

GRACE

PERSONAL AND CONFIDENTIAL

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C. N. Graf

May 24, 1977

From: E. S. Wood

Subj: Tremolite in Vermiculite

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The purpose of this memorandum is to discuss in some detail the nature of the tremolite problem as it impacts our vermiculite business, and also to outline our plans for dealing with the problem. These plans are based on extensive product testing, analysis of alternative configurations of the Zonolite business, and consultation with legal counsel, including the Corporate Legal Division.

THE PROBLEM

Tremolite is present as a tramp mineral in our vermiculite deposits, and while most of it is separated from the vermiculite in the milling process, small amounts are carried to expanding plants and ultimately into finished products. Tremolite is classified as asbestos and regulated by the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Mining Enforcement and

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Safety Administration (MESA), the Consumer Product Safety Act (CPSA), and the Toxic Substances Control Act (TSCA) as a carcinogen. Although we have been working since 1971 to reduce tremolite in our product, in our expanding plants, and in our mills, we have felt until now that tremolite was misclassified by OSHA and others as a form of asbestos. This was based on our understanding of the difference in physical characteristics of tremolite compared to other fibrous forms of commercial asbestos, as well as outside studies such as the animal study sponsored by Johnson & Johnson on a tremolite talc which showed no carcinogenicity.

Two recent developments have changed our views on this subject. First, an in-house study of mortality rates among ex-employees at Libby indicates that their risk of lung cancer is five times the national average. In this connection, we have experienced asbestosis in 41.5% of the workers (with over 10 years' service) in Libby, as well as in 28% of the workers (with over 10 years' service) exposed to Libby ore in the expanding plants. (The experience at Libby is confused because all of the aforementioned workers were exposed to high dust count levels in the old dry mill. The present Libby dust environment with the new mill represents a major change in this respect. Fiber counts have dropped from a level of above 30 f/ml on the average to a level below 5 f/ml. Also, the expanding plant employees mentioned have also been exposed to commercial asbestos in the manufacture of MK for a number of years.) Secondly, with respect to national safety regulations, the prior distinctions between "commercial asbestos" and "non-commercial asbestos" (tramp contaminants) are being erased as the general nature of the hazard of exposure to fibrous materials is more thoroughly studied.

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A great deal of controversy exists over what constitutes a safe level of exposure to a carcinogen. Most people would agree that safe levels are very difficult to establish. One view, taken by most regulating agencies, is that since no safe level can be unequivocally demonstrated, carcinogens must be eliminated where there are acceptable substitutes. Where the carcinogen cannot be eliminated by substitution, exposure must be controlled at the lowest level which can be technically achieved and reliably monitored. The opposing group makes a strong case that no unusual health risks have been rigorously documented for asbestos exposures below 5 f/ml (8-hour time weighted average), much less the present standard of 2 f/ml, or proposed standard of .5 f/ml. In the presence of such controversy it is difficult to determine what posture is appropriate for us in establishing limits of exposure for our employees and customers. A more detailed discussion of the health hazards associated with asbestos exposure is contained in Appendix I.

The exposure problems that we have seen to date are limited to the fibrous type of tremolite that occurs in the Libby deposits. The tremolite associated with our deposits in and around Enoree, South Carolina is largely non-fibrous. Since we have no evidence of asbestosis or other excess health risk associated with asbestos exposure among employees working in South Carolina, we do not believe that the levels of exposure to our employees or customers utilizing material from South Carolina creates a health hazard of any kind. In the case of material from Libby, we believe that lower levels of exposure are required to assure the safety and well-being of our employees. Moreover, regulations already proposed, when put into effect, will mandate lower levels.

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at \$605,000 in the 1977 capital budget). Included in this amount will be \$331,000 of spending against RCA 12-2 (budgeted for this year at \$204,000) for mill-related fiber and dust segregation, collection and disposal equipment. The remaining \$387,000 (budgeted at \$401,000 for 1977) will be directed at mine area dust control and vehicular dust control equipment. Authorization for this spending is being requested under separate RCA's and shop orders.

