examined were run at [redacted] on September 25 and 26, 1972. These tests were intended to simulate conditions on the North Slope. Dumping was done in a small, covered enclosure about 10' x 11' x 9' high. Dumps were made with one side open 8' to approximate normal conditions and with everything closed as occurs in the Arctic during extremely cold and windy weather. Finely-ground hydrophobic asbestos (Arcovis 953) and granular Super-Visbestos were dumped on successive days.

Finely-Ground Hydrophobic Asbestos: In the first day's test, 30 sacks of Arcovis 953 were dumped in 29 minutes with the 8' door open. Dust levels were monitored during the dump and for a 1-1/2 hour period thereafter.

Approximately 2-1/2 hours later the door was closed and 30 more sacks of Arcovis were dumped in 36 minutes. Dust levels were again measured during the dump and for about 1-1/2 hours thereafter. The data are shown in Figure 2 with the airborne asbestos dust concentration in fibers/cc. greater than 5 micrometers given as a function of elapsed time.

The exact sample point locations referred to in the figure are shown in the appended report. They are approximately:

1. In a "dead" corner adjacent to the door.
2. Directly over the hopper. (The hopper is near the wall on the opposite side from the door.)
3. Breathing zone of operator during dump.
4. Over empty sacks in rear corner near hopper.

During the first dump, with the door open, the ceiling concentration sample from the operator's breathing zone gave a level of 1.3 fibers. All of the other samples were 0.3 fiber or less.

In the second dump with the room closed tightly, the breathing zone (#3) and the sample directly over the hopper were very close at 5.5 and 5.2 fibers, respectively. When the dump was finished, the level over the hopper (#2) then dropped sharply to 0.5 fiber. At the same time, the level at Point 4, near the hopper but over the empty bags was only 0.3 fiber.

In normal practice in the Arctic, the dump is made and the operator leaves the area entirely. On this basis, it would be reasonable to use a value of 0 fibers for the time outside of the dump in estimating the TWA exposure. In order to keep the data directly comparable with the other locations covered in this report, however, the value of 0.3 fiber will be used. The results in Figure 2 also corroborate that the 0.3 level for general background is probably high.

The data can be used to estimate the TWA values for both the open and closed dumps. For the open dump, consider the exposure to be 1.3 fibers for 1/2 hour and 0.3 fiber for 7-1/2 hours.

Thus:

$$TWA = \frac{(1.3)(0.5) + (0.3)(7.5)}{8} = 0.4 \text{ fiber}$$

For the closed-door dump, the values are 5.5 fibers ~2/3 hours and 0.3 fibers for the remaining 7-1/3 hours to give:

$$TWA = \frac{(5.5)(2/3) + (0.3)(7-1/3)}{8} = 0.7 \text{ fibers}$$

Granular Super-Visbestos: In the second day's test, 30 bags of granular Super-Visbestos were dumped in 29 minutes with the door opening closed off. Dust levels were monitored during the dump and for a 1-1/2 hour period thereafter. The door was then opened and 30 more bags were dumped in 30 minutes. Dust levels were again measured during the dump and for approximately 1-1/3 hours thereafter. Sample collection points were at the same locations just described. The data are shown in Figure 3 in the same coordinates as Figure 2 but at different scales.

Before examining the data, it should be recalled that on the previous day, a more dusty product, Arcovis 953, had been dumped with the building closed. Sample Point #1 gave a reading of 1.0 fibers on a sample collected during and after the Arcovis dump. (See Figure 2)

During the first Super-Visbestos dump shown in Figure 3, Point 1 gave a value of 0.8 fiber. This dropped sharply to only 0.1 fiber when the door was opened. Also, a background sample taken over the hopper before the start of this dump had a reading of 0.7 fiber. This suggests that the closed room at the start of these dumps contained a level of 0.7 - 0.8 fibers as a residual from the previous days' tests.

During the second dump, with the door open, the breathing zone (#3) and hopper (#2) samples were both only 0.4 fiber. The formerly "dead" area (#1) was 0.1 fiber throughout. The hopper (#2) dropped to 0.1 fiber after the dump was completed. The #4 position, in the corner over the bags, went up from 0.1 fiber to the still very low level of 0.3 fiber.

Recognizing the inherent inaccuracies in the dust count technique, these data obtained and those obtained with the Arcovis present an internally consistent picture. It appears that the hopper is generally acting as an aspirator and is removing dust-laden air from the immediate vicinity. Its effect does not appear to reach as far as the opposite corner of the room, Position #1, however. The modest increase in Point #4 with the door open could be due to a "dead" area developing in the corner but the data are too limited to more than speculate.

The data from Figure 3 can be used to estimate the TWA values for the operator. For the closed-door case, the peak concentration would be 1.8 fibers for 1/2 hour to give;

$$TWA = \frac{(1.8)(0.5) + (0.3)(7.5)}{8} = 0.4 \text{ fiber}$$

For the open-door dump, the values are 0.4 and 0.3, respectively, to give:

$$TWA = \frac{(0.4)(0.5) + (0.3)(7.5)}{8} = 0.3 \text{ fiber}$$

The third series of tests were run at [REDACTED]
[REDACTED] The mud was mixed in a 25' x 7' mud house with open doors at both ends. The hopper was adjacent to the door at one end of the house. A diagram is available in the complete report appended.

The test consisted of a dump of 10 bags of Super-Visbestos at regularly spaced intervals of 6 minutes over a 60-minute period. This was followed by a 30-minute wait and then a dump of 10 bags of granular Super-Visbestos in the same manner. During the entire period, the wind outside was blowing strongly. It was in a direction, however, such that even though both doors were open there was no strong draft through the building.

For these tests, samples were collected at the following points:

Position 1: Opposite corner at same end of trailer as mud hopper.

Position 2: End of trailer at opposite from the mud heaper.

Position 3: Operator breathing zone during dumps.

The dust count results obtained are shown graphically in Figure 4. For the dump of regular Super-Visbestos, the dust level in the breathing zone was 1.0 fiber. The environmental samples near the hopper and at the other end of the trailer were considerably lower and decreased with distance from the hopper.

During the following half hour (12:15-12:45), the two environmental samples showed a moderate increase which also continued over the ensuing one-hour dump of the granular Super-Visbestos. In the half hour after the second dump, however, the levels at both Position 1 and Position 2 dropped. The breathing zone sample collected during this dump was the same as the adjacent environmental sample at Position 1, i.e., 0.5 fiber.

This pattern suggests that the second breathing zone sample is more representative of the general level at the hopper end of the trailer than a direct measure of dust generation by the granular Super-Visbestos. The correct granular Super-Visbestos level, however, should be no more than the 0.5 fiber measured.

As in the previous tests, the general level of environmental samples, i.e., 0.1 - 0.3 fibers in the opposite end of the trailer, and 0.3 - 0.5 fibers directly adjacent to the dumping area, continue to support the validity of the value of 0.3 fiber as the background exposure level for the time period when asbestos is not being handled.

Regular Super-Visbestos:

$$TWA = \frac{(1.03) (1) + (0.3) (7)}{8} = 0.4 \text{ fiber}$$

Granular Super-Visbestos:

$$TWA = \frac{(0.5) (1) + (0.3) (7)}{8} = 0.3 \text{ fiber}$$

South Louisiana Well Location

The last data to be considered were obtained by [REDACTED]. This was an open-air dump wherein 21 bags of granular Super-Visbestos were dumped in 15 minutes and 5 minutes were spent in cleanup and disposal of the bags. A slight wind was blowing towards the worker. Two samples were collected simultaneously in the breathing zone of the worker during the dump. (1) One sample was collected at the same time in the breathing zone of an observer standing about 3' upwind. Results are shown in the table below.

SAMPLE NO.	LOCATION	TIME MINUTES	FLOW RATE LITERS/MIN	TOTAL VOLUME LITERS	ASBESTOS CONC. FIBERS/CC.
1	At breathing zone of worker.	22.0	1.5	33.0	1.4
2	At breathing zone of worker.	21.3	2.9	61.8	0.6
3	At breathing zone of the observer.	20.3	4.3	87.3	0.0

(1) During the dump, as well as during cleanup and associated operations.

The data from the two breathing zone samples, although somewhat different, are in reasonable agreement for this kind of dust sampling and counting. The levels found are also in the same general range as the results obtained at the other three locations. The zero level found for the observer also supports the assumption of the 0.3 fiber value for TWA calculations. Thus:

$$TWA = \frac{(1.4)(0.33) + (0.3)(7.67)}{8} = 0.35$$

or using the 0.6 fiber reading

$$TWA = \frac{(0.6)(0.33) + (0.3)(7.67)}{8} = 0.31$$

DISCUSSION OF RESULTS

The data from the various tests have been assembled in Table I arranged approximately in the order of increasing dumping rate. Both ceiling concentration and estimated time-weighted-average values are included. The data are shown graphically as a function of dumping rate in Figures 5 and 6.

Ceiling Concentration

Figure 5 gives the ceiling concentration results. The highest value observed was 5.5 fibers that occurred when the fine-ground material was dumped in a small enclosed area. Even this level, however, is only 55% of that allowable in the OSHA regulations. All of the other data regardless of asbestos-type dumping rate or type of enclosure are below 2 fibers.

Certain of the data were paired, as shown by the connecting arrows, to test the effect of a single variable. The two pairs of points connected by the solid arrows are a direct comparison between coarse-ground (regular) and granular Super-Visbestos. As would be expected, the granular form gives half as much dust or less. The other points for granular dumps in open air at higher dump rates (open squares) bear out that the granular product form gives very low-dust levels.

The two sets of points connected by the dashed arrows compare open and enclosed dumping. Again, as is reasonable, the levels were approximately four times as great for the confined areas.

Estimate Time-Weighted Averages

Figure 6 gives the estimated TWA values for the various dumps. As noted previously, these were calculated on the basis of the observed ceiling concentration during the dump and an assumed background of 0.3 fiber over the remainder of the shift.

The highest value found was only 0.7 fiber with all of the rest of the results in the 0.3 - 0.4 range. These numbers are approximately 3% of the present allowable level of 5 fibers and only 20% of the 1976 level of 2 fibers.

Location Key:

I Texas Panhandle
 II Central Oklahoma
 III Near Houston
 IV Near Houston
 V South Louisiana

TABLE I

AIRBORNE ASBESTOS DUST CONCENTRATIONS

IN DRILLING FLUID OPERATIONS

	LOCATION	SUPER-VISBESTOS PRODUCT	CONDITIONS	DUST LEVEL (1)						
				DUMPING			Ceiling Concentration		Time-Weighted Ave. (TWA) (2)	
				Sacks	Min.	Rate (Sacks/Min.)	Fibers/cc. (3)	% of Allowable (4)	Fibers/cc. (3)	% of Allowable (5)
I		Coarse-Ground (Regular)	7'x25' Mud House. Open door at both ends	10	59	0.17	1.0	10	0.4	
		Granular	7'x25' Mud House. Open door at both ends	10	59	0.17	0.5	5	0.3	
II		Coarse-Ground (Regular)	Open air Light breeze	20	21	0.95	1.9	19	0.4	
		Granular	Open air Light breeze	20	26	0.77	0.4	4	0.3	
III		Fine-Ground (Hydrophobic)	10'x11' Room Totally enclosed	30	36	0.83	5.5	55	0.7	14
		Fine-Ground (Hydrophobic)	10'x11' Room 1 side open, 8'	30	29	1.03	1.3	13	0.4	8
IV		Granular	10'x11' Room Totally enclosed	30	29	1.03	1.8	18	0.4	8
		Granular	10'x11' Room 1 side open, 8'	30	30	1.00	0.4	4	0.3	6
V		Granular	Open air Slight breeze	21	15	1.40	1.4 (6)	14	0.3	6
	0.6 (6)						6	0.3	6	

(1) Sampling and dust counting carried out in accordance with OSHA Regulation 1910.93a.

(2) Calculated at a background exposure of 0.3 fiber/cc. for all time except during actual dumping. One dump per 8-hour shift.

(3) Fibers/cc. greater than 5 micrometers in length.

(4) Allowable = 10 fibers/cc. greater than 5 micrometers.

(5) Allowable = 5 fibers/cc. greater than 5 micrometers.

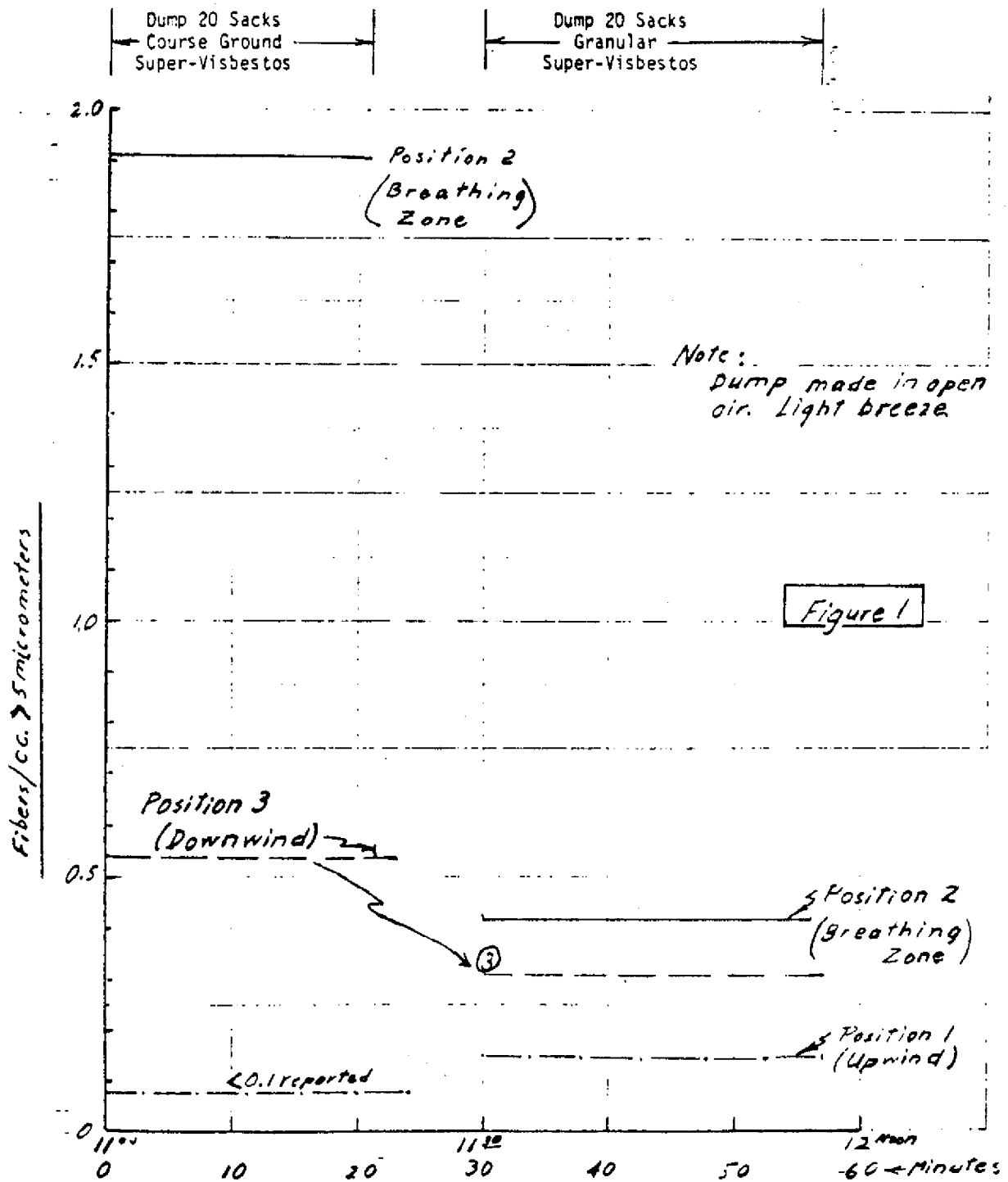
(6) Operator wore 2 samplers.

020498

Central Oklahoma Well Location

September 27, 1972

COURSE GROUND (REGULAR) AND GRANULAR SUPER-VISBESTOS



ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

Location Near Houston, Texas

September 25, 1972

FINE GROUND HYDROPHOBIC ASBESTOS (ARCOVIS 953)

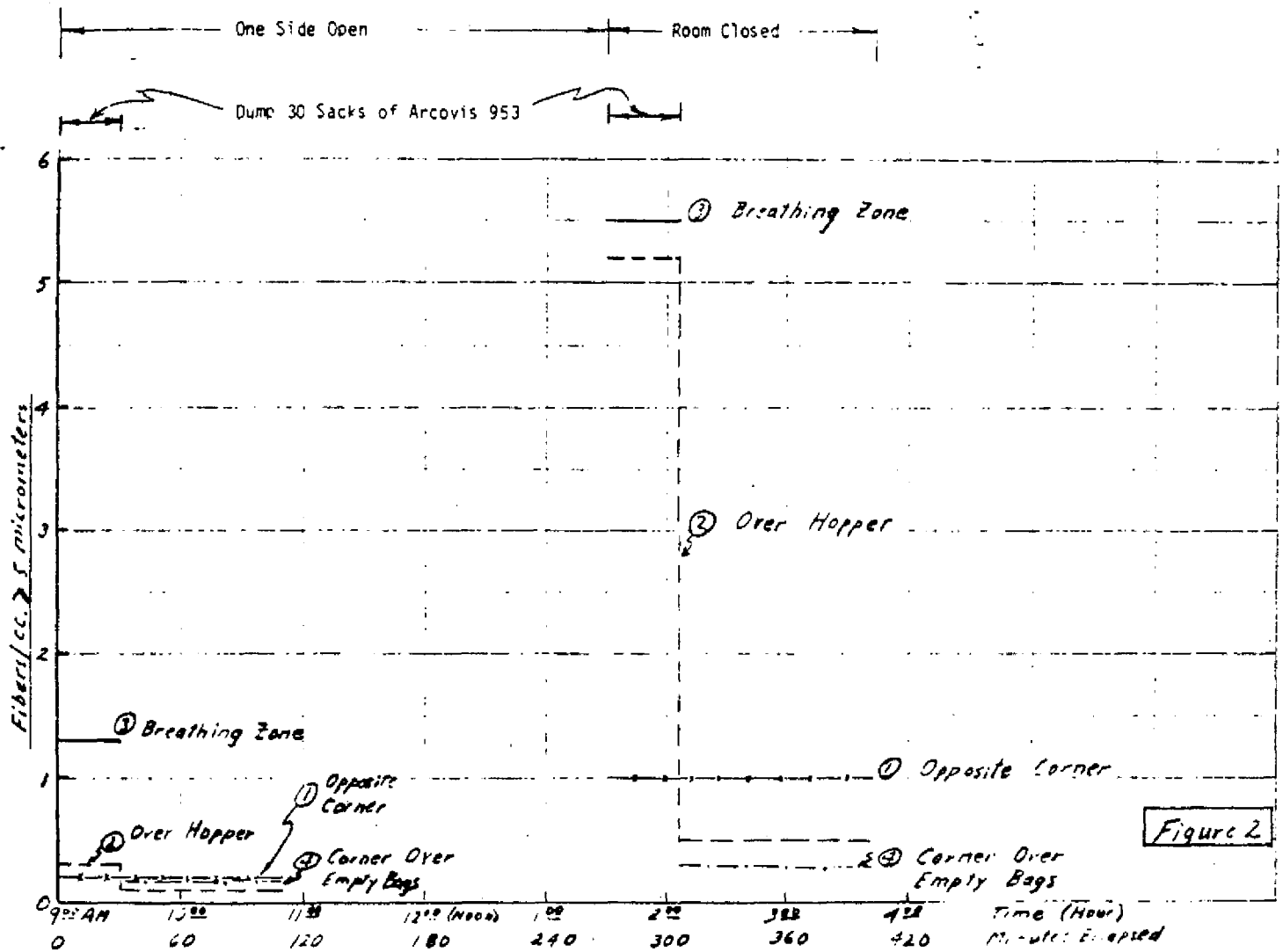


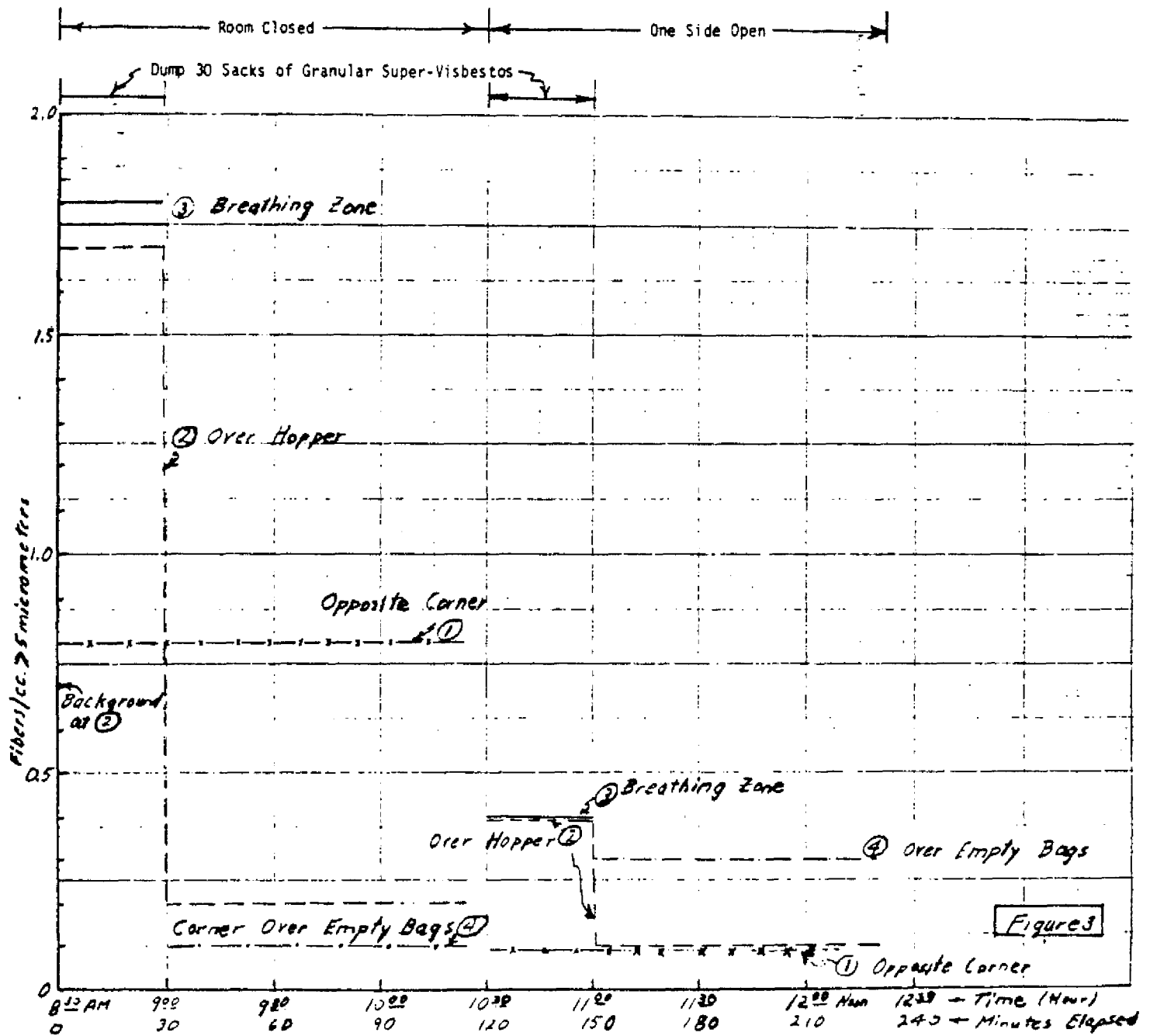
Figure 2

ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

Location Near Houston, Texas

September 26, 1972

GRANULAR SUPER-VISBESTOS



ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

020502

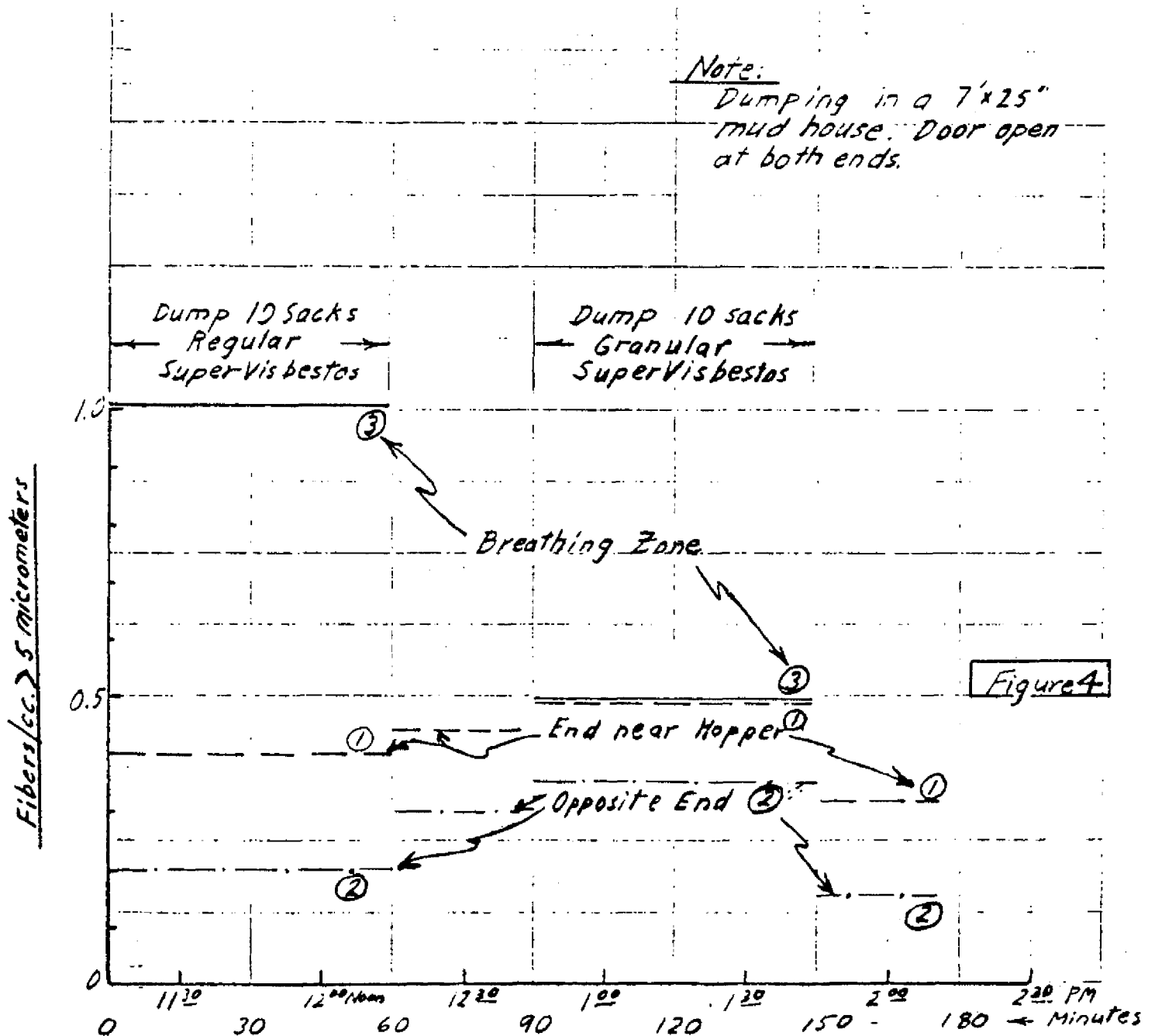
Texas Panhandle Well Location

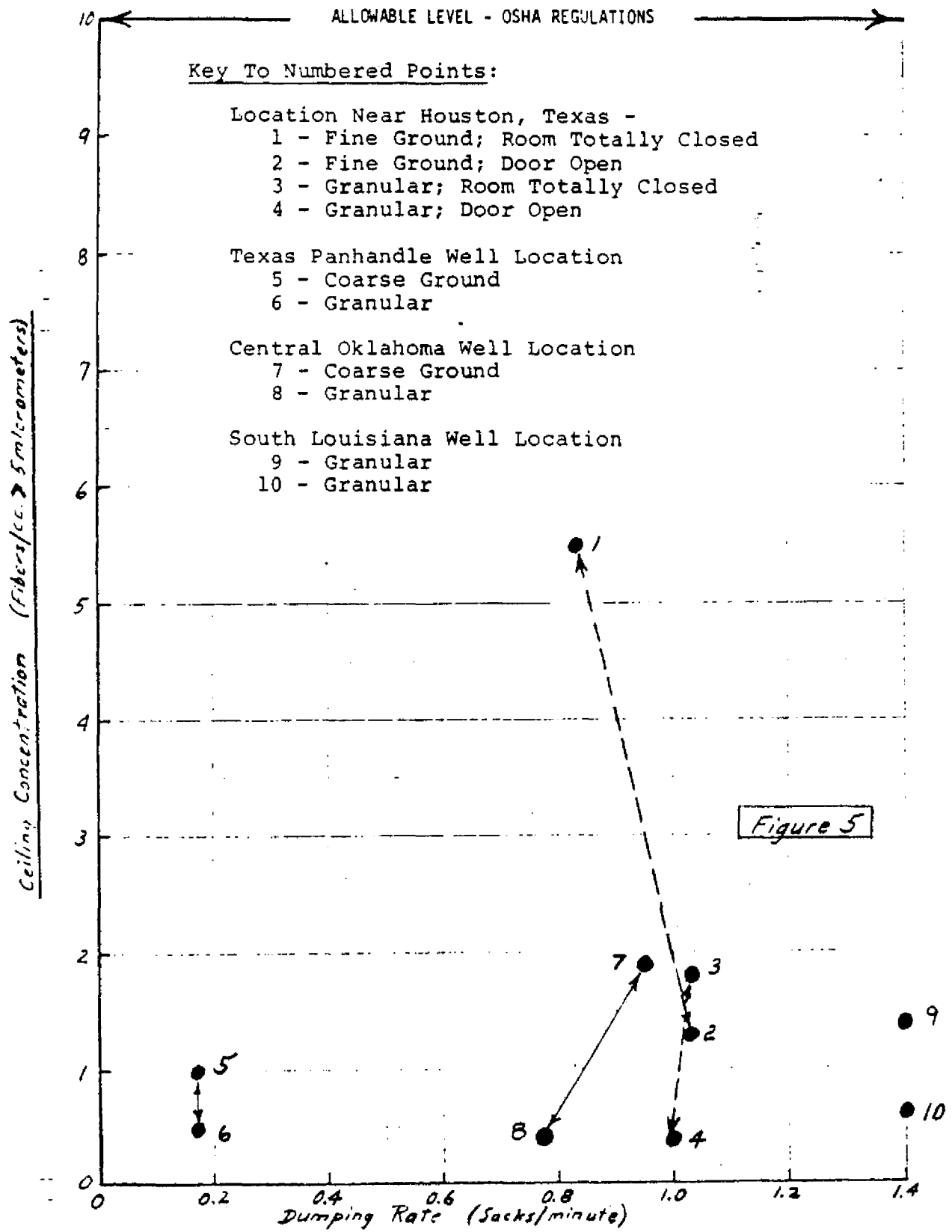
September 28, 1972

COARSE GROUND (REGULAR) AND GRANULAR SUPER-VISBESTOS

Note:

Dumping in a 7'x25' mud house. Door open at both ends.





ASBESTOS DUST

ESTIMATED TIME-WEIGHTED AVERAGE CONCENTRATIONS

Key To Numbered Points:

Location Near Houston, Texas -

- 1 - Fine Ground; Room Totally Closed
- 2 - Fine Ground; Door Open
- 3 - Granular; Room Totally Closed
- 4 - Granular; Door Open

Texas Panhandle Well Location

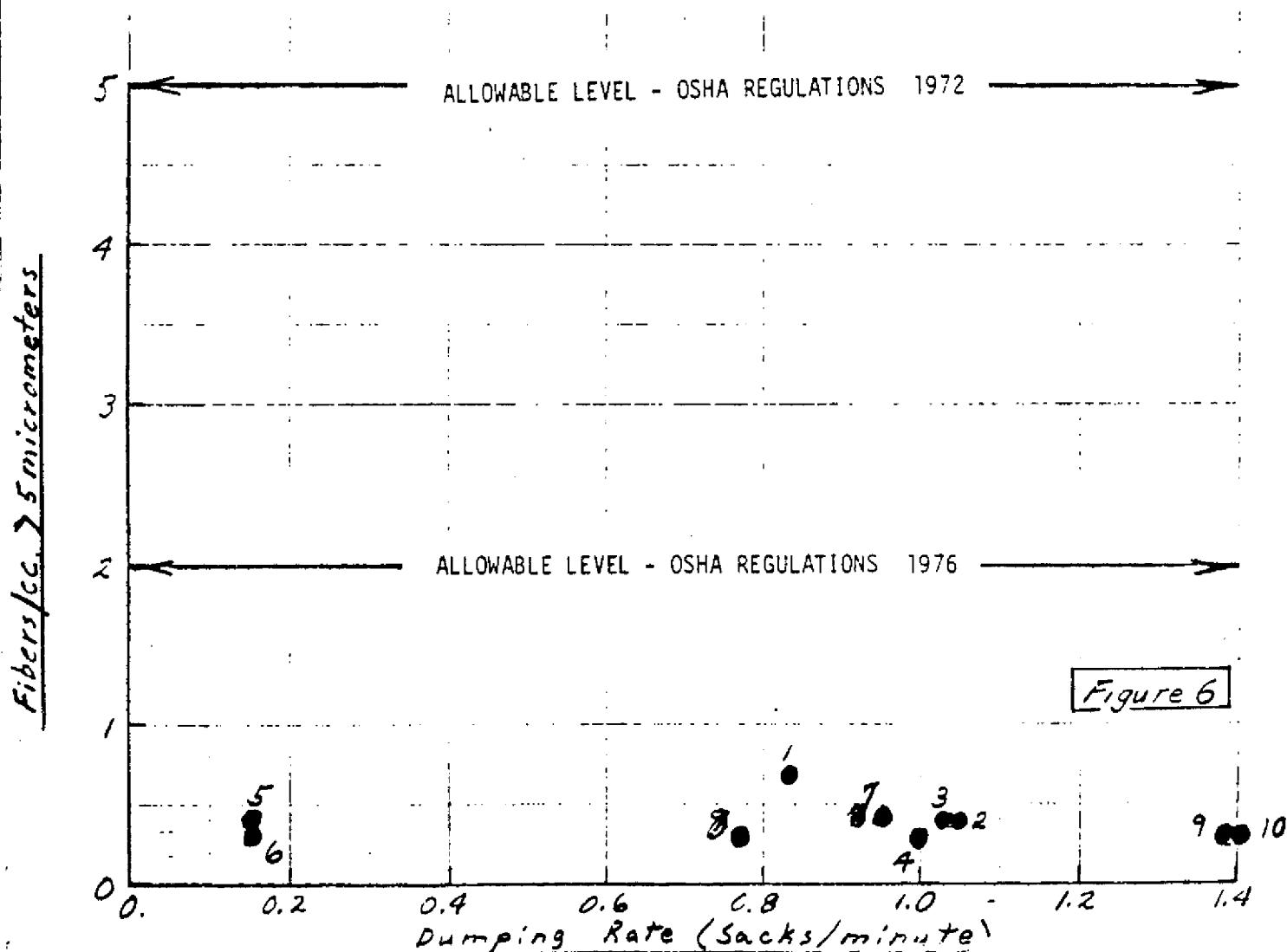
- 5 - Coarse Ground
- 6 - Granular

Central Oklahoma Well Location

- 7 - Granular
- 8 - Coarse Ground

South Louisiana Well Location

- 9 - Granular
- 10 - Granular



ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

Central Oklahoma Well Location

This report gives the details of
the dumping and sampling at
the location shown above.

September 27, 1972

On-Site Report No.1

PERSONNEL PRESENT

Montello, Inc. : R. Newman

Union Carbide Corporation: E. Lieber
J. Myers

UNION CARBIDE CORPORATION
Mining and Metals Division
Niagara Falls, New York

OBJECTIVE

Monitor airborne asbestos under "on site" conditions.

INTRODUCTION

On September 27, 1972 tests were conducted at [REDACTED] to provide [REDACTED] on site airborne asbestos data. Two products were evaluated; Super Visbestos, a cracked pellet form of asbestos and New Granular Super Visbestos, a pelletized product.

TEST METHOD

11:00 - 11:30 - 20 bags Super Visbestos added to premix pit.

11:30 - 12:00 - 20 bags New Granular Super Visbestos added to premix pit.

PREMIX PIT - (See Figure 1)

Pit was approximately 30' x 8' x 5' deep. The 20 bags of product were added to a hopper connected to a discharge pipe. The vacuum created by the flow of liquid through the pipe was sufficient to keep the addition rate at a little over 1 bag/min.

SAMPLER LOCATIONS - (See Figure 1)

The samplers were left in the same positions for both tests. They are designated position 1, 2, and 3.

Position 1 - 9 ft. upwind from hopper across tank, mounted on light pole, approx. 3 ft. above top rim of premix pit.

Position 2 - Located on operator as he dumps 20 bags of product.

Position 3 - 7 ft. downwind from operator on top of a pile of bags, approx. 2-1/2 ft. above top rim of premix pit.

Note: The terms upwind and downwind are fairly accurate. However, the wind did some shifting during the tests.

EQUIPMENT

Sampling and dust counting were carried out in accordance with OSHA Regulation 1910.93a.

Personal air samplers were used to collect personal breathing zone and environmental samples on Millipore Membrane Filters of 0.8 micron porosity.

Air samplers were as follows:

MSA Personal Sampler - Calibrated to draw 2 liters per minute of air used in positions 3 and 4.

Unico Personal Sampler "A" - Draws 1.8 liters per minute. Used in position 1.

Unico Personal Sampler "B" - Draws 1.7 liters per minute. Used in position 2.

Fiber counting was performed on a Leitz Microscope utilizing Phase Contrast Illumination at 400X and a Patterson Globe and Circle Reticule.

TEST RESULTS - (See Table 1)

Table 1 contains the results of the sample analysis dust counting. The count is reported as fibers greater than 5 microns in length per milliliter of air sampled. A fiber is defined as any material having an aspect ratio greater than 3.

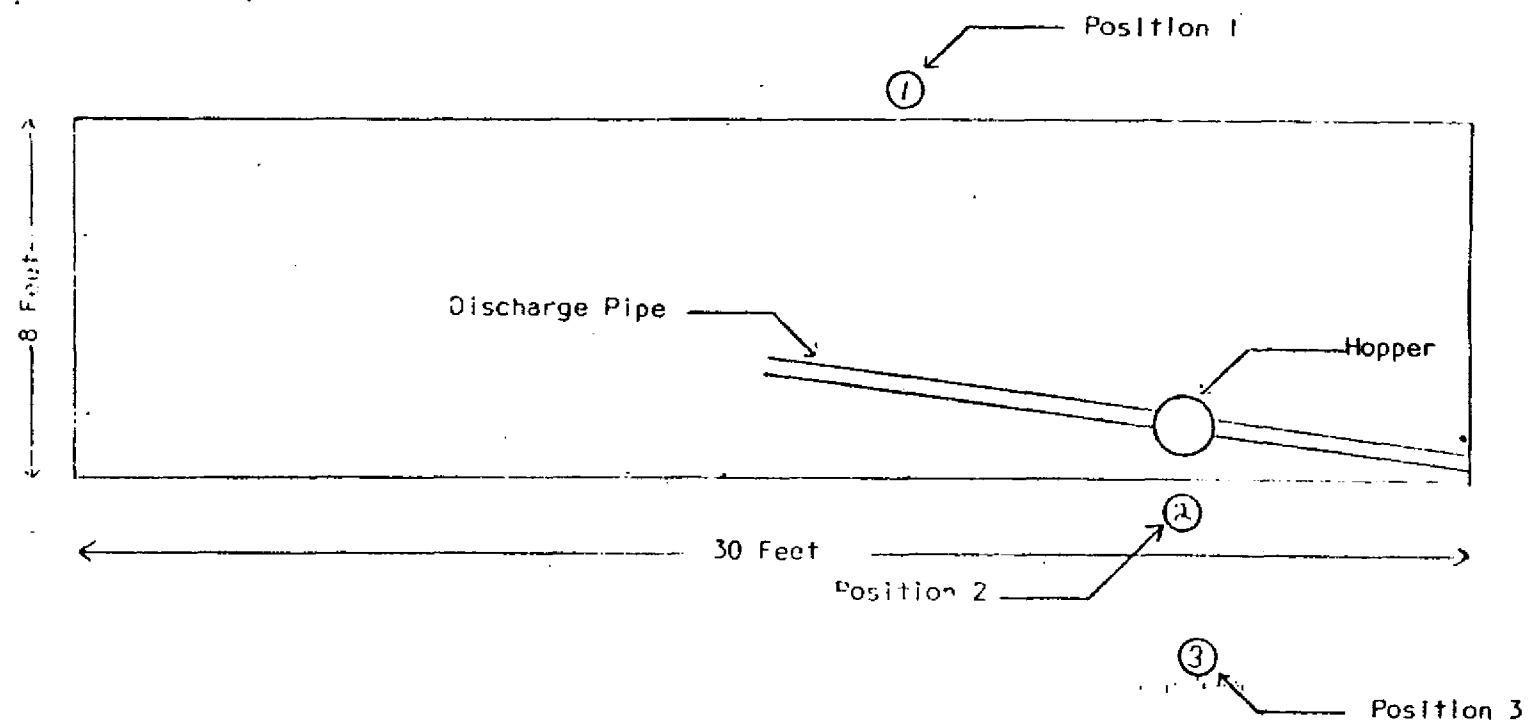
INTERPRETATION

Although the figures speak for themselves, it may be worthwhile to briefly review the Time Weighted Average (TWA) aspect. The Regulations have been established with a limit of 5 fibers per milliliter greater than 5 microns in length on a Time Weighted Average. This means the figures must be arranged to show the employee's average intake of fibers per milliliter on an 8 hour day. For example, a worker dumping asbestos for one hour per day and inhaling 8 fibers per milliliter during that hour would have a TWA of 1 fiber per milliliter and for 2 hours dumping at the 8 fibers per milliliter level would be 2 fibers per milliliter, etc. The highest reading in Table 1 is 1.91 fibers per milliliter and the operator was exposed to this level for only 21 minutes. If this were his only exposure during the day, his TWA would be less than 0.1 fiber per milliliter.

TABLE I
SUMMARY OF DUST COUNTS

<u>N.B. No.</u>	<u>Field No.</u>	<u>Time (Minutes)</u>	<u>Position</u>	<u>Description</u>	<u>Fibers/ml</u> <u>> 5 μ</u>
Addition of 20 bags Super Visbestos					
1929-34-1	5	24	1	Environmental	<0.1
1929-34-2	4	21	2	Personal	1.91
1929-34-3	6	23	3	Environmental	0.54
Addition of 20 bags New Granular Super Visbestos					
1929-34-4	37	27	1	Environmental	0.15
1929-34-5	16	26	2	Personal	0.42
1929-34-6	25	27	3	Environmental	0.31

FIGURE 1
Premix Pit



ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

Location Near Houston, Texas

[REDACTED]

This report gives the details of
the dumping and sampling
at the location shown above.

September 25-26, 1972

On-Site Report No. 2

PERSONNEL PRESENT

[REDACTED]	:	[REDACTED]
Montello, Inc.	:	R. Newman
[REDACTED]	:	[REDACTED]
		[REDACTED]
Union Carbide Corporation:		E. Klebe J. Myers

UNION CARBIDE CORPORATION
Mining and Metals Division
Niagara Falls, New York

OBJECTIVE

Monitor airborne asbestos in simulated North Slope mud house conditions.

INTRODUCTION

On September 25 & 26, 1972 tests were conducted [REDACTED] in order to determine the amount of airborne asbestos that could be generated in a North Slope drilling operation. A building was constructed for the tests and all air samples were taken inside this structure. Two products were evaluated:

(1) Arcovis 953, essentially 100% liberated fiber and New Granular Super-Visbestos, a pelletized form of asbestos.

TEST METHOD

In order to closely simulate North Slope drilling mud preparation conditions, tests were made as follows:

- | | |
|-------------------------|---|
| - September 25th | - 30 bags of Arcovis 953 added to 100 barrels |
| - 9:00 a.m. - Noon | of diesel. "Door" open. |
| September 25th | - 30 bags of Arcovis 953 added to 100 barrels |
| 1:30 p.m. - 4:00 p.m. | of diesel. "Door" closed. |
| September 26th | - 30 bags of New Granular Super-Visbestos added |
| 8:30 a.m. - 10:30 a.m. | to 125 barrels of water. "Door" closed. |
| September 26th | - 30 bags of New Granular Super-Visbestos added |
| 10:30 a.m. - 12:30 p.m. | to 125 barrels of water. "Door" open. |

PHYSICAL DIMENSIONS OF BUILDING - (See Figure 1)

A specially constructed plywood building, approximately 9 x 10 x 11.5 feet was used for all tests. The building was enclosed on all sides except for an 8 x 9 foot opening in front.

When a "Door open" test was run the opening was left alone and wind was free to blow about. When a "Door closed" test was conducted a large piece of plastic was stapled over the opening, effectively shutting off outside wind. This technique was devised to simulate a cold day on the North Slope when trailer doors would be closed.

SAMPLER LOCATIONS - (See Figure 1)

In order to obtain a high amount of comparative data it was decided that the samplers would be located in the same positions for all tests. For ease of identification they have been labeled positions 1, 2, 3, and 4.

Position 1 - Approximately 7 feet from Hopper in corner near door opening. Somewhat of a "dead" area from the standpoint of air circulation. In all tests this sampler ran both during dump and in the "settling" period.

Position 2 - Directly over Hopper. It was decided that since the operator moves about quite a bit obtaining and disposing of bags, a stationary sample would be of value to catch any "blow back" from the Hopper. This sampler was run during the dump. Upon completion a new filter was inserted and allowed to run through the "settling" period. This accounts for two position 2 samples in each test.

(1) Use of this product is covered by U. S. Patent Number 3,618,680.

Position 3 - Attached to operator and run during entire dump.

Position 4 - Placed over bag disposal area, approximately 5 feet from Hopper. Run after completion of dump.

MISCELLANEOUS

All samplers were 5-1/2 to 6 feet above the ground, except background sample on 9/25 which was 4-1/2 feet above the ground.

In each test, 30 bags of asbestos were added through a Hopper to approximately 100 barrels of liquid (either diesel or water) in a 170 barrel tank at the rate of 1 bag per minute. A 6 x 8 inch B. J. Centrifugal Pump operated at 790 G.P.M.

Background sample 1929-32-12 has a rather large fiber content. This is probably due to movement in the area kicking up the previous day's dust and the placement of a pallet of asbestos during sampling time.

EQUIPMENT

Sampling and dust counting were carried out in accordance with OSHA Regulation 1910.93a.

Personal air samplers were used to collect personal breathing zone and environmental samples on Millipore Membrane Filters of 0.8 micron porosity.

Air samplers were as follows:

MSA Personal Sampler - Calibrated to draw 2 liters per minute of air. used in positions 3 and 4.

Unico Personal Sampler "A" - Draws 1.8 liters per minute. Used in position 1.

Unico Personal Sampler "B" - Draws 1.7 liters per minute. Used in position 2.

Fiber counting was performed on a Leitz Microscope utilizing Phase Contrast Illumination at 400X and a Patterson Globe and Circle Reticle.

TEST RESULTS - (See Table 1)

Table 1 contains the results of the sample analysis dust counting. The count is reported as fibers greater than 5 microns in length per milliliter of air sampled. A fiber is defined as any material having an aspect ratio greater than 3.

INTERPRETATION

Although the figures speak for themselves, it may be worthwhile to briefly review the Time Weighted Average (TWA) aspect. The Regulations have been established with a limit of 5 fibers per milliliter greater than 5 microns in length on a Time Weighted Average. This means the figures must be arranged to show the employee's average intake of fibers per milliliter on an 8 hour day. For example, a worker dumping asbestos for one hour per day and inhaling 8 fibers per milliliter during that hour would have a TWA of 1 fiber per milliliter and for 2 hours dumping at the 8 fibers per milliliter level would be 2 fibers per milliliter, etc. The highest reading in Table 1 is 5.5

020513

fibers per milliliter and the operator was exposed to this level for only 35 minutes. If this were his only exposure during the day his TWA would be 0.4 fibers per milliliter.

SUMMARY OF DUST COUNTS

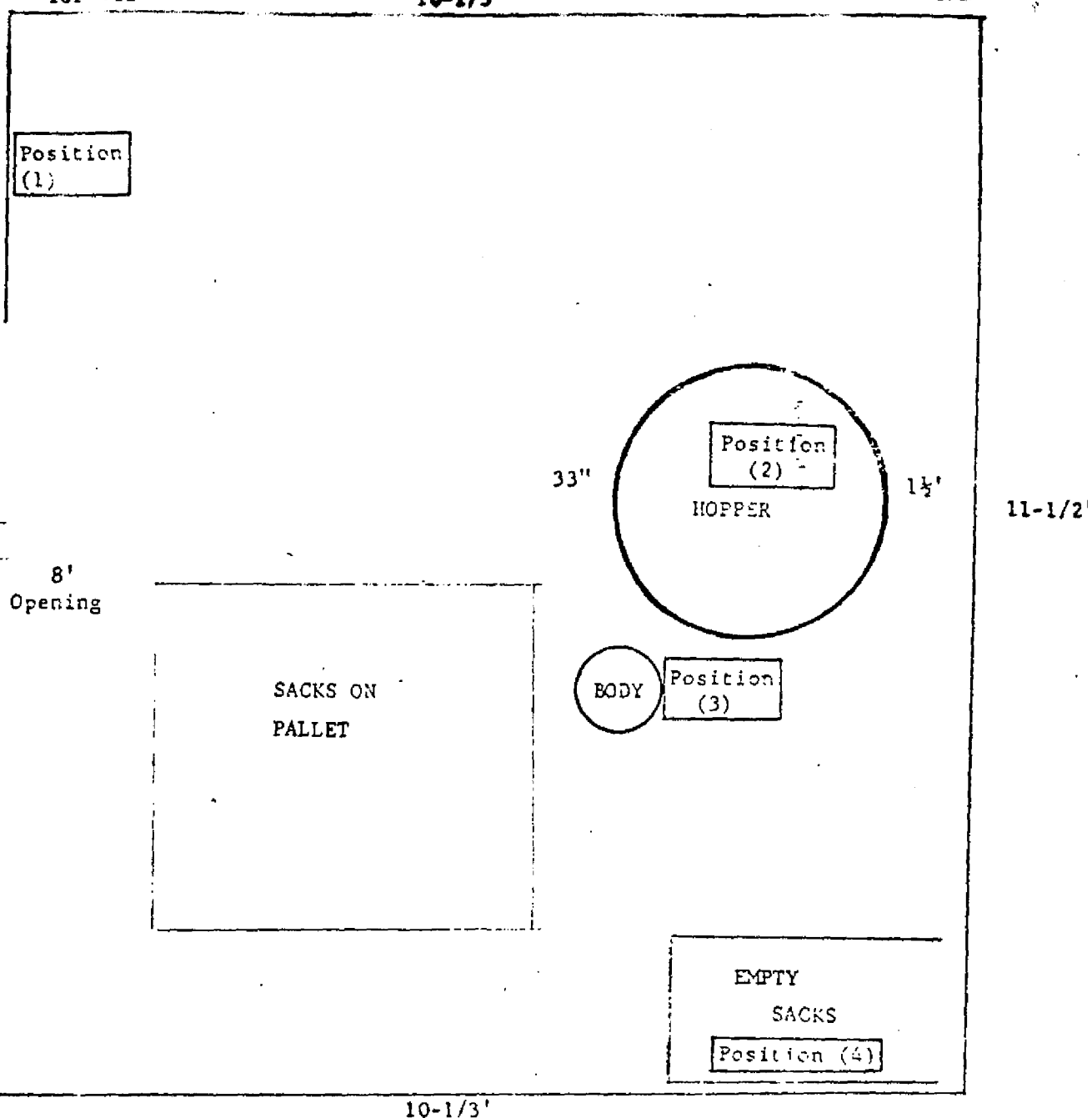
020514

<u>N.B. No.</u>	<u>Field No.</u>	<u>Time (Minutes)</u>	<u>Position</u>	<u>Description</u>	<u>Fibers/ml</u> <u>5</u>
<u>September 25, 1972</u>					
1929-32-1	58	56	2	Background for 9/25	0.1
OPEN SYSTEM - Addition of 30 bags Arcovis 953 to 100 barrels of diesel					
1929-32-2	62	29	2	Environmental - During Dump	0.3
1929-32-3	52	30	3	Operator - During Dump	1.3
1929-32-4	70	81	2	Environmental - After Dump	0.1
1929-32-5	54	78	4	Environmental - After Dump	0.2
1929-32-6	56	110	1	Environmental - During & After Dump	0.2
CLOSED SYSTEM - Addition of 30 bags Arcovis to 102 barrels of diesel/Arcovis mix					
1929-32-7	57	36	2	Environmental - During Dump	5.2
1929-32-8	55	35	3	Operator - During Dump	5.5
1929-32-9	82	95	2	Environmental - After Dump	0.5
1929-32-10	50	95	4	Environmental - After Dump	0.3
1929-32-11	63	132	1	Environmental - During & After Dump	1.0
<u>September 26, 1972</u>					
1929-32-12	23	31	2	Background for 9/26	0.7
CLOSED SYSTEM - Addition of 30 bags New Granular Super Visbestos to 125 barrels of water					
1929-32-13	93	29	2	Environmental - During Dump	1.7
1929-32-14	95	29	3	Operator - During Dump	1.8
1929-32-15	68	85	2	Environmental - After Dump	0.2
1929-32-16	92	83	4	Environmental - After Dump	0.1
1929-32-17	27	114	1	Environmental - During & After Dump	0.8
OPEN SYSTEM - Addition of 30 bags New Granular Super Visbestos to 120 barrels of water					
1929-32-18	90	31	2	Environmental - During Dump	0.4
1929-32-19	79	30	3	Operator - During Dump	0.4
1929-32-20	19	77	2	Environmental - After Dump	0.1
1929-32-21	36	77	4	Environmental - After Dump	0.3
1929-32-22	74	107	1	Environmental - During & After Dump	0.1

TOP VIEW

10-1/3'

020515



All monitors about 5.5' above ground level
Building 9' high
Hopper 3' high

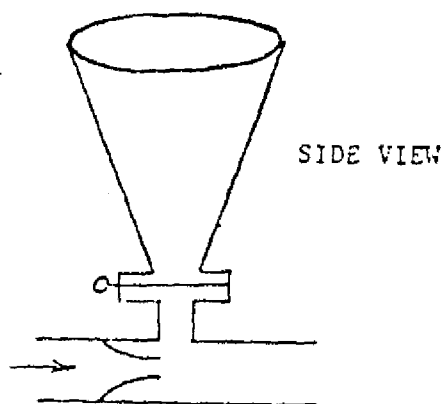


FIGURE 1 - HOPPER AND BUILDING

ASBESTOS FIBER COUNTS OF AIRBORNE SAMPLES COLLECTED

Texas Panhandle Well Location

This report gives the details of
the dumping and sampling
at the location shown above.

September 28, 1972

On-Site Report No. 3

PERSONNEL PRESENT

[REDACTED] :

Montello, Inc. : R. Newman
H. Wyatt

Union Carbide Corporation: E. J. Gieber

UNION CARBIDE CORPORATION
Mining and Metals Division
Niagara Falls, New York

OBJECTIVE

Monitor airborne asbestos in an actual on site condition inside a mud house.

INTRODUCTION

On September 28, 1972 tests were conducted at a [REDACTED] drilling site [REDACTED]. All samples were collected in a mud house approx. 25' x 7' with a Quonset hut roof 7 ft. high at the zenith. Two asbestos products were evaluated: Super-Visbestos, essentially 100% liberated fiber, and New Granular Super-Visbestos, a pelletized form.

TEST METHOD

11:15 - 12:45 - 10 bags Super-Visbestos added to hopper.

12:45 - 2:10 - 10 bags New Granular Super-Visbestos added to hopper.

The first hour of each test was the dumping of asbestos, 1 bag every 6 minutes. The last half hour was monitored as a settling period.

SAMPLER LOCATIONS - (See Figure 1)

The samplers were left in the same spots for each test. They are designated as Position 1, 2, and 3.

Position 1 - 4 ft. from hopper in somewhat of a "dead" air area, 5-1/2 ft. above floor.

Position 2 - At opposite end of mud house, 3 ft. from door, downwind from hopper, 5-1/2 ft. above ground.

Position 3 - Operator dumping bags at the rate of 10/hour.

EQUIPMENT

Sampling and dust counting were carried out in accordance with OSHA Regulation 1910.93a.

Personal air samplers were used to collect personal breathing zone and environmental samples on Millipore Membrane Filters of 0.8 micron porosity.

Air samplers were as follows:

MSA Personal Sampler - Calibrated to draw 2 ltr. per minute of air. Used in position 3.

Unico Personal Sampler "A" - Draws 1.8 liters per minute. Used in position 1.

Unico Personal Sampler "B" - Draws 1.7 liters per minute. Used in position 2.

Fiber counting was performed on a Leitz Microscope utilizing Phase Contrast Illumination at 400X and a Patterson Globe and Circle Reticle.

TEST RESULTS - (See Table 1)

Table 1 contains the results of the sample analysis dust counting. The count is reported as fibers greater than 5 microns in length per milliliter of air sampled. A fiber is defined as any material having an aspect ratio greater than 3.

INTERPRETATION

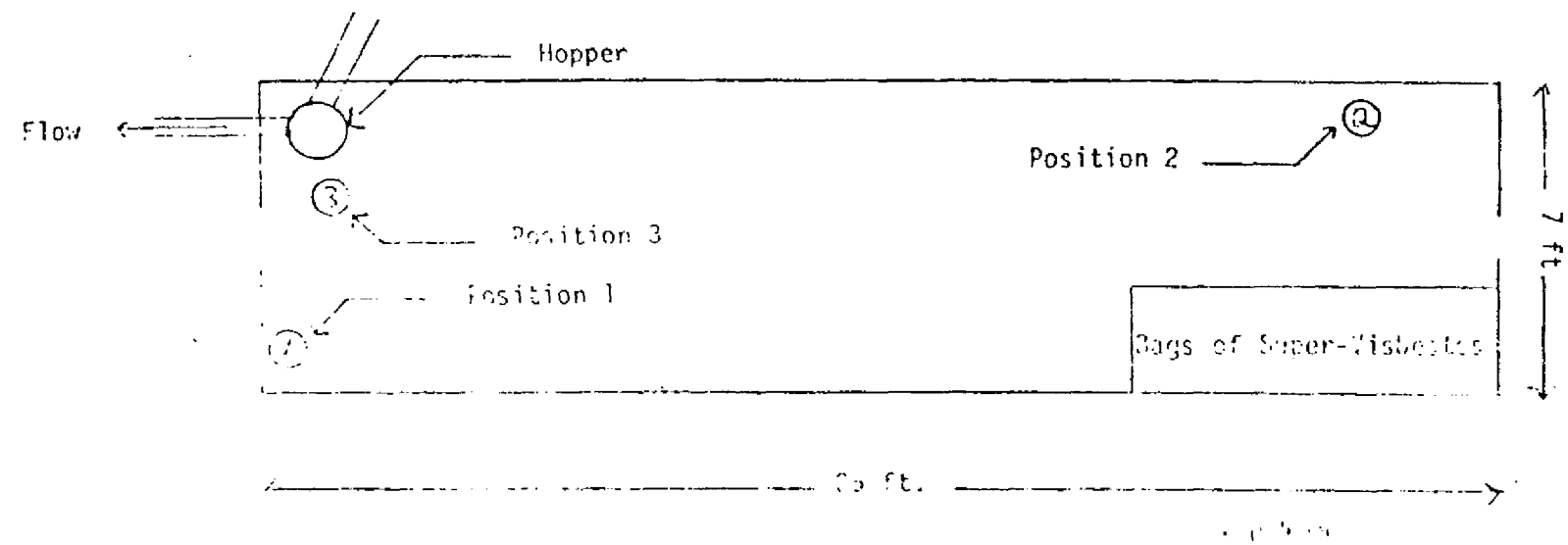
Although the figures speak for themselves, it may be worthwhile to briefly review the Time Weighted Average (TWA) aspect. The Regulations have been established with a limit of 5 fibers per milliliter greater than 5 microns in length on a Time Weighted Average. This means the figures must be arranged to show the employee's average intake of fibers per milliliter on an 8 hour day. For example, a worker dumping asbestos for one hour per day and inhaling 8 fibers per milliliter during that hour would have a TWA of 1 fiber per milliliter and for 2 hours dumping at the 8 fibers per milliliter level would be 2 fibers per milliliter, etc. The highest reading in Table 1 is 1.03 fibers per milliliter and the operator was exposed to this level for 59 minutes. If this were his only exposure during the day, his TWA would be less than 0.2 fiber per milliliter.

TABLE I

SUMMARY OF DUST COUNTS

<u>N.B. No.</u>	<u>Field No.</u>	<u>(Minutes)</u>	<u>Position</u>	<u>Description</u>	<u>Fibers/ml</u> <u>> 5 μ</u>
Dumping of 10 bags Super-Visbestos					
1929-36-1	33	60	1	Environmental	0.40
-2	41	61	2	Environmental	0.20
-3	47	59	3	Personal	1.03
-4	9	27	1	Env. - After Dump	0.44
-5	34	27	2	Env. - After Dump	0.31
Dumping of 10 bags New Granular Super-Visbestos					
-6	15	59	1	Environmental	0.47
-7	11	60	2	Environmental	0.35
-8	10	59	3	Personal	0.49
-9	42	25	1	Env. - After Dump	0.32
-10	46	25	2	Env. - After Dump	0.16

FIGURE 1
Mud House



Site Report No. 4
South Louisiana Well Location

020521

SUMMARY

A survey indicated that the asbestos exposure of the employee dumping asbestos (Visbestos, Montello Inc., Tulsa, Oklahoma) into the hopper leading to the tank containing drilling mud was well below the present OSHA permissible limit.

PURPOSE

At the request of [REDACTED], a survey was made by [REDACTED] of asbestos exposure during the dumping of asbestos into drilling mud at the [REDACTED]. The operation at [REDACTED] is similar to what occurs at a drilling rig except that only 1/3 of the amount of asbestos is used in the latter operation.

Messrs. [REDACTED] were present to observe and discuss the procedure and survey.

SURVEY

Personal samples were collected at the breathing zone of the worker during the dumping of asbestos using 37 millimeter Millipore type (membrane) AA filter in a holder connected to a MSA or Unico pump pulling air through the filter at a constant flow rate. The determination of asbestos concentrations was made by counting asbestos fibers longer than 5 micrometers at 400-450 X magnification (4 millimeters objective) with phase contrast illumination.

DESCRIPTION OF OPERATION

In drilling operations a mud circulates around the drill for cooling and lubrication. The mud is treated for weight, viscosity and gel strength. Asbestos increases the effectiveness of gel, that is, keeps it from setting up like cement. The mud must be left in the annulus of the drill with gel characteristics.

Bags weighing 50 pounds of Super Visbestos, Montello Inc., Tulsa, Oklahoma were dumped into a hopper (15" x 15" opening) over a tank containing 215 barrels of mud (14.5 lbs/gal lignosulfonate). The Montello asbestos, produced by Union Carbide by a wet process, is in a pelletized form. Twenty-one bags of asbestos were dumped over a period of approximately 15 minutes. About 5 minutes was spent in disposing of the empty bags. A slight breeze was blowing dust toward the worker but the dust began to settle before reaching the breathing zone. [REDACTED]

RESULTS

<u>SAMPLE NO</u>	<u>LOCATION</u>	<u>TIME MINUTES</u>	<u>FLOW RATE LITERS/MIN</u>	<u>TOTAL VOLUME LITERS</u>	<u>ASBESTOS CONC FIBERS/CC</u>
1	At breathing zone of worker, [REDACTED]	22.0	1.5	33.0	1.4
2	At breathing zone of worker, [REDACTED]	21.3	2.9	61.3	0.6
3	At breathing zone of [REDACTED]	20.3	4.3	87.3	0.0

Two samplers were placed at the breathing zone of the operator. The sampler was placed at the breathing zone of the surveyor who observed the operator and work procedure at approximately 3 feet from the hopper. (1)

DISCUSSION

The Occupational Safety and Health Administration (OSHA) regulation requires that the 8-hour time-weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed five fibers longer than 5 micrometers, per centimeter of air. The ceiling (maximum) concentration is 10 fibers, longer than 5 micrometers, per cubic centimeter of air.

The results of the sampling and determinations indicated that the asbestos exposure of the employee dumping asbestos was below the present OSHA permissible level. The result was below 2 fibers/cc, the limit which will be effective on July 1, 1976.

[REDACTED]

November, 1972

(1) The samples were collected simultaneously during dumping as well as during cleanup and associated operations.

tions for an Occupational Exposure Standard for Asbestos by the National Institute for Occupational Safety and Health (NIOSH). Public notice was given of the receipt of the recommendations and their availability for inspection and copying. On or about February 25, 1972, the Advisory Committee on Asbestos Dust submitted its written recommendations to the Assistant Secretary of Labor for Occupational Safety and Health.

Pursuant to the notice of rule making, a hearing was held on March 14 through 17, 1972, for the purpose of receiving oral data, views, and arguments concerning the proposed standard. On or about March 31, 1972, the presiding hearing examiner certified to the Assistant Secretary of Labor for Occupational Safety and Health the record of the proceeding. The record includes prehearing written comments, a transcript of the oral presentations made at the hearing, and numerous exhibits received during the course of the hearing or within the period allowed after the close of the hearing.

The proposed standard dealt with (1) permissible concentrations of asbestos fibers; (2) methods of compliance; (3) warning signs; (4) monitoring; (5) medical examinations; and (6) recordkeeping. Each of these major proposals elicited comments, arguments, objections, and counterproposals. They all have been examined and considered.

1. *Acceptable concentrations of asbestos dust.* The proposed standard would limit occupational exposure to 8-hour time-weighted average (TWA) airborne concentrations of asbestos dust not exceeding five fibers longer than five micrometers per milliliter. Concentrations above five fibers but not to exceed 10 fibers (ceiling concentration) would be permitted up to 15 minutes in an hour, but for not more than 5 hours in any one 8-hour day.

NIOSH in effect has recommended that the five-fiber TWA and 10-fiber peak concentrations be permitted only for 2 years; thereafter, TWA concentrations should be not more than 2 fibers per cubic centimeter (cm.³) of air, and peak concentrations should not exceed 10 fibers/cm.³, with no time restriction. Numerous objections and counterproposals have been made, with regard to both the limits of asbestos fiber concentrations and the time periods to comply with them. Some, for example, have recommended return to a 12-fiber standard of an earlier day; i.e., a level adopted under the Walsh-Healey Public Contracts Act in 1969. Others have recommended a two-fiber standard to become effective in 6 months, then a one-fiber standard for 2 years, and finally a zero-fiber standard after 3 years. These recommendations give a fair indication of the wide spread of the counterproposals.

No one has disputed that exposure to asbestos of high enough intensity and long enough duration is causally related to asbestosis and cancers. The dispute is as to the determination of a specific level below which exposure is safe. Various studies attempting to establish quantitative relations between specific levels of

exposure to asbestos fibers and the appearance of adverse biological manifestations, such as asbestosis, lung cancers, and mesothelioma, have given rise to controversy as to the validity of the measuring techniques used and the reliability of the relations attempted to be established. Because of the long lapse of time between onset of exposure and biological manifestations, we have now evidence of the consequences of exposure, but we do not have, in general, accurate measures of the levels of exposure occurring 20 or 30 years ago, which have given rise to these consequences. There are also controversies concerning the relative toxicity of the various kinds of asbestos, and varying hazards in different workplaces.

It is fair to say that the controversy has centered in the area between a two-fiber TWA concentration and five-fiber TWA concentration, with variations on the time needed for compliance. Many employers support a five-fiber TWA. Most medical opinion is divided between a two-fiber standard and a five-fiber standard.

In view of the undisputed grave consequences from exposure to asbestos fibers, it is essential that the exposure be regulated now, on the basis of the best evidence available now, even though it may not be as good as scientifically desirable. An asbestos standard can be re-evaluated in the light of the results of ongoing studies, and future studies, but cannot wait for them. Lives of employees are at stake.

It is concluded that there should be one minimum standard of exposure to asbestos applicable to all workplaces exposed to any kind, or mixture of kinds, of asbestos. Reasons of practical administration preclude a variety of standards for different kinds of asbestos and of workplaces. Also, while the evidence tends to show that crocidolite, for instance, is more harmful than chrysotile, the evidence is not sufficient to establish separate standards for varieties of asbestos.

Because there must be one standard governing exposure to all varieties of asbestos, and in workplaces apparently more hazardous than others; because some present employees with regular exposure to asbestos have probably already accumulated great doses of asbestos fibers, due to higher levels of exposure in the past; because it appears that levels of exposure which may be safe with regard to asbestosis are not safe with regard to mesothelioma; because the statute requires the protection of every employee, even of one who may have regular exposure to asbestos during a working life which may reach, or even exceed, 40 years; and because of several other considerations which have been urged and are reflected in the record of the proceeding, the conflict in the medical evidence is resolved in favor of the health of employees. As of July 1, 1976, TWA concentrations of asbestos fibers longer than 5 micrometers will not be allowed to exceed two fibers/cc., with a ceiling value of 10 fibers/cc. The current TWA concentrations of five fibers, and

Title 29—LABOR

Chapter XVII—Occupational Safety and Health Administration, Department of Labor

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Standard for Exposure to Asbestos Dust

On December 7, 1971, an emergency temporary standard concerning exposure to asbestos fibers was published in the FEDERAL REGISTER (36 F.R. 23207). In accordance with section 6(c) (3) of the Williams-Steiger Occupational Safety and Health Act of 1970, a notice of proposed rulemaking regarding a permanent standard for exposure to asbestos fibers was published in the FEDERAL REGISTER on January 12, 1972 (37 F.R. 466). The notice invited interested persons to submit both orally and in writing, data, views, and arguments concerning the proposal.

On or about January 24, 1972, the Advisory Committee on Asbestos Dust was established and requested to make written recommendations with regard to the proposed standard on asbestos. On or about February 1, 1972, the Department of Health, Education, and Welfare transmitted to the Secretary of Labor a criteria document containing Recommenda-

ceiling concentrations of 10 fibers/cc, will be permitted until July 1, 1976, during what will be a transitional period deemed necessary to allow employers to make the needed changes for coming into compliance with the more stringent standard.

The record shows that the many work operations subject to the single asbestos standard (textile, manufacturing, industrial, and marine installation, etc.) will meet varying degrees of difficulty in complying with the standard. In some plants, extensive redesign and relocation of equipment may be needed. It appears, however, the delay in the effective date of the two-fiber standard will provide all employers a reasonable time to comply. At the same time, so long as the ceiling limit is complied with, no harm is reasonably expected to result from exposures during the transitional period.

2. *Methods of compliance.* It has been pointed out by many persons, that protection against asbestos fibers is best obtained by controlling the generation of fibers first, and secondly, by controlling the dispersion of released fibers into the ambient air of the workplaces. Therefore, the standard requires feasible technological controls and appropriate work practices as the primary means of compliance. Rotation of employees as a way of meeting the TWA concentration requirement is allowed only in stated exceptional circumstances, because, as a general rule, it would be difficult to implement. Personal protective equipment, such as respirators, cannot be relied upon because, among other reasons, they may be so uncomfortable as to be burdensome, except for short periods of time. Therefore, it is expected that respirators and shift rotation will be used during the period necessary to install engineering controls and to train employees in sound work practices, but, after technological compliance has been achieved, their use must be limited to special work situations and emergencies. Where both are practicable, shift rotation is required.

3. *Labeling.* The proposed standard stopped short of requiring labeling asbestos and asbestos-containing products. The proposed standard would have required only warning signs at locations where asbestos hazards are present. However, labeling, rather than warning signs, has proved to be a point of controversy. Both NIOSH and the Advisory Committee on Asbestos Dust recommended labels for asbestos products and containers, and these recommendations became very controversial in the course of the proceeding. Many counterproposals have been made as to the language of the warning as well as to the products to be subject to the labeling requirements. Employers, in general, strongly contend that (1) finished products which effectively entrap asbestos

fibers so that these would not be released in the normal use of the products, should not be required to be labeled; and (2) words such as "danger" and "cancer" are unwarrantedly alarming.

Both contentions have merit, and the standard has been changed accordingly.

4. *Monitoring.* The proposed standard would have required personal monitoring and environmental monitoring. Many issues have been raised concerning the availability and reliability of measuring instruments, frequency of monitoring, and conditions in which monitoring should be required. The adopted standard takes the objections into consideration. It requires periodic monitoring at intervals no longer than 6 months, thus allowing considerable time and discretion, and prescribes the use of the membrane filter method, which is an acceptable method for determination of asbestos fibers.

It has also been recommended that employees or their representatives should have an opportunity to observe the monitoring. The recommendation has been accepted.

5. *Medical examinations.* The proposed standard would only require an appropriate medical examination on a periodic basis. The generality of the proposal has attracted many objections and also many helpful comments. The recommendations of NIOSH and of the Advisory Committee on Asbestos Dust were much more specific with respect to both frequency and type of medical examinations to be required. The comments vary as to the class of employees to be examined and as to the frequency of the examinations.

The adopted standard requires medical examinations both at the beginning and the termination of employment exposed to concentrations of asbestos fibers, and also requires annual medical examinations of every employee exposed to airborne concentrations of asbestos. It has been pointed out that in certain industries, such as construction, an employee may work for several employers during the same year. Accordingly, the standard does not require either preemployment, or termination, or periodic examination of any employee who has been examined in accordance with the standard within the past year.

One question which has been raised goes to whether the employer or the employee should be allowed to choose the examining physician. The standard gives the option to the employer. Since some employers already have a medical examination program in operation, and, also, have medical departments with some expertise in the diagnosis of asbestos-related diseases, it seems more reasonable to permit them to utilize the present programs and expertise, than to permit an employee to choose a private general practitioner.

6. *Records.* The standard, as proposed and as adopted, requires maintenance of records of monitoring and of medical examinations. Most of the controversy in this area has revolved around the question whether an employer should be allowed to have access to the results of the required medical examinations. The apprehension of those who have argued against employer access is based on the expectation that some employers will use the medical examinations as a means of screening employment applicants, and worse, as grounds for discharging current employees, who show signs of being affected by exposure to asbestos. Since the purpose of the medical examinations is to monitor the health of employees exposed to the hazards of asbestos, employees cannot in reason be granted the privilege of refusing to disclose to their employers results of occupational exposure. It does not make sense to require employers to provide medical examinations if they cannot know and use the results of the examinations. For these reasons the standard provides that employers may have a restricted access to some medical information.

On the other hand, there is no intention to allow employers to abuse medical information obtained pursuant to the Act, to the detriment of employees. Therefore, the administration of the medical records requirement will be closely watched, and, in cases of abuse, appropriate action will be considered.

The issues discussed above are believed to be the major ones. Numerous other issues have been raised in the rulemaking proceedings. Some have been referred to incidentally. Many recommendations, for instance, about work practices, are so obviously meritorious that their adoption needs no exposition here. Other recommendations and many objections have not been adopted for a variety of reasons which should be manifest. Several, for instance, have recommended the use of respirators only pursuant to a variance, or in cases of emergency and occasional short-term exposures. The recommendation with respect to variances undoubtedly has many merits, but is considered administratively impractical.

