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SUBMISSION OF

CATERPILLAR TRACTOR CO.

to

State of Illinois

Pollution Control Board

at

Regional Hearing on Asbestos and Spray Insulation

Waukegan, Illinois

October 19, 1971

PREFACE

It is the sincere desire of Caterpillar Tractor Co. to cooperate with and assist the State of Illinois Pollution Control Board in the preparation of the proposed Asbestos and Spray Insulation Regulations 871-16 in accordance with the Environmental Protection Act of the State of Illinois.

The purpose of this booklet prepared by Caterpillar Tractor Co. is to supplement the statement and document the information presented by the Company at the Regional Hearing on Asbestos and Spray Insulation Regulations at Waukegan, Illinois on October 19, 1971.

Included in this booklet are: (1) Caterpillar's concerns regarding the possible prohibition of asbestos brake linings; and (2) Caterpillar's recommendations relative to the proposed Regulations which would ban asbestos brake linings by 1975. Also included in Appendix B is a copy of Caterpillar Tractor Co.'s oral testimony presented at the Waukegan Hearings, October 19, 1971.

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I. INTRODUCTION

A. Purpose of Booklet

The purpose of this booklet is to supplement and support the oral statement made by Caterpillar Tractor Co. at the Regional Hearing on Asbestos and Spray Insulation Regulations at Waukegan, Illinois on October 19, 1971. Recommendations and suggestions contained herein are intended to apply only to products of a type and kind built by Caterpillar Tractor Co. The information presented is brief; the intent is to provide the Company's position relative to the proposed ban on the use of asbestos brake linings.

B. Caterpillar Product Line

Caterpillar currently produces 52 models of track or wheeled earthmoving equipment (in addition to 53 models of Towmotor material handling equipment), all of which have braking systems which utilize asbestos friction material. The following listing gives the number of models in each specific product line (Appendix A pictorially illustrates the Caterpillar product line):

- 6 - models of track-type tractors
- 6 - models of wheel-type tractors and compactors
- 5 - models of track-type loaders
- 7 - models of wheel loaders
- 5 - models of pipelayers
- 13 - models of wheel tractor-scrapers
- 6 - models of motor graders
- 2 - models of off-highway trucks
- 2 - models of off-highway tractors

52 - Total Models

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CATERPILLAR CONCERNS

A. Proposed Regulation R71-16, "Asbestos and Spray Insulation"

The specific portion of the proposed Regulation that concerns Caterpillar Tractor Co. is Part VII - Asbestos Containing Products, Section 702, which states:

"The use of asbestos in the brake lining of vehicles manufactured after January 1, 1975, and sold for use in Illinois is prohibited."

B. Definition of a Vehicle

The lack of a definition for the word "vehicle" in the proposed regulation is of concern to Caterpillar Tractor Co. The Illinois Vehicle Code (Section 1-217) defines a vehicle as "every device, in, upon or by which any person or property may be transported or drawn upon a highway...". Although this definition could provide some clarification to the proposed regulation (if included), it is obviously quite general. Earthmoving equipment does not normally operate on public highways and is not designed for such use, although certain equipment, such as the 613 Elevating Scraper is small and light enough to be driven on the highway in its movement from one job site to another; motor graders may also be used to repair and maintain existing roads.

Regulatory statutes typically have differentiated between motor vehicles and earthmoving equipment. It is, therefore, the Company's suggestion that this distinction should be recognized

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and dealt with by including the following definition of vehicle in Section 103 of the proposed Regulations:

Vehicle - Any self-propelled device designed primarily for transporting persons or property on a street or highway.

A specific definition of this type would properly exclude from the proposed Regulation earthmoving and construction equipment -- not designed primarily for use on public highways.

C. Reasons for Caterpillar Concern

Unaware of the full intent of the proposed Regulation and uncertain as to whether or not Caterpillar product is included in the proposed Regulation, the Company felt it mandatory to present its case assuming the intent was to include earthmoving equipment.

1. Prohibition of Asbestos Brake Linings

It is the Company's concern that all "use of asbestos in brake lining...is prohibited." Asbestos brake linings are used in all Caterpillar product because of their demonstrated safety and durability characteristics (which will be discussed in more detail later). At this time, Caterpillar is unaware of a safe substitute for asbestos brake linings (our experience with sintered metal brake material has been unsatisfactory).