For the long term, research is being carried on at North Carolina State, aimed at improved separation techniques that appear to be effective in clean-up of our finer grades (No. 3 and No. 4). Unfortunately, this approach does not seem to be effective for the coarse grades (No. 1 and No. 2) which are used almost exclusively for Attic Insulation (hence the need for a binder development for Attic Insulation). Laboratory scale results indicate that a reduction of over 90% in the level of fibrous tremolite in fine grades may be achievable. This would appear to be the preferred long-term solution to tighter fiber exposure levels both at our expanding plants and in the customer use environment for the greatest volume of our products (\$28.3 million out of a total \$35.5 million of expanded vermiculite sales and ore sales to outsiders using Libby ore in 1977).

A series of changes primarily in ore handling facilities will be made at eight expanding plants which do not presently meet the OSHA standard of 2 f/ml (8-hour TWA). These changes will total \$943,000 of capital as follows: Denver (\$50,000); Newark (\$114,000); Phoenix (\$110,000);

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Dallas (\$50,000); Portland (\$107,000); Dearborn (\$197,000); and Omaha (\$315,000). Since the steps taken to reduce fiber counts to 2 f/ml, with proper plant maintenance, can generally bring fiber counts below 1 f/ml with appropriate peripheral equipment, we expect to achieve a level of 1 f/ml at all expanding plants by mid-1978. An additional \$93,000 of capital will be required for peripheral equipment to meet 1 f/ml at the following plants: Easthampton (\$17,000); St. Louis (\$26,000); Little Rock (\$50,000). These changes will be handled through a series of individual plant RCA's or shop orders, with the exception of Omaha spending which has already been approved under RCA E76-317 (\$247,000 approved by the President on November 26, 1976), and RCA E76-311 (\$68,000 approved by the CPD President on September 27, 1976). Excluding Omaha, the expanding plant capital spending totals \$721,000 versus budgeted 1977 and 1978 figures totaling \$666,000.

In part, these changes are being undertaken now since they represent relatively small capital increments (above what would be required to reach the present mandatory levels) that will yield substantially lower exposure levels to our employees. However, it is clear that the levels which we propose meeting will eventually be embodied in stricter state and federal standards. Moreover, it is clear that the Federal Government policy for the long run will be directed to achieving the lowest level which is technically feasible and which does not have an adverse impact on the economy as a whole.

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Standards as low as .1 f/ml have been proposed by the National Institute for Safety and Health (NIOSH). While this was a proposal that has been made without regard for its economic impact or technical feasibility, it is indicative of the general philosophy behind control of substances defined as carcinogens.

2. Product Labeling

Based on the advice of corporate general counsel, we have decided not to affix asbestos warning labels on any of our expanded products which, in their normally intended use, do not expose customers to fiber levels above those permitted by OSHA. Thus, no products made from South Carolina ore will require labeling. Subject to the results of additional job-site tests, no present expanded products using Libby ore will require labeling, with the possible exception of industrial grades for which we may not be able to identify and test all end uses. This policy is consistent with the posture of Johns-Manville, the largest supplier of asbestos products in the U.S. and a leader in the field of asbestos safety and health precautions. Effective July 1, 1977, all new packaging purchased will include a general dust warning label printed on the package.

In the case of consumer products, we are operating under the presumption that the present controversy over regulation of materials containing asbestos will be resolved by the Consumer Product Safety Commission (CPSC) in favor of a complete ban on consumer products containing asbestos fibers unless they can be shown to be "bound". Recent action of the CPSC

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in proposing a ban on drywall joint compounds containing asbestos, artificial fireplace logs using free asbestos fibers, and spackling compounds containing tremolitic talcs tends to support our presumption of an eventual ban on unbound asbestos-containing consumer products.

Equipment is being installed at 14 key plants at a projected cost of \$130,000 (average of \$9,300 per plant) using individual, locally approved shop orders. This equipment will permit us to apply a binder for our two major consumer products -- Attic Insulation and Horticultural Vermiculite. Simultaneously with the installation of the equipment, we are in the process of choosing an appropriate binder and level of treatment with the objective of reducing the use exposure for these products to a level of 1 f/ml maximum exposure and .2 f/ml on an 8-hour time weighted average basis. These are levels chosen because we think they are technically achievable and are close (within a factor of 2) to the level which NIOSH proclaims to be the lowest level which can be reliably monitored.

