PLAINTIFF'S EXHIBIT
EXX-219

James W. Hammond, Sr.
1010 Townplace Private
Houston, Texas 77057

ST0012853

February 16, 1989

Mr. William Baggett
P. O. Box 7820
Lake Charles, LA 70606-7820

RE: HISTORY OF RECOGNITION, EVALUATION AND CONTROL OF HAZARDS OF ASBESTOS DUST IN THE PETROLEUM AND PETROCHEMICAL INDUSTRY FROM 1930 TO 1970

Dear Mr. Baggett:

In 1937 Mr. Roy S. Bonsib, Chief Safety Inspector, Medical Department, Standard Oil Company (N.J.) released his bulletin, "Dust Producing Operations in the Production of Petroleum Products and Associated Activities." He subtitled the report, "A Medico-Safety Survey."

Dr. W. J. Denno, M.D., General Medical Director of Standard Oil Company (N.J.) wrote a foreword for Bonsib's bulletin. Because Dr. Denno so clearly and concisely expressed the moral duty of the petroleum industry for its employees, the full foreword is attached. See Item "1. One may know that he expresses his management's policy for the N.J. Company and all of its affiliates. In 1947 Humble Oil and Refining Company's board approved the sharing of industrial health knowledge and medical experiences with the API members and with its customers without reservations. I was employed by Humble in 1947 to supervise industrial hygiene.

In 1937 Mr. Bonsib wrote that dust was not only a nuisance but was recognized as dangerous as a cause of occupational diseases. He quoted Professor Philip Drinker, Harvard, "It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument." Professor Drinker give examples of hazardous dust by naming asbestos and silica. He read his paper before the annual National Safety Congress, October, 1936. Mr. Bonsib referred to silica and asbestos dust as being highly hazardous when inhaled at work. Mr. Bonsib referred to the broad studies on animals that had been carried on by both the U.S. Bureau of Mines and the U.S. Public Health Service. He referred to publications of these studies by these agencies and the National Safety Counsel. Occupational exposure to asbestos before 1937 was known to have caused loss of lung capacity, and an enlarged heart.

These diseases were known by Mr. Bonsib before he began his study of the Oil refineries in 1936 or 1937. The study report listed the many workplaces in the refineries where asbestos is commonly used in large amounts. The attached several sheets are taken directly from the report of his industrial hygiene study made in 1936 and 1937. See Item #2.

At the end of Mr. Bonsib's Bulletin one's attention is attracted by the list of authoritative experts who he conferred with. His standard for dust concentration that could be tolerated without high risk was used by government and industry until the 1960's. His method of evaluation was acceptable for a like period where a close estimate was suitable.

Mr. Bonsib studied those dusty operations where asbestos was present. In 1937 he described the nature of the work practices, locations, physical methods and average dust concentrations in several refineries.

His recommended measures for controlling dust in oil refineries are basic ones for today. He failed to emphasize substitution of non-asbestos insulation and filler materials. However, as shown by the experiences of those employees who worked with asbestos and used his safety measures their exposure was under control.

As early as 1942 a national standard for asbestos dust of 5 million particles per cubic foot (MPPCF) was commonly recognized. This Maximum Allowable Concentrations was set by a group of authorities representing a good cross section of governmental, insurance, and industrial representatives. These experts were a committee of the American Standard Association.

Dr. James Sterner, (1942), in lectures and in publications in several medical schools, and journals, both safety and industrial hygiene, discussed the MAC values.

By 1950 the experts issuing MAC values had united behind the threshold committee of the American Conference of Governmental Industrial Hygienists, (ACGIH). This committee is still active and publishes those TLV's annually. Before a value is changed a national notice of the intended change is circulated for two years. This notice alerts all parties concerned to come forth with unpublished information to guide the TLV committee. Since 1948, the petroleum industrial hygienist and safety inspectors have discussed those proposed changes in API professional committee meetings.

Beginning with the asbestos TLV in 1950, the changes by the TLV Committee were none until 1968 when the supreme importances of fibers was accepted. The TLV for asbestos of 5 million particles dust per cubic foot (total count) was reduced to 2 MPPCF or 12 fibers per milliliter of air. The fiber was defined as to its ratio between length (more than 5 microns) and its breadth.

Item #3 shows how few changes are made for the long list of substances in any year. Also it gives one a clear definition of TLV's.

The next enclosure marked Item #4 is added because of its concise history of occupational diseases from workers' exposure to asbestos. It was found in "Documentation of the Threshold Limit Values and Biological Exposure Indices", 5th Ed. 1986. This publication was issued by the ACGIH, Inc. The latest edition may be purchased from Am. Conf. of Govern. Hygienist, Inc., 6500 Glenway Avenue, Building D-7, Cincinnati, Ohio, 45211.