Accordingly, after consideration of the whole record of the proceeding, and pursuant to sections 6 (b) and (c) and 8(c) of the Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1596, 1599; 29 U.S.C. 655, 657), 29 CFR 1910.4, and to Secretary of Labor's Order No. 12-71 (36 F.R. 8754), Part 1910 of Title 29 of the Code of Federal Regulations is amended as set forth below.

(1) Section 1910.93 is amended by revising Table G-3 to read as follows:

RULES AND REGULATIONS

1910.93 Air contaminants.

TABLE G-3—MINERAL DUSTS

Substance	Mppcf	Mg/M ³
Silica—		
Crystalline—		
Quartz (respirable).....	250	10mg/M ³ =
	%SiO ₂ +5	%SiO ₂ +2
Quartz (total dust).....		%SiO ₂ +2
Cristobalite: Use 1/2 the value calculated from the count or mass formulae for quartz.		
Tribolite: Use 1/2 the value calculated from the formulae for quartz.		
Amorphous, including natural diatomaceous earth.....	20	80mg/M ³
		%SiO ₂
Silicates (less than 10% crystalline silica):		
Albite.....	20	
Forsterite.....	20	
Tridymite.....	20	
Portland cement.....	20	
Tridymite (natural).....	15	
Coal dust (respirable fraction less than 6% SiO ₂).....		2.4mg/M ³ or 10mg/M ³
For more than 5% SiO ₂		%SiO ₂ +2
Inert or Nuisance Dust:		
Respirable fraction.....	15	5mg/M ³
Total dust.....	50	15mg/M ³

NOTE: Conversion factors—
 mppcfX35.3 = million particles per cubic meter
 = particles per c.c.
 Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.
 The percentage of crystalline silica in the formula is the amount determined from air-borne samples, except in those instances in which other methods have been shown to be applicable.
 As determined by the membrane filter method at 40X phase contrast magnification.
 Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC instrument. If the respirable fraction of coal dust is determined with a MRE the figure corresponding to that of 2.4 Mg/M³ in the table for coal dust is 4.5 Mg/M³.

2. A new § 1910.93a is added to Part 1910, reading as follows:

§ 1910.93a A-bestos.

(a) **Definitions.** For the purpose of this section, (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) **Permissible exposure to airborne concentrations of asbestos fibers.**—(1) **Standard effective July 7, 1972.** The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) **Standard effective July 1, 1976.** The 8-hour time-weighted average airborne concentrations of asbestos fibers

to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) **Ceiling concentration.** No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(c) **Methods of compliance.**—(1) **Engineering methods.** (i) **Engineering controls.** Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) **Local exhaust ventilation.** (a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of ANSI Z9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(iii) **Particular tools.** All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) **Work practices.**—(i) **Wet methods.** Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) **Particular products and operations.** No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) **Spraying, demolition, or removal.** Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d) (2) (iii) of this section and with special clothing in accordance with paragraph (d) (3) of this section.

(d) **Permissible exposure equipment.**—(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivisions (i), (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 FR 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) **Air purifying respirators.** A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) **Powered air purifying respirators.** A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) **Type "C" supplied-air respirators, continuous flow or pressure-demand class.** A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) **Establishment of a respirator program.** (a) The employer shall establish a respirator program in accordance with

the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

b. See § 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms: (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering: (a) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) Method of measurement. All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 X (magnification) (4 millimeter objective) with phase contrast illumination.

(f) Monitoring—(1) Initial determinations. Within 6 months of the publication of this section, every employer shall cause every place of employment

where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) Personal monitoring—(1) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) Environmental monitoring—(1) samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) Caution signs and labels. (1) Caution signs. (i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by subdivision (1) of this

subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	Notation
Asbestos.....	1" Sans Serif, Gothic or Block.
Dust Hazard.....	¾" Sans Serif, Gothic or Block.
Avoid Breathing Dust....	¾" Gothic.
Wear Assigned Protective Equipment.	¾" Gothic.
Do Not Remain In Area Unless Your Work Requires It.	¾" Gothic.
Breathing Asbestos Dust May Be Hazardous To Your Health.	14 point Gothic.

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution labels—(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) Label specifications. The caution labels required by subdivision (1) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION
Contains Asbestos Fibers
Avoid Creating Dust
Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) Housekeeping—(1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) Waste disposal. Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) Recordkeeping—(1) Exposure records. Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 3 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National

Institute for Occupational Safety and Health, and a representative of either.

(2) *Employee access.* Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) *Employee notification.* Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) *Medical examinations—(1) General.* The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) *Preplacement.* The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV₁).

(3) *Annual examinations.* On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV₁).

(4) *Termination of employment.* The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV₁).

(5) *Recent examinations.* No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) *Medical records—(i) Maintenance.* Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examina-

tions. Records shall be retained by employers for at least 20 years.

(ii) *Access.* The contents of the records of the medical examinations required by this paragraph shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of NIOSH, to authorized physicians and medical consultants of either of them, and, upon the request of an employee or former employee, to his physician. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

3. A new § 1910.19 is added to Subpart B of Part 1910, reading as follows:

§ 1910.19 Asbestos dust.

Section 1910.93a shall apply to the exposure of every employee to asbestos dust in every employment and place of employment covered by § 1910.12, § 1910.13, § 1910.14, § 1910.15, or § 1910.16, in lieu of any different standard on exposure to asbestos dust which would otherwise be applicable by virtue of any of those sections.

Effective date. Paragraph (b)(2) of § 1910.93a shall become effective July 1, 1976. All other provisions of §§ 1910.93a, 1910.93, and 1910.19 shall become effective July 7, 1972. The current emergency temporary standard remains in effect until July 7, 1972.

(Secs. 6, 8, 84 Stat. 1593, 1598; 29 U.S.C. 655, 657; 29 CFR 1910.4; Secretary of Labor's Order No. 12-71, 36 F.R. 8754)

Signed at Washington, D.C., this 2d day of June 1972.

G. C. GUENTHER,
Assistant Secretary of Labor.

[FR Doc. 72-8574 Filed 6-6-72; 8:48 am]

UNION CARBIDE CORPORATION

METALS DIVISION

020528

TECHNOLOGY DEPARTMENT - PRODUCT DEVELOPMENT

TRIP TO: Elk City, Oklahoma - Little Rock, Ark.

DATE: January 16-20, 1983

BY: F. L. Smith

PURPOSE: Customer Service Dust Count

Discussion

Airborne asbestos emission samples were collected at two production facilities:

1. Western Drilling Rig #209 This is a natural gas well going to 26,000 ft. While drilling surface casing (~5500 ft.) "Supervisbestos" (distributed by Montello, Inc.) is used in conjunction with bentonite to provide viscosity in the drilling fluid. This operation may use between 600-800 bags of Supervisbestos. Airborne asbestos samples were collected from the Derrick Hand and three environmental locations:

Persons Interviewed

- A. - Bud Shreeves - Drilling consultant, Leede Oil and Gas Company.
 - B. - Gerald Garner and Ray Taylor - Mud engineers, X-Puet Mud Co.
 - C. - Doug Goyer and Charlie Alexander - Montello, Inc.
2. Ameron -Enmar Finishes Division This is a RG-110 and RG-244 customer using our products in ZN-rich primers and coatings. Airborne asbestos samples taken from mixer operator and locations adjacent to the mixing equipment. This customer is handled by D&F Distributing, Dallas, Texas.

Persons Interviewed

- A. Dick Byrd - Technical Director, Ameron Finishes Division.
- B. Ross Frank - V.P. , D&F Distributing, Dallas, Texas.


F. L. Smith

MUD REPORT

020529

Title: Field Mud - Western Rig 209 1/18/83

Sample Description

- 1) Suction Pit 11:00 AM
 2) Flowline 1:00 PM
 3) Flowline 3:00 PM

Pre-mixing Fresh water + bentonite

Adding Super Visbestos directly to the active system.

Maintaining funnel vis of 42-44 sec/qt and 9.0 to 9.2 #/gal mud wt.

	1	2	3			
Weight (lb/gal)	9.1+	9.2+	9.2			
600 Reading	65	65	50			
300 Reading	62	63	48			
Plastic Viscosity (cp)	3	2	2			
Yield Point, lb/100 sq ft	59	61	46			
Apparent Viscosity (cp)	32½	32½	25			
Initial Gel	8	7	8			
10-Min Gel	9	7	8			
Beckman pH	9.3	9.3	9.5			
API Water Loss	145.0	142.0	135.0			
H.P.-H.T. Fluid Loss	-	-	-			
Cake Thickness (1/32's)	8	8	7			
Mud Alkalinity (Pm)	0.2	0.1	0.2			
P-Alkalinity (Pf)	<0.1	<0.1	<0.1			
M-Alkalinity (Mf)	0.1	0.1	0.1			
Chloride, ppm	30,200	33,200	31,600			
Calcium, ppm	1,160	1,580	1,580			
Total Hardness (as CaCO ₃)	3,950	3,950	3,550			
Solids (% by Vol)	4	4	4			
Oil (% by Vol)	0	0	0			
MBT (#/bbl)	6	6	6			
Remarks:						

By: _____

1/24/83

020530

Fred Smith

Personal counts - Western Drilling #209

12 sx - .777 F/cc

15 sx - .853

3 sx - .410

13 sx - .232

TWA = .256 rounded to .3 F/cc

2,150 lbs Super Vis mixed over 44% of the work day.

1/18/83

020531

Western Drilling Rig 209

Derrick - David Reeves

Mixing

40 Gel - 2 hrs (approx 7:45am - 9:45am)

12 SY 10:00A - 10:30A

15 SY 10:30A - 11:15A

3 SY 11:15A - 12:30P

in meeting 11:30 - 12:30P

40 Gel 12:30P - 2:20P

13 SY 2:20P - 3:20P

off @ 4:00P

Totals : 80 Gel (2 pre-mix tanks)
43 SY

Samples :

- 1) Suction Pit @ 11:00 AM
- 2) Flowline @ 1:00 PM
- 3) Flowline @ 3:00 PM

Mud Report
1/18/83 @ 6:45 AM
by Gerald Garner

Leede Oil + Gas
Green #1-3

9.0 #/gal
41 sec/qt
4 PV
43 YP
8/11 Gels
9.0 pH
N/C F/L

Bit 20"
D.P. 5"
D.C. 6-8-10" (655')

Depth 4,081 @ 12:00 PM
8-12 ft/hr

31,000 Cl⁻
Hvy Ca⁺⁺ (>2,000?)
3.5% Solids

Treatment

1) Premix
Freshwater + 1 sz Soda Ash + 40 sz Gel
to 120+ Funnel

2) Active System
add Super Vis for 42-44 sec/qt Funnel
8 NaOH / tout
Water to maintain 9.0-9.2 #/gal

Rig Location

1/17/83

EIK City

- 1) Hwy 6 West
thru 4 way stop to Hwy 152 (TV Tower)
Turn S Go 3 mi
Rowan Rig on Hwy
Southwestern Rig just to West
(SW Rig 209)

OR

- 2) I 40 to Sayer OK
Hwy 152 N to Rowan Rig on Hwy
approx 12 mi.

Gerald Garner - Mud Consultant
Bob Shreves - Co. Man

Reservations, starting at 11:00 AM Mon. & Tue.

405-225-6637

020534

1. V-Punt

Roy Taylor, Harvey Hanson

405-225-3511

2. Gerald Garner

405-225-2794 (Home)

Mud consultant on the job, I spoke to Gerald Sat. night, told him you would try & get in touch with him today.

Operator is Leeds Oil & Gas

915-682-2535

Tom A. Morgan - V.P.

Gene Pollard - Drilling & Completions mgr.

I spoke with Gene last week in Midland, he requested monitoring.

Contractor: Western Rig # 209

Consultants on Rig: Everett Leeburg } 7/7
Bud Shreves }

Warehouse: Mud Trans 409 S. Pioneer Road

Burt Hutson

405-225-0321 Office

225-1821 Home

ileage
then
n 529 mi
IK City
248,260

020535



UNION CARBIDE CORPORATION
METALS DIVISION

4625 ROYAL AVE., P.O. BOX 575, NIAGARA FALLS, N.Y. 14303

February 16, 1983

Mr. Ken Campbell
Mr. Doug Goyer
Mr. Allen Johnson
Montello, Inc.
6106 E. 32nd Place
Tulsa, Oklahoma 74135

Enclosed are the airborne asbestos emission results for Western Drilling Co. Rig #209. Also, as per your request I have forwarded samples C-1, K-32, B-48, K-43, B-64, K-37, and J-21 to Environmental Analysis Laboratory in Richmond, California. These are the personal (Derrick Hand) samples.

Many thanks for your efforts at this location. If there is anything else you need, or if I may be of further help with the report, please do not hesitate to call.

Regards,

A handwritten signature in dark ink, appearing to read "F. L. Smith", written over a horizontal line.

F. L. Smith

/j1
Enclosure

020536

AIRBORNE ASBESTOS COUNTS

For
Western Drilling Rig #209

Date Sampled: January 18, 1983
Date Reported: January 30, 1983

Samples Collected By: F. L. Smith
Union Carbide Corp.

Samples Analyzed By: F. L. Smith
Union Carbide Corp.

Reported By: F. L. Smith
Union Carbide Corp.

Union Carbide Corporation
Metals Division
Niagara Falls, New York

Summary

020537

Airborne asbestos concentrations were measured by collecting personal and environmental samples during a typical work day at a natural gas drilling location in the Anadarko Basin of western Oklahoma. These concentrations were determined for a product known as "Supervisbestos", distributed by Montello, Inc., and were accomplished in accordance with OSHA regulation 1910.1001. Monitoring involved sampling at the drilling location before, during and after asbestos usage for the entire day shift.

Time Weighted Averages (TWA) and Maximum Ceiling Values of asbestos emissions are summarized in Table I below:

TABLE I

<u>Location Monitored</u>	<u>Sample Description</u>	<u>TWA Fiber/cc of Air</u>	<u>Maximum Ceiling Value Fiber/cc of Air</u>
Western Drilling	Personal	0.3 (7.8)*	0.9 **
Rig #209	Area-location #1	0.2 (7.8)*	0.8 **
	Area-location #2	0.2 (7.8)*	0.7 **
	Area-location #3	0.2 (7.8)*	0.6 **

Note: * Indicates hours upon which TWA is based

** Indicates maximum ceiling value obtained during asbestos additions

Introduction

This field test was performed as part of an on-going monitoring program to determine airborne asbestos fiber emissions during the use of asbestos under actual conditions. This product is usually added to the fluid recirculation system (alone, or with other solids eg. - bentonite, etc.) to facilitate the lifting of cuttings and other debris associated with the drill bit action to the surface by providing increased viscosity to the fluid in the annulus between the borehole and drillpipe. In this operation, asbestos was added to a premix tank which contained suspended bentonite and asbestos. These additions occupied approximately 45% of the work day. Total asbestos added to the system was 45 bags or 2,150 lb. All solid additions were accomplished in an enclosed area with ventilation provided by the suction at the hopper and partially opened doorways.

not added to premix: vent directly to suction

Discussion

Personal breathing zone (an area defined as a 300 mm radius about the face) and environmental (fixed locations near the work site) samples were collected and evaluated during the use of "Supervisbestos" while drilling a 20" surface borehole. Personal samples were collected from Derrick Hand who is a member of the drilling crew assigned to maintain solids in the drilling fluid system. Monitoring equipment was worn by this individual for the entire work day.

020538

Discussion cont'd

Environmental samples were obtained from positions within the "mud house" at varying distances from the mud hopper. This monitoring equipment was also in operation for the entire work day.

Weather conditions were approximately 25-30°F with the wind swirling about the location @ 15-25 mph and occasional snow flurries.

maybe for New York!

Remarks

It can be noted that emission data varied significantly in the mud house depending on the room ventilation conditions as determined by opened or closed doorways. During the first 3.3 hours of the shift, 1350 lb. of "Supervisbestos" was added to the fluid recirculation system. At this time weather conditions were such that the main loading door on the west side of the enclosure was closed, the north door was partially open and the east door was wide open. Emission levels were at 0.8 and 0.9 fibers/cc of air for the Derrick Hand within this time frame and 0.8 and 0.7 and 0.6 fiber/cc of air for environmental samples # 1, 2 and 3, respectively. After this period of time the loading door was opened to discard used bags, bring up new stock from the ground, etc. and left open. Also, the north door was opened fully and remained that way until the end of the day. Looking at the personal sample emission data graphically (Appendix I, Figure 1) the curve shows a sharp decline in fiber/cc of air for the remainder of the day with a moderate increase at the last addition of 650 lb. of "Supervisbestos" with the changing ventilation pattern within the mud house. Figures 2, 3 and 4 representing fiber/cc of air emissions at the environmental locations give a similar impression. A negative exhaust system to evacuate air within the mud house and an exhaust near the face of the hopper would contribute to reduce emissions.

020539

Sampling and dust counting are carried out in accordance with OSHA Regulation 1910.1001, based on NIOSH Analytical Method PCM 239 and OSHA methods; reference - Occupational Safety and Health Administration Methods, W. C. Dixon, pp 431, NBS special publication No. 506, U.S. Department of Commerce, November 1978.

Battery-powered air pumps (M.S.A. type), calibrated to 2 liters per minute, are used to collect personal breathing zone and environmental samples on Millipore membrane filters of 0.8 micron porosity. Fiber counting is performed on a Nikon phase contrast microscope at 400X utilizing a Porton reticle for sizing and field definition.

The counts reported are for all fibers having an aspect ratio ≥ 3 and a length $> 5\mu$ that are in the operator's judgement, chrysotile. In the event of doubt or the absence of further information, any fiber having the above physical dimensions is counted as chrysotile.

COMMENTS

The OSHA regulations permit a maximum limit of 2 fibers greater than 5 microns in length per cubic centimeter of air sampled on the basis of an 8-hour, time-weighted average (TWA). The formula $\frac{C_1 T_1 + C_2 T_2 + C_n T_n}{\sum T}$ describes the TWA where C= fiber count in fibers/cc and T= time.

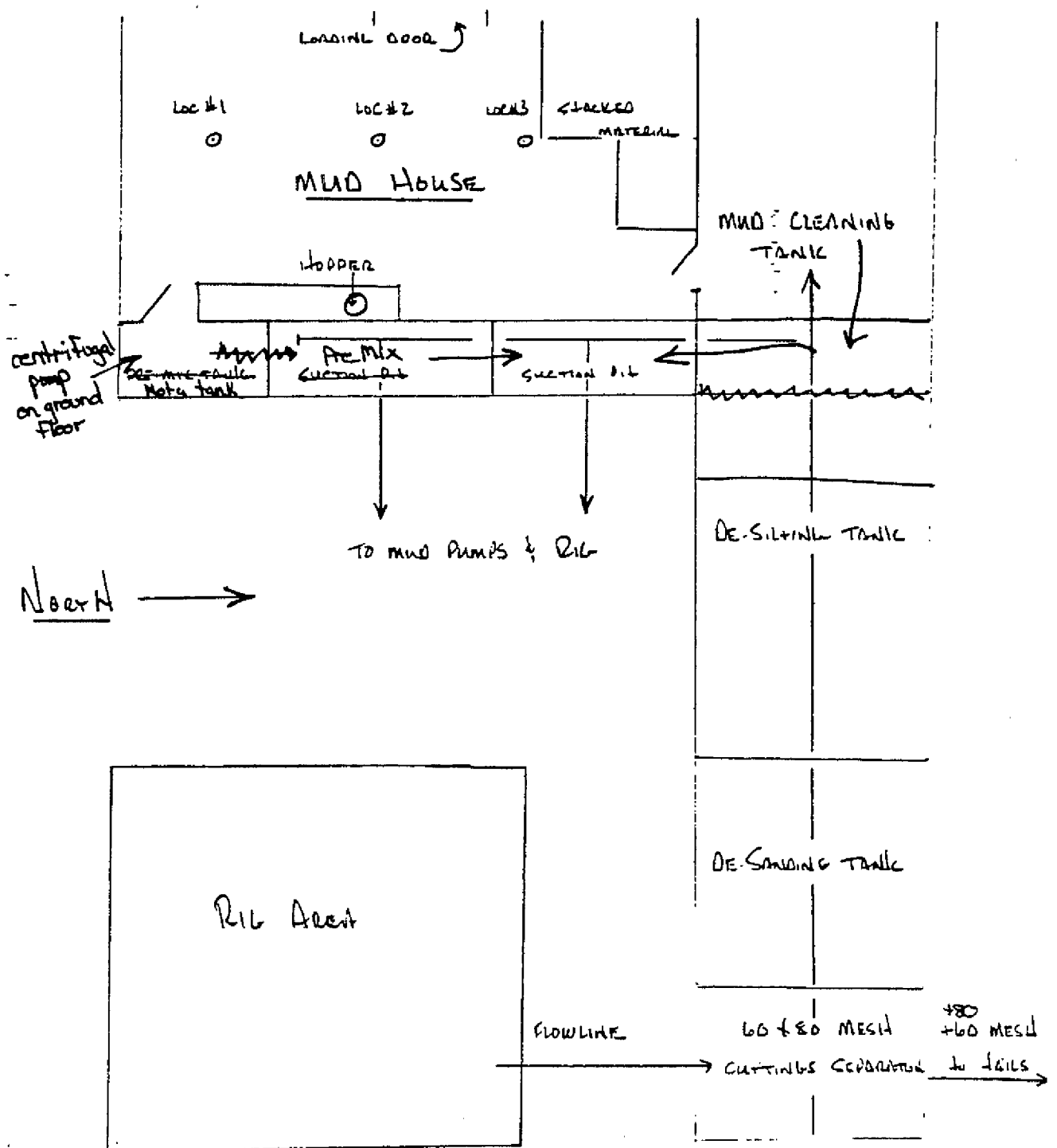
The regulations also stipulate a ceiling concentration of 10 fibers/cc greater than 5 microns which is not to be exceeded at any time.

LIMITS AND CONDITIONS

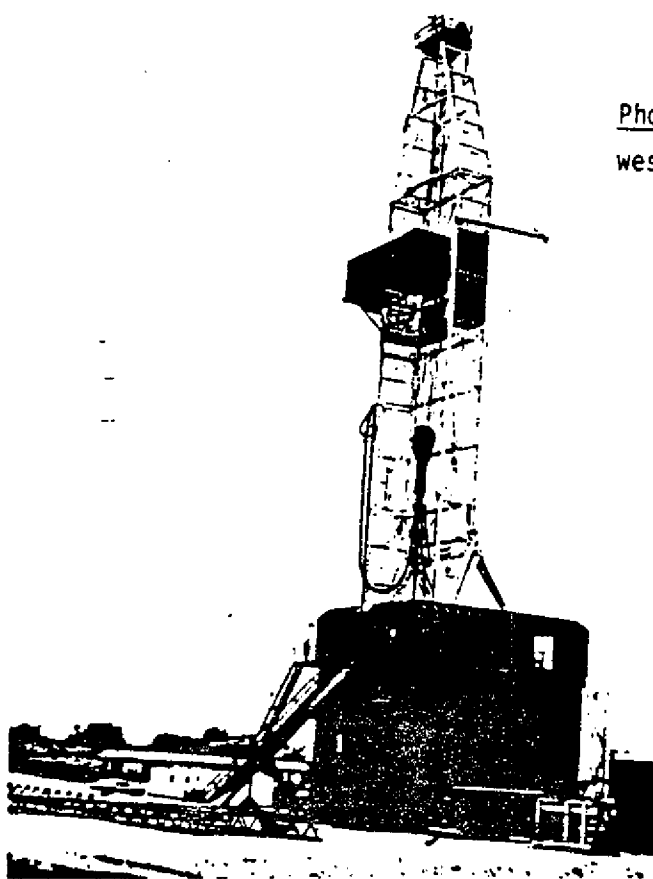
1. In compiling this report, Union Carbide followed procedures which it believes to be accurate and reliable but there may be other methods for evaluating asbestos fiber emissions which may produce different results.
2. The air monitoring results reported herein are not necessarily representative of the results which may be found at different locations or under different operating conditions.
3. Any use of or reliance upon the data or other information contained herein by yourself or any other party shall be without any recourse to or liability on the part of Union Carbide.
4. The breathing of asbestos dust may cause serious bodily harm and Union Carbide makes no warranty or guarantee that the results contained herein indicate safe levels of exposure. It is the responsibility of any user of asbestos or asbestos-containing product to ensure that safe handling procedures are employed and that applicable government regulations are complied with. Appropriate literature and other information concerning asbestos and health or regulations are available upon request.
5. Regardless of the results of these tests you should consider the advisability of further air monitoring.

TEST RESULTS

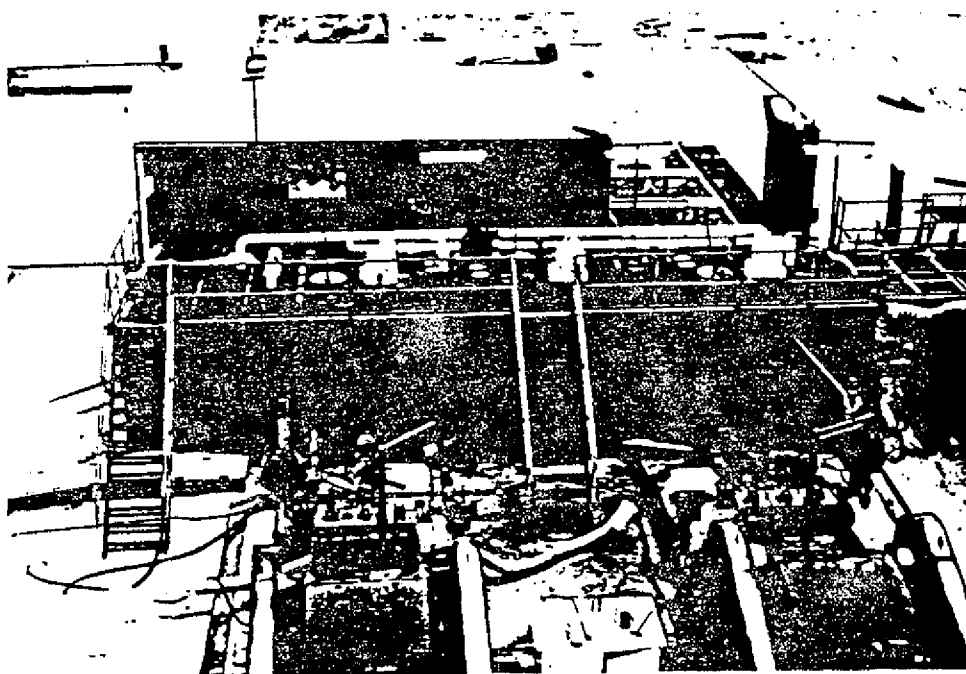
The details of sample collection and resultant fiber counts are listed in the attached table(s).

GENERAL OVERVIEW OF FLUID SYSTEM

Photograph #1 - General view of
western drilling rig #209



Photograph #2 - Mud house, pre-
mix and suction pit tanks, and
mud pumps.





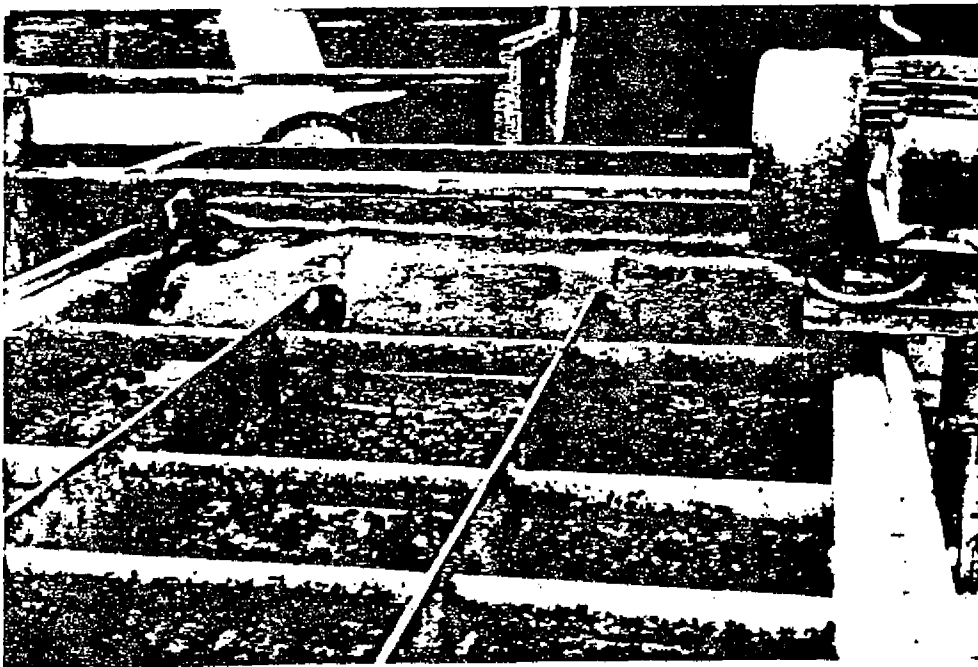
Photograph #3 - Operator
adding "Supervisbestos" to mud
hopper



Photograph #4 - Operator
continuing to add "Supervisbestos"

Photographs (cont'd)

Photograph #5 - Operator during
bag disposal near partially
open loading door.



Photograph #6 - Drilling fluid
returning to surface at shaker
screen.

SUMMARY OF FIBER COUNTS

Sample	No.	Air Sample		Operation Description	Chrysotile Asbestos	
		Time	Minutes		Fiber/Field	Fiber/c
C-1		On: 7:55 a Off: 10:00 a	125	Personal sample - David Reeves. Derrick Hand. During normal checking of mud operations (screens, cyclones, pumps, etc.) and the addition of 40 bags Bentonite (4000 lbs.) to mud system.	0.065	< 0.1
K-32		On: 10:01 a Off: 10:35 a	34	Personal sample - David Reeves. Addition of 12 bags (600 lbs.) Supervisbestos to mud system.	0.34	0.8
B-48		On: 10:36 a Off: 11:17 a	41	Personal sample - David Reeves. Addition of 15 bags (750 lbs.) Supervisbestos to mud system.	0.45	0.9
K-43		On: 11:17 a Off: 12:30 p	73	Personal sample - David Reeves. Addition of 3 bags (150 lbs) Supervisbestos to mud system.	0.385	0.4
B-64		On: 12:31 p Off: 2:22 p	111	Personal sample - David Reeves. Addition of 40 bags bentonite (4000 lbs.) to mud system.	0.07	< 0.1
K-37		On: 2:23 p Off: 3:20 p	57	Personal sample - David Reeves. Addition of 13 bags Supervisbestos (650 lbs.) to mud system.	0.17	0.2
J-21		On: 3:21 p Off: 3:50 p	29	Personal sample - David Reeves. Normal duties associated with drilling operation.	0.08	0.2

TWA Chrysotile $\frac{121.19}{.470} = 0.3$ Fiber/cc of air

SUMMARY OF FIBER COUNTSEnvironmental Samples
Location #1

Sample No.	Air Sample		Operation Description	Chrysotile Asbestos	
	Time	Minutes		Fiber/Field	Fiber/c
A-21	On: 8:00 a Off: 10:00 a	120	Environmental sample - location #1. Located at south end of mud house 6' above floor and 10' from mud hopper. Addition of 40 bags bentonite.	0.035	< 0.1
K-33	On: 10:00 a Off: 11:20 a	80	Environmental sample - location #1. During addition of 27 bags Supervis- bestos.	0.78	0.8
B-47	On: 11:21 a Off: 12:40 p	79	Environmental sample - location #1. During addition of 3 bags Super- visbestos.	0.12	0.1
K-42	On: 12:41 p Off: 2:22 p	101	Environmental sample - location #1. Addition of 40 bags bentonite.	0.05	< 0.1
K-38	On: 2:23 p Off: 3:18 p	55	Environmental sample location #1. Addition of 13 bags Supervisbestos.	0.25	0.4
C-35	On: 3:19 p Off: 3:51 p	32	Environmental sample -location #1. normal activities.	0.035	0.1

TWA Chrysotile $\frac{98.695}{467} = 0.2$ Fiber/cc of air

SUMMARY OF FIBER COUNTS

Sample No.	Air Sample		Environmental Samples	Chrysotile Asbestos	
	Time	Minutes	Location #2	Fiber/Field	Fiber/c
			Operation Description		
K-34	On: 8:00 a Off: 10:00 a	120	Environmental sample - location #2. Located at center of mud house, 6' above floor and 10' from mud hopper. Addition of 40 bags Bentonite.	0.04	< 0.1
K-39	On:10:00 a Off:11:21 a	81	Environmental sample - location #2. Addition of 27 bags Supervisbestos.	0.74	0.7
B-55	On:11:22 a Off:12:40 p	78	Environmental sample - location #2. Addition of 3 bags Supervisbestos.	0.14	0.1
B-50	On:12:41 p Off: 2:23 p	102	Environmental sample - location #2. Addition of 40 bags Bentonite.	0.035	< 0.1
K-51	On: 2:24 p Off: 3:18 p	54	Environmental sample - location #2. Addition of 13 bags Supervisbestos.	0.26	0.4
C-41	On: 3:19 p Off: 3:51 p	32	Environmental sample - location #2. Normal activities.	0.035	0.1

TWA Chrysotile $\frac{97.22}{467} = 0.2$ Fiber/cc of air

SUMMARY OF FIDER COUNTS

020547

Environmental Samples

Location #3

Sample No.	Air Sample		Operation Description	Chrysotile Asbestos	
	Time	Minutes		Fiber/Field	Fiber/c
K-50	On: 8:00 a Off: 10:00 a	120	Environmental Sample - location #3. located at north end of mud house above asbestos storage area and 20' from mud hopper. Addition of 40 bags bentonite.	0.045	< 0.1
B-62	On: 10:00 a Off: 11:23 a	83	Environmental Sample - location #3. Addition of 27 bags supervisbestos.	0.615	0.6
B-66	On: 11:24 a Off: 12:41 p	77	Environmental Sample - location #3. Addition of 3 bags supervisbestos.	0.135	0.1
B-61	On: 12:42 p Off: 2:24 p	102	Environmental Sample - location #3. Addition of 40 bags bentonite.	0.06	< 0.1
B-60	On: 2:25 p Off: 3:19 p	54	Environmental Sample - location #3. Addition of 13 bags supervisbestos.	0.225	0.3
K-47	On: 3:20 p Off: 3:51 p	31	Environmental Sample - location #3. Normal activities.	0.05	0.1

$$\text{TJA Chrysotile } \frac{87.823}{467} = 0.2 \text{ Fiber/cc of air}$$

APPENDIX I

Figure 1

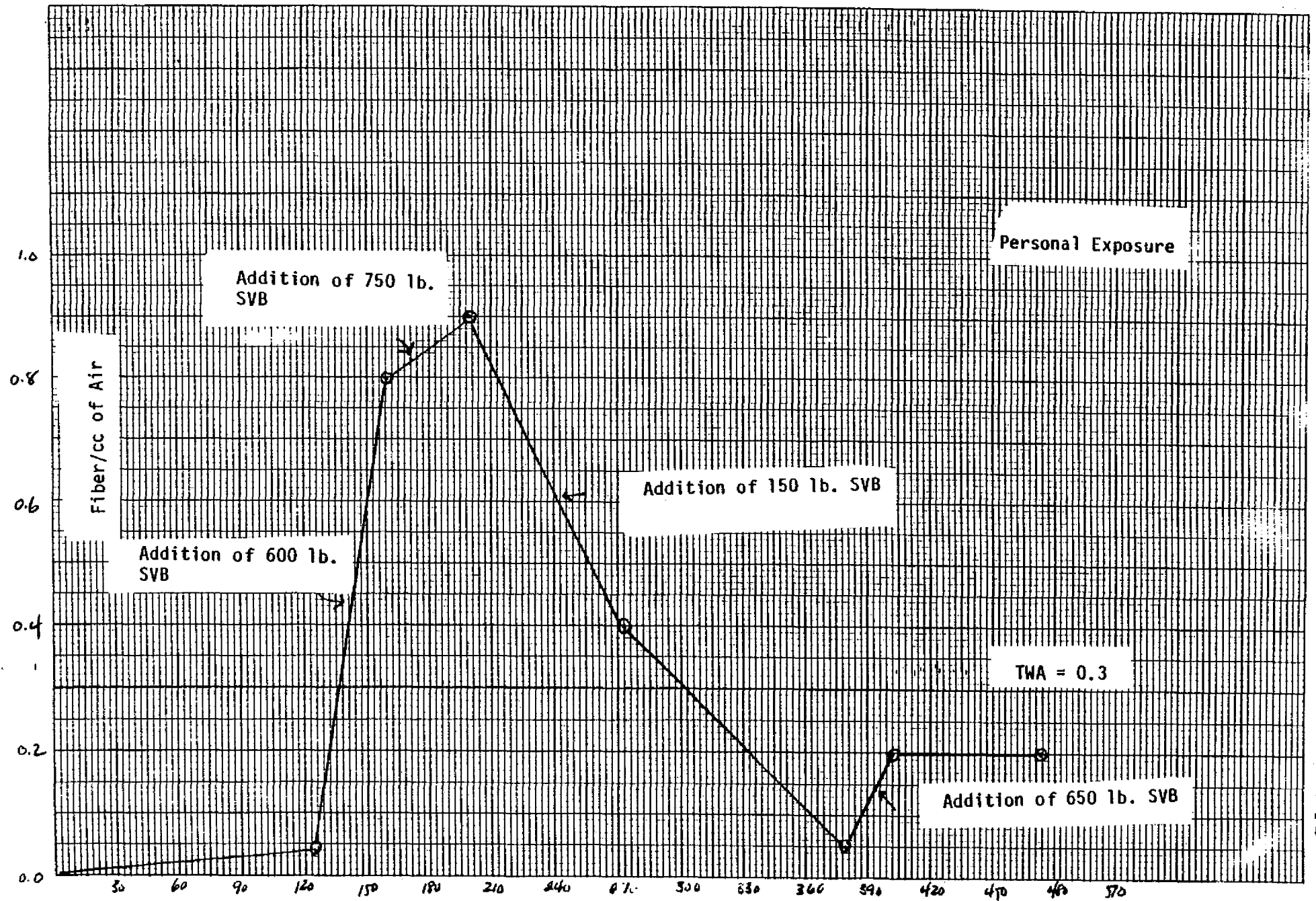


Figure 2

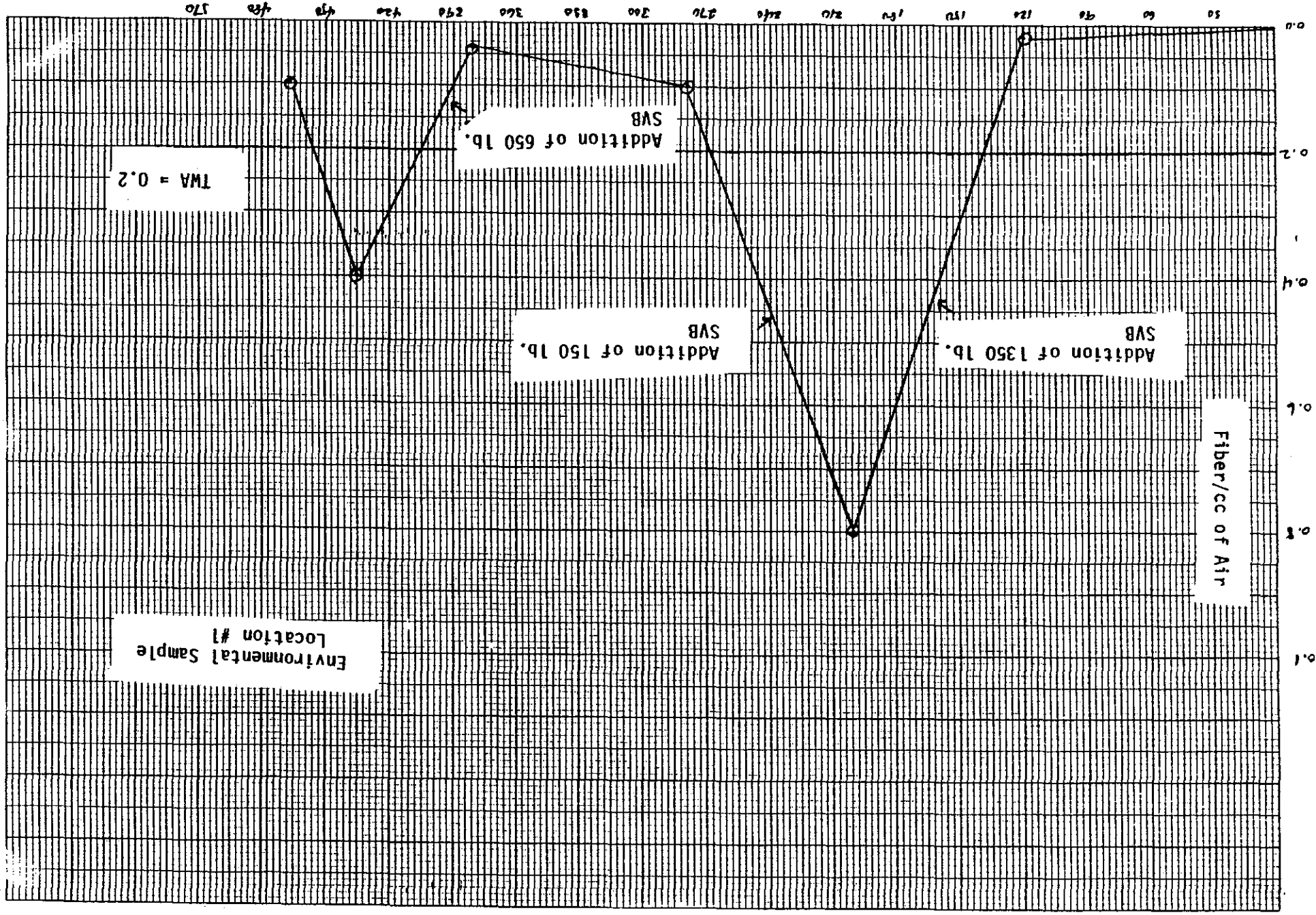


Figure 3

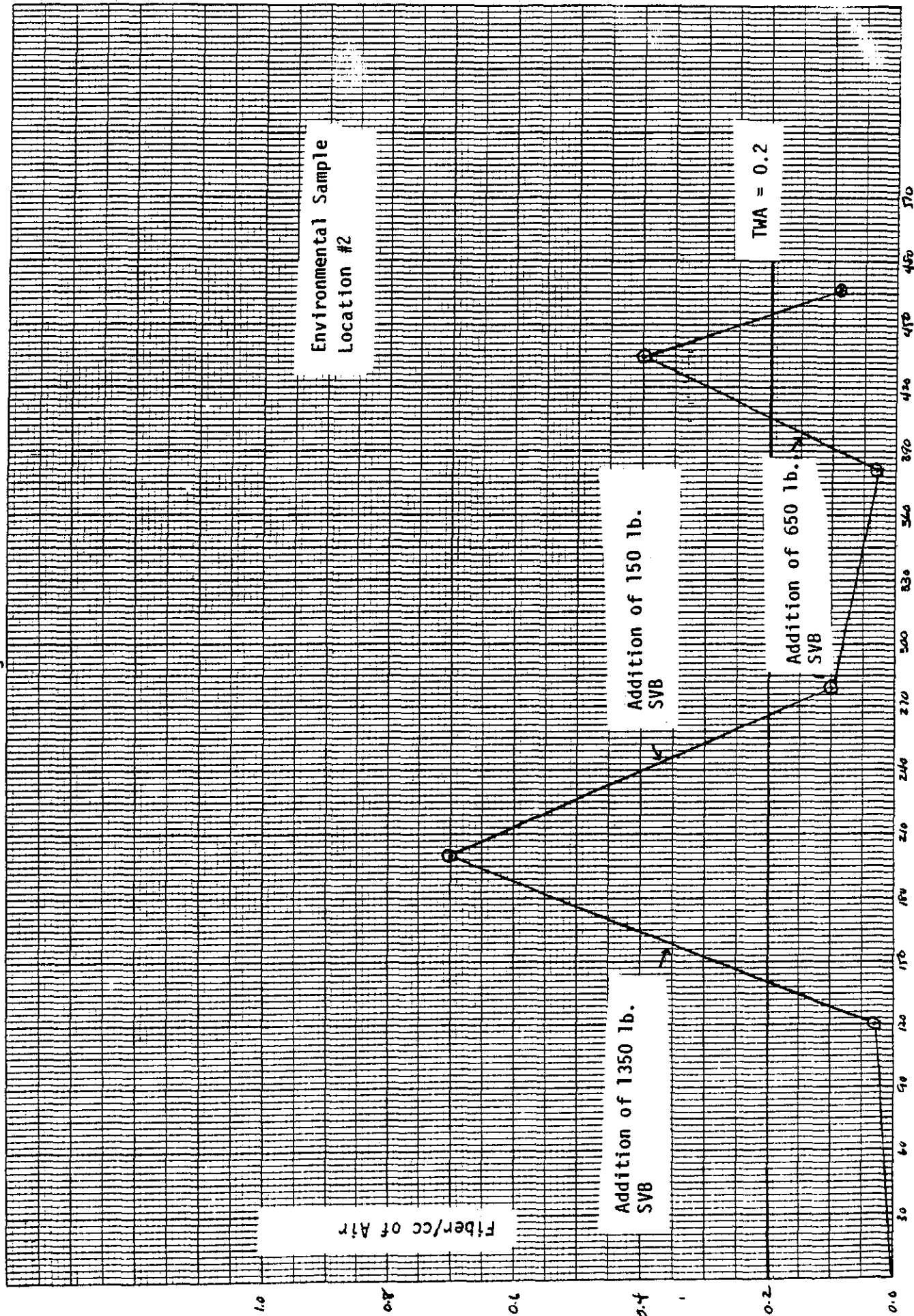
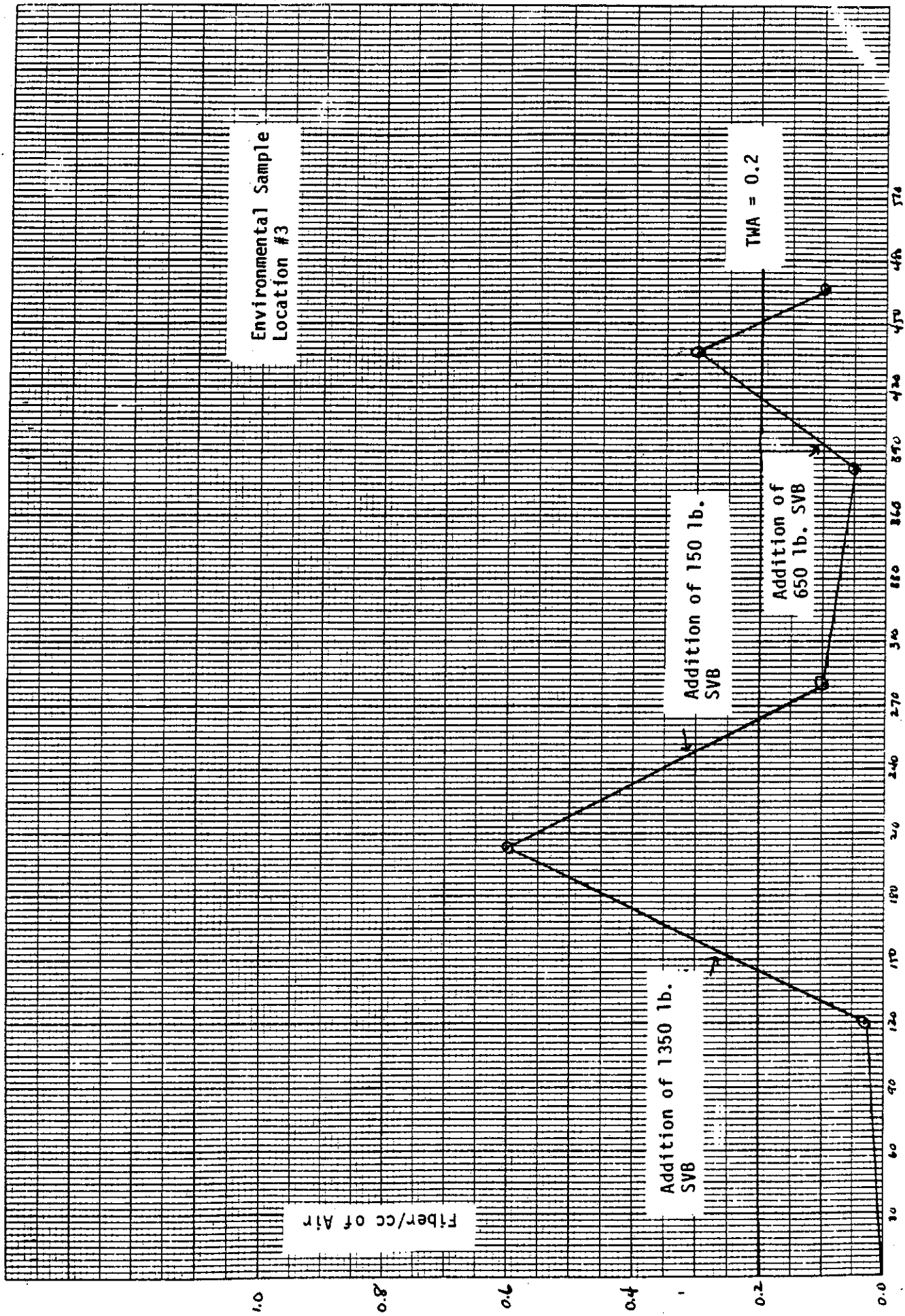


Figure 4



020000

June 2, 1967

Mr. Don Lawrence
Sun Oil Company
P.O. Box 2880
Southland Center
Dallas, Texas

Dear Mr. Lawrence:

Presented below is a tabulation of Visbestos sales to Mud Companies, both major and independent. Visbestos sales to each customer in the combined Oklahoma and Panhandle areas have also been included for your information.

Total sales to both major and independent Mud Service Companies during the reporting period was 61,552 sacks. Major Mud Company purchases are broken down as follows:

Baroid-----	15,029 sacks	Total
	2,000 sacks	Panhandle Area
	5,529 sacks	Oklahoma
I.M.C.-----	11,355 sacks	Total
	245 sacks	Panhandle Area
	1,000 sacks	Oklahoma
Milwhite-----	3,528 sacks	Total
	500 sacks	Panhandle Area
	500 sacks	Oklahoma
Mageobar-----	3,235 sacks	Total
	560 sacks	Panhandle Area
	1,000 sacks	Oklahoma

During this same period of time the combined sales to independent Mud Companies was 28,405 sacks.

Major Mud Companies	33,147 sacks
Independent Mud Co.	<u>28,405</u> sacks
Total	61,552 sacks

Mr. Don Lawrence

-2-

June 2, 1967

Total sales to Independent Mud Companies in the Oklahoma and Panhandle area for the same reporting period was 7,424 sacks. This can be broken down as follows:

Drilling Mud, Inc.-----	2,220 sacks
Davis Mud Company ----	1,524 sacks
Oil States -----	1,480 sacks
United -----	1,200 sacks
Tri-State-----	600 sacks
Titan -----	340 sacks
Atlas -----	60 sacks

Total 7,424 sacks

The Major and Independent Mud Service Company sales in the Oklahoma and Panhandle area for the same reporting period as given above are as follows:

Baroid -----	7,529 sacks	United-----	1,200 sacks
Drilling Mud--	2,220 sacks	Milwhite ---	1,000 sacks
Mageobar-----	1,560 sacks	Tri State---	600 sacks
Davis Mud-----	1,524 sacks	Titan -----	340 sacks
Oil States----	1,480 sacks	Atlas -----	60 sacks
I.M.C.-----	1,245 sacks		

Visbestos purchases in West and East Texas during this same reporting period by the four Major Mud Service Companies are as follows:

	<u>Baroid</u>	<u>I.M.C.</u>	<u>Mageobar</u>	<u>Milwhite</u>
West Texas	6,750	2,450	1,225	500
East Texas	500	-0-	-0-	500

Mr. Don Lawrence

-8-

June 2, 1967

In addition to these figures Texas Mud and Chemical has purchased 1,400 sacks and Buckeye Supply Company of Midland, Texas (wholesaler) has purchased 4,525 sacks.

Don, this gives you a comparison of the percentages of Visbestos purchased by the different Mud Service Companies in the different areas. If additional information is desired please let us know. We certainly appreciate your continued assistance in the use and distribution of Visbestos.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

HMW/gdj

Boat Supply

Ship Date	Pheno Sml	Selsonito	Veibestas
1-13	55,000	25,000	
2-14	50,000		
6-3		40,000 RS	
6-10	50,000		
8-4			3,400
8-15			3,000 = Total 6400
8-7		40,000 RS	
9-7			
9-7			{3,400}
9-7			27,500 = 24,100
9-10		50,000 RS	
10-25	20,000		
11-5		40,000 RS	
12-3	10,000	79,900 RS	
12-22			25,000
Totals	185,000	274,900	55,500

Decker

Ship Date	Pheno Sal	Delonite	Vichestas
1-7-66	30,000		
1-19-66	30,000	60,000	
3-4-66	30,000		
3-16-66	40,000		
3-4-66	30,000	100,000	
6-15-66	30,000		
7-7-66	30,000		
9-22-66	30,000		
11-10-66	30,000		
12-30-66	30,000		
Total	320,000		

Maguebar

Ship Date	Ofeno Seal	Suborut	Vibestas	Salesman
1-25-67		8,500		Ray
3-10-66		<4,100>		<Ray>
4-1-66	7,500			BrW
4-1-66		3,500		S+U
6-16-66		7,500		Ray
7-5-66		1,000		Ray
7-13-66		2,500		Ray
9-8-66			25,000	S+U
9-28-66		10,000 (m-2)		Ray
11-1-66			25,000	S+U
12-3-66	15,000			Ray
12-8-66		<2,800 m2>		<Ray>
Total	22,500	26,100	50,000	

277C

Ship Date	Pheno Seal	Gilsonite	Visbestos	Salesman
1-1-66	30,000			Ros
1-1-66	3,500			Ray
2-1-66	11,250			L & Y
2-4-66	11,250			L & Y
2-3-66	30,000			Whitey
2-12-66	3,750			Ray
2-11-66	30,000			Whitey
2-8-66	30,000			Whitey
3-8-66	2,500			Ray
3-10-66	5,000			Br W
3-18-66	2,500			Br W
3-19-66	10,000			Br W
4-10-66	5,000			Ray
5-15-66	10,000			Br W
6-11-66	10,000			Br W
6-28-66	50,000			Ros
7-1-66	40,000			Ros
7-12-66			14,700	Ros
7-10-66	5,000			Ray
7-27-66	6,250			Br W
7-28-66	5,000			L & Y
8-28-66	10,000			Ray
8-29-66			45,000	Ros
9-27-66			10,000	Dawk
10-1-66			17,500	Ros
10-3-66			15,000	Ros
10-19-66			17,550	Ros
10-20-66	30,000			also mostly
10-21-66	10,000			Burr
10-25-66	10,000			Burr
10-15-66	11,250			Burr
11-2-66	30,000		10,000	Ros
11-1-66	10,000			Burr
11-10-66	10,000			Surr

16415 596,550 PS 15,000 TS

Baroid

Ship Date	Pheno Seal	Chilsonite	Vibrestex	Salesman
1-22-66	36,000			Elliott
3-22-66	30,000			Rso.
3-30-66		10,000		Ray
5-18-66	12,500			Dr. Y.
6-4-66		2,500		Ray
6-8-66	30,000			Rso.
6-3-66	20,000			Ray
6-24-66	30,000			Hawk
7-11-66	14,500			Sy. Olson
7-22-66		5,750		Ray
7-23-66			50,000	Hawk
8-3-66			10,000	Hawk
8-22-66		2,000		Ray
9-2-66	13,750			Ray
9-5-66		2,000		Ray
9-12-66				Dr. Y.
9-10-66		2,500		Ray
9-19-66		1,500		Ray
9-22-66		1,500		Ray
9-27-66		12,500		Hawk
10-4-66				Dr. Y.
9-17-66				Ray
10-19-66	(10,000 TS)			Rso.
10-20-66				
11-1-66			25,000	Dr. Y.
11-5-66				Ray
11-14-66			12,500	Dr. Y.
11-5-66			100,000	Hawk
11-10-66				Ray
11-4-66			25,700	Dr. Y.
12-7-66		3,000		Ray
12-9-66			25,000	Ray
12-13-66	30,000			Ray
12-19-66		1250		Ray

80,000

29,000

35,000

10,000

12,500

25,000

2,500 (M-2)

2,000

25,000

12,500

100,000

25,700

63,700

Baroid

Ship Date	Pheno Sol	Gulconite	Vishetos	Salesman
12-21-66	3,750			Ray
12-21-66		2,500 (ms)		Ray
12-8-67		6,750	100,000	Ray
12-23-66			25,000	S. G.
12-31-66			25,000	Curr

TOTAL ~~225,500~~
 210,500 PS
 10,000 TS

51,500

445,700

Milchem

Ship Date	Ohio Sul	Gilsonite	Wichestoe	Salesmen
1-5-66	36,000			BrW
1-7-66	36,000			Whitely
1-13-66	36,000			BrW
1-14-66	30,000			Ros
1-22-66	7,500			Ray
1-25-66		21,100		Ray
2-14-66	36,000			BrW
2-25-66		10,000		Ray
3-19-66	43,750			BrW
3-25-66		2,500		Ray
4-1-66	29,700			Sumers New No Mex
4-9-66	17,000			Sumers New No Mex
4-12-66	18,000			Sumers New No Mex
4-21-66		12,500		J. Y.
4-21-66	15,000			BrW
4-30-66	30,000			Ros.
5-5-66	15,000			BrW
6-1-66	28,250			Ros.
6-15-66	10,000			Ray
7-1-66		10,000		Ray
7-11-66	2,500			Ray
7-15-66		5,000		J. Y.
7-29-66	40,000			BrW
8-15-66			400	Ros
8-17-66	7,250			Clark
8-22-66	2,500			Ray
8-27-66	30,000			Ros
7-81-66	5,000			Ray
9-66			25,000	J. Y.
-12-66		7,500		J. Y.
22-66		10,000		J. Y.
30-66	36,000			Ray
2-66		2,000		J.
12-66				BrW

Mishers

Ship Mats Phenol Sul
12-23-66 30,000

Gulsonite

Sisbestos

Salem
Ris

Totals

535,450

90,600

50,400



020012

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641

• Nights: 918 RI 3-3105

VISBESTOS

A top grade chrysotile asbestos compound for increasing viscosity and drilling fluid carrying capacity.

VISBESTOS

CHRYSOTILE ASBESTOS COMPOUND

FOR ALL DRILLING FLUID SYSTEMS

Mfg. & Lic. for use under U. S.
Pat. No. 2,727,001 & 2,732,343

MONTELLO, INC.

Tulsa, Oklahoma

VISBESTOS

Visbestos is a top grade chrysotile asbestos compound mined in Coalinga, California and processed under rigid quality control specifically for use as a drilling mud additive.

Visbestos, compatible with all drilling fluid systems, was designed primarily as a viscosity builder and is used successfully to increase the carrying capacity and suspending ability of drilling muds.

Some of the first work with asbestos and drilling fluids was performed by Mr. David A. Rowe in the 1940's. Patents were assigned to a major oil company. Visbestos is covered under letters patent #2,727,001 and 2,732,343. These patents inclusively cover the use of chrysotile asbestos in drilling fluids, according to the opinion of very competent patent counsel.

There are six types of asbestos. Five types are charged negatively and one type, chrysotile, is charged positively. We will only discuss chrysotile asbestos since it is the only one of the six types that exhibits the desired properties.

Asbestos samples from Quebec, the East Coast, Arizona, Wyoming, California and other locations have been tested in order to determine the very best product from which to produce Visbestos. There was a tremendous variation in the performance of these samples. Most samples failed on the first test, that of building viscosity. After considering all the test indexes only the top grade chrysotile asbestos material proved to be acceptable.

What does Visbestos do? It builds viscosity and increases the carrying capacity of drilling fluid -- that is a fact!

The increase in viscosity of a drilling fluid caused by the addition of asbestos depends on the drilling fluid system, the concentration of asbestos and the amount of work that is done in mixing, (i.e. the amount of shear). As discussed above, the grade of asbestos also effects the viscosity yield.

For instance the same concentrations of a first and second grade asbestos were checked with the following results:

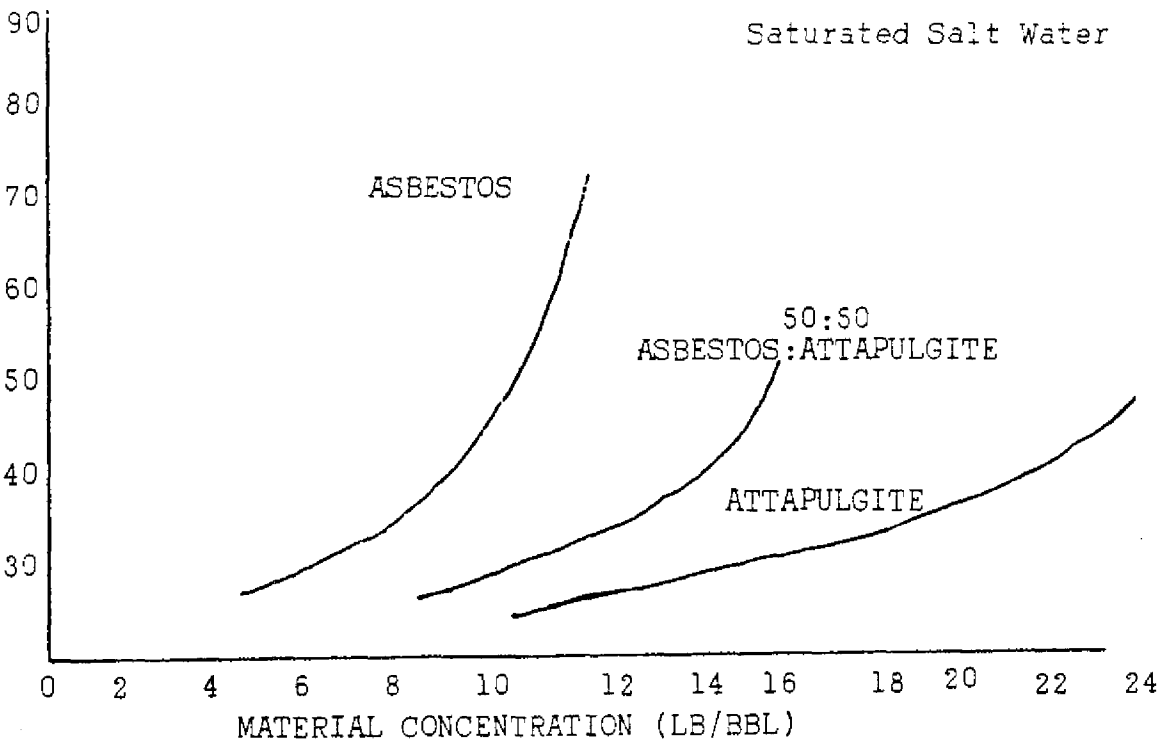
Fann V G	Grade #1	Grade #2
@ 600	82	47

This is very important -- do not become partial to a certain brand name that may look like "Visbestos" but does not perform like a top grade asbestos. Require performance runs to indicate which material is the best buy.

Visbestos (asbestos) definitely has a place in the drilling industry and has proven its economy numerous times in many areas.

Figure 1 - indicates the viscosity building characteristics of Visbestos in saturated salt water. The values shown are an average of laboratory test runs. Similar results are obtained when tested in fresh water.

Figure 1



Visbestos (asbestos) also builds viscosity in oil emulsion mud. For instance Visbestos was tested using Kerosene @ 70° F with the following results:

Fann V G	Kerosene	3% Visbestos Low	3% Visbestos High
600	3	14	24

Why does Visbestos (asbestos) react in this manner? A study of the data given in Figures 2 and 3 below gives us a good hint as to the reason for the viscosity building characteristics of asbestos.

Figure 2

COMPARISON OF FIBRE DIAMETERS

Type of Fibre	Dia. - Inches
Human Hair	.00158
Wool	.0008 to 0.0011
Nylon	.0003
Glass	.00026
Asbestos (Chrysotile)	.000000706 to 0.00000118

Figure 3

SURFACE AREA OF FIBRES

Type of Fibre	Surface Area by N ₂
Nylon	3,100
Cotton	7,200
Wool	9,600
Asbestos (Chrysotile)	130,000 to 220,000

Please note the fibre diameter of asbestos compared to other fibres. Also note the extremely high surface area of asbestos compared to nylon, cotton and wool. The tremendous strength of the asbestos fibres (figure 4) reveals why the asbestos fibres are not destroyed by mixing and agitation of the drilling fluid system.

Figure 4

COMPARISON OF TENSILE STRENGTH

Type of Material	Strength - psi
Wrought Iron	48,000
Carbon Steel	155,000
Rock Wool	60,000
Asbestos (Chrysotile)	100,000 to 300,000

Laboratory tests and field applications proved that a top grade chrysotile asbestos (Visbestos) is compatible to all mud systems and can be used economically in the following systems.

Brine
 Fresh Water
 Emulsion Muds
 Sample Muds
 Spud Muds
 Work Over Muds

Some advantages of Visbestos are:

- *Lower solids mud.
- *Replaces or complements bentonite and attapulgate clays.
- *Increases carrying capacity and suspending ability of drilling fluids.
- *Larger formation samples and cuttings are removed from well.

A recent report from South Louisiana revealed that a major mud company was using asbestos in 80 - 85 % of the wells they are servicing.

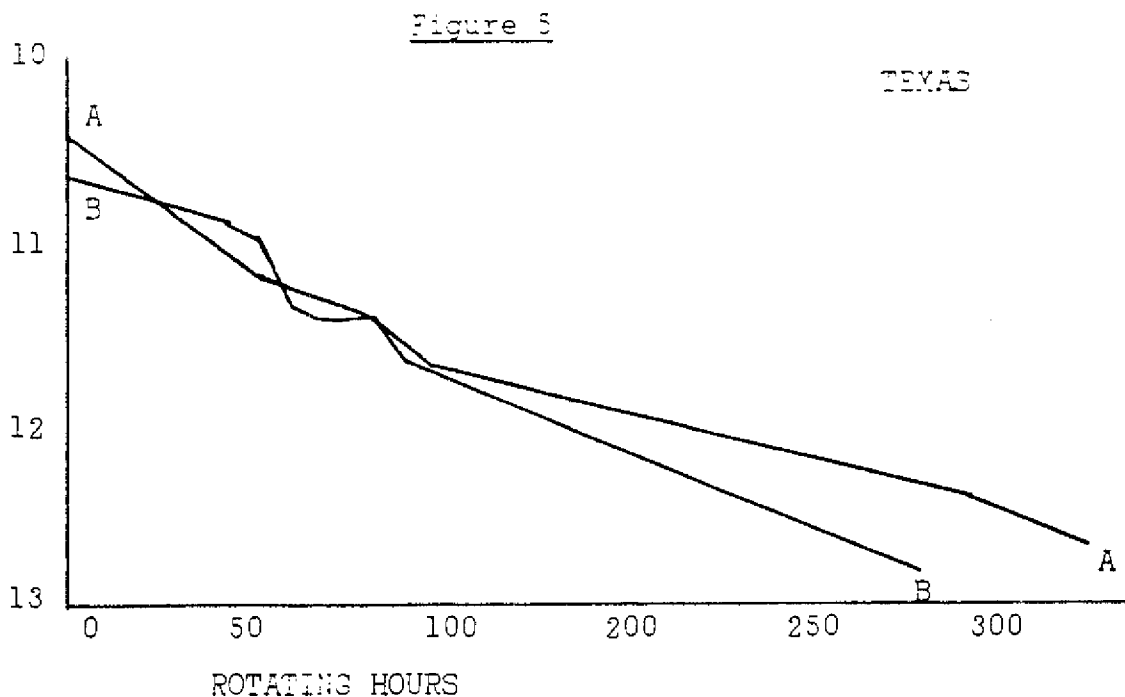
Outstanding results were reported when using 50 to 100 sacks of asbestos and some clay while drilling surface hole.

After this company started using asbestos the following advantages were noted.

- * Drilling time definitely decreased.
- * Cuttings were considerably larger.
- * Better gauge hole (no washing out while crushing or drilling up large, hand size rocks).
- * Better penetration.
- * Easier setting pipe.
- * Better cementing jobs (less fill required).

A study of figure 5 and figure 6 presents field evidence of the economy and advantages of Asbestos (Visbestos).

Figure 5: These wells were drilled by the same contractor, same rig, and same operator. Well A was drilled to 11,700 feet with water, 6-percent oil and emulsifier. At this depth a low viscosity sample mud with fluid loss control was added. Well B was drilled to 11,700 feet with water, 6-percent oil and asbestos. At depth a fluid loss control agent was added. For recovery of good samples, hold conditions required the introduction of asbestos. Fluid properties were 8.5 ppg, viscosity 34 to 40 seconds.

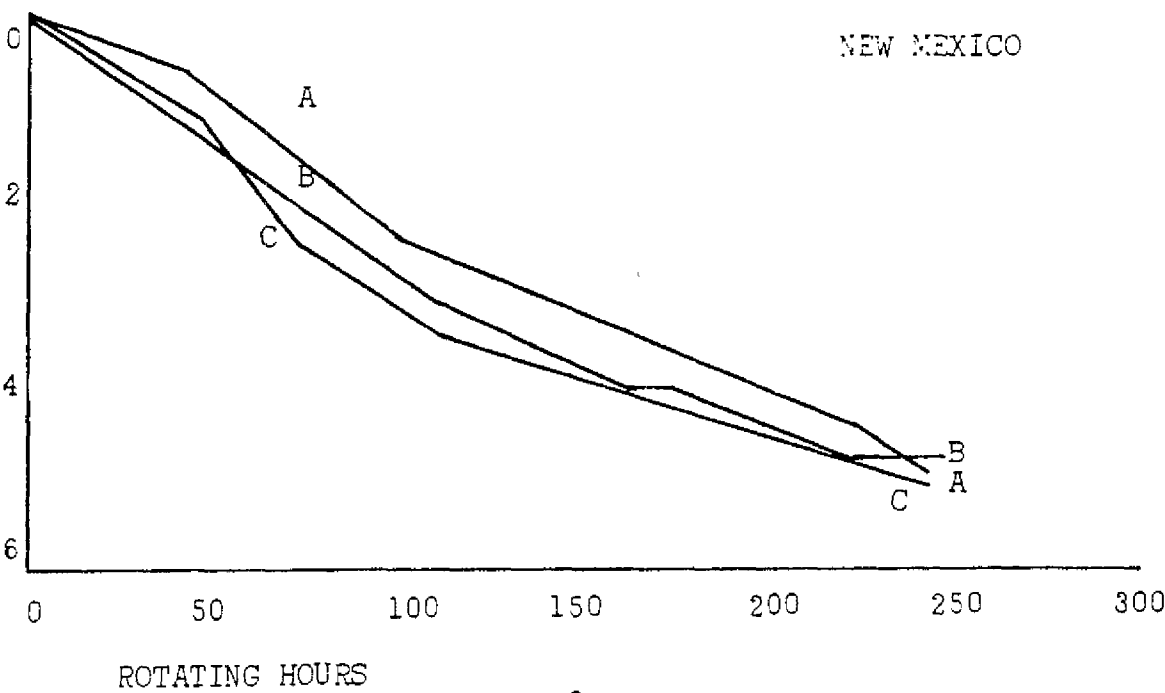


Comparative Penetration Rates

	Well A	Well B
Footage	2198	2407
no. of Bits	10	7
Rotating Hours	283	231
Avg. ft./bit	220	344
Avg. ft./hour	7.7	10.4
Bit size	7 7/8"	7 7/8"

Figure 6: Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 32 second viscosity was maintained as samples were desired from 900 feet.

Figure 6



COMPARATIVE PENETRATION RATES

	Well A	Well B	Well C
Footage	4847	4733	4908
Number of bits	8	10	7
Avg. ft./bit	606	473	701
Avg. ft./hour	19.9	19.6	19.9
Bit size	17½"	17½"	17½"
Rotating hours	243	241	247

In summary Asbestos has been economically and successfully used in:

Fresh water muds
 Salt water muds (no gelling)
 Low solids muds
 Emulsion muds
 Oil

The following advantages were realized:

- * Increased carrying capacity of mud.
- * Increased suspending ability of mud.
- * Stable at high temperature.
 (no increase in viscosity due to temperature)
- * Larger samples.
- * Synergistic effect on polymers and starch.
- * Inhibits flocculation.
- * Better penetration rates.
 (longer bit life).

Be sure the grade you use will do the job.

VISBESTOS IS THE BEST



020020

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISBESTOS

Availability and recommended treatment

VISBESTOS is available through your mud service company. If his stock is depleted, Montello, Inc. has back up stocks in your area which can be obtained by calling Montello's representative for your area or by calling Montello direct.

VISBESTOS has been used in brine muds, fresh water muds, emulsion muds, sample muds and work over muds. The treatment (#/BBL) of VISBESTOS depends upon the drilling fluid system and the amount of work that is done on the VISBESTOS during mixing. The more slowly the material is mixed, the higher the shear and the better your results.

Normal concentrations of VISBESTOS vary from 3# to 5# per barrel. A good sand mud was obtained by using 3#/BBL of VISBESTOS to 10#/BBL of Gel. Excellent sample muds have been prepared with as little as 2#/BBL of VISBESTOS. The exact concentration of VISBESTOS depends on the fluid system, the amount of mixing and the desired mud properties. Any mud engineer familiar with asbestos will have no difficulty using VISBESTOS. The only difference is that you will get the same results with less material.

VISBESTOS yields better in salt water than fresh water. VISBESTOS yields faster at the rig than competitive products due to extra shear during the manufacture of VISBESTOS. You will notice the larger size of VISBESTOS bags because of this.

Thank you for considering the best -----VISBESTOS.



020021

TECHNICAL REPORT # VIS 66-6

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days. 918 CI 5-6641
• Nights. 918 RI 3-3105

VISBESTOS

Problem: Quick viscosity and increased carrying capacity of mud required to keep hole clean.

Location: North Dakota

Depth: 9,700 feet

Drilling Fluid: Salt water and attapulgite

Temperature: Normal for area

Solution: A major oil company while drilling in North Dakota needed to build viscosity quickly and also to increase the cutting carrying capacity of the drilling fluid to help keep the hole clean.

VISBESTOS, (a high grade chrysotile asbestos compound), was added at pump suction through mud hooper to a concentration of approximately 3#/331.

The VISBESTOS was added slowly allowing about 15 minutes per 50# bag for maximum shear.

The desired viscosity was obtained in one round trip. Both the operator and mud service company were very pleased with the quick, economical results obtained using VISBESTOS.

Their only complaint -- "We could have done the job with less VISBESTOS!!!!!!"



020022

TECHNICAL REPORT # VIS 66-8

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISEESTOS

Problem: Drilling 3,000 feet of 17" surface hole.

Location: South Louisiana

Depth: Surface to 3,000 feet.

Temperature: Normal

Situation: Considerable trouble has been and is being experienced in this area when drilling surface hole. Difficulties are experienced in keeping hole clean. Cuttings are as big as a man's fist.

Tarulated below is a comparison of two surface holes cut with different types of mud - same depth - size and area.

Attapulgate Gel Mud

VISEESTOS + Gel
3# VISEESTOS to 10# Gel

Mud cost \$2,600.00 plus
Hole trouble all the way
Gauge very bad
Very bad cement job
Plug bit nearly every time
connection was made

Mud cost \$1,213.00
No hole trouble
Good gauge
Good cement job
Did not plug bit.

Conclusion: Due to poor carrying capacity of attapulgate gel mud difficulties were experienced with drill cuttings settling to bottom. Everytime a connection was made the cuttings would settle to bottom and plug bit. Also it was necessary to wash hole clean after connection was made which enlarged hole leading to poor cement job.