It should be emphasized that these steps are being taken to comply with the extremely stringent projected regulations, and not because we feel that the use of these products creates a serious risk for consumers.

Considering the brief and irregular pattern of use, we do not believe that asbestos exposure from our products causes an increased risk of health problems. However, there is a fringe of expert opinion, most prominently and articulately represented by a well-publicized expert from Mt. Sinai (Dr. Selikoff) suggesting that even brief exposures, presumably at high levels, can later produce mesothelioma. Mesothelioma is a rare form

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of lung cancer linked to asbestos exposure. For this reason, and the expected stiff regulation of asbestos-containing materials in consumer products, we feel that it is prudent to develop a treatment for our consumer products, even though it is anticipated this will increase our cost of manufacture by up to 15%.

Even though we will not be labeling most of our products, we intend to notify customers who inquire that small amounts of tremolite are present in our end products with the exception of our mixed products. In the case of mixed products (MONOKOTE and soil mixes), tremolite is detectable only through the use of internally developed analytical procedures which require elaborate techniques not commonly recognized or employed in the scientific community for detection of asbestos. For this reason, we are taking the position with all but authorized government authorities that our mixed products are "non-asbestos" products. Obviously, in responding to government inquiries we intend to provide specific data, which we have, that identifies trace levels of tremolite even in mixed products. It is our belief, for purposes of the law, that the amount of fibrous tremolite present in our mixed products is de minimis.

Requests for written statements concerning the presence of asbestos in our products from customers will be answered by indicating that we have small amounts of tremolite present in the product and by referring them to the OSHA regulations covering asbestos-containing products.

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ZONOLITE PROFITABILITY IMPACT

Comparative financial analyses have been completed for the present Zonolite business and several alternative configurations which could be forced by future regulatory activity and/or our ability to meet future fiber standards. The base case and alternative case assumptions and financial comparisons are presented in Appendix III. The following table summarizes key financial statistics for: 1.) the Zonolite 1977 budget and forecast, prepared in October 1976; 2.) a 1977 re-estimate completed in January 1977 reflecting adjustments to sales and gross margins based on the economic outlook at that time (used as the "base case" in Appendix III); 3.) a "most likely" future case reflecting additional capital spending for fiber control, additional costs for binder treatment in certain products, withdrawal of certain consumer products such as Attic Insulation in the U.S., and labeling of the remaining consumer products (Case B in Appendix III).

(\$000)	1977			1980		
	Budget	Base Case	Case B(1)	Budget	Base Case	Case B
Net Sales	\$65,719	\$63,495	\$57,303	\$92,639	\$92,281	\$80,232
Operating Profit	5,201	4,183	3,033	8,278	8,512	6,065
Profit After Tax	2,779	2,556	2,018	5,305	5,373	3,758
Total Capital Employed	\$31,573	\$30,891	\$29,937	\$37,613	\$37,215	\$34,328
% Return on TCE	9.0%	8.5%	7.0%	14.3%	14.6%	11.2%

(1) Case B presented in 1977 is for comparative purposes only. The full-year impact of assumptions in Case B would not actually be experienced in 1977.

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Our projections indicate that even with the loss of our consumer business (assuming the Canadian Attic Insulation business continues) Zonolite continues to be a viable business albeit at lower than forecasted returns.

More selective internal use of South Carolina ore in place of Libby ore can largely eliminate the 10-50% reduction in sales volume that would result from a requirement to label our products as containing asbestos. The reduction in sales from labeling is primarily the result of our being the first labeled product on a construction job site which would force contractors to comply with impractical OSHA regulations.

ALTERNATIVE APPROACHES

Considering the large potential liability that results from the sale of products that contain even a small amount of contaminant defined by the government as a carcinogen, it is reasonable to question whether there are alternatives to the proposed action. Our exposure to law suits cannot be ignored. In addition, we are forecasting a continued demand for no return capital to be invested in the business in order to meet increasingly tighter standards for asbestos fiber exposure, independent of whether a proven risk exists or not. Two obvious alternatives would be to seek divestment of the business or to close Libby and retrench to South Carolina where the health issues are minimal (but not eliminated).

Divestment of Zonolite has been considered in the past and been judged impractical. It is felt that no buyer could be found, capable of continuing to operate the business (with adequate capital resources) to give us an acceptable price for the business as compared to other alternatives.