The brakes on some of Caterpillar's equipment are totally enclosed. The brakes on many models are immersed and rotating in cooling oil. In these cases, asbestos wear products

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cannot get into the atmosphere except possibly when the brake compartment covers are removed for service. Other models have brakes with shields which are not air tight and thus brake lining wear products can escape to the atmosphere. The characteristics of these wear products are described in Section III of this booklet.

Some Caterpillar models use caliper disc brakes, which are not enclosed, and the brake pads, containing asbestos, can emit their wear products directly into the air.

2. Some Types of Disc Brakes Are Not a Solution

In the explanation of Proposed Regulations (R71-16), the statement is made: "It is contemplated that the ban will necessitate design changes, probably to disc brakes..."

As previously mentioned, Caterpillar Tractor Co. currently utilizes caliper disc brakes on some of its models; however, asbestos friction material pads are still utilized in this type of brake because of the safe, sure stop they provide.

It must be pointed out that caliper disc brakes are not an alternative solution to banning the use of asbestos brake linings. In fact, with the open nature of caliper disc brakes, it is easy for brake-pad wear products to be emitted.

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PROBLEM IDENTIFICATION

A. Types of Caterpillar Product Brakes

Asbestos-type friction material is used for brake lining throughout the entire line of Caterpillar Tractor Co.'s earthmoving equipment. A few of the models are shown in Figure No. 1: A is a wheel-type tractor, B is a motor grader, C is a wheel-type

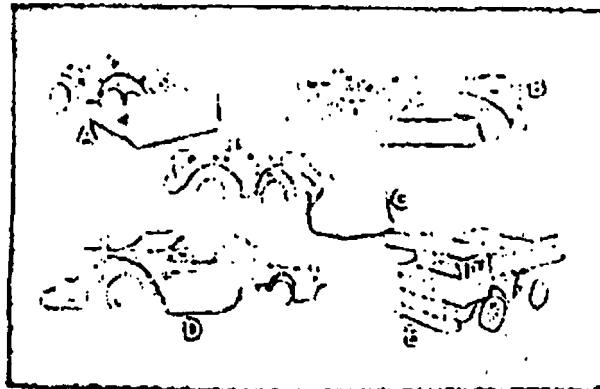


FIGURE NO. 1
EXAMPLES OF CATERPILLAR EARTHMOVING EQUIPMENT

loader, D is a wheel tractor-scraper, and E is an off-highway truck. Asbestos friction material is not used in Caterpillar's brakes from happenstance but is chosen for its performance, reliability and safety. Some of the products use dry friction surface brakes and some are bathed in cooling oil. For example, the off-highway truck (E) has totally enclosed oil cooled multi-disc brakes while the wheel tractor-scraper (D) has shoe brakes. Each product (e.g., truck, wheel tractor-scraper, etc.) requires a specific brake type and friction material depending on its primary application.

As early as 1937 Caterpillar was conducting research work to identify operating characteristics of all known types of brake lining material. It is a necessity that Caterpillar provide its customers with the best performing and safest brakes possible. So far, a material superior to asbestos-type that fulfills all the requirements needed for the heavy-duty brakes required on earthmoving equipment has not been found.

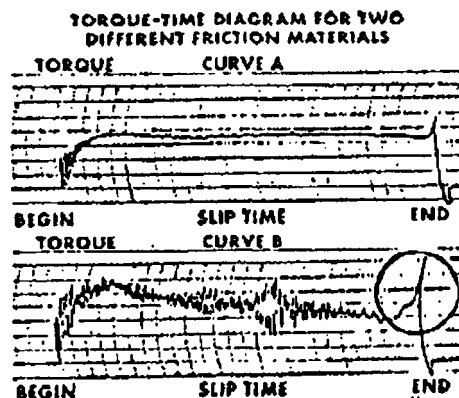


FIGURE NO. 2
TORQUE CURVES OF FRICTION MATERIALS

Figure No. 2 is a strip chart recording of the torque-time relationship for two different friction materials. These two traces illustrate the frictional behaviour throughout a brake application. In curve A, note the smooth deceleration or braking as the wheel speed is reduced to zero, from beginning to end of stop. This is one of the characteristics we expect from asbestos-type material. On the other hand, curve B of a non-asbestos friction material shows undesirable speed change conditions. The trace exhibits considerable frictional vibration. This results

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in noise and undue stress in the whole brake system. The abrupt change to a static level at the end of braking (as circled in Figure No. 2 on the right of curve B) causes instability and an erratic, unsafe brake operation.