With a VISEESTOS mud settling did not occur, drilling was immediately continued after connection was made. The drilling contractor saved many hours which led to savings both to operator and drilling contractor.

STOS ASBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 INC. MONTELO, INC. TULSA, OKLAHOMA	VISBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 MONTELO, INC. TULSA, OKLAHOMA	VISBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 MONTELO, INC. TULSA, OKLAHOMA	VISBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 MONTELO, INC. TULSA, OKLAHOMA	VISBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 MONTELO, INC. TULSA, OKLAHOMA	VISBESTOS CHRYSONITE ASBESTOS COMPOUND FOR ALL DRILLING FLUID SYSTEMS Mfg. & Lic. for use under U.S. Pat. No. 2,727,001 & 2,732,343 MONTELO, INC. TULSA, OKLAHOMA
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R Visbestos
IMPROVES YIELD
INCREASING CAPACITY
Lic. For Use Under
2,727,001 & 2,732,343
MONTELO, INC.
OKLAHOMA

VISBESTOS

**CHRYBOTILE
ASBESTOS
COMPOUND**

FOR ALL DRILLING FLUID SYSTEMS

Mfg. & Lic. for use under U. S.
Pat. No. 2,727,001 & 2,732,343

MONTELLO, INC.
Tulsa, Oklahoma

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MONTELLO, INC.
Tulsa, Oklahoma

Asbestos in drill water 020027 helps cut drilling costs

Capitan and Highland Drilling Companies have
increased penetration rates in West Texas

William C. Smith, Drilling Superintendent,
Capitan and Highland Drilling Companies,
Odessa, Texas

20-second summary

Asbestos added to drill water has been found effective in retaining good water penetration rates along with recovery of good samples. The asbestos can be added to fresh or salt water directly through the mud hopper. The asbestos has been found compatible with all mud additives used in West Texas drilling operations.

CAPITAN AND HIGHLAND DRILLING COMPANIES of Odessa, Texas, have achieved water penetration rates along with good samples by adding an asbestos material to the drill water (Figure 1).

Asbestos, an inorganic material, increases the carrying capacity and suspending ability of drill water. It can be used in fresh, salt or a mixture of both with a minimum of solids. Since it is chemically inert, it does not control water loss or cause water to gel. The material requires no new equipment at the rig for handling. It is added to the mud system through the mud hopper.

To continue reducing drilling costs, it is essential that every means possible be used to increase rock bit penetration rates. After analyzing each foot of hole to be drilled and applying optimum drilling technique, it is

possible, in many cases, to lower the footage price. This can be done in cooperation with the operator by reducing the amount of hole that is drilled with mud to recover good samples.

Since 1958 the West Texas drilling industry has been able to increase over-all penetration rates about 20 percent. This has been done by using improved hydraulic programs, correct bit selection, more drill collar weight, and using clean water or brine as drilling fluid.

Results of a recent McElroy Field study of wells drilled with a chemical mud from 1958 to 1960 compared with wells drilled in 1963 and 1964 with brine, or very low solid muds, showed the later wells had a 15-18 percent higher penetration rate. Clean water as a drilling fluid, of course, produces the fastest hole.

Although water cannot always be used as a drilling fluid because of hole conditions, much footage drilled today with mud could be water drilled if good formation samples could be obtained.

Since most wells are contracted on a footage basis to total depth, the upper, or faster drilled, part of the hole is where the contractor usually makes the most money.

The top hole is almost always drilled with water, but the lower part of the hole is where the most improvement can be made in penetration rates. Too many times—just because only a few hundred feet or at most a thousand feet are involved—a contractor does nothing about trying to improve the drilling fluid program.

Capitan and Highland Drilling Companies had drilled some 9,300-foot wells in Ector County, Texas, and were



FIG. 1—Samples in this photograph on the right were taken while drilling with water, and the larger samples on the left were after adding asbestos to the water.

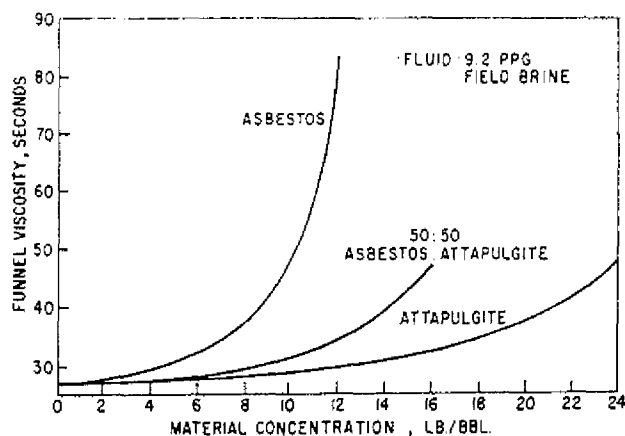


FIG. 2—Funnel viscosity vs. various material requirements.

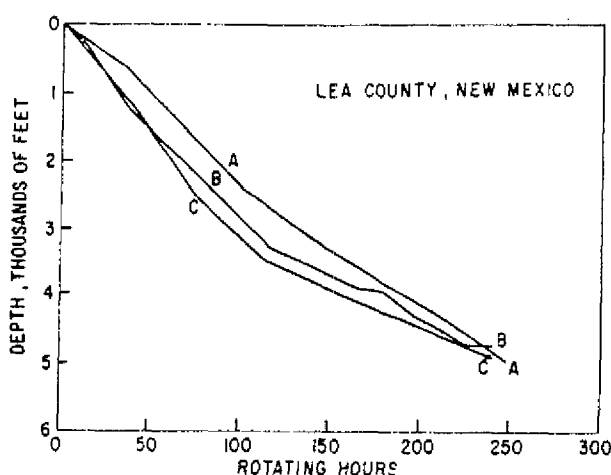


FIG. 3—Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 32-second viscosity was maintained as samples were desired from 900 feet.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B	WELL C
Footage	4,847	4,733	4,908
No. of bits	8	10	7
Avg. ft./bit	606	473	701
Avg. ft./hour	19.9	19.6	19.9
Bit size	17½"	17½"	17½"
Rotating hrs.	243	241	247

required to mud-up at 6,900 feet so the geologist could recover good samples. After study of the problem and discussions with mud and bit company engineers, it was decided that water could be used to safely drill to 8,500 feet.

Drilling bids were recalculated assuming that from 6,900-7,900 feet the increase in penetration with water versus mud would be 90 percent, and that from 7,900 to 8,500 feet the increase would be 75 percent, not considering savings in bit cost. The operator then was offered a choice of price reductions on the bid of 15 cents per foot if the mud-up point was lowered to 7,900 feet and 20 cents per foot if lowered to 8,500 feet. This is a savings per well, to the operator, of \$1,395 and \$1,860, respectively. To the contractor, this meant an added profit of 5 to 10 cents per foot.

To allow recovery of good samples while drilling with water, a new long fiber asbestos material was tested. Addition of this asbestos material to the drilling fluid was designed to allow good sample recovery and still maintain penetration rates near that of water. Capitan and Highland Drilling Companies added this asbestos material at 6,700 feet to the drilling fluid and achieved penetration rates about 95 percent of those expected with water.

In many cases, the same funnel viscosity can be achieved with as little as 25 percent of the material requirements as when bentonite or attapulgite is used. Figure 2 indicates the funnel viscosity versus material requirements.

The asbestos material was found compatible with all

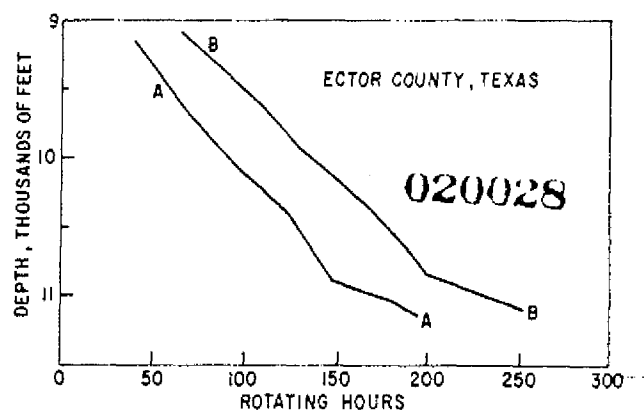


FIG. 4—These wells were drilled in the same field with comparable rigs but by different contractors. Well A drilled this interval with water, 6-percent oil and emulsifier. Well B drilled this interval with water and asbestos to secure good samples. Fluid properties were 8.5 ppg, with a viscosity of 35-38 seconds.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B
Footage	2,649	2,955
No. of bits	8	8
Rotating hrs.	194	252
Avg. feet/bit	331	369
Avg. feet/hour	13.6	11.7
Bit size	8¾"	8¾"

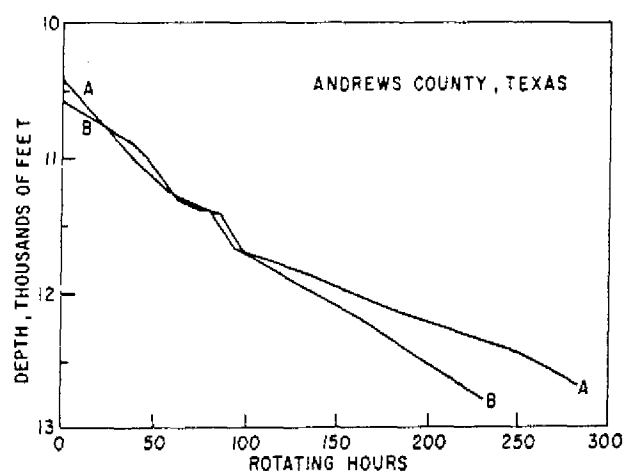


FIG. 5—These wells were drilled by the same contractor, same rig, and same operator. Well A was drilled to 11,700 feet with water, 6-percent oil and emulsifier. At this depth a low viscosity sample mud with fluid loss control was added. Well B was drilled to 11,700 feet with water, 6-percent oil and asbestos. At depth a fluid loss control agent was added. For recovery of good samples, hole conditions required the introduction of asbestos. Fluid properties were 8.5 ppg, viscosity 34-40 seconds.

COMPARATIVE PENETRATION RATES

	WELL A	WELL B
Footage	2,198	2,407
No. of Bits	10	7
Rotating hrs.	283	231
Avg. ft./bit	220	344
Avg. ft./hour	7.7	10.4
Bit size	7⅞"	7⅞"

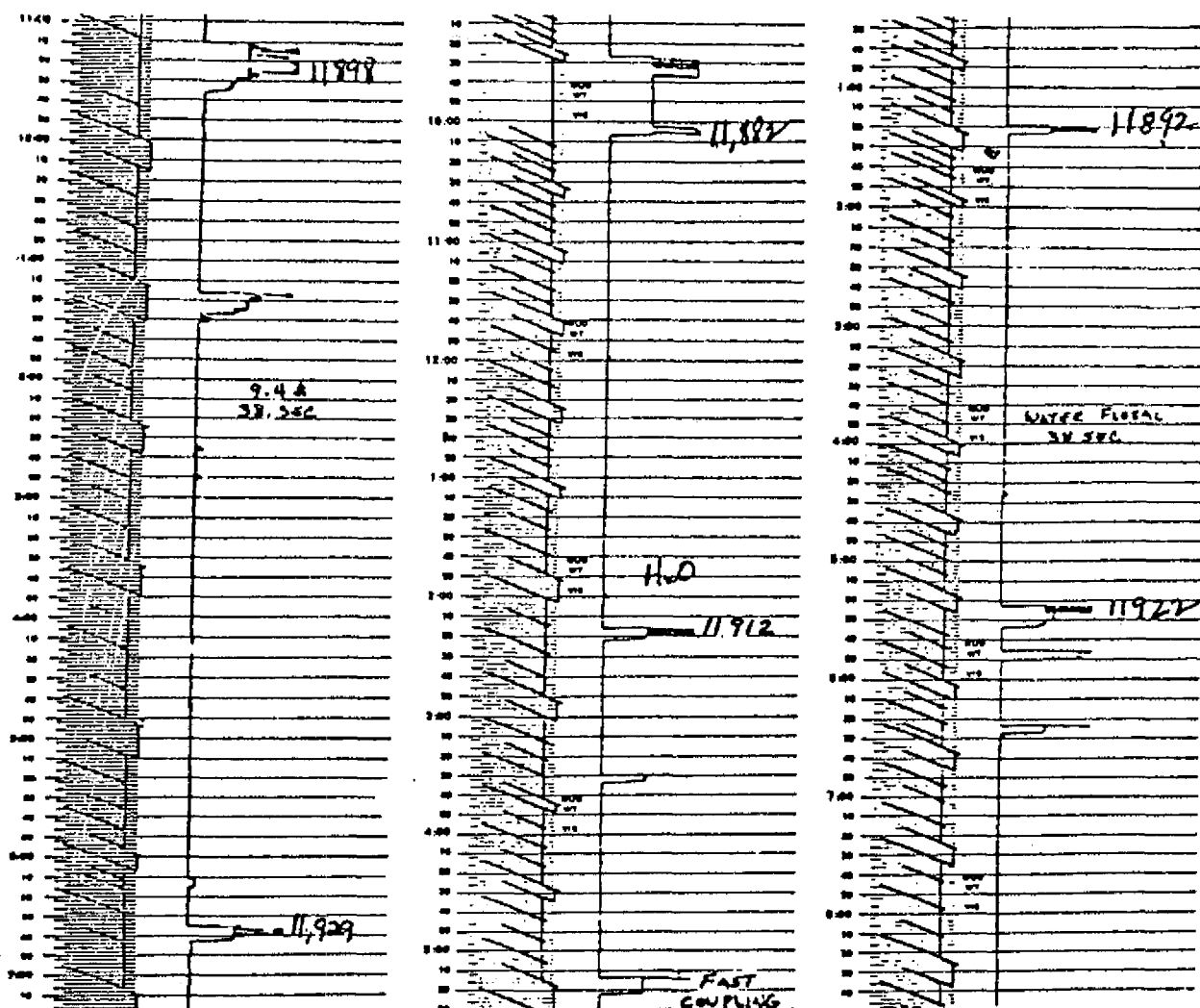


FIG. 6—These wells were drilled by the same contractor, same rig, same operator. Well A was drilled with bentonite sample mud, no water loss control. Well B was drilled with water and 6-8 percent oil. The increase on penetration over mud was

about 27 percent for the interval shown. Well C was drilled with water and asbestos. The increase on penetration over mud was about 39 percent for the interval shown. Asbestos was added to obtain good samples.

mud additives used in West Texas drilling operations. However, in lost circulation zones such as the San Andres, the asbestos material can be dangerous in wall sticking, if not used along with a water loss control agent.

Figures 3, 4, and 5 indicate comparative penetration rates for water and brine versus water and brine with asbestos added.



About the author

WILLIAM C. SMITH is drilling superintendent for Capitan and Highland Drilling Companies in Odessa, Texas. He was graduated from Texas A & M University in 1945 with a B.S. degree in chemical engineering. Prior to joining Capitan and Highland Drilling Companies, he worked 11 years with Baroid Division of The National Lead Company. Smith is an active member of the API, AIME and AAODC.

Figure 6 compares three drilling rate charts of development wells drilled in the same field in San Andrews County, Texas. This is a case where the operator needed samples for the interval. A bentonite sample mud without water loss control was used in Well A. In an attempt to reduce cost, water and oil were substituted for mud in Well B. The drilling rate increased about 29 percent, but samples recovered were not satisfactory.

In Well C, use of the asbestos material and water increased the drilling rate about 37 percent and did produce good samples. The operator is continuing to use this drilling fluid program in development work.

It is through research and development of specialized techniques and continued cooperation of service companies, contractors and operators that drilling prices can be kept in line.

This article is based on a paper titled "Good Samples with Water Penetration Rates," presented at the Spring Meeting of the Southwestern District Meeting of API in Dallas, March 10-12, 1965.



020030

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISBESTOS

A top grade chrysotile asbestos compound for increasing viscosity and drilling fluid carrying capacity.

VISBESTOS

CHRYOTILE
ASBESTOS
COMPOUND

FOR ALL DRILLING FLUID SYSTEMS

Mfg. & Lic. for use under U. S.
Pat. No. 2,727,001 & 2,732,343

MONTELLO, INC.

Tulsa, Oklahoma

VISBESTOS

Visbestos is a top grade chrysotile asbestos compound mined in Coalinga, California and processed under rigid quality control specifically for use as a drilling mud additive.

Visbestos, compatible with all drilling fluid systems, was designed primarily as a viscosity builder and is used successfully to increase the carrying capacity and suspending ability of drilling muds.

Some of the first work with asbestos and drilling fluids was performed by Mr. David A. Rowe in the 1940's. Patents were assigned to a major oil company. Visbestos is covered under letters patent #2,727,801 and 2,732,343. These patents inclusively cover the use of chrysotile asbestos in drilling fluids, according to the opinion of very competent patent counsel.

There are six types of asbestos. Five types are charged negatively and one type, chrysotile, is charged positively. We will only discuss chrysotile asbestos since it is the only one of the six types that exhibits the desired properties.

Asbestos samples from Quebec, the East Coast, Arizona, Wyoming, California and other locations have been tested in order to determine the very best product from which to produce Visbestos. There was a tremendous variation in the performance of these samples. Most samples failed on the first test, that of building viscosity. After considering all the test indexes only the top grade chrysotile asbestos material proved to be acceptable.

What does Visbestos do? It builds viscosity and increases the carrying capacity of drilling fluid -- that is a fact!

The increase in viscosity of a drilling fluid caused by the addition of asbestos depends on the drilling fluid system, the concentration of asbestos and the amount of work that is done in mixing, (i.e. the amount of shear). As discussed above, the grade of asbestos also effects the viscosity yield.

For instance the same concentrations of a first and second grade asbestos were checked with the following results:

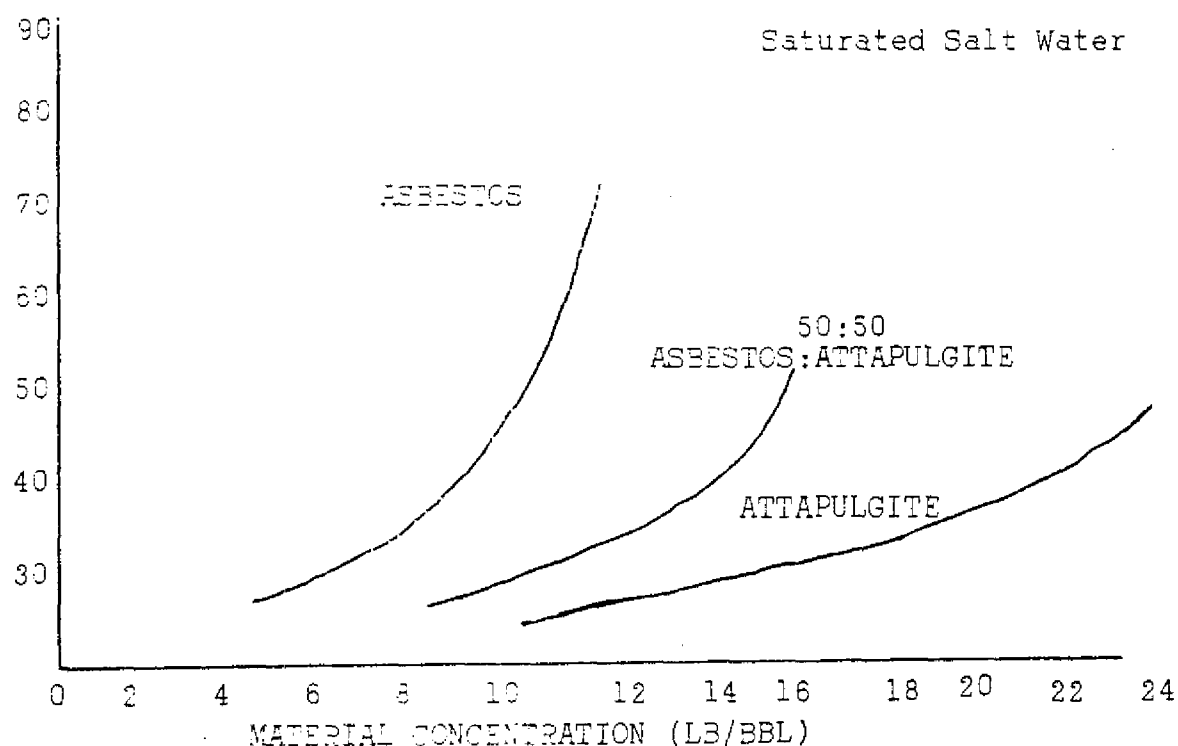
Pann V G	Grade #1	Grade #2
@ 600	82	47

This is very important -- do not become partial to a certain brand name that may look like "Visbestos" but does not perform like a top grade asbestos. Require performance runs to indicate which material is the best buy.

Visbestos (asbestos) definitely has a place in the drilling industry and has proven its economy numerous times in many areas.

Figure 1 - indicates the viscosity building characteristics of Visbestos in saturated salt water. The values shown are an average of laboratory test runs. Similar results are obtained when tested in fresh water.

Figure 1



Visbestos (asbestos) also builds viscosity in oil emulsion mud. For instance Visbestos was tested using Kerosene @ 70° F with the following results:

Fann V G	Kerosene	3% Visbestos Low	3% Visbestos High
600	3	14	24

Why does Visbestos (asbestos) react in this manner? A study of the data given in Figures 2 and 3 below gives us a good hint as to the reason for the viscosity building characteristics of asbestos.

Figure 2

COMPARISON OF FIBRE DIAMETERS

Type of Fibre	Dia. - Inches
Human Hair	0.00185
Wool	0.0018 to 0.0011
Nylon	0.0013
Glass	0.00025
Asbestos (Chrysotile)	0.00000708 to 0.00000118

Figure 3

SURFACE AREA OF FIBRES

Type of Fibre	Surface Area by Sq
Nylon	3,100
Cotton	7,200
Wool	9,600
Asbestos (Chrysotile)	130,000 to 220,000

Please note the fibre diameter of asbestos compared to other fibres. Also note the extremely high surface area of asbestos compared to nylon, cotton and wool. The tremendous strength of the asbestos fibres (figure 4) reveals why the asbestos fibres are not destroyed by mixing and agitation of the drilling fluid system.

Figure 4

COMPARISON OF TENSILE STRENGTH

Type of Material	Strength - psi
Wrought Iron	48,000
Carbon Steel	155,000
Rock Wool	60,000
Asbestos (Chrysotile)	100,000 to 300,000

Laboratory tests and field applications proved that a top grade chrysotile asbestos (Visbestos) is compatible to all mud systems and can be used economically in the following systems.

Brine
 Fresh Water
 Emulsion Muds
 Sample Muds
 Spud Muds
 Work Over Muds

Some advantages of Visbestos are:

- *Lower solids mud.
- *Replaces or complements bentonite and attapulgite clays.
- *Increases carrying capacity and suspending ability of drilling fluids.
- *Larger formation samples and cuttings are removed from well.

A recent report from South Louisiana revealed that a major mud company was using asbestos in 80 - 85 % of the wells they are servicing.

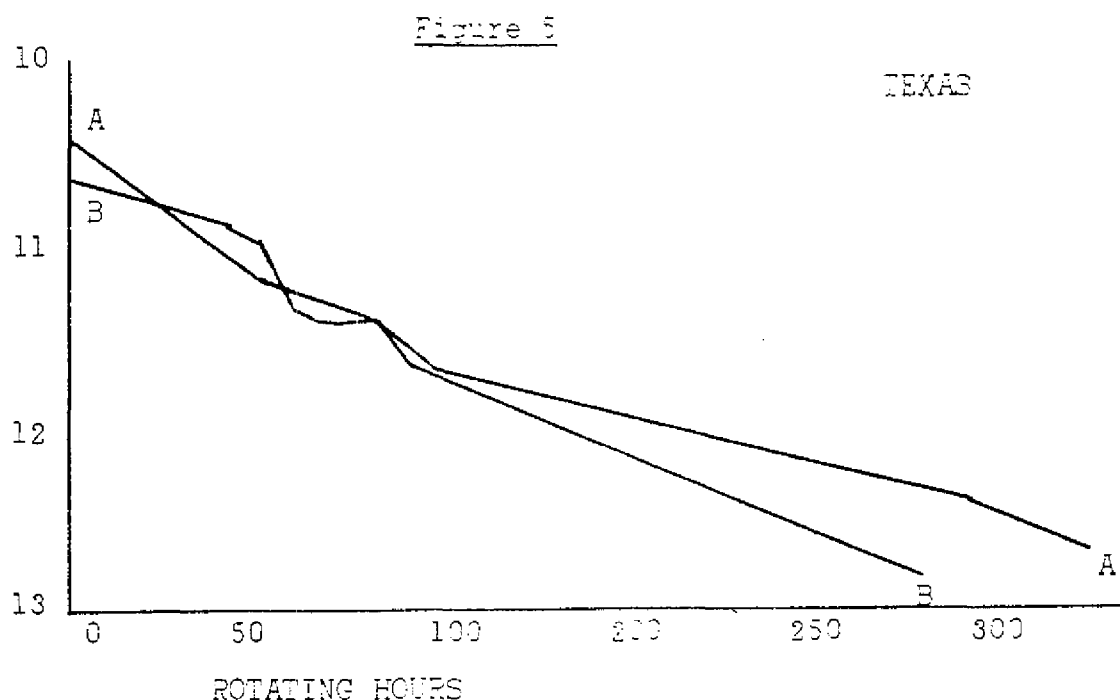
Outstanding results were reported when using 50 to 100 sacks of asbestos and some clay while drilling surface hole.

After this company started using asbestos the following advantages were noted.

- * Drilling time definitely decreased.
- * Cuttings were considerably larger.
- * Better gauge hole (no washing out while crushing or drilling up large, hand size rocks).
- * Better penetration.
- * Easier setting pipe.
- * Better cementing jobs (less fill required).

A study of figure 5 and figure 6 presents field evidence of the economy and advantages of Asbestos (Visbestos).

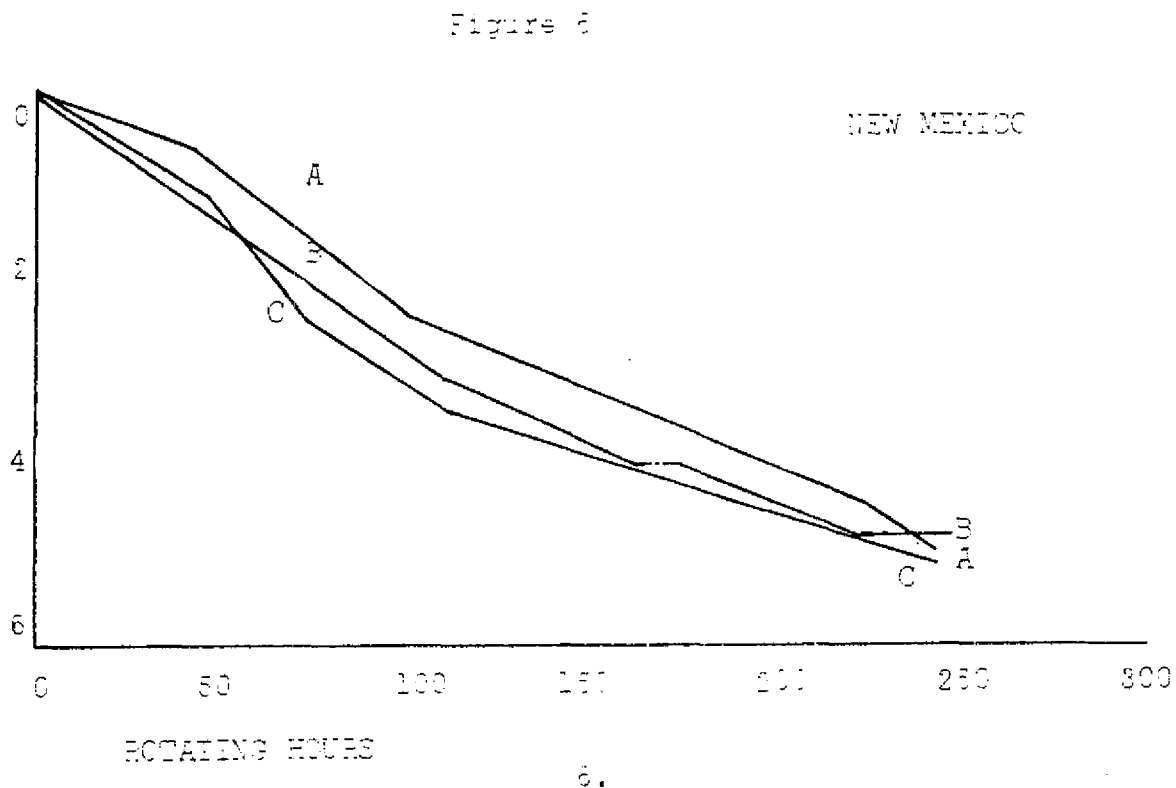
Figure 5: These wells were drilled by the same contractor, same rig, and same operator. Well A was drilled to 11,700 feet with water, 6-percent oil and emulsifier. At this depth a low viscosity sample mud with fluid loss control was added. Well B was drilled to 11,700 feet with water, 6-percent oil and asbestos. At depth a fluid loss control agent was added. For recovery of good samples, hold conditions required the introduction of asbestos. Fluid properties were 8.5 ppg, viscosity 34 to 40 seconds.



Comparative Penetration Rates

	Well A	Well B
Footage	2198	2407
no. of Bits	10	7
Rotating Hours	283	231
Avg. ft./bit	220	344
Avg. ft./hour	7.7	10.4
Bit size	7 7/8"	7 7/8"

Figure 6: Comparison of three wells drilled by different contractors but with comparable rigs. Well A was drilled with clear saturated brine water. Well B was drilled with saturated brine water with flocculant. Well C was drilled with saturated brine water and asbestos. A 32 second viscosity was maintained as samples were desired from 900 feet.



COMPARATIVE PENETRATION RATES

	Well A	Well B	Well C
Footage	4847	4783	4908
Number of bits	8	11	1
Avg. ft./bit	606	435	701
Avg. ft./hour	130.3	130.6	13.3
Bit size	1 7/8"	1 7/8"	1 7/8"
Rotating hours	243	241	247

In summary Asbestos has been economically and successfully used in:

Fresh water muds
 Salt water muds (n. gelling)
 Low solids muds
 Emulsion muds
 Oil

The following advantages were realized:

- * Increased carrying capacity of mud.
- * Increased suspending ability of mud.
- * Stable at high temperature.
 (no increase in viscosity due to temperature)
- * Larger samples.
- * Economical: little or no polymers and starch.
- * Inhibits flocculation.
- * Better penetration rates.
 (longer bit life)

Be sure the grade you use will do the job.

WISCONSIN IS THE WAY



020038

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISBESTOS

Availability and recommended treatment

VISBESTOS is available through your mud service company. If his stock is depleted, Montello, Inc. has back up stocks in your area which can be obtained by calling Montello's representative for your area or by calling Montello direct.

VISBESTOS has been used in brine muds, fresh water muds, emulsion muds, sample muds and work over muds. The treatment (#/BBL) of VISBESTOS depends upon the drilling fluid system and the amount of work that is done on the VISBESTOS during mixing. The more slowly the material is mixed, the higher the shear and the better your results.

Normal concentrations of VISBESTOS vary from 3# to 5# per barrel. A good sand mud was obtained by using 3#/BBL of VISBESTOS to 10#/BBL of Gel. Excellent sample muds have been prepared with as little as 2#/BBL of VISBESTOS. The exact concentration of VISBESTOS depends on the fluid system, the amount of mixing and the desired mud properties. Any mud engineer familiar with asbestos will have no difficulty using VISBESTOS. The only difference is that you will get the same results with less material.

VISBESTOS yields better in salt water than fresh water. VISBESTOS yields faster at the rig than competitive products due to extra shear during the manufacture of VISBESTOS. You will notice the larger size of VISBESTOS bags because of this.

Thank you for considering the best -----VISBESTOS.



020039

TECHNICAL REPORT # VIS 66-6

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISBESTOS

Problem: Quick viscosity and increased carrying capacity of mud required to keep hole clean.

Location: North Dakota

Depth: 9,710 feet

Drilling Fluid: Salt water and attapulgite

Temperature: Normal for area

Solution: A major oil company while drilling in North Dakota needed to build viscosity quickly and also to increase the cutting carrying capacity of the drilling fluid to help keep the hole clean.

VISBESTOS, (a high grade non-toxic asbestos compound), was added at pump station through mud hopper to a concentration of approximately 3#/BBL.

The VISBESTOS was added slowly allowing about 15 minutes per SB# for maximum shear.

The desired viscosity was obtained in one round trip. Both the operator and mud service company were very pleased with the quick, economical results obtained using VISBESTOS.

Their only complaint -- "We could have done the job with less VISBESTOS!!!!!!"



020040

TECHNICAL REPORT # VIS 66-8

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641
• Nights: 918 RI 3-3105

VISEESTOS

Problem: Drilling 3,000 feet of 17" surface hole.

Location: South Louisiana

Depth: Surface to 3,000 feet.

Temperature: Normal

Situation: Considerable trouble has been and is being experienced in this area when drilling surface hole. Difficulties are experienced in keeping hole clean. Cuttings are as big as a man's fist.

Tabulated below is a comparison of two surface holes cut with different types of mud - same depth - size and area.

Attapulapita Gel Mud

VISEESTOS + Gel
3# VISEESTOS to 10# Gel

Mud cost \$1,511.10 plus
hole trouble all the way
Gauge very bad
Very bad cement job
Plug bit nearly every time
connection was made

Mud cost \$1,213.10
No hole trouble
Good gauge
Good cement job
Did not plug bit.

Conclusion: Due to poor carrying capacity of attapulapita gel mud difficulties were experienced with drill cuttings settling to bottom. Everytime a connection was made the cuttings would settle to bottom and plug bit. Also it was necessary to wash hole clean after connection was made which enlarged hole leading to poor cement job.

With VISEESTOS mud settling did not occur, drilling was immediately continued after connection was made. The drilling contractor saved many hours which led to savings both to operator and drilling contractor.



02/04/

REPORT # V12-66-1

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA

• Night 9/11/55

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AVIS 66

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P. O. BOX 1046 SAND SPRINGS, OKLAHOMA

• Night RI 3105

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SAND SPRINGS, OKLAHOMA

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• Nights: 918 RI 3-3105

... compound for increasing
... carrying capacity.

020044

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days: 918 CI 5-6641

VISBESTOS

• Nights: 918 RI 3-3105

Visbestos is a top grade chrysotile asbestos compound mined in Coalinga, California and processed under rigid quality control specifically for use as a drilling mud additive.

Visbestos, compatible with all drilling fluid systems, was designed primarily as a viscosity builder and is used successfully to increase the carrying capacity and suspending ability of drilling muds.

Some of the first work with asbestos and drilling fluids was performed by Mr. David A. Ross in the 1940's. Patents were assigned to a major oil company. Visbestos is covered under letters patent #2,727,001 and 2,732,343. These patents inclusively cover the use of chrysotile asbestos in drilling fluids, according to the opinion of very competent patent counsel.

There are six types of asbestos. Five types are charged negatively and one type, chrysotile, is charged positively. We will only discuss chrysotile asbestos since it is the only one of the six types that exhibits the desired properties.

Asbestos samples from Quebec, the East Coast, Arizona, Wyoming, California and other locations have been tested in order to determine the very best product from which to produce Visbestos. There was a tremendous variation in the performance of these samples. Most samples failed on the first test, that of building viscosity. After considering all the test indexes only the top grade chrysotile material proved to be acceptable.

What does Visbestos do? It builds viscosity and increases the carrying capacity of drilling fluid -- that is a fact!

The increase in viscosity of a drilling fluid caused by the addition of asbestos depends on the drilling fluid system, the concentration of asbestos and the amount of work that is done in mixing, (i.e. the amount of shear). As discussed above, the grade of asbestos also effects the viscosity yield.

020045

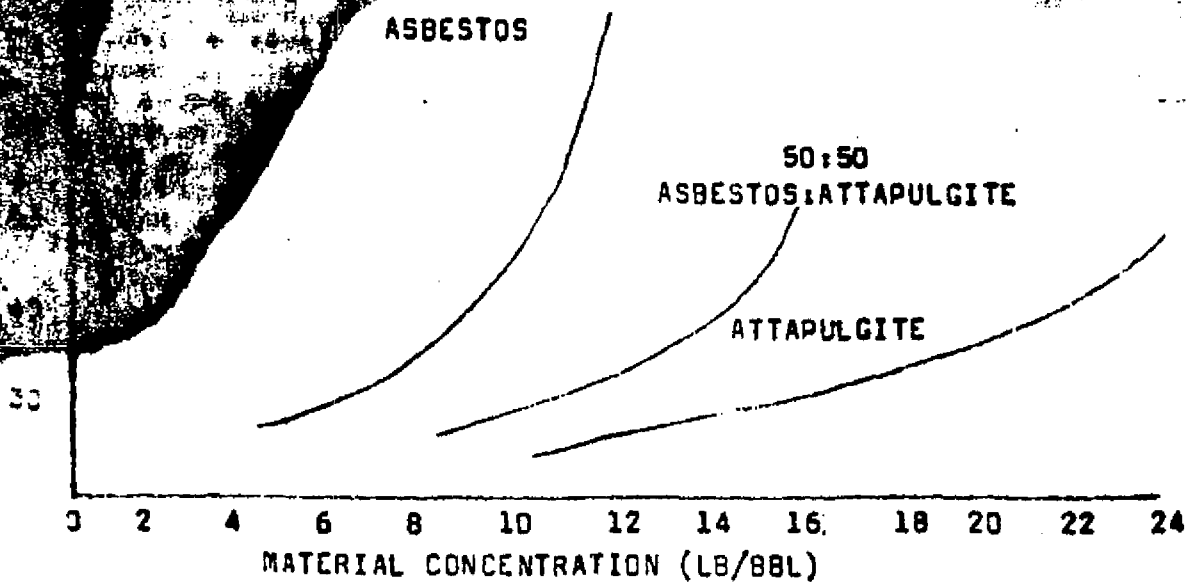
P. O. BOX 1044 • SAND SPRINGS, OKLAHOMA • Day: 918 RI 3-3105
 The same concentrations of a first and second grade
 were checked with the following results:

Grade #2
 47

It is very important not to become partial to a certain brand
 that may look like "Asbestos" but does not perform like a
 grade asbestos. Require performance runs to indicate which
 asbestos (asbestos) performs best, a piece in the drilling in-
 ventory and has proven its economy numerous times in many areas.

Figure 1 - indicates the viscosity building characteristics of
 various materials. The values shown are an av-
 erage of laboratory tests. Results are obtained
 when tested in fresh water.

Saturated Salt Water



020046

P. O. BOX 1045 • SAND SPRINGS, OKLAHOMA

Days 918 C 5-6611

Nights: 918 RI 3-3105

(asbestos) also builds viscosity in oil emulsion mud. Asbestos fibres are tested using Kerosene @ 70°F with the following results:

Sample	3% Visbestos	3% Visbestos
Low	14	High
High	24	

Why does asbestos (asbestos) react in this manner? A study of the data given in Figures 2 and 3 below gives us a good hint as to the reason for the viscosity building characteristics of as-

COMPARISON OF FIBRE DIAMETERS

Fibre	Dis. - Inches
Human Hair	0.00158
Wool	0.0008 to 0.0011
Nylon	0.0003
Cotton	0.00026
Asbestos (Chrysotile)	1.000000706 to 0.00000118

Figure 3

SURFACE AREA OF FIBRES

Fibre	Surface Area by No.
Human Hair	3,100
Wool	7,200
Nylon	9,600
Asbestos (Chrysotile)	130,000 to 220,000

Please note the fibre diameter of asbestos compared to other fibres. Also note the extremely high surface area of asbestos compared to nylon, cotton and wool. The tremendous strength of the asbestos fibres (Figure 4) reveals why the asbestos fibres are not destroyed by mixing and agitation of the drilling fluid system.

020047

P. O. BOX 1046 • SAND SPRINGS, OKLAHOMA • Days 918 CI 5-66

• Nights: 918 RI 3-3105

COMPARISON OF TENSILE STRENGTH

Kind of Material	Strength - psi
Cast Iron	60,000
Carbon Steel	100,000
Hot Iron	60,000
Asbestos (Chrysotile)	100,000 to 300,000

Laboratory tests and field applications proved that a top grade chrysotile asbestos is compatible to all mud systems and can be used economically in the following systems.

- Lower solids mud.
- Replaces or compliments bentonite and attapulgite clays.
- Increases carrying capacity and suspending ability of drilling fluids.
- Larger formation samples and cuttings are removed from well.

A report from South Louisiana revealed that a major mud company is using asbestos in 80 - 85 % of the wells they are drilling.

Outstanding results were reported when using 50 to 100 sacks of asbestos and some clay while drilling surface hole.



020048

P. O. BOX 111, SAND SPRINGS, OKLAHOMA

Days 98 G-5-62

Nights: 918 RI 3-3105

A company started using asbestos the following advantages

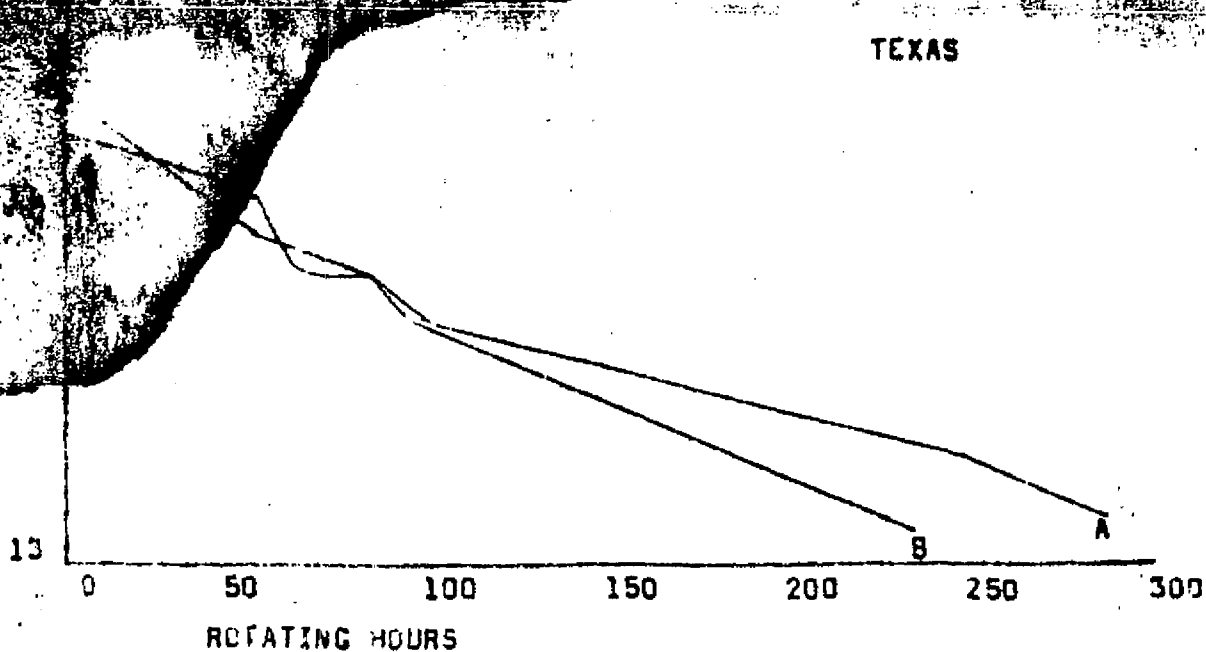
- Drilling time definitely decreased.
- Cuttings were considerably larger.
- Better gauge hole (no washing out while washing or drilling up large, hard side rocks).
- Better cementation.
- Faster setting time.
- Better cementing jobs (less fill required).

Figure 5 and Figure 6 presents field evidence of the advantages of asbestos.

Well A and Well B were drilled by the same contractor, same rig and same operator. Well A was drilled to 11,700 feet with 5-percent oil and asbestos. At this depth a low viscosity mud with fluid loss control was added. Well B was drilled to 11,700 feet with 5-percent oil and asbestos. A fluid loss control was added. For recovery of cuttings, hole cleaning required the introduction of asbestos. Fluid properties were 1.5 ppg, viscosity 34 to 40 seconds.

Figure 5

TEXAS



S.

020049

P. O. BOX 1046 SAND SPRINGS, OKLAHOMA

Days: 98 C 3-64

Comparative Penetration Rates

Nights: 918 RI 3-3105

Well B

2407

7

231

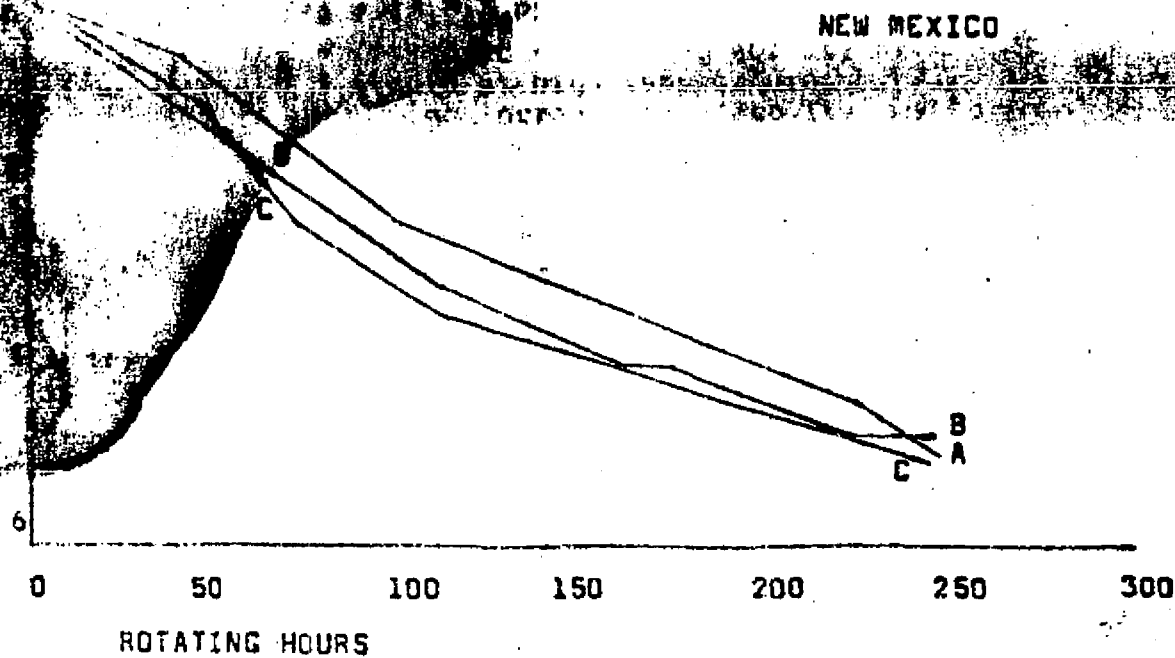
344

10.4

7 7/8"

Comparison of three wells drilled by different con-
 ditions. Well A was drilled with
 water with saturated
 water with saturated
 viscosity was maintained

NEW MEXICO



020050

P. O. BOX 1000 • SAND SPRINGS, OKLAHOMA

• Nights: 918 RI 3-3105

COMPARATIVE PENETRATION RATES

Well A	Well B	Well C
4847	4733	4908
8	10	7
885	473	701
19.9	19.6	19.9
174"	174"	174"
243	241	247

visbestos has been economically and successfully used

Fresh water muds
 Salt water muds (no gelling)
 Loss solid muds
 Emulsion muds
 Oil

Following advantages were realized:

- Increased carrying capacity of mud.
- Increased suspending ability of mud.
- Stable at high temperature.
 (no increase in viscosity due to temperature)
- Larger samples.
- Synergistic effect on polymers and starch.
- Inhibits flocculation.
- Better penetration rates.
 (longer bit life)

visbestos grade you use will do the job.

VISBESTOS IS THE BEST

Handwritten signature
11

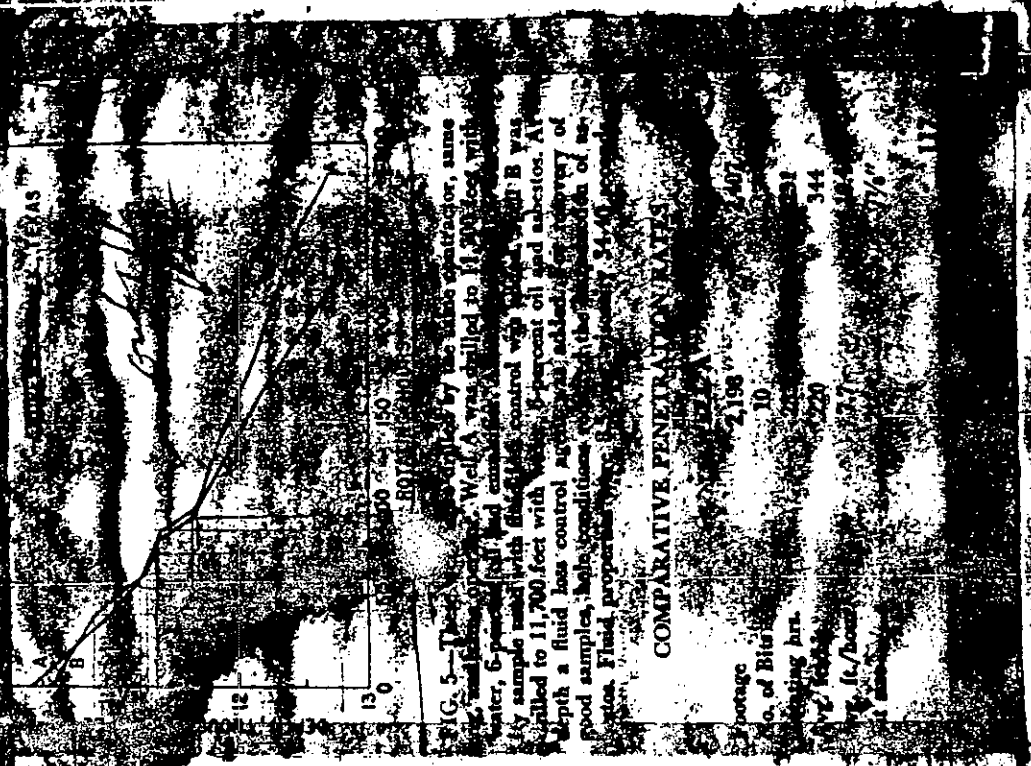


FIG. 5—The well, drilled by the same contractor, same location, same water, 6 percent oil and 4 percent gas. The sample was taken from the control well, and B was drilled to 11,700 feet with water, 5 percent oil and asbestos. At depth a fluid loss control was added, and the recovery of good samples, both conditions, was the same. The fluid loss was 10 percent. The fluid loss was 10 percent.

COMPARATIVE PENETRATION RATES

Portage	2,198
No. of Bits	10
Penetrating Rate	221
Wg. (lb./hr.)	344
Wg. (lb./hr.)	117



Sample in the photograph on the right was taken

020054

REPORT

SAND SPRINGS, OKLAHOMA

Day 98 C

Nights: 918 RI 3-3105

VISBES 105

17" surface hole.

SOUTH TULSA

Normal

Considerable trouble has and is being experienced in this area with drilling surface. Difficulties are experienced in keeping cuttings from falling as a man's fist. Comparison of two surface types of mud - same

VISBES 105 to 107 Gel
3# VISBES 105 to 107 Gel

500.00 plus	Mud cost \$1,213.00
is all the way	No hole trouble
bad	Good gauge
cement job	Good cement job
every	
was made.	Did not plug bit.

Due to poor carrying capacity of mud difficulties were experienced with drill cuttings settling to bottom. Every connection was made the cuttings would settle to bottom and plug bit. Also it was necessary to wash hole clean after connection was made. Unplugged hole leading to a poor connection.

SW 5/8" mud settling did not occur, drilling was very continuous after connection was made. The drilling contractor saved many hours which led to savings both to operator and drilling contractor.

TO: H. T. # VIS 6-51

020055

P.O. BOX 245 LAND SPRINGS, OKLAHOMA

• Nights: 918 RI 3-3105

Problem: Quick viscosity and increased carrying capacity of mud required to keep hole clean.

Location: North Dakota

Depth: 9700 feet

Drilling Fluid: Salt water and attapulgit

Temperature: Actual for area

Result: The company while drilling in North Dakota, had to build viscosity quickly and also to increase the cutting carrying capacity of the drilling fluid to help keep the hole clean.

VISBESTOS, a high grade chrysotile asbestos compound, was added at pump section through mud hoses to a concentration of approximately 3#/88L.

VISBESTOS was added slowly allowing about 15 minutes per 50# bag for maximum shear.

The desired viscosity was obtained in one round trip. Both the operator and mud service company were very pleased with the quick, economical results obtained using VISBESTOS.

Their only complaint -- "We could have done the job with less VISBESTOS!!"

0250

SAND SPRINGS, OKLAHOMA

Day 918 C

• Nights: 918 RI 3-3105

DISTRIBUTOR PRICE LIST

VISBESTOS

Effective June 15, 1966

Rail Description:

Item 1019 of TC-2

Prices:

Visbestos (no minimum), F.O.B.

Coalinga, California.....\$8.25 per lb.

Visbestos (no minimum), F.O.B.

Sand Springs, Oklahoma.....\$7.25 per lb.

Visbestos (no minimum), F.O.B.

Montello's Field Warehouses.....\$8.75 per lb.

Invoice Terms:

2% cash discount for payment in ten days;
Net cash in thirty days.

Delivery Terms:

Freight will be paid by Montello, Inc. and
billed to mud service company along with the
material for shipments from Coalinga, Calif.
and Sand Springs, Oklahoma

All Montello products are manufactured and licensed for use
under appropriate patents. All royalties are included in our
posted prices.

Recommended
Work Practices
for Using
Asbestos in
Drilling and

[illegible]

Asbestos and Health

The health problems which are occurring today are associated primarily with excessive past occupationally-related exposure to airborne asbestos dust. However, there is no evidence of any health risk to the general public from all levels of asbestos in our society, no from the small amounts of asbestos in drinking water.

It should be emphasized that the health risks of asbestos are not additive to the health risks of cigarette smoking and of other factors which produce physical health problems. Cigarette smoking and asbestos work-related health risks are not additive.

We will continue to have asbestos-related disease for some years because of the long-term legacy of excessive past exposure. Current medical evidence leads to the expectation that workers exposed to current permissible levels of asbestos dust will not develop disease.

The present state of scientific knowledge shows clearly that minimizing exposure to airborne asbestos dust reduces the risk of asbestos-related disease. Good work practices are one means of significantly reducing generation of dust.

Summary of OSHA Asbestos Standard

Under the current OSHA standard, employers have the responsibility to assure that exposure of employees to airborne concentrations of asbestos does not exceed the following permissible exposure levels:

- a. Eight-hour time-weighted average (TWA):
Two fibers longer than 5 micrometers per cubic centimeter.
- b. Ceiling concentrations: Ten fibers longer than 5 micrometers per cubic centimeter (MPPCL).

OSHA Instruction CPL 2-2.21A of February 18, 1981 states that in certain exemption requirements of the asbestos standard will be required where the 8-hour TWA fiber concentration is 0.1 f/cc or greater.

Extensive field monitoring has demonstrated that the proper use of asbestos mud additives can result in dust levels which are less than an 8-hour TWA of 0.1 f/cc. EPA has approved these mud additives for use in the construction industry. EPA has also approved the use of these mud additives in the construction industry.

OSHA has approved these mud additives for use in the construction industry.

OSHA's New Construction Standard

OSHA's new construction standard will require employers to use mud additives in the construction industry.

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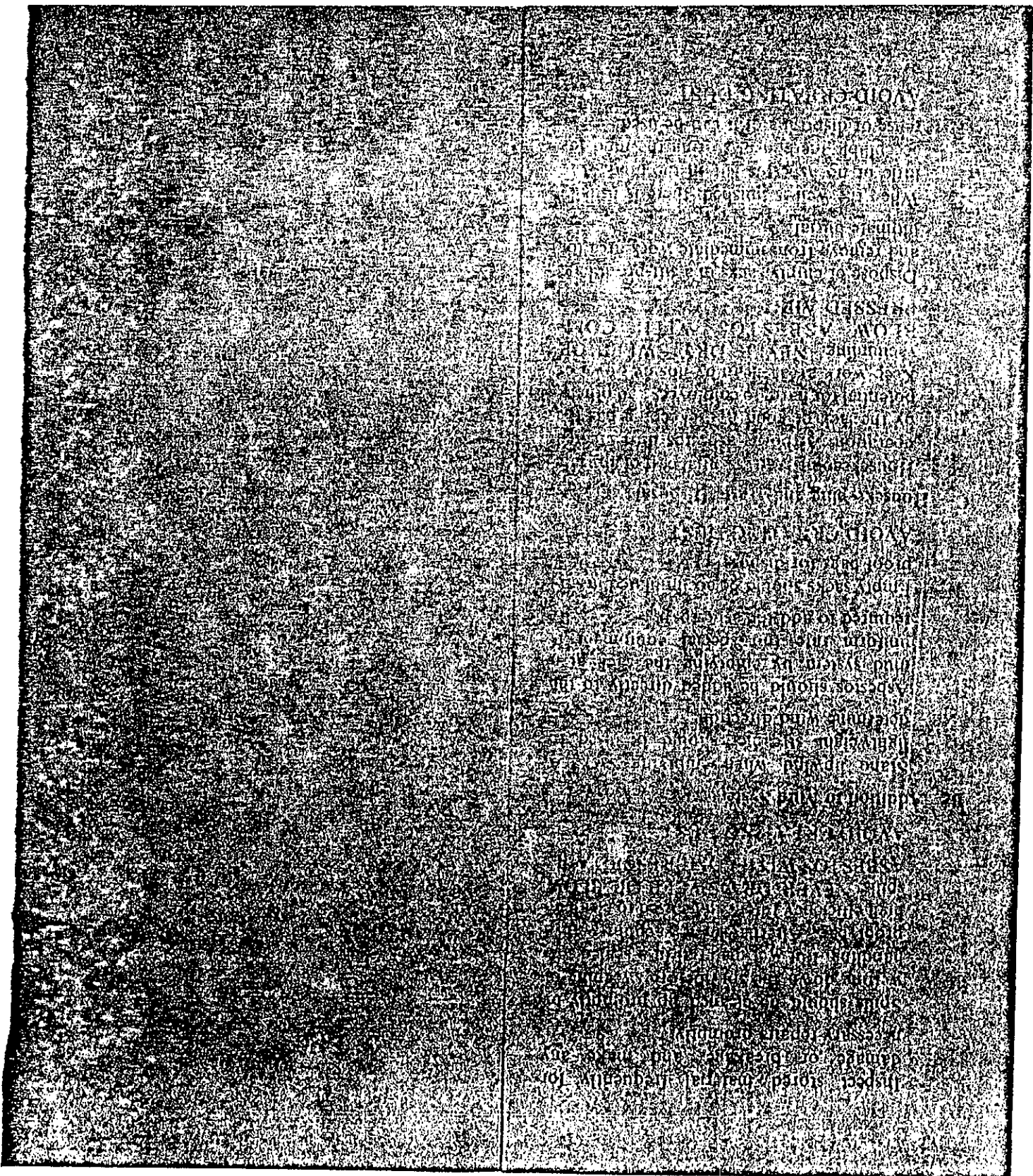
OSHA's new construction standard will require employers to use mud additives in the construction industry.

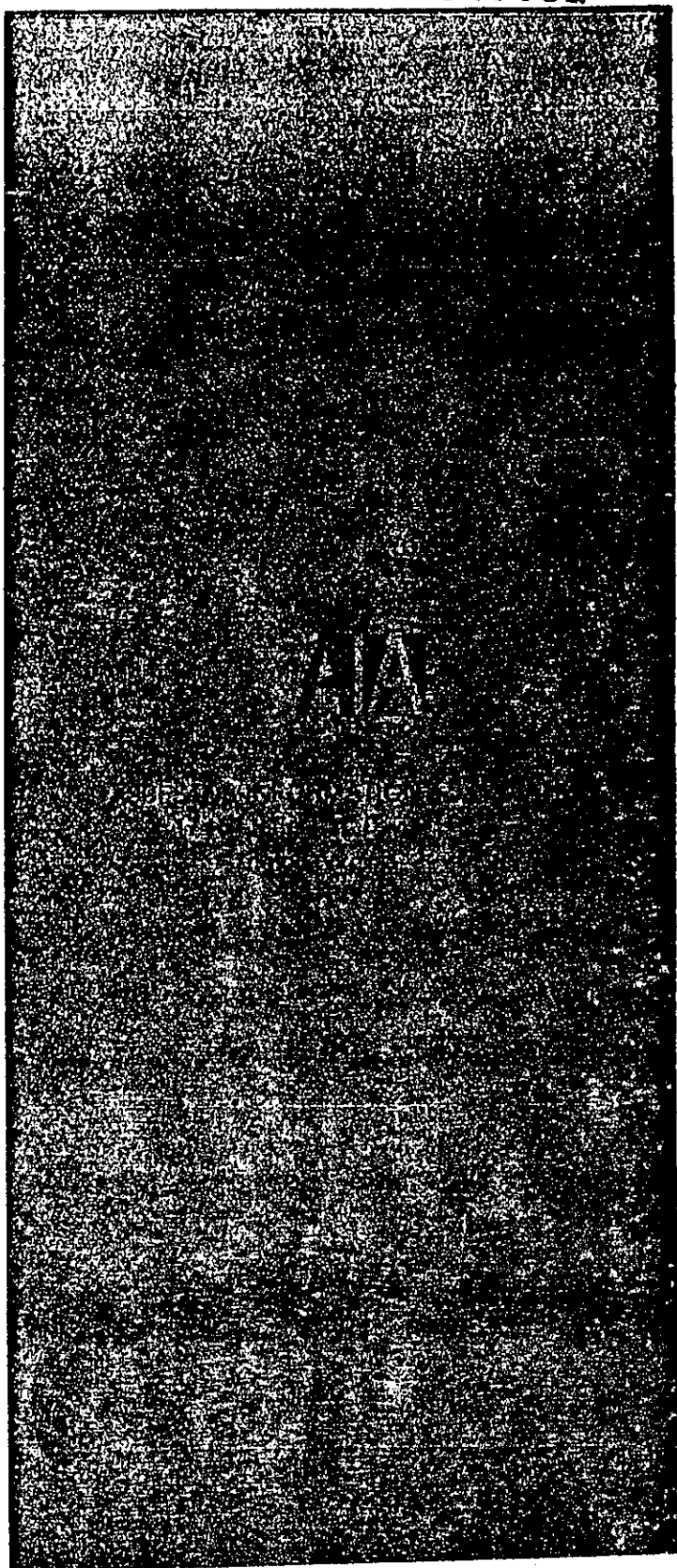
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Exposure Limits

Current OSHA asbestos regulations establish permissible exposure limits (PEL) of 10 fibers/cc (f/cc) maximum ceiling count and 2 f/cc on an 8 hour time weighted average (TWA). A variety of special actions must be taken by employers whenever employees are reasonably expected to be exposed to fiber concentrations in excess of the PEL. For many years Montello and Union Carbide Corporation, our supplier, have carried on a joint program of field monitoring, covering a wide variety of representative drillsite workplaces. The result is a large body of data in which there is no instance of exceeding the PEL. In fact, with only rare exceptions, fiber counts have been less than 10% of the PEL.

Safety Requirements

Based on this, we believe there is no reasonable expectation of exceeding the PEL when using Univis or Super Visbestos in drilling fluids. We therefore believe that the requirements on subsequent monitoring, special clothing, change rooms, double lockers, laundering procedures and caution signs, do not apply to the drillsite workplace when using our products. Further, we believe monitoring performed upon representative workplaces will adequately assure performance below the PEL.

Field Monitoring Results

To clarify the regulations on medical examinations, OSHA recently issued a compliance programming letter, (CPL2-2.21A). It states in part, "Medical examinations — will be required for any 7 to 8 hour time weighted average concentration of 0.1 fibers/cc, or for a greater concentration." All monitoring of Univis usage in the field has resulted in TWA counts below 0.1 f/cc. TWA counts for Super Visbestos are also consistently below 0.1 f/cc.

Summary

In summary, we believe that, with proper work practices and housekeeping, it is possible to use Univis and Super Visbestos in drilling fluid applications without exceeding the OSHA PEL, or violating any of the asbestos regulations.

Additional Information

A detailed Field Monitoring Information Summary will be sent upon request. We will also furnish the current OSHA regulations, along with a review of the regulatory background. Also, The Asbestos Information Association of North America has developed recommended work practices for the use of asbestos drilling mud additives. We will be glad to supply you with copies upon request.

The conditions and use of the products set forth herein are beyond the control of Montello. For this reason any information, statements, recommendations or suggestions are made by Montello without warranty or guarantee, either express or implied. Also for this reason, Montello shall not be responsible for any failure to comply with any federal, state or local safety or environmental standard or regulation, which results from the use of its products.

Printed in USA

Montello, Inc. 6106 East 32 Place, Tulsa, Oklahoma 74135, Telephone (918) 665-1170, TWX 910-845-2396

Montello

020063

6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

<u>U N I V I S</u> Universal Viscosifier (Wet-refined, Pelletized) Free Flowing, Low Dust Product
--

HOW PACKAGED:

Multi-wall paper sacks - 50 pounds each.

FUNCTION:

For hole cleaning in any aqueous drilling fluid. Builds quick yield with and without bentonite or attapulgite. Provides a "natural", inexpensive, low-solids drilling fluid for clear water drilling rates.

EFFECT ON DRILLING FLUID PROPERTIES:

- * Increases carrying capacity.
- * Improves flow properties.
- * Used 50/50 with bentonite, synergism gives 3 to 5 times greater yield than dry ground asbestos.
- * Stabilizes high temperature gelation of bentonite.
- * Stabilizes salt flocculation of bentonite.
- * Synergizes with attapulgite for higher yield.
- * Controls progressive gels.

WHERE USED:

Drilling fluid: All aqueous and oil base drilling fluids.
Hole interval: Surface to total depth.

HOW USED:

Add 1 to 3 lbs./bbl. at mud hopper for quick yield and better cutting transport.

To avoid fill-up during trips, sweep hole clean with 2 to 5 bags flushed through the hopper.

Builds inexpensive workover or packer fluid.

In low fluid loss mediums (generally 20-30 cc), UNIVIS may require additional time to yield. Accomplish this by aqueous pre-yielding, or bypassing shale shaker temporarily.

See other side ...

020064

ADVANTAGES:

- * Unique, wet-processing means less shear required at rig.
- * Provides desired yield with half the poundage of dry ground products.
- * 98% open fiber, compared with 50% for dry ground products.
- * Hole cleaned with lower annular velocity, less wash-out, less fill-up and less redrilling. (Means reduced rotating hours, bits used, mud cost and days on location.)
- * Twice as effective and half as bulky as dry ground products. (Means 50% less drayage and 75% less storage space required.)
- * Not affected by contamination, bacteria or temperature. (Used to over 600°F.)
- * No formation damage, acid soluble.

SPECIAL NOTE ON SAFE USE:

An extensive field study has revealed that UNIVIS offers a 5 to 1 or better safety margin in complying with OSHA health hazard regulations.

Based on this study, Montello believes there is no reasonable expectation of exceeding the legal exposure limits when using UNIVIS.

January 12, 1967

C
O
P
Y

Superintendent
I.M.C. Drilling Mud Company
1626 Barrow
Houma, Louisiana

Dear Sir:

Your order for 1,000 sacks of Visbestos
(your number 6DM103135) for delivery to
Colley Switch, Louisiana has been shipped
from Coalinga on Car No. SP-211764.

Thank you very much for your valued business.
We appreciate this opportunity to serve you.

Sincerely,

MONTELLLO, INC.

Harry M. Wyatt

HMW/dlo

020066

January 12, 1967

Milchem, Inc.
Milwhite Mud Sales
614 West Francis
Pampa, Texas

Gentlemen:

Your order for 500 bags of Visbestos for delivery to Perryton, Texas has been shipped from Coalinga on Car No. I&N 98766; delivering carrier will be Santa Fe.

We will appreciate it if you will have your people re-level the load after they pull your 500 bags. This will prevent damage to the balance of the material at final destination.

We certainly appreciate your business and your consideration of the above request.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

HMW/dlo

020067

January 12, 1967

C
O
J
Y
Oil Base, Inc.
3625 S.W. Freeway
Houston, Texas

Attention: Mr. Arnold Joyce

Dear Mr. Joyce:

Your order number 1318 for 500 bags of asbestos, designated as OBI packer fluid additive, has been shipped from Coalinga, California to Galena Park on Car Number IC-24560.

Thank you very much for your order. We appreciate this opportunity to serve you.

Sincerely,

MONTELLLO, INC.

Harry M Wyatt

HMW/dlo

020068

January 12, 1967

Mr. J. D. Sullivan
P.O. Box 135
New Iberia, Louisiana

Dear J.D.:

2,000 sacks of Visbestos has been shipped from Coalinga, California on railroad Car Number SP-211764. This car is scheduled as follows: 1,000 sacks to our warehouse in New Iberia, Louisiana for stopover partial unloading, with the remaining 1,000 sacks going on to I.M.C. at Houma, Louisiana.

When the above car number arrives in New Iberia, please unload 1,000 sacks in our warehouse and re-level the load to prevent damage.

Hope to see you soon.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

HMW/dlo

020069

January 5, 1967

C
O
P
Y

Colonel Grubb
Brine Service & Chemical Company
P.O. Box 755
Lake Charles, Louisiana

Dear Colonel Grubb:

As requested by your Mr. Schwartz, we are sending you under separate cover today the following:

1. Twelve "Visbestos" reports
2. Twelve "World Oil" reprints
3. One Montello Product Information booklet

Thank you very much for your fine business. We certainly appreciate your use of our products. I am looking forward to meeting you the next time I am in Lake Charles.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

HMW/dlo

CC: Mr. Schwartz - Houston

020070

January 5, 1967

C
O
P
Y

Mr. Dick Stubbs
Baroid Division
National Lead Company
P.O. Box 1675
Houston, Texas

Dear Dick:

Attached is a complete price list that you requested during my recent visit with you in Houston. Please note that the separate price lists on Pheno Seal, Visbestos and Super Lube Flow also include the freight classifications, which were inadvertently left off of the composite price list.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

HMW/dlo

Encls.

January 5, 1967

Mr. J. D. McCarter
Gary-Nees Lumber Company
Box 714
Gainesville, Texas

Dear J.D.:

Sometimes, for some reason, things just do not work out the way they are supposed to. There is no one that feels worse than we do because they did not get results out of the Visbestos or Super Lube Flow. We certainly do appreciate the work and trouble you have gone to in trying to get results in the application of these two products.

J.D., as I promised in the beginning, your company will not get stuck with this material. We are having the samples of mud that you gave us checked to determine the concentration of Visbestos. We are also checking the Visbestos samples that we picked up at the rig. Please let us know how much Visbestos was used on this application and we will credit your account for the same amount. Also, when you send us the "count" let us know how you want this credit handled, cash or otherwise.

We have enclosed, for your information, four Super Lube Flow reports and two Visbestos reports for your files. These reports outline the kind of results we are experiencing on other similar applications. I am sure we will get results as good as these in your area eventually.

Thanks again for the wonderful cooperation you are giving us. I am looking forward to spending a day or two with you in the near future.

Sincerely,

MONTELLO, INC.

Harry M Wyatt

HMW/dlo

Encls.(6)

January 5, 1967

Mr. Charlie Reeves
1250 Eddie Street
Eunice, Louisiana

Re: Your letter 1-2-67
Extra sacks

Dear Charlie:

We are sending Rock Supply today from Sand Springs the following extra Pheno Seal empty bags:

25 Fine;
15 Medium;
10 Coarse.

The extra Rock Seal bags will be shipped to Rock Supply with their next order.

We are waiting for delivery on 500 open mouth Visbestos bags and as soon as they are received in Tulsa we will ship same to Rock Supply direct.

Sincerely,

MONTELLO, INC.

Harry M Wyatt

HMW/dlo

CC: Mr. Charlie Norman

020073

December 27, 1966

Mr. Calvin Ortego
Louisiana Mud Company
P.O. Box 1023
Houma, Louisiana

Dear Mr. Ortego:

Enclosed is our Invoice #2085 covering the 500 bags of Visbestos shipped to you as well as the 200 bags of Visbestos picked up at our New Iberia Warehouse on 11-21-66 (Ticket No. M-2427).

The 200 bags were picked up by you as a loan against your order for the 500 bag split earload. We will be happy to accept the 200 bags at our New Iberia Warehouse if you wish to return it. We will issue you a credit memorandum as soon as the ticket for the return is received from our warehouseman.

Thank you for your orders. We will look forward to serving you again soon.

Sincerely,

MONTELLO, INC.

Kenneth N. Campbell

KNC/dlo

Encl.(1)

C
O
P
Y

December 27, 1966

C
O
P
Y

Mr. Bill Chafin
1710 Evergreen
Pampa, Texas

Dear Bill:

Around the first of October 1966, prior to the time you started representing us in the panhandle area, Baker & Taylor received delivery on 500 sacks of Visbestos. They thought it was consigned, even though we never consign; but, never-the-less, on this first case we went along with them.

We have just received payment on this 500 sacks of Visbestos, which might indicate they have used most or all of this material. Therefore, I would suggest that you call on Roy Bulls, Baker & Taylor Drilling Company, Spearman, Texas. You might have another 500 or 1,000 sack order of Visbestos.

If my schedule holds up I plan on being in the Amarillo area on Wednesday, January 4th. Will give you a ring ahead of time to confirm this date.

Sincerely,

MONTELO, INC.

Harry M. Wyatt

HMW/dlo

020075

December 27, 1966

C
O
P
Y

Mr. Grant Gould
Baker & Taylor Drilling Co.
P.O. Box 2748
Amarillo, Texas

Dear Grant:

We are sending you today, under separate cover, a small sample of Super Grind Pheno Seal.

If my schedule holds up, I plan to be in Amarillo Wednesday, January 4th. I will check with you ahead of time to see if we can make connections.

Thank you very much for the check covering the 500 sacks of Visbestos. I trust this means you have used most of this material. We certainly appreciate your assistance in developing the use of Gilsonite and Visbestos in your area.

Sincerely,

MONTELLIO, INC.

Harry M. Wyatt

HMW/dlo

020076

December 20, 1966

Mr. A. K. Schwartz
Brine Service & Chemical Company
Room 802
3400 Montrose Building
Houston, Texas

Dear Mr. Schwartz:

Your order for 500 bags of Visbestos for delivery to Lake Charles will be shipped today from Coalinga on Car No. IC 25410. Delivering carrier will be Southern Pacific.

We will appreciate it if you will have your people re-level the load after they pull the 500 bags. This will prevent damage of the balance of the material at final destination.

As mentioned earlier this week, Harry intends to be in Houston about the 28th. He will contact you by telephone for an appointment while he is there.

Please accept our best wishes for a Merry Christmas and a Happy New Year. Will look forward to serving you again soon.

Sincerely,

MONTELLO, INC.

Kenneth N. Campbell

KNC/dlo

CC: Mr. Charlie Reeves

December 20, 1966

Mr. J. D. Sullivan
P.O. Box 135
New Iberia, Louisiana 70560

Dear J.D.:

We have ordered a car of Visbestos from Coalinga today. It is being shipped on Car No. IC 25410. We have scheduled the New Iberia warehouse as the final destination. When the car arrives it will have 500 to 600 bags for unloading at our warehouse. We will need an accurate count on the actual number unloaded, the number of bags broken, and a railroad damage report form on the breakage.

Please accept our best wishes for a Merry Christmas and a Happy New Year.