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Closing of Libby and retrenching to South Carolina would require a drastic change in the basis on which the business is run. It is likely that we would be operating a regional business in the East, Midwest, and Southeast, rather than the present national business for Zonolite products. This alternative, if required, would be expected to produce a high return but substantially lower after-tax profits. For example, our projection for 1980 for a regional business, without Libby, shows after-tax profit of 2.6 million dollars giving a 15.2% return on the 17.2 million dollar Total Capital Employed. (This case is presented as Case C in Appendix III.) Large asset write-offs and interim operating losses would be incurred to convert to this regional business basis.

We now believe the most likely case for 1980, retaining Libby, but recognizing the possible loss of consumer businesses to be a 3.8 million dollar after-tax profit, generating an 11.2% return on 34.3 million dollars of Grace Capital Employed.

Our forecast indicates that continuing to operate Libby and continuing to conduct a national business is a preferred alternative unless large amounts of capital are required to meet drastically tightened asbestos fiber exposure levels. Our best estimate is that a 1 f/ml standard for Libby would require 3.6 million dollars of additional capital. A tightening of the OSHA regulations covering our expanding plants to a level of .1 f/ml would require 6 million dollars of additional capital. Based on our present assessment of what is technically required, a move to the standards of .1 f/ml in the expanding plants and 1.0 f/ml in Libby would make it uneconomical to continue operating Libby.

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In the absence of such extreme (and unlikely) tightening of standards, our projections indicate that the best course is continued operation of Zonolite from two mine locations.

RISKS

There are seven specific risks associated with tremolite in our workplaces and products which we assess as follows:

1. Harm to customers.

We do not feel that our products create a hazard for normal end uses. The highest level of exposure is for Attic Insulation and Masonry Insulation. The high concentrations of upwards of 15 f/ml (15 minute maximum) for Attic Insulation and 12 f/ml (15 minute maximum) for Masonry Insulation that were observed in simulated tests early in 1976 have not been confirmed by the results of more recent testing in actual field use. (The present OSHA ceiling limit is 10 f/ml for any 15 minute period.) The maximum concentration in the case of Masonry Insulation observed in recent testing was 3.65 f/ml (15 minute maximum) and in the case of Attic Insulation was 4.28 (15 minute maximum). However, we have observed very large variations in simulated test results such that further improvement in Attic Insulation, in particular, may be necessary to be assured that we reliably fall below 10 f/ml maximum exposure during use. Due to the products' short and irregular periods of use, it seems unlikely that we would exceed the 2 f/ml, 8-hour time weighted average, OSHA standard with Attic Insulation or Masonry Insulation.

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All other products appear to be well below permitted levels, in most instances by a good margin. (See Appendix IV for representative test results.)

2. Harm to employees.

The present level of exposure for our Libby employees (up to 5 f/ml TWA), while materially better than the harmful exposures before the new wet mill, still represents concern to us. Therefore, we will be undertaking an employee education program as well as further reduction in the fiber levels to 2.0 f/ml, in order to reduce the risk of harm to our Libby employees' health.

The reduction to 1 f/ml in the expanding plants, which we expect to accomplish by mid-1978, should give us a comfortable margin of safety in concluding that there is very low risk to our employees in the expanding plant work environments.

The risk to expanding plant employees using South Carolina ore, as well as to the mine/mill employees in South Carolina, is negligible.

3. Product bans.

There is a high risk that our products will be banned in several significant uses.

We forecast that our vermiculite consumer products, namely Attic Insulation, Horticultural Vermiculite, and Pool Base, will eventually be banned by the Consumer Product Safety Commission, and this has been assumed in the 1980 financial projections (Appendix III). We place our chances at 50:50 of binding the tremolite such that we could effectively argue that no fibers will be released during use.

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There is also a high risk (30%) during the next 18 months that MONOKOTE fireproofing will be considered to fall within the ban in selected states (California, New York, Minnesota, Massachusetts, and Illinois) of fireproofing products containing asbestos, although it would appear that this is an unintended ban. Legislators in those states simply failed to consider trace tramp minerals when wording the prohibition against a product containing any asbestos for sprayed applications. We are actively working on a vermiculite free fireproofing material for introduction in mid-1978.