FIGURE NO. 3
TRACK-TYPE LOADER WITH RAISED BUCKET

If a track-type loader (see Figure No. 3) stops abruptly, rather than smoothly, while backing up with a raised bucket full of rocks, some of the rocks leave the bucket and continue in the rearward direction and end up in the operator's lap. This safety hazard also applies to other earthmoving machines which can spill a load due to an abrupt stop.

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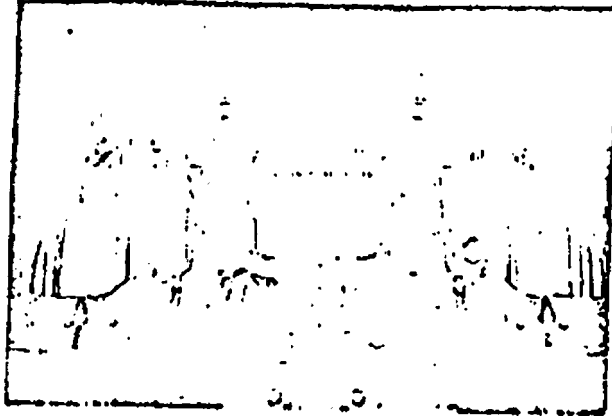


FIGURE NO. 4
TRACK-TYPE TRACTOR
ENCLOSED BRAKE COMPARTMENT

The enclosed brake compartment in Figure No. 4, shown with covers removed, has hand brakes (noted by arrows), which are used either dry or bathed in oil. In either case, due to the enclosure, brake wear products cannot be emitted into the ambient air during normal operation. When servicing these compartments, they are exposed to the ambient air and the products found (Figures No. 11 and 12 and discussion) are powder rather than fibrous in nature and submicron in size.

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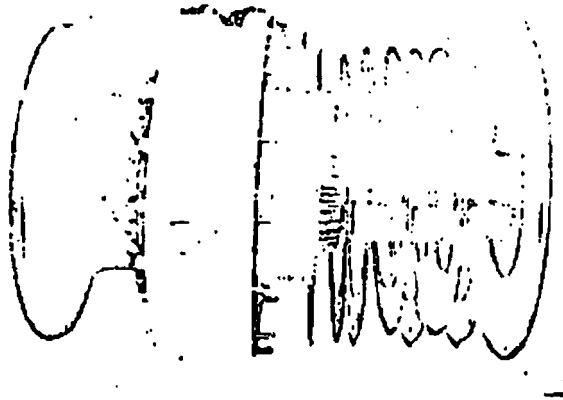


FIGURE NO. 5
OFF-HIGHWAY TRUCK
ENCLOSED, OIL COOLED, MULTIDISC BRAKE

Figure No. 5 is an example of multidisc brakes which are totally enclosed and bathed in cooling oil. The only time brake wear products from this type brake are exposed to the ambient air is during servicing. This brake was originally designed to use sintered metal friction material. Poor performance, reliability, and safety requirements necessitated a change to asbestos-type material.

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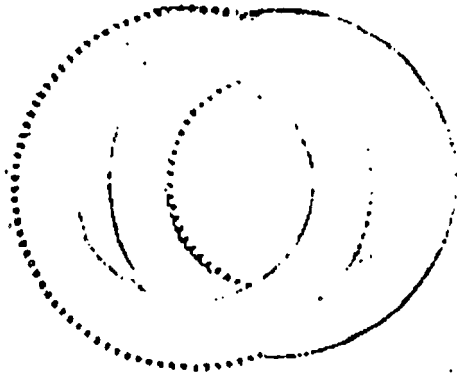


FIGURE NO. 6
FRICTION PLATE AND MATING PLATE
FROM BRAKE IN FIGURE NO. 5

Figure No. 6 shows the asbestos containing friction plate used in the previously mentioned multidisc off-highway truck brake design. This design of disc brake system cannot emit wear products into the air during operation due to its oil environment and the fact that it is contained in an enclosed compartment.