Sincerely,

MONTELLLO, INC.

Kenneth N. Campbell

KNC/dlo

CC: Mr. Charlie Reeves

December 20, 1966

Mr. George Locker
Buckeye, Inc.
P.O. Box 5564
Midland, Texas

Dear George:

Your order for 1,000 bags of Visbestos will be shipped today from Coalinga on Car No. IC 25410. Delivering carrier will be T & P.

In order to avoid unnecessary damage at the final destination, we will appreciate it if you will have the load releveled after taking off your 1,000 bags.

Best wishes for a Merry Christmas and a Happy New Year. We will look forward to hearing from you again soon.

Sincerely,

MONTELLLO, INC.

Kenneth M. Campbell

ENC/dlo

CC: Mr. Frank Dawkins

November 30, 1966

Mr. George Locker
President
Buckeye, Inc.
P. O. Box 5564
Midland, Texas

Dear George:

We understand that your company acts as a basic source of materials for a number of independent service companies. We understand further that you offer a number of services to these companies including credit, warehousing, delivery, etc. This qualifies your company as distributor with respect to your customers in the West Texas area.

The purpose of this letter is to inform you that, on the basis of the above, we have established a distributor discount for Buckeye. It must be understood that continuation of this discount depends in large measure upon the cooperation and marketing assistance given by Buckeye. This discount will apply to all Visbestos purchases by your company for a period of one year from this date. The amount will be \$10.00 per ton, which will be deducted from the face of each invoice. The minimum order acceptable under this arrangement is 1,000 bags.

If this meets with your approval, please sign below as indicated and return one copy for our files.

Sincerely,
MONTELLO INC.

Approved:
BUCKEYE, INC.

Kenneth N. Campbell
President

George Locker
President

November 29, 1966

Mr. Jim Edison
Sun Oil Company
P. O. Box 2792
Odessa, Texas

Dear Mr. Edison:

Following is a list of Visbestos sales for your area, by company, from July 1, 1966 until today:

Baroid	262,500
IMC	60,000
Mageobar (Permian)	57,500
Buckeye, Inc.	76,250
(supplier to independent mud companies)	
Texas Mud and Chemical	22,500

The sales tempo of Visbestos has steadily increased since its introduction in late summer. Baroid is by far the most progressive in purchasing and promoting of Visbestos in the Permian Basin area. Baroid is also the leader in the Oklahoma area. They have been extremely cooperative in furnishing technical information on field applications of this product.

We are pleased with the performance of Visbestos. Recent reports received in our office indicate that Visbestos yields faster and is more uniform in its performance than other type asbestos materials available in your area. The test runs by your laboratory in Beaumont, Texas to select the best grade Chrysotile Asbestos Fiber have been invaluable in providing the best and most economical material to the drilling industry.

Thanks very much for your acceptance and assistance in promoting Visbestos to its rightful place as a drilling mud additive.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt

cc: W. E. Pierce *Odessa, Texas*
Don Lawrence, *General, Southland Center Box 2880, Dallas*
T. S. Carreza *La Brea, La Brea, Texas*

020081

November 24, 1947

Mr. James Smith
Sun Oil Company
P. O. Box 150
Lafayette, La.

Dear Mr. Smith:

Following is a list of Viscostee sales for your area, by company, since July 1, 1947 until today:

MO	1,700
Louisiana M. Co.	10,000
Rock Supply	27,300
Gulf Coast Drilling	21,000
Crane Sales	23,100
Others	15,000

The sales tempo of Viscostee has steadily increased since its introduction in late summer. MO is by far the most progressive in purchasing and promoting of Viscostee in the South Louisiana area. MO has been very cooperative in furnishing technical information on field uses of Viscostee.

We are very pleased with the performance of this product. Reports received in our office indicate that Viscostee yields faster and is more uniform in its performance than other asbestos type materials available in your area. The test made by the Sun Oil Co. at Beaumont to select the best grade dry-asbestos floor have been valuable in providing the best and most economical material to the drilling and industry.

Thanks very much for your acceptance and assistance in promoting Viscostee to its rightful place as a drilling and additive.

Sincerely,

Respectfully,

Harry W. Wyatt

cc: Mr. Jack Eaton
Mr. Charlie Reeves

November 3, 1966

C
O
P
Y

Mr. W. B. Kirkland
Baroid Division
National Lead Company
P. O. Box 1675
Houston, Texas -- 77001

Dear Woody;

Reference your letter dated October 28, 1966 regarding the freight rate on our Visbestos material. Your traffic people refer to rail item 8065 of TC 2 which shows a rate of \$1.17 per CWT on 100,000 lbs. carload of asbestos shorts. If your traffic section will check item 1225 of TC 2, they will find that a rate of \$1.00 per CWT applies on minimum 120,000 lbs. carload. This rate applies to 100,000 lbs. asbestos when loaded to full visible capacity.

It is under this last clause that we are shipping Visbestos as all cars are loaded to full visible capacity. Please let us know if any further information is required.

Sincerely,

MONTELLO INC.

Kenneth N. Campbell

KNC/pg

criteria for a recommended standard 020083

OCCUPATIONAL EXPOSURE TO

ASBESTOS

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
HEALTH SERVICES AND MENTAL HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

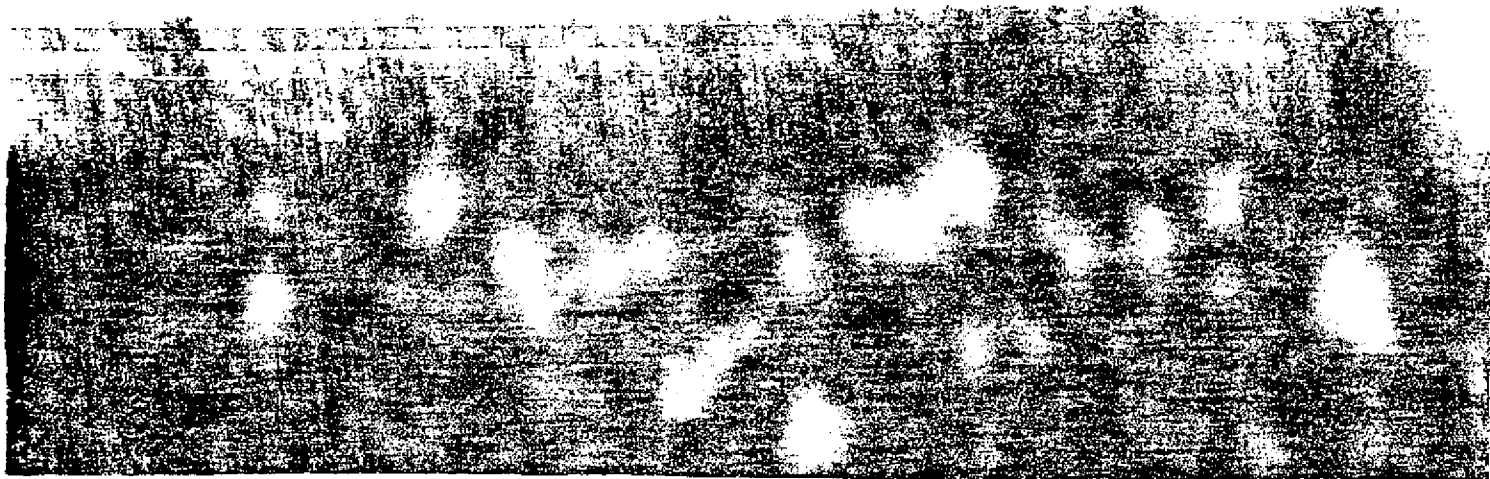
criteria for a recommended standard

OCCUPATIONAL EXPOSURE
TO
ASBESTOS



U.S. Department of Health, Education, and Welfare
Public Health Service
Health Services and Mental Health Administration
National Institute for Occupational Safety and Health

1972



020085

HSM 72-10267
Second Printing

PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health of workers exposed to an ever increasing number of potential hazards at their workplace. To provide relevant data from which valid criteria and effective standards can be deduced, the National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices.

It is intended to present successive reports as research and epidemiologic studies are completed and sampling and analytic methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this first report on asbestos by members of my staff, and the valuable constructive comments by the Review Consultants on Asbestos. A list of these contributors and reviewers appears on pages iii and iv. The contributions of others are also acknowledged:

Dohrman H. Byers*
Bureau of Occupational
Safety and Health
Cincinnati, Ohio

Andrew D. Hosey*
Bureau of Occupational
Safety and Health
Cincinnati, Ohio

Bobby J. Gunter, Ph.D.;
Bureau of Occupational
Safety and Health **
Cincinnati, Ohio

Glen W. Sutton*
Bureau of Occupational
Safety and Health
Cincinnati, Ohio

Richard E. Kinser
Bureau of Occupational
Safety and Health **
Cincinnati, Ohio

John L. Holtz
Bureau of Occupational
Safety and Health **
Cincinnati, Ohio

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Roger A. Nelson*
Bureau of Occupational
Safety and Health
Cincinnati, Ohio

Edward J. Baier
Occupational Health
Program
Pennsylvania Department of Health

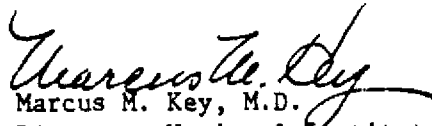
Paul Gross, M.D.
Graduate School of Public Health
University of Pittsburgh

John C. Lumsden
North Carolina State
Board of Health

Morris Kleinfeld, M.D.
New York State Department
of Health

Irving J. Selikoff, M.D.
Mount Sinai School of Medicine
City University of New York

Douglas H. K. Lee, M.D.
National Institute of
Environmental Health Sciences


Marcus M. Key, M.D.
Director, National Institute
for Occupational Safety and Health

*former staff

**now National Institute for Occupational Safety and Health

REVIEW COMMITTEE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Howard E. Ayer
Assistant Director, Division of
Field Studies and Clinical Investigations

John V. Crable
Acting Chief, Laboratory of Physical
and Chemical Analysis

Bobby F. Craft, Ph.D.
Acting Director, Division of Technical
Services

Lewis J. Cralley, Ph.D.
Office of the Associate Director,
Cincinnati Operations

Lorice Ede, J.D.
Office of Research & Standards
Development

Edward J. Fairchild, Ph.D.
Acting Associate Director, NIOSH
Cincinnati Operations

William M. Johnson, M.D.
Associate Director, Division of
Field Studies and Clinical Investigations

Jeremiah R. Lynch
Acting Deputy Director,
Division of Laboratories
and Criteria Development

Raymond T. Moore, M.D.
Associate Director, NIOSH
Washington Operations

Charles H. Powell, Sc.D.
Assistant Director, NIOSH
for Research and Standards
Development

Warren L. Smith, M.D.
Division of Field Studies
and Clinical Investigations

Herbert E. Stokinger, Ph.D.
Division of Laboratories and
Criteria Development

Joseph K. Wagoner, S.D. Hyg.
Director, Division of Field
Studies and Clinical Inves-
tigations

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NIOSH REVIEW CONSULTANTS ON ASBESTOS

W. Clark Cooper, M.D.
Professor in Residence
Occupational Health
Division of Environmental Health Sciences
University of California
School of Public Health
Berkeley, California

Duncan A. Holaday
Research Professor
Mount Sinai School of Medicine
City University of New York
New York, New York

George W. Wright, M.D.
Head, Department of Medical Research
St. Lukes Hospital
Cleveland, Ohio

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN
OCCUPATIONAL EXPOSURE STANDARD FOR ASBESTOS

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I. RECOMMENDATIONS FOR AN ASBESTOS STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to asbestos dust in the workplace be controlled by requiring compliance with the following sections. Control of worker exposure to the limits stated will prevent asbestosis and more adequately guard against asbestos-induced neoplasms. The standard is amenable to techniques that are valid, reproducible, and available to industry and governmental agencies. It will be subject to review and will be revised as necessary.

Section 1 - Environmental (work place air)

(a) Concentration

Occupational exposure to airborne asbestos dust shall be controlled so that no worker shall be exposed to more than 2.0 asbestos fibers per cubic centimeter (cc) of air based on a count of fibers greater than 5 micrometers ($>5\ \mu\text{m}$) in length ((determined by the membrane filter method at 400-450X magnification (4 millimeter objective) phase contrast illumination, as described in Appendix I)), determined as a time-weighted average (TWA) exposure for an 8-hour work day, and no peak concentration of asbestos to which workers are exposed shall exceed 10.0 fibers/cc $>5\ \mu\text{m}$ as determined by a minimum sampling time of fifteen minutes.

(b) Sampling

Procedures for sampling, calibration of equipment, and analysis of asbestos samples shall be as provided in Appendix I.

(c) It is recommended that this Section I become effective two years after promulgation as a standard, and that until the date of





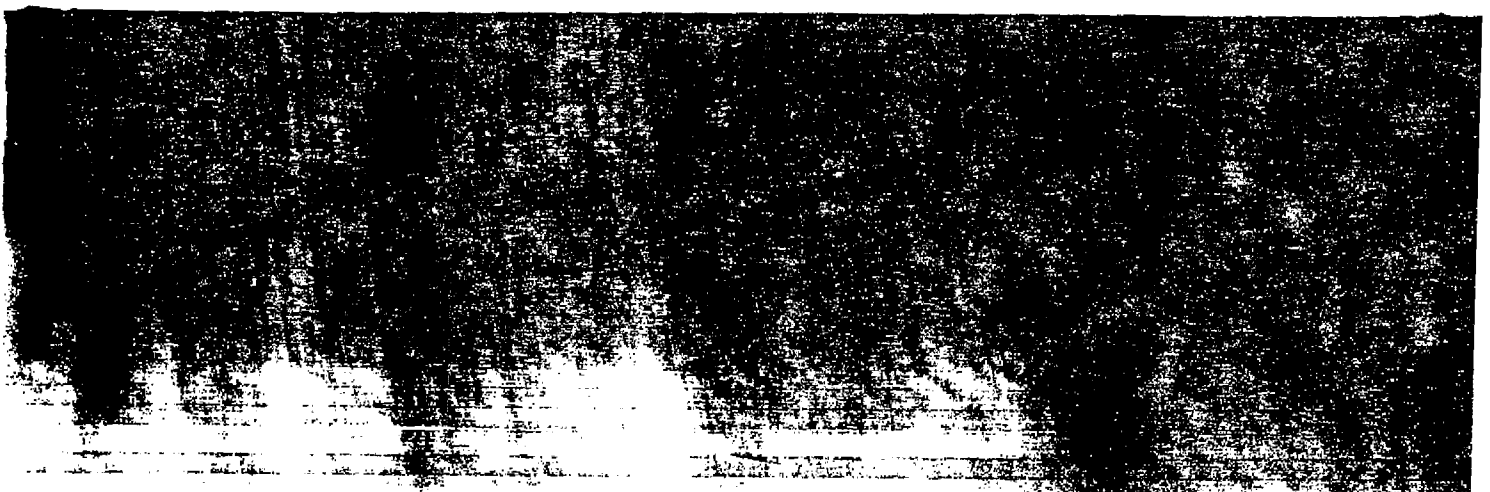
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publication, the present emergency standard for exposure to asbestos dust (29 CFR 1910.93a) shall be in effect. This period is believed necessary to permit installation of necessary engineering controls.

Section 2 - Medical

Medical surveillance is required, except where a variance from the medical requirements of this proposed standard have been granted, for all workers who are exposed to asbestos as part of their work environment. For purposes of this requirement the term "exposed to asbestos" will be interpreted as referring to time-weighted average exposures above 1 fiber/cc or peak exposures above 5 fibers/cc. The major objective of such surveillance will be to ensure proper medical management of individuals who show evidence of reaction to past dust exposures, either due to excessive exposures or unusual susceptibility. Medical management may range from recommendations as to job placement, improved work practices, cessation of smoking, to specific therapy for asbestos-related disease or its complications. Medical surveillance cannot be a guide to adequacy of current controls when environmental data and medical examinations only cover recent work experience because of the prolonged latent period required for the development of asbestosis and neoplasms.

Required components of a medical surveillance program include periodic measurements of pulmonary function (forced vital capacity (FVC)), and forced expiratory volume for one second (FEV_1), and periodic chest roentgenograms (postero-anterior 14 x 17 inches). Additional medical requirement components include a history to describe smoking habits and details on past exposures to asbestos and other dusts and to determine presence or absence of pulmonary, cardiovascular, and gastrointestinal symptoms, and a physical examination, with special attention to pulmonary rales, clubbing of fingers, and other signs related to cardiopulmonary systems.



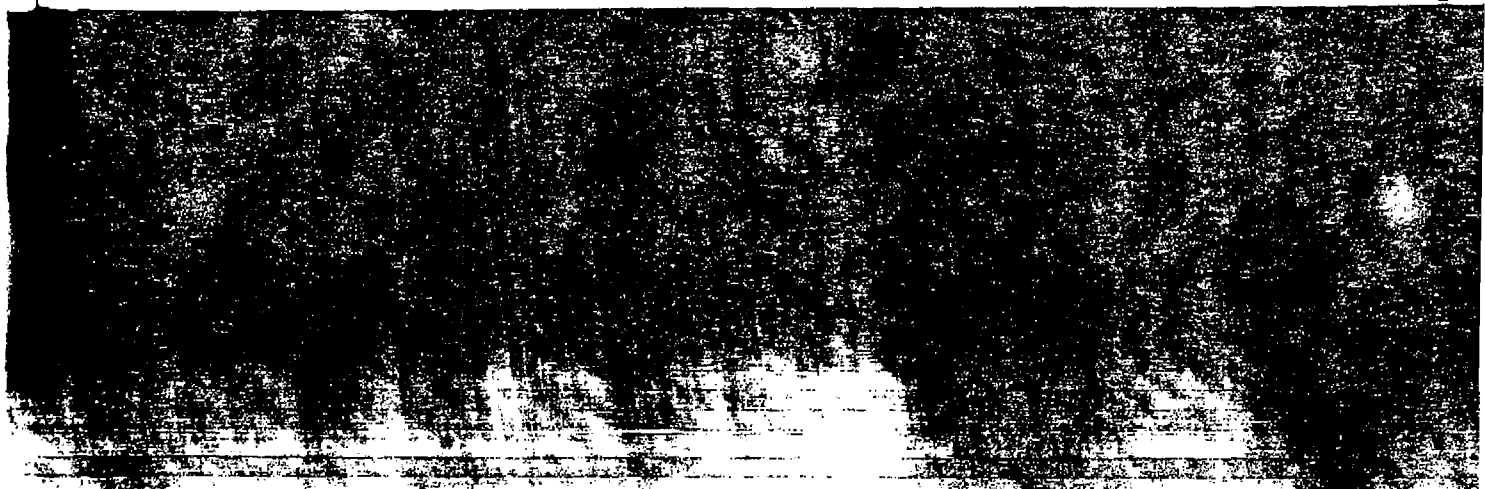
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Chest roentgenograms and pulmonary function tests will be performed at the employer's expense, at least every 2 years on all employees exposed to asbestos. These tests will be made annually to individuals, (1) who have a history of 10 or more years of employment involving exposure to asbestos or, (2) who show roentgenographic findings (such as small opacities, pleural plaques, pleural thickening, pleural calcification) which suggest or indicate pneumoconiosis or other reactions to asbestos, or (3) who have changes in pulmonary function which indicate restrictive or obstructive lung disease.

Preplacement medical examinations and medical examinations on the termination of employment of asbestos exposed workers are also required.

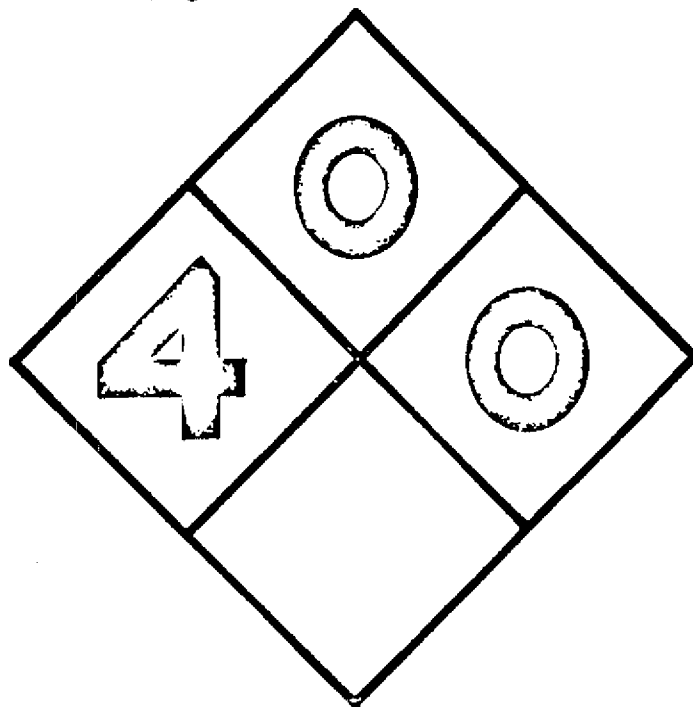
Section 3 - Labeling

- (a) A warning label for asbestos as shown in Figure 1 shall be used.
- (b) Numerical designations indicate the following:
 - (i) 4= Health Hazard (color code, blue). Inhalation may cause asbestosis, pleural or peritoneal mesothelioma, or lung cancer.
 - (ii) 0= Fire Hazard (color code, red). Asbestos is non-flammable and has negligible vapor pressure, volatility, flash point, and explosive limits.
- (c) The details of the numerical hazard rating system are found in Appendix II.



020096

ASBESTOS



HARMFUL: May Cause Delayed Lung Injury
(Asbestosis, Lung Cancer).

DO NOT BREATHE DUST

Use only with adequate ventilation and
approved respiratory protective devices.

Section 4 - Personal Protective Equipment and Clothing

This section shall apply whenever a variance from the standard set in Section I is granted under provisions of the Occupational Safety and Health Act.* Use of respirators can be decided on the basis of time-weighted average or peak concentration. When the limits of exposure to asbestos dust prescribed in paragraph (a) of Section 1 cannot be met by limiting the concentration of asbestos dust in the work environment, an employer must utilize as provided in subsections (a) and (b) of this Section a program of respiratory protection and furnishing of protective clothing to effect the required protection of every worker exposed.

(a) Respiratory Protection

(1) For the purpose of determining the class of respirator to be used, the employer shall measure the atmospheric concentration of airborne asbestos in the workplace when the initial application for variance is made and thereafter whenever process, worksite, climate or control changes occur which are likely to affect the asbestos concentration. The employer shall test for respirator fit and/or make asbestos measurements within the respiratory inlet covering to insure that no worker is being exposed to asbestos in excess of the standard either because of improper respirator selection or fit.

(11) As noted above, the use of respirators and protective clothing can be decided on the basis of either time-weighted average or peak concentrations. For determining usage or compliance, the peak concentration of 10 fibers/cc is preferable.

*Variance procedures will not be required for emergency and occasional short-term exposures in excess of the environmental standard. However, the use of respirator equipment as indicated in this Section (4) will be required under conditions in excess of the standard.

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(iii) For an atmosphere containing not more than 10 fibers/cc greater than 5 μ m in length over an 8-hour average or more than 50 fibers/cc over any 15 minute period, a reusable or single use filter-type air-purifying respirator, operating with a negative pressure during the inhalation phase of breathing, approved under the provisions of 30 CFR 14 (Bureau of Mines Schedule 21B) or valveless respirators providing equivalent protection shall be used.

(iv) For an atmosphere containing not more than 100 fibers/cc greater than 5 μ m in length over an 8-hour average or more than 500 fibers/cc over any 15 minute period, a powered air-purifying positive-pressure respirator approved under the provisions of 30 CFR 14 (Bureau of Mines Schedule 21B) shall be used.

(v) For an atmosphere containing more than 100 fibers/cc greater than 5 μ m in length over an 8-hour average or over 500 fibers/cc for any period in excess of 15 minutes, a type C positive-pressure supplied air respirator approved under the provisions of 30 CFR 12 (Bureau of Mines Schedule 19B) shall be used.

(vi) The employer shall establish a respirator program in accordance with the requirements of the American National Standard for Respiratory Protection Z88.2--1969.

(b) Protective Clothing

(1) The employer shall provide each employee subject to exposure in a variance area with coveralls or similar full body protective clothing and hat, which shall be worn during the working hours in areas where there is exposure to asbestos dust.

(ii) The employer shall provide for maintenance and laundering of the soiled protective clothing, which shall be stored, transported and disposed of in sealed non-reusable containers marked "Asbestos-Contaminated Clothing" in easy-to-read letters.

(iii) Protective clothing shall be vacuumed before removal. Clothes shall not be cleaned by blowing dust from the clothing or shaking.

(iv) If laundering is to be done by a private contractor, the employer shall inform the contractor of the potentially harmful effects of exposure to asbestos dust and of safe practices required in the laundering of the asbestos-soiled work clothes.

(v) Resin-impregnated paper or similar protective clothing can be substituted for fabric type of clothing.

(vi) It is recommended that in highly contaminated operations (such as insulation and textiles) provisions be made for separate change rooms.

020100

Section 5 - Appraisal of Employees of Hazards from Asbestos

Each employee exposed to asbestos shall be apprised of all hazards, relevant symptoms, and proper conditions and precautions concerning use or exposure. Each exposed worker shall be informed of the information which is applicable to a specific product or material containing 5% or more asbestos (see Appendix III for details of information required). The information shall be kept on file and readily accessible to the worker at all places of employment where asbestos materials are manufactured or used in unit processes and operations. It is recommended, but not required, that this information be provided for asbestos processes and operations where the asbestos content is less than 5%.

Information as specified in Appendix III shall be recorded on U. S. Department of Labor Form OSHA-20, "Material Safety Data Sheet", (see page X-3 and X-4), or a similar form approved by the Occupational Safety and Health Administration, U. S. Department of Labor.

Section 6 - Work Practices

(a) Asbestos cement, mortar, coatings, grout, and plaster shall be mixed in closed bags or other containers.

(b) Asbestos waste and scrap shall be collected and disposed of in sealed bags or other containers.

(c) All cleanup of asbestos dust shall be performed by vacuum cleaners or wet cleaning methods. No dry sweeping shall be performed.

020102

Section 7 - Monitoring and Recordkeeping Requirements

Employers will be required* to maintain records of environmental exposure to asbestos based upon the following environmental sampling and recordkeeping schedule. Personal exposure samples will be collected at least annually by specific maximum-risk work operations from a number of employees. The first sampling period will be completed within 180 days of the date of this standard. These selected samples will be collected and evaluated as both time-weighted and peak concentration values. The personal sampling regime shall be on a quarterly basis for maximum-risk work areas under the following conditions:

- (a) The environmental levels are in excess of the standard.
- (b) There are other conditions existing that necessitate the requesting of a variance from the Department of Labor.

Records of the type of respiratory protection in use during the quarterly sampling schedule must also be maintained. Quarterly sampling, monitoring and recordkeeping will be required only until environmental levels comply with the standard.

*Except where a variance for monitoring and recordkeeping has been granted.

II. INTRODUCTION

This report presents the criteria and the standard based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to asbestos dust. The necessary relevant data are made available for use by the Secretary, Department of Health, Education, and Welfare in accordance with the provision of the Occupational Safety and Health Act of 1970 requiring the development of criteria by "The Secretary, Department of Health, Education, and Welfare...on the basis of such research, demonstrations, and experiments and any other information available to him...to effectuate the purposes of this Act."..., "...: by providing medical criteria which will assure insofar as practicable that no employee will suffer diminished health, functional capacity, or life expectancy as a result of his work experience"...

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultations with others, formalized a system for the development of criteria upon which standards can be established to protect the health of workers from exposure to hazardous chemical and physical agents. It should be pointed out that any recommended criteria for a standard should enable management and labor to develop better engineering controls and more healthful work practices and should not be used as a final goal.

These criteria for a standard for asbestos dust are the first of the criteria developed by NIOSH. The criteria and standard speak only to the processing, manufacture, and use of asbestos products as applicable under the Occupational Safety and Health Act of 1970.

020104

The occupational safety and health aspects of the mining and milling of asbestos ores are covered by provisions of the Federal Metal and Nonmetallic Mine Safety Act (30 US.C. 725 et seq.) under which provisions the Bureau of Mines has promulgated applicable regulations. Relevant data, however, bearing on the safety and health hazards from exposure to asbestos dust in the mining and milling of ores were considered in this document.

These criteria were developed to assure that the standard based thereon would, (1) protect against asbestosis and asbestos-induced neoplasms, (2) be amenable to techniques that are valid, reproducible, and available to industry and official agencies, and (3) be attainable with existing technology.

The recommended standard is designed primarily to prevent asbestosis. For other diseases associated with asbestos, there is insufficient information to establish a standard to prevent such diseases including asbestos-induced neoplasms by any all-inclusive limit other than one of zero. Nevertheless, a safety factor has been included in arriving at the concentration level that will reduce the total body burden and should more adequately guard against neoplasms.

Asbestos has been mined, milled, processed, and used for many years, and as a result, a number of workers have experienced significant accumulative exposure to asbestos dust over a working lifetime. It has been recognized that biological monitoring (by periodic chest roentgenograms) and removal from further exposure after initiation of fibrosis, calcification or neoplasia will not absolutely prevent

further progression of asbestosis or the clinical development of neoplasms. Therefore, it is absolutely essential that a low level of concentration be set to preclude the initiation of diseases resulting from exposure to asbestos. And of necessity, any prolonged delay in the establishment of the standard may require a more stringent standard in the future to assure the reduced total body burden of employees which is necessary to protect their safety and health.

III. BIOLOGIC EFFECTS OF EXPOSURE TO ASBESTOS

Asbestos is a generic term that applies to a number of naturally occurring, hydrated mineral silicates incombustible in air and separable into filaments. The most widely used in industry in the United States is chrysotile ($3\text{MgO} \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$), a fibrous form of serpentine. Other types include amosite (FeMgSiO_3); crocidolite ($\text{NaFe}(\text{SiO}_3)_2 \cdot \text{FeSiO}_3 \cdot \text{H}_2\text{O}$); tremolite ($\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$); anthophyllite ($\text{MgFe}_7\text{Si}_8\text{O}_{22}(\text{OH})_2$); and actinolite ($\text{CaO} \cdot 3(\text{MgFe})\text{O} \cdot 4\text{SiO}_2$).

Extent of Exposure

Almost one million tons per year of asbestos are used in the United States. In 1965, approximately 74 percent of the asbestos produced was used in the construction industry (532,300 tons) while 26 percent was used in non-construction industries (187,400 tons). Approximately 92 percent of the half million tons used in the construction industry is firmly bonded, i.e., the asbestos is "locked in" in such products as floor tiles, asbestos cements, and roofing felts and shingles; while the remaining 8 percent is friable or in powder form present in insulation materials, asbestos cement powders, and acoustical products.¹ As expected, these latter materials generate more airborne fibers than the firmly bonded products. The 187,400 tons of asbestos used in non-construction industries in 1965 were utilized in such products as textiles, friction material including brake linings, and clutch facings, paper, paints, plastics, roof coatings, floor tiles, and miscellaneous other products.

Mining and milling of asbestos in the United States is a small industry, employing fewer than a thousand workers. The health and safety

020107

aspects of mining and milling operations are not covered under the Occupational Safety and Health Act of 1970.

The construction industry has, in recent years, applied asbestos insulation materials by spraying, a method of application that generates more airborne asbestos fibers than older conventional methods. This technique at present utilizes only a small percentage of the total asbestos produced and its use is decreasing.

There are approximately 40,000 field insulation workers in the United States who are exposed to asbestos dust. The activities of these workers cause secondary exposures to an estimated three to five million other building construction and shipyard workers.²

Since the dust exposure to the individual worker is extremely variable and the number of asbestos workers at any one location is small, the primary and secondary asbestos dust exposures to all workers have never been satisfactorily estimated.

An estimated 50,000 workers are involved in the manufacture of asbestos-containing products. This figure does not include secondary manufacture of products which contain asbestos, such as electrical or thermal insulation, or products which include previously manufactured components containing asbestos.³

The following information, furnished by the Pennsylvania Division of Occupational Health, shows the number and variety of plants using asbestos in which potential exposures can occur. These figures are based on a survey of a total of 18,439 manufacturing plants in that

State as of August 22, 1969, and represents about 1.4 percent of all manufacturing operations in Pennsylvania. Service facilities such as garages are not included.

	<u>No. of Plants</u>
Insulation, including cutting, drilling, and tape manufacture	75
Manufacturing and processing	16
Brakes and friction	10
Cement, clay	18
Miscellaneous*	146
*Gaskets	
Signs	
Safety equipment	
Laminated material	
Paint and roofing materials	
Shipbuilding and shipbreaking	
Impregnating resin and urethane	
Textile	
Undercoating material	
Ironing board covers	
Flooring	
TOTAL	<u>265</u>

Early Historical Reports

The widespread use of asbestos fibers did not begin until the last quarter of the nineteenth century.² With the increasing use of asbestos materials and increasing reports of asbestos related disease there developed concern over the role of these minerals as factors in human disease. Differentiation of the type of asbestos fiber was not made in most studies related to occupational exposure. In the United States the exposures of greatest concern usually involve more than one type of fiber, although chrysotile predominates. To refine our knowledge of the biological actions of asbestos, it is imperative that the character of the exposure as to concentration, size, and type of fiber be known. At present, data of this complexity are scanty or often non-existent with respect to human exposure.

The first record of a case of asbestosis was reported in England by Montague Murray in 1906.⁴ The first complete description of asbestosis and of the "curious bodies" seen in lung tissue appeared in 1927 when Cooke⁵ reported on a case of asbestosis and McDonald⁶ reported on the same and another case. Each author gave reasons for believing that these "curious bodies" originate from asbestos fibers that reach the lungs.

Many of the people exposed to asbestos dust develop the disease "asbestosis" if the dust concentration is high or the duration of their exposure is long. This has been documented by the following studies: Merewether and Price, 1930; Fulton et al., 1935; and Dreessen et al., 1938. In 1918, Hoffman⁷ reported that it was the practice of

American and Canadian insurance companies not to insure asbestos workers due to the assumed health-injurious conditions of that industry. In 1917, Pancoast, Miller and Landis⁸ reported on X-ray appearances of pneumoconiosis in 15 individuals exposed to asbestos.

Mills' publication⁹ in 1930 was the first report on a case of asbestosis published in the United States, and in that same year, Lynch and Smith¹⁰ reported on "asbestosis" bodies* found in the sputum of asbestos workers. In Merewether's review of asbestosis,¹¹ emphasis was placed on the relation of asbestosis to dusty working conditions.

The clinical aspects of asbestosis are well documented. Gloyne¹² discussed the pathology of asbestosis and methods for diagnosing asbestos bodies and asbestosis. Selikoff and Hammond¹³ analyzed 1,975 autopsies in three large New York City hospitals and found asbestos bodies in 942 (47.7%). Broadly considered, 40 percent of housewives, 50 percent of "white collar" males, and 50 percent of "blue collar" males showed asbestos bodies; but males who had a history of shipyard or construction work had higher incidence of asbestos bodies, i.e., 90 of 129 cases or 70 percent. Selikoff's observations also suggest that asbestos bodies were as frequently present 38 years ago as now.

Although a large percentage of the lungs of adult urban dwellers may be found to contain ferruginous bodies (depending on the method of examination), the significance of this is as yet unknown.

*"Ferruginous bodies" is a more descriptive term. This and other aspects of the biologic effects of asbestos are well documented in the Annals of the New York Academy of Science.¹



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The core fibers have not been systematically identified to indicate how many are asbestos bodies, and there are little data bearing on possible health effects associated with the low concentrations of fibers found in ambient air.

An abnormality, occurring with unusually greater frequency in populations exposed to inhalation of asbestos fiber, is that of localized thickening, or plaques, of the pleura with or without calcification of the plaques. The role of the asbestos fiber in this manifestation is not clear.

The medical aspects of exposure to asbestos and the development of the occupational disease, asbestosis, are characterized by:

- (1) A pattern of roentgenographic changes consistent with diffuse interstitial fibrosis of variable degree and, at times, pleural changes of fibrosis and calcification.
- (2) Clinical changes including fine rales and finger clubbing. These may be present or absent in any individual case.
- (3) Physiological changes consistent with a lung disorder.
- (4) A known history of occupational exposure to airborne asbestos dust. In general, a considerable time lapse between inhalation of the dust and appearance of changes as determined by X-ray.

The several clinical abnormalities listed above appear to occur with unusual frequency in those environments where airborne asbestos fibers, often in association with other substances, exist. One of these abnormalities, a diffuse chronic inflammation and scarring

of the lung, is the one recognized early in this century and referred to as "asbestosis."

Epidemiological Studies

Harries¹⁴ in 1968 suggested that first impressions would lead one to believe that only workers continuously exposed to asbestos are at risk of developing asbestosis, however, a number of trades experiencing intense intermittent exposures are also suspect. These other trades involve work with asbestos insulation in confined spaces onboard ship. Work in these trades has been accepted by the Pneumoconiosis Panel of the United Kingdom as associated with asbestosis. Selikoff,¹⁵ however, in a study of 232 former insulation plant employees reported positive X-ray findings among individuals having had known exposures to asbestos as short as one day (Table XXVII).

In the late 1940's a frequency of bronchogenic cancer greater than that expected on the basis of the general male population was manifest among persons who worked in the manufacture of asbestos products.¹⁶ This excess of bronchogenic cancer was also demonstrated among a group of workers in the United States exposed to airborne asbestos fibers in the installation of insulation.^{17,18} Among 632 asbestos insulation installers observed from 1943 to 1967 there were 99 excess deaths (above that expected on the basis of the U. S. white male population) for three types of malignancies-- bronchogenic (63), gastrointestinal (26) and all other sites combined (10). Elmes and Simpson¹⁹ recently reported findings of similar magnitude among men employed as insulators and pipe coverers in Belfast. Newhouse²⁰ found an excess of lung cancer

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in a study of over 4,500 male workers employed at an asbestos factory making both textile and insulation materials. This excess of lung cancer was demonstrated among those workers with jobs which entailed heavy exposure irrespective of the duration of employment.

More recent observations by Selikoff in the United States indicate a lung cancer risk for workers exposed to amosite asbestos in the production of insulation material.²¹

The possibility that the carcinogenic role of asbestos is solely that of a cocarcinogen has been suggested by Wright.² This suggestion stems from the observation by Selikoff and associates¹⁷ that among 370 asbestos insulators, exposure to asbestos dust does not greatly increase the risk of bronchogenic cancer in the absence of regular cigarette smoking. More recent observations among this same group of workers,²² however, demonstrate that this interpretation is largely a function of sample size as one lung cancer death vs. 0.02 expected was observed among non-smokers as contrasted with 27 vs. 2.83 expected among cigarette smokers. Moreover, Decoufle²³ demonstrated that the excess of lung cancer mortality among several subgroups of retired asbestos workers could not be explained by cigarette smoking alone.

Concerning mesothelioma, 80 percent of the cases studied in South Africa and the United Kingdom have been shown to have an occupational or para-occupational association with asbestos fibers.² In the United States, Selikoff and co-workers have reported the occurrence of 14 deaths from mesotheliomas among 532 asbestos insulation workers studied in retrospect from 1943 to 1968 compared to no deaths which

would be expected in the same number of similar individuals in the general population.^{17,18} Information is insufficient at this time to set an exposure standard (other than zero) which would assure prevention of mesothelioma in all workers, as the disease may occur following a very limited exposure 20-30 years earlier.

An increased rate of occurrence of mesothelioma of the pleura or peritoneum was reported in some populations in 1959 and in subsequent years. The possibility that asbestos may play a role in this distribution has been raised. Investigations of the distribution of mesothelioma in populations occupationally exposed to asbestos indicate a strong relationship between exposure to asbestos fiber and the presence of mesothelioma.^{18,20,24,25}

Neoplasms, such as mesothelioma, may occur without radiological evidence of asbestosis at exposure levels lower than those required for prevention of radiologically evident asbestosis. This may be of particular importance when consideration is given to short-term, high levels of exposure, and may result in the development of mesothelioma before or after completion of a normal span of work either in or out of the asbestos industry.

This is illustrated by several case studies, including two cases of malignant mesothelioma, one a "family" and the other a "neighborhood" case.²⁶ In another "family" case, a woman washed the overalls of her three daughters at home; all three daughters worked for an asbestos company with possible heavy exposures to asbestos.

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The time lapse between onset of exposure and mesothelioma in 344 deaths among asbestos insulation workers was studied. Mesothelioma developed after a longer lapse of time from onset of exposure to asbestos than was the case in the development of asbestosis (Table XXVIII).¹⁵ Knox²⁷ reported 4 cases of mesothelioma in men and women with less than 10 years exposure, one with only seven months exposure, with the latent time for the development of the mesothelioma from 23 to 53 years.

D. L. Cran²⁸ indicated that mesothelioma did occur in cases of asbestosis, but that in most cases of mesothelioma that he had seen, the occurrence of asbestosis was not found. He postulated that the difference being the long periods of exposure required to produce asbestosis, while mesothelioma could occur long after a short intensive exposure. The 27 cases of mesothelioma in children under 19 years of age indicates the latent time period for development of mesothelioma may be shorter than first estimated.²⁹

Fifteen cases³⁰ of pleural mesothelioma associated with occupational exposure were reported in Australia. The relationship between the mesothelioma development and asbestos was based upon occupational histories and finding of asbestos bodies in the tissue. In some of these cases, the relationship to occupational exposure could not be developed with any degree of certainty, but included patients whose exposure was as short as six months. No patient was regarded clinically or radiologically as suffering from asbestosis; one person had pleural plaques that were radiologically visible.

Stumphius,³¹ between 1962 and 1968, found 25 cases of mesothelioma on Walcheren Island. Of these cases, 22 had been employed in the shipyard trades. Stumphius noted that the shipyard employed about 3000 men. This would result in a rate of mesothelioma of approximately 100 per 100,000 males per year. He also noted that the rate for Dutch provinces with heavy industry is 1.0 per 100,000 per year.³¹ In the same study, examination of sputum from 277 shipyard workers showed that 60% had asbestos bodies. The frequency varied from 39% of those with no obvious exposure to 100% among those with slight but definite asbestos exposure.

McEwen³² found that the incidence of mesothelioma in Scotland was similar to that found in other parts of the United Kingdom and confirmed the association between the development of the tumor and occupational exposure to asbestos.

In 1968 Stumphius and Meyer³³ concluded that asbestos exposure may lead to asbestosis, to carcinoma of the lungs and digestive tract, and to mesothelioma. They further stated that there may be no indication of definite exposure to asbestos. It must be pointed out that a clear picture of the relationship between the type of asbestos and the production of asbestosis, neoplasms, and mesotheliomas is not defined in the exposures reported. In many cases mixed exposures have occurred; e.g., the cases from the Naval dockyards in Great Britain where exposures have occurred in unknown amounts to crocidolite and amosite.

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Animal Toxicity

Experimental Animal Studies. Experimental exposure of animals to asbestos has been in progress for more than 40 years. During this time, a precise experimental animal model, from which could be derived dose-response relationships that could be used in estimating the appropriate value for a work place air standard has not yet been reported.

The rate of development of asbestotic pulmonary fibrosis and of induction of pleural mesotheliomas is so slow that the animals die before onset of the condition. Accordingly, to develop either condition, experimenters have had to use inordinately high exposure levels or abnormal modes of administration or both, thus nullifying the animal model. The classical demonstrations of diffuse pulmonary fibrosis in guinea pigs with accompanying asbestos bodies by Gardner and Cummings³⁴ and by Vorwald et al.³⁵ became possible only by using fiber levels of from 1,400 to 5,000/cc (39 million to 138 million fibers/cubic foot); and the uniform production of mesotheliomas in rats by Wagner and Berry³⁶ was attained only after administering the asbestos by intra-pleural injection at the extraordinarily high dose of 20 mg.

Stanton et al.³⁷ were unable, even when aided by chemical means, to induce neoplasms of any type in a tumor-susceptible strain of rats at low dosages of asbestos (type unspecified); but Gross et al.³⁸ did produce in rats malignant pulmonary tumors of several types from exposure at very high doses (ca. 22,000 fibers/cc 86 mg/m³) of chrysotile asbestos that had been hammermilled to an increase in cobalt of 145%; nickel, 82%; and chromium, 34%.

Differences in animal responses to "harsh" and "soft" chrysotile asbestos were seen by Smith et al.³⁹: granulomatous and fibrous pleural adhesions were thicker, and pleural mesotheliomas appeared more rapidly in response to harsh chrysotile. (Harsh chrysotile was characterized as appearing in thicker bundles and was hydrophobic whereas the soft chrysotile was hydrophilic).

There are no experimental animal dose-response data that can be used in estimating a work place air standard for asbestos.

Contributions to Occupational Exposure Standards from Animal Studies.

Of possible value in estimating occupational exposure limits are data regarding the relative disease-producing potency of the various forms and types of asbestos.

Wagner⁴⁰ found in the three species exposed (guinea pigs, rabbits, and monkeys) that amosite produced more marked interstitial fibrosis than chrysotile and the lesions occurred earlier. No statement on relative potency of crocidolite could be made because of the impure nature of the test specimen. On the other hand, amosite was found by the same investigator³⁶ to be about one-half as potent in the production of mesotheliomas in rats as chrysotile and crocidolite; if numbers and rate of production are used as indicators. An incidental finding was no evidence for difference in effect between natural and oil-extracted forms of crocidolite, a subject considered as a possible factor in the induction of asbestos cancers.⁴¹

Naturally Occurring Effects in Lower Animals. No evidence appears to exist that domestic or wild animals can provide criteria for standards,



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or for controlling asbestos emissions, although a few confirmatory reports have been made that asbestosis can occur in such animals. Webster⁴² has demonstrated fibrosis with associated asbestos bodies and fibers in wild rodents in South Africa, in one of a troop of baboons, and in two donkeys that had either worked in, or lived around, crocidolite mines or mills. And Schuster⁴³ reported pulmonary asbestosis, without asbestos bodies, in a dog that had lived for about 10 years in a London asbestos factory as a rat catcher. The magnitude or the type of exposure was not reported in any instance.

Factors Influencing Pathogenesis-- Experimental Animal. Experimental animal studies have been informative in elucidating the factors that modify or explain the biologic action of asbestos. At least six factors have been investigated: (1) fiber length and bundle size; (2) cytotoxicity; (3) red cell hemolytic activity; (4) asbestos hydrocarbons; (5) morphologic changes; and (6) trace metals in asbestos.

(1) Fiber length and bundle size. The relation between length of fibers and of fibers to motes (nonfibrous particles) and asbestos induced disease has been one of continuing experimental inquiry. Gardner and Cummings³⁴ and Gardner⁴⁴ found that longer fibers appeared to have a greater fibrogenic effect, although fibrosis developed in animals exposed to dusts which were composed of but one to 1.5 percent fibers. The high exposure concentration of 100 mppcf (ca. 3,600 fibers/cc) makes any decision on the relative potency of fibers vs. motes virtually impossible; however, when animals were exposed to short-fiber asbestos dust, although the type and rate of tissue reaction

were essentially the same, the extent of involvement was very much less than that of longer fibers. Inasmuch as exposure concentrations in these comparable studies were about the same, the conclusion can reasonably be made that longer fibers are more fibrogenic, but that the motes are not without fibrogenic potential.

In experiments with rabbits, King, Clegg, and Rae⁴⁵ using Rhodesian chrysotile fibers averaging 2.5 μm and 15 μm in length, concluded that the shorter fibers produced generalized interstitial fibrosis, whereas the longer fibers produced nodular lesions. This finding was not confirmed by one of the investigators (King) in another animal species.⁴⁶ Later repetition of the investigations, with "fine" chrysotile and amosite (85% and 82.6% respectively, less than 1 μm in length) by Wagner⁴⁰ yielded definite fibrosis with both dusts, thus confirming the original work of Gardner that short fibers or motes have fibrogenic potential.

This experimental work has significance for industrial air standards in indicating the need to support additional research on the "greater than 5 μm in length" specific requirement and the more general relation of fiber length to cancer induction, which has never been determined experimentally.

(2) Cytotoxicity. Both chrysotile and crocidolite were found to be markedly toxic to guinea pig macrophages in vitro.⁴⁷ The fibrous fraction showed a high, and the particulate, a moderate toxicity, thus providing evidence in conformity with the relative biologic potencies of fibrous and nonfibrous forms found in vivo studies.

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(3) Hemolytic Activity. In a similar effort to discover the initial stages of biologic activity of asbestos, and in particular to account for the iron-staining character of asbestos bodies, the hemolytic action of four asbestos types was determined. Whereas chrysotile proved to be potently hemolytic, crocidolite, amosite and anthophyllite were either completely inactive or only weakly.⁴⁸ No attempt was made, however, to correlate the greater hemolytic activity of chrysotile with the iron-staining intensity of its asbestos bodies relative to those from other asbestos forms.

(4) Asbestos Hydrocarbons. As chrysotile proved to be most adsorptive of iron, so was it most adsorptive of benzpyrene; compared with 100% adsorption for chrysotile, crocidolite and amosite absorbed from solution 40% and 10% respectively.⁴⁹ On this basis, chrysotile should prove the most potent cocarcinogen of the three forms if its action is mediated through exogenous benzpyrene. This has not been demonstrated as yet in humans. A 10% desorption from chrysotile by serum in three days was demonstrated,⁴⁹ a condition considered an essential first step in hydrocarbon carcinogenesis.

(5) Morphologic Changes. Electron microscopy of animal tissues has greatly enlarged understanding of the processes that occur following contact of pulmonary cells with asbestos. Examination by light, phase, and electron microscopy by Suzuki and Churg⁴⁹ of subcellular tissue of hamsters intratracheally exposed to chrysotile revealed the successive steps that occurred in the cytoplasm of certain pulmonary cells. Particularly informative for the mode of chrysotile action was the description of the formation and the ultrastructure of the asbestos

body, and the indication that instilled fibers tend to split longitudinally with time. The suggestion that chrysotile breaks up into short fragments on the evidence that the majority of the fibers found in the alveoli were less than one-sixth the injected length, one and two years later, is open to the alternative interpretation that, inasmuch as longer particles are more readily phagocytosed, what is actually observed is the residual, smaller, nonphagocytosed chrysotile.⁵⁰ Thus, despite the detailed, in-depth information furnished by electron microscopy, no body of knowledge yet exists that permits the assigning of relative risk factors to fibers of differing lengths.

In respect to asbestos bodies, it should be noted that "ferruginous bodies" produced in guinea pigs in response to other fibrous material, fine fibrous glass and ceramic aluminum silicate were identical in fine structure to that of asbestos bodies,⁵¹ thus rendering firm diagnostic decisions difficult in cases of multiexposures to different fibrogenic fibers in the electron and light microscopic range.

(6) Trace Metals. Harington and Roe⁴¹ and later Cralley *et al.*⁵² reported large amounts of nickel, chromium, manganese, and iron are intimately associated with certain forms of chrysotile. On the possibility that trace metals may be associated with the induction of asbestos, cancer studies in animals were performed⁵³ which supported the hypothesis that, in the induction of asbestos cancers, trace metals play an active cocarcinogenic role along with the exogenously derived carcinogen benzpyrene, while asbestos plays a passive role as a metal carrier.

Correlation of Exposure and Effect

Available information on the relationship of asbestos exposure and the risk of asbestosis and/or bronchogenic carcinoma is somewhat

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extensive, indicating a strong association between the diseases and such exposure under a variety of conditions^{2,15,22,28} and evidence of dose-response relationship.

Enterline and associates⁵⁴ have recently demonstrated convincing evidence for an exposure-response relationship between asbestos as measured in terms of million parts per cubic foot years (mppcfyr), and the risk of malignant and non-malignant respiratory disease. Specifically, the risk of respiratory cancer increases from 166.7 (standardized mortality ratio) at minimal exposures to 555.6, at accumulative exposures in excess of 750 mppcfyr (Table XXX).

Knox et al.²⁷ suggested that in one asbestos plant where environmental levels varied between 1 and 8 particles/cc > 5 μ m in length, the risk to bronchial carcinoma may have been largely eliminated, but that insufficient data were available to estimate the extent of the risk that may remain. The different textile operations were fiberizing, carding, spinning, weaving, and plastering. When environmental samples collected by operation in 1961 and 1966 were summed, the averages were between 4 to 6 fibers/cc. Operational averages were from a low of 2.5 fibers/cc in weaving to a high of 6.5 fibers/cc in carding.

In 1968, Balzer and Cooper⁵⁵ reported asbestosis among insulation workers exposed at levels not exceeding the time-weighted average of 5 mppcf.

McDonald et al.⁵⁶ reported in May 1971, on 129 primary thoracic neoplasms in the workers employed in Quebec chrysotile asbestos mines and mills out of a total of 9304 former employees; five of these cases were mesothelioma. The authors concluded that the additional data

supports evidence of other studies that even heavy exposure to asbestos in mining and milling carries only modest risk of contracting lung cancer and less still of contracting malignant mesothelioma. McDonald et al. suggest that any increased risk of respiratory cancer or pneumoconiosis at a dust-index below 200 would not be detectable and would still be in doubt below 400. At a dust index of 200 an employee could work for 40 years at a dust concentration of 5 mppcf. The author assumes that the fiber content of the dust is about 10% and he states that this is equivalent to about 12 fibers/cc.

Wright⁵⁷ pointed out that others have noted the striking differences in the health experiences of workers in mines and mills as compared to other workers, specifically in comparison to insulation operations, but that he felt the question was still unresolved. In contrast to populations exposed to mixed environments, those engaged in the mining and milling of asbestos fibers showed no augmented frequency of bronchogenic cancer.²

Selikoff,¹⁵ however, indicated that McDonald's "heavily exposed" group had 5 times as much lung cancer as the "lightly exposed" workers. Furthermore, lung cancer among insulation workers was found to be about 7 times greater than expected compared to the general non-exposed population.¹⁵ A non-exposed group was not reported by McDonald.⁵⁶

Although it has been suggested that the risks associated with asbestos exposure may be less in mining than in industrial operations, additional study will be necessary to confirm if such is true, based upon the comparison made by Selikoff.¹⁵

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Consideration must be given to McDonald's analysis of levels of exposure of 12 fibers/cc. At this level, he assumes that some degree of asbestosis may occur. The mathematical assumption made to arrive at this environmental level leaves a great deal to question, even without attempting to relate this information to the asbestos industry in general. Two primary considerations lack the evidence necessary to make general comparisons of these data with other reported work: the assumption as stated by McDonald⁵⁶ that the fiber content of the dust is 10%, and the method used to convert from mppcf to fibers/cc is not explained in the paper.

Murphy et al.⁵⁸ found that asbestosis was 11 times more common among pipe coverers in new ship construction than among a control group. The asbestosis was first found after 13 years of exposure or about 60 mppcf years. The prevalence was 38% after 20 years. The asbestosis was defined by the presence of at least three of the following signs: (1) basular rales in two or more sites, (2) clubbing of the fingers, (3) a vital capacity of less than 80% of the predicted, and (4) roentgenography consistent with moderately advanced, or advanced asbestosis, and (5) dyspnea on climbing one flight of stairs. The environmental level was based upon samples collected in an impinger and all the results were time-weighted average exposures and these were averaged over several different operations. The highest average concentration was with hand-saw cutting at 10.0 mppcf and the lowest average was 0.8 mppcf when mixing mud. The average of all operations was 5.2 mppcf. One-hundred and one workers were

in the exposed group with 94 used as controls matched for age, duration of employment and smoking habits. Both amosite and chrysotile were used in these operations while crocidolite was not. Murphy states that in his study no asbestosis was found for men exposed to 60 mppcf-years while 20% of those exposed for 75 to 100 mppcf-years were considered to have asbestosis. Consideration must be given to averaging the time-weighted average values of the environmental samples over what seem to be several different sampling locations or operations. Were workers who were classified as suffering from asbestosis exposed in the hand-saw cutting, or mixing mud, or both, and for what time interval? Answer to this question would have a major effect upon the relationship between the development of asbestosis and environmental levels, and the relation of these impinger counts to fibers/cc.

In a recent unpublished paper, Williams, Baier, and Thomas compiled data from the Pennsylvania Department of Health files on exposure levels at various textile processing operations in two plants. The data included dust concentrations from 1930 through 1967 in one plant and from 1948 through 1968 in the second plant. Even though controlled exposures were for the most part below 5 mppcf and in many cases below the 1968 ACGIH Notice of Intended Change to 2 mppcf, 64 cases of asbestosis were reported from these two asbestos textile plants. The authors conclude that: "If asbestosis is to be prevented, airborne asbestos dust must be stringently controlled in the working environment. From these data a TLV of 3 mppcf would provide inadequate protection and the proposed 2 mppcf may not be substantiated."

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Thus, considerable evidence exists indicating that the prevention or reduction of the occurrence of asbestosis among workers requires that the concentration of asbestos fibers to which they are exposed be reduced.

There is at this time, however, only scant correlation of epidemiological data with environmental exposure data upon which a definitive standard can be established.

Champion²⁶ reported two cases of malignant mesothelioma in two men, 31 and 32 years old, following exposure to asbestos. In the first case, the only documented exposure of the patient was from his father, who at 68 years of age, had severe asbestosis following employment as a pipe lagger in Scotland. In this case, no special precautions were taken to protect the children from contact with the father's work clothing, which was washed at home. The man smoked about 20 cigarettes per day for sixteen years and had a brief history of breathlessness and other signs which could have been related to asbestos exposure. The second case involved a patient who had moved to Asbestos, Quebec, where he lived for the next 23 years. This patient had worked for 10 years as an asbestos prospector and had worked for a short period in open-pit mining. Seven years before his death in 1968, he moved away from the area and became a salesman in a department store. The patient smoked 20 to 30 cigarettes per day for 14 years. In this case, it was believed that he was exposed only to chrysotile and primarily in mining operations. Champion's two cases seem to support earlier data of family cases¹⁵ with reasonably short and/or low levels of exposure.

Murphy et al.⁵⁹ presented data concerning two cases of workers exposed to asbestos. One case on biopsy confirmed mesothelioma and the other case had extensive pleural calcification. Both workers had frequently sanded asphalt and vinyl tile floors prior to installation of new floor covering. A technique to simulate normal work practice was developed and levels of 1.2 and 1.3 fibers/cc $>5 \mu\text{m}$ in length resulted. The authors noted that under other work conditions these values may be higher. In the case involving mesothelioma, the worker was 44 years old and had no other history of occupational exposure to asbestos, although he had worked in a shipyard in a "non-dusty" gyroscope repair area from 1945-1947. The repair area would practically have to be considered a clean room operation in view of the precision involved in gyroscopic instrument repairs. He had smoked one package of cigarettes a day between the ages of 17 and 30 and had worked from 1948-1967 as a floor tile installer. The second case involved a 61-year-old worker who had been a floor tile installer for the last 30 years and had smoked one pack of cigarettes per day for the last 45 years. This second patient had no history of other asbestos exposure different from the first; however, some question may be raised of a possible neighborhood exposure even if it only concerned going to work. The possibility of such exposure must be considered in view of the neighborhood case noted by Selikoff,¹⁵ Table XXIX.

The possibility of the development of asbestos-related diseases in floor tile installation must be considered, and special attention must be given to this operation when considering the low levels of

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exposure that may be related to these two cases. If even in actual practice, levels were found to be 10 times those found by the investigators, it would substantiate the low levels of exposure recommended in this standard. The time interval for sanding as compared to tile installation must be small, and, if this is true, then, in fact, any level found would be very low if based on a time-weighted average exposure. This increases the weight of consideration that must be given to this possibly exposed occupational group and the relationship of these low exposures to asbestos to the development of disease.

Consideration must also be given related to the effect that may have resulted from exposure to other material in the floor tile. The level of, and effect of such material as asphalt and any decomposition products from sanding must be considered.

Isolated clinical case reports are difficult to interpret in terms of dose-time response relationship and can only be used to indicate other possible problem areas and to highlight what may prove to be practicable areas for further study.

The use of asbestos has changed with the addition of new products and with changes in the industrial processes. These changes and a growing awareness of the health effects from exposure of the worker to asbestos have resulted in a changing work environment within the asbestos industry. The lack of environmental data for previous years and the changes in technology used to collect samples, now and in the past, have resulted in the availability of comparable environmental data for only the last few years. Thus, the scant data and the long latent period for the development of bronchogenic cancer and mesothelioma do not permit the establishment of the dose-response relationship at this time. However, as has been indicated, the development of the diseases has been proven in workers exposed to asbestos and environmental data does exist for the last several years.

Table XIV shows the average concentration of asbestos fibers to which a number of insulation workers were exposed in 1969. The results shown are not time-weighted averages, but are averages of concentrations found for individual exposures during the time samples were collected (usually 15, 30, or 60 minutes). Although the average concentrations are reasonably low, with the exception of spraying, individual exposures varied from 0 to 100 fibers/cc. The latter occurred during a 60-minute period while a workman sprayed asbestos fiber on a turbine.

McClure⁶⁰ summarized results of a preliminary survey conducted by the U. S. Department of Labor during the period July, 1969, to January, 1970, at nine private shipyards as follows: 37 of 74 samples

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collected during various operations of preparing and applying insulation were above 2 fibers/cc (50%) and 19 of 74 were about 12 fibers/cc (26%). These were not time-weighted average exposures, but represented average fiber concentrations during the sampling period. Furthermore, none of these samples represented workers' exposures while tearing out old insulation and lagging--an operation that has been previously found to produce more dust than the application of the insulation.

A summary of some of the environmental data collected by NIOSH is presented in Table I through XII. The environmental data presented in this document represent only that collected in the last few years and reported in fibers/cc $\geq 5 \mu$ m as counted by phase contrast light microscopy. As pointed out by Ayer *et al.*⁶¹, "It is obviously impossible to give any single ratio that would accurately represent all processes at all times in each plant." As a result, little correlation, if any, can be made between early data (collected with an impinger where settled particles were counted) with current data (collected with a personal sampler and counted under a microscope equipped with a 16 mm 10X objective).

These data represent only the levels found during the time the samples were actually being taken. The sampling times were usually between 15 minutes to one hour, and should not be considered as time-weighted average exposures even though credence could be given to this approach due to the large number of samples collected.

Levels of exposure in the manufacture of asbestos are given in Table I through XII. In a total of 7 asbestos cement pipe plants, a range of individual samples was from 13.4 in coupling finishing, to levels too low to count in pipe forming, curing, pipe finishing,

coupling finishing, packing and miscellaneous operations (Table I).

It should also be noted in Table I that when consideration is given to feasibility of engineering control, in coupling finishing, the individual highest sample was 13.4 and the lowest and second lowest samples were zero. Warehousing and mixing (6.3 fibers/cc $\times$ 5 μ m) and packing (6.1 fibers/cc $\times$ 5 μ m) were the highest means by operation (Table II), and the lows were both 0.4 fibers/cc $\times$ 5 μ m. These data indicate the possibility of controlling these operations to below the proposed standards.

These wide ranges of individual samples and means by operations were also shown in asbestos friction plants (Tables III and IV), cement shingle, millboard, and gasket operations (Tables V and VI), insulation (Tables IX and X), and from asbestos paper, packing and asphalt products (Tables VII and VIII).

In textile operations, while the individual low and second lowest concentrations were, in all cases, below 1.0 fiber/cc (except fiber preparation, 1.4 fibers/cc), the means by operations exceeded 2.0 fibers/cc in fiber preparation (7.4 fibers/cc), carding (6.1 fibers/cc), spinning (3.7 fibers/cc), and twisting (3.2 fibers/cc). In the second lowest group, all operations except finishing exceeded 2.0 fibers/cc. These values, when considered with the highest means and highest individual samples (143.9 fibers/cc in carding and 123.2 in weaving), indicate that present methods of control practiced in the textile industry are not adequate for the standard proposed.

This is probably true in insulation operations as well. Even though levels were below the level of 2.0 fibers/cc $\times$ 5 μ m, the individual samples and operational means were high.

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The individual sample high (Table IX) was 208.4 in finishing and 188.9 fibers/cc in mixing. Table XXV shows that in at least one insulation plant, 100 percent of all samples taken were less than or equal to 2 fibers/cc $>5 \mu\text{m}$, and in one other, all but the mixing operations met the 5 fibers/cc $>5 \mu\text{m}$ value. In textiles, under present operating conditions, none of the plants met the 2 fibers/cc $>5 \mu\text{m}$ criteria (Table XXV). This does not imply that industry could not meet the proposed standard of a time-weighted average exposure of 2.0 fibers/cc $>5 \mu\text{m}$, but only that it is not meeting it at the present in the insulation and textile plants, and it probably could meet the standard if given time to clean-up the plant operations.

Secular trends indicate that there is a wide variation between a few samples taken over large intervals of time. The evaluation of these trends, if indeed they are trends, would be open to question. However, it does point out that much can be done in the improvement of plant operations. It is not reasonable to associate these differences with changes in field sampling methods, counting techniques, or locations of sampling devices when similar trends are not apparent in cement pipe (Table XV), friction (Table XVI), or shingle, millboard and gasket operations (Table XVII). Variation in trends in insulation and textile plants (Tables XIX to XXI) indicate stable plants in some areas and not in others. The comparatively low values in textiles is somewhat surprising.

At most of the operations in the well-controlled plants, it is possible to meet the proposed standard with only small changes in engineering practices (Table XII). This is also true to a lesser degree

in friction operations (Table XXIII), and shingle, millboard, and gasket operations (Table XXIV), and true in only a few operations in textiles and insulation operations (Tables XXV-XXVI).

It must be noted that in asbestos plants having the same operations, some have been able to meet the proposed standard, while others have exhibited environmental values at higher levels, which suggests the need for engineering control - not the lack of engineering feasibility to meet the standard.

It will not be easy to control exposure in the insulation and textile industries, where higher levels of asbestosis, lung cancer, and mesothelioma are known to occur. There is a high priority requirement to protect the workers in these industries to assure that excessive asbestosis, lung cancer, and mesothelioma will not continue and, at the same time, give the worker the type of protection that is required at once. Table XIII gives an indication of the dramatic reduction in time-weighted average exposures that could be accomplished if peak or ceiling exposures were eliminated. In this case, reducing the peaks in insulation operations to the ceiling of 10 fibers/cc reduced the time-weighted average to near 2 fibers/cc.

V. DEVELOPMENT OF STANDARD

Various criteria have been used for categorizing the dustiness of the environment. Recent developments have made it clear that a method utilizing the capture and direct estimation of fibers of asbestos should be utilized for environmental measurement of exposure to asbestos. In the past, in the United States, asbestos fibers were measured by the impinger method which included counting particles as well as asbestos fibers.

The question still exists as to whether or not different varieties of asbestos fibers may have varying biological effects. This will not be answered until more definitive information is available on the specific etiological agent(s) and mechanisms of injury involved. The consumption of asbestos in this country is overwhelmingly in the form of chrysotile. Where other forms of asbestos are used, such as crocidolite and amosite, they are often mixed with chrysotile and are encountered alone, mainly in research and specialty situations. It would be extremely difficult on the basis of current information on biological effects and industrial practices to establish and administer separate standards for different types of asbestos.

The question also arises on the validity of basing standards on the number of respirable fibers in the air greater than 5 micrometers in length. It is fully realized that the fiber-size spectrum of respirable asbestos fibers in any particular industrial environment will range from that of bundles of fibrils in the upper respirable size to those of the individual fibrils in the sub-micron size. The type and grade of fibers, nature of processing, and controls in existence will greatly

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influence the fiber-size spectrum (fiber length and diameter) in any given environment. The problem is further complicated by the lack of definitive information on the biologic response to fibers of different sizes. It is known, however, that the longer fibers show a dose-response relation to asbestosis, and may have a different behavior and degree of response than the shorter size fibers which may, in the lower and sub-micron range, tend to resemble more the physical behavior of non-fibrous respirable particulates. Since it would not be feasible to have a standard on the total respirable fibers which would necessitate the routine use of expensive and time-consuming techniques including electron microscopy, an index of exposure must be selected which, as nearly as possible, relates to the predominant biologic activity and dose-response of the size spectrum of fibers most commonly encountered. It is assumed for the present that the factor of safety associated with the standard will allow for differences in the size spectrum of respirable fibers that may be encountered.

The British, in evaluating respirable chrysotile fiber exposures in relation to the ongoing epidemiologic studies in the textile industry and for the basis of a standard for chrysotile, established as an index of exposure, fibers greater than 5 micrometers in length.⁶² A substantial amount of information on the biologic effects of asbestos has, and is, being obtained using this parameter of exposure measurement. A review of the research in Britain, with concurrence on the rationale involved, made it prudent that we use the same definition of index-of-exposure on which to base criteria for standards. These criteria should be re-evaluated when,

(1) more definitive information on the biologic response of asbestos including the agent(s) and dose-response data on different lengths of fiber is

available, (2) the spectrum of fiber lengths encountered in industry by types of asbestos and operations is ascertained, and (3) more precise epidemiologic data are developed.

To prevent fibrosis and excessive rates of neoplasia, such as mesothelioma, respiratory cancer, and gastrointestinal cancer, a standard for asbestos dust should be based on a concept of dose-response that includes not only the factor of fiber count times years of exposure but also that for total asbestos dust fibers retained over a number of years.

Thus, the effect after several decades of a one-time acute dose of limited duration which overwhelms the clearing mechanism, and is retained in the lungs, may be as harmful as the cumulative effect of lower daily doses of exposure over many years of work.

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Basis for Previous Standards

The first standard for controlling exposure to asbestos dust was recommended by Dreessen et al.⁶³ in 1938 following a study of 541 employees in four asbestos textile plants where massive exposures occurred. A tentative limit for asbestos dust in the textile industry of 5 million particles per cubic foot (mppcf), determined by the impinger technique, was recommended. They found numerous well-marked cases of pneumoconiosis where concentrations exceeded 5 mppcf, but only three doubtful cases where concentrations were under 5 mppcf. However, only five persons had been exposed for more than 10 years to concentrations from 0.0 to 4.9 mppcf. None of the 39 persons exposed to concentrations below 2.5 mppcf showed evidence of asbestosis; but only six of these had been employed more than five years.

The study by Dreessen et al. had unavoidable limitations such as the fact that 333 of the 541 employees studied had worked less than five years in these textile mills, only 66 were employed as long as 10 years, and only 2 for more than 20 years. Furthermore, the average age of these asbestos textile workers was 32.1 years and only one of the four plants studied had been in operation for more than 15 years. Thus, the first standard established was based upon limited data. The authors recognized the limitations and stated that . . . "5 mppcf may be regarded tentatively as the threshold value for asbestos-dust exposure until better data are available."

The American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Value (TLV) for asbestos dust was 5 mppcf

from 1946 to 1970. This limit was based on the study by Dreessen et al.⁶³ and subsequent investigations by others. In 1968 and 1969, ACGIH published notices of intended changes to lower the TLV to 12 fibers/ml $>5 \mu\text{m}$ in length or 2 mppcf and they published in 1970 and 1971 a still lower limit of 5 fibers/ml $>5 \mu\text{m}$ in length as a notice of proposed intended change. The conversion of data from mppcf to fibers/ml in all asbestos operations can only be done with considerable risk to the validity of the results. Lynch et al.⁶⁴ pointed out in 1970 the need for such conversion data and that the data reported in 1965⁶¹ of the 12 fiber/ml equivalent to 2 mppcf relationship was obtained in textile mills and should not be applied to other product areas. Estimates of risk of disease in other product areas should be based on fiber counts since this method yields a more direct estimate of airborne asbestos concentration.

In 1968, the Committee on Hygienic Standards of the British Occupational Hygiene Society (BOHS) after reviewing medical evidence, results of studies made by the asbestos industry in the United Kingdom, and epidemiological data from the United States, published Hygienic Standards for Chrysotile Asbestos Dust.⁶² It stated:

"1. As long as there is any airborne chrysotile dust in the work environment there may be some small risk to health. Nevertheless, it should be realized that exposure up to certain limits can be tolerated for a lifetime without incurring undue risks.

"2. The committee believes that a proper and reasonable objective would be to reduce the risk of contracting asbestosis to 1 percent of those who have a lifetime's exposure to the dust. By 'asbestosis'

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this committee means the earliest demonstrable effects on the lungs due to asbestos.

"It is probable that the risk of being affected to the extent of having such early clinical signs will be less than 1 percent for an accumulated exposure of 100 fiber years per cm^3 or 2 fibers/ cm^3 for 50 years, 4 fibers per cm^3 for 25 years or 10 fibers per cm^3 for 10 years.

"3. It is recommended that exposures which lie in certain ranges of dustiness be designated by categories according to the following scheme:

DUST CATEGORY	CONCENTRATION AVERAGED OVER 3 MONTHS (FIBERS/ cm^3)
Negligible	0-0.4
Low	0.5-1.9
Medium	2.0-10.0
High	Over 10.0

"4. The levels are expressed in terms of the number of fibers per cm^3 greater than $5\ \mu\text{m}$ in length as determined with the standard membrane filter method. Any other method can be used provided it is accompanied by appropriate evidence relating its results to those which would have been obtained with the standard membrane filter method.

"5. When it is necessary to work intermittently in a 'high dust' area an approved mask should be worn, provided that the concentration is no more than 50 fibers per cm^3 a higher standard of respiratory protection should be provided such as a pressure-fed breathing apparatus.

"Additional Recommendations

"1. It is recommended that where practicable an up-to-date employment record card be kept of every person which indicates, every calendar quarter, the category or categories in which he or she has been employed and in which he or she is recommended to work.

"2. All employees exposed to risk should be medically examined before employment. Periodic examinations should be made thereafter, annually.

"Notes:

"These hygienic standards are subject to review in the light of new evidence and improved methods of measurement.

"The standards are, in our opinion, the best that can be drawn from the existing data. These data are scanty and based on factory experience of continuous exposure during working hours. Due caution should be exercised in applying these standards to other patterns of exposure. As far as possible the dust exposures have been estimated conservatively and, in particular, in the period 1933-1950 the average hours of work were substantially greater than 40 per week.

"It is hoped to supplement the existing data in due course, when the standards will, if necessary, be modified. These standards will be formally reviewed in three years."*

In an unpublished paper, Williams, Baier, and Thomas compiled data from the Pennsylvania Department of Health files on exposure levels at

*As of 1/6/72 their standards as effective in May 1970 had not been revised. Per telephone conversation with Dr. S. Holmes, Secretary to the Asbestosis Research Council.

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various textile processing operations in two plants. Their data included dust concentrations from 1930 through 1967 in one plant and from 1948 through 1968 in the second plant. Even though controlled exposures were, for the most part, below 5 mppcf and in many cases below the 1968 ACGIH Notice of Intended Change to 2 mppcf, 64 cases of asbestosis were reported from these two asbestos textile plants. The authors conclude that: "If asbestosis is to be prevented, airborne asbestos dust must be stringently controlled in the working environment. From these data a TLV of 3 mppcf would provide inadequate protection and the proposed 2 mppcf may not be substantiated."

Gee and Bouhuys,⁶⁵ in December, 1971, pointed out that on the basis of "reasonable probability," decisions must be made to control exposure to asbestos rather than from a precise definition of dose-response relationship, and "the present threshold limit value for asbestos should be lowered far below some recent proposal."

U. S. Emergency Standard

The present emergency standard for exposure to asbestos dust (29 CFR 1910.93a) published in the Federal Register, Vol. 36, No. 234, page 23207, December 7, 1971) is as follows:

"The 8-hour time-weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed 5 fibers per milliliter greater than 5 microns in length, as determined by the membrane filter method at 400-450X magnification (4 millimeter objective) phase contrast illumination. Concentrations above 5 fibers per milliliter but, not to exceed 10 fibers per milliliter, may be permitted up to a total of 15 minutes in an hour for up to 5 hours in an 8-hour day."

The 1971 ACGIH tentative threshold limit value is 5 fibers/ml > 5 μ m in length. Both are higher than the British standard of 2 fibers/cc by at least a factor of 1.5 times.