4. Label requirements.

We believe that a decision to affix asbestos warning labels to our products would result in substantial sales losses. This view is shared by Johns-Manville in the case of their labeled construction products. It is further supported by J-M's experience with their tremolite talcs.

Based upon advice from corporate counsel, our products do not require labels if the OSHA limits are not exceeded in their intended use. This is also J-M's position for their own products. We believe that all of our products fall below the limits established by OSHA and that we will be able to continue to fall below more stringent standards being projected, thus avoiding the need to label our products.

Secondly, any change in interpretation which would require a labeling of selected products, such as Masonry Insulation, can probably be avoided by redistribution of the cleaner South Carolina ore and withdrawal from selected isolated territories.

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Continued programs aimed at cleaning up the product should allow us to meet the projected tighter limits that may be imposed by OSHA in 1978 and 1980.

5. Increasingly restrictive standards and higher capital requirements to meet the more stringent future standards.

We believe there is a very high risk that standards will become more restrictive requiring additional capital for continued operation of Libby and of expanding plants using Libby ore. In addition to the 1.9 million dollars which we propose to spend between now and mid-1978 to comply with asbestos fiber safety standards, an additional one million dollars is expected to be needed by 1980 in order to meet a projected OSHA standard of .5 f/ml.

There is a risk, which we place at less than a 20% chance, that additional investment of up to 10 million dollars would be required in order to reach a level of 1 f/ml at Libby (\$3.7 MM) and .1 f/ml at expanding plants using Libby ore (\$6.3 MM). Such a development would probably result in a decision to close Libby and the retrenchment of our business to a regional basis supplied entirely out of South Carolina. (See Appendix III, Case C for details of the financial impact of a decision to close Libby.)

6. Adverse publicity

There is a risk that Grace will attract adverse publicity from national media concerning the presence of asbestos in vermiculite. This

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information is already being circulated within government agencies, such as OSHA and has been reported on a local basis in connection with the Louisa County dispute over the mining of vermiculite ore. Future steps, such as the development of a case for continued sale of Attic Insulation to the Consumer Product Safety Commission, will increase the risk of widespread adverse publicity.

7. General liability to employees, customers, and the public.

Liability to employees is limited by the Workmen's Compensation Laws. However, we should expect increased Workmen's Compensation rates in Libby as the number of disabilities increase among employees who have been exposed in the past to the high fiber concentrations of the old dry mill. Liability among expanding plant employees and the South Carolina mine/mill employees appears minimal.

The risk of liability to customers is heightened by the decision not to label our products. Under the strict liability criteria, we may be liable to customers who can demonstrate they (1) were exposed to asbestos fibers and (2) sustained personal harm. Based on advice of corporate counsel, this risk is categorized as moderate. Moreover, it seems unlikely that bona fide cases of personal harm could be well documented considering the pattern of use and exposure levels of our customers.

General public liability, stemming from the sale of consumer products, is a low-level risk with very high potential liability if it develops. While we have no evidence of any adverse effect of our products on consumers, neither can we offer convincing evidence that they are ab-

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solutely safe. Making such a case is handicapped by the number of "experts" who claim that there is no safe level with the inference that any exposure is potentially hazardous. This leaves us open to liability without a good defense over a broad range of alleged hazards. A decision to label our consumer products would eliminate the risk of future liability, while exacerbating the risk of claims (mostly not bona fide) from past use of the product.

E. S. Wood

ESW/CGR
Attachments

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APPENDIX I

MEDICAL EVIDENCE ON THE EFFECT OF ASBESTOS EXPOSURE

Exposure to high concentrations of asbestos fibers results in increased risk to health of three different types:

Asbestosis is a scarring of the lungs that is a chronic condition appearing first in chest x-rays, usually after 5 or more years of exposure. It can be reliably diagnosed from x-rays and is specifically identified with exposure to asbestos fibers.