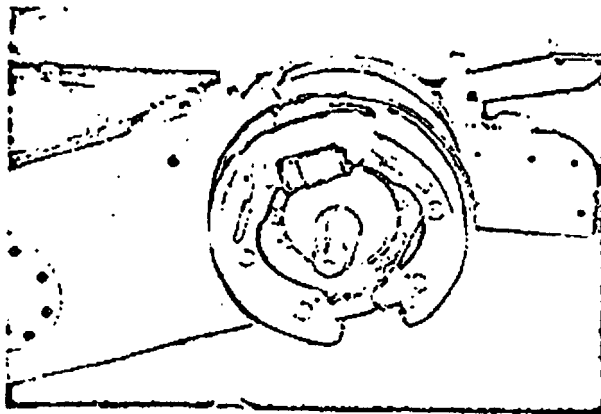


FIGURE NO. 7
MOTOR GRADER SHOE BRAKE (DRUM REMOVED)

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Figure No. 7 shows a shoe brake located in the wheels of rubber-tired earthmoving equipment. Motor grader shoe brakes of this type normally are shrouded to protect the operating mechanism. The shrouding may allow brake wear products to be emitted into the ambient air since it does not provide an airtight compartment.

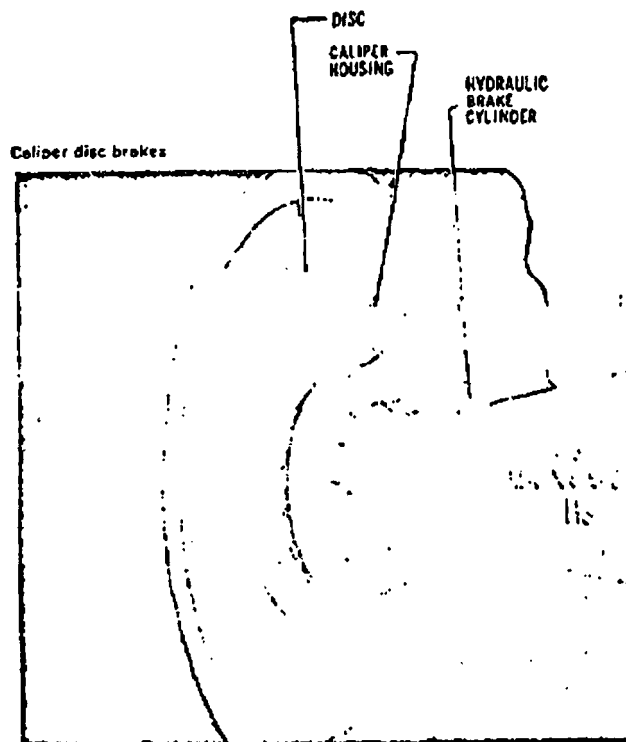


FIGURE NO. 8
WHEEL TYPE LOADER CALIPER DISC BRAKE

Conventional caliper disc brakes are also used on some Caterpillar product and are shown in Figure No. 8. The pads in the brake caliper contain asbestos. With this type of brake system any brake wear products are emitted directly into the ambient air.

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The heavy-duty performance of Caterpillar machines and their braking requirements are considerably more stringent than automotive applications and need to be explained. It is normal for track-type or wheel loaders to go forward and reverse as frequently as 180 times per hour, all day long, and often three shifts a day. This means as many as 360 brake applications per hour. Bulldozing operations also require severe usage of brakes since track-type tractors are steered by the brakes.

Caterpillar 666 Wheel Tractor-Scrapers weigh 250,000 pounds when loaded to capacity. Typical applications will find these machines going downhill when fully loaded. The brakes on a 250,000 pound scraper, stopping from 45 miles per hour on the level, convert enough energy into heat to melt 41 pounds of iron. (A typical passenger car stopping from this same speed would develop enough heat to melt 2/3 of a pound of iron.) Of course, downhill operation increases the energy dissipation further. Off-highway trucks weigh slightly less and must perform in similar situations.

Pipelayer brakes must hold as much as 200,000 pounds of pipe suspended over a trench, while men are working beneath the pipe.

Track-type tractors often operate in conditions where very steep slopes must be negotiated (in forward and reverse). Since these machines are steered by the brakes, the safest possible linings must be used to prevent brake failure which could result in a machine attaining runaway speeds on these steep slopes.

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It is Caterpillar's candid opinion that the prohibition of asbestos from brake linings would place a severe penalty on the performance and safety of earthmoving equipment.

B. Brake Wear Products

In the December 1968, Air Pollution Control Association Journal, Jeremiah Lynch presented the results of his study entitled "Brake Lining Decomposition Products." In an initial study, dust samples taken from automobile brake drums were examined. Electron micrographs did not reveal the presence of any free fiber. Additional study, on a laboratory basis, was conducted. Decomposition products of various brake linings were sampled under simulated operating conditions. In all but a very few cases the linings tested showed less than 1% free asbestos fiber in the decomposition product. This is a significant finding since the original linings averaged 50% asbestos by weight. In the isolated cases where significant free asbestos fiber was found, the test conditions were such that brake failure would have occurred if the linings had been subjected to like conditions in a vehicle.