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Basis for Recommended Standard

The number of studies that have collected both environmental and medical data and with a significant number of exposed workers is not sufficient to establish a meaningful standard based upon firm scientific data. The requirement to protect the worker exposed to asbestos is defined in a number of studies outlined in this document. The general recognition of the increasing number of cases of asbestosis, bronchogenic cancer, and mesothelioma indicates the urgent need to develop a standard at the present time.

NIOSH recognizes that these data are fragmentary and, as a result, a safety factor must be included in any standard considered. On this basis the research that did include both environmental and medical data, or where a standard or limit had been proposed, was given a careful and detailed study to determine its particular contribution to the development of a national standard.

The development of a standard for asbestos dust⁶⁶ in Great Britain and the evaluation made by the British Occupational Hygiene Society (BOHS) Sub-committee on Hygiene Standards for Asbestos,^{62,66} which considered data to reduce the risk of asbestosis, was given great weight in the development of this asbestos standard. The BOHS fitted the data available to a dose-response curve and the conclusion was drawn that an accumulated exposure of 100 fiber-years/cm³ would reduce early clinical signs to less than 1%. This would be 2 fibers/cm³ for 50 years of exposure or 4 fibers/cm³ for 25 years. According to Roach,⁶⁷ "The British Occupational Hygiene Society Standards Sub-committee on Asbestos expressed the view that a proper and reasonable objective would be to reduce exposures to below this level and thereby reduce the risk of

contracting asbestosis to less than 1% of those who have a lifetime exposure to the dust. For such workers, who may possibly work for 50 years, the long-term average concentration to which they are exposed would need to be less than 2 fibers/cm³. For others, who will be exposed to asbestos dust in air for shorter periods, the long-term average concentration need not be so low, as long as their exposure will amount to less than 100 fiber-years/cm³."

It is recognized that the British standard is based upon data not as precise as desired, but it does offer a mechanism for comparison with the ACGIH TLV and after three years of use no change has been recommended. The British standard was primarily based upon a study of 290 men employed for 10 years or longer between 1933-1966 in an asbestos textile mill. The environmental dust concentrations to which different workers had been exposed were estimated to have varied from 1 to 27 fibers/cm³. The risk-exposure relationships were developed based upon basal rates and X-ray changes. In this study, basal rates were considered the key symptom since all workers exhibiting X-ray changes also exhibited basal rates.

In reviewing the values on the basis of the 100 fiber-years/cm³ proposed by the British Hygiene Standards Committee, the following comparisons can be made between the British Standard and the Emergency U. S. Standard. Each standard is normalized to 100 fiber-years to account for differences in the working lifetime of the average asbestos worker. The Emergency U. S. Standard is based upon the ACGIH TLV which, in turn, is based upon an exposure time of 30 years to 5 fibers/ml > 5 um in length⁶⁸,

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and the British, 50 years of exposure at 2 fibers/cm³ > 5 μ m in length.

In summary:

	<u>British</u>	<u>U. S. Emergency ACGIH</u>
	2 fibers/cc	5 fibers/ml
Fiber- yrs/cc	100	150

The validity of this type of comparison has already been questioned in this document, i.e., the "K" factor used to change ACGIH impinger data to fiber counts.^{61,64}

However, on this basis, data suggest that the ACGIH value is higher than the British value.

In addition to consideration of the British data, the comparison of British and ACGIH data suggests that the 30-year exposure value for a U. S. Standard should be about 3 fibers/cc 5 μ m in length in order to assure that less than 1% of the workers exposed are at risk of developing the earliest clinical signs of asbestosis.

However, additional consideration must be given to the concepts of carcinogenesis as they relate to the determination of a standard for asbestos exposure. Any carcinogen (initiator) must be assumed, until otherwise proven, to have discrete, dose-dependent, irreversible and additive effects to cells that are transmissible to the cell progeny. Thus, initiation of malignancy following single small exposures to asbestos is possible, but of a low probability. With frequent or chronic exposure and a low dose-rate, the probability of initiation of malignancy is increased. Yet, even under optimal conditions of cell proliferation (in the presence of promoters) these malignant

transformations do not lead to instantaneous cancer, but remain insidious for a number of years (latent).

In protracted exposure, some of the total accumulated exposure is "wasted" (or irrelevant) as far as the initiator of cancer is concerned. Exposures in excess of the minimal initiation dose conceivably may shorten the latent period to some extent by substituting for other contributing factors that would have eventually been effectual in converting the latent tumor into a frank malignancy. Analytic methods used in the epidemiology of asbestos-induced cancers are unable to discriminate between the initiating dose and subsequent (wasted) exposure.

Consideration must also be given to the concept that an inverse relationship exists between dose-rate and the latent period. As the dose-rate becomes progressively lower, the latent period may approach or exceed the life span of exposed individuals.

Adherence to these concepts would argue toward reducing asbestos exposure substantially below those levels currently demonstrated to be associated with the disease. Such a course of action is consistent with the Surgeon General's ad hoc Committee on Evaluation of Low Levels of Environmental Chemical Carcinogens statement that, "for carcinogenic agents, a safe level for man cannot be established by application of our present knowledge."

Work practices in industries should be encouraged to develop work practice standards by the consensus method so that the lowest feasible environmental levels can be obtained. The following work practice standards are included in the emergency standard for asbestos and are included in the recommended standard:

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(a) Asbestos cement, mortar, coatings, grout, and plaster shall be mixed in closed bags or other containers.

(b) Asbestos waste and scrap shall be collected and disposed of in sealed bags or other containers.

(c) All cleanup of asbestos dust shall be performed by vacuum cleaners or by wet cleaning methods. No dry sweeping shall be performed.

The need in industry for a proper precautionary label for asbestos and for other hazardous materials associated with the mining, production, and use of chemical compounds has existed for a number of years. The development of a labeling system for use as an occupational hazard warning system overlaps into so many other labeling areas, e.g., transportation of chemicals, fire fighting, use by the military, etc., that it would be necessary either to develop a separate system for use in relation to occupational exposures only, or to combine all the present systems into one.

The addition of one more labeling system compounds the multi-labeling requirement presently imposed on industry and creates one more labeling system the worker must recognize. Combining all systems into one requires the coordination of many governmental, professional, trade, manufacturing, and international and local organizations. Time required to accomplish this task is prohibitive in relation to the requirement for the immediate development of an occupational health standard for asbestos. As a result, NIOSH recommends as an interim system the adoption, with modification, of the system for the Identification of the Fire Hazards of Materials of the National Fire Protection Association and the Guide to Precautionary Labeling of

It is recognized that this system may not be the most appropriate system and may require additional development to permit the worker, himself, to use it to identify the hazards to which he is exposed and to learn the necessary precautions to assure him safe working conditions. (See Appendix II for the details and modification of the labeling system).

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Summary of the Basis for the Recommended Standard

The recommendation for an environmental standard for asbestos is based upon health considerations and limited engineering feasibility data. The overriding considerations are the health effects.

Evidence indicates that past and current standards for fiber concentrations in the working places where asbestos fibers occur, though undoubtedly contributing to reduction of the severity and frequency of asbestosis, have not provided complete protection from exposure to asbestos, necessitating development of a new standard.

Consideration was given to previous reports and studies, recent data, and the present "state-of-the-art." It is recognized that additional data would be desirable to support an asbestos standard, but because of immediate need for worker protection, it is necessary to make a recommendation based on available studies and data. The following constraints in applicability of research data were considered in the development of the recommendations:

(a) Few epidemiological studies or clinical reports with supporting environmental data are available in the exposure range that must be considered.

(b) Environmental data on practically all studies were collected only over the last few years and/or they were collected by other techniques and expressed in terms other than fibers/cc.

(c) The environmental samples were expressly collected in many cases for control purposes rather than for research and, as a result, meaningful evaluations cannot be made.

(d) There is a lack of data to define with any degree of precision the threshold of development of neoplasms resulting from exposure to asbestos and the relationship of the latent period between exposure and development of neoplasms.

The standard recommended in this document is similar to the standard adopted by Her Majesty's Factory Inspectorate in 1969⁶⁶ (still in effect as of December 29, 1971), and more stringent than the recent U. S. Emergency Standard. It is felt to be feasible technologically for the control of the exposure to the worker and effective biologically for protection of the worker against asbestos-induced diseases.

Considerations of carcinogenesis indicated the need for a measure of prudence. As a result of this rationale, a factor was added to reduce the time-weighted average exposure to 2.0 fibers/cc > 5 μ m. A ceiling value of 10.0 fibers/cc > 5 μ m that was not to be exceeded was included to reduce the possibility of the short-term heavy exposures to asbestos that have been reported to cause mesothelioma. In addition, this should reduce the likelihood of diseases (malignant and non-malignant) resulting from exposures in excess of 30 years or with very long latent periods.

VI. COMPATIBILITY WITH EMISSION STANDARDS

The proposed national emission standard for asbestos was published in the Federal Register, Vol. 36, No. 235, pages 2342-2343 (40 CFR 61.20-61.24) by the Environmental Protection Agency. The emission standard will be applicable to asbestos mines, mills; building structures, or facilities within which manufacturing or fabricating operations involving the use of commercial asbestos; buildings or structures which have been or will be constructed or modified using asbestos insulation products; roadway facilities which would be surfaced or resurfaced using asbestos tailings.

The standards are based upon information derived from many sources, including health effect levels, meteorology, technical analysis of control capability, and consideration of economic impact. The overriding considerations are health effects. These standards are based upon specific operations and physical conditions and are limited in general to emissions to the atmosphere.

1. Emissions shall not exceed those which would be emitted from operations if proper engineering control had been installed (i.e. fabric filter, cyclone gas cleaning devices).
2. Visible emissions of particulate
3. Spraying of asbestos
4. Use of asbestos for surfacing or resurfacing of roads.

The use of procedural standards and visible emissions as the basis for evaluation for compliance with the standard are designed to minimize emission to the atmosphere. EPA determined that there

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is no suitable technique for sampling and analysis of asbestos in ambient air or emission gases. This determination was made as only limited information had been developed from measuring fibers in community air. The use of high volume samplers for collection of samples and counting by light microscopic techniques similar to industrial hygiene methods has shown only small numbers of fibers in urban areas.⁶⁹

It was felt that these values were low when compared to occupational health experience and values to few too use with confidence.⁶⁹

As a result there is no direct comparison possible between the proposed national emission standards for asbestos and the recommended criteria for occupational exposure except to say that the levels of exposure to the general public on a 24-hour day, 7 days a week, basis would be lower, as would be expected, than occupational standards based on an 8-hour day, 40-hour work week.

The Illinois Pollution Control Board on November 30, 1971,⁷⁰ published a notice of proposed final draft of emission standards for asbestos that can be more easily related to the recommended occupational standard than those proposed by EPA. Illinois includes a provision that, "After June 30, 1972, a factory, plant or enterprise which engages in the processing or manufacturing of any asbestos-containing product shall discharge no visible emission of particulate matter from such manufacturing or processing into the ambient air and shall emit no concentrations of asbestos fiber in excess of 2 fibers per cubic centimeter of air."

The method of counting the asbestos fibers is that proposed by Edwards et al.⁷¹ and similar to the technique proposed in Appendix I of this report. This proposed Illinois standard places a ceiling value of 2 fibers/cc on emissions from processing on manufacturing of asbestos containing products. In the explanation of the revision of the proposed Illinois regulation they state:

"IV. Part V, controlling manufacturing sources, is changed to require an emission standard of 2 fibers per cubic centimeter and no visible emissions. While some testimony indicated the difficulty in measuring compliance with a numerical emission standard, overall the evidence establishes both the need (protection against the great proportion of invisible fiber) and the ease of measurement of such a criterion. A "no visible emission" standard has been added to the numerical standard to simplify enforcement against exceptionally dirty emission sources. A grace period, until June 30, 1972, has been added to permit acquisition of the necessary control equipment to attain the emission standard."

This air quality standard is, as it should be, more restrictive than an occupational standard due to differences in exposure time.

This proposed occupational standard would seem to be compatible with the proposed emission standard and each should complement the other in the control of asbestos exposure.

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Air Sampling Methods

In the study of asbestosis conducted by Dreessen et al.⁶³ midget impinger count data were used as an estimate of dust exposure. All of the dust particles seen, both grains and fibers, were counted since too few fibers were seen to give an accurate measurement. The resulting count concentration was a measure of overall dust levels rather than a specific measurement of the asbestos concentration. This method was satisfactory at that time since exposures were massive and the control measures installed to reduce overall dust levels also reduced the asbestos dust levels.

As dust levels were reduced, it became necessary to measure the biologically appropriate attribute of the dust cloud. At equal levels of overall dustiness, the concentration of asbestos could vary considerably from textile manufacture (75-85%) to insulation (5-15%). Furthermore, if the limit were lowered below the 5 mppcf used previously and dust counts taken by the impinger technique, it would be necessary to consider the effect of background dust, which could be as high as 1 mppcf.

A number of methods for measurement of asbestos dust concentrations have been used in the NIOSH epidemiological study of the asbestos product industry.^{73,74,75,76} Based on these data, the preferred index of asbestos exposure is the concentration of fibers longer than 5 μ m counted on membrane filters at 430X with phase contrast illumination.^{71,72} This index is utilized in the method adopted as the standard field sampling method by the Public Health Service.



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Fibers longer than 5 μm in length are counted in preference to counting all fibers seen in order to minimize observer/microscope resolving power variability. Furthermore, the British define a "fibre" as a particle, "of length between 5 μm and 100 μm and having a length-to-breadth ratio of at least 3:1, observed by transmitted light by means of a microscope at a magnification of approximately 500X."⁶²

Although the British have refrained from standardizing on a single method of measurement, recent measurements have been performed by a method essentially identical to the fiber-count method described in detail below, and the British hygiene standards for use with their asbestos regulations are stated in these terms.⁶²

Principles of Sampling

A dust sampling procedure must be designed so that samples of actual dust concentrations are collected accurately and consistently. The results of the analysis of these samples will reflect, realistically, the concentrations of dust at the place and time of sampling.

In order to collect a sample representative of airborne dust, which is likely to enter the subject's respiratory system, it is necessary to position a collection apparatus near the nose and mouth of the subject or in his "breathing zone".

The concentration of dust in the air to which a worker is exposed will vary, depending upon the nature of the operation and upon the type of work performed by the operator and the position of the operator relative to the source of the dust. The amount of dust inhaled by a worker can vary daily, seasonally, and with the weather. In order to obtain representative samples of workers' exposures, it is necessary to collect samples under varying conditions of weather, on different

days, and at different times during a shift.

The percentage of working time spent on different tasks will affect the concentration of dust the worker inhales since the different tasks usually result in exposure to different concentrations. The percentage can be determined from work schedules and by observation of work routines.

The daily average weighted exposure can be determined by using the following formula:

$$\frac{(\text{Hours X conc. task A}) + (\text{Hours X conc. task B}) + \text{etc.}}{8 \text{ Hours (or actual hours worked)}}$$

The concentration of any air contaminant resulting from an industrial operation also varies with time. Therefore, a longer sampling time will better approximate the actual average.

With the following recommended sampling procedure, it is possible to collect samples at the workers' breathing zones for periods from 4 to 8 hours, thus permitting the evaluation of average exposures for a half or full 8-hour shift--a desirable and recommended procedure. Furthermore, dust exposures of a more normal work pattern result from the use of personal samplers. In evaluating daily exposures, samples should be collected as near as possible to workers' breathing zones.

Collecting Sample

The method recommended in this report for taking samples and counting fibers is based on a modification of the membrane filter method described by Edwards and Lynch.⁷¹

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The sample should be collected on a 37-millimeter Millipore type AA* filter mounted in an open-face filter holder. The holder should be fastened to the worker's lapel and air drawn through the filter by means of a battery-powered personal sampler pump similar to those approved by NIOSH under the provisions of 30 CFR 74. The filters are contained in plastic filter holders and are supported on pads which also aid in controlling the distribution of air through the filter. To yield a more uniform sample deposit, the filter-holder face-caps should be removed. Sampling flow rates from 1.0 liter per minute (lpm) up to the maximum flow rate of the personal sampler pump (usually not over 2.5 lpm) and sampling time from 15 minutes to eight hours are acceptable provided the following restraints are considered:

- (a) In order to obtain an accurate estimate of the number of fibers the statistical error resulting from the random distribution of the fibers must be kept to an acceptably low level. Since fiber counts follow a Poisson distribution, a count of 100 fibers in a sample would have a standard deviation of $\sqrt{100}$ or 10 fibers or $\pm 10\%$. Thus the 95% confidence limits would be approximately 2 standard deviations or $\pm 20\%$. Since the 37 mm filter has an effective collecting area of 855 mm^2 and the projected field area of the Porton reticle is 0.005 mm^2 , each field represents $1/171000$ of the sample. Based on this ratio the following number of fields must be counted to measure the various limits in various sampling times:

*Mention of commercial products does not constitute endorsement by the Public Health Service or U. S. Department of Health, Education and Welfare.

Sampling Time Minutes	Flow Rate lpm	Number of Fields for 100 Fibers		
		0.2 fibers/ml	2.0 fibers/ml	10 fibers/ml
10	2	4350	435	91
15	2	2860	286	<u>58</u>
30	2	1430	143	<u>29</u>
90	1	1000	100	20
90	2	500	<u>50</u>	10
240	1	260	<u>26</u>	7
240	2	180	<u>18</u>	4
480	1	180	<u>18</u>	4

- (b) Do not count a field containing over 20 fibers because in addition to the fibers being counted, there are also present a number of grains, which interfere with the accuracy of the count.

Based on these restraints, i.e., number of fields to be counted and maximum number of fibers per field, acceptable sampling parameters for the various limits are underlined in the above table.

The following conclusions may be drawn from this analysis:

- (1) The short-term limit should be for a period of at least 15 minutes and preferably 30 minutes.
- (2) The 2.0 fiber/cc limit may be evaluated over periods of from 90 to 480 minutes.

As many fields as required to yield at least 100 fibers should be counted. In general the minimum number of fields should be 20 and the maximum 100.

Mounting Sample

The mounting medium used in this method is prepared by dissolving 0.05 g of membrane filter per ml of 1:1 solution of dimethyl phthalate



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and diethyl oxalate. The index of refraction of the medium thus prepared is $ND = 1.47$.

To prepare a sample for microscopic examination, a drop of the mounting medium is placed on a freshly cleaned, standard (25 mm X 75 mm), microscopic slide. A wedge-shaped piece with arc length of about 1 cm is excised from the filter with a scalpel and forceps and placed dust-side-up on the drop of mounting solution. A No. 1-1/2 coverslip, carefully cleaned with lens tissue, is placed over the filter wedge. Slight pressure on the coverslip achieves contact between it and the mounting medium. The sample may be examined as soon as the mount is transparent. The optical homogeneity of the resulting mount is nearly perfect, with only a slight background granularity under phase contrast, which disappears within one day. The sample should be counted within two days after mounting.

Evaluation

The filter samples mounted in the manner previously described are evaluated in terms of the concentration of asbestos fibers greater than 5 μm in length. A microscope equipped with phase-contrast optics and a 4-mm "high-dry" achromatic objective is suitable for this determination. 10X eyepieces, one of which contains a Porton or other suitable reticle at the level of the field-limiting diaphragm, should be used. The left half of the Porton reticle field serves to define the counting area of the field. Twenty fields located at random on the sample are counted and total asbestos fibers longer than 5 μm are recorded. Any particle having an aspect ratio of three or greater is considered a fiber.

The following formulae are used to determine the number of fibers/ml:

$$(1) \frac{\text{Filter area (mm}^2\text{)}}{\text{Field area (mm}^2\text{)}} = K$$

$$(2) \frac{\text{Average net count} \times K}{\text{Air volume sampled (ml)}} = \text{fibers/ml}$$

For example, assume the following: area of the filter used was 855 mm², counting area of one field under the Porton reticle was 0.005 mm²; average net count per field of 20 fields was 10 fibers; and sample was collected at 2 liters per minute for 90 minutes: Then:

$$\frac{855 \text{ mm}^2}{0.005 \text{ mm}^2} = 171,000 (K)$$

$$\frac{10 \text{ fibers} \times 171,000}{2,000 \text{ ml/min} \times 90 \text{ min}} = 9.5 \text{ fibers/ml}$$

Calibration of Personal Sampler

The accuracy of an analysis can be no greater than the accuracy of the volume of air which is measured. Therefore, the accurate calibration of a sampling device is essential to the correct interpretation of an instrument's indication. The frequency of calibration is somewhat dependent on the use, care, and handling to which the pump is subjected. Pumps should be calibrated if they have been subjected to misuse or if they have just been repaired or received from a manufacturer. If hard usage is given the instrument, more frequent calibration may be necessary.

Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, a 1-liter burette or wet-test meter should be used. In the field, a rotameter is the most convenient



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instrument used. The actual set-up will be the same for all of these instruments. The calibration instrument will be connected in sequence to the filter unit which will be followed by the personal sampler pump. In this way, the calibration instrument will be at atmospheric pressure. Connections between units can be made using the same type of tubing used in the personal sampling unit. Each pump must be calibrated separately for each type of filter used, if, for example, it has been decided to use a filter with a different pore size. The burette should be set up so that the flow is toward the narrow end of the unit.

Care must be exercised in the assembly procedure to insure adequate seals at the joints and that the length of connecting tubing be kept at a minimum. Calibration should be done under the same conditions of pressure, temperature and density as will be encountered. The rotameter should be used only in the field as a check if the diaphragm or piston pumps are not equipped with pulsation dampeners. The pulsating flow resulting from these type pumps causes the rotameter to give results which are not as accurate as that obtained with a burette or wet-test meter. Calibration can be accomplished with any of the other standard calibrating instruments, such as spirometer, Marriott's bottle, or dry-gas meter. The burette and wet-test meter were selected because of their accuracy, availability, and ease of operation.

IX. APPENDIX II

NUMERICAL HAZARD RATING SYSTEM

The numerical hazard ratings given to products for each category of hazard shall be in accordance with the following criteria. Figure 2 graphically illustrates the hazard identification system.

Health hazards shall be rated as follows:

The health hazard rating of a material shall be determined by evaluating the potential for exposure and the relative toxicity of the most toxic ingredient of a compound or mixture. For this evaluation, the following relative toxicity criteria* for absorbed or exposure dose will be used:

Commonly Used Term	LD ₅₀ Simple Oral Dose Rats mg/kg	Inhalation 4-hr. Vapor Exposure, Rats Mortality of 2/6 to 4/6 ppm	LD ₅₀ - Skin Rabbits mg/kg
Extremely toxic	≤1	≤10	≤5
Highly toxic	1.1 to 50	11 to 100	5.1 to 43
Moderately toxic	50.1 to 500	101 to 1000	44 to 340
Slightly toxic or practically non-toxic	501 to 15,000	1,001 to 100,000	350 to 22,600
Relatively harmless	15,000	100,000	22,600

Degree 4: Extremely Hazardous.

Materials, which on very short exposure, can cause death or major permanent injury, even though prompt medical treatment were given, including those which are too dangerous to be approached without specialized

*(Reference: A.I.H.A. Quarterly, Vol. 15, No. 2, June 1954. "Safe Handling Procedures for Compounds Developed by the Petro Chemical Industry," p. 141.)

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protective equipment, such as self-contained breathing apparatus or a hose mask with blower, and impervious clothing. This rating includes:

- (a) Carcinogens
- (b) Materials capable of producing sensitization
- (c) Extremely toxic materials which can penetrate ordinary protective clothing.
- (d) Extremely hazardous materials, when under normal conditions give off gases that are extremely toxic or corrosive through inhalation or by contact with or absorption through any body surface.

Degree 3: Highly Hazardous.

Materials which on short exposure can cause serious temporary or residual injury, even though prompt medical treatment were given, including those requiring protection from all bodily contact. This rating includes:

- (a) Materials giving off highly toxic combustion products
- (b) Materials giving off highly toxic gases or vapors, under normal conditions
- (c) Materials corrosive to living tissue or highly toxic by skin absorption

Degree 2: Hazardous.

Materials which on continued exposure can cause temporary incapacitation or possible residual injury unless prompt medical treatment is given. This rating includes:

- (a) Materials giving off moderately toxic combustion products
- (b) Materials which either under normal conditions or under fire conditions give off moderately toxic vapors lacking warning properties.

Degree 1: Slightly hazardous.

Materials, which on exposure at normal conditions, would cause irritation but only minor residual injury even if no treatment is given.

This rating includes:

- (a) Materials which under fire conditions give off slightly toxic or irritating combustion products
- (b) Materials which on the skin could cause irritation without destruction of tissue

Degree 0: Harmless.

Materials which on exposure by skin contact, inhalation, or ingestion are relatively harmless or which under fire conditions offer no hazard beyond that of ordinary combustible materials.

Flammability hazards shall be rated as follows:

Degree 4.

Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or which are readily dispersed in air, and which will burn readily. This degree should include:

Gaseous materials: Cryogenic materials; any liquid or gaseous material which is a liquid while under pressure and having a flash point below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C). (Class 1A flammable liquids.)

Materials which on account of their physical form or environmental conditions can form explosive mixtures with air and which are readily dispersed in air, such as dusts of combustible solids and mists of flammable or combustible liquid droplets.

Degree 3.

Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous

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atmospheres with air under almost all ambient temperatures, are readily ignited under almost all conditions. This degree should include: Liquids having a flash point below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C) and those liquids having a flash point at or above 73°F (22.8°C) and below 100°F (37.8°C). (Class 1B and Class 1C flammable liquids);

Solid materials in the form of coarse dusts which may burn rapidly but which generally do not form explosive atmosphere with air;

Solid materials in a fibrous or shredded form which may burn rapidly and create flash fire hazards, such as cotton, sisal and hemp;

Solids which burn with extreme rapidity usually by reason of self-contained oxygen (e.g., dry nitrocellulose);

Materials which ignite spontaneously when exposed to air.

Degree 2.

Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree should include:

Liquids having a flash point about 100°F, but not exceeding 200°F; solids and semisolids which readily give off flammable vapors.

Degree 1.

Materials that must be preheated before ignition can occur.

Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur.

This degree should include:

Materials which will burn in air when exposed to a temperature of 1500°F for a period of five minutes or less;

Liquids, solids and semisolids having a flash point above 200°F; this degree includes most ordinary combustible materials.

Degree 0.

Materials that will not burn. This degree should include any material which will not burn in air when exposed to a temperature of 1500°F for a period of five minutes.

Reactivity hazards shall be rated as follows:

Degree 4.

Materials which are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This degree should include materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

Degree 3

Materials which are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This degree should include materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures or which react explosively with water without requiring heat or confinement.

Degree 2.

Materials which are normally unstable and readily undergo violent chemical change but do not detonate. This degree should include materials which can undergo chemical change with rapid release of energy at normal

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temperatures and pressures or which can undergo violent chemical change at elevated temperatures and pressures. It should also include those materials which may react violently with water or which may form potentially explosive mixtures with water.

Degree 1.

Materials which are normally stable, but which may react with water with some release of energy but not violently.

Degree 0.

Materials which are normally stable, even under fire exposure conditions, and which are not reactive with water.

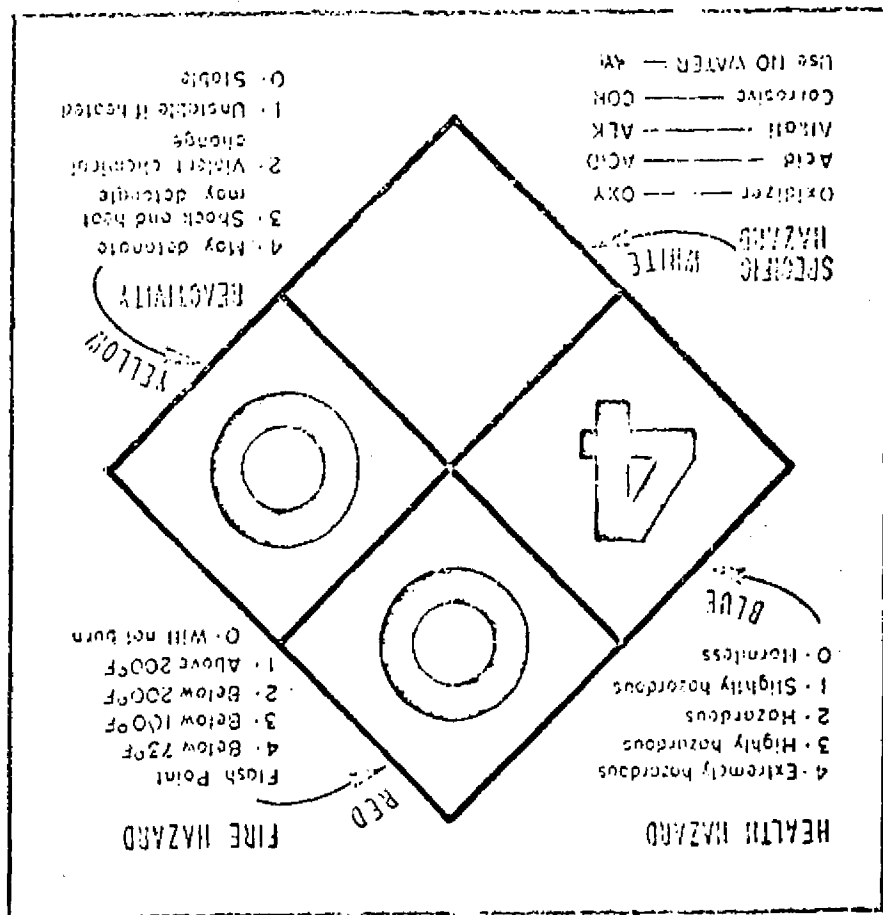
Specific hazards:

Oxidizing Material. A substance as chlorate, permanganate, peroxide, or a nitrate that yields oxygen to support combustion or which reacts readily to oxidize fuels or other combustible materials.

Corrosive Material. Acids, alkali or other material that will cause severe damage to living tissue or to other material it contacts.

Water Reactivity Hazard (Use No Water). Any material that may be a hazard because of its specific reactivity with water.

Figure 1. Hazard Identification System



COLOR AND DIMENSION

Color format for NFPA No. 704M designations are shown above. The colors indicated shall perceptibly match in shade the applicable color of FPD-57D-595 as follows:

Color	Class
Black	17038
Red	11105
White	17875
Yellow	13538
Blue	15102

Dimensions of the symbol and LAPI warning combination shall be optional but of such size and location as to be readily visible and legible. The symbol and warning shall be applied by stenciling, painting, printing, lithographing, with fade-resistant materials.

X. APPENDIX III

MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material containing 5% or more of asbestos shall be provided in the appropriate section of the Material Safety Data Sheet or approved form. If a specific item of information is inapplicable (i.e. flash point) initials "n.a." not applicable should be inserted.

(i) The product designation in the upper left hand corner of both front and back to facilitate filing and retrieval. Print in upper case letters in as large print possible.

(ii) Section I. Name and Source

(A) The name, address and telephone number of the manufacturer or supplier of the product.

(B) The trade name and synonyms for a mixture of chemicals, a basic structural material, or for a process material; and the trade name and synonyms, chemical name and synonyms, chemical family, and formula for a single chemical.

(iii) Section II. Hazardous Ingredients.

(A) Chemical or widely recognized common name of all hazardous ingredients.

(B) The approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range of maximum amount, i.e., 10-20% V; 10% max. W.

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(C) Basis for toxicity for each hazardous material such as established OSHA standard (TLV), in appropriate units and/or LD₅₀, showing amount and mode of exposure and species or LC₅₀ showing concentration and species.

(iv) Section III. Physical Data

(A) Physical properties of the total product including boiling point and melting point in degrees Fahrenheit; vapor pressure, in millimeters of mercury, vapor density of gas or vapor (air = 1), solubility in water, in parts per hundred parts of water by weight; specific gravity (water = 1); percent volatile, indicate if by weight or volume, at 70° Fahrenheit; evaporation rate for liquids (indicate whether butyl acetate or ether = 1); and appearance and odor.

(v) Section IV. Fire and Explosion Hazard Data.

(A) Fire and explosion hazard data about a single chemical or a mixture of chemicals, including flash point, in degrees Fahrenheit; flammable limits, in percent by volume in air; suitable extinguishing media or agents; special fire fighting procedures; and unusual fire and explosion hazard information.

(vi) Section V. Health Hazard Data.

(A) Toxic level for total compound or mixture, relevant symptoms of exposure, skin and eye irritation properties, principle routes of absorption, effects of chronic (long-term) exposure and emergency and first aid procedures.

(vii) Section VI. Reactivity Data.

(A) Chemical stability, incompatibility, hazardous decomposition products, and hazardous polymerization.

(viii) Section VII. Spill or Leak Procedures.

(A) Detailed procedures to be followed with emphasis on precautions to be taken in cleaning up and safe disposal of materials leaked or spilled. This includes proper labeling and disposal of containers containing residues,

contaminated absorbants, etc.

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(ix) Section VIII. Special Protection Information.

(A) Requirements for personal protective equipment, such as respirators, eye protection and protective clothing, and ventilation such as local exhaust (at site of product use or application), general, or other special types.

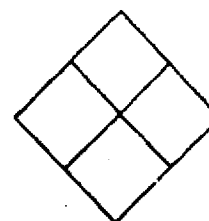
(x) Section IX. Special Precautions.

(A) Any other general precautionary information such as personal protective equipment for exposure to the thermal decomposition products listed in Section VI, and to particulates formed by abrading a dry coating, such as by a power sanding disc.

(xi) The signature of the responsible person filling out the data sheet, his address, and the date on which it is filled out.

(xii) The NFPA 704M numerical hazard ratings as defined in section (c) (5) following. The entry shall be made immediately to the right of the heading "Material Safety Data Sheet" at the top of the page and within a diamond symbol preprinted on the forms.

PRODUCT DESIGNATION

MATERIAL SAFETY
DATA SHEETForm Approved
Budget Bureau No.
Approval Expires
Form No. OSHA

SECTION I SOURCE AND NOMENCLATURE

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, ZIP Code)	
TRADE NAME AND SYNONYMS	CHEMICAL FAMILY
CHEMICAL NAME AND SYNONYMS	FORMULA

SECTION II HAZARDOUS INGREDIENTS

BASIC MATERIAL	APPROXIMATE OR MAXIMUM % WT. OR VOL.	ESTABLISHED OSHA STANDARD	LD ₅₀		LC ₅₀	
			ORAL	PERCUT.	SPECIES	CONC.

SECTION III PHYSICAL DATA

BOILING POINT	°F.	VAPOR PRESSURE	mm Hg.
MELTING POINT	°F.	VAPOR DENSITY (Air=1)	
SPECIFIC GRAVITY (H ₂ O=1)		EVAPORATION RATE (_____ =1)	
SOLUBILITY IN WATER	Pts/100 pts H ₂ O	VOLATILE	% Vol. % Wt.
APPEARANCE AND ODOR			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	FLAMMABLE (EXPLOSIVE) LIMITS	UPPER
METHOD USED		LOWER
EXTINGUISHING MEDIA		
SPECIAL FIRE FIGHTING PROCEDURES		
UNUSUAL FIRE AND EXPLOSION HAZARDS		

PRODUCT
DESIGNATION

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SECTION V HEALTH HAZARD DATA

TOXIC
LEVEL

CARCINOGENIC

PRINCIPLE ROUTES
OF ABSORPTION

SKIN AND EYE
IRRITATION

RELEVANT SYMPTOMS
OF EXPOSURE

EFFECTS OF
CHRONIC EXPOSURE

EMERGENCY AND
FIRST AID
PROCEDURES

SECTION VI REACTIVITY DATA

CONDITIONS CONTRIBUTING
TO INSTABILITY

CONDITIONS CONTRIBUTING
TO HAZARDOUS POLYMERIZATION

INCOMPATIBILITY
(Materials to Avoid)

HAZARDOUS DECOMPOSITION
PRODUCTS

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN
CASE MATERIAL IS
RELEASED OR SPILLED

WASTE DISPOSAL
METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS
LOCAL EXHAUST

PROTECTIVE EQUIPMENT (Specify Types)
EYE

MECHANICAL (General)

GLOVES

SPECIAL

RESPIRATOR

OTHER PROTECTIVE
EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE
TAKEN IN HANDLING
AND STORAGE

OTHER PRECAUTIONS

Signature

Address

Date

TABLE I
CEMENT PIPE PLANTS
NUMBER OF PLANTS = 7

INDIVIDUAL SAMPLES BY OPERATION AND SAMPLE SIZE

OPERATION	HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND LOWEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	LOWEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT
Warehousing & Mixing	7.0	2	O	5.6	2	O	0.2	3	P	0.2	4	Q
Pipe Forming	3.7	6	O	3.4	3	N	0.1	6	O	0.0	6	AA
Curing	2.6	3	O	2.1	15	BB	0.1	4	Z	0.0	6	P
Pipe Finishing	4.6	10	Z	4.0	5	Q	0.0	6	N	0.0	10	Z
Coupling Finishing	13.4	7	Z	10.5	7	Z	0.0	16	P	0.0	21	AA
Epoxy	4.7	1	N	2.1	6	BB	0.3	5	Z	0.2	6	BB
Packing	6.1	1	Q	2.5	7	Z	0.1	13	AA	0.0	13	AA
Miscellaneous	1.7	9	Z	1.4	9	P	0.1	9	P	0.0	9	Z

1 - All samples expressed as fibers >5µ/cc counted by the standard method recommended in this document.
(Latest Available NIOSH Data Collected during the Years 1969 through 1970).

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TABLE II
ASBESTOS CEMENT PIPE PLANTS

NUMBER OF PLANTS = 7

MEANS BY OPERATION AND SAMPLE SIZE ()

OPERATION	HIGHEST	PLANT	SECOND HIGHEST	PLANT	SECOND LOWEST	PLANT	LOWEST	PLANT
Warehousing & Mixing	6.3 (2)	O	2.7 (4)	N	0.7 (5)	AA	0.4 (3)	P
Pipe Forming	2.2 (3)	N	1.8 (4)	Z	0.5 (6)	AA	0.3 (4)	P
Curing	2.0 (3)	O	0.9 (15)	BB	0.4 (4)	Z	0.3 (6)	P
Pipe Finishing	1.7 (10)	Z	1.3 (5)	Q	0.6 (9)	AA	0.5 (6)	N
Coupling Finishing	5.3 (7)	Z	3.8 (4)	O	0.6 (21)	AA	0.5 (16)	P
Epoxy	4.7 (1)	N	1.1 (6)	BB	0.6 (6)	P	0.3 (1)	AA
Packing	6.1 (1)	Q	1.1 (7)	Z	0.7 (6)	BB	0.4 (13)	AA
Miscellaneous	0.5 (9)	Z	0.5 (6)	BB	0.4 (9)	P	0.2 (3)	Q

1 - All samples expressed as fibers >5u/cc counted by the standard method recommended in this document. (Latest Available NIOSH Data Collected during the years 1969 through 1970).

TABLE III

ASBESTOS FRICTION
NUMBER OF PLANTS = 5

INDIVIDUAL SAMPLES BY OPERATION AND SAMPLE SIZE

OPERATION	HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	LOWEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT
Mixing, Coating & Extruding	32.4	16	S	18.4	16	S	0.1	7	M	0.1	7	M
Forming	16.2	3	U	9.2	4	S	0.3	6	H	0.1	6	H
Hot Pressing	7.3	5	S	6.0	5	S	0.2	7	H	0.1	7	H
Baking	7.4	5	S	7.3	5	S	0.5	2	M	0.1	2	H
Grinding & Sanding	20.5	8	T	16.6	16	S	0.1	10	R	0.1	10	H
Cutting & Drilling	14.4	22	S	14.4	22	S	0.4	12	H	0.1	7	M
Bonding & Riveting	8.7	4	H	1.5	4	H	0.2	1	T	0.1	1	M
Inspection & Packing	11.1	4	S	9.9	13	H	0.1	13	H	0.1	13	H
Miscellaneous	6.4	9	H	6.4	9	H	0.1	5	T	0.1	9	H

1 - All samples expressed as fibers >5 μ /cc counted by the standard method recommended in this document. (Latest available NIOSH Data collected during the years 1968 through 1971).

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TABLE IV
ASBESTOS FRICTION PLANTS

NUMBER OF PLANTS - 5

MEANS BY OPERATION WITH SAMPLE SIZE ()

OPERATION	HIGHEST	PLANT	2nd HIGHEST	PLANT	2nd LOWEST	PLANT	LOWEST	PLANT
Mixing, Coating & Extruding	11.0 (16)	S	5.3 (2)	H	4.3 (2)	U	1.9 (7)	M
Forming	6.0 (3)	U	3.6 (4)	S	0.5 (2)	T	0.5 (6)	H
Hot Pressing	4.9 (5)	S	1.5 (2)	U	1.4 (4)	M	0.7 (7)	H
Baking	5.4 (5)	S	3.7 (1)	U	0.6 (2)	M	0.4 (2)	H
Grinding & Sanding	6.3 (4)	U	5.2 (16)	S	2.7 (7)	M	1.1 (10)	H
Cutting & Drilling	14.4 (1)	U	7.7 (22)	S	0.9 (7)	T	0.6 (7)	M
Bonding & Riveting	2.8 (4)	H			0.2 (1)	T	0.1 (1)	M
Inspection & Packing	5.1 (4)	S	3.7 (3)	U	1.0 (4)	M	0.9 (7)	T
Miscellaneous	2.2 (9)	H	1.4 (1)	M	0.8 (3)	U	0.5 (5)	T

1 - All samples expressed as fibers >5 μ /cc counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1968 through 1971).

TABLE V
ASBESTOS CEMENT SHINGLE, MILL BOARD AND GASKET
NUMBER OF PLANTS = 3

INDIVIDUAL SAMPLES BY OPERATION AND SAMPLE SIZE

OPERATION	HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT
Warehousing	1.4	3	R	0.4	3	R	0.2	3	R	0.1	1	V
Mixing	16.6	15	R	9.5	6	W	0.5	6	W	0.3	15	R
Forming	6.4	18	R	3.7	3	W	0.1	18	R	0.0	18	R
Curing	2.5	2	R	1.6	2	V	0.4	1	W	0.2	2	R
Finishing	5.4	17	R	4.4	17	R	0.1	7	V	0.1	7	W
Packing	3.8	4	R	1.1	2	W	0.2	2	W	0.1	4	R
Miscellaneous	1.4	2	W	1.2	4	R	0.9	2	W	0.6	4	R

1 - All samples expressed as fibers > 5µ/cc counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1970).

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TABLE VI

ASBESTOS CEMENT SHINGLE, MILLBOARD AND GASKET
 NUMBER OF PLANTS = 3
MEANS BY OPERATION AND SAMPLE SIZE ()

OPERATION	HIGHEST	PLANT	2nd HIGHEST	PLANT	2nd LOWEST	PLANT	LOWEST	PLANT
Warehousing	0.7 (3)	R					0.1 (1)	V
Mixing	4.4 (6)	W	3.8 (15)	R			1.8 (1)	V
Forming	2.6 (3)	W	1.3 (18)	R			0.9 (6)	V
Curing	1.5 (2)	V	1.4 (2)	R			0.4 (1)	W
Finishing	1.9 (17)	R	1.5 (2)	W			1.0 (7)	V
Packing	1.2 (4)	R	0.7 (2)	W			0.5 (2)	V
Miscellaneous	1.2 (2)	W	1.0 (4)	R			0.9 (1)	V

1 - All samples expressed as fibers $>5\mu$ /cc counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1970).

TABLE VII

ASBESTOS PAPER, PACKING, AND ASPHALT PRODUCTS

INDIVIDUAL SAMPLES BY OPERATIONS AND SAMPLE SIZE*

PRODUCT AREA	INDIVIDUAL HIGH	OPERATION	INDIVIDUAL LOW	OPERATION
Asbestos Paper	10.9	Asbestos Mixing	0.0	Wood Mixing Paper Making
Asbestos Packing	18.9	Weaving	0.1	Braiding Mixing & Calender Forming Cutting & Trimming
Asbestos Asphalt Products	16.3	Dry Mixing	0.0	Dry Mixing Wet Mixing Forming Finishing Inspection & Packing

* IN THESE THREE ASBESTOS PRODUCT AREAS, INSUFFICIENT DATA PREVENTS TABULATING ENVIRONMENTAL LEVELS INTO HIGHEST AND LOWEST INDIVIDUAL SAMPLE CATEGORIES BY OPERATION. BASED ON A SMALL NUMBER OF PLANTS FOR EACH PRODUCT AREA, ONLY THE HIGH, LOW FOR INDIVIDUAL SAMPLES WERE DETERMINED.

1 - All samples expressed as fibers $> 5\mu/\text{cc}$ counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1970).

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TABLE VIII

ASBESTOS PAPER, PACKING AND ASPHALT PRODUCTS

MEANS BY OPERATIONS AND SAMPLE SIZE*

PRODUCT AREA	HIGH MEAN	OPERATION	LOW MEAN	OPERATION
Asbestos Paper	3.4	Asbestos Mixing	0.7	Miscellaneous
Asbestos Packing	13.6	Weaving	0.2	Mixing & Calender
Asbestos Asphalt Products	2.4	Dry Mixing	0.2	Forming Finishing

*IN THESE THREE ASBESTOS PRODUCT AREAS, INSUFFICIENT DATA PREVENTS TABULATING ENVIRONMENTAL LEVELS INTO HIGHEST, LOWEST MEAN CATEGORIES BY OPERATION. BASED ON A SMALL NUMBER OF PLANTS FOR EACH PRODUCT AREA, ONLY THE HIGH MEAN AND LOW MEAN WERE DETERMINED.

- 1 - All samples expressed as fibers >5 μ /cc counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1970).

TABLE IX

 ASBESTOS INSULATION PLANTS
 NUMBER OF PLANTS = 5

INDIVIDUAL SAMPLES BY OPERATION AND SAMPLE SIZE

OPERATION	HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT
Mixing	188.9	11	X	169.7	11	X	0.4	3	DD	0.2	7	R
Forming	134.4	39	X	111.2	39	X	0.0	10	R	0.0	10	R
Curing	23.5	5	X	19.9	5	X	1.5	1	DD	0.1	1	CC
Finishing	208.4	26	X	97.3	26	X	0.1	4	CC	0.1	11	R
Inspection & Packing	92.3	15	X	73.6	15	X	0.1	11	R	0.0	11	CC
Miscellaneous	42.3	24	X	37.5	24	X	0.1	4	CC	0.1	4	CC

1 - All samples expressed as fibers $>5\mu/cc$ counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1971).

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TABLE X
 ASBESTOS INSULATION PLANTS
 NUMBER OF PLANTS - 5
MEANS BY OPERATION AND SAMPLE SIZE ()

OPERATION	HIGHEST	PLANT	2nd HIGHEST	PLANT	2nd LOWEST	PLANT	LOWEST	PLANT
Mixing	74.4 (11)	X	46.3 (7)	Y	4.1 (7)	R	1.7 (2)	CC
Forming	50.6 (39)	X	25.2 (32)	Y	0.7 (10)	R	0.2 (7)	CC
Curing	14.4 (5)	X			1.5 (1)	DD	0.1 (1)	CC
Finishing	39.5 (26)	X	15.0 (17)	Y	1.0 (11)	R	0.9 (4)	CC
Inspection & Packing	22.8 (15)	X	11.0 (19)	Y	0.5 (1)	R	0.3 (11)	CC
Miscellaneous	16.6 (24)	X	2.7 (5)	Y	2.6 (4)	DD	0.2 (4)	CC

1 - All samples expressed as fibers $>5\mu$ /cc counted by the standard method recommended in this document. (Latest available NIOSH data collected during the years 1966 through 1971).

TABLE XI
LATEST SURVEY RESULTS

ASBESTOS TEXTILE
NUMBER OF PLANTS = 8

INDIVIDUAL SAMPLES BY OPERATION AND THE SAMPLE SIZE INDIVIDUAL SAMPLE WAS TAKEN FROM

OPERATION	FIBERS/cc 5u											
	HIGHEST INDIVIDUAL SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND HIGHEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	SECOND LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT	LOWEST INDIVID. SAMPLE	SAMPLE SIZE FROM WHICH INDIVIDUAL SAMPLE DRAWN	PLANT
Fiber Preparation	120.3	12	B	40.9	4	A	1.4	9	K	0.4	9	K
Carding	143.9	30	B	72.2	30	B	0.7	22	K	0.4	40	J
Spinning	40.9	36	K	28.7	43	B	1.0	36	K	0.4	43	B
Twisting	31.1	7	A	25.3	8	K	0.5	8	K	0.2	8	G
Winding	18.4	24	B	17.9	40	K	0.1	40	K	0.0	40	K
Weaving	123.2	57	B	38.5	25	A	0.1	50	K	0.1	50	K
Rope, Wick, Braid & Cord	11.0	3	D	10.3	3	D	0.1	4	K	0.1	3	D
Finishing	5.6	3	G	3.8	28	B	0.2	28	B	0.1	28	B
Miscellaneous	37.0	2	A	22.7	2	A	0.1	45	K	0.1	45	K

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TABLE XII
 LATEST SURVEY RESULTS
 ASBESTOS TEXTILE PLANTS
 NUMBER OF PLANTS = 8
 MEANS BY OPERATION WITH SAMPLE SIZE ()
 FIBERS/CC >5 μ

OPERATION	HIGHEST	PLANT	SECOND HIGHEST	PLANT	SECOND LOWEST	PLANT	LOWEST	PLANT
Fiber Preparation	22.3 (4)	A	20.3 (12)	B	7.6 (9)	K	7.4 (5)	J
Carding	27.3 (10)	A	26.4 (30)	B	7.1 (22)	K	6.1 (14)	G
Spinning	12.5 (36)	K	10.9 (11)	A	5.8 (11)	C	3.7 (2)	J
Twisting	14.5 (7)	A	10.7 (19)	B	4.8 (4)	C	3.2 (8)	G
Winding	9.7 (12)	A	5.9 (24)	B	2.8 (10)	J	2.0 (5)	G
Weaving	12.4 (25)	A	10.0 (16)	J	2.5 (11)	C	1.1 (3)	E
Rope, Wick, Braid & Cord	7.1 (3)	D	3.5 (2)	J	2.6 (4)	A	1.3 (4)	K
Miscellaneous	29.9 (2)	A	9.7 (2)	G	2.5 (4)	J	0.2 (2)	E
Finishing	2.5 (3)	G	1.8 (2)	C	1.3 (28)	B	0.1 (5)	E

TABLE XIII
ASBESTOS CONCENTRATION* BY OPERATION
FOR INSULATION WORKERS

Marine Con- struction Repair	No. of Samples	Actual Arithmetic Means	Recalculated Mean***	Previous Time-Weighted Average***	Recalculated Time-Weighted Average***
Prefabrication	7	30.4	8.7)	9.2	1.8
Application	25	6.2	2.6)		
Mixing	19	21.2	6.4)		
General	18	0.6	0.6)		
Tear Out	14	31.5	8.3)		
Finishing	19	0.3	0.3)		
Light and Heavy Industrial Construction					
Prefabrication	23	10.1	6.6)	4.2	2.2
Application	36	3.1	2.4)		
Mixing	17	4.7	2.9)		
General	19	1.6	1.1)		
Tear Out	10	12.8	7.1)		
Finishing	16	0.9	0.9)		

* Fibers/ml > 5 μ in length

** Summarized from data

*** Personal communication, March 1970 from Balzer & Cooper⁽⁴⁾.

020194

TABLE XIV

ASBESTOS CONCENTRATION BY OPERATION*, 1969

Work practice	Environmental conditions	Average asbestos fiber levels		
		Personal Samples Fibers/ml	Area Samples Fibers/ml	Distance from Source
#1 Asbestos cement	High ceiling room. Louvre venting	2.4	.45	2'
#2 Asbestos cement	Low ceiling room. Poor ventilation	2.6	-	-
#3 Asbestos cement	Access tunnel	6.1	-	-
#4 Asbestos cement	Power house. Low Ceiling, poor ventilation	3.9	2.5	3-5'
Cutting calcium silicate, block, pipe #1	Table and hand saws, in power house - open	1.2	-	-
Cutting calcium silicate, block & pipe #2	Same - in industrial building. Good ventilation.	4.1	-	-
Cutting calcium silicate block & pipe	Apartment house boiler room. No ventilation. Work 3"-18" from breathing zone.	11.5	-	-
Cutting calcium silicate block & pipe #4	Limited ventilation	9.4	1.6	3-4'
Spraying insulation	Turbines in power plant - very high ceiling, good ventilation.	47.7	19.5	3' 28.0 6'

Fibers/ml > 5 μ in lengthNotes:

1. Conditions usually variable: Cement mixed dry - applied wet; rapid changes in local ventilation; composition of material may vary; number of men on job may vary.
2. Average of counts (excluding spray insulation): ≥ 5 fibers/ml = 64.5%;
5-12 fibers/ml = 25.5%; > 12 fibers/ml = 10.0%. (5)
3. Information prepared by Reitze, Nicholson, and Holaday.

TABLE XV
 ASBESTOS PLANT Z - CEMENT PIPE
 PERSONAL SAMPLES - SECULAR TRENDS
 MEANS BY OPERATION AND SAMPLE SIZE

OPERATION	1967		1971	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Warehousing & Mixing	6.2	4	2.3	2
Pipe Forming	2.1	15	1.8	4
Curing	1.3	8	0.4	4
Pipe Finishing	5.0	6	1.7	10
Coupling Finishing	12.8	9	5.3	7
Epoxy	2.6	2	0.9	5
Packing	1.7	6	1.1	7
Miscellaneous			0.5	9

1 - All samples expressed as fibers $>5\mu/cc$ by the standard method recommended in this document.

2 - Information prepared from NIOSH data.

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TABLE XVI

ASBESTOS PLANT S - FRICTION

PERSONAL SAMPLES - SECULAR TRENDS

MEANS BY OPERATION WITH SAMPLE SIZE

OPERATION	1966		1969		1971	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Mixing, Coating & Extruding	7.5	24	8.0	6	11.0	16
Forming	5.7	7	0.5	3	3.6	4
Hot Pressing	13.1	15	1.8	3	4.9	5
Baking	9.1	1	2.6	4	5.4	5
Grinding & Sanding	10.8	34	4.7	10	5.2	16
Cutting & Drilling	11.0	31	2.8	8	7.7	22
Bonding & Riveting						
Inspection & Packing	9.6	21	1.9	5	5.1	4
Miscellaneous Friction	6.7	6	1.8	10		

1 - All samples expressed as fibers $>5 \mu/\text{cc}$ by the Standard Method recommended in this document.

2 - Information prepared from NIOSH data.

TABLE XVII
 ASBESTOS CEMENT SHINGLE, MILLBOARD AND GASKET
 PERSONAL SAMPLES - SECULAR TRENDS
 MEANS BY OPERATION AND SAMPLE SIZE

OPERATION	1967		1970	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Warehousing	8.9	4		
Mixing	8.3	14	4.4	6
Forming	1.8	36	2.6	3
Curing			0.4	1
Finishing	4.3	35	1.5	7
Packing	2.5	22	0.7	2
Miscellaneous	2.3	13	1.2	2

- 1 - All samples expressed as fibers $>5 \mu/cc$ by the Standard Method recommended in this document.
 2 - Information prepared from NIOSH data.

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TABLE XVIII
 ASBESTOS, INSULATION PLANT X
 PERSONAL SAMPLES - SECULAR TRENDS
 THERMAL PIPE
 MEANS BY OPERATION WITH SAMPLE SIZE

OPERATION	1967		1970		1971	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Mixing	163.0	5	36.2	3	74.4	11
Forming	33.3	18	25.7	3	50.6	39
Curing	2.5	1	31.0	1	14.4	5
Finishing	44.6	3	34.8	4	39.5	26
Inspection & Packing	16.7	7	17.9	3	22.8	15
Miscellaneous			13.8	2	16.6	24
Office Worker						

1 - All samples expressed as fibers $>5 \mu/cc$ by the Standard Method recommended in this document.

2 - Information prepared from NIOSH data.

TABLE XIX

ASBESTOS, INSULATION PLANT Y

PERSONAL SAMPLES - SECULAR TRENDS

THERMAL PIPE

MEANS BY OPERATION WITH SAMPLE SIZE

OPERATION	1967		1970		1971	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Mixing	107.0	3	27.7	2	46.3	7
Forming	98.9	12	24.1	13	25.2	32
Curing						
Finishing	32.2	4	16.8	2	15.0	17
Inspection & Packing	13.3	2	13.0	8	11.0	19
Miscellaneous			21.0	14	2.7	5

1 - All samples expressed as fibers $>5 \mu/cc$ by the Standard Method recommended in this document.

2 - Information prepared from NIOSH data.

020199

TABLE XX
 ASBESTOS TEXTILE PLANT A
 PERSONAL SAMPLES - SECULAR TRENDS
 MEANS BY OPERATION WITH SAMPLE SIZE

OPERATION	1964		1966		1970	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Fiber preparation	13.6	6	9.6	4	22.3	4
Carding	14.5	4	52.2	7	27.3	10
Spinning	11.8	2	15.3	9	10.9	11
Twisting	5.4	7	9.2	8	14.5	7
Winding	9.5	5	13.8	4	9.7	12
Weaving	5.6	11	17.7	15	12.4	25
Rope, Wick, Braid & Cord	0.2	6	6.9	2	2.6	4
Finishing	5.7	2	7.5	1	29.9	2
Miscellaneous						

1 - All samples expressed as fibers $>5 \mu/\text{cc}$ by the Standard Method recommended in this document.

2 - Information prepared from NIOSH data.

TABLE XXI

ASBESTOS TEXTILE PLANT J

PERSONAL SAMPLES - SECULAR TRENDS

MEANS BY OPERATION WITH SAMPLE SIZE

OPERATION	1965		1967		1971	
	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES	MEAN	NO. OF SAMPLES
Fiber preparation	6.4	7	15.7	5	7.4	5
Carding	8.1	17	12.6	11	7.8	40
Spinning	7.9	14	27.4	11	3.7	2
Twisting	7.3	20	17.7	9	6.9	35
Winding			3.4	3	2.8	10
Weaving	5.6	47	6.8	12	10.0	16
Rope, Wick, Braid & Cord					3.5	2
Miscellaneous					2.5	4

1 - All samples expressed as fibers $>5 \mu/cc$ by the Standard Method recommended in this document.

2 - Information prepared from NIOSH data.

020201

TABLE XXII

ASBESTOS CEMENT PIPE
 PERCENT OF SAMPLES LESS THAN OR EQUAL TO 2 FIBERS/CC,
 5 FIBERS/CC AND 10 FIBERS/CC LONGER THAN 5 μ IN LENGTH,
 BY PLANT AND OPERATION
 () = NO. OF SAMPLES
 REPRESENTS FIBERS LONGER THAN 5 μ

OPERATION	PLANT N			PLANT O			PLANT P			PLANT Q			PLANT Z			PLANT AA			PLANT BB		
	X_2	X_5	X_10	X_2	X_5	X_10	X_2	X_5	X_10	X_2	X_5	X_10	X_2	X_5	X_10	X_2	X_5	X_10	X_2	X_5	X_10
Warehousing & Mixing	25 (4)	100	100	0	0 (2)	100	100	100	100	100	100	100	50 (2)	100	100	100	100	100	80 (5)	100	100
Pipe Forming	33 (3)	100	100	33	100 (6)	100	100	100	100	100	100	100	75 (4)	100	100	100	100	100	100	100	100
Curing	100 (3)	100	100	67	100 (3)	100	100	100	100	100	100	100	100 (4)	100	100	100	100	100	93 (15)	100	100
Pipe Finishing	100 (6)	100	100	100	100 (4)	100	100	100	100	80	100 (5)	100	70 (10)	100	100	100	100	100 (9)	100	100	100
Coupling Finishing	100 (4)	100	100	25	50 (4)	100	100	100	100	80	100 (5)	100	43 (7)	57	71	100	100 (21)	100	90 (10)	100	100
Epoxy	0 (1)	100	100	100	100 (1)	100	100	100	100	-	-	-	100 (5)	100	100	100	100	100 (1)	83 (6)	100	100
Packing	100 (4)	100	100	100	100 (1)	100	-	-	-	0	0 (1)	100	86 (7)	100	100	100	100 (13)	100	100 (6)	100	100
Miscellaneous	-	-	-	-	-	-	100	100 (9)	100	100	100 (3)	100	100 (9)	100	100	100	100 (8)	100	100 (6)	100	100

- Not Applicable

TABLE XXIII

ASBESTOS FRICTION PLANTS
 PERCENT OF SAMPLES LESS THAN OR EQUAL TO 2 FIBERS/CC,
 5 FIBERS/CC, AND 10 FIBERS/CC LONGER THAN $\frac{5}{8}$ "
 BY PLANT AND OPERATION
 () = NUMBER OF SAMPLES

OPERATION	PLANT H			PLANT M			PLANT S			PLANT T			PLANT U		
	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10
Mixing, Coating & Extruding	0	50 (2)	100	71	86 (7)	100	13	19 (16)	44	-	-	-	0	50 (2)	100
Forming	100	100 (6)	100	-	-	-	75	75 (4)	100	100	100 (2)	100	67	67 (3)	67
Hot Pressing	100	100 (7)	100	50	100 (4)	100	0	40 (5)	100	-	-	-	100	100 (2)	100
Baking	100	100 (2)	100	100	100 (2)	100	0	40 (5)	100	100	100 (2)	100	0	100 (1)	100
Grinding & Sanding	90	100 (10)	100	57	86 (7)	100	13	56 (16)	94	88	88 (8)	88	0	25 (4)	100
Cutting & Drilling	50	75 (12)	83	100	100 (7)	100	5	32 (22)	64	86	100 (7)	100	0	0 (1)	0
Bonding & Riveting	75	75 (4)	100	100	100 (1)	100	-	-	-	100	100 (1)	100	-	-	-
Inspecting & Packing	54	69 (13)	100	100	100 (4)	100	50	50 (4)	75	86	100 (7)	100	0	67 (3)	100
Miscellaneous	67	78 (9)	100	100	100 (1)	100	-	-	-	100	100 (5)	100	100	100 (3)	100

- Not applicable

U.S. G. P. O.

TABLE XXIV

ASBESTOS CEMENT SHINGLE, MILLBOARD AND GASKET
 PERCENT OF SAMPLES LESS THAN OR EQUAL TO 2 FIBERS/CC,
 5 FIBERS/CC, AND 10 FIBERS/CC LONGER THAN 5μ
 BY PLANT AND OPERATION
 () = NUMBER OF SAMPLES

OPERATION	$\bar{x} \leq 2$	PLANT R		$\bar{x} \leq 2$	PLANT U		$\bar{x} \leq 2$	PLANT W	
		$\bar{x} \leq 5$	$\bar{x} \leq 10$		$\bar{x} \leq 5$	$\bar{x} \leq 10$		$\bar{x} \leq 5$	$\bar{x} \leq 10$
Warehousing	100	100 (3)	100	100	100 (1)	100	-	-	-
Mixing	53	67 (15)	93	67	100 (3)	100	50	67 (6)	100
Forming	83	94 (18)	100	100	100 (6)	100	33	100 (3)	100
Curing	50	100 (2)	100	100	100 (2)	100	100	100 (1)	100
Finishing	71	94 (17)	100	86	100 (7)	100	71	100 (7)	100
Packing	75	100 (4)	100	100	100 (2)	100	100	100 (2)	100
Miscellaneous	100	100 (4)	100	100	100 (1)	100	100	100 (2)	100

- Not Applicable

TABLE XXV

ASBESTOS INSULATION PLANTS
 PERCENT OF SAMPLES LESS THAN OR EQUAL TO 2 FIBERS/CC,
 5 FIBERS/CC, AND 10 FIBERS/CC LONGER THAN 5μ
 BY PLANT AND OPERATION
 () = NUMBER OF SAMPLES

OPERATION	PLANT R			PLANT X			PLANT Y			PLANT CC			PLANT DD		
	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10	≤ 2	≤ 5	≤ 10
Mixing	57	71 (7)	86	0	0 (11)	18	0	0 (7)	0	100	100 (2)	100	67	67 (3)	67
Forming	90	90 (10)	100	0	0 (39)	15	0	9 (32)	13	100	100 (7)	100	100	100 (5)	100
Curing	-	-	-	0	0 (5)	40	-	-	-	100	100 (1)	100	100	100 (1)	100
Finishing	82	100 (11)	100	8	12 (26)	15	6	6 (17)	29	100	100 (4)	100	40	100 (5)	100
Inspection & Packing	100	100 (1)	100	13	27 (15)	40	0	16 (19)	63	100	100 (11)	100	63	100 (8)	100
Miscellaneous	-	-	-	21	46 (24)	54	40	100 (5)	100	100	100 (4)	100	50	100 (4)	100

- Not applicable

020205

TABLE XXVI

ASBESTOS TEXTILE PLANTS
 PERCENT OF SAMPLES LESS THAN OR EQUAL TO 2 FIBERS/CC,
 5 FIBERS/CC, AND 10 FIBERS/CC LONGER THAN 5 μ
 BY PLANT AND OPERATION
 () = NUMBER OF SAMPLES

OPERATION	PLANT A			PLANT B			PLANT C			PLANT D			PLANT E			PLANT G			PLANT J			PLANT K		
	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀	X ₂	X ₅	X ₁₀
Fiber Preparation	0	0 (4)	25	0	17 (12)	58	0	0 (3)	33	0	0 (3)	33	-	-	-	0	0 (2)	50	20	40 (5)	80	22	44 (9)	67
Carding	0	0 (10)	10	0	7 (30)	40	0	0 (4)	75	20	40 (10)	60	-	-	-	14	57 (14)	71	13	38 (40)	80	23	36 (22)	77
Spinning	0	9 (11)	36	5	26 (43)	77	0	36 (11)	91	0	13 (16)	44	-	-	-	0	33 (6)	100	0	100 (2)	100	3	14 (36)	42
Twisting	0	0 (7)	29	0	11 (19)	58	0	75 (4)	100	13	50 (8)	75	-	-	-	38	75 (8)	100	6	26 (35)	89	25	38 (8)	50
Winding	8	33 (12)	50	25	54 (24)	83	0	60 (5)	100	43	71 (7)	86	-	-	-	60	100 (5)	100	40	90 (10)	100	40	53 (40)	78
Weaving	4	16 (25)	44	16	58 (57)	86	36	100 (11)	100	8	33 (24)	88	67	100 (3)	100	8	50 (12)	100	0	25 (16)	56	26	76 (50)	96
Rope, Wick, Braid & Cord	50	75 (4)	100	40	100 (5)	100	-	-	-	33	33 (3)	33	-	-	-	-	-	-	0	100 (2)	100	75	100 (4)	100
Miscellaneous	0	0 (2)	0	33	67 (3)	100	-	-	-	0	50 (6)	83	100	100 (2)	100	0	50 (3)	50	50	100 (4)	100	80	91 (45)	100
Finishing	-	-	-	82	100 (28)	100	50	100 (2)	100	-	-	-	100	100 (5)	100	67	67 (2)	100	-	-	-	63	100 (8)	94

- Not Applicable

TABLE XXVII

Duration of employment and known exposure to Asbestos and the development of X-ray findings of Asbestosis in 232 employees of an Asbestos Insulation Factory, employed sometime in 1941-1945 and examined in 1969-1970.

X-RAY ASBESTOSIS

<u>DURATION OF EMPLOYMENT</u>	<u>TOTAL</u>	<u>0</u>	<u>+ -</u>	<u>1+</u>	<u>2+</u>	<u>3+</u>
1 DAY OR LESS	7	3	0	4	0	0
1 - 7 DAYS	13	4	3	5	1	0
1 - 4 WKS	15	5	3	6	1	0
1 - 3 MOS	35	6	5	23	1	0
3 - 6 MOS	35	8	3	19	5	0
6 - 12 MOS	31	5	3	15	5	3
1 - 2 YRS	48	7	5	25	8	3
2 - 5 YRS	36	3	8	16	6	3
5 - 14 YRS	<u>12</u> 232	1	0	5	4	2

ALL EMPLOYEES INCLUDED. EXPOSURES VARIED FROM "NONE" (OFFICE) THROUGH THAT OF MANAGEMENT, ENGINEERING AND SHIPPING, TO THAT OF PRODUCTION EMPLOYEES.

1 - Personal Communication Dr. Irving Selikoff, January, 1971.

020208

TABLE XXVIII

Lapsed period from onset of exposure in 344
deaths among employees of an asbestos
insulation factory, employed at some time
in 1941-1945 and followed to 1970.

<u>Cause of Death</u>	<u>Years from Onset</u>							<u>TOTAL</u>
	<u>0-4</u>	<u>5-9</u>	<u>10-14</u>	<u>15-19</u>	<u>20-24</u>	<u>25+</u>		
Lung cancer	0	3	8	14	16	18	=	59
Mesothelioma	0	0	0	0	2	2	=	4
G. I. cancer	1	1	6	3	4	3	=	18
Asbestosis	0	2	1	8	8	5	=	24
All other cancer	1	3	9	7	6	5	=	31
All other causes	<u>26</u>	<u>28</u>	<u>30</u>	<u>52</u>	<u>42</u>	<u>30</u>	=	<u>208</u>
TOTAL	28	37	54	84	78	63	=	344

1 - Personal communication Dr. Irving Selikoff, January, 1971.

TABLE XXIX

SUMMARY OF 4 CASE HISTORIES OF EXPOSURE TO
ASBESTOS AND SUBSEQUENT DEVELOPMENT OF MESOTHELIOMA

Race Sex	W M	W F	W M	W F
<u>Occupational History</u>				
Before asbestos exposure	None	Student	None	None
<u>Asbestos exposure</u>				
Duration of exposure	Unknown	6 weeks	3 years	Unknown - at least several yrs
Type of Work	Engineer	Pipe Insulation	Neighborhood exposure	Family exposure
After asbestos exposure	Unknown	Housewife	Bookkeeper-floor manager	Housewife
Type of asbestos	Chrysotile-amosite-crocidolite	Chrysotile-amosite	Chrysotile-amosite	Amosite
Respirator protection	None	None	NA	NA
<u>Mesothelioma History</u>				
Age at death	74	41	30	52
Site	Peritoneal & Pleural	Right Pleural	Pleural	Left Pleural
Histological diagnosis	Biphasic	(Biphasic) epithelial & fibrous	Biphasic Pleomorphic	-
Lapsed period since exposure	25 years	21 years	19 years	Unknown
Duration of illness	13 weeks	5 weeks	1 year	2 years
Concurrent asbestosis	Pleural Calcification	Grade I by X-Ray	None	None by X-Ray
Smoking history	0	40	20	NA
Duration of smoking history (years)	-	24	5 years Stopped in 1965	-
1 - Personal communication	Dr. Irving Selikoff - January, 1971.			

TABLE XXX

Observed and Expected Deaths Through December 31, 1969 by Cause and Dust Exposure Score, for 291 Males who Worked Primarily in Non-Asbestos Production and Maintenance Service Jobs and for 1464 Males who Worked Primarily in Asbestos Production and Maintenance-Service Jobs and Retired During 1941-1967, Showing Standardized Mortality Ratios (SMR's)

Accumulative exposure to asbestos in million parts per cubic foot years (mppcfyr)

Cause of Death and International List Number	Limited Exposure			< 125			125-250			250-500		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
All Causes	114	129.9	87.8	365	344.8	105.8	162	139.8	115.9	184	156.7	117.4*
All Cancer (140-205)	22	22.3	98.6	74	56.3	131.4*	23	23.6	97.4	52	26.4	197.1*
Digestive System (150-159)	9	8.2	109.8	27	21.9	123.3	5	8.9	56.2	19	10.0	190.0*
Lung, Bronchus, Trachea & Pleura (162-163)	8	4.8	166.7	18	10.7	168.2	11	4.9	224.5*	16	5.4	296.3*
All Other Cancer	5	9.3	53.8	29	23.7	122.4	7	9.8	71.4	17	11.0	90.9
Cerebral Vascular Lesions (330-334)	15	14.8	101.4	31	41.4	74.3	14	16.2	86.4	15	18.2	82.4
All Heart Disease (400-443)	46	60.8	75.6	168	161.2	104.2	72	65.5	109.9	75	73.3	102.3
Coronary Heart Disease (420)	39	48.9	80.1	129	124.8	103.4	59	52.2	113.0	55	57.8	95.2
All Other Heart Disease	7	12.1	57.8	39	36.4	107.1	13	13.3	97.7	20	15.5	129.0
Diseases of the Respiratory System (470-527)	10	7.7	129.9	26	19.0	162.5*	11	80	137.5	17	8.9	191.0*
Pneumoconiosis & Pulmonary Fibrosis (523-525)	5	-	-	8	-	-	3	-	-	8	-	-
All Other Causes	22	24.5	89.8	66	66.6	99.1	42	26.5	158.5*	25	29.9	83.6

* SMR significantly different from 100 at 5% level.

Source: A Study of the Dose-Response Relationship Between Asbestos Dust and Lung Cancer by Philip Enterline, Pierre DeCoufle and Vivian Henderson (Unpublished Manuscript)

TABLE XXX (continued)

Cause of Death and International List Number	500-750			>750								
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
All Causes	77	50.2	153.4*	34	26.2	129.8						
All Cancer (140-205)	18	8.7	206.9*	9	4.5	200.0						
Digestive System (150-159)	6	3.3	181.8	2	1.7	117.6						
Lung, Bronchus, Trachea & Pleura (162-163)	9	1.8	500.0*	5	0.9	555.6						
All Other Cancer	3	3.6	83.3	2	1.9	105.3						
Cerebral Vascular Lesions (330-334)	5	5.6	89.3	3	3.0	100.0						
All Heart Disease (400-443)	36	23.5	153.2*	11	12.3	89.4						
Coronary Heart Disease (420)	24	13.8	127.6	8	9.9	80.8						
All Other Heart Disease	12	4.7	255.3*	3	2.4	125.0						
Diseases of the Respiratory System (470-527)	11	2.8	392.8*	0	1.5	600.0*						
Pneumoconiosis & Pulmo- nary Fibrosis (523,525)	8	-	-	5	-	-						
All Other Causes	7	9.6	72.9	2	4.9	40.8						

*SMR significantly different from 100 at 5% level.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972 - 759-451/301

030311

Mud Service Company Price List

EFFECTIVE ON SHIPMENTS AFTER

~~January 15~~, 1979-
12/1/79

Listed inside are carload and field warehouse prices for our more active products.

A brief description of Montello products is given on the back page.

For complete information on any of these products, or for the answer to any related question, please call our 24 hour Tulsa number -- 918+665-1170

montello

P.O. BOX 130, SAND SPRINGS, OKLAHOMA 74063/(918)—245-6661/TWX 910-840-3007

TWX 910-845-2396
 24 HOUR TELEPHONE 918+665-1170
 Tulsa, Okla. 74135

Price List Effective 12/1/79

Product Name	Unit Description	Suggested Minimum
Mon Pac Ultra Lo	50# bag	600
Biotrol	5 gal. can	1 & up
Free Holē	5 gal. can	1 & up
HME Energizer	5 gal. can	1 & up
Mon Pac	50# bag	600
Mon Ex	50# case (2# pkgs.)	1 & up
Mon Hib	5 gal. can	1 & up
Pheno Seal (all grades)	40# bag	750
Superdril	50# bag	800
Super Lube Flow	50# bag	800
Super Visbestos	50# bag (shrink filmed)	1,200
FL-1	50# bag	800
Foam Brake	5 gal. can	1 + Up
Mon Det	5 gal. can	1 + Up
Slit	55 gal drum	1 + Up
Uni Vis	50# bag	1 + Up

1. Terms of sale to approved accounts are Net 30 to past due accounts. Prices subject to change w/ U.S. dollars, and include patent royalties where app.