Lung cancer (bronchogenic carcinoma) can develop as a result of exposure to asbestos fibers or to other causes (such as smoking). It is difficult to diagnose due to the long latency period between initial exposure to asbestos and development of symptoms. Furthermore, since there are a number of causes of lung cancer, it is more difficult to establish a cause-effect relationship between exposure to asbestos fibers and lung cancer. Nonetheless, a great deal of work has been done which convincingly indicates a relationship between an excess risk of lung cancer and exposure to high concentrations of asbestos (above 5 f/ml). A combination of exposure to high concentrations of asbestos fibers and smoking is more damaging than either alone. One study among asbestos workers has shown that smokers have eight times the risk of lung cancer than non-smokers have.

Mesothelioma is a rare form of cancer which can occur either in the lungs or in the stomach. It can be specifically diagnosed only by taking a biopsy of the affected organ. It is specifically associated with asbestos exposure. Around 85% of cases diagnosed as mesothelioma occur in patients who have a history of exposure to asbestos.

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Although there is disagreement between experts on this point, the determination of an increased risk of asbestosis may also be indicative of an increased risk of lung cancer.

For purposes of assessing the risk to our employees, the only practical indicator is the incidence of confirmed cases of asbestosis. This is due to the extreme difficulty of determining the cause of cancer in any group of people considering the long latency period and general lack of specificity between lung cancer and any single cause. The exception to this would be cases of mesothelioma. However, we have no reports of mesothelioma even at Libby.

As a result of the particular philosophy employed by government agencies to regulate carcinogens, as well as the experimental difficulty of establishing safe levels, very little scientific work is available to help identify the health risk posed by exposure to low levels of asbestos fibers (under 5 f/ml).

There are three sources of information outside CPD which purport to indicate that asbestos fibers cause increased health risks even at low concentrations.

The first is a study among hard rock miners in Idaho (Gillam et al.) which indicates an increased risk of lung cancer in the presence of asbestos fiber exposures of around 0.24 f/ml. However, this study is confounded by the presence of other potentially carcinogenic materials, notably arsenic-containing compounds and radon daughters. A still unpublished study of a larger group of the same miners (McDonald et al.) has indicated no increased

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mortality risk from silicosis. This particular evidence of a hazard associated with low level exposures would seem to be seriously impugned.

A second purported indication of the hazard associated with low exposure levels is an increased risk of lung cancer among relatives of asbestos miners. However, more recent measurements indicate that fiber exposures in home environments of asbestos workers can be high and therefore this probably does not represent a low level exposure environment.

The third collection of evidence is of mesothelioma (not other asbestos-related diseases) in individuals and in animals exposed to high concentrations for brief periods of time (as little as 8 hours). The cases in men are few in number typically involving one or two individuals with unknown but probably very high exposure concentrations. Due to the small number of cases, definite cause-effect relationships cannot be drawn. The cases among animals are at extremely high dosage levels in species which are especially sensitive and, therefore, extrapolation to the effects on man are not well-founded.

In spite of the lack of hard evidence, there is a respected group of professional researchers who express the opinion that exposure to levels as low as 2 f/ml (8-hour TWA) create an increased risk of cancer in man after 30 or more years of exposure.

Results of our own in-house epidemiological studies indicate that conditions which existed in the old dry mill in Libby (34 f/ml TWA) and in unregulated expanding plants using Libby ore (29 f/ml TWA) created a health hazard to our employees. Among present employees with 10 or more

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years of service who would have been exposed to the conditions in the old Libby dry mill, 41.5% exhibit asbestosis. Moreover, there is a five-fold increased risk of lung cancer among retired and ex-employees who worked in the Libby mine (as compared to the general population).

We are encouraged by the absence of any new cases of asbestosis found at the last annual check-up at Libby.

Among expanding plant employees, the high employee turnover and variety of past exposures make conclusions difficult. Among 9 employees with 10 or more years' service in plants which have not used Libby ore, there is no incidence of asbestosis, even though several of these plants have previously used commercial asbestos in some products. Among 14 employees with ten or more years of service in expanding plants which have used Libby ore, 28% exhibit asbestosis. However, any cause-effect conclusions are confounded by the fact that all of these plants have used commercial asbestos in the past.

Chest x-rays for the 77 employees at our Enoree mine/mill give no indication of adverse health effects from exposure to the lower level of tremolite fibers (0.8 f/ml) found in South Carolina. While there is incidence of positive chest x-rays in 12 employees (16% of total), only one case is consistent with exposure to asbestos. That particular employee worked for a great number of years exposed to commercial asbestos in another Zonolite location. Of the 12 positive chest x-rays, 5 stem from previous cotton spinning mill exposure which produces "brown lung" disease. There is no indication of excess mortality due to lung cancer among the South

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Carolina mine employees. Since the South Carolina mine has only operated for 29 years, there is still the possibility of extremely long latency periods before excess mortality would be observed.