Lynch states that in all but the most extreme driving conditions, only a very small fraction of the 30% - 50% asbestos present in brake lining escapes into the ambient atmosphere as a free fiber. Wear apparently occurs not by abrasion but in minute areas of intense heat at points of contact between the drum and lining. At these temperatures, about 900°F., decomposition products do not generally contain free fiber, but are a different mineral resulting from the thermal breakdown of the asbestos.

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ELECTRON MICROSCOPE PHOTOGRAPHS



FIGURE NO. 9
Asbestos fiber from new brake lining
5000x



FIGURE NO. 10
New brake lining scrapings after
heating to 1200°F. for 30 min.
5000x

All fibers in Figures No. 10, 11 and 12 are below 5 micron in length:

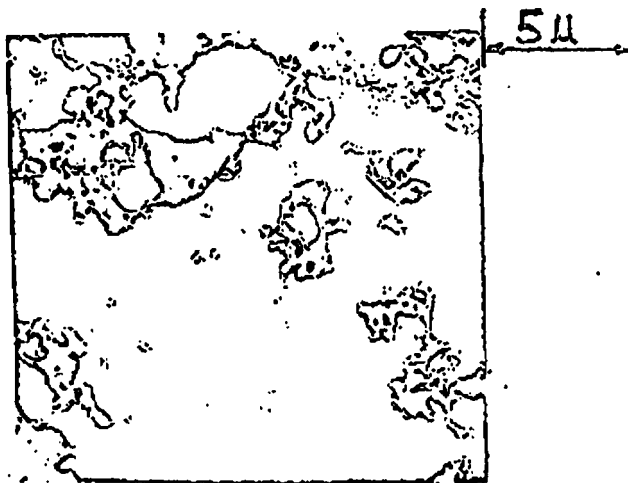


FIGURE NO. 11
Debris from dry brake compartment
5000x



FIGURE NO. 12
Debris from dry brake compartment
5000x

35 Microns - Thickness of a human hair at 5000x

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Recently, tests were made by Caterpillar's Research Department on the wear debris found in an enclosed, tractor, dry brake compartment which corroborates Lynch's findings. The four photographs on the opposite page were made with an electron microscope at 5000 x magnification. Note the 5 micron (two ten thousandths of an inch or 0.0002") scale in the center of page No. 14. Section 601 in the proposed Regulation states that "only fibers of 5 microns or greater in length...shall be counted" in the emissions from a factory into ambient air. The scrapings from an unused asbestos brake lining shown in Figure No. 9 obviously have fibers longer than 5 microns in length. Heating these scrapings (which provides a laboratory simulation of continued brake applications) from an unused brake lining destroys the fibrous nature. This is shown in Figure No. 10. Mechanically rubbing the deteriorated fibers in a brake would further powder this material. Figures No. 11 and No. 12 show the actual debris found in dry brake compartments. Any fibers visible are submicron in size. With the intense heat resulting from brake application, it is expected that a breakdown to sub-micron debris would also occur in enclosed, oil cooled brake compartments.

If the standards in Section 601 of the proposed Regulation were applied to brake emissions into the air, the brake wear products of heavy-duty earthmoving equipment would be under 5 microns in size and therefore be within threshold limits.

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It should be pointed out that there are well over 100 different natural minerals having a degree of fibrous structure. Some investigators consider respirable fibers to be ubiquitous (everywhere at the same time) and feel that much more definitive information must be obtained on their identification, source, and biologic response.

A good example of this is talcum powder which is found in almost every home and is a measurable source of asbestos fiber. Tremolite, another form of asbestos, occurs naturally in most talc used in this country and is thus found in talcum powder. Industrial talc may contain as much as 30% tremolite. Since more than 750,000 tons of talc are used in this country annually, it must be considered to be a prime source of respirable asbestos fibrils. (The finest single fiber shown in Figure No. 9 can be called a fibril.)

C. Asbestos Usage - Caterpillar vs. U.S. Consumption

Finally, it should be pointed out that of the more than 800,000 tons of asbestos used in this country each year, only about 3% of this goes into the manufacture of friction materials such as brake linings. Caterpillar's dry brake asbestos material usage amounts to 0.006% of the total asbestos usage in the U.S.A. and less than 0.2% of the total friction material usage of asbestos in the U.S.A. It is felt that the amount of free asbestos fiber that can potentially become airborne, as a result of breakdown of brake linings of earthmoving equipment, is quite low and unlikely to be significant from a health standpoint.