2. Brief descriptions of Montell's products are given below:

1. Terms of sale to approved accounts are Net 30 to past due accounts. Prices subject to change with U.S. dollars, and include patent royalties where app

2. Brief descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24 hour number in Tulsa, collect - 918+245-6661. Also call this number for any other information, including:

—Export and CIF quotations.

—Detailed product information.

~Nearest field Representative.

- Assistance in arranging warehouse pick ups.

—Information on pool or split carloads.

Amoco Royalty-

Pheno Blend - 32# bag

HME - 10%

FL-1 - 57.

WHSE. 3U/T 266-3U34

Vernal, Utah

801+789-1696

Williston, North Dakota

701+572-2855

Lake Charles, Louisiana

318+
or 433-8547

New Iberia, Louisiana

Charlie Reeves
318+457-2612

Odessa, Tx . 915 + 383-4081

Ada. OK . 405 + 436 - 2521

Burns Flat, ok. 405 + 225-6845

OKlahoma City, OK 405-232-6893

Wilburton, OK 918 + 465-3842

Sand Springs, Oklahoma

918+245-6661

3. The conditions and use of the products set forth herein are beyond the control of Montello. For this reason any information, statements, recommendations or suggestions are made by Montello without warranty or guarantee, either express or implied. Also for this reason, Montello shall not be responsible for any failure to comply with any federal, state or local safety or environmental standard or regulation, which results from the use of its products.

In addition to these locations, Montello products are available from most Wyo Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call

020214

HME	- 5/gal	= 43-Lbs
SV	- 50 th bag	= 51-Lbs
DF Floc		45-Lbs
Foam Brake		40-Lbs

Handling chg. 60¢
Phen. Blank 76¢ cwt

HME	- 4.53 cwt New Ibera	
	- 4.39 cwt Duke Charles	
PS	- 1.53 cwt	
SV	- 3.01 cwt	
SD	- 3.16 cwt	
SLF	- 3.16 cwt	
Biotrol	- 4.36 cwt	- 45-lb can
D.F. Floc	- 7.00 cwt	
Mora Nib	6.00 cwt	

Brief product descriptions are listed below. Please call our Tulsa number (918+245-6661), collect, for complete details on any of these fine Montello products.

ACRIPOL	Readily soluble liquid sodium polyacrylate for easy addition to drilling fluids, in building filtration control without excessive viscosity increase.
ATTA GEL	A premium grade attapulgite clay, used primarily to build viscosity in salt water muds.
BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective, liquid preservative with low mammalian toxicity.
FILTROL	Pregelatinized corn starch for economical filtration control in salt contaminated drilling fluids.
FL-1 (Refined)	Improved organic polymer for building low solids, non-dispersed drilling fluids, regardless of contamination.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for non-dispersed aqueous systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.
IME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdril and Super Lube Flow.
HOLEMAKER FLOC	Selective, non-ionic, powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.
MON DET	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.
MON EX	Powdered copolymer clay extender and flocculant.
MON FOAM	Non-ionic surface-active agent formulated for use in oil field brines and fresh water. An excellent foamer, even in heavy brines, and is used in gas wells and air drilling for this reason.
MON HIB	Specially formulated film-forming amine corrosion inhibitor for use in high and low pH systems.
MON LUBE	Non-foaming drilling fluid lubricant for overall friction reduction, regardless of contaminants. Much more efficient than diesel or crude oil.
MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
SUPERDRIL	Modified gilsonite for hole stabilization primarily in dispersed drilling fluids.
SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale.
SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Montello

P.O. BOX 130, SAND SPRINGS, OKLAHOMA 74063



6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020216

MUD SERVICE COMPANY PRICE LIST

CARLOAD LOTS

EFFECTIVE MAY 1, 1980

Product	Unit Description	Suggested Minimum	F.O.B. Point	Unit Price
BIOTROL - Liquid biocide	5 gal can	1 & up	Sand Springs, OK	62.25
FOAM BRAKE - liquid defoamer	5 gal can	1 & up	Sand Springs, OK	32.75
HME ENERGIZER - selective surfactant	5 gal can	1 & up	Sand Springs, OK	32.75
MONTELLO DETERGENT - drilling detergent	5 gal can	1 & up	Sand Springs, OK	11.05
MON EX - powdered bentonite extender	50# case/ (2# bags)	1 & up	Sand Springs, OK	125.00
MON HIB - corrosion inhibitor	5 gal can	1 & up	Sand Springs, OK	51.90
MON PAC - anionic cellulosic polymer	50# bag	600 1 & up 1 & up 1 & up	Kobe, Japan Oakland, CA Houston, TX Denver, CO	74.75 82.65 83.00 83.00
MON PAC ULTRA 10 - extremely low viscosity Mon Pac	50# bag	600 1 & up 1 & up	Kobe, Japan Oakland, CA Houston, TX	80.25 88.15 88.50
PHENO SEAL - for lost circulation	40# bag	750	Sand Springs, OK	8.75
SUPERDRIL - treated gilsonite	50# bag	800	Craig, CO	14.75
SUPER LUBE FLOW - powdered gilsonite	50# bag	800	Craig, CO	12.50
SUPER VISBESTOS - viscosifier	50# bag, Loose Pallet, Wrapped	1200	King City, CA	8.35 8.75

GENERAL INFORMATION

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2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONDIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogenous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020218

MUD SERVICE COMPANY PRICE LIST
ROCKY MOUNTAIN WAREHOUSES
EFFECTIVE MAY 1, 1980

Product	Unit Description	(No Minimum - No Returns)	
		Casper, WY	Williston, ND
BIOTROL - liquid biocide	5 gal can	69.25	69.25
HME ENERGIZER - selective surfactant	5 gal can	38.25	40.25
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00	130.00
MON PAC - anionic cellulosic polymer	50# bag	104.25	106.75
PHENO SEAL - for lost circulation	40# bag	11.50	11.50
SUPERDRIL - treated gilsonite	50# bag	17.10	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	15.10	16.10
SUPER VISBESTOS - viscosifier	50# bag	12.45	12.45

GENERAL INFORMATION

Twenty-four hour numbers are listed below for the Rocky Mountain warehouses.
Call for street address or pick up information.

Casper, WY - 307+234-3493

Williston, ND - 701+572-2855

1. Terms of sale to approved accounts are Net 30 days, 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:

-Export and CIF quotations.

-Information on pool or split carloads.

-Detailed product information.

-Nearest field Representative.

-Assistance in arranging warehouse pick ups.

See reverse side for product descriptions
and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
MOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



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020220

MUD SERVICE COMPANY PRICE LIST
SOUTH LOUISIANA WAREHOUSES
EFFECTIVE MAY 1, 1980

Product	Unit Description	(No Minimum - No Returns)	
		Lake Charles	New Iberia
HME ENERGIZER - selective surfactant	5 gal can	38.25	38.25
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00	130.00
MON PAC - anionic cellulosic polymer	50# bag	95.05	
MON PAC ULTRA LO - extremely low viscosity Mon Pac	50# bag	103.15	
PHENO SEAL - for lost circulation	40# bag	11.50	11.50
SUPERDRIL - treated gilsonite	50# bag	18.10	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10	16.10
SUPER VISBESTOS - viscosifier	50# bag	12.45	

GENERAL INFORMATION

Twenty-four hour numbers are listed below for the South Louisiana warehouses.
Call for street address or pick up information.

Lake Charles, LA	-	318+433 8547
Night	-	318+457-2612
New Iberia, LA	-	318+364-5519
Night	-	318+457-2612

- Terms of sale to approved accounts are Net 30 days; 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
- Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONDIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water), invert oil emulsion drilling fluids, and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



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(918) 665-1170 / TWX 910-845-2396

020222

MUD SERVICE COMPANY PRICE LIST
SOUTH TEXAS WAREHOUSE
EFFECTIVE MAY 1, 1980

Product	Unit Description	(No Minimum - No Returns)
		Corpus Christi
BIOTROL - liquid biocide	5 gal can	69.25
HME ENERGIZER - selective surfactant	5 gal can	38.25
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00
PHENO SEAL - for lost circulation	40# bag	11.50
SUPERDRIL - treated gilsonite	50# bag	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10
SUPER VISBESTOS - viscosifier	50# bag	12.45

GENERAL INFORMATION

Twenty-four hour number is listed below for the South Texas warehouse.
Call for street address or pick up information.

Corpus Christi - 512+888-6593

1. Terms of sale to approved accounts are Net 30 days; 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918+665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions
and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIDTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid IP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogenous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



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020224

MUD SERVICE COMPANY PRICE LIST
WEST TEXAS WAREHOUSE
EFFECTIVE MAY 1, 1980

Product	Unit Description	(No Minimum - No Returns)
		Odessa
BIOTROL - liquid biocide	5 gal can	69.25
HME ENERGIZER - selective surfactant	5 gal can	38.25
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00
MON PAC - anionic cellulosic polymer	50# bag	98.50
MON PAC ULTRA LO - extremely low viscosity Mon Pac	50# bag	108.50
PHENO SEAL - for lost circulation	40# bag	11.50
SUPERDRIL - treated gilsonite	50# bag	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10
SUPER VISBESTOS - viscosifier	50# bag	12.45

GENERAL INFORMATION

Twenty-four hour number is listed below for the West Texas warehouse.
Call for street address or pick up information.

Odessa, TX - 915+333-4081

1. Terms of sale to approved accounts are Net 30 days. 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
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- Export and CIF quotations.
- Information on pool or split carloads.
- Detailed product information.
- Nearest field Representative.
- Assistance in arranging warehouse pick ups.

See reverse side for product descriptions
and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONDIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogenous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020226

MUD SERVICE COMPANY PRICE LIST
OKLAHOMA WAREHOUSES
EFFECTIVE MAY 1, 1980

Product	Unit Description	(No Minimum - No Returns)	
		Elk City	Ada
BIOTROL - liquid biocide	5 gal can	69.25	69.25
HME ENERGIZER - selective surfactant	5 gal can	38.25	38.25
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00	130.00
MON PAC - anionic cellulosic polymer	50# bag	95.05	95.05
MON PAC ULTRA LO - extremely low viscosity Mon Pac	50# bag	103.15	103.15
PHENO SEAL - for lost circulation	40# bag	11.50	11.50
SUPERDRIL - treated gilsonite	50# bag	18.10	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10	16.10
SUPER VISBESTOS - viscosifier	50# bag	12.45	12.45

GENERAL INFORMATION

Twenty-four hour numbers are listed below for the Oklahoma warehouses. Call for street address or pick up information.

Ada, OK - 405+436-2521
Elk City, OK - 405+225-6845

1. Terms of sale to approved accounts are Net 30 days; 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdril and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRIL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.

Montello

6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020228

CANADIAN
MUD SERVICE COMPANY PRICE LIST
CARLOAD LOTS
EFFECTIVE MAY 1, 1980

Product	Unit Description	Suggested Minimum	F.O.B. Point	Unit Price US DLRS
BIOTROL - liquid biocide	5 gal can	1 & up	Sand Springs, OK	62.25
FOAM BRAKE - liquid defoamer	5 gal can	1 & up	Sand Springs, OK	32.75
HME ENERGIZER - selective surfactant	5 gal can	1 & up	Sand Springs, OK	32.75
MON COSE - pure CMC Lo Vis	25 kilo bag	800	Vancouver, BC	70.93
MONTELLO DETERGENT - drilling detergent	5 gal can	1 & up	Sand Springs, OK	11.05
MON EX - powdered bentonite extender	50# case/ (2# bags)	1 & up	Sand Springs, OK	125.00
MON HIB - corrosion inhibitor	5 gal can	1 & up	Sand Springs, OK	51.90
MON PAC - anionic cellulosic polymer	25 kilo bag	800	Vancouver, BC	82.92
PHENO SEAL - for lost circulation	40# bag	750	Sand Springs, OK	8.75
SUPERDRIL - treated gilsonite	50# bag	800	Craig, CO	14.75
SUPER LUBE FLOW - powdered gilsonite	50# bag	800	Craig, CO	12.50
SUPER VISBESTOS - viscosifier	50# bag, Loose Pallet, Wrapped	1200	King City, CA	8.35 8.75

GENERAL INFORMATION

- Terms of sale to approved accounts are Net 30 days; 2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
- Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations,
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MONDIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
FOAM BRAXE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	MONI PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	MONI PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogenous drilling fluids, especially with Superdrill and Super Lube Flow.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	PHEND SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
MONTELLO DETERGENT	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SUPERDRIL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 405+436-2521
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo-Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect in Tulsa, 918+665-1170.



6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020230

MUD SERVICE COMPANY PRICE LIST
ROCKY MOUNTAIN WAREHOUSES
EFFECTIVE DECEMBER 1, 1979

Product	Unit Description	(No Minimum - No Returns)	
		Casper, WY	Williston, ND
BIOTROL - liquid biocide	5 gal can	67.75	67.75
HME ENERGIZER - selective surfactant	5 gal can	33.85	35.85
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00	130.00
MON PAC - anionic cellulosic polymer	50# bag	104.25	106.75
PHENO SEAL - for lost circulation	40# bag	10.10	10.10
SUPERDRIL - treated gilsonite	50# bag	17.10	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	15.10	16.10
SUPER VISBESTOS - viscosifier	50# bag	11.85	11.85

GENERAL INFORMATION

Twenty-four hour numbers are listed below for the Rocky Mountain warehouses.
Call for street address or pick up information.

Casper, WY - 307+234-3493

Williston, ND - 701+572-2855

1. Terms of sale to approved accounts are Net 30 days; 1 1/2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions
and field warehouse locations.

020231

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MONDIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
DF FLOC	Selective, non-ionic, liquid flocculant for easy addition to fresh or salt water drilling fluids, in maintaining low solids.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	PHENO BLEND	A balanced blend of the most effective bridging and sealing materials for control of lost circulation.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	RELEASE	A differential pressure surfactant formulated to reduce differential sticking forces, drag and torque on drill pipe.
MON DET	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EI	Powdered copolymer clay extender and flocculant.	SODIUM BICHROMATE (LIQUID)	Liquid form of sodium bichromate used for corrosion inhibition and to rejuvenate organic dispersants.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 915+333-4081
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect, in Tulsa, 918+665-1170.



6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

020232

MUD SERVICE COMPANY PRICE LIST
SOUTH LOUISIANA WAREHOUSES
EFFECTIVE DECEMBER 1, 1979

Product	Unit Description	(No Minimum - No Returns)	
		Lake Charles	New Iberia
HME ENERGIZER - selective surfactant	5 gal can	33.85	33.85
MON COSE - pure CMC lo vis	50# bag	77.70	
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00	130.00
MON PAC - anionic cellulosic polymer	50# bag	89.70	
MON PAC ULTRA LO - extremely low viscosity Mon Pac	50# bag	97.50	
PHENO SEAL - for lost circulation	40# bag	10.10	10.10
SUPERDRIL - treated gilsonite	50# bag	18.10	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10	16.10
SUPER VISBESTOS - viscosifier	50# bag	11.85	11.85

GENERAL INFORMATION

Twenty-four hour numbers are listed below for the South Louisiana warehouses.
Call for street address or pick up information.

Lake Charles, LA	-	318+433-8547
Night	-	318+457-2612
New Iberia, LA	-	318+364-5519
Night	-	318+457-2612

1. Terms of sale to approved accounts are Net 30 days; 1 1/2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Detailed product information.
 - Assistance in arranging warehouse pick ups.
 - Information on pool or split carloads.
 - Nearest field Representative.

See reverse side for product descriptions
and field warehouse locations.

020233

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOFLOC	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
DF FLOC	Selective, non-ionic, liquid flocculant for easy addition to fresh or salt water drilling fluids, in maintaining low solids.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	DET-S	Liquid, non-catalyzed, long life oxygen scavenger.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	PHENO BLEND	A balanced blend of the most effective bridging and sealing materials for control of lost circulation.
HMC ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	RELEASE	A differential pressure surfactant formulated to reduce differential sticking forces, drag and torque on drill pipe.
MON DET	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole sticking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SODIUM BICHROMATE (LIQUID)	Liquid form of sodium bichromate used for corrosion inhibition and to rejuvenate organic dispersants.
MON HIB	Specially formulated film forming anionic corrosion inhibitor for use in high and low pH systems.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 915+333-4081
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect, in Tulsa, 918+665-1170.

020234

Montello

6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

MUD SERVICE COMPANY PRICE LIST
WEST TEXAS WAREHOUSE
EFFECTIVE DECEMBER 1, 1979

Product	Unit Description	(No Minimum - No Returns) Odessa
BIOTROL - liquid biocide	5 gal can	67.75
HME ENERGIZER - selective surfactant	5 gal can	33.85
MON COSE - pure CMC lo vis	50# bag	88.50
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00
MON PAC - anionic-cellulosic polymer	50# bag	98.50
MON PAC ULTRA LO - extremely low viscosity Mon Pac	50# bag	108.50
PHENO SEAL - for lost circulation	40# bag	10.10
SUPERDRIL - treated gilsonite	50# bag	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10
SUPER VISBESTOS - viscosifier	50# bag	11.85

GENERAL INFORMATION

Twenty-four hour number is listed below for the West Texas warehouse.
Call for street address or pick up information.

Odessa, TX - 915+333-4081

- Terms of sale to approved accounts are Net 30 days. 1 1/2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
- Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Information on pool or split carloads.
 - Detailed product information.
 - Nearest field Representative.
 - Assistance in arranging warehouse pick ups.

See reverse side for product descriptions
and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MONOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
DF FLOC	Selective, non-ionic, liquid flocculant for easy addition to fresh or salt water drilling fluids, in maintaining low solids.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FL-1	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	OXY-S	Liquid, non-catalyzed, long life oxygen scavenger.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	PHENO BLEND	A balanced blend of the most effective bridging and sealing materials for control of lost circulation.
HME ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	RELEASE	A differential pressure surfactant formulated to reduce differential sticking forces, drag and torque on drill pipe.
MON DET	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SODIUM BICHROMATE (LIQUID)	Liquid form of sodium bichromate used for corrosion inhibition and to rejuvenate organic dispersants.
MON HIB	Specially formulated film forming anionic corrosion inhibitor for use in high and low pH systems.	SUPERDRIL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling sloughing shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 915+333-4081
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect, in Tulsa, 918+665-1170.

020236

Montello

6106 EAST 32ND PLACE
TULSA, OKLAHOMA 74135
(918) 665-1170 / TWX 910-845-2396

MUD SERVICE COMPANY PRICE LIST
SOUTH TEXAS WAREHOUSE
EFFECTIVE DECEMBER 1, 1979

Product	Unit Description	(No Minimum - No Returns)
		Corpus Christi
BIOTROL - liquid biocide	5 gal can	67.75
HME ENERGIZER - selective surfactant	5 gal can	33.85
MON EX - powdered bentonite extender	50# case/ (2# bags)	130.00
PHENO SEAL - for lost circulation	40# bag	10.10
SUPERDRIL - treated gilsonite	50# bag	18.10
SUPER LUBE FLOW - powdered gilsonite	50# bag	16.10
SUPER VISBESTOS - viscosifier	50# bag	11.85

GENERAL INFORMATION

Twenty-four hour number is listed below for the South Texas warehouse.
Call for street address or pick up information.

Corpus Christi - 512+888-6593

1. Terms of sale to approved accounts are Net 30 days, 1 1/2% per month added to past due accounts. Prices subject to change without notice. All prices are in U.S. dollars, and include patent royalties where applicable.
2. Descriptions of Montello products are given on the back page. For prices on products not listed above, please call our 24-hour number in Tulsa, collect 918-665-1170. Also call this number for any other information, including:
 - Export and CIF quotations.
 - Detailed product information.
 - Assistance in arranging warehouse pick ups.
 - Information on pool or split carloads.
 - Nearest field Representative.

See reverse side for product descriptions
and field warehouse locations.

The following is a list of Montello's proprietary products, with brief descriptions. In addition to the products listed, Montello can supply a full range of standard drilling fluid additives. For complete product information or assistance on any related question, call or write our Tulsa office, collect, day or night.

BIOTROL	Economical, easily handled, non-selective biocide for all aqueous environments, including drilling fluids. A very effective liquid preservative with low mammalian toxicity.	MOMOIL CONCENTRATE	A liquid concentrate designed as the primary additive for the formulation of oil base drilling fluids (no water); invert oil emulsion drilling fluids; and completion fluids.
DF FLOC	Selective, non-ionic, liquid flocculant for easy addition to fresh or salt water drilling fluids, in maintaining low solids.	MON PAC	High molecular weight, polyanionic cellulosic polymer for filtration and viscosity control in contaminated drilling fluid systems.
FL-I	A natural organic polymer with a high encapsulating affinity for shales. Produces minimum viscosity. For use in inhibitive, low solids, non-dispersed systems.	MON PAC ULTRA LO	Cellulosic polymer for filtration control with minimum increase in viscosity.
FOAM BRAKE	Specially formulated liquid drilling fluid defoamer, primarily for low solids, non-dispersed polymer systems.	DIY-S	Liquid, non-catalyzed, long life oxygen scavenger.
FREE HOLE	Additive for oil in building spotting fluid to free stuck pipe.	PHENO BLEND	A balanced blend of the most effective bridging and sealing materials for control of lost circulation.
MMC ENERGIZER	Selective, non-ionic surface active agent for building homogeneous drilling fluids, especially with Superdrill and Super Lube Flow.	PHENO SEAL	High strength, inert plastic chips for superior bridging, to control lost circulation in all drilling fluids. (Three grades)
HOLEMAKER FLOC	Selective, non-ionic powdered flocculant for maintaining low solids in fresh or salt water drilling fluids.	RELEASE	A differential pressure surfactant formulated to reduce differential sticking forces, drag and torque on drill pipe.
MON DET	Biodegradable drilling detergent for improved water base drilling fluid lubricity and reduced drag.	SLIX	Liquid extreme pressure hole slicking agent. Non-fluorescent, non-corrosive, biodegradable, non-petroleum base.
MON EX	Powdered copolymer clay extender and flocculant.	SODIUM BICHROMATE (LIQUID)	Liquid form of sodium bichromate used for corrosion inhibition and to rejuvenate organic dispersants.
MON HIB	Specially formulated film forming amine corrosion inhibitor for use in high and low pH systems.	SUPERDRILL	Modified gilsonite for hole stabilization, primarily in dispersed drilling fluids.
MON LUBE	Non-foaming drilling fluid EP lubricant for overall friction reduction, regardless of contaminants.	SUPER LUBE FLOW	Pure, non-toxic, pulverized gilsonite for controlling slaughting shale. Also for building viscosity and improving filtration control in oil base systems.
		SUPER VISBESTOS	Presheared, wet-refined, condensed asbestos for quick yield and viscosity in all drilling fluids.

Twenty-four hour numbers are listed below for Montello field warehouses. Call for street address or pick up information.

Casper, WY	- 307+234-3493	Ada, OK	- 915+333-4081
Williston, ND	- 701+572-2855	Elk City, OK	- 405+225-6845
Lake Charles, LA	- 318+433-8547	Oklahoma City, OK	- 405+232-6893
Night	- 318+457-2612	Tulsa, OK	- 918+665-1170
New Iberia, LA	- 318+364-5519	Corpus Christi, TX	- 512+888-6593
Night	- 318+457-2612		
Odessa, TX	- 915+333-4081		

In addition to these locations, Montello products are available from most Wyo Ben Products Company warehouses throughout Canada.

If any difficulty is encountered, call our twenty-four hour number collect, in Tulsa, 918+665-1170.

PRODUCT

Oil Net Asbestos

70th

Odessa

[illegible]

Odessa

PRODUCT Oil Nit Asbestos 70# Large

[illegible]

PRODUCT

Ada w/h

DATE	DESCRIPTION	IN	OUT	BALANCE
8/15/77	From O/F	234		234
10/14/77	From O/F	81		315
10/31/77	Old Chem 9464 S.S. 8521		72	243
11/7/77	Old Chem 9481 8554		30	213
12/9	1 ton for	15		228
2/10/78	Old Chemical 9599 8556		40	188
12/31/77		16		204
8/22/78	Superior mud 10291 9675		40	164
9/13/78	Dmf 10353 9107		75	89
9/30/78	adli	7		96
11/10/78	1 ton for Superior mud 10533 CW 9129	17		113
2/7/79	Cruspy Dalg 10722 9155		113	-0-
8-31-79	Transferred from Wilbertson	300		200
8/31/79	Broken		2	198
9/5/79	Transferred to Lt Chem 11058		200	-0-
11/5/79	Rec'd when 11548		98	98
11/18/79	B+B Dalg 11698 11552		30	68
11/25/79	B+B Dalg 11584 11554		5	63
11/30/79	B+B Dalg (credit) 11571 CW 11540	5		68
12/1/79	adli	2		70
1/18/80	Bund 11720 12209		40	30
7/1/80	Rec'd when 12212	260		270
10/1/80	d-Q mud Co 12927 13357		2	268
11/1/80	Big Mud Co 12981 13359		3	265

020241

PRODUCT

Super Cheaters

Hillston

DATE	DESCRIPTION	IN	OUT	BALANCE
7/6/80	Petro Chem 12662 13119		40	180
7/6/80	Petro Chem 12495 13120		78	102
7/11/80	Rec'd when 13121	840		942
7/15/80	Longhuden 12491 13126		50	892
7/19/80	Petro Chem 12045 13123		40	
7/20/80	Petro Chem 12046 13122		40	
7/19/80	Petro Chem 12046 13124		50	762
8/3/80	Petro Chem 12532 13127		14	748
7/21/80	adi. L. min		59	689
8/1/80	Petro Chem 12666 13424		40	649
8/1/80	Petro Chem 12664 13423		10	639
9/3/80	Rough Riders 12724 13471		120	519
9/4/80	Petro Chem 12764 13429		90	429
9/27/80	Petro Chem 12831 13430		50	379
10/1/80	Petro Chem 12893 13432		19	360
10/20/80	Petro Chem 12899 13434		50	310
11/10/80	Petro Chem 12942 13444		60	250
11/15/80	Petro Chem 13015 13444		40	210
11/30/80	4 Bags Discharged		4	206
12/1/81	Petro Chem 13290 13458		160	46
2/1/81	Petro Chem 13371 13463		46	-0-
2/23/81	Rec'd when 13464	840		840
2/23/81	Petro Chem 13443 13466		30	810
2/23/81	Petro Chem 13442 13467		50	760
4/4/81	Petro Chem 13658 14403		26	734
6/15/81	Petro Chem 13916 14415		40	694
9/1/81	Petro Chem 14299 14441		10	684
9/1/81	Petro Chem 14352 15101		10	674
9/23/81	Diner Chem 14367 15103		25	649
10/6/81	Petro Chem 14434 15107		50	599
10/9/81	Petro Chem 14449 15109		40	559
10/10/81	Petro Chem 14493 15110		50	509
10/13/81	Petro Chem 14494 15111		30	479
10/13/81	Diner Chem 14486 15112		50	429
10/24/81	Rec'd when 14516 15113		50	379 ✓

020242

PRODUCT *Super Vichestas**Hallston*

DATE	DESCRIPTION	IN	OUT	BALANCE
2/25/80	Petro-Chem 11861 12751		50	143
2/27/80	Petro-Chem 11898 12768		60	83
3/1/80	Dresser 11887 12233		40	43
3/5/80	Dresser 11908 12235		20	23
3/10/80	Petro-Chem 11930 12231		47	(24)
3/11/80	rec'd whse 12766	840		816
3/17/80	Petro-Chem 11946 12240		20	796
3/19/80	Petro-Chem 11945 12239		50	746
3/20/80	Petro-Chem 11956 12242		25	721
3/24/80	Petro-Chem 11994 12243		20	701
3/27/80	Dresser 12017 12246		75	626
3/31/80	Petro-Chem 12036 12247		30	596
4/2/80	Dresser 12018 12754		20	576
4/1/80	Petro-Chem 12038 12248		40	536
4/6/80	Petro-Chem 12056 12765		12	
4/8/80	Imco Inc. 12053 12755		50	
4/11/80	Imco Inc. 12052 12758		100	374
4/13/80	Petro-Chem 12010 12759		20	354
5/1/80	Petro-Chem 12168 13082		12	342
5/6/80	Petro-Chem 12186 13086		32	310
5/1/80	rec'd whse 13085	840		1150
5/1/80	Petro-Chem 12222 13091		100	
5/13/80	Petro-Chem 12220 13089		100	
5/14/80	Petro-Chem 12219 13088		50	
5/14/80	Petro-Chem 12221 13090		20	880
5/21/80	Barrid 12267 13095		22	758
5/27/80	Petro-Chem 12217 13096		120	
5/27/80	Petro-Chem 12216 13095		53	685
5/28/80	Longhider 12302 13099		80	605
6/1/80	Longhider 12349 13107		25	580
6/1/80	Petro-Chem 12341 13106		70	510
6/1/80	Petro-Chem 12371 13109		75	435
6/1/80	Barrid 13111		100	335
6/1/80	Barrid 13111		100	335
6/1/80	Petro-Chem 12384 13112		40	295
6/19/80	Barrid (Return) 13114	100		395
6/21/80	Petro-Chem 12399 13113		75	
6/21/80	Petro-Chem 12400 13115		80	
6/21/80	Petro-Chem 12402 13116		20	220

020243

William

Super Products

DATE	DESCRIPTION	IN	OUT	BALANCE
3/6/79	Milkman, Inc. 10793 11364		70	380
4/2/79	Milkman, Inc. 10836 11364		50	330
3/5/79	Ad. & Exc. Ticket 11566	62		392
4/10/79	Milkman, Inc. 10865 11370		150	242
4/30/79	Ad. & Exc. Ticket 11373		69	173
5/11/79	Milkman, Inc. 10948 11373		50	123
5/17/79	Milkman, Inc. 10953 11375		100	23
5/25	Milkman, Inc. 10974 11378		21	2
6/3/79	Milkman, Inc. 11379 880			880
6/13/79	Milkman, Inc. 11043			
6/19/79	Milkman, Inc. 11380			
6/19/79	Milkman, Inc. 11035 11382		80	622
6/19/79	Milkman, Inc. 11030 11381		50	572
6/23/79	Milkman, Inc. 11043 11385		50	522
6/30/79	Ad. & Exc. Ticket 11566		2	520
8/1/79	Milkman, Inc. 11144 11606		80	440
8/2/79	Milkman, Inc. 11170 11610		40	400
8/29/79	Milkman, Inc. 11201 11612		50	350
8/28/79	Milkman, Inc. 11252 11611		30	320
9/1/79	Milkman, Inc. 11220 11628		50	270
9/1/79	Milkman, Inc. 11251 11613		100	170
9/5/79	Milkman, Inc. 11235 11615		100	70
9/6/79	Milkman, Inc. 11236 11614		20	50
9/10/79	Milkman, Inc. 11251 11617		49	1
9/22	Milkman, Inc. 11618 850			851
10/4/79	Milkman, Inc. 11218 11620		100	751
10/6/79	Milkman, Inc. 11301 11621		50	701
10/28/79	Milkman, Inc. 11301 11627		25	676
10/29/79	Milkman, Inc. 11301 11626		40	636
10/31/79	Milkman, Inc. 11301		1	635
11/3/79	Milkman, Inc. 11661		42	593
11/3/79	Milkman, Inc. 11528 11660		30	563
11/20/79	Milkman, Inc. 11525 11665		30	533
12/4/79	Milkman, Inc. 11559 11668		20	513
12/5/79	Milkman, Inc. 11559 11669		120	393
12/28/79	Milkman, Inc. 11639 11676		9	384
1/4/80	Milkman, Inc. 11659 11677		30	354
1/30/80	Milkman, Inc. 11785 12775		25	329
2/1/80	Milkman, Inc. 11825 12773		40	289
2/2/80	Milkman, Inc. 11829 12769		96	193

020244

PRODUCT

*Super Visbestos**Millerton*

DATE	DESCRIPTION	IN	OUT	BALANCE
1/23/78	Bussit 9677 8846		20	55
2/1/78	Shunt		35	-0-
3/7/78	Rec'd whse 8849	600		600
3/24/78	Mitchem Inc 8852		50	550
3/29/78	Peter Chen 8853		100	450
4/11/78	Mitchem Inc 9881 8856		200	250
4/1/78	Mitchem Inc 9895 8858		200	50
4/26/78	Relg. Mut 9930 8859		50	-0-
5/23/78	Rec'd whse 8861	850		850
6/1/78	Bussit 10038 8862		50	800
6/2/78	Mitchem 10024 8864		100	700
6/3/78	Mitchem 10023 8865		20	680
6/7/78	Mitchem 10043 8868		100	580
6/9/78	Mitchem 10051 8870		150	430
6/12/78	Bussit 10050 9376		150	280
6/22/78	Peter Chen 10071 9382		100	180
6/29/78	Peter Chen 10072 9380		150	30
6/29/78	Rec'd whse	350		380
7/6/78	Bussit 10113 9387		150	230
7/15/78	Mitchem 10151 9389		30	200
7/17/78	Relg. Mut Inc 10146 9388		30	170
7/11/78	Mitchem Inc 10172 9392		10	160
7/17/78	Mitchem Inc 10166 9391		40	120
7/20/78	Relg. Mut Inc 10182 9393		70	50
7/25/78	Relg. Mut 9395		50	-0-
8/4/78	Rec'd whse 9397	399		399
8/8/78	Relg. Mut Inc 10237 9399		25	374
8/18/78	Mitchem Inc 10246 9400		100	274
8/10/78	Relg. Mut 10231 9083		80	194
8/14/78	Relg. Mut 10262 9084		194	-0-
8/28/78	Rec'd whse 9088	849		849
9/9/78	Relg. Mut 10347 9092		50	799
9/13/78	Dresser 10351 9094		50	749
9/22/78	Drilling Mut 10371 9097		100	649
10/27/78	Bussit Mut 10562 11088		100	549
10/27/78	Mitchem Inc 10564 11090		100	449
11/5/78	Dresser 10565 11086		50	399
12/15/78	Dresser 10666 cm 11096	50		449
3/16/79	adj.	1		450

020245

PRODUCT *Crushed Super Viskates**Shelton*

DATE	DESCRIPTION	IN	OUT	BALANCE
3/29/76	Imco 8392 7509		200	640
4/4/76	Mitchem Inc 8405 7510		100	540
4/12/76	Mitchem Inc 8416 7511		100	
	Mitchem Inc 8417 7512		100	340
4/24/76	see w/H 7514	790		1130
5/6/76	Barrit 8442 7518		40	
5/1/76	Barrit 8441 7517		40	1050
5/9/76	Barrit 8465 7519		50	1000
5/24/76	Imco 8478 7521		200	800
6/5/76	Imco 8489 7522		100	700
6/16/76	Barrit 8500 7525		30	670
8/4/76	Imco 8589 7779		60	610
8/23/76	Imco 8617 7782		200	410
9/1/76	Barrit 8635 7783		90	320
9/16/76	Imco 8679 7788		200	120
9/17/76	Barrit 8678 7784		123	--
9/25/76	see w/H 7744	850		850
10/8/76	Barrit 8724 7715		150	700
10/15/76	Imco 8730 7741		30	670
10/27/76	Barrit 8757 7786		40	630
11/20/76	Barrit 8811 8221		150	480
12/6/76	Barrit 8867 8227		50	430
12/13/76	Barrit 8915 8229		60	370
1/5/77	Only Mnt Inc 8956 8230		20	350
3/2/77	Mitchem Inc 9051 8239		80	270
4/16/77	Barrit 9112 8433		100	170
5/23/77	see w/H 8440	450		620
6/16/77	Barrit 9211 8446		40	580
6/20/77	Barrit 9219 8448		60	520
6/24/77	Barrit 9223 8576		75	445
6/28/77	Barrit 9232 8578		150	295
7/6/77	Barrit 9243 8580		200	95
7/27/77	see w/H 7095	400		495
7/25/77	Mitchem Inc 9287 8585		50	445
8/25/77	Barrit 9330 8588		80	365
9/6/77	Only Mnt Inc 9349 8589		30	335
10/20/77	Only Mnt Inc 9577 8597		100	235
1/3/78	Mitchem Inc 9631 8598		100	135
1/14/78	Mitchem Inc 9666 8600		60	75

020246

PRODUCT *Crushed Super Washstar**Wilmington*

DATE	DESCRIPTION		IN	OUT	BALANCE
6/7/74	PO 1683	(6003)	450		572
7/1/74	Imco	7152 (6009)		100	472
7/14/74	Imco	7153 (6008)		100	372
7/29/74	Imco	7185 (6011)		100	272
8/26/74	PO 1719	(6014)	450		722
8/27/74	Imco	7220 (6013)		200	522
9/20/74	Imco	7269 (6017)		50	472
10/18/74	Imco	7336 (6019)		140	332
11/12/74	Imco	7367 (6032)		75	257
11/21/74	PO 1785	(6053)	400		657
11/21/74	Imco	7445 (6056)		50	607
8/23/75	Baroid	7954 (7186)		450	157
9/9/75	Rec'd in w/h	7192	850		1007
9/10/75	Q K Black	8000 (7193)		30	977
9/20/75	Baroid	8007 (7194)		100	877
9/23/75	Baroid	8018 (7200)		100	777
11/1/75	Imco	8109 7305		150	627
10/29/75	Q K Black	8095 7303		100	527
11/1/75	Q K Black	8116 7306		60	467
11/4/75	Imco	8104 7307		100	367
11/4/75	Imco	8107 7308		100	267
11/19/75	Imco	8136 7311		200	67
11/25/75	2m Stock		392		459
11/28/75	Baroid	8179 7313		65	394
12/10/75	Baroid	8206 7316		100	294
12/19/75	Imco	8236 7317		150	144
12/22/75	Q K Black	8235 7318		60	84
12/23/75	Baroid	8234 7319		50	34
12/31/75	Q K Black	8230 7321		34	-0-
1/14/76	Imco	8266 7324		200	(200)
1/14/76	rec'd in w/h	7323	800		600
1/17/76	Baroid	8267 7501		40	560
1/14/76	Q K Black	8280 7322		100	460
1/23/76	Q K Black	8281 7503		30	430
1/20/76	Melchem Inc	8290 7502		60	370
2/26/76	Baroid Inc	8347 7505		80	290
2/27/76	Imco	8357 7506		200	90
3/8/76	Rec'd in w/h	7508	850		940
3/8/76	Melchem Inc	8369 7507		100	840

020247

PRODUCT

Crushed
Super 2's

W. H. Stewart - M. A. T. J. Black

DATE	DESCRIPTION	IN	OUT	BALANCE
8/24/72	P01314 Willis (4821)	1200		1200
9/24/72	Willis 5683 (5372)		30	1170
9-27-72	magnal 5686 (5372)		30	1140
10/4/72	mags 5703 (5377)		10	1130
10/1/72	To J Black (5382)	20		1150
10/4/72	Imco 5723 (5378)		150	1000
10/16	Wyo Ben 5736 (5385)		20	980
10/20	Imco 5743 (5387)		50	930
10/24	MAG Ben 5754 (5389)		85	845
10/21	Imco 5757 (5388)		80	765
11/2/72	Wyo Ben 5791 (5259)		300	
11/11/72	Imco 5790 (5258)		30	435
11/9/73	Bonnel 5871 (5271)		100	335
2/6/73	Imco 5915 (5273)		50	285
2/20	J K Black 5964 (5274)		8	277
4/9/73	J K Black 5993 (5275)		85	192
5/8/73	Imco	200		392
7-15-73	Imco	500		342
7-16-73	Imco	500		342
7/2/73	Mod.			192
9/7/73	Imco 6211 (5286)		100	
9/7/73	Imco 6210 (5287)		60	32
9/27/73	P01529 (5288)	400		432
9/25/73	Imco 6256 (5289)	60		492
10/73	Imco 6308 (5292)		40	452
10/26	Imco 6358 (5294)		100	352
11/26/73	Imco 6503 (5979)		150	202
1/26/74	Imco 6518 (5980)		100	102
1/26/74	Imco		1.00	2
2/27/74	P01620	600		602
3/18/74	Imco 6576 (5981)		100	502
4/3/74	Imco 6640 (5982)		30	472
5/1/74	Imco 7019 (5987)		100	
5/2/74	Imco 7020 (5988)		150	222
5/10/74	Imco 7027 (5990)		150	72
5/17/74	Imco 7044 (5994)	200		272
5/23/74	Imco 7074 (5994)		100	172
5/27/74	Imco		50	122

Wallerstein

Super Vis

DATE	DESCRIPTION	IN	OUT	BALANCE
6/16/72	Phil Farrant			925-
6-2-72	Dinner 5521 (4805)		20	905
6-14-72	LMC 5522 (4804)		50	855-
7-11-72	Dinner 5549 (4806)		20	835
7-31-72	Dinner 5560 (4809)		20	815
8-11-72	LMC 5590 (4814)		100	715
8-10-72	LMC 5591 (4811)		100	615
8-10-72	LMC 5592 (4812)		125	490
8-11-72	Matchbook 5594 (4813)		40	450
8/14/72	LMC 5622 (4816)		100	350
8/18/72	LMC 5623 (4818)		150	200
9/10/72	LMC 5652 (5249)		50	150
9/17/72	LMC 5650 (5246)		130	20
10/1/72	FR - Hillen	20		-0-

PRODUCT

Super Vestos -

Williston

DATE	Balance	DESCRIPTION	IN	OUT	BALANCE
9-23-71	✓	Druck 5131 - Baroid (4577)		100	
9-30-71	✓	Druck 5136 (4579)		100	
✓	Druck 5137 (4580)			100	
✓	Druck 5138 (4581)			75	
✓	Druck 5139 (4582)			100	
✓	Baroid 5140 (4583)			150	
✓	Druck 5141 (4584)			100	
✓	✓ 5142 (4585)			125	<1189
9/71	PO 1501 - K144 (4586)	1200			
9/71	PO 1499 - K144 (4575)	882	9/31		943
10-11-71	Druck 5156 (4587)			275	
✓	Baroid 5158 (4589)			30	
✓	✓ 5159 (4590)			50	
✓	Druck 5160 (4591)			320	
10-18-71	Druck 5167 (4592)			100	
✓	Druck 5168 (4593)			100	
✓	Druck 5169 (4594)			100	
✓	Druck 5170 (4595)			100	
10/11	P.O. 1514 - (Vol. 1, 1971) (4597) ^{BNW} 4550	1062			
10/23	P.O. 1520 - MP355899 (4601)	1200			
10/26	P.O. #1525 (Vol. 1, 1971) (4607) ^{BNW} 319668	200	10/30		2330
11-19-71	Druck 5216 (4612)			100	
✓	Druck 5218 (4613)			75	
11-30-71	Druck 5227 (4614)			35	
12-3-71	Druck 5242 (4773)			35	
✓	Druck 5243 (4774)	11/30		200	1085
12-14-71	Druck 5256 (4775)			50	
12-28-71	Druck 5277 (4777)			25	
✓	Druck 5278 (4778) ^{BNW} 4761			40	1770
2/11/72	Druck 5326, 5327 (4782 & 4783)			70	1700
3/1/72	Druck 5367 (4786) ^{BNW} 4752			100	1600
✓	Druck 5368 (4787) 2/2/72			100	1500
✓	Druck 5369 (4788) 2/9/72			20	1480
✓	Druck 5366 (4784) 2/7/72			30	1450
3-9-72	Druck 5396 (4791)			50	1400
3-31-72	Druck 5399 (4817)			75	1325
4-3-72	Druck 5402 (4792)			100	1225
5-1-72	Druck 5426 (4795)			100	1125
5-16-72	Druck 5453 (4799)			200	925

STRAIGHT BILL OF LADING - SHORT FORM - ORIGINAL-NOT NEGOTIABLE

020250 11

Malton Trucking
(Name of Carrier)

Carrier's No. _____

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

Shipper's No. 1105150VAt King City (Welby), Ca. 6-27, 1985 From**Calidria**
CORPORATION*In Emergencies call 304-744-3487**Callant*

The property described herein is in apparent good order, except as noted, contents and condition of contents of packages unknown, marked, consigned, and destined as indicated below, which said carrier, the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract, agrees to carry to its usual place of delivery at said destination, if on its route otherwise to deliver to another carrier on the route to said destination. It is mutually agreed by the carrier of all or any of said property over all or any portion of said route to destination and at each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth in the Uniform Freight Classification in effect on the date hereof, if this is a rail or a rail-water shipment, or "I" in the applicable motor carrier classification or tariff, if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof set forth in the classification or tariff which governs the transportation of this shipment and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consigned to Montell Inc % Agri Express Customer's Order No. 42212
Destination Odessa State Texas County _____

Route _____

Delivering Carrier _____ Car or Vehicle Initials _____ No. _____ Seal No. _____

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
300 bags (20 pallets)	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0-0-8-8. MATERIAL CERTIFIED TO TEST NOT MORE THAN 0-0-8-8. (Rail)				Signature of Consignor If charges are to be prepaid, write or stamp here, "To Be Prepaid." TO BE PREPAID Received \$ _____ to apply in prepayment of the charges on the property described hereon. Agent or Cashier Per _____ (The signature here acknowledges only the amount prepaid.) Charges Advanced \$ _____ 1. The fibre boxes used for this shipment conform to the specifications set forth in the box maker's certificate thereon, and all other requirements of Rule 41 of the Uniform Freight Classification.
	ASBESTOS SHORTS OR WASTE, TESTING NOT OVER 0-0-8-8. (Truck)	41200 Ks			
	<i>weight of pallets</i>	740 Ks			
		41940 Ks			
Phone 915-563-4777 for delivery instructions					
Bill prepaid freight to Montell Inc 6106 E 32nd Pl Arlene Oaks 74135					
REQUEST FOR APPLICATION OF FREIGHT OF PALLET PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS COVERING THIS SHIPMENT					
PALLETIZED GROSS WEIGHT _____ LBS					
WEIGHT OF PALLETS _____ LBS					
FREIGHT CHARGES APPLY ON _____ LBS					
THIS PALLETIZED SHIPMENT HAS BEEN GLUED AS A UNIT TO FACILITATE LOADING AND UNLOADING UNDER NO CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED FROM PALLETS. SUCH ACTION MAY SUBJECT CARRIER TO POSSIBLE CLAIM AT DESTINATION					
THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING ARE CORRECT. SUBJECT TO VERIFICATION BY THE TRANS. CONTINENTAL FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362.					

* This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation, according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard.

* If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight.

* Shipper's imprint in lieu of stamp, not a part of bill of lading approved by the Interstate Commerce Commission.

Note - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____

Calidria
CORPORATIONPer *Henry G. Quinn* Shipper.Per *J. Robert Edwards* Agent.

Permanent postoffice address of shipper _____

P. O. Box K, King City, Ca. 93930

DISTRIBUTION DEPT. - 1

CC 008 1 M

©s

Montello, Inc.

020252

PURCHASE ORDER

Nº 4486

6106 EAST 32nd PLACE • TULSA, OKLAHOMA 74135
PHONE (918) 665-1170 • (24 HRS) - TWX 910-845-2396

THIS NUMBER MUST APPEAR ON IN-
VOICES, B/L, BUNDLES, CASES, PACK-
ING LISTS AND CORRESPONDENCE.

Calidria Corporation
P. O. Box K
King City, CA 93930

DATE	3/7/85
DATE WANTED	3/11/85
TERMS	Net 30
FOB	King City, CA
SHIP VIA	7/24/ Freight Sales - ppd.

SHIP TO

Montello, Inc. c/o Agri Empresa, Odessa, Texas

915+563-4777

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Super Visbestos pallet/wrapped	5.75 21.00/ton	\$4830.00 441.00 \$5271.00
Verbal: Judy to Linda Grogan			
CONFIRMATION - DO NOT DUPLICATE			

BY

AUTHORIZED SIGNATURE

PURCHASE ORDER

020254

Nº 4465

MONTELLO, INC.

6100 EAST 32nd PLACE • TULSA, OKLAHOMA 74135
PHONE (918) 685-1170 • (24 HRS) - TWX 910-045-2364

THIS NUMBER MUST APPEAR ON IN-
VOICES, B-I, BUNDLES, CASES, PACK-
ING LISTS AND CORRESPONDENCE

Calidria Corporation
P. O. Box K
King City, CA 93930

DATE	1/30/85
DATE WANTED	2/4/85
TERMS	Net 30
FOB	King City
SHIP VIA	Arrow Trucking - Prepaid

SHIP TO

Montello C/O Agri-Empresa, Odessa, Texas

915+563-4777

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 Bags	Super Visbestos	5.75	4830.00
	Pallet/Wrapped	21.00/ ton	441.00
			5271.00
	Verbal Petri to Linda		
	CONFIRMATION - DO NOT DUPLICATE		
	Freight Rate: 1308 miles @ 1.05 mile		

BY

AUTHORIZED SIGNATURE

STRAIGHT BILL OF LADING -SHORT FORM- ORIGINAL-NOT NEGOTIABLE

MCI

(Name of Carrier)

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

Carrier's No. _____

Shipper's No. 11121001

At King City (Welby), Co. 12-11 19 84 From

Calidria
CORPORATION

020255

The property described below in apparent good order, except damaged (damaged), and condition of contents of packages, viz: marked, cartoned, and destined as indicated below, when sold carrier (the said carrier) being understood throughout this contract as meaning any person or corporation in possession of the property under the contract of carriage to carry to its usual place of delivery, and destination (the said destination) after its receipt whereupon to deliver to consignee (carrier) the goods to be delivered. It is mutually agreed as to each carrier of all or any of said property, one or all, as any goods, one or all, to said destination and at each party at any time when entered in bill of lading of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Freight Bill of Lading (set forth in said Uniform Freight Classification in effect on the date hereof) in this a bill of lading, and in the applicable motor carrier classification or tariff, as the case may be, in effect on the date hereof.

It is further understood that the carrier (the said carrier) shall be bound to transport the property described herein in conformity with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted by himself and his consignee.

Consigned to Montello Inc., c/o Agri Empresa Customer's Order No. 4440

Destination Odessa State Texas County _____

Route _____

Delivering Carrier	Vehicle Initials	No.	No.	0001939
--------------------	------------------	-----	-----	---------

Seol
No. 0001939

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
840 bags 21 pallets	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0-0-8-8. MATERIAL CERTIFIED TO TEST NOT MORE THAN 0-0-8-8 (Rail)	43,260 lbs.			
	Weight of pallets	777 lbs.			
		44,037 lbs.			
PHONE: 915-563-4777					Signature of Consignor
					If charges are to be prepaid, write or stamp here, "To be Prepaid"
					TO BE PREPAID
					Received \$ to apply in prepayment of the charges on the property described hereon
					Agent or Cashier

BILL PREPAID FREIGHT TO:

BILL PREPAID FREIGHT TO:

Montello Inc.
6106 E. 32nd Place
Tulsa, OK 74135

REQUEST FOR APPLICATION OF FREWEIGHT OF PALLET
PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS
COVERING THIS SHIPMENT

PALLETIZED GROSS WEIGHT _____ LBS

WEIGHT OF PALLETS _____ LBS

FREIGHT CHARGES APPLY ON _____ LBS
 THIS PALLETIZED SHIPMENT HAS BEEN GLUED AS A UNIT TO
 FACILITATE LOADING AND UNLOADING UNDER NO
 CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED
 FROM PALLETS. SUCH ACTION MAY SUBJECT CARRIER TO
 POSSIBLE CLAIMS AT DESTINATION.

THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING
ARE CORRECT, SUBJECT TO VERIFICATION BY THE TRANS-CONTI-
NENTAL FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362.

* This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation, according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard.

* If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight.

Note - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____.

\$ _____ per _____

Calidria
CORPORATION

Per Linda G. Brown ^{Shipper}
P. O. Box K, King City, Ca.

Per ANCJ - - 12-11
Burgundy Canyon

Permanent postoffice address of shipper _____ P. O. Box R, King City, Cal. 93930

DISTRIBUTION DEPT. - 1

CC: 008/1M*

PURCHASE ORDER

020256

N2 4440

MONTEILLO, INC.

8188 EAST 32nd PLACE • TULSA, OKLAHOMA 74136
 PHONE (918) 685-1170 • (24 HRS) - TWX 910-845-2303

THIS NUMBER MUST APPEAR ON IN-
 VOICES, B/L, BUNDLES, CASES, PACK-
 ING LISTS AND CORRESPONDENCE

Calidria Corporation
 P. O. Box K
 King City, CA 93930

DATE	December 6, 1984
DATE WANTED	By 12/11/84
TERMS	Net 30
FOB	King City, CA
SHIP VIA	MCI - prepaid

SHIP TO

See below

QUANTITY	DESCRIPTION	PRICE	AMOUNT
1680 bags	Super Visbestos	5.75	\$9660.00
	Pallet/wrapped	21.00/ton	882.00
			\$10542.00
	1st Stop: Brasher Mud Company Midland, Texas Phone: 915-697-2727 440 bags - 11 pallets Final: New park Drilling 2266 Industrial Abilene, Texas Phone: 915-698-8121 400 bags - 10 pallets Montello c/o Agri Empresa Odessa, Texas Phone: 915-563-4777 840 bags - 21 pallets Verbal Judy to Linda CONFIRMATION ONLY-DOO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

STRAIGHT BILL OF LADING -SHORT FORM- ORIGINAL-NOT NEGOTIABLE

1

MCI
(Name of Carrier)
RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

Carrier's No. _____

Shipper's No. 11120304

At King City (Weiby), Ca. 12-3, 19 84 From

Calidria
CORPORATION

020257

The property described below is in apparent good order, except as noted, contents and condition of contents of packages unknown, marked, transported, and destined as indicated below, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery or said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property, that all or any portion of said route to destination and on to each party at any time interested in or any of said property that every carrier to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth in the Uniform Freight Classification in effect on the date hereof. If this is a rail or a rail-water shipment, or if in the applicable motor carrier classification or if it is a motor carrier shipment, the carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

Consigned to Montello Inc., c/o Reeves Oilfield Services Customer's Order No. 4430

Destination Eunice State Louisiana County _____

Route _____

Delivering Carrier Car or Vehicle Initials No. Seal No. 0001924

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
840 bags (21 pallets)	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0.0-8-8 MATERIAL CERTIFIED TO TEST NOT MORE THAN 0.0-8-8 (Rail)				
	ASBESTOS SHORTS OR WASTE, TESTING NOT OVER 0.0-8-8. (Truck)	43,260 lbs.			
	Weight of pallets	777 lbs.			
		44,037 lbs.			
	PHONE 318-457-2612.				

BILL PREPAID FREIGHT TO:

Montello Inc.
6106 E. 32nd Place
Tulsa, OK 74135

REQUEST FOR APPLICATION OF FREEWEIGHT OF PALLET PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS COVERING THIS SHIPMENT

PALLETIZED GROSS WEIGHT _____ LBS
WEIGHT OF PALLET'S _____ LBS
FREIGHT CHARGES APPLY ON _____ LBS
THIS PALLETIZED SHIPMENT HAS BEEN QUOTED AS A UNIT TO FACILITATE LOADING AND UNLOADING UNDER NO CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED FROM PALLET'S SUCH ACTION MAY SUBJECT CARRIER TO POSSIBLE CLAIM AT DESTINATION

THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING ARE CORRECT, SUBJECT TO VERIFICATION BY THE TRANS-CONTINENTAL FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362.

This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard.
If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight.
Shipper's imprint in lieu of stamp; not a part of bill of lading approved by the Interstate Commerce Commission.
Note: Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.
The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____

NOTE TO CARRIER
BILL PREPAID CHARGES TO:

Calidria
CORPORATION

Per Linda J. Brown Shipper

Per Buck Reel for MCI Agent

Permanent postoffice address of shipper P.O. Box K, King City, Ca. 93930

DISTRIBUTION DEPT. - 1

CC: 008/1M

©s

PURCHASE ORDER

020238

MONTELLO, INC.

8108 EAST 32nd PLACE • TULSA, OKLAHOMA 74135
 PHONE (918) 685-1170 • (24 HRS) - TWX 910-845-2366

NO 4432

THIS NUMBER MUST APPEAR ON IN-
 VOICES, B/L, BUNDLES, CASES PACK-
 ING LISTS AND CORRESPONDENCE.

Calidria Corporation
 P. O. Box K
 King City, CA 93930

DATE	11/28/84
DATE WANTED	By week of 12/3/84
TERMS	Net 30
FOR	King City, CA
SHIP VIA	MCI MCI - Freight Prepaid

SHIP TO

Montello c/o Reeves Oilfield Service, Eunice, LA

Telephone: 318/457-2612

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Univis	5.75	4830.00
	Pallet/wrapped	21.00/Ton	441.00
			5271.00
	Verbal Judy to Linda		
	CONFIRMATION ONLY - DO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

PURCHASE ORDER

020259

N2 4410

MONTELLO, INC.

6186 EAST 32nd PLACE • TULSA, OKLAHOMA 74135
PHONE (918) 885-1170 • (24 HRS) - TWC. 918-813-2388

THIS NUMBER MUST APPEAR ON IN-
VOICES, B/L, BUNDLES, CASES, PACK-
ING LISTS AND CORRESPONDENCE.

Calidria Corporation
P. O. Box K
King City, CA 93930

DATE	October 30, 1984
DATE WANTED	11/5/84 or sooner
TERMS	Net 30
FOR	King City, CA
SHIP VIA	MCI - prepaid

SHIP TO

See below

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Super Visbestos	5.75	4830.00
	Pallet/wrapped	21.00/ton	441.00
			5271.00
	1st Stop: Horizon Mud Midland, Texas Phone: 915+687-1171 440 bags - 11 pallets		
	Final: Montello c/o Agri Empresa Odessa, Texas Phone: 915+563-4777 400 bags - 10 pallets		
	Verbal - Chuck to Linda		
	CONFIRMATION ONLY - DO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

C20260

PURCHASE ORDER

MONTELLO, INC.

6108 EAST 32nd PLACE • TULSA, OKLAHOMA 74136
PHONE (918) 885-1170 • (24 HRS) - TWX 910-845-2388

N2 4399

THIS NUMBER MUST APPEAR ON IN-
VOICES, B/L, BUNDLES, CASES PACK-
ING LISTS AND CORRESPONDENCE

Calidria Corporation
P O Box K
King City, CA 93930

DATE	October 11, 1984
DATE WANTED	10/15/84
TERMS	Net 30
FOB	King City, CA
SHIP VIA	NCI - prepaid

SHIP TO

See below
Montello

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	SUPER VISBESTOS	5.75	4830.00
	pallet/wrapped	21.00/ton	<u>441.00</u>
			5271.00
	1st stop: Petroplex Odessa, Texas phone: 915+367-4987 400 bags - 10 pallets		
	Final: Montello c/o Agri Empresa Odessa, TX phone: 915+563-4777 840 bags - 11 pallets		
	Verbal - Chuck to Linda		
	CONFIRMATION - DO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

STRAIGHT BILL OF LADING - SHORT FORM - ORIGINAL - NOT NEGOTIABLE

1

Interstate

(Name of Carrier)

Carrier's No.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

Shipper's No. 11090403

At King City (Welby), Ca. 9-6, 19 84 From

Calidria
CORPORATION

020261

The property described herein is in apparent good order, except as noted; contents and condition of contents of packages unknown, marked, consigned, and destined as indicated before which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery or to such destination as in its route otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier, of all or any of said property over all or any portion of land route to destination and as to each party, at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Interstate Through Bill of Lading set forth in the Uniform Freight Classification in effect on the date hereof, if this is a rail or a rail-water shipment; or 2) in the applicable motor carrier classification and tariff if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consigned to Montello Inc., c/o Agri Empresa

Customer's Order No. 4376

Destination Odessa

State Texas

County

Route

Delivering Carrier

Car or Vehicle Initials

No.

Seal No.

0005978

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0.088 MATERIAL CERTIFIED TO TEST NOT MORE THAN 0.088 (Rail)				
840 bags (21 pallets)	ASBESTOS SHORTS OR WASTE, TESTING NOT OVER 0.088 (Truck)	43,260 lbs.			
	Weight of pallets	777 lbs.			
		44,037 lbs.			
					Signature of Consignor
					If charges are to be prepaid, write or stamp here "To Be Prepaid"
					TO BE PREPAID
FOR INSTRUCTIONS, CALL 915-563-4777.					Received \$
					to apply in prepayment of the charges on the property described hereon.
BILL PREPAID FREIGHT TO:					Agent or Cashier

Montello Inc.
6106 E. 32nd Place
Tulsa, OK 74135

REQUEST FOR APPLICATION OF FREEWEIGHT OF PALLET PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS COVERING THIS SHIPMENT

PALLETIZED GROSS WEIGHT _____ .85

WEIGHT OF PALLET'S _____ .85

FREIGHT CHARGES APPLY _____ .85

THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING ARE CORRECT, SUBJECT TO VERIFICATION BY THE TRANSCONTINENTAL FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362

THIS PALLETIZED SHIPMENT HAS BEEN CLASSED AS A UNIT TO FACILITATE LOADING AND UNLOADING UNDER NO CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED FROM PALLET'S SUCH ACTION MAY SUBJECT CARRIER TO POSSIBLE CLAIM AT DESTINATION

This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard

If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight

Shipper's imprint in lieu of stamp, not a part of bill of lading approved by the Interstate Commerce Commission

Note - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____

NOTE TO CARRIER

BILL PREPAID CHARGES TO:

Calidria
CORPORATIONPer Jude J. Brogan ShipperPer Bice Storer Agent

Permanent postoffice address of shipper

P. O. Box K, King City, Ca. 93930

DISTRIBUTION DEPT. - 1

CC: 008/1M

©s

PURCHASE ORDER

MONTELLO, INC.

8108 EAST 32nd PLACE • TULSA, OKLAHOMA 74136
PHONE (818) 825-1170 • (24 HRS) - TWX 810-845-2338

020262

No 4376

THIS NUMBER MUST APPEAR ON IN-
VOICES, B/L, BUNDLES, CASES PACK-
ING LISTS AND CORRESPONDENCE

Calidria Corporation
P. O. Box K
King City, CA 93930

DATE	8/29/84
DATE WANTED	9/4-5/84
TERMS	Net 30
FOB	King City, CA
SHIP VIA	Interstate Systems - Prepaid

SHIP TO

Montello c/o Agri Empresa, Odessa, TX

915+563-4777

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Super Visbestos	5.00	\$4200.00
	Pallet/wrapped	21.00/Ton	442.00
			\$4641.00
	Verbal Judy to Linda		
	CONFIRMATION ONLY - DO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

STRAIGHT BILL OF LADING - SHORT FORM - ORIGINAL - NOT NEGOTIABLE

1

Interstate
(Name of Carrier)
RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

Carrier's No. _____
Shipper's No. 11082702

At King City (Weiby), Ca. 8-28, 19 84 From

Calidria
CORPORATION

020263

The property described below is apparent good order, except as noted; contents and condition of contents of packages unknown, marked, consigned, and destined as indicated below, which said carrier, the said carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract, agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Freight Bill of Lading set forth in the Uniform Freight Classification in effect on the date hereof, if this is a rail or a motor carrier shipment, or 2 in the applicable motor carrier classification or tariff if this is a motor carrier shipment.
Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof set forth in the classification or tariff which governs the transportation of this shipment and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consigned to Montello Inc., c/o Reeves Oilfield Services Customer's Order No. 4371
Destination Eunice State Louisiana County _____

Route _____
Delivering Carrier _____ Car or Vehicle Initials _____ No. _____ Seal No. 0005964

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 2 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
840 bags 21 pallets	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0.0 8 8 (Rail) ASBESTOS SHORTS OR WASTE, TESTING NOT OVER 0.0 8 8 (Truck)	43,260 lbs.			Signature of Consignor If charges are to be prepaid write or stamp here: To Be Prepaid TO BE PREPAID Received \$ _____ to apply in payment of the charges on the property described herein. Agent or Cashier Per: _____ The signature here acknowledges on the amount prepaid. Charges advanced \$ _____ 1 The fibre boxes used for this shipment conform to the specifications set forth in the box maker's certificate thereon, and all other requirements of Rule 41 of the Uniform Freight Classification.
	Weight of pallets	777 lbs.			
		44,037 lbs.			
CALL 318-457-2612.					

BILL PREPAID FREIGHT TO:

Montello Inc.
6106 E. 32nd Place
Tulsa, OK 74135

REQUEST FOR APPLICATION OF FREIGHT OF PALLET PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS COVERING THIS SHIPMENT
PALLETIZED GROSS WEIGHT _____ LBS
WEIGHT OF PALLET _____ LBS
FREIGHT CHARGES APPLY ON _____ LBS
THIS PALLETIZED SHIPMENT HAS BEEN CLASSIFIED AS A UNIT TO FACILITATE LOADING AND UNLOADING UNDER NO CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED FROM PALLET. SUCH ACTION MAY SUBJECT CARRIER TO POSSIBLE CLAIM AND DESTINATION.

THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING ARE CORRECT, SUBJECT TO VERIFICATION BY THE TRANSCONTINENTAL FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362

This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation, according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard.
If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight.
Shipper's imprint in lieu of stamp: not a part of bill of lading approved by the Interstate Commerce Commission.
Note - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.
The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____

NOTE TO CARRIER

BILL PREPAID CHARGES TO:

Calidria
CORPORATION

Per Linda J. Morgan Shipper

Per [Signature] Agent

Permanent postoffice address of shipper

P.O. Box K, King City, Ca. 93930

DISTRIBUTION DEPT. - 1

CC: 008/1M

PURCHASE ORDER

MONTELLO, INC.**020264****Nº 4371**

6108 EAST 32nd PLACE • TULSA, OKLAHOMA 74135
 PHONE (918) 835-1170 • (24 HRS) - TWX 910-845-2358

THIS NUMBER MUST APPEAR ON IN-
 VOICES, B/L, BUNDLES, CASES PACK-
 ING LISTS AND CORRESPONDENCE

Calidria Corporation
 P. O. Box K
 King City, CA 93930

DATE	8/23/84
DATE WANTED	8/27/84
TERMS	Net 30
FOR	King City, CA
SHIP VIA	Interstate - Freight Prepaid

SHIP TO

Montello c/o Reeves Oilfield Service, Eunice, LA

Telephone: 318/457-2612

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Univis	5.75	4830.00
	Ballet/wrapped	21.00/Ton	441.00
			5271.00
Verbal Petri to Linda			
CONFIRMATION ONLY - DO NOT DUPLICATE			

BY

AUTHORIZED SIGNATURE

PURCHASE ORDER

MONTELLO, INC.

020265

N2 4365

8100 EAST 32nd PLACE • TULSA, OKLAHOMA 74136
 PHONE (918) 685-1170 • (24 HRS) - TWX 910-845-2380

THIS NUMBER MUST APPEAR ON IN-
 VOICES, B/L, BUNDLES, CASES PACK-
 ING LISTS AND CORRESPONDENCE

Calidria Corporation
 P. O. Box K
 King City, CA 93930

DATE	8/9/84
DATE WANTED	8/13/84
TERMS	Net 30
FOB	King City
SHIP VIA	Interstate Frt. Prepaid

SHIP TO

QUANTITY	DESCRIPTION	PRICE	AMOUNT
840 bags	Super Yisbestos 50#	5.75	4830.00
	Pallet/wrapped	21.00/Ton	441.00
			5271.00
	1st Stop: Horizon Mud 1110 Dayton Road Midland, TX 915+687-1173 440 bags 11 pallets		
	Final Stop: Dfcovery Mud #12 E. Industrial Loop Midland, TX 915+687-0403 400 bags 10 pallets		
	Verbal Johnson to Linda		
	CONFIRMATION ONLY - DO NOT DUPLICATE		

BY

AUTHORIZED SIGNATURE

STRAIGHT BILL OF LADING -SHORT FORM- ORIGINAL-NOT NEGOTIABLE

1

Interstate

(Name of Carrier)

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

020267

Carrier's No.

Shipper's No. 11070204

At King City (Welby), Co. 7-5, 19 84 From

UNION CARBIDE CORPORATION
METALS DIVISION

The property described below in apparent good order except as noted, contents and condition of contents of packages unknown, marked, consigned, and destined as indicated below, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property prior to or at any time of said route to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth in Uniform Freight Classification in effect on the date hereof, if this is a rail or a rail-water shipment, or in the applicable motor carrier classification or tariff if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consigned to Montello Inc., c/o Reeves Oil Field Services

Customer's Order No. 4332

Destination Eunice State Louisiana County

Route

Delivering Carrier

Car or Vehicle Initials

No.

Seal No.

0004118

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	Weight (Sub. to Correction)	Class or Rate	Check Column	Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
840 bags 21 pallets	ASBESTOS SHORTS OR WASTE, CONSISTING OF MATERIAL TESTING NOT MORE THAN 0-0-8-8 MATERIAL CERTIFIED TO TEST NOT MORE THAN 0-0-8-8	1			
	ASBESTOS SHORTS OR WASTE, TESTING NOT OVER 0-0-8-8	2	43,260 lbs.		
	ASBESTOS SHORTS OR WASTE Weight of pallets	3	777 lbs.		
	ASBESTOS FIBRE, IN PACKAGES OR IN BULK	4	44,037 lbs.		
CALL 318-457-2612					Signature of Consignor
					If charges are to be prepaid, write or stamp here: "To Be Prepaid"
					TO BE PREPAID
					Received \$
					to apply in prepayment of the charges on the property described hereon
					Agent or Cashier
					Per (The signature here acknowledges only the amount prepaid)
					Charges Advanced
					\$

BILL PREPAID FREIGHT TO:

Montello Inc.
6106 E. 32nd Place
Tulsa, OK 74135

REQUEST FOR APPLICATION OF FREEWEIGHT OF PALLET PROVISIONS IN ACCORDANCE WITH GOVERNING TARIFFS COVERING THIS SHIPMENT

PALLETIZED GROSS WEIGHT _____ LBS

WEIGHT OF PALLET'S _____ LBS

FREIGHT CHARGES APPLY ON _____ LBS

THIS PALLETIZED SHIPMENT HAS BEEN GLUED AS A UNIT TO FACILITATE LOADING AND UNLOADING UNDER NO CIRCUMSTANCES ARE BAGS OR CARTONS TO BE REMOVED FROM PALLET'S SUCH ACTION MAY SUBJECT CARRIER TO POSSIBLE CLAIM AT DESTINATION

THE DESCRIPTION AND WEIGHT INDICATED ON THIS BILL OF LADING ARE CORRECT, SUBJECT TO VERIFICATION BY THE TRANSPORTATION FREIGHT BUREAU ACCORDING TO AGREEMENT A 5362.

This is to certify that the above articles are properly described by name and are packed and marked and are in proper condition for transportation, according to the regulations prescribed by the Interstate Commerce Commission and the commandant of Coast Guard.

If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is carrier's or shipper's weight.

Shipper's imprint in lieu of stamp; not a part of bill of lading approved by the Interstate Commerce Commission.

Note - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ per _____

NOTE TO CARRIER

BILL PREPAID CHARGES TO:

UNION CARBIDE CORPORATION
METALS DIVISION

Per Linda J. Brown Shipper

Per

Agent.

Permanent postoffice address of shipper P.O. Box K, King City, Co. 93930

DISTRIBUTION DEPT. - 1

25

FORM 15504 REGENT FORMS BELLMAR NJ 08031

50 pounds net

Q20270

UNIVIS

**Viscosifier For All
Drilling Fluids**

**MONTELLO
TULSA, OK**

CAUTION

**Contains Asbestos Fibers
Avoid Creating Dust
Breathing Asbestos Dust May Cause
Serious Bodily Harm**

January 24, 1973

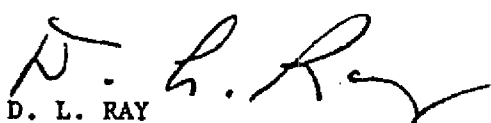
020272

safely applied to any of the several dry ground asbestos products on the market.

2. On all tests, the coarse ground Super Visbestos consistently fell well below the present OSHA regulations as to maximum ceiling limit of airborne peak fiber concentration and fiber lengths and 8-hour time weighted average.
3. The new granular Super Visbestos in the form of 1/8" pellets proved to be cleaner than the present regular Super Visbestos.
4. On no test did either product exceed even the much more stringent TWA level to be imposed by OSHA in 1976.
5. Based on these extensive tests under varied conditions, no special breathing apparatus would be required when running either Montello's regular Super Visbestos or the much cleaner new granular Super Visbestos.

For your information Standard of Indiana's Industrial Hygiene personnel have reviewed all of the test results and have concurred with the conclusions stated above. Should you so desire, I am sure that Montello's Mr. Kenneth N. Campbell, P. O. Box 130, Sand Springs, Oklahoma, 74083, would be glad to furnish you a copy of the complete report covering the field tests conducted at the four drilling locations.

While the above indicates you can safely mix wet processed Super Visbestos into drilling mud systems, airborne fiber conditions resulting from the use of the several dry ground asbestos products which are being marketed for use as drilling mud additives are still unknown. Should you desire to utilize such products it very definitely would be in order to conduct on-site tests where such additives are being utilized. Please advise this office sufficiently in advance so that necessary information can be secured and furnished on sampling procedures or arrangements made with Industrial Hygiene for needed air monitoring and necessary sample collection.


D. L. RAY

cc: Mr. L. E. Elkins✓
Mr. Owen B. Rowley
Mr. H. O. Boswell
Mr. H. H. Young, Jr.



Asbestos Test files



THE DISCOVERY COMPANY

UNION CARBIDE CORPORATION • MINING & METALS DIVISION • P.O. BOX 579 • NIAGARA FALLS, N.Y. 14302 • TEL: 716-285-3311

October 10, 1972

020273

Dr. J. T. Siedlecki
Standard Oil of Indiana
910 South Michigan Avenue
Chicago, Illinois 60680

Dear Dr. Siedlecki:

As you know, airborne dust samples were collected September 27, 1972 for Amoco Oil Company at Fault Block 253, 6 miles from County Line, Oklahoma.

Portions of each of the 6 samples collected have been shipped to your attention.

Our fiber counts will be done in accordance with the Bayer, Zummalde and Brown method of counting asbestos fibers by phase contrast microscopy (2/69). We will report fibers/milliliter greater than 5 microns in length.

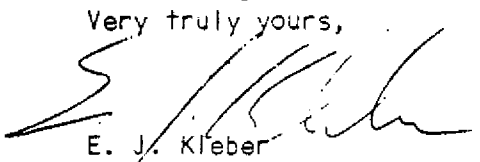
The filter area of our Millipore Filters is 855 mm², volumes of air for each sample are as follows:

#4 - 41.0 Liters	#16 - 51.0 Liters
#5 - 42.5 Liters	#25 - 45.6 Liters
#6 - 39.6 Liters	#37 - 47.4 Liters

We would appreciate the return of the six cartridges upon completion of testing.

If you have any questions, or if we can be of any assistance please let us know.

Very truly yours,


E. J. Kleber
Customer Service Representative

/cvb

cc: Mr. K. Campbell

August 2, 1968

Mr. Huell Ham
 DMC Drilling Mud Company
 2400 West Loop South
 P. O. Box 22605
 Houston, Texas----77027

Dear Huell:

You are absolutely right. I will personally take all the blame for the foul-up in the West Texas area. Our representatives were instructed by letter (copy to you) to follow your instructions in dealing with DMC personnel. Since February 1967 both DMC and Montello have had changes in personnel. We evidently did not properly inform our new personnel. We have checked into this situation and find three cases of gross disregard by our representatives and warehousemen of your instructions of February 7, 1967.

They all have happened over a short period of time.
 Situation No. 1: A well recently drilled in the New Mexico area----- called for Super Visbestos---you had none---Montello had 1,200 sacks in Monahans. Regular asbestos was moved to location---operator specified Super Visbestos---DMC picked up same and moved to location. This got you out of a hot water spot---we thought we did you a favor. This was our fault. Three days after material was picked up, Sand Springs office received paper work. Your New Mexico distributor was billed in error. When we discovered this error, we recalled the invoice immediately and billed DMC.