As very little published medical evidence exists for tremolite exposures, as opposed to the commercial forms of asbestos, we have sponsored animal studies on tremolite and a mixture of vermiculite and tremolite to determine whether tremolite is carcinogenic. The test animals have concluded 400 days of treatment and are scheduled to terminate after 730 days. While no definite conclusions can be drawn from the results to date, indications are that our tremolite creates less of a problem than commercial asbestos. As we have not yet completed the "critical" period of the animal studies, between 370 and 450 days, the lack of a significant difference in mortality between the test animals and the control group is not yet meaningful. Results of this study should be complete and available by October 1978.

We have sought and obtained advice from several outside professionals with respect to what tremolite levels create a hazard.

Dr. William E. Smith of Fairleigh Dickinson University has responded (Appendix V), indicating that notwithstanding the "new evidence" presented by OSHA and NIOSH there is no convincing evidence of an excess risk to health from low level asbestos fiber exposures (below 5 f/ml).

Dr. MacMahon, Professor of Epidemiology at Harvard University, has questioned the conclusions of a leading epidemiologist, Dr. Selikoff of Mt. Sinai, that exposures to low levels are potentially hazardous. More-

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over, he indicates that an unpublished study of shipyard workers in the Pearl Harbor Navy Yard who have been tracked since 1943, indicates no excess risk of cancer mortality contradicting the evidence presented by Selikoff. He derides Selikoff's statements with respect to low exposure level hazards as being unprofessional and not well-founded scientifically.

Dr. Enterline of the University of Pittsburgh has proposed a mathematical model which closely fits the observed relationship between mortality rate and time of exposure among the group of 17,000 shipyard workers studied by Selikoff. We are in the process of using this model to predict the effect of exposure levels of 1 or 2 f/ml. Even assuming that tremolite fibers are as biologically active as commercial chrysotile asbestos (an unduly pessimistic assumption), preliminary indications are that the increased mortality risk from lung cancer as a result of a 50-year exposure to 2 f/ml is only 10% above those not exposed to asbestos fibers.

Discussions with Johns-Manville revealed that two "modern" asbestos fabricating plants (one in Texas and one in California), built in 1956-57, show no cases of asbestos-related disease among their employees. Exposures at these plants have been consistently below 10 f/ml (8-hour TWA), probably in the 2-5 f/ml range, with exposures during the 70's consistently below 2 f/ml. This suggests no excess health risk at concentrations up to 5 f/ml (8-hour TWA).

Amidst such conflicting scientific opinion, any conclusions which we draw must necessarily contain large elements of personal judgment and at least some level of uncertainty. Nevertheless, we must establish levels of

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exposure calculated to protect both employees and customers from excess health hazards. Accordingly, we have concluded that in a regulated and monitored environment such as our plants, a reduction in exposure to 1 f/ml creates a worthwhile margin of safety over the present OSHA standard of 2 f/ml for our employees. A level of 1 f/ml is not expected to have an adverse health effect. A level of 2 f/ml, while probably not hazardous, does not have an acceptable margin of safety and will be reduced if economically feasible. No customers or employees will be exposed knowingly to concentrations above a level of 2 f/ml without adequate warning of the potential hazards involved. Johns-Manville also selects 2 f/ml as a limit below which there is "no excess risk of asbestos-related disease" (compared to those who are not exposed to asbestos).

In unmonitored environments, involving daily use of our products, such as construction sites, a typical exposure from our products of .5 f/ml (TWA) is not considered a hazard.

With the exception of mixed horticultural products, exposure levels for users of our product are above background levels. It is not likely that any improvement which we may make will reduce the exposure of users to levels as low as background. However, our long-range objective will be to reduce customer exposure levels to "the lowest limit at which asbestos fiber concentrations can be reliably monitored". According to NIOSH, this level is .1 f/ml on an 8-hour time weighted average basis and .5 f/ml for any 15-minute period.

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