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1. CONCEPTS

A. An Illinois Standard Would Dictate Worldwide Caterpillar Requirement

The establishment of a standard which prohibits the use of a material in vehicles which are manufactured and sold for use in Illinois has the effect of setting national or even international standards. It is impossible to know the ultimate destination of Caterpillar machines as they are assembled and to provide for selective assembly or alternate brake systems for those to be sold in Illinois. In order to provide competitive leadership on a worldwide basis, Caterpillar has established the policy to use interchangeable parts on all models so that specifications can be followed for purchase and manufacture at any plant in the world.

If there were a material that would do the same job as asbestos in brakes, it is highly improbable that it could be a direct substitute. Other mechanical parts would have to be modified to adapt this new material. The results would be an "Illinois only" machine with parts only available locally, not worldwide. The customer could immediately react to this and buy a standard machine in a neighboring state and move it into Illinois as a used machine.

Caterpillar Tractor Co. has long been a leading and vitally important company in Illinois. As the state's largest private employer with over 41,000 employees and 6 manufacturing facilities, it has become the largest dollar exporter of product in the United

States. Over 52% of the \$2.1 billion annual sales reached in 1970 were outside the United States. Illinois would not be the leading state in exports to other countries without Caterpillar.

Imposition of a ban on the use of asbestos in brakes would impose a severe restriction upon Caterpillar Tractor Co.

B. Effect of Proposed Regulations on Illinois Caterpillar Dealers

The requirement for a specific design of earthmoving equipment for Illinois could result in a hardship for Caterpillar dealers and Illinois earthmoving contractors, and a subsequent loss of sales tax to the State. Special brake assemblies to meet the Illinois requirement would, of necessity, result in higher first cost of product. This higher first cost would result in higher bid prices for road building and earthmoving contracts. Thus, with a fixed State budget for road improvement, etc., less work would be done, and fewer machines would be sold.

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7. SUMMARY AND RECOMMENDATIONS

Caterpillar Tractor Co. sincerely believes that the information presented in this booklet establishes reasonable doubt about the real contribution of earthmoving equipment to the asbestos environmental problem. It has been pointed out that each Caterpillar product uses a distinctive brake system design which is influenced by its working environment, job application spectrum, performance criteria and safety requirements. However, all Caterpillar product brake systems use asbestos friction material since it has evolved over the years as the most satisfactory material, all aspects (particularly safety) considered. Caterpillar Tractor Co. tests and total Company usage of asbestos both indicate that asbestos friction material used in our product does not significantly contribute to the level of asbestos fibers in ambient air -- at least not to the point where its use should be prohibited.

Based on the aforementioned points and the significant interstate and international commerce aspects, Caterpillar Tractor Co. questions whether the intent of the Asbestos and Spray Insulation Regulations is actually accomplished by the proposed ban of asbestos brake linings. If research work and data on ambient concentration levels of asbestos fibers which are detrimental to society establish a need for asbestos brake control and/or regulation, Caterpillar recommends that Section 702, Part VII of R71-16 (Asbestos and Spray Insulation Regulations) be modified to allow the following exceptions:

That asbestos brake linings (friction material) may be used in a brake system when the friction material operates in either a dry or oil-wetted environment in a totally enclosed brake compartment which prevents the emission of brake wear products into the ambient air.

2. That asbestos brake linings (friction material) may be used in a brake system, when the friction material operates in a non-enclosed brake compartment, until conclusive medical evidence proves that the emitted brake wear products contain harmful amounts of asbestos fibers.

If all evidence indicates the need for asbestos brake controls and/or regulations, Caterpillar would further recommend that reasonable threshold limits of asbestos fiber be established by qualified personnel (based on scientific fact and foreseeable technological advances). Test procedures which measure the concentration of asbestos fibers must also be developed which are understandable, repeatable, and realistic. Place the burden on the manufacturer to design his product to meet reasonable, attainable standards — don't just prohibit the use of asbestos for brakes.

As mentioned at the beginning of this booklet, Caterpillar Tractor Co. agrees in principle with the objectives of the Environmental Protection Act. The Company stands ready and willing to assist the Board in the establishment of asbestos regulations which serve the intent of the legislation.

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