Situation No. 2: A railroad car at Ft. Stockton unloading at Baroid. Our man and DMC man called the railroad agent and instructed him to spot this car at your Ft. Stockton warehouse. We thought this situation was O.K. with Houston. DMC had two wells requesting Visbestos---you had none in stock at Ft. Stockton. Thought we were doing DMC a favor---we goofed---this was also our fault.

Situation No. 3: Railroad car unloading at Monahans at Baroid---DMC needed Visbestos as per customer request. You had none---the warehouse price was 10¢/lb.---the carload price, minimum 500 sacks was .0625¢/lb. plus freight. This transaction saved DMC \$625.00 plus it made it possible for DMC to fulfill the request to their valued customers. Thought this was also a favor to DMC

C
O
P
Y

Mr. Huell Ham

-2-

August 2, 1968

but this was also our fault.

Many times our salesman do not know of warehouse shipments until they receive their copy of our invoice to the customer, since we attempt, in most cases, to keep our warehouse separated from our sales force. Warehouse personnel change quite often---they usually work on a callout basis only. We have again informed all salesman personnel and warehouse personnel that your (DMC) wishes of February 7, 1967 are still in force. Now we hope and pray they will pay attention.

Huell, we are very proud to announce that all Visbestos and Super Visbestos now being marketed by Montello, Inc. is processed and produced by Union Carbide Corporation.

This new Visbestos is 20% more effective than other asbestos products now offered to the drilling mud industry. Super Visbestos (pelletized) is twice as effective, one-half as bulky and yields ten times faster than the regular asbestos products.

We are sure that DMC wants to furnish their valued customers, the operator; the very best, the most effective and the most economical products available. If so, they can only furnish them with Visbestos and Super Visbestos as manufactured by Union Carbide Corporation.

Thank you for reading this far. We trust that you had an enjoyable vacation. We hope that we can continue to serve you in the future and will be favored by your very valuable business.

Sincerely,

MONTELLO, INC.

Harry M. Wyatt
HMM:js

C
O
P
Y

COMES TO

Operations Managers
C. P. Loucks
Doyle Waller
Jack Laidlaw

020276



TO ALL AREA MANAGERS - DISTRICT MANAGERS - WAREHOUSEMEN - ENGINEERS
FROM R. N. Davidson
DATE July 25, 1968
SUBJECT VISBESTOS AND SUPER VISBESTOS

It has been brought to my attention that there seems to be an increasing number of requisitions for the above two products, several of which have, again, been "after the fact" requisitions. These are not our principally approved products of this type. Instructions have been issued to the Purchasing Department that absolutely no purchases of Super Visbestos will be made until - and if - a new price is established on this material and, further, that each requisition must have the written approval of the Operations Managers and still further approval, if granted, by the Houston Purchasing Agent.

no copies
sent to P.H.

Also, effective immediately, all requisitions for Visbestos will be filled with Flosal, unless written approval for Visbestos, per se, is received from your Operations Manager. Final approval on this is still subject to approval by Huell Ham and will be filled in most cases through transfers rather than additional purchases.

Lastly, Montello has been officially notified that absolutely no field orders are to be accepted on ANY product which they sell. Do not attempt to place any field orders for any Montello product no matter what the circumstances may be. We will recommend that anyone violating this lose his authority to requisition anything.

R N Davidson
R. N. Davidson

RND/bbm



IMC DRILLING MUD
INTERNATIONAL MINERALS & CHEMICAL CORPORATION
P.O. BOX 27605 • HOUSTON, TEXAS

PURCHASE ORDER

020277

ACCOUNT NO.

REQ. NO.

DATE

PURCHASE ORDER NO.

Joe Plemons

8-20-68

70M-05171

TO

MONTELLO INCORPORATED
P. O. Box 1046
Sand Springs, Oklahoma

SHIP TO - ADDRESS PRINTED ABOVE UNLESS OTHERWISE INDICATED.

IMC Drilling Mud
International Minerals & Chemical Corp.
Fort Stockton, Texas

TERMS

2% 10, Net 30

FOB Shipping Point

SHIPPING DATE IS

PROMPTLY

SHIPPING INSTRUCTIONS

P & SF Delivery

ITEM NO.	QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
1.	800/50#	VISBESTOS, Regular	125.00/Ton	
		Plus Prepaid Freight	1.20/cwt	
		Plus Stopover Charge	24.00	
		Confirming Ham - Campbell, 8-19-68.		
		DO NOT DUPLICATE		
	HH/oe			

The acceptance copy must be signed and returned.

1. VENDOR

FORM O-206-E REV. 11-66 PRINTED IN U.S.A.



INTERNATIONAL MINERALS & CHEMICAL CORPORATION
P.O. BOX 77605 • HOUSTON, TEXAS

PURCHASE ORDER

020278

ACCOUNT NO

DATE
Joe Plemons

8-20-68

PURCHASE ORDER NO

1001-08171

TO

MONTELLO INCORPORATED
P. O. Box 1046
Sand Springs, Oklahoma

SHIP TO - ADDRESS PRINTED ABOVE UNLESS OTHERWISE INDICATED

IMC Drilling Mud
International Minerals & Chemical Corp.
Fort Stockton, Texas

TERMS

2% 10, Net 30

☒ Shipping Point

SHIPPING DATE

PROMPTLY

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		Plus Stopover Charge	24.00	

Confirming Ham - Campbell, 8-19-68.

DO NOT DUPLICATE

HH/oe

I. VENDOR

FORM O-206 E REV. 11-66 PRINTED IN U.S.A.

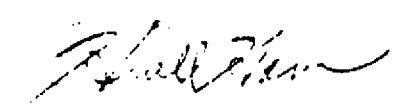


INTERNATIONAL MINERALS & CHEMICAL CORPORATION

P. O. Box 22605, Houston, Texas 77027

PURCHASE ORDER

020279

ACCOUNT NO.	REQ NO. 17	DATE 10-3-68	PURCHASE ORDER NO. 8DM-516
TO Montello, Inc. P. O. Box 1046 Sand Springs, Oklahoma			
SHIP TO - ADDRESS PRINTED ABOVE UNLESS OTHERWISE INDICATED. IMC Drilling Mud International Minerals & Chemical Corp. St. Stockton, Texas			
TERMS Net 30	FOB D		
SHIPPING DATE (S) Promptly	DESTINATION ☐ SHIPPING POINT ☒		
SHIPPING INSTRUCTIONS Santa Fe Delivery			

ITEM NO.	QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
1.	1200/50#	Visbestos Reg. Plus prepaid freight Confirming Ham-Campbell 10-3-68. DO NOT DUPLICATE	.0625/# 1.20/cwt	

The undersigned hereby certifies that the above information is true and correct.

1 VENDOR

FORM 0-206 REV. 11-65 PR. D IN U.S.A.



INTERNATIONAL MINERALS & CHEMICAL CORPORATION

O. Box 22605, Houston, Texas 77027

PURCHASE ORDER

020280

PURCHASE ORDER NO.

ACCOUNT NO.

REQ. NO.

DATE

17

10-3-68

8DM-516

TO

Montello, Inc.
P. O. Box 1046
Sand Springs, Oklahoma

SHIP TO - ADDRESS PRINTED ABOVE UNLESS OTHERWISE INDICATED

IMC Drilling Mud
International Minerals & Chemical Corp.
St. Stockton, Texas

TERMS

Net 30

FOR

X

SHIPPING DATE (S)

Promptly

☐ DESTINATION ☒ SHIPPING POINT

SHIPPING INSTRUCTIONS

Santa Fe Delivery

ITEM NO.	QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
1.	1200/50#	Visbestos Reg. Plus prepaid freight Confirming Ham-Campbell 10-3-68. DO NOT DUPLICATE	.0625/# 1.20/cwt	

The acceptance copy is to be signed and returned.

• VENDOR

FORM 0-206 REV. 11-66 PR. © IN U.S.A.

cc for J. L. Myers
W. C. Thurber
File

bcc: Ken Campbell (Montello)

INDUSTRIAL CARBIDE CORPORATION

Agara Falls, N.Y. 14302

By E. J. Kleber

Date 9-24-74

Full Name	Shell Oil	Interviewed	Bob Jones - Regional Industrial Hygienist
Address	various locations near Traverse City, MI		Claude Osborn - Safety Director, Mich. Drilling
Mfrs. of			Larry Kinney - Kinco Inc. (Montello agent)

OBJECTIVES

Conduct air sampling tests at drilling rigs during the addition of NGSV to muds.

OBSERVATIONS

Air samples were collected at 3 Shell Oil drilling sites and the results will be reported in the next couple of weeks. This report deals with discussions on Shell's policies and observations regarding asbestos.

First, some background on Mr. Jones. He is a certified industrial hygienist (certified hygienists are the "royalty" of their profession) who has experience in most areas of industrial hygiene. He toiled for many years in Kentucky as a state hygienist, where he had a tiff with, of all people, Dr. Selikoff over something in the Kentucky coal mines. It would be fair to say that Mr. Jones has a very low opinion of the good doctor. He agrees that the asbestos and health question has been blown way out of proportion, but he intends to see that rules laid down in the health and safety area are adhered to. In short, he sympathizes with our plight and will put in a good word only if the tests prove to be within the acceptable limits.

Mr. Jones made some comments during the day that are worth while noting:

1. At the warehouse - the first thing we did upon arrival was inspect the pallets. Incidentally, from a distance, the pallets appear to be quite neat, sitting as they were in a corner of the warehouse. Up close however the picture changes. In almost every bag there was approximately 1-4 tablespoons of the mini-pellets laying in the sleeve. As soon as the bags are handled, the pellets dribble out to the floor. He also noted that a thin layer of dust was present on every bag and as soon as the bag was moved some of it became airborne. This layer of dust problem became even more evident when one of the men loading the bags held the bag against his chest while waiting for an opportunity to set it down. When the bag was put down the mans shirt was covered with white dust. Mr. Jones commented that every time the man moved or touched his shirt he certainly was releasing asbestos fiber in the air near his breathing zone.

Calidria ASBESTOS

020281

cc for J. L. Myers
W. C. Thurber
File

INITIAL CARBIDE CORPORATION

bcc: Ken Campbell (Montello) ✓

Troy, New York 14302

By E. J. KleberDate 9-24-74

Full Name	Shell Oil	Interviewed	
Address	various locations near Traverse City, MI	Bob Jones - Regional Industrial Hygienist	
Mrs. of		Claude Osborn - Safety Director, Mich. Drilling	
		Larry Kinney - Kinco Inc. (Montello agent)	

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Report of Call
Shell Oil

-2-

9-24-74

It can be safely assumed that this white dust is asbestos, since our products are the only material presently in the warehouse. They were put there directly from one of our rail cars. Air samples were taken during the warehouse operation.

2. At the drilling sites - to make a long story short the handling of our products by the "Roughnecks" (honest, that's what the laborers are called) is nothing short of atrocious. Bag opening on two of the three rigs was accomplished by punching the bags with a chisel until the weight of the pellets on the inside of the bag causes the bag to break the rest of the way and in 10 seconds 50 pounds are sitting in the hopper. Bag disposal is non-existent unless a stiff wind begins blowing them about. Then they will pick the bags up and toss them in a pit dug in the ground for trash disposal. Otherwise they'll sit on the ground next to the hopper until shift clean-up.

3. Political aspects - there is an unusual relationship in the oil fields that needs some explaining. An oil company does not own the drilling rigs. The rigs are hired on a contract basis and sometimes communication between the oil company and the rig company is not very good.

Shell feels responsible for on-the-job safety and apparently any OSHA citations and/or fines become Shell's responsibility. One of the major problems Shell has is the education of these employees who are not working directly for them. The handling of asbestos is a prime example. According to Claude Osborne they have been told time and time again to exercise care when handling these products. This approach does not seem to be working.

The biggest stumbling block of all is medical exams. Although Shell does have a comprehensive medical program, they are not about to pay for X-rays of thousands of people who do not work for them. It all boils down to the kind of numbers we get from these tests. If Shell feels they don't have to pay for exams we have a chance. If, however, medical exams are indicated, I suspect they will forbid the use of New Granular Super Visbestos.

There is one more factor of note. The industrial hygienists in the oil industry seem to have excellent communications with one another. It would, therefore not be surprising to find one company make a decision and others follow the lead.

RECOMMENDED ACTION

EJK

Report results of fiber counts to Montello as soon as possible and stay in touch with Bob Jones on the outcome of their counts.

typed 9/27/74
mlv

Report of Call
Shell Oil

-2-

9-24-74

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RECOMMENDED ACTION

EJK

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typed 9/27/74
mlv

020283



Caloria ASBESTOS

UNION CARBIDE CORPORATION • MINING & METALS DIVISION • P.O. BOX 579 • NIAGARA FALLS, N. Y. 14302 • TEL: 716-278-3376

November 18, 1974

Mr. Kenneth Campbell
Montello, Inc.
P. O. Box 130
Sand Springs, OK 74063

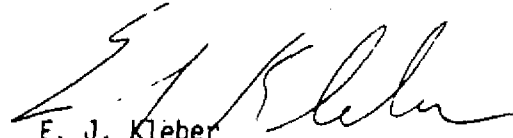
Dear Ken:

Enclosed are two copies of the results of our air sampling tests conducted near Kalkaska, Michigan on September 23, 1974.

The numbers, while somewhat higher than previous tests, are neither outrageously large nor, frankly, surprising. In previous tests, sack handling was done by oil company engineers, while in this test all handling was done by on-site personnel. This factor almost certainly is the reason for the higher fiber counts.

As always, if we can answer any questions regarding the tests or any other matter, please do not hesitate to call either Harry Rhodes or me.

Best regards,


E. J. Kleber
Customer Service Representative

EJK:cjb
Enclosures

CC: H. B. Rhodes

020284

AIRBORNE FIBER COUNTS

for

Shell Oil Company
At Various Locations Near Traverse City, Michigan

November 18, 1974

Samples Collected And Analyzed By:

E. J. Kleber
Union Carbide Corporation

Union Carbide Corporation
Mining and Metals Division
Niagara Falls, New York

OBJECTIVES

Determine the concentrations of airborne asbestos fiber generated during the use of New Granular Supervisbestos at a number of Shell Oil Company drilling rigs.

OPERATIONS MONITORED

Air Samples were collected September 24, 1974 at three drilling sites on Shell Oil properties known as Cactus #16, Cactus #21, and Cedco #37. 25 sacks weighing 50 pounds each were dumped at each location.

DESCRIPTION OF LOCATIONS AND SAMPLES COLLECTED

1. Cactus #16 - This location featured a mixing hopper with top about 3-1/2 ft. above the ground. Sacks were transported from the back of a truck located approximately 20 ft. from the hopper (Figure 1). Nine air samples were collected at this location; environmental (stationary) samples located 3-1/2 ft. off the ground, 7 ft. downwind from the hopper, were taken before the test, during the first dumping operation, between operations, during the second dump, and after the tests were complete. Personal breathing zone samples were collected from both operators during each of the two dumping operations. Sampling time included transportation of the sacks from truck to hopper, a distance of approximately 20 ft. 12 sacks were dumped in the first operation and 13 in the second.

2. Cactus #21 - The drilling rig operation was essentially similar to Cactus #16 with one exception. Asbestos was added to a hopper which was located in a mud house approximately 7 ft. x 7 ft. x 6 ft. The mud house was open on three sides, however, and the breeze was blowing throughout the test (Figure 2). Eight samples were collected at this location. Environmental (stationary) samples were collected 3 ft. from the hopper in the mud house during the first dumping operation; one between operations, one during the second dump and one after the completion of the operation. Personal breathing zone samples were collected from both operators during each dump. As in Cactus #16, sampling time included transportation of the sacks from truck to hopper, a distance of approximately 30 ft. 12 sacks were dumped in the first operation, and 13 in the second.

3. Cedco #37 - The drilling operation was essentially to Cactus #16 in that the hopper was outside and entirely exposed to the elements (Figure 3). One major difference in this test was that all 25 sacks were dumped at once. Three samples were collected at this rig. An environmental, located over the hopper, was collected upon completion of dumping. One had been attempted during dumping, but mud "blow back" spurted up from the hopper and destroyed the filter. Personal breathing zone samples were collected from both operators during the dump. All 25 sacks were dumped at one time in this operation and, again, sampling time included sack transportation, a distance of approximately 20 ft.

GENERAL CLIMATIC CONDITIONS

The test at Cactus #16 was marred by a sporadic light rain. The day improved slowly to scattered clouds by the time the tests ended. Temperatures hovered around 50° all day with a very gusty wind 10-25 mph.

EQUIPMENT AND PROCEDURE

Sampling and dust counting were carried out in accordance with OSHA Regulation 1910.93a, using the Bayer, Zummalde and Brown method for counting asbestos fibers by phase contrast microscopy (Bureau of Occupational Safety and Health, Feb. 1969).

Battery-powered air pumps (M.S.A. type) calibrated to 2 liters per minute were used to collect personal breathing zone and environmental samples on millipore membrane filters of 0.8 micron porosity.

Fiber counting was performed on a Vicker's phase contrast microscope at 400X utilizing a Porton reticle for sizing and field definition.

TEST RESULTS

Reported as fibers greater than 5 microns in length per cubic centimeter of air sampled. A fiber is defined as a material having an aspect ratio greater than 3:1.

INTERPRETATION

The OSHA regulations have been established with a limit of 5 fibers greater than 5 microns in length per cubic centimeter of air sampled on an 8-hour time-weighted average (TWA). The formula $\frac{C_1T_1 + C_2T_2 + C_nT_n}{\Sigma T}$ describes

time-weighted average where C = fiber count in fibers/cc and T = time.

The 8-hour time-weighted averages calculated below have been based on the assumption that New Granular Supervisbestos will be dumped only once a day. Also, due to a lack of sampling time available, environmental samples have been used in place of the normal personal breathing zone samples. They are noted and explained in each calculation.

1. Cactus #16

Calculations based on two personal breathing zones samples for each operator (M-9 and M-24 for David Kniss and M-8 and M-23 for Carl Wind) and two environmental samples (M-7 and M-20). Sample M-20, taken after completion of the test, was used to approximate the exposure during the bulk of the day.

A) David Kniss

$$\frac{(3.7)(5) + (0.4)(15) + (2.2)(6) + (0.2)(454)}{480}$$

$$= 0.27 \text{ fibers/cc TWA}$$

B) Carl Wind

$$\frac{(5.7)(5) + (0.4)(15) + (3.9)(6) + (0.2)(454)}{480}$$

$$= 0.31 \text{ fibers/cc TWA}$$

2. Cactus #21

Calculations based on two personal breathing zone samples for each operator (M-16 and H-8 for Don Gustafson and M-22 and D-45 for Mike Jewett) and two environmental samples (M-18 and I-8). Sample I-8, taken after completion of the test, was used to approximate the exposure during the bulk of the day.

A) Don Gustafson

$$\frac{(6.7)(9) + (0.3)(20) + (2.1)(9) + (0.3)(442)}{480}$$

$$= 0.45 \text{ fibers/cc TWA}$$

B) Mike Jewett

$$\frac{(8.3)(9) + (0.3)(20) + (2.3)(9) + (0.3)(442)}{480}$$

$$= 0.49 \text{ fibers/cc TWA}$$

3. Cedco #37

Calculations based on one personal breathing zone sample for each operator (I-37 for Donald Thompson and J-23 for George Arnott) and one environmental sample (M-21) which was used as exposure for the bulk of the day.

A) Donald Thompson

$$\frac{(1.9)(15) + (0.4)(465)}{480}$$

$$= 0.45 \text{ fibers/cc TWA}$$

B) George Arnott

$$\frac{(0.7)(15) + (0.4)(465)}{480}$$

$$= 0.41 \text{ fibers/cc TWA}$$

SUMMARY OF FIBER COUNTS

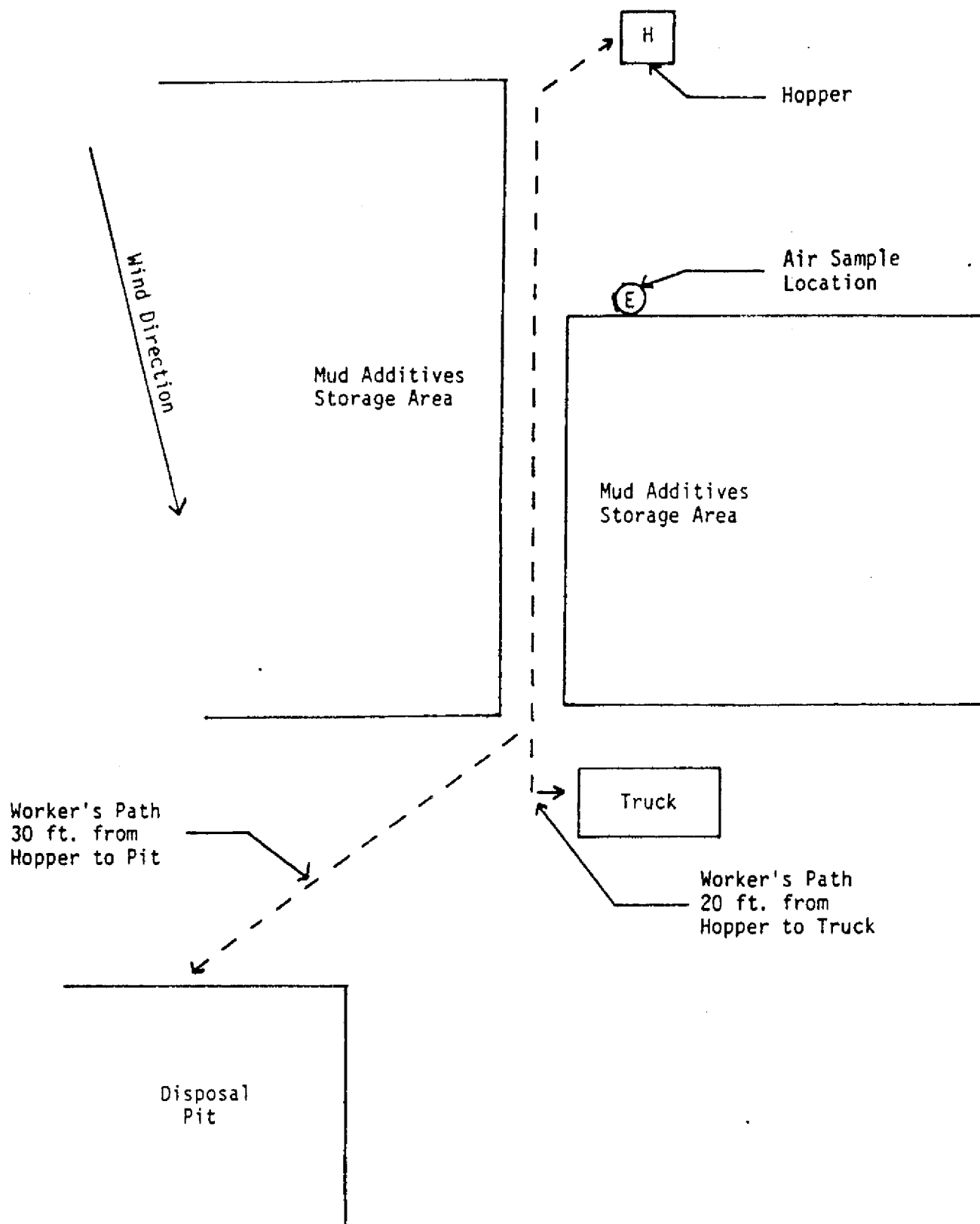
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<u>Sample No.</u>	<u>Sampling Time</u>	<u>Description</u>	<u>Fibers/cc</u> <u>>5μ</u>
<u>Cactus #16</u>			
M-14	13 min.	Environmental - Located 3-1/2 ft. off ground, 7 ft. downwind from hopper prior to test.	0.1
M-9	5 min.	Personal - Operator (David Kniss) transporting 6 bags of New Granular Super-visbestos (NGSV) from truck to hopper and dumping them in.	3.7
M-8	5 min.	Personal - Operator (Carl Wind) transporting 6 sacks of NGSV from truck to hopper and dumping them in. Sample run simultaneously with M-9.	1.4
M-5	6 min.	Environmental - Located in same position as M-14 during first test (M-8 and M-9).	1.8
M-7	5 min.	Environmental - Located in same position as M-14 between runs.	0.4
M24	6 min.	Personal - Operator (David Kniss) transporting 6 sacks NGSV from truck to hopper and dumping. Sampling time includes transporting empty sacks to pit, a distance of about 30 ft.	2.2
M-23	6 min.	Personal - Operator (Carl Wind) transporting 7 sacks NGSV from truck to hopper and dumping. Sampling time includes transporting empty sacks to pit, a distance of about 30 ft. Sample run simultaneously with M-23.	3.9
M-25	7 min.	Environmental - Same location as M-14 during second test (M-23 and M-24).	1.3
M-20	13 min.	Environmental - Same location as M-14 after test.	0.2
<u>Cactus #21</u>			
M-16	9 min.	Personal - Operator (Don Gustafson) transporting 6 sacks NGSV from truck to mud house and dumping them in.	6.7
M-22	9 min.	Personal - Operator (Mike Jewett) transporting 6 sacks NGSV from truck to mud house and dumping. Sample run simultaneously with M-16.	8.3

Summary of Fiber Counts - Continued

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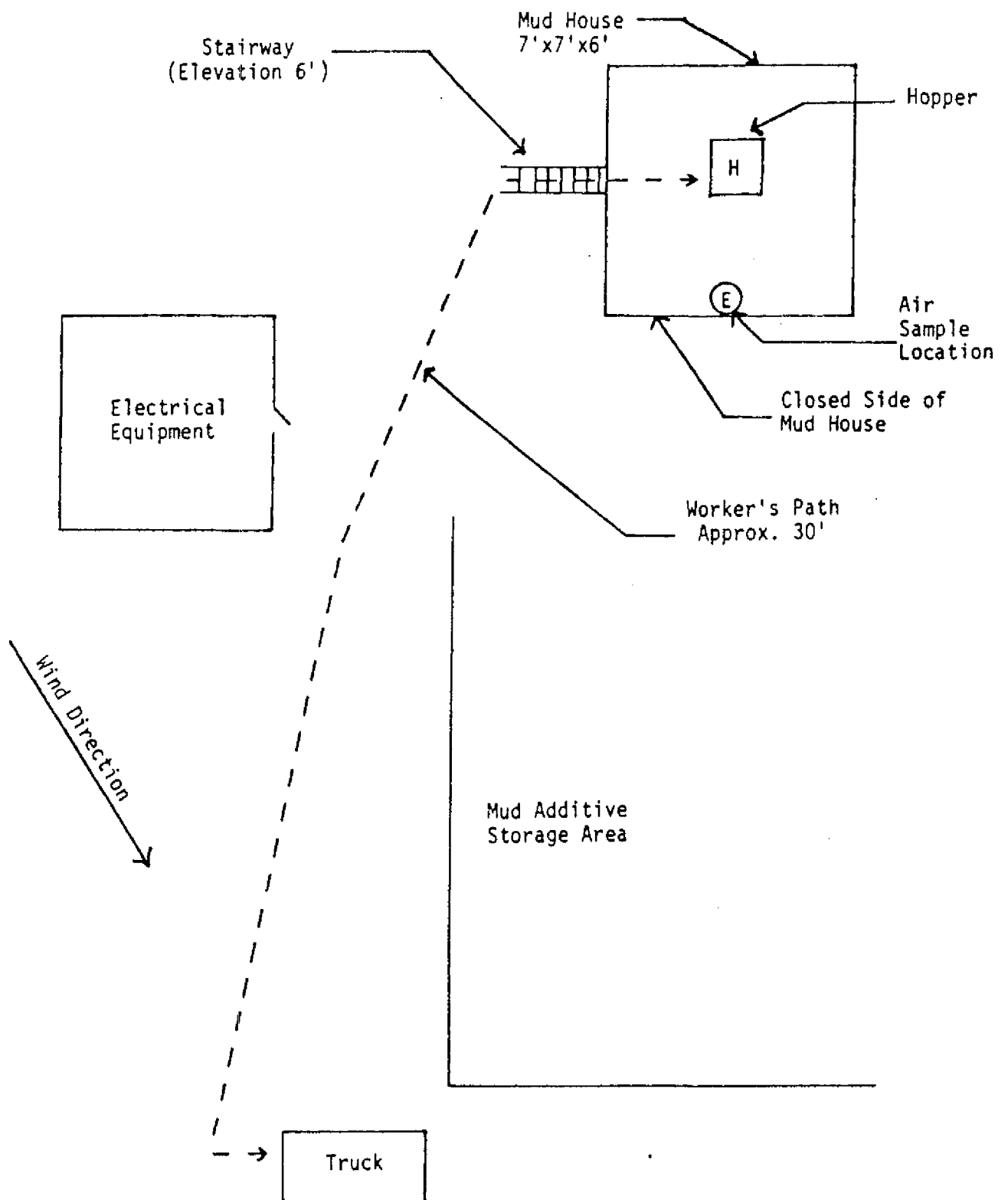
<u>Sample No.</u>	<u>Sampling Time</u>	<u>Description</u>	<u>Fibers/cc</u> <u>>54</u>
M-17	10 min.	Environmental - Located in mud house, 5-1/2 ft. off floor, 3 ft. from hopper during test (M-22 and M-16).	0.4
M-18	20 min.	Environmental - Same location as M-17 between tests.	0.3
H-8	9 min.	Personal - Operator (Don Gustafson) transporting 7 sacks NGSV to mud house and dumping.	2.1
D-45	9 min.	Personal - Operator (Mike Jewett) transporting 6 sacks NGSV to mud house and dumping. Sample run simultaneous with H-8.	2.3
K-11	8 min.	Environmental - Same position as M-17 during test (D-45 and H-8).	1.6
I-8	13 min.	Environmental - Same position as M-17 after test.	0.3
<u>Cedco #37</u>			
I-37	15 min.	Personal - Operator (Donald Thompson) hauling 13 sacks NGSV from truck to hopper and dumping.	1.9
J-23	15 min.	Personal - Operator (George Arnott) hauling 12 sacks NGSV from truck to hopper and dumping.	0.7
M-21	13 min.	Environmental - Located directly over the hopper, after test.	0.4



CACTUS 16

FIGURE 2

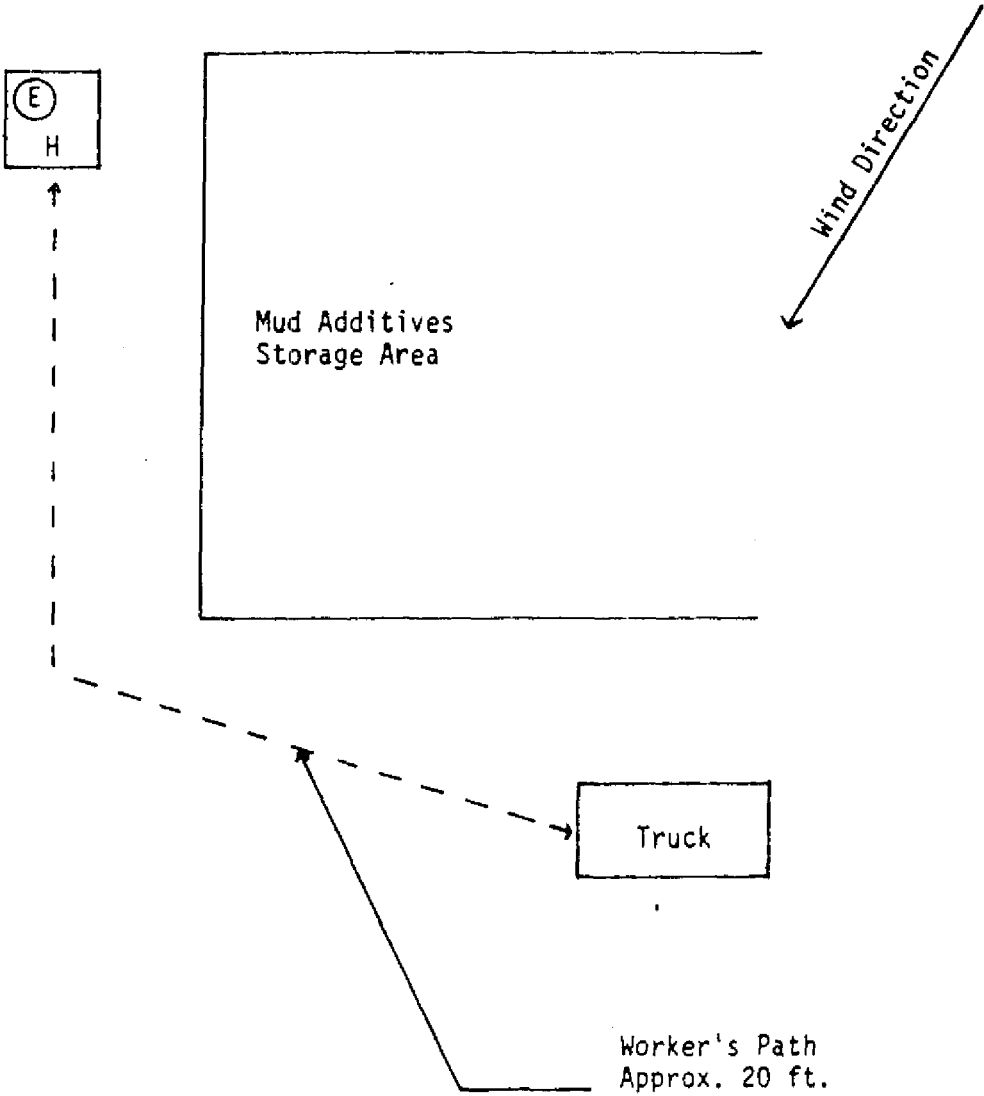
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CACTUS 21.

FIGURE 3

020292



CEDCO 37



THE DISCOVERY COMPANY

020293

Calidria ASBESTOS

March 25, 1969

Mr. Kenneth N. Campbell
Montello, Incorporated
P. O. Box 1046
Sand Springs, Oklahoma

Dear Ken:

I appreciate your recent letters on the labeling on our bags and the sales activity with Super Visbestos.

With respect to the first item I discussed this with Harry in your absence and, frankly, our purpose in including this label was to remind our customers that the presence of air borne dust could be a problem and adequate precautions should be taken. Our Medical and Legal Departments also advised us to include such a notice not only for our own protection, but also for the sake of the customer. I agree that we should have advised you sooner on this, and I apologize for not doing so. Actually, the wording on this label is the most innocuous that we could devise and in essence it merely reminds people to follow good practices which, for the most part, they are following anyway. In respect to how to respond to your customers it would be my suggestion that you follow the same approach we have taken. That being that this is a reminder to take proper precautions to minimize dusty environments, particularly with the increasing concern (and possible legislation) over air pollution and dust control.

I do not know whether any of the other asbestos producers will mark their bags in a similar manner, but our position with respect to this is that we feel we should take a leadership role here and if they care to follow, fine. I realize that your use situation is quite a bit different than most in that the material is used out in a drilling rig in the open air miles from nowhere, but, again, I believe a precautionary notice is worthwhile. We do not feel we should eliminate the label from the bags.

Mr. Kenneth N. Campbell

-2-

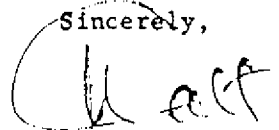
March 25, 1969

With regard to the Super Visbestos sales, again Harry and I discussed this briefly. Our whole intent was to bring this condition to your attention. I am sure that you are just as anxious to promote this product as we are and if we can help in any way we want to do so.

I am enclosing a copy of the Directory of Marine Drilling Rigs by Ocean Industries which may be of interest to you and Harry.

It has been some time since we got together and probably we are due for another session in a month or so. I will look forward to a visit to Tulsa to review our plans and programs.

Sincerely,



Walter S. Young, Jr.
Market Manager
Calidria Asbestos

WSY/ds
Enc...

cc: Mr. Harry Wyatt

A I R B O R N E A S B E S T O S

A Report Prepared by the
Committee on Biologic Effects of Atmospheric
Pollutants
of the
Division of Medical Sciences, National Research
Council

National Academy of Sciences

National Academy of Engineering Washington, D.C. 1971

Committee on Biologic Effects of Atmospheric Pollutants, Division of
Medical Sciences, National Research Council:

020296

- Dr. Arthur B. DuBois, Department of Physiology, School of Medicine,
University of Pennsylvania, Philadelphia, Pennsylvania, Chairman
- Mr. Vinton W. Bacon, College of Applied Science and Engineering,
University of Wisconsin, Milwaukee, Wisconsin
- Dr. Anna M. Baetjer, Department of Environmental Medicine, School of
Hygiene and Public Health, The Johns Hopkins University,
Baltimore, Maryland
- Dr. W. Clark Cooper, School of Public Health, University of California,
Berkeley, California
- Dr. Morton Corn, Graduate School of Public Health, University of
Pittsburgh, Pittsburgh, Pennsylvania
- Dr. Bertram D. Dinman, School of Public Health, University of Michigan,
Ann Arbor, Michigan
- Dr. Leon Golberg, Institute of Experimental Pathology and Toxicology,
Albany Medical College, Albany, New York
- Dr. Paul B. Hammond, Department of Physiology and Pharmacology, College
of Veterinary Medicine, University of Minnesota, St. Paul, Minnesota
- Dr. Samuel P. Hicks, Department of Pathology, University of Michigan
Medical Center, Ann Arbor, Michigan
- Dr. Victor G. Laties, Department of Radiation Biology and Biophysics,
University of Rochester Medical Center, Rochester, New York
- Dr. Abraham M. Lillienfeld, Department of Chronic Diseases, School of
Hygiene and Public Health, The Johns Hopkins University, Baltimore,
Maryland

Committee on Biologic Effects of Atmospheric Pollutants, Division of
Medical Sciences, National Research Council (cont'd.):

Dr. Paul Meier, Biomedical Computation Facilities, University of
Chicago, Chicago, Illinois

Dr. James N. Pitts, Jr., Department of Chemistry, University of
California, Riverside, California

Dr. Gordon J. Stopps, Haskell Laboratory, E. I. duPont de Nemours and
Company, Newark, Delaware

Dr. O. Clifton Taylor, Department of Horticulture, University of
California, Riverside, California

Dr. Jaroslav J. Vostal, Department of Pharmacology and Toxicology,
University of Rochester Medical Center, Rochester, New York

Executive Director, T. D. Boaz, Jr., M.D.

Panel on Asbestos:

Dr. W. Clark Cooper, School of Public Health, University of
California, Berkeley, California, Chairman

Dr. Lewis J. Cralley, Bureau of Occupational Health and Safety,
Division of Epidemiology and Special Services, U. S. Public
Health Service, Cincinnati, Ohio

Dr. Benjamin G. Ferris, Jr., Department of Physiology, Harvard
School of Public Health, Boston, Massachusetts

Dr. Paul Gross, Industrial Hygiene Foundation, Inc., Pittsburgh
Pennsylvania

Mr. Duncan A. Holaday, Occupational Health Field Station, Salt
Lake City, Utah

Dr. Irving J. Selikoff, Environmental Sciences Laboratory, Mount
Sinai Hospital, New York, New York

Dr. George W. Wright, Medical Research Department, St. Luke's
Hospital, Cleveland, Ohio

Dr. Samuel P. Hicks, Department of Pathology, University of
Michigan Medical Center, Ann Arbor, Michigan, Associate Editor

Dr. T. D. Boaz, Jr., Division of Medical Sciences, National
Research Council, Washington, D.C., Staff Officer

The naturally occurring fibrous silicates classified as "asbestos" have become almost indispensable in modern technology.^{67,125,142} The world's annual production has grown from a few thousand tons in 1900 to over 3 million tons in 1968.¹²¹ Annual consumption in the United States averaged nearly 800,000 tons during the period 1965-1969.¹²¹ The potential of asbestos as a hazard to health has been the subject of a number of reviews in recent years.^{22,49,60,134,137,146,148,168}

Although it has been known for a half-century that persons who inhaled large amounts of asbestos dust in the course of their work sometimes developed disabling or fatal fibrosis of the lungs, it has been only within the last three decades that other serious effects, such as cancer, have been associated with occupational exposures. Recently, the likelihood of exposure of the public at large to asbestos has been recognized and has led to a demand for more rigorous control of asbestos emissions into the atmosphere.

"Asbestos" is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils.⁴⁶ Although there are many asbestos minerals, only six are of commercial importance: chrysotile, a tubular serpentine mineral, accounts for 95% of the world's production; the others, all amphiboles, are amosite, crocidolite, anthophyllite, tremolite, and actinolite. The asbestos minerals differ in their metallic elemental content, range of fiber diameters, flexibility or harshness, tensile strength, surface properties, and other

attributes that determine their industrial uses and may affect their respirability, deposition, retention, translocation, and biologic reactivity.

This report (1) summarizes the major evidence of the pathogenicity of asbestos in man and animals, (2) summarizes the evidence of human nonoccupational exposure to asbestos, (3) evaluates the evidence of a health risk associated with various degrees and types of exposure, (4) identifies sources of environmental contamination by asbestos, and (5) offers recommendations concerning the need for and feasibility of control measures.

W. Clark Cooper
Chairman

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PATHOGENICITY OF ASBESTOS

The effects of fibers in biologic systems may result not only from the properties of the fibers themselves, but also from contamination with inorganic or organic substances that occur naturally or are added during mining, milling, processing, shipping, or use. Contaminants acquired from the atmosphere or in the respiratory tract may be carried on the surface of fibers. Fibers may act as cofactors; conversely, their action may be modified by other cofactors.

PATHOGENICITY IN MAN

The proven or suspected effects of asbestos minerals on human health include nonmalignant changes, such as pulmonary and pleural fibrosis, and several types of malignancy, notably of the lung, pleura, and peritoneum. Nearly all the positive evidence of an association between asbestos and human disease has come from occupational groups. With few exceptions, these have consisted of workers engaged in the mining and milling of asbestos, the manufacture of asbestos-containing products (such as textiles and construction materials), and the application and removal of asbestos-containing insulating materials.

Asbestosis

Asbestosis, or asbestotic pneumoconiosis, was the first clearly demonstrated adverse effect of asbestos in man. It is characterized by a pattern of roentgenographic changes in the lung consistent with diffuse interstitial fibrosis of variable degree and at times with fibrosis and calcification of the pleura; clinical changes that include fine rales,

finger clubbing, and shortness of breath, each of which may be absent in an individual case; and physiologic changes consistent with a restrictive lung disorder.

The first published mention of a case, in a man who had worked for 10 years in the carding room of an asbestos factory, was by H. Montague Murray in 1907.¹¹¹ Cooke reported a second case in 1924²⁰ and in 1927 provided a more detailed description,²¹ in which the term "asbestosis" was first used. In 1930, Merewether¹⁰⁵ reviewed the salient features of the disease and the environmental exposures of workers, including data derived from an epidemiologic study reported in more detail by Merewether and Price.¹⁰⁶ This led to the promulgation of regulations for environmental and medical control in the United Kingdom, which became effective in 1932.⁷ Cases were first reported in the United States in 1930,^{110,141} and guidelines for acceptable dust concentrations were proposed by Dreessen et al. in 1938.³²

Industrial experience indicates that pulmonary fibrosis sufficient to interfere with respiratory or cardiovascular function can be prevented by reducing asbestos dust concentrations to levels that are still far above any likely to be encountered in community air.

Pleural Calcification

Calcified pleural plaques occur frequently in workers exposed to asbestos.^{5,6,43,103,108,130} When multiple or bilateral, they are regarded by some as almost diagnostic of asbestos-related disease.^{43,71} In asbestos workers, calcified plaques rarely appear until 20 years after first exposure and do not necessarily correlate with parenchymal fibrosis.⁹¹

Calcification appears to differ in frequency in different occupationally exposed groups, but studies are inadequate to verify or explain such differences.

Bronchogenic Carcinoma

No features of bronchogenic carcinoma associated with asbestos are pathognomonic. Primary sites are more often in the lower lobes, in contrast with the usually higher frequency of upper lobe tumors.

Peripheral primary sites are common in asbestos-related lung cancer.

All cell types are represented in most series.

The first suggestion that asbestos might be causally related to cancer of the lung was made in 1935 by Lynch and Smith,⁹¹ who described squamous cell carcinoma in a South Carolina textile worker with asbestosis. Despite other isolated reports, an association was not firmly supported by epidemiologic evidence until 1947, when Merewether, Chief Inspector of Factories in the United Kingdom, reported 31 instances of cancer of the lung in 235 persons known by his department to have died with asbestosis between 1924 and 1946.¹⁰⁴ That constituted an incidence of 13.2%, compared with 1.32% (91/6884) in persons certified as having had silicosis during the same period. Gloyne in 1951⁵⁰ reported on the pathologic findings in 1205 lungs from workers whose cases were being evaluated for pneumoconiosis. In 132 asbestos workers, he found 121 with asbestosis, of whom 17, or 14.0% had cancer of the lung, compared with 55 (6.9%) of 796 persons who had silicosis. The study was done, however, in a hospital to which suspected tumor patients would have been referred; thus, there may have been an overestimate of risk. Doll in 1955,³¹ after analyzing the causes

of death among 105 men who had worked for at least 20 years in areas of asbestos textile plants defined as dusty, concluded that the 18 cases of lung cancer that occurred indicated a risk about 10 times that in the general male population.

Other studies^{11,13,15,18,23,24,33,34,38-40,59,70,74-76,80-82,87,93,94,98,101,112,131,149,154,155,161,169} have confirmed an association between occupational exposure to asbestos and a higher-than-expected incidence of bronchogenic cancer. Some studies¹³ have demonstrated differences in the degree of risk among different occupationally exposed groups, probably related to dose, as well as to other factors.

Mesothelial Tumors

Primary malignant tumors of the pleura and peritoneum have been regarded as exceedingly rare by most pathologists; until recent years, some even questioned their existence. There are still differences of opinion as to diagnostic criteria.^{18,70,98,149} Therefore, statistics on prevalence or incidence in one geographic area cannot be safely compared with those from another. Adherence to strict diagnostic criteria, including an autopsy complete enough to rule out other primary tumors that could metastasize to or involve serosal surfaces, is a difficult constraint on a retrospective series.

It was after 1960 that serious consideration was first given to asbestos as an etiologic factor in mesothelial malignancies. In that year, Wagner et al.¹⁶¹ reported 33 cases of pleural mesothelioma in a part of South Africa important for crocidolite mining. For all but two of the patients, the authors discovered likely asbestos contacts two decades or

more earlier. However, only 17 of these had had occupational exposure.

The remainder had lived near mines or had had household contacts. Although mesothelioma had previously been attributed by some to asbestos exposures,^{86, 164, 165, 169} no evidence of a strong association had been developed.

Additional information supporting a relationship between asbestos and malignant mesothelioma has accumulated since 1960.^{9, 12, 36, 37, 41, 42, 59, 75, 80, 88, 93, 95, 99, 100, 102, 113-116, 132, 134, 136} An outstanding feature has been the long period, commonly over 30 years, between the first exposure to asbestos and the appearance of a tumor, as emphasized in reports by Wagner¹⁵⁸ and Selikoff et al.¹³⁴

Other Neoplasia

Associations between asbestos exposures and malignancies of the gastrointestinal tract and of other sites have been reported, but the data are still inconclusive.^{52, 59, 77, 94, 134}

Mutagenic Effects

There is no evidence that asbestos is associated with mutagenesis.

PATHOGENICITY IN LOWER ANIMALS

A comprehensive review of information derived from experimental work in animals entails consideration not only of the variables related to the type and dimensions of the asbestos fibers and of adsorbed or concurrently administered contaminants, but also of the species and strain of animal, the route of administration, and the time and dosage factors. There are at present no satisfactory experimental models to duplicate prolonged inhalation of asbestos by man, but many isolated segments of the problems have been elucidated. The studies are best divided into those dealing with asbestosis and those dealing with neoplasia.

Experimental Asbestosis

Asbestotic pulmonary fibrosis has been produced experimentally in various species of animals, including rats,^{45,58,156,157} guinea pigs,^{29,45,69,157} hamsters,⁵⁵ rabbits,¹⁵⁷ and monkeys.¹⁵⁷ In many of the studies, the disease resembled early asbestotic development in man--e.g., it was multifocal. Diffuse fibrosis has also been produced,¹⁵⁷ but to do so it was necessary to use very high concentrations of asbestos dust and long periods of exposure or observation after exposure. (In contrast, experimental silicosis can be produced with lower cumulative exposure.) In the course of the investigations, it has been asked whether the fibrogenicity of asbestos dust is mostly confined to fibers longer than 5 μ m;^{45,156} the question is still unanswered.

Experimental Neoplasia

Lung cancer from chrysotile dust has been produced experimentally in rats⁵⁸ and in mouse lung implants.¹⁴⁰ Other investigators who used different methods for introducing the dust¹⁴³ did not find lung cancer in the animals they studied. That some asbestos dust has an increased content of trace metals--particularly nickel, chromium, and cobalt--may explain these differing experiences. Rats whose lung clearance had been artificially impaired had twice the lung cancer rate of animals with normal clearance.⁵⁸

Cancer of the pleural surface (mesothelioma) has been reported in rats and hamsters that received intrapleural injections of the three most common types of asbestos.^{139,159,160} The amounts of asbestos dust introduced into the thoracic cavity were very large, and translation of results to human inhalation of asbestos is uncertain.

The studies of Roe et al.,¹²⁴ which involved pleural and peritoneal mesotheliomas of mice after subcutaneous injections of crocidolite, amosite, or chrysotile, are of particular interest because they yielded evidence of migrations of fibers.

Naturally Occurring Effects in Lower Animals

There is no evidence that effects on domestic or wild animals are important as criteria for controlling asbestos emissions. Schuster has described pulmonary asbestosis (without the development of asbestos bodies) in a dog that lived for nearly 10 years as a ratcatcher in a London asbestos factory.¹²⁸ Webster has demonstrated fibrosis in donkeys, baboons, and wild rodents in South Africa,¹⁶³ and Kiviluoto has described the finding of anthophyllite asbestos in the lungs of a cow in an anthophyllite-producing area of Finland.⁷⁹

STUDIES IN VITRO

There have been limited studies of the effects of asbestos in biologic systems in vitro. For example, MacNab and Harington⁹² demonstrated in 1967 that asbestos would hemolyze sheep erythrocytes. This has been confirmed by others.^{127,129} Although chrysotile is markedly hemolytic, amosite, crocidolite, and anthophyllite have little or no activity under similar conditions.

Parazzi et al.¹¹⁷ demonstrated in 1968 that both crocidolite and chrysotile were cytotoxic for guinea pig macrophages in culture. The activity of the former was greater; the cytotoxicity of neither was inhibited by

polyvinylpyridine N-oxide, a macromolecular chemical that is effective in preventing the cytotoxic damage caused by crystalline silica in experimental conditions.

Although the foregoing types of study have no known relationship to fibrogenic or carcinogenic effects in vivo, they provide systems that may prove useful in determining mechanisms of action and approaches to prophylactic or therapeutic measures.

INFLUENCE OF MAJOR VARIABLES ON PATHOGENICITY

When considering the importance of type of asbestos, fiber size, and cofactors on biologic effects, it is necessary to emphasize that a given attribute may influence in differing ways the respirability, deposition, retention, clearance, translocation, and biologic reactivity. Although some in vitro and laboratory studies yield different responses to different types of asbestos, the results do not justify drawing firm conclusions as to the relative pathogenicity of the different types. Nor do epidemiologic studies conclusively support such differences. All the commercially used forms of asbestos can produce asbestosis. In only relatively few studies has the incidence of malignancies been determined in groups with exposures to a single asbestos type. Where there are data that suggest a lower risk, as in the chrysotile-producing areas of Canada^{13,100} and Italy,¹⁵⁴ there are possible explanations for the difference other than asbestos type. The high incidence of mesothelial tumors in the North Western Cape area of South Africa has led to the suggestion that crocidolite is unusually hazardous, but mesotheliomas have been rare in the Transvaal, where crocidolite is also produced.^{49,138} Although Selikoff et al.¹³² found

many mesotheliomas in insulation workers whose exposures had been largely to chrysotile and amosite, Sluis-Cremer¹³⁸ and Webster¹⁶² have not found the incidence of mesothelioma high in areas where amosite was mined and milled, and McDonald¹⁰¹ did not report an excess in the chrysotile mining and milling areas of Canada.

All epidemiologic studies that appear to indicate differences in pathogenicity among types of asbestos are flawed by their lack of quantitative data on cumulative exposures, fiber characteristics, and the presence of cofactors. The different types, therefore, cannot be graded as to relative risk with respect to either asbestosis or neoplasia.

Fiber size is critically important in determining respirability, deposition, retention, and clearance from the pulmonary tract and is probably an important determinant of the site and nature of biologic action. Little is known about the movement of fibers within the body, including their potential for entry through the gastrointestinal tract. The aerodynamic properties of fibers depend largely on their diameter; fibers below 3.5 μm in diameter are regarded as being in the respirable range.¹⁵² Fiber length affects deposition, longer fibers apparently having greater fibrogenic effects.^{44,156} Until recently, most work and speculation have involved only fibers detectable by the optical or light microscope (LM), approximately 0.5 μm in diameter and larger. The application of electron microscopic (EM) techniques¹³⁴ has enlarged our horizons as to the variables that must be considered. Tissues and air samples may contain many EM-sized fibrils for every LM-sized fiber that can be demonstrated.^{84,134} There is, however, no body of knowledge that permits the assigning of relative risk factors to fibers in the EM

range, compared with fibers in the LM range. It is possible that the relative risks associated with fibers of different sizes are different for nonmalignant and malignant changes. The evidence that bundles of fibrils may be broken down within the body to individual fibrils is important.¹⁴⁷

A number of investigators have postulated that a probable role of asbestos fibers in producing disease is to carry toxic or oncogenic substances to vulnerable sites. Studies bearing on this have included analysis of various types of asbestos to determine the contaminants present, with special emphasis on metals^{26,27} and polycyclic hydrocarbons;^{48,61-64} studies of the elution of contaminants in biologic materials;²⁶ and the concurrent exposure of animals to asbestos and to other materials.¹⁰⁹ The present consensus is that contaminants are present, but a special pathogenetic role is still speculative.

The work of Selikoff et al.¹³⁵ strongly suggests a synergism of cigarette smoking and asbestos exposure in the increased risk of lung cancer in insulation workers. It is not known whether this is because of reduced clearance of asbestos, transportation of cigarette-smoke carcinogens by asbestos fibers, or the promotion by one factor of cancer initiated by another.

EVIDENCE OF HUMAN NONOCCUPATIONAL EXPOSURES

Direct and indirect evidence that persons other than those working directly with asbestos minerals are being exposed to asbestos is of several types. For example, asbestos fibers can be demonstrated in the lungs of persons not occupationally exposed. In a few geographic areas, pathologic changes regarded as representing a reaction to asbestos (e.g., pleural calcification) have been found in populations with no history of occupational exposure. Asbestos fibers have been demonstrated in ambient air.

FIBERS IN LUNG TISSUE

Structures that appear to be fibers coated with a pigmented material were described in lung tissue as early as 1907 by Marchand.⁹⁶ These structures were actually fibers coated with hemosiderin. In 1929, Cooke¹⁹ described such "curious bodies" in association with pulmonary fibrosis. Stewart and Haddow¹⁴⁴ referred to them as "asbestosis bodies." Because those who work with asbestos exhibit them a few months after starting work, it was recognized that they were evidence of exposure, but not of asbestosis. The term "asbestos body" came to be the preferred designation.

As long as the coated fibers were found in persons known to have been occupationally exposed to asbestos, the identity of the central fiber was seldom questioned, although from time to time similar objects were found in persons with no known exposure to asbestos. Meurman¹⁰⁷ in 1966 summarized 19 reports published between 1932 and 1962 in which these objects were associated with exposure to graphite, coal, hornblende, rutile, diatomaceous earth, carborundum, and talc (in which case tremolite asbestos might have been involved). The demonstration by Gross^{54,56} that other fibers may

produce such bodies in experimental animals indicates that they result from a nonspecific reaction to any sparingly soluble fibrous foreign body, as had first been suggested by Cooke in 1929.¹⁹ There is thus ample justification for abandoning "asbestos body" as a generic term; Cough⁵¹ in 1965 suggested the term "mineral fiber-body," and Gross⁵³ in 1966 recommended "ferruginous body."

Thomson et al.,¹⁵¹ in 1963, were the first to show that these coated fibers were present in a high proportion of lungs obtained by routine autopsy. They found that 26.4% of lung smears in 500 consecutive autopsies in Cape Town showed what were called "asbestos bodies." Reports from many other areas have confirmed a high prevalence in lungs obtained in similar autopsy series.^{3,8,17,30,47,107,118,123,150} Utidjian et al.¹⁵³ inferred that, if a sufficient volume of lung tissue were examined in each case, nearly all persons would be found to have such bodies; their study of 100 lungs in Pittsburgh confirmed their suggestion.

Identification of the core fibers has proved to be a formidable technical task.^{57,84,119} Without fiber-by-fiber analysis, all that can be said is that coated fibers resembling those in asbestos workers are present in most persons in our urban centers. Stripping the coating and analyzing the cores by various techniques can sometimes demonstrate that the cores are asbestos, but the process is tedious and often inconclusive.

Attention is now being directed toward study, not of the ferruginous bodies alone, but of the total fiber content of the lungs, whether such fibers are coated or uncoated. In a study of 3,000 consecutive autopsies in New York City, Langer et al.⁸⁴ have found thin, uncoated, optically

visible fibers in two-thirds of the 1,449 lung specimens in which coated fibers were demonstrated and in one-fourth of those in which uncoated fibers were demonstrated. Twenty-eight consecutive samples of lung tissue from the same series examined by electron microscopy were found to contain EM-sized chrysotile fibers.⁸⁵ Pooley et al.¹¹⁹ have reported similar findings.

Evidence is therefore strong that most human lungs harbor thousands or millions of fibers. Some of these are chrysotile asbestos, and other types of asbestos minerals are probably there also. In most persons not occupationally exposed to asbestos, the numbers of fibers are relatively small, compared with the numbers found in the occupationally exposed.¹³³ The systematic application of quantitative techniques, measuring both coated and uncoated fibers, is needed to define a gradient of accumulated fibers for correlation with incidence of disease, on the one hand, and history of environmental exposure, on the other.

Although there appears no doubt that asbestos fibers are present in many human lungs, there are sources of airborne fibers other than asbestos.^{28,57} Some are probably derived from the burning of leaves and plant products, such as paper, wood, and coal. Man-made (mostly vitreous) fibers have also been identified in the sediment isolated from human lungs. Talc, often used generously as a dusting powder, may contain a significant amount of tremolite asbestos fibers.

Information is sparse concerning possible increase of fibers in lungs with increasing use of asbestos and concerning the existence of significant differences between urban and rural populations. Selikoff and Hammond¹³³ compared lung tissues obtained in 1934 and 1967 and found no significant

increase in the proportion containing ferruginous bodies. This suggested that, despite increasing use of asbestos in New York City between 1934 and 1967, fibers of a type producing ferruginous bodies had not been increasing at a corresponding rate. However, Chang-Hyun Um⁷³ reports an increase over each decade in asbestos bodies in samples of lungs from persons who died in London in 1936, 1946, 1956, 1966.

PLEURAL CALCIFICATION IN THE GENERAL POPULATION

Mourman¹⁰⁸ in 1968 reviewed critically the literature related to pleural calcification and asbestos exposure. A number of studies strongly suggested an association between pleural calcification and nonoccupational exposures to asbestos. For example, Kiviluoto⁷⁹ in 1960 reported calcifications in 9% of the adult population detected during mass roentgenographic surveys in a Finnish commune in which there was an asbestos mine and mill; the frequency was low for the remainder of the Finnish population. Raunio¹²⁰ enlarged on these observations in 1966, reporting that, of 633,201 chest films taken in Finland between 1960 and 1965, 1516 showed pleural calcifications; 1232 of the latter were among 43,483 films taken in 10 communes in which there were anthophyllite mines. Rock and soil in such areas also contain much asbestos, so that the demonstration that airborne anthophyllite could be demonstrated over 25 km from the mines is not necessarily relevant. Anspach⁴ reported that, of 244 subjects with pleural calcification found in a chest roentgenographic survey in Dresden, 177 had either worked in or lived near an asbestos factory. Zolov *et al.*¹⁷⁰ described a 5.1% prevalence of pleural calcification in a rural population in Bulgaria and suggested that the most likely cause was asbestos in the soil. However, Hromek,⁷² Marsová,⁹⁷ and Rous and

Studený,¹²⁶ reporting on a high prevalence of pleural plaques in a rural district of Czechoslovakia, have been unable to demonstrate a source of asbestos exposure. The consensus at present is that calcification alone may not invariably be considered an index of asbestos exposure in the general population, although it may prompt a search for an environmental source of asbestos.

MEASUREMENT OF AIRBORNE ASBESTOS

A more direct method of obtaining evidence on the likelihood of exposure of the general population would be the sampling of air to determine the presence and amount of respirable asbestos fibers. There are, however, many uncertainties as to the best methods of sampling, identifying, and quantitating airborne asbestos and interpreting data so obtained.^{78,90,122,137} Limited information has been derived from measuring fibers on sampling sites, such as that by Laamanen *et al.*,⁸³ who showed asbestos fallout diminishing rapidly beyond 1 km from an anthophyllite quarry, but still detectable at 27 km. Counts of asbestos fibers collected on membrane filters by high-volume air sampling and estimated by light microscopic techniques similar to those used in industrial hygiene have shown small numbers of fibers in a few urban sites.^{10,16} Such results, although showing numbers of fibers detectable by the light microscope that were low by occupational health experience, have been too few and variable to be used with confidence. Alternative methods that are currently under development, including estimations of the number and mass of fibers in the LM and the EM size ranges, have shown measurable concentrations of asbestos in many samples of ambient air.^{1,66,137} Such environmental measurements are in their earliest stages and provide few clues to the extent or significance of the risk from this type of exposure to asbestos or to other mineral fibers.

CHAPTER 3

ESTIMATION OF RISK IN NONOCCUPATIONAL EXPOSURES

Industrial experience has shown that prolonged inhalation of asbestos can increase the risk of neoplastic disease. Examination of lung tissue has made it apparent that a much larger proportion of the general public has inhaled and retained asbestos fibers than had formerly been realized; in fact, most urban dwellers have some such fibers in their lungs. Can these facts be related? Does the general public--as well as persons working near occupational sources, living in the households of asbestos workers, living in the neighborhoods of asbestos plants, or having occasional random exposures--have a detectably increased risk of malignancy or other disease because of airborne asbestos? The limited information we have to answer these questions comes either from direct epidemiologic studies of groups with various levels of nonoccupational exposure or by extrapolation from the experience of industrial populations with direct or indirect asbestos exposures.

EPIDEMIOLOGIC STUDIES RELATED TO NONOCCUPATIONAL EXPOSURES

Two general indices of asbestos exposure are available for use in direct epidemiologic studies of groups not known to be occupationally exposed to asbestos. The first is based on knowledge of each member's place of work and place of residence; because of the long latent periods of asbestos-related disease, this knowledge must cover each person's whole lifetime. The second is a quantitative estimate of each member's lung content of asbestos fibers. There are few such direct epidemiologic studies, and they are inadequate to answer the questions at issue.

The only studies that appear to implicate asbestos in the development of malignancies in persons not occupationally exposed are those involving diffuse mesothelioma, a tumor that is uncommon and that has been the subject of special attention in recent years. Many of the mesotheliomas reported by Wagner et al.¹⁶¹ in South Africa were attributed to household and neighborhood exposures in a crocidolite-producing area. Although non-occupational, these exposures have been described as substantial.¹⁶⁸ Newhouse¹¹⁴ studied 76 patients with mesothelioma diagnosed in London Hospital from 1917 to 1964. Of these 31 (40.8%) had occupational exposures to asbestos, 9 (11.8%) had a relative who worked with asbestos, 11 (14.5%) had neither of those backgrounds but had lived within a half-mile of an asbestos factory, and 25 (32.9%) had no known contacts. Corresponding percentages for a group of matched control subjects (patients in the same hospital for other diseases) were 10.5%, 1.3%, 6.6%, and 81.6%. Stumphius and Meyer¹⁴⁵ reported no mesotheliomas in the community near the shipyard in Flushing (Holland), although 17 of 21 mesotheliomas reported in the province of Zeeland in 1964-1967 had been in workers in that yard. Raunio¹²⁰ found no excess of pulmonary, pleural, or peritoneal malignancies in the areas of Finland where pleural calcifications attributed to anthophyllite were present in 6%-9% of routine chest survey films. In a series of 17 mesotheliomas collected by Borow et al.,¹² all but two were in persons who had worked in an asbestos mill, although the autopsy series from which the cases were drawn came from an area that included inhabitants of the mill's environs. Lieben and Pistawka⁸⁷ found that of 42 persons with mesotheliomas reported in Pennsylvania, 10 had worked in asbestos plants, 8 lived or worked close to an asbestos industry, and 3 were members of families that

included asbestos workers; in 11, no history of exposure could be obtained, and the remaining 10 had questionable random exposures. McDonald et al.¹⁰⁰ collected information on 165 fatal malignant mesotheliomas known to pathologists in Canada between 1959 and 1968. They confirmed an association with occupational exposure to asbestos but concluded that the excess was in the manufacture and industrial application of asbestos, rather than in mining or milling. It is apparent that no quantitative conclusions were possible from these studies, which present serious methodologic problems to the epidemiologist. They suggest a risk in household contacts and in residence in the immediate neighborhood of asbestos plants. There appear to be different levels of risk in different types of occupational exposures, and some of these may be reflected in corresponding household and neighborhood experience.

In no analysis of causes of death in a large population has there been quantitative estimation of the lung content of ferruginous bodies and bare asbestos fibers, to determine whether a detectable gradient of disease can be correlated with asbestos content. The series so far studied have been too small, and methods have been too variable, to permit any conclusions as to the importance of small numbers of fibers in the lung.

EXTRAPOLATION FROM OCCUPATIONAL EXPERIENCE

Another source of evidence of the relative risks associated with inhaling moderate or small numbers of asbestos fibers is the experience of persons who have had occupational exposures below those known to be definitely hazardous. The maximal airborne fiber concentrations recommended for prevention of asbestosis are much higher than any likely to be encountered in

nonoccupational situations. For example, one recommended standard would limit the average concentration of airborne chrysotile to 2000 fibers per liter as determined by light-field count.¹⁴ Another that has been proposed would limit average concentrations of fibers to 5000 fibers per liter.²

Occupation-related asbestosis can be effectively controlled with airborne fiber concentrations much higher than are likely to be encountered in non-occupational situations. It is important to determine whether workers whose exposures have been reduced to levels that prevent or greatly delay asbestosis, as well as others whose exposures are indirect, have a lower risk of lung cancer than those with higher and more direct exposures.

Workers who began employment in a British textile mill after 1933, when implementation of the Asbestos Industry Regulations of 1931 reduced (but did not abolish) dust exposures, were reported in 1968 to show no excess of neoplasms.⁸² The long latent periods of asbestos-related lung cancer and mesothelioma, which would probably be even longer at lower dose levels, are such that it is too soon to draw final conclusions as to the eventual incidence of these malignancies. Nevertheless, reduced exposure seems to be having an effect. Another indication of reduced incidence or delayed onset of disease with lower exposure is in the observations of Newhouse,¹¹² who found that, although there were more deaths from lung cancer and chronic respiratory disease among those who had heavy exposures many years previously in a London asbestos-products plant, this was not true among those who had low or moderate exposures. McDonald *et al.*¹⁰¹ recently reported the mortality experience of men who worked in chrysotile mines and mills of Quebec. There was a slight excess of lung cancer among the 2457 deaths in workers born 1890-1920, but all could be explained by the excess that

occurred in those who had been maximally exposed. This suggests that, insofar as chrysotile miners and millers are concerned, the risk drops off rapidly with decreasing accumulated dosage.

Most series of case reports of mesothelioma include some persons who have worked in the construction or shipbuilding industries, but in trades not involving direct contact with asbestos.¹⁰² Such persons as plumbers, electricians, and metal workers often have more ferruginous bodies in their lungs than do white-collar workers.¹³⁴ Although Dunn and Weir,³³ in a study of occupational groups in California that revealed an excess of deaths from lung cancer in insulation workers, found no excess lung-cancer deaths in other construction trades, the groups they studied were diluted with many persons who were unlikely to have had exposures.

Nevertheless, there may be a definable gradient of effect within the construction trades. More thorough studies of groups with indirect exposures are certainly needed.

We cannot extrapolate from the mortality experience of those who are directly and indirectly exposed to asbestos in their employment to the general public who have had moderate or slight exposures from ambient air. There is evidence to suggest a gradient of effect from direct occupational, to indirect occupational, to family and neighborhood situations, in all of which dust concentrations are probably high by comparison with most community air. This suggests that there are levels of asbestos exposure that will not be associated with any detectable risk. What those levels are is not known, but there is no evidence that persons in the general population--without occupational, household, or neighborhood exposures--have any increased risk of neoplasm, even though there may be ferruginous bodies of fibers in their lungs.

SOURCES OF ASBESTOS FIBERS IN AMBIENT AIR

Precise information is not available on tonnages, numbers of fibers, fiber sizes and varieties, atmospheric dispersion, and ultimate fate of the asbestos emitted into ambient air. Although there are no reliable data to justify extrapolation from the more completely studied occupational exposure experience, information regarding actual and potential sources of emissions of asbestos fibers is of value both for directing future studies and for understanding the steps that might be taken now to safeguard the health of the public.

NATURAL SOURCES OF AIRBORNE ASBESTOS FIBERS

Several varieties of asbestos ore and counterpart rock (containing EM-sized asbestos fibers) occur as outcroppings or are just below the surface of the earth throughout the world. Asbestos fibers can become airborne from these formations during road-building, construction, and tilling of the soil, as well as by landslides, erosion, and weathering. Talc, mined and used extensively in the United States, exists in fibrous, as well as platy, form. Like asbestos ore and rock, talc exists on or close to the earth's surface and is subject to disseminating forces. Such naturally occurring talc, as well as the large quantities used as a diluent and carrier for pesticides, can add to the background fiber concentration in the ambient air.^{166,167} It is thought that studies of fibers in glacial and polar ice now under way will permit comparisons of recent deposition with those in the past and thereby provide definite information on the relative contributions of natural and industrial sources.

MINING AND MILLING OF ASBESTOS

Mining and milling of asbestos provides another source of asbestos emissions. In the United States, such activity is presently confined to a few mines in California, Vermont, Arizona, and North Carolina. Fibers are emitted during removal of overburden and preparation of the ore body for open-pit mining. Further release occurs during drilling and ore-breaking. Waste dumps from mining and milling are exposed to wind and to disturbance by bulldozing. Fibers are emitted during drying, crushing, grinding, and screening of the ore. If dust collectors and air-cleaning devices are used, disposal of the collected dust provides a potential source of fiber emission.

TRANSPORTATION OF MATERIALS CONTAINING ASBESTOS

Transportation of asbestos ore, milled asbestos fiber, and asbestos-containing products and wastes is an emission source of varying importance. Movement of asbestos ore from mine to mill in open trucks contributes to the overall emission. The shipment of milled asbestos fiber, usually in bags, can result in emissions. If bags are reused, either in the asbestos industry or elsewhere, they will become a source of fibers. Occasionally, bags are broken and asbestos is spilled during handling. Similar emissions

occur during the shipment of products. Transporting asbestos-containing solid wastes in open vehicles through urban areas can be a more important emission source.

MANUFACTURE OF PRODUCTS CONTAINING ASBESTOS

Industries that must provide ventilation and other dust-control measures for the protection of workers may emit asbestos fibers into the surrounding environment unless effective air cleaning is applied to effluents. Fibers removed by ventilation and filtering devices and not reintroduced into the production process and asbestos-containing waste products of the manufacturing process ultimately are disposed of outside the plant.

USE OF PRODUCTS CONTAINING ASBESTOS

Many products, at times unknown to the user, contain asbestos of one kind or another. There are great variations among such products with respect to the chances of fiber release during the use of the product. The likelihood depends predominantly on the ease with which the fibers can be dislodged by the application of energy and on the degree to which the application of energy actually destroys the fibers during the use of the product. Almost all the asbestos fibers used in the United States for manufacturing products becomes tightly bound within the products and undergoes little actual abrasion or wear before being discarded. Asbestos cement products (accounting for most of the asbestos used in the United States), shingles, and floor tiles are in this category. Some asbestos-containing products, such as brakelinings, are subjected to high energy, and their rate of wear is considerable and at times almost complete. In the case of brakelinings, the application of energy is so intense and the heat created so great that

most chrysotile fibers are destroyed by being converted to another substance, which is nonfibrous.^{65,68,89} Nevertheless, an appreciable percentage (1%-3%) remains as fibrous asbestos. In some products-- for example, asbestos cloth, paper, and sprayed fireproofing materials-- asbestos fibers are not tightly bound or mixed with other material that holds them in place. Fiber release from these products occurs primarily during application and removal. The spray fireproofing of buildings with asbestos-containing materials is a case in point. This operation can be a serious source of emission, in that it usually occurs in densely populated areas. The total amount of asbestos fiber used in such procedures, however, is relatively small.

Talc is mined and milled and used in greater quantities than is asbestos in the United States. Because it contains asbestos fibers, its uses will add to the total number of fibers (including nonasbestos fibers) emitted. The use of talc in dispensing pesticides over wide areas of the country and its use in cosmetics are two examples of how this material may act as a source of asbestos and other fibers.

DEMOLITION

For years, asbestos has been incorporated in building materials. In some forms of insulation and wallboard, the amount present is less than 20% of the total; but other materials consist mostly or entirely of asbestos. When a building is demolished, areas of loosened asbestos are open to the ambient air and fibers are emitted. In general, single-family residential structures contain only small amounts of asbestos insulation. Demolition of industrial and commercial buildings that have been fireproofed

with asbestos-containing materials will prove to be an emission source in the future, requiring control measures.

SOLID-WASTE DISPOSAL

Solid wastes produced during manufacture of asbestos-containing products, use of such products, and demolition can be emission sources. These waste materials are usually disposed of without regard to their potential as emission sources. Alternate methods of disposal often result in commingling of asbestos-containing wastes with municipal wastes in open dumps and thus create a long-term emission source.

The natural background level of asbestos fibers is difficult to quantify or modify. The major sources of local ambient-air contamination with asbestos are industrial processing and use of products containing asbestos. It is feasible to identify the sources of emission, select those to which presently available control procedures can be applied, and point out areas that need further study and development of new methods of control.

NATURAL SOURCES OF AIRBORNE ASBESTOS FIBERS

Natural sources of asbestos fibers have been identified in many areas of the United States. It is assumed that emissions of fibers from these reservoirs through erosion and wind make up a natural background of asbestos in ambient air. Few data are available on the magnitude of the contamination from natural sources, variation with geographic location, and seasonal variation. It is desirable to have information on the natural background, because it would assist in evaluating the effects of control measures and permit some estimates of the lower limits of contamination that might be achieved in different areas of the country.

MINING OF ASBESTOS

The standard techniques for dust control in underground or open-pit mines, if not already in use, can be applied in asbestos mines. Roadways in open pits should be treated with dust-suppressive agents; truckloads of ore should be covered with tarpaulins while being transported; handling of ore should be minimized; ore storage piles should be moistened to reduce wind erosion; and waste dumps should be treated with dust-suppressive agents.

MILLING OF ASBESTOS

An in-plant dust-control program for protecting workers in asbestos mills includes exhaust ventilation with efficient dust-collecting and air-cleaning equipment, isolation, enclosure, wet methods, and good housekeeping and maintenance.