Blazer and Cooper in 1968 published results in Am. Ind. Hyg. Assoc. J. of their study of the work environment of insulating workers (v. 29, 1968). Dust surveys were made in small and large industrial plants.

Dust concentrations by insulating job classification, based on both million particles per cubic foot and fibers per cc (ml) are given in attached tables. See Item #5. Past concentrations standards for asbestos were based on MPPCF until 1968. In that year the TLV Committee recognized the improvement of the TLV by basing the value on fiber concentration. The concentration values by MPPCF to fibers per cc by a multiple of approximate 6 or divisor of 6 are to convert fibers per cc into MPPCF. The fibers with a length of greater than 5 micros are the ones that are converted in fibers per cc.

The Hygiene Guide Series, AIHA, was prepared by professional and certified industrial hygienists. These scientists are from industry, universities, government and research institutes. The Guide for Asbestos was prepared before 1962, and therefore, is a sound standard and state-of-art for the period from 1940 and before/until 1960.

An article by Harold Scarlett, a known legible reporter, is attached as item #6 for your information and files. It is a good example of how broad the asbestos health hazard is.

Yours very truly,

JAMES W. HAMMOND, SR.

FOREWORD

Because it is the duty of industry to protect its employees and because no comprehensive survey of the hazards incident to occupational dust problems had yet been made, it was felt that here was an opportunity to render a serivce to the petroleum industry and its employees by making such a survey.

It is hoped that the information presented in this bulletin will assist in finding proper answers to some of the many questions which have recently arisen concerning the health hazards of employees whose work involves exposure to dusts of various origin.

An attempt has been made to consolidate opinions from the most experienced students of occupational-dust problems to show the relative hazards of dusts and the duration of exposure which may prove harmful to the worker.

Furthermore, a study of the prevalence of dust particles occurring in various operations in the petroleum industry has been made and included in this report; also a description of the protective devices and equipment provided for the protection of the workmen.

This report should serve as a guide to operating executives and safety engineers in handling personnel and in providing adequate protection in dusty occupations. It should also resolve many of the fears and questions of industrial workers in these occupations.

The study confirms an opinion that dusty occupations, thoroughly understood and intelligently handled should result in no serious disability.

Willard J. Denno

Willard J. Denno, M.D.
General Medical Director
Standard Oil Company (N.J.)

ITEM # 1

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III - INSULATING OPERATIONS

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Insulation plays an important part in the processing of petroleum products. The two types of insulating material most frequently used are "Sponge Felt" (asbestos with ground sponge to give dead air space and thus increase the effectiveness of the insulation) and a mixture of 85% magnesia and 15% asbestos. Rock wool is used to a considerably lesser degree. In the ordinary commercial form, Rock Wool, as used at our refineries, does not present a dust hazard. It is also used for house insulation, and is available in small nodule form which can be blown into place. "85% magnesia" is a mixture of magnesia and granulated asbestos and pressed into blocks of various sizes and shapes (usually 16" x 18" x 1-1/2"). The most dust comes from dismantling old insulation and grinding scrap material for use as a plaster or "ganister". The average service of men engaged in insulating operations is about fifteen years. Most of these men have been transferred from the Common Labor Department. They work nine out of fourteen eight-hour shifts, in gangs of from two to six men, and are actually exposed to dust for less than sixty per cent. of their working time. Goggles are sometimes provided, and occasionally MSA "Comfo" Respirators, but this equipment is not used as much as it should be. Generally speaking, about 85% of their work is with sponge felt and 15% with 85% magnesia insulation. At one of the larger southern refineries about 300,000 square feet of sponge felt and 50,000 square feet of 85% magnesia are handled a year.

A - <u>What Physiological Reactions are Provoked by Insulating Materials?</u> According to Dr. Leroy U. Gardner (Journ. Indust. Hyg. Mar. 1937, Vol. 19, No. 3, P. 121) asbestos dust with its fibrous particles does not seem to be readily handled by the protective mechanism of the lungs. Quoting from his article:

> "They are not removed to the lymphoid tissue but remain in contact with the delicate walls of the air spaces. They become surrounded by an iron-containing coating that fractures and gives rise to the peculiar structures known as 'asbestosis bodies'. The fibers are irritating, perhaps because of their form, and they excite a fibrosis which begins about the terminal bronchioles and spreads to form diffuse patches in the parenchyma. Often the distribution is sub-pleural. In the presence of infection, the reaction to asbestos dust is much more severe than that caused by the dust alone."

There is nothing in the pertinent literature, nor does the Bureau of Mines know of any evidence, which would demonstrate magnesite (a natural magnesium carbonate) to be harmful. It would fall in the class of "nuisance dusts" such as gypsum. While many of the so-called "nuisance dusts" have never been found to be harmful, it is the opinion of most investigators in the field of industrial hygiene that no worker should be exposed to any dust in a concentration exceeding 