MANUFACTURE OF PRODUCTS CONTAINING ASBESTOS

The elements of dust control recommended for the milling of asbestos are also apply to the manufacture of asbestos-containing products. It is important that a dust-control system be specific to the operation for which it is used and that it be tested to ensure its effectiveness.

Only persons especially trained and experienced in dust control should be used to develop and institute dust-control procedures.

USE OF PRODUCTS CONTAINING ASBESTOS

An important emission source is the use of insulating materials containing asbestos. This constitutes only a small fraction of the asbestos used. But the asbestos in some insulating materials is not bound as it is in cementitious products or tiles; construction activities usually are carried on in urban areas where many people are exposed to contaminated air; and control of dust during construction, although feasible, is difficult.

The most effective approach in reducing exposures of the general public to asbestos from this source involves controlling dust production and release at its origin during construction work. The generation of dust should be reduced by changing material-handling methods, work practices, and cleanup procedures. Local exhaust systems should be used for dust collection at points of generation; for example, dust collectors for band

saws are available, and hand-powered tools supplied with exhaust systems are being made. Much developmental work is needed to produce portable air-moving and air-cleaning systems for use in tunnels, crawl spaces, and other confined spaces. This subject has been neglected by industrial hygienists and ventilation engineers, and no satisfactory equipment is available.

DEMOLITION AND WASTE DISPOSAL

Demolition and waste disposal are likely to be emission sources if appreciable amounts of asbestos are used in construction, unless operational procedures are strictly controlled. Isolation, enclosure, and wetting down are useful. Caution must be observed not to demolish during high winds and to keep sludge from drying out and becoming airborne later through natural forces and from being introduced into sources of drinking water.

MEASUREMENT OF AIRBORNE ASBESTOS

An important consideration in the development of a strategy for control is whether there are methods for measuring airborne concentrations of asbestos that are sufficiently sensitive, specific, and reproducible. Present methods of sampling, identifying, and measuring airborne asbestos are not entirely satisfactory, especially if one is dealing with low concentrations and unidentified or mixed sources. Only within recent years have methods for determining concentrations of fibers for industrial hygiene purposes been standardized;^{14,35} they use samples collected on membrane filters in which fibers are counted with phase-contrast illumination. Electron microscopic methods give a much more complete indication of the total fiber content

of the air; but when the need for fiber identification is included, they are tedious and expensive for routine use.^{1,66,137} The relative biologic significance of different sizes of fibers is not known, nor is the relative importance of fiber numbers and fiber mass. There appear to be no published data on the efficiency of air-cleaning equipment as related to fibers of different sizes.

In spite of the difficulties, it is possible to sample air, determine the approximate concentration of airborne fibers, and identify the major types of asbestos. It is not desirable to limit environmental measurements to a single method until there is a clearer definition of the critical variables in terms of health. Because of methodologic and other uncertainties, it is not yet feasible to base control on numerical ambient air quality standards.

CHAPTER 6
RESEARCH NEEDS

020331

Two recent reports^{25,167} have discussed in some detail the many kinds of research needed to answer pressing questions concerning the effects of asbestos on health and the degree and nature of necessary controls.

Investigations along the following lines should be given high priority.

Study of the mechanism of action of the asbestos minerals should continue, with particular attention to carcinogenic effects. It is important to learn more about the influence of asbestos type and fiber size on respirability, deposition, retention, translocation, and effects at the tissue, cellular, and molecular levels, with and without cofactors. It is especially important that the role of fibers below the LM range be clarified.

Methods of sampling, identifying, and quantitating airborne asbestos need continued development. Coordination with studies in animals and man is essential to ensure that environmental data will be biologically relevant. Similarly, methods for identifying and quantitating asbestos in biologic tissue need development and application.

Quantitative methods for measuring airborne asbestos should be applied widely to determine the natural background and the concentration and distribution of fibers in the air near various sources. Conventional LM methods and EM methods should be applied simultaneously in selected occupational and community situations.

More epidemiologic studies are needed. Populations in several different exposure ranges should be studied, including occupational, household, and neighborhood exposures. Special studies of mesothelioma are needed to determine whether the incidence has been increasing and to determine the current pattern of distribution. A large series of routine autopsies should be studied to determine whether causes of death can be related to amounts of asbestos in the lungs and other organs. All the above are urgent if a range of safe exposure is to be established with confidence.

CONCLUSIONS AND RECOMMENDATIONS

PATHOGENICITY OF ASBESTOS MINERALS

Any of the commercially used asbestos minerals, when inhaled in sufficient numbers, as in uncontrolled occupational exposures, can cause disabling fibrosis of the lungs. An association between occupational exposures to asbestos and bronchogenic carcinoma has been established, but the dose relationship and the role of cofactors have not been defined. Evidence of a causal association between some but not all exposures to asbestos fibers and diffuse malignant mesotheliomas of the pleura and peritoneum is substantial, but evidence of such a relationship with other tumors is inconclusive. Although the different types of asbestos differ in some of their biologic effects, no type can be regarded as free of hazard. The hypothesis that asbestos fibers act as cofactors or carriers of carcinogens is attractive, but as yet unproved.

EVIDENCE OF HUMAN NONOCCUPATIONAL EXPOSURES TO ASBESTOS

The demonstration of ferruginous bodies, similar to those found in asbestos workers, in a large proportion of randomly selected lung specimens in many parts of the world is presumptive evidence that persons with no occupational contact may have inhaled and retained asbestos. Proof has come in some areas with positive identification of chrysotile asbestos fibers. Analyses of community air for asbestos have been too limited to define the sources, concentrations, and distribution of fibers in the environment. The fiber concentrations that have been demonstrated in ambient air are small, compared with those in industry, but data are inadequate for definitive comparisons.

ESTIMATION OF RISK IN HUMAN NONOCCUPATIONAL EXPOSURES TO ASBESTOS

The most important question in the case of persons with nonoccupational exposures to asbestos is whether there is an increased risk of malignancies. Industrial experience indicates that there is no likelihood of significant asbestosis in nonoccupational exposures. The major potential for risk appears to lie in those with indirect occupational contacts, household contacts, or residence in the immediate neighborhood of asbestos sources; and even there, the actual risk is poorly defined. But the fact that there appears to be a gradient of effect in such groups suggests that there are levels of inhaled asbestos without detectable risk. It is not known what range of respirable airborne asbestos fibers will ultimately be found to have no measurable effects on health. At present, there is no evidence that the small numbers of fibers found in most members of the general population affect health or longevity.

NEED FOR AND FEASIBILITY OF CONTROLS

Asbestos is too important in our technology and economy for its essential use to be stopped. But, because of the known serious effects of uncontrolled inhalation of asbestos minerals in industry and uncertainty as to the shape and character of the dose-response curve in man, it would be highly imprudent to permit unrestricted additional contamination of the public environment with asbestos. Continued use at minimal risk to the public requires that the major sources of man-made asbestos emission into the atmosphere be defined and controlled. In the absence of such controls, local fiber concentrations might at times approach those in occupational sites. Analytic methods and epidemiologic data are inadequate for the development of ambient air standards, but emission controls are needed and appear feasible.

020335

8/17/72

Mr. Campbell:

Mr. Myers asked me to send the attached Testimonies by Dr. George W. Wright and Dr. J. Corbett McDonald. One set is for you and the other for ARCO.

Thank you.

Connie Bilek

020336

Statement by George W. Wright, M.D., Head of
the Division of Medical Research in the Dept. of
Medicine of St. Luke's Hospital, Cleveland, Ohio

before

U. S. Dept. of Labor, Occupational Safety and
Health Hearing on proposed occupational asbestos
standard

Washington, D.C.
March 16, 1972

My name is George W. Wright. I am the Head of Medical Research in the Department of Medicine of St. Luke's Hospital, Cleveland, Ohio. In 1932 I received the MD degree from Indiana University School of Medicine. After five years of Post Graduate Training in Internal Medicine with special training in pulmonary disease I spent two additional years in research training in the Department of Physiology at Case-Western Reserve University. From 1939 to 1953 I was a member of the Saranac Laboratories of the Trudeau Foundation engaged in studies of the pneumoconiosis, including asbestosis. Since 1953, I have continued this general field of study in my current position.

My statement will be confined to consideration of a single primary question. This question is: What is the quantity or concentration of asbestos, in the air breathed by those engaged in the production, manufacture or use of asbestos products, which can be tolerated for a normally expected work life without risk that such exposure will cause disease? The answer to this question goes to the heart of these hearings. While the question is rather easy to formulate it is difficult though not impossible to answer.

The obligatory information required for developing an answer to the primary question on an acceptable scientific basis is of two categories. One of these essential categories concerns the dose or quantity of asbestos inhaled and the other essential category concerns the biological response. What we need to learn is the dose-risk relationship.

The dose is estimated in terms of concentration of respirable asbestos in the air multiplied by the duration of the

exposure. It is obligatory that we establish a dose, in measurable terms, at which the biological manifestation of disease occurs and then, by observing populations exposed to progressively smaller and smaller doses, determine the level at which the biological reaction to asbestos no longer occurs. To make observations with regard to the various dose levels of different working populations without knowledge of the biological response of these same populations is of no use in answering the primary question. To make observations of the biological response in various working populations without valid knowledge of the different levels of asbestos exposure experienced by these same populations is equally of no use for finding an answer to the primary question. Standards for a safe level of asbestos exposure proposed or set in the absence of reliable and valid data in both of these two categories must be considered empirical and to some degree arbitrary and should be recognized as such.

I wish to indicate some of the difficulties encountered in efforts to obtain the information essential for determining what the safe level of asbestos in the occupational environment truly is.

Asbestos is a generic term embracing four varieties that are in common commercial use. Of these, chrysotile is used in largest quantities followed by crocidolite, amosite and anthophyllite. Each of these has different chemical and physical attributes. Some working populations are exposed to only one variety of asbestos while others are exposed to two or more simultaneously and in varying proportions. Thus there are several

kinds of populations each exposed in quite different ways to one or more kinds of asbestos, each of which might react biologically in a different manner. Moreover, workers exposed to asbestos are further exposed simultaneously to other airborne agents. In production, manufacturing and utilization processes these may differ greatly. For example, the asbestos producer is exposed to asbestos with minimal coexisting agents while, in contrast, the insulation manufacturer inhales asbestos plus silica plus other pneumoconiosis producing dusts. Insulation applicators inhale these materials plus a variety of additional agents present in whatever the environment is in the place where he is working at that time. Attention to such coexisting agents has been ignored in studies of insulation workers. Variations of type of fiber and the circumstances surrounding their use must be taken into account in answering the primary question and would suggest the possibility that different standards might be rational in order to meet different conditions of use of asbestos.

There are four, totally different biological phenomena or diseases thought to be related in some way to the inhalation of asbestos fiber. These are pulmonary fibrosis, bronchogenic cancer, thickening of the pleura, and mesothelioma. Not a single one of these diseases is peculiarly related to or caused solely by the inhalation of asbestos fiber. Each of these four diseases occurs *an d2 novo* or for other reasons in persons who have never been exposed occupationally to asbestos. The fact is, the biological reaction attributable to asbestos is not a

specific kind of disease induced solely by asbestos. Instead, the biological reaction to asbestos manifests itself by the fact that in some populations occupationally exposed to asbestos, there is, in contrast to non-exposed populations, an excess occurrence of one or more of the four previously mentioned diseases. To determine the safe level for the use of asbestos, we are required to demonstrate the level of exposure to asbestos at which no excess of disease develops when the exposed population is compared to a non-exposed population. In order to establish a safe level we must examine suitable control populations not exposed to asbestos, but age matched and residence matched, from which population one can learn the frequency of occurrence of the specific diseases in question. In addition, we must examine an exposed population, which can be ranked in various levels of exposure, in order to learn at what level an excess of these diseases occur in the exposed population. The observation of a biological abnormality in only one or two persons who have been exposed to the inhalation of asbestos fibers does not permit a comparison to suitable control groups or afford contrasting exposure values. Such observations are of no use for determining a safe level standard. Isolated case reports of mesothelioma, bronchogenic cancer or pulmonary fibrosis in individuals who may also have had an exposure to the inhalation of asbestos fiber are of no use in setting a safe standard for asbestos based upon sound scientific principles. Larger populations in which only the frequency of occurrence of disease is reported, without the necessary data indicating ranges of exposure and in which no attempt to relate variations of exposure to disease is made, fall into the same non-

usable category for setting a valid safe level. This is not to say that observations in such groups are of no value for other purposes, but the issue should not be confused by introducing data from such inadequate studies into considerations of safe levels of asbestos exposure. Suitable control populations made up of individuals in sufficient number who were never exposed to the occupational inhalation of asbestos fiber and occupational groups whose exposures are demonstrated to have wide variation are difficult to obtain but absolutely essential for our purpose. The absence of this kind of control data, excused or overlooked on the basis that it cannot be obtained, is an unacceptable condition if the safe level standard is alleged to be set on the basis of universally accepted scientific principles.

There is difficulty also with assessing the frequency of occurrence of the diseases thought to be related under some circumstances to the inhalation of asbestos fiber. There is no agreement as to the criteria for a valid diagnosis of mesothelioma. The criteria for a diagnosis of "asbestosis", especially in its least severe manifestation, are not generally agreed upon. The use of the chest x-ray for diagnosing the early manifestation of asbestosis is a case in point. A recent report by Murphy and his co-workers of a study of employees in a shipyard demonstrated that twenty percent of the control, or non-exposed population gave evidence of x-ray abnormalities which, if observed in the exposed population in the absence of controls, in all probability would have been interpreted as being evidence of the effect of the inhalation of asbestos fibers. In a population

which has been exposed to asbestos inhalation, it is very tempting to ascribe any departure from a perfect appearance in the chest roentgenogram to the occupational exposure, and indeed, in some studies this has been done. It is imperative to recognize that some persons who have never had an occupational exposure to asbestos will show the same x-ray shadows that have been interpreted by some as evidences of asbestosis in populations exposed to the inhalations of asbestos fiber. Studies such as those by Murphy et al exemplify the necessity of having suitable controls included in epidemiological studies bearing on the determination of a safe standard for asbestos.

There are still other difficulties having to do with establishing the dose-risk relationship. The health effects of asbestos inhalation are both dose and lapse-time related. Overt evidences of asbestosis do not appear until years after the initiation of the exposure. The interval between onset of exposure and its effect is even greater for the development of bronchogenic cancer or mesothelioma. This interval ranges between twenty and forty years. Because of the long time lapse between the initiation of exposure and the manifestation of injury, the incidence of disease occurring in populations now under study is the result of, and must be related to, exposures which took place twenty to forty years or more ago. To relate exposure measured only in the past five or so years to the current frequency of development of disease which actually was induced by exposure occurring years earlier, is a serious error. During the past twenty-five to thirty years there have been many technological changes in the production, manufacture and use of asbestos containing material. In many situations there is much

less asbestos now being incorporated in the material than was true twenty or more years ago. In addition, there has been a progressive dust control effort to reduce the concentration of airborne asbestos in mines, mills and manufacturing establishments in a deliberate attempt to reduce and abolish asbestos related disease. So much has been accomplished in this direction by technological change and systematic asbestos control efforts, that contemporary measurements of occupational environments cannot be accepted as representative of conditions twenty to forty years ago.

To summarize this part of my statement I strongly urge that when data offered in support of setting a safe level standard is being judged, one should ask the following questions:

1. What were the different kinds and proportions of asbestos used and what were the coexisting agents to which workers were exposed in the different occupations?
2. What were the specific criteria and methods used, and were they adequate for making a diagnosis of the biological reaction attributed to the inhalation of asbestos?
3. Were suitable controls in the sense of non-exposed populations and exposed populations whose exposures varied in intensity and duration utilized?
4. Was the exposure which was actually responsible for the disease properly determined or were contemporary dust estimates inappropriately applied to disease which was in fact due to exposure years ago?

The demands inherent in these questions pose formidable obstacles to arriving at a scientifically valid single number which will indicate the concentration of occupational airborne asbestos that can be tolerated with safety for the customary duration of employment. In spite of this, as I will show later, there are substantial data which will satisfy the requirements posed by these questions and which can be used for the purpose of determining at least a first approximation to the safe level of occupational exposure to airborne asbestos.

We must now examine the various established and proposed standards for a safe level of asbestos in the occupational environment, in the light of the just discussed requirements as to data needed for setting a standard on a sound scientific basis. Systematic efforts to reduce the amount of asbestos in the air of working places by governmental directive was made in the factories of Great Britain beginning in 1911. No numerical standard for this purpose was set, but Statutory Rules and Orders were promulgated. Later, on the basis of limited data relating impinger dust counts to x-ray abnormalities in several asbestos textile factories of the USA, Sayers and Dreeson suggested a numerical standard of five mp/ft^3 as a tentative safe level. This was the limit adopted by the American Congress of Governmental Industrial Hygienists in 1946. Utilizing the conversion data for textile mills published by Lynch and Ayers of the U. S. Public Health Service, five mp/ft^3 is the equivalent of approximately thirty fibers/cc.

In 1968 the British Occupational Hygiene Society suggested numerical guides aimed at reducing the risk of developing asbestosis.

The suggested guides indicate that those concentrations, averaged over a three month period below 2 fiber/cc ought to be considered low, and that over the course of 50 years of employment, 100 fiber years is the level below which there would be less than a 1% chance of developing asbestosis as defined chiefly by the presence of rales. If asbestosis is defined by x-ray abnormality, the level becomes 135 fiber years. In 1968 the ACGIH changed its recommended standard to a TWA of 2 mp/ft³, or twelve fibers/cc. In 1970 this Committee decided to change the standard to 5 fibers/cc, which is equivalent to less than 1.0 mp/ft³. Several months ago OSHA set an emergency standard of 5 fibers/cc, and within the past few days NIOSH now proposes a standard of 2 fibers/cc.

What is the scientific basis for these various standards? The standard proposed by Sawyer and Dreessen did attempt to relate dose of dust containing asbestos, as measured by the midget impinger to the risk of developing pulmonary abnormalities in terms of abnormal x-ray patterns. Their study showed a higher frequency of abnormal x-ray patterns in the most heavily exposed as contrasted to those less exposed. They found no excess of abnormal chest x-ray patterns in those workers exposed to less than 5 mp/ft³. Hence their suggested standard of 5 mp/ft³. We now know, however, that the population studied was not observed long enough for the full range of disease to develop. The authors appreciated this possibility and proposed the standard as being a tentative one. In retrospect we know that the standard, although it led to marked lessening of the dustiness in some occupations, was not adequately based and the passage of time has demonstrated it to be an inadequate standard.

The numbers proposed by the British Occupational Hygiene Society are based on a study of 290 male employees from a single asbestos textile mill. Their employment began after 1933, all had worked for at least ten years, and the exposure period extended from 1933 until 1966. The indicator of disease was basal rates and x-ray changes. No measurements of dustiness in this mill were available prior to 1950. Membrane fiber counts done in the modern manner were used only in the last year of the study and these served as the factor for converting previous counts using other methods to an expression in terms of fibers. To obtain an index of exposure for the period between 1933 and 1950 - a crucial period of exposure - the first measurements made in 1950 were raised by 50%. No evidence was given for using this very slight augmentation. Studies in other textile factories such as those by Sayers and Drexson indicate that when ventilation controls were first applied in their textile mills the dust counts dropped 1,000% or more. One would assume that the same happened in this British textile mill. The seventeen years of exposure during that most crucial period between 1933 and 1950 would appear to have been substantially underestimated. This study, in spite of its less than adequate scientific base is important because it was the first attempt after 1933 to set numerical guidelines for the prevention of asbestosis. The number of persons in the study is very small; the criteria for disease, especially basal rates, not universally accepted; and the estimate of dustiness seriously lacking in rigor. The estimate of dustiness was on the low side for the reasons that I have already mentioned and, in addition, because no attempt was made to further

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adjust for the longer working hours and hence of exposure during the war and earlier years. In spite of all of this, the study is a first approximation to a solution of a problem for which there were essentially no other available data in 1968 upon which to attempt a dose-risk estimate. It is my understanding that the enforcement agency of Great Britain looks upon these standards as guidelines and not as rigid requirements for all circumstances in which asbestos is used. Thus, they recognize the incomplete nature of the data used in developing the numbers.

The lowering of the 1938 standard from 5, to 2 mp/ft³ and 12 fibers per cc, adopted by the ACGIH in 1968 appears to have been based in part upon the data underlying the British proposal and also upon the fact that there was a growing awareness that the old standard of 1938 was not universally effective. The further lowering to 5 fibers/cc was not based upon new scientific data, but appeared to have been made to establish a margin or Factor of 1. In a personal communication from Dr. Herbert Stockinger, Head of the Division of Laboratory and Criteria Development of the National Institute of Occupational Safety and Health and Chairman of the Committee on Threshold Limit Values of the American Conference of Government Industrial Hygienists, I am informed that four months ago, in November of 1971, the Committee of the ACGIH reviewed the standard of 5 fibers/cc and found no evidence to indicate that it should be changed. There are several relatively current studies which support this decision.

I would now like to discuss five of these supporting studies. Murphy et al, in December of 1971 published data on workers exposed

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over a period of approximately thirty-five years as pipe coverers in new ship construction. The authors demonstrate that no evidence of asbestosis was found until at least 60 million particles per cubic foot years of exposure had been exceeded. This would indicate that for a forty year period of employment, 1.5 million particles per cubic foot would be the value below which no asbestosis occurred. The report indicated that the actual occurrence of asbestosis was restricted almost solely to those exposed to more than 75 million particles per cubic foot years, which would be close to a value of 2.0 million particles per cubic foot for those employed for forty years. Utilizing a conservative number to convert particles to fibers per cc, one arrives at a level of 5 or more as being that below which no asbestosis was observed. If one utilizes their X-ray data, one can, by suitable calculations, estimate that average exposure for these workmen was in the neighborhood of 1 fiber per cc, and this too would suggest that a number of 5 or more fibers per cc would have been the level below which no asbestosis developed. This study indicates, not only that the standard of 5 mp/ft³ is unsafe but also that a standard of 1 fiber/cc will prevent asbestosis in employees working for forty years or more.

An extensive and detailed study of a population comprising thousands of workers in the mining and milling of chrysotile in eastern Canada conducted over the past few years by Dr. Corbett McDonald and his associates is of great importance in our considerations because this study has dust counts going back many years and chest roentgenograms available from approximately 1935 to 1955.

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Dr. McDonald will report on these studies at these hearings. It is my understanding that these studies support the conclusion that those individuals exposed in these occupations for forty or more years would have to be exposed to higher than 6 fibers/cc in order to reveal any evidences of asbestosis.

Becklake and her co-workers, utilizing a segment of the population from McDonald's larger study, have demonstrated that in those individuals who have been employed for long periods of time in the mining and milling of chrysotile asbestos and who do not even show evidence of x-ray changes, the accumulated exposure must have been more than 110 mp/ft^3 years before the most sophisticated techniques can detect evidence of those physiologic changes thought to develop in response to inhalation of asbestos. These data suggest that something larger than 200 million particles per cubic foot over a forty year period can be tolerated without even the most subtle manifestations of asbestos exposure. This number would translate into something between five and 10 fibers per cubic centimeter.

In the fall of 1973 at the 11th International Congress on Pneumoconiosis, held in London, Dr. McDonald updated his previously reported large study and reaffirmed that an excess of bronchogenic cancer did not occur in the workers in mining and milling of chrysotile asbestos until an exposure equivalent to 200 million particles per cubic foot years was exceeded. This translates into 5 million particles per cubic foot for forty years. It indicates that in the mining and milling of chrysotile an excess of bronchogenic cancer would not be demonstrable for individuals who were exposed to less than 5 million

particles per cubic foot. This is equivalent to 10 or more fibers per cc. This most important finding supports the view held by Stewart and others that an excess of bronchogenic cancer occurs only in those who have manifestations of asbestosis and that the standard adequate to protect against bronchogenic cancer is a larger number than that required to protect against asbestosis.

Recently, Enterline and his co-workers have reported the results of a study of retirees employed in various asbestos-using manufacturing processes including textiles and where the exposure was different from that in mining and milling because of the inclusion of exposure to crocidolite and amosite as well as other agents which might co-exist. This study shows, and I quote "there appeared to be no direct relationship between asbestos dust exposure and respiratory cancer below 100 million particles per cubic foot years. Important increments in respiratory cancer mortality apparently occurred somewhere between 100 and 200 million particles per cubic foot years exposure". This would indicate that exposure to 3 million particles per cubic foot would be tolerated for a forty year period without a risk of excess bronchogenic cancer in these types of occupations. Using the conversion factor suggested by Lynch et al, this is equivalent to 18 fibers/cc.

This series of studies indicates that a lower standard is required to protect against pulmonary fibrosis or asbestosis than to protect against bronchogenic cancer. These five studies offer strong support for the position taken by the American Conference of Governmental Industrial Hygienists that there is no need to lower the standard below 5 fibers/cc in order to protect against pulmonary fibrosis or bronchogenic cancer.

In my judgement, we have no specific information of a suitable scientific nature expressing the dose-risk relationship for mesothelioma. Isolated case reports of mesothelioma are of no value in establishing a dose-risk relationship. Equally useless for this purpose are the data offered in studies of insulation workers, asbestos miners and millers, workers in asbestos using manufacturing, domestic exposures and neighborhood exposures. Not a single one of these studies offers data comparing variable exposures to the incidence of mesothelioma and they are therefore of no use for establishing a safe level of asbestos in the occupational environment. These studies do indicate that in some circumstances the risk is present but none speak to the question of the safe level on scientifically acceptable grounds. Nevertheless, these studies of larger numbers of cases of mesothelioma suggest that, in some circumstances, the exposure to asbestos which may be related to the development of mesothelioma might be less than that required to produce asbestosis or an excess of bronchogenic cancer. One factor, which has been demonstrated with respect to the relationship between mesothelioma and inhalation of asbestos is of the utmost importance. In all of those circumstances where a strong relationship between mesothelioma and the inhalation of asbestos is suspected, two varieties of asbestos, namely crocidolite and amosite, invariably have been implicated either alone or combined. This is the case in the excess occurrence of mesothelioma among crocidolite miners, asbestos using insulation workers, workers in asbestos textile and insulation manufacturing and in a large multiproduct asbestos using manufacturing plant in the USA. In most of these circum-

stances there has been a mixed exposure and chrysotile has also been present. In striking contrast, however, when exposure has been solely to chrysotile, as in mining and milling of chrysotile, the frequency of occurrence of mesothelioma has either not been increased or increased only to the very slightest degree. The virtual absence of an excess of mesothelioma in populations exposed solely to chrysotile has been reported by Gilson, Vigliani, Wagner and McDonald on the basis of separate studies. With respect to anthophyllite, no excess of mesothelioma has ever been reported. On the basis of information currently in hand, therefore, mesothelioma appears to be predominantly linked with exposures to crocidolite or amosite but the dose relationships are unknown.

The studies referred to thus far are the only ones that I am aware of which in my judgment have a meaningful bearing on the setting of a standard for control of asbestos exposure. Other data does exist but in my judgment it does not conform to those criteria, universally agreed upon, for a sound scientific basis upon which to predicate a safe standard.

There is an abundant other body of data which indicates that the prolonged inhalation of asbestos fibers above some level is hazardous, that the biological effect is dose related but that many of the workers exposed for a lifetime never do develop asbestos related disease. This data indicates clearly that past exposures in some occupations, as for example the mining and milling of chrysotile were far less hazardous than exposures in asbestos textile manufacture or the insulation workers' trade and possibly in other occupations as well. Reasons for these differences are

not entirely resolved at this time. ^{which is not} The insulation trade uses much more amosite than chrysotile and in some work, especially in England, large amounts of crocidolite have been used. There are coexisting agents in the insulation trade which are not present in mining and milling of chrysotile. The peak exposures appear to be much higher in the insulation trades than in mining, milling or manufacturing. Peak exposures may be much more hazardous than lower levels of prolonged exposure. Fiber counts in the insulation trade in shipbuilding in Great Britain and in construction in Finland ranged from twenty to hundreds of fibers/cc depending upon the kind of work being done. Fiber counts in the construction industry in this country currently indicate somewhat lower TWA levels but intermittent high peaks of exposure. For example, during the mixing of asbestos cement, dust counts commonly as high as 75 fibers/cc during a 5 to 10 minute period are reached as often as 5 times or more a day. Unfortunately, there are no data in the insulation worker trade that compare degrees of exposure over a period of many years to the biological manifestations of excess disease. Until this is available, there is no way of utilizing data from these trades to establish a standard for the control of asbestos inhalation.

There is every indication that the levels of exposure should be lowered, especially the peak levels, but whether or not a lower TWA standard is needed in the insulation trade than in the other trades remains unsettled. There is substantial reason to believe that crocidolite and amosite should be controlled more stringently than is chrysotile. There is also reason to believe that the geometric conformation of the fibers in the mining and milling of

chrysotile may be different from those fibers generated subsequently in manufacture and use of asbestos. Moreover, the fibers of crocidolite and amosite even in mining have a different geometric configuration, as actually observed by Timbrell in airborne specimens, from that of some forms of chrysotile. For these reasons the pulmonary retention of chrysotile may be substantially less than for other varieties of asbestos or for the kinds of fibers generated in other occupations than mining and milling. Animal experiments have demonstrated this to be true.

On the basis of data now available and adequate for the purpose, I wish to indicate that in my judgement a standard of five fibers/cc TWA with peaks not to exceed 10 fibers/cc, such as recommended by OSHA in its present standard and by the ACGIH constitutes a level which will protect against the development of asbestosis and bronchogenic cancer and includes a safety factor since it is a level substantially below that which has been demonstrated to be associated unequivocally with an excess of these two abnormalities. There is evidence relating crocidolite and possibly amosite to excess mesothelioma which suggest that a more rigorous control of amosite or crocidolite would be justified. For this reason it may be rational to have different standards covering different occupations depending upon the variety of asbestos used.

Since I am in disagreement with the recommendation of the Criteria Document that two fibers/cc be established as the safe level of occupational airborne asbestos, it is incumbent upon me to indicate the important points of my disagreement.

In my opinion it is incumbent upon the authors of the Criteria Document to present evidence, which will meet the requirements for scientific validity, in support of their proposal to change the standard and to establish a new one. In the entire document I do not find reference to a single study containing data which will, on the one hand meet the criteria of scientific validity for setting standards and, on the other, support the need to change the standard from 5 fibers/cc or to set it at 2 fibers/cc. In fact, the Criteria Document explicitly says on page 10 of section 5 "The number of studies that have collected both environmental and medical data and with a significant number of exposed workers, is not sufficient to establish a meaningful standard based upon firm scientific data". In other words, the authors of the Criteria Document do not provide any scientific data upon which to base their proposal to change the standard from 5 to 2 fibers/cc or to support the choice of a standard of 2 fibers/cc. The failure to provide this support, in my judgement casts the most serious doubts upon the validity of the proposals.

I am in complete disagreement with the Criteria Document with respect to its expressed opinion that the data relating exposure to biological reaction is inadequate to establish a meaningful standard at this time. While the evidence may not be as far reaching as we would like, it is scientifically valid and adequate to support as a first approximation the opinion that the present standard, established by OSHA several months ago at 5 fibers/cc TWA and peaks not to exceed 10 fibers/cc should not be lowered but left as it is. I have cited the studies supporting this opinion.

Lacking dose-risk relationship data adequate to support the proposal of 2 fibers/cc, the Criteria Document appears to promote an aura of extreme toxicity of asbestos fibers in order to justify the new level. This is done chiefly by citing isolated case reports. In my judgement an inordinate amount of weight is given to isolated case reports which, though of interest and some importance, have no possible utility in setting a numerical standard. Their use in the Criteria Document is doubly difficult to accept in view of the fact that on page 24 of Section III there is the following statement "Isolated clinical case reports are difficult to interpret in terms of dose-time response relationship and can only be used to indicate other possible problem areas and to highlight what may prove to be practicable areas for further study".

An attempt to convey the implication of extraneous exposure of asbestos is again made on page 7 of Section 3 by reference to a study of 232 former employees in a plant that manufactures insulation. This study, by Selikoff, is quoted as revealing four employees who developed x-ray evidence of asbestosis after only one day's exposure to asbestos. Observation of a control group for comparison to those who had been exposed, is totally absent from the Tables for this study that are shown in the Criteria Document. Murphy's study of pipe-coverers, referred to earlier in this statement, demonstrates beyond doubt that in any adult population not exposed occupationally to asbestos there will be some individuals with x-ray shadows that could be interpreted as evidence of slight asbestosis. In the absence of suitable controls, Selikoff's study cannot, on scientific grounds, be interpreted to prove that one day of exposure to asbestos causes

asbestosis. To do so on the basis of the data shown is epidemiologically unsound and to cite this study as evidence of extreme toxicity of asbestos is completely unwarranted.

The manner in which reports and data of different investigators throughout the world are utilized and criticized does not appear to be uniform in this document. For example, the comprehensive review of the epidemiology of asbestos related cancers by Wagner et al, published in 1971 is not referred to. The report by McDonald et al of an extensive epidemiologic study relating dose to risk in 11,788 workers employed in the Quebec chrysotile asbestos mining industry is not discussed in the Criteria Document. This study, published in June, 1971 is the single most detailed and complete study in the world's literature of the dose-risk relationship of one kind of population exposed to airborne asbestos. The only reference made in the Criteria Document to this study, pages 13 and 20 of Section 1 is a criticism of a "progress report" given by McDonald at the Bucharest meeting in September of 1971. One would think that a study of this magnitude would require discussion in a document intended to be a fully developed presentation of the evidence supporting recommendations of such great importance.

It is difficult to understand why McDonald's report is criticized, as stated at the top of page 20 of Section 3, because of the conversion of numbers of particles to numbers of fibers. Particles are converted to fibers by the British Occupational Hygiene Society in developing their standard and at no place in the Criteria Document, pertaining to the British recommendation, does one see a questioning of that procedure. If it is acceptable in the one circumstance it should be acceptable in the other.

It is even more difficult to understand the criticism expressed in the last sentence of the 1st paragraph on page 20 of Section 3 to the effect that the McDonald study lacks the evidence necessary to make general comparisons with the data of other reported work. The published paper by McDonalds' group contains the complete biological data and the required exposure data expressed in mp/ft^3 . This is substantially more data than that furnished by others since it relates exposure to biological effect in the same population whereas other studies such as those of insulation workers do not in any way provide this co-related data. The index of dustiness used in the McDonald report is the same as in those of Murphy et al, Decoufle-Enterline and Williams, all of which are quoted in this document. The criticism that McDonald did not indicate the details of the method used for converting particles/ ft^3 to fibers/cc could easily have been answered by a letter or a telephone call, if the authors of the Criteria Document had been desirous of making the comparisons.

Much weight is given to an unpublished paper by Williams, et al from the Pennsylvania Department of Health. One wonders why, in such an important document as the NIOSH Criteria Package, the crude data of the Williams' study was not shown in the tables of the Criteria Document. The way in which the sixty-four cases of asbestosis seemed to be related to what was undoubtedly a variable exposure is not shown. It is very probable that all of these 64 cases occurred in those who were most highly exposed, very possibly in the neighborhood of five million or more particles per cubic foot. The failure to handle such data in the conventional dose-risk relationship is a serious error.

Inordinate and unwarranted attention is given to contemporary dust counts. The impression is given that these present day counts represent the conditions that existed over the past 40 years. While this may not be intended, more care should have been taken to indicate that the counts were substantially higher in the past, especially in manufacturing places where effort toward controlling exposures by exhaust ventilation, etc. has been expended in the past 30 years. In addition, the reduction of the amount of asbestos contained in manufactured materials has further reduced the exposures, particularly in asbestos insulation workers.

Most of the counts in the tables of this document are expressed as averages, as for example, Tables 13 and 14 pertaining to exposures of insulation workers. This is an inadequate way to display data, since it can give misleading information by masking high exposures if there are a large number of low exposures to dilute the high ones. Biological effects are much more likely to occur in the persons heavily exposed than in those with low exposure, thus, averages of all exposures have little meaning or use in determining the dose-risk relationship.

It is not possible to evaluate fully the exposures from the data shown in some of the Tables of this document. For this we need to know not only the TWA's but also the peaks, the number of observations and the conditions of the environment during the time of sampling. This criticism is especially pertinent to the exposures of insulation workers shown in Table 14. The insulation worker experiences great variability with respect to job conditions, to a large degree dictated by the volume of the space in which he works and by natural ventilation as well as the kind of work he is doing

at the time. Dust counts under all sorts of conditions, and peak as well as TWA exposures must be measured before the insulation worker's exposure can be portrayed. With respect to Table 14, it is surprising that the job of "cement mixing", notoriously characterized by peaks of exposure as high as 75 fibers/cc for periods of 5 to 10 minutes several times a day, is omitted.

The summary, on page 16 of Section 5, describing the basis for the new standard recommended by the Criteria Document is confusing and inconsistent. I quote from the second paragraph, "evidence indicates that past and current standards for fiber concentrations in the working places where asbestos fibers occur, though undoubtedly contributing to reduction of the severity and frequency of asbestosis, have not provided complete protection from exposure to asbestos, necessitating development of a new standard". There is evidence that asbestosis developed under some circumstances, in places thought to have an average exposure of five million particles per cubic foot, or in modern parlance, thirty fibers/cc. This was the standard set in 1938. The ACGIH created a new lower standard in 1968 and another still lower, introducing a safety factor in 1970. The British Occupational Hygiene Society suggested numbers that might serve as a standard in 1968. The current standard in the USA set by OSHA is five fibers/cc, and was set only a few months ago. If there is to be a new standard it will be one set since a few months ago, or at most, set since three years ago. The statement in the Criteria Document, to which I have just referred, indicates that the authors have evidence that the standard recommended by ACGIH in 1968 has been inadequate and has not provided complete protection and hence a new standard is needed. The authors of the Criteria Document

should be required to give that evidence and it is obvious that they have not. Could it be that they are referring to the fact that the standard set in 1938 is inadequate and that a better standard is needed? If so, a lower standard was provided in 1968 and still lower in 1970, and it is this standard which was promulgated as an "emergency standard" by OSHA. It is this OSHA standard for which I believe there is substantial factual evidence of a supportive nature.

An even more serious inconsistency is demonstrated on page 16 of Section 5. Close examination of Items a, b, c, and d reveals in unequivocal terms, that in the judgement of the authors of the Criteria Document there are no scientifically usable data on which to base a standard. Nevertheless, without such data they decide that the current standard must be changed and moreover recommend precisely what the new one should be. There is a strong inference from the second paragraph of page 17, Section 5 that one and perhaps the chief reason for setting the recommended standard at two fibers/cc is that the British have recommended such a standard. I disagree with the concept, if actually intended, that this represents a scientifically valid reason for recommending such a standard. Moreover, it is my understanding that the British did not set a standard in the same sense that it is intended to be used under the new Occupational Safety and Health Act. The British standard is a series of numbers proposed to furnish a guideline with a wide range of personal judgement on the part of their inspectors as to the need for corrective measures when these numbers are exceeded. Under our act it is my interpretation that a standard must be set which, if not complied with, places the operator under certain penalties. To my mind the two conditions are utterly different.

SUMMARY

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In this statement I have described the kind of data required for characterizing the dose-risk relationship in such a manner, that it can be used for setting an occupational standard for airborne asbestos on a scientific rather than an arbitrary basis. Because of the difficulties described, much of the data now extant, concerning asbestos associated disease, is of no use for setting a standard. Isolated case reports and data giving exposures or biological effects without relating the two in the same population are examples of this kind of unusable information. Unfortunately, much of the data now available is competent only to say that asbestos is more or is less hazardous in different groups and that the exposure is varied. Nevertheless, although not numerous, there are specific data competent to speak to dose-risk relationship and can be used for our purpose. I have cited these.

I have indicated the reasons for my opinion that the Criteria Document has failed to do that which is incumbent upon it, namely, to provide sound scientific evidence to support their request for a change from the OSHA emergency standard and for a new standard of 2 fibers/cc TWA and peaks not to exceed 10 fibers/cc.

I disagree with the view of the Criteria Document that there are no scientifically obtained data adequate for the purpose of setting a standard. I have cited the studies which I believe are scientifically valid and adequate for setting a first approximation to a standard or safe level of airborne asbestos in occupational environments. In my opinion, these studies fully support the

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current OSHA temporary standard of 5 fibers/cc TWA with peaks not to exceed 10 fibers/cc, and the recent decision of the ACGIH that there is no need to change from this standard. It should be emphasized that prior to 1940 and for some years thereafter, when many of those persons now developing disease were actually being exposed, the dust counts in mining, milling and manufacturing commonly were in the range of 10 to 100 mp/ft³. This was most likely equivalent to 30 to 600 fibers/cc. There is no evidence that exposures during that period for insulation workers was substantially lower and, on the basis of British and Finnish data, it was in that range. It is clear then, that the current OSHA temporary standard represents a tremendous reduction from the dust levels of previous years and, in my opinion, includes a substantial safety factor. I believe this level will protect workers, using asbestos over a forty year or more span of employment, from developing asbestosis or experiencing an excess of bronchogenic cancer. If crocidolite and perhaps amosite are more stringently controlled, the liability of experiencing mesothelioma will be markedly reduced and probably abolished.

1972-13, 1972

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UNITED STATES DEPARTMENT OF LABOR HEARINGS ON A STANDARD FOR EXPOSURE TO ASBESTOS

WASHINGTON D.C., MARCH 14-17, 1972

STATEMENT BY DR J CORBETT McDONALD, MCGILL UNIVERSITY, MONTREAL, CANADA

My name is John Corbett McDonald; I am Professor of Epidemiology and Chairman of the Department of Epidemiology and Health at McGill University, Montreal. I graduated in medicine from London University in 1942 and have specialized in epidemiology and related subjects for the past twenty-four years.

I am very grateful to those responsible for these hearings for permission to testify today, for two main reasons which are as follows:-

1. A substantial research team at McGill has devoted the last 6 years to a wide variety of studies, under my direction, into the quantitative relationships which exist between asbestos exposure and its effects on man. We believe therefore that our findings bear directly on the question of standards for asbestos exposure.
2. The brief references to our work in Section II pp 19-20 of the Criteria Document are almost wholly inaccurate, out of context and seriously misleading. They were made without my knowledge or advice and I ask that they be discounted. I am very glad, therefore, to be allowed this opportunity to place on record a more balanced account of our research and its results.

The rest of my presentation is in the form of a report entitled "The health of chrysotile asbestos mine and mill workers of Quebec" which my colleagues and I have prepared for publication in the near future. This paper summarizes our main findings to date and I believe it appropriate therefore to ask that it be included in the record of these hearings. This paper is not yet in its final form and still subject to revision but is unlikely that we shall find reason to alter our conclusions in any important respect.

020365

The Health of Chrysotile Asbestos
Mine and Mill Workers of Quebec

by

J. Corbett McDonald, MD
Margaret W. Becklake, MD
Graham W. Gibbs, MSc
Alison D. McDonald, MD
Charles E. Rossiter, MA

From the Department of Epidemiology and Health,
McGill University, Montreal. Mr Rossiter is
presently with the Medical Research Council
Pneumoconiosis Unit, Penarth, S. Wales.

Reprint requests to 3775 University Street,
Montreal 110 (Dr J.C. McDonald)

In recent years, exposure to asbestos dust has been widely recognized as an etiological factor of importance in pulmonary fibrosis, lung cancer and malignant mesothelial tumours. However, exposure has usually been complicated by the presence of more than one form of asbestos and of other materials in the manufacture or application of asbestos products. In the mining and milling industry of Quebec, where almost half the world's supply of chrysotile is produced, there has been very little exposure to other types of asbestos or to materials used to make asbestos products. An epidemiological study in this industry was started in 1966 to assess the effects of pure exposure to chrysotile. Our aims were to relate dust exposure assessments to mortality, radiographic changes, lung function and respiratory symptoms. The results of these studies are presented in separate papers on mortality^{1,2,3,4}, radiographic changes⁵, lung function^{6,7,8} and respiratory symptoms⁹. The purpose of this report is to synthesize these and certain subsidiary findings and to discuss their implications for control.

Outline of study

Records of the mining companies were used to identify all persons known to have worked in the industry since its inception in 1878. Earlier records tended to be incomplete or missing and certain sets had been destroyed, but altogether some 28,000 employees, mostly male, were identified and information gathered for them. Of these 6,400 were working on November 1st 1966, the registration date for the study. The information collected for each person consisted of

date of birth and full industrial history. The latest chest radiograph for each employee, if available, was provided by the industrial medical clinics and read by an international group of 6 readers using the UICC/Cincinnati Classification. A follow-up of ex-employees was made and death certificates and autopsy reports were examined for those who had died. One section of this paper deals with results in women and the rest is concerned with men only.

Dust exposure

Dust exposure levels were determined for each recorded job within the industry and for each year of employment. These levels were used to calculate a total dust exposure index for each worker. Gibbs and Lachance¹⁰ described the techniques used and Gibbs¹¹ considered certain qualitative aspects. The main index was based on particle counts from midget impinger samples, expressed as millions of particles per cubic foot (mpcf). For each worker, total dust exposure was calculated by multiplying the dust exposure index by the number of years of exposure at that index, expressed as mpcf-years.

The results which follow are presented in terms of range of total dust exposure (see Table 1). The direct equivalents in particles per millilitre-years, obtained by simple arithmetic, are also shown. The dust indices expressed in fibre years were calculated using an equivalence factor of 1 mpcf (midget impinger) = 2.3 fibres/ml (membrane filter). This estimate of equivalence was based on 32 side-by-side samples taken in the summer of 1971 at three companies at Thetford Mines, and at present is the best available for the industry. The

midget impinger technique was the same as was used to assess dust exposure indices throughout our studies. Fibres of 5 μm or more in length were collected and counted using essentially the method recommended by the United States Public Health Service. The equivalence ratio increased from mining (1.1) through crushing and drying (1.6) to milling (4.3) but the number of readings in each situation was small. Nevertheless, the mean for all areas (2.3) may underestimate the fibre exposure of mill workers and overestimate that of miners.

An alternative approach to the question of equivalence makes use of information on the fibre content of dust obtained from membrane filter measurements. A series of 81 observations was made in the same three mines and mills during the same period of time with findings ranging from 1% to 9% and an average of 3%. These proportions also relate to fibres of 5 μm or more in length, counted at 500-fold magnification. The average ratio of membrane filter to midget impinger particle counts of total dust was 2.3 based on the 32 side-by-side observations described above. The equivalence factor calculated by simple arithmetic from these data was 2.4. Agreement between this figure (2.4), based in part on independent data on fibre content, and 2.3 estimated by direct comparison of midget impinger and membrane filter is reassuring. Nevertheless, a larger series of parallel measurements is needed to establish the relationship in this industry with certainty. The current British standard for exposure to chrysotile¹² is 2 fibres per ml, averaged over 3 months, for a 50 year working life (ie 100 fibre/years). The upper limit of our second dust group (230 fibre/years) is equivalent to more than twice this level.

Table 1 also lists the number of men included in the main analyses considered in this report.

Radiographic changes

The prevalence of parenchymal and pleural changes was higher in the area of Thetford Mines than of Asbestos, Quebec, though the towns are only about 50 miles apart and the asbestos mined is geologically similar. The two main indices of response to asbestos exposure were irregular small opacities and pleural thickening. At Thetford Mines the prevalences of these indices rose steadily with dust exposure, whereas at Asbestos there was very little relation to exposure (Table 2). The average prevalence of irregular small opacities of category 1 or more at Asbestos was about 2/3 that at Thetford Mines; for pleural thickening of grade 1 or more, the prevalence at Asbestos was only 1/2 that at Thetford Mines. The biggest difference among all the radiographic features was in pleural calcification, for which the prevalence of grade 1 or more were 0.45 at Asbestos and 5.27 at Thetford Mines. Although these relations to dust exposure were clearly present, no correlation exceeded 0.3. This is largely a reflection of the very high proportion of men who showed no radiographic change. Some of the differences between the two areas were not surprising since the level of dust exposure at Asbestos was considerably lower than at Thetford Mines, but other differences cannot yet be explained in terms of dust exposure or geology. If variation in fibre content of dust were an important factor the results in different areas, for whom the fibre proportion was low, should differ from those for mill workers, for whom the fibre proportion was higher. Altogether, there

were 506 worker, who had worked for ten or more years exclusively in mining or entirely in milling. Analysis of their radiographic changes showed that though mill workers had a slightly higher prevalence of irregular small opacities, the same differences between Thetford Mines and Asbestos remained. No other consistent differences were detectable between the mine and mill workers.

Mortality

This study was limited to those who had worked for one month or more and who were born between 1891-1920. The records of older persons were too frequently incomplete for satisfactory analysis and few of the younger ones had died. The initial analysis¹ was limited to deaths before November 1st 1966, but the follow-up is continuing. By the end of December 1969, 87.5% of the 12,572 persons in the cohort and 99% of those who had worked 10 years or more were traced². Of these 3,270 had died, comprising 65.4% of those born between 1891-1900 and 9.8% of those born between 1916-20.

Age standardized death rates for some causes of death are given in Table 3. Cancer of the lung showed a rising death rate with increasing dust exposure, particularly in the two highest dust exposure groups. Abdominal cancers also showed a rise in the two highest categories and pneumoconiosis in the highest. Of 134 deaths from respiratory cancer, 5 were from pleural mesothelioma. These cases showed no clear relationship with dust exposure. There were no abdominal mesotheliomas. The mortality rates from all causes fell with increasing dust exposure probably because those who died young could not attain a high dust exposure and perhaps also because tracing of those with short exposure was less

complete, with possible bias towards successful follow-up of those who had died.

It seemed possible that the radiographic differences between Thetford Mines and Asbestos might also be reflected in mortality. There was little evidence of this. Age-standardized death rates/1000 for all causes, all malignancies, all respiratory diseases and all circulatory diseases were 342, 54, 20 and 120 at Asbestos and 362, 61, 22 and 121 at Thetford Mines. All detailed comparisons showed the same remarkable similarity. For example, in Table 4 age standardized death rates by dust exposure are presented for lung cancer and pneumoconiosis. The only apparent difference is that the lung cancer rate rose in relation to dust slightly earlier but to a less extent at Thetford Mines.

Mortality and radiographic changes

Of 10,120 persons traced in the mortality study, 9,692 were men and of these 5,082 had chest radiographs and 785 had died. At Thetford Mines, there were 354 deaths in 2,448 men traced. Death rates were calculated by date of birth, dust exposure and the presence or absence of parenchymal or pleural radiographic changes. The death rate from all causes combined was raised in the highest dust exposure group but, taking into account exposure and date of birth, those whose radiographs showed parenchymal changes had a higher rate (220/1000) than those without radiographic changes (131/1000) or with pleural changes only (126/1000).

In Table 5, the observed number of deaths by year of birth and radiographic change is compared with the expected number based on those without radiographic change. Of 97 deaths in those with parenchymal changes, 30 were in

excess of the expected figure. Considering only deaths from respiratory disease, including tuberculosis and cancer, we calculated in a similar way that there were 32 deaths in those with parenchymal change compared with 8 expected, an excess of 24. Thus of the 33 excess deaths in this group at Thetford Mines, 24 were attributed to respiratory causes.

At Asbestos, the difference between the mortality of those with and without radiographic changes was less. Similar calculations to those used for Table 5 showed that only seven of the 431 total deaths were associated with parenchymal change and of these 2.4 were in the respiratory group.

Dust exposure levels at Thetford Mines were much higher than at Asbestos; thus, in the highest exposure group there were 386 and 69 men respectively who had been X-rayed and subsequently traced. Though the excess death rate in this highest exposure group was about 9% at both places, the number of excess deaths were therefore 35 and 6 respectively.

Lung function

A total of 1,015 current employees underwent lung function studies during the summers of 1967 and 1968^{5,7}. The sample chosen for study was stratified to include a higher proportion of older than younger workers, as the former were more likely to show lung function changes. Those tested comprised 81% of the sample selected.

The variation in some of the lung function indices by dust level in smokers and non-smokers are shown in Tables 1, 2 and 3. The results of each test

were standardized to age 50 years, height 170 cm and weight 70 kg. Total lung volume fell slightly with increasing dust exposure but exposure had little effect on either functional residual capacity or residual volume. Thus exposure to chrysotile affected only the inspiratory capacity portion of the total lung volume. Forced vital capacity and forced expiratory volume (1 second) both declined with increasing exposure - the forced vital capacity falling by about 18% in the highest dust group and the forced expiratory volume rather less. Neither steady state nor single breath diffusing capacities showed any effect of exposure at rest; on exercise, the steady state diffusion declined slightly.

Analysis of the relation between lung function and radiographic changes⁶ showed that in those with small opacities of category 2 or more there was an average reduction of 20% in 3 indices:- functional residual capacity, residual volume and single breath diffusing capacity at rest. Most indices showed a regular reduction with increasing category of small opacities but only vital capacity and forced vital capacity showed significant reductions in the presence of the earliest radiographic changes. Pleural changes were also associated with depressed lung function ranging from about 3% in those without parenchymal changes to about 6% in those with advanced parenchymal changes. An additional small survey showed that changes in pulmonary mechanics possibly precede both X-ray and other function changes⁸.

Respiratory symptoms

Each of the 1,015 workers in the function survey answered a slightly modified version of the M.R.C. respiratory questionnaire given in

French or English by a bilingual interviewer. Persistent cough and phlegm (bronchitis) and breathlessness on exercise were related to exposure. Table 6 shows, however, that after standardizing for age, the prevalence of bronchitis rose to about 50% with either increasing dust or with increased smoking. The effect of heavy exposure and heavy smoking together were the same as that of either separately. In contrast, the prevalence of breathlessness on exercise was unaffected by smoking but increased steadily with dust exposure.

Effect of smoking

Smoking habits were originally determined only for employees in the lung function survey. Figures 1, 2 and 3 show that, with many of the lung function indices, the effect of smoking was greater than the effect of exposure to asbestos dust. This was most clear for functional residual capacity, residual volume and perhaps for the steady-state diffusing capacity at rest. Forced vital capacity and forced expiratory volume at one second were both depressed to a similar extent with increasing dust exposure but only forced expiratory volume was lower in smokers. As discussed above, smoking and dust exposure were both related to the prevalence of bronchitis but smoking was not associated with breathlessness.

Attempts are now being made to collect smoking histories in the cohort study of mortality both for those who are still alive and for those who are dead. This may eventually provide prospective and retrospective evidence on the interrelationship of smoking and asbestos exposure. A controlled retrospective study¹³ has been made, based on deaths from lung cancer in the cohort

study. Each case was matched with a death from lung cancer from the same hospital records in a man never employed in the industry of approximately the same age and year of death. There was higher proportion of non-smokers in cases than controls which suggests that lung cancer may be caused by asbestos exposure in the absence of smoking. The controls were on average heavier smokers which also suggests this, but does not rule out the possibility of synergism between asbestos exposure and cigarette smoking. Clear evidence was obtained from a survey of all known cases of malignant mesothelioma in Canada that this disease was unrelated to smoking^{3,4}.

Women

The number of women ever employed in the Quebec asbestos industry is small. In the mortality study, 428 of 465 women in the cohort were traced and of these 54 had died. One death was ascribed to lung cancer and none to pneumoconiosis. Only 79 women had worked for more than ten years and few had been exposed heavily to asbestos dust.

There were 847 women for whom chest radiographs were available. Most of them were aged 30 or less and the total prevalence of radiographic changes of category or grade 1 or more was less than 1%. Detailed study suggests that women in the higher dust exposure categories had a slightly lower rate of radiographic change than comparably exposed men.

Discussion

Though death may be the most definite and serious manifestation

of exposure to asbestos, it need not be the most sensitive. Exposure-related excess deaths altogether were probably no more than 2% of the 3,270 deaths in the cohort study. Most of these were attributed to lung cancer and pneumoconiosis and almost all were in the two highest dust exposure categories. Thus, excess mortality was virtually confined to men with exposure equivalent to at least 920 fibre/years, ie nearly 10 times the British standard. Detailed examination of the death rates showed no particular cause, except pneumoconiosis, with rates above those expected from those of the general population of Quebec.

An investigation of the 235 known cases of malignant mesothelioma in Canada⁴, 1959 through 1970, showed definite or probable occupational exposure to asbestos in 23% of cases, and in a further 9% there may have been indirect domestic exposure. Of the remaining 68% of cases, not one had ever lived within 20 miles of an asbestos mine or mill. Of all known mesothelioma cases, only 7 altogether, and 5 in the cohort studied, had worked in the Quebec chrysotile mining and milling industry.

These death rates are very low by comparison with the studies of the New York insulation workers¹⁴ and the London crocidolite factory workers¹⁵, in both of which there were much higher rates of malignancy, particularly of mesothelioma. Other studies of the chrysotile industry in the USSR¹⁶ and in Italy¹⁷ confirm the conclusion that only high levels of exposure to chrysotile during mining and milling have an appreciable effect on mortality.

Although radiographic changes had some relationships to dust exposure, the clinical significance of the minor changes is uncertain. Usually, irregular small opacities of category 2 and pleural thickening of grade 2 are considered clinically important. Changes of this order occurred in only 1.0%

and 0.7% of the entire working population. In men aged 61-65, employed on average for 20 years in the industry, the rates were 5.0% and 2.5% for exposure levels of 30 fibres/ml. This is equivalent to 600 fibre/years or 6 times the British standard. These rates are very similar to those found in the chrysotile mining and milling industry in Cyprus¹⁸, but are much lower than those in the New York insulation workers¹⁴, or in the British Royal Naval Dockyards^{19,20}.

For lung function and respiratory symptoms, the effect of smoking was generally greater than the effect of exposure to asbestos. However, for inspiratory capacity, forced flow rates and breathlessness on exercise, relations to dust exposure were found. With these indices a 5% reduction in non-smokers occurred after a total exposure in excess of 100 mpcf/years (230 fibre/years). This is close to the lower limit of the dust category at which 1% of subjects had grade 2 radiographic changes and is approximately equivalent to exposure to 5 fibres per ml for 50 years.

In the Quebec studies, information on dust exposure was obtained, whereas in most other studies quantitative information is not available. Murphy et al²¹ found 11 cases of asbestosis in 101 New England shipyard workers with an average exposure of 120 mpcf-years. These workers appear to show a larger effect of asbestos exposure than those engaged in chrysotile production. However, the main constituent of the insulating materials used was amosite, with chrysotile to a lesser extent and crocidolite never.

Dust exposure assessments were also made for the Cyprus mining and milling industry¹⁸ and the rates of radiographic change for the same exposure levels were very similar to those in Quebec. Exposure indices have also been assessed in a study of two asbestos-cement plants in the USA by Weill et al, where the main exposure has been to chrysotile and silica, but the results are not yet available.

The limit standards for occupational exposure to asbestos based solely on the airborne concentration of dust or fibre, averaged over a lifetime's work and the results in this report have been presented from this point of view. There was some evidence in our studies that longer exposures for the same total dust levels are associated ^{with} slightly higher prevalence rates of radiographic change. However, the radiographs were all taken during working life, so the correlation between total dust and years of exposure or years since first exposure is high, and the separation of the contributions from these two factors - duration and concentration - would be very difficult. The cohort study also showed that lung cancer mortality rates were higher in those who worked longer to reach a given dust level so, in assessing the overall affect of asbestos exposure, duration of exposure should not really be ignored. For this reason it would be unwise to apply the results of these or other descriptive epidemiologic studies to widely different circumstances.

The British dust standard of 2 fibres per ml, averaged over 3 months, is based on the 1% risk of acquiring clinically significant disease in a 50 year lifetime of exposure is acceptable. The evidence from our studies suggests that if in the chrysotile mining and milling industry of Quebec all dust exposures were reduced to the level of this standard, there would be a much less than 1% chance of acquiring clinically significant disease. Considering all aspects of disease (death, radiographic changes, lung function changes and respiratory symptoms) the 1% risk is reached by men in our third dust exposure category (230-460 fibre/years). This implies that a reasonable standard for chrysotile mines and mills would be between 5 and 9 fibres/ml on average for 10 years, and correspondingly higher for shorter periods of employment.

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Figure 1 Variation in lung volumes with dust levels standardized for age, height and weight

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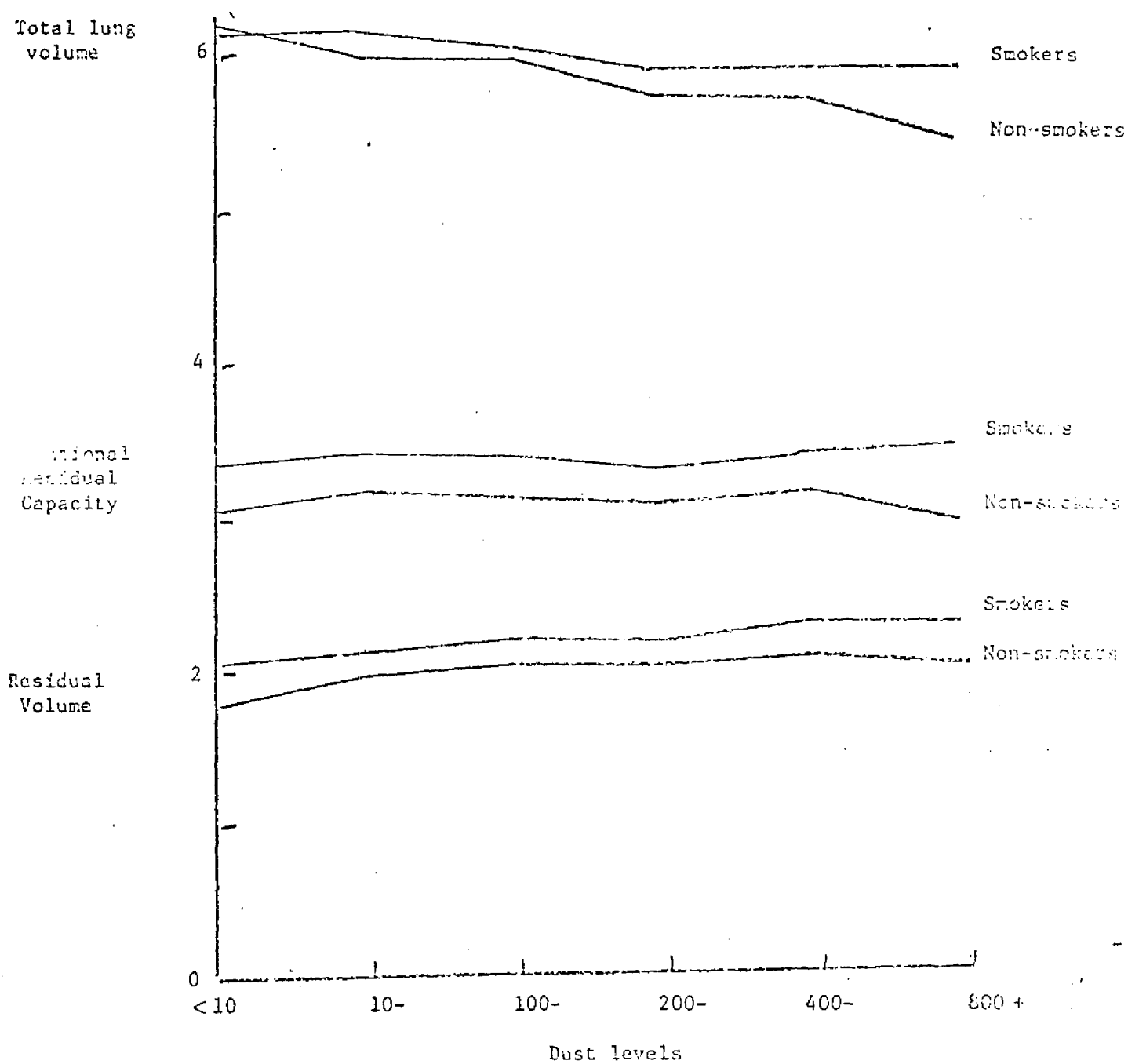


Figure 2 Variation in flow rates with dust exposure - standardized for age, height and weight

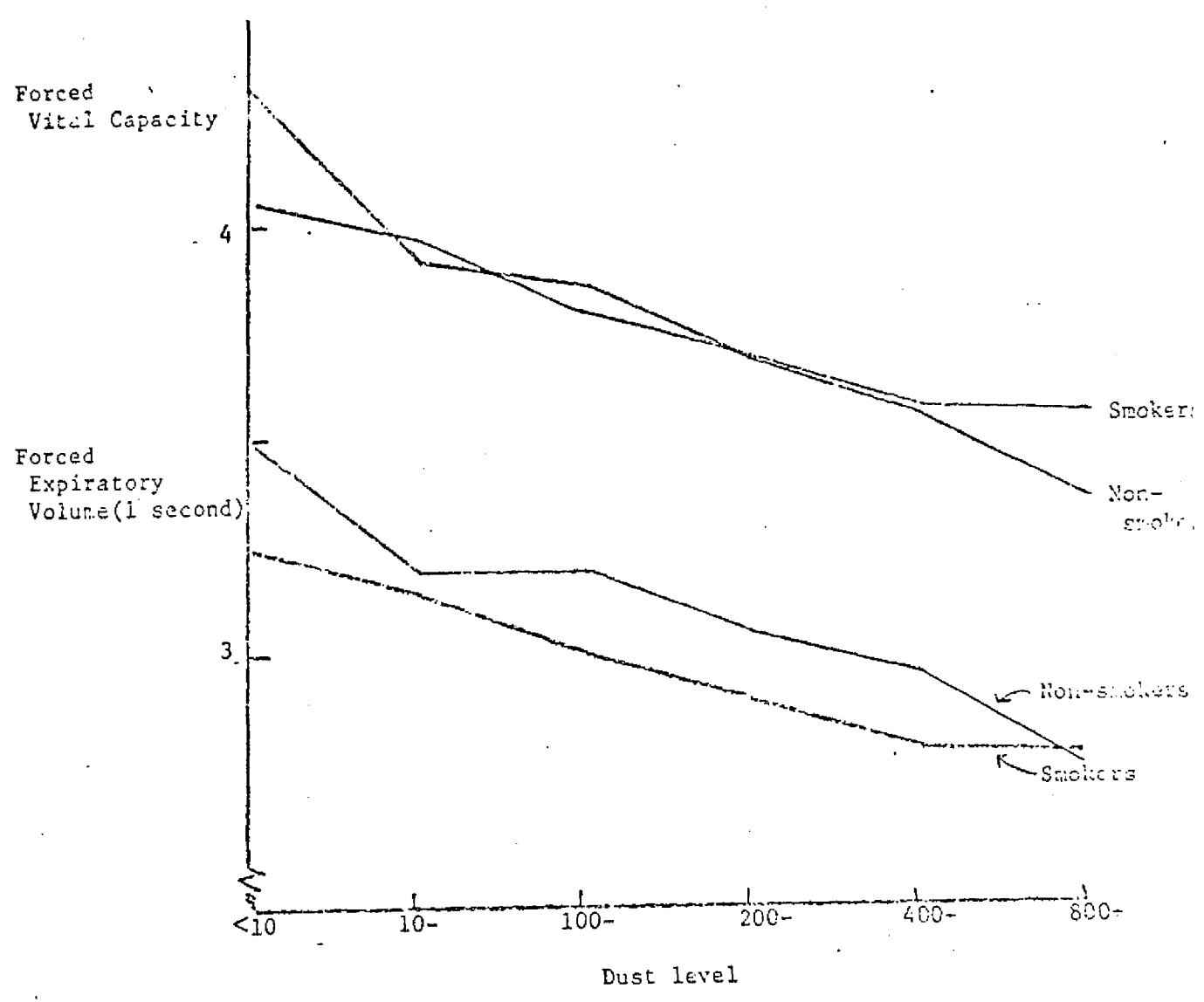


Figure 3 Variation in diffusion with dust level -
standardized for age, height and weight

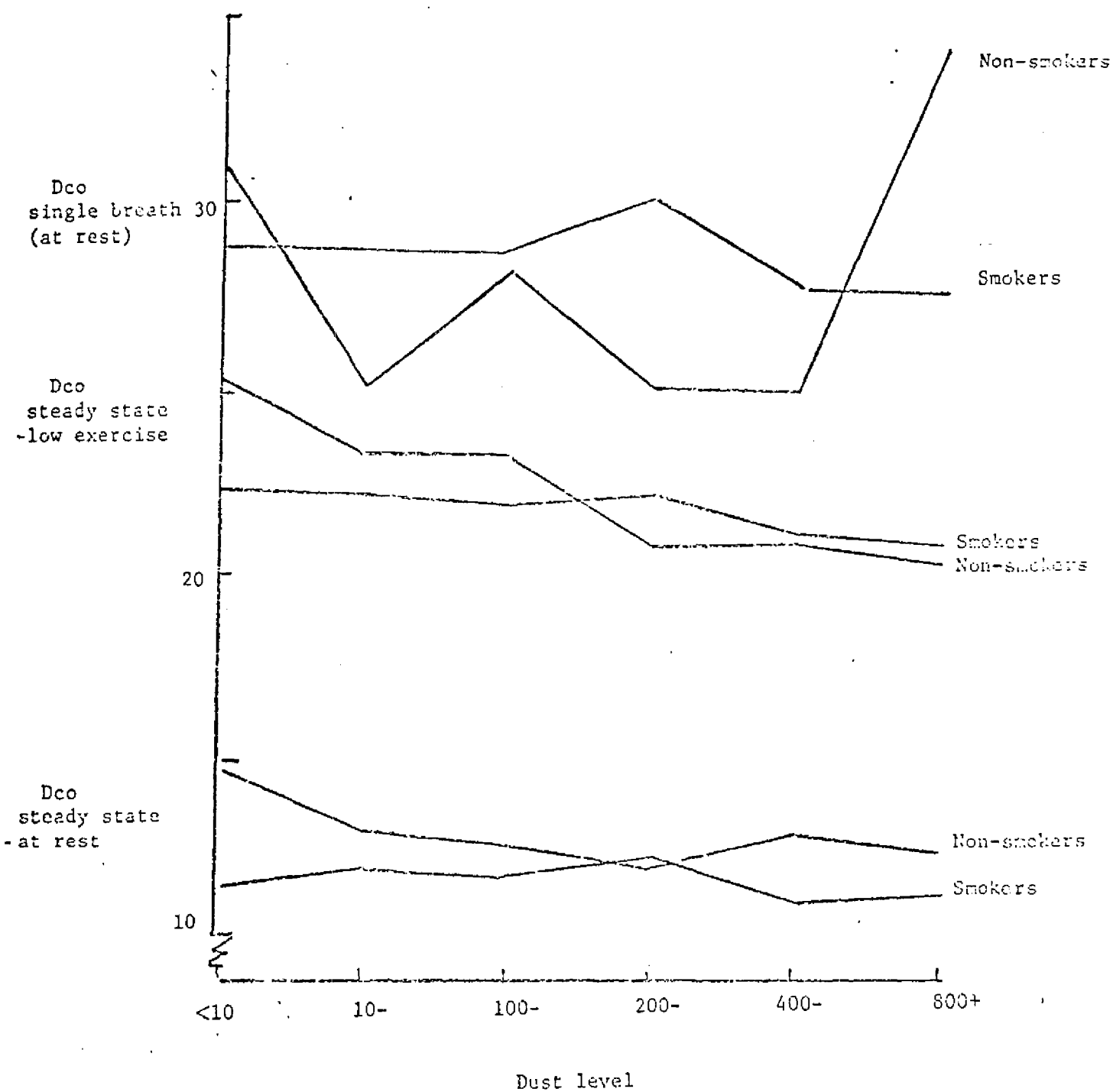


TABLE 1 - Dust exposure levels, and numbers in each analysis

<u>Dust exposure in millions of particles per cubic foot x years</u>	<10	10-	100-	200-	400-	800 +	
Equivalent in particles per ml x years	<350	350	3500-	7000-	14000-	28000 +	
Equivalent in fibres per ml x years	<23	23-	230-	460-	920-	1840 +	
<u>Numbers of men in each analysis</u>							<u>Total</u>
Mortality study	2810	3329	1124	1007	837	585	9692
Radiographic study	1537	1522	1133	912	718	707	
Lung function and respiratory symptoms	91	455	159	134	109	67	
Smokers	69	381	144	117	96	59	866
Non-smokers	22	74	15	17	13	8	149

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TABLE 2 - Radiographic changes - Prevalence rates % standardized for age and years in industry
Males aged 36-65 at time of radiograph

	Dust group						
mpcf-years	<10	10-	100-	200-	400-	800+	
fibres/ml years	<23	23-	230-	460-	920-	1840 +	Average
<u>Thetford Mines</u>							
Irregular small opacities - 1/0 +	1.8	3.3	6.3	8.7	12.0	17.2	7.6
- 2/1 +	0.0	0.2	2.2	0.9	2.4	9.2	2.0
Pleural thickening - grade 1+	2.4	4.6	6.5	5.8	8.3	10.5	6.4
- grade 2+	1.3	0.7	0.8	1.2	1.3	2.0	1.1
<u>Asbestos</u>							
Irregular small opacities - 1/0 +	6.4	3.7	6.3	5.0	6.8	7.0	5.1
- 2/1 +	0.0	0.4	1.5	0.8	0.6	3.9	0.8
Pleural thickening - grade 1+	2.9	2.6	3.0	3.0	4.7	5.8	3.2
- grade 2+	0.0	0.6	1.0	0.5	1.4	0.7	0.7

TABLE 3 - Mortality study - equivalent average death rates/1000
Deaths to December 1969
Males born between 1891-1920

	Dust group					
mpcf-years	<10	10-	100-	200-	400-	800 +
fibres/ml years	<23	23-	230-	460-	920-	1840 +
All causes	365	355	354	313	323	395
Cancer of bronchus, traches, lung	10.3	13.1	13.4	15.5	21.4	32.1
Abdominal cancers	18.0	13.6	18.7	11.6	26.3	28.7
Pneumoconiosis	1.6	1.5	0.8	4.9	4.9	23.6

TABLE 4 - Equivalent average death rates/1000 men from respiratory cancer and pneumoconiosis at Thetford Mines and Asbestos

	Dust group					
mpcf-years	< 10	10-	100-	200-	400-	800+
fibres/ml years	< 23	23-	230-	460-	920-	1840+
Cancer of bronchus, trachea and lung						
Thetford Mines	9	12	18	15	24	31
Asbestos	11	13	8	18	13	43
Pneumoconiosis						
Thetford Mines	4	1	1	7	6	24
Asbestos	0	0	0	5	3	24

TABLE 5 - Thetford Mines - mortality from all causes and radiographic changes

	Observed and expected death by year of birth cohort*													
	1891-95		1896-00		1901-05		1906-10		1911-15		1916-20		TOTAL	
<u>Men with:</u>	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
Parenchymal changes only	17	10.6	7	7.8	4	3.9	11	4.5	7	1.6	2	1.6	48	30.0
Pleural changes only	11	10.3	15	16.8	10	9.2	5	5.2	2	3.4	2	2.4	45	47.3
Both parenchymal & pleural changes	14	11.4	17	12.7	8	6.6	6	2.2	3	0.6	1	0.2	49	33.7

* The expected number was calculated from death rates in men without radiographic change.

TABLE 6 - Age standardized prevalence rates (%) for bronchitis, and breathlessness by dust exposure and cumulative smoking habits

		Dust index					
mpcf-years		<10	10-	100-	200-	400-	800 +
fibres/ml years		<23	23-	230-	460-	920-	1840 +
Bronchitis	Never smoked	10	19	19	46	21	49
	Up to 100 cigarette years	18	0	12	0	46	0
	100-499	41	28	21	33	42	43
	500-999	32	38	44	28	47	58
	1000 +	100	47	45	55	54	35
Breathlessness	Never smoked	0	14	24	31	13	4
	Up to 100 cigarette years	0	12	39	21	41	43
	100-499	16	14	8	20	42	18
	500-999	9	19	21	19	14	39
	1000+	0	23	27	31	34	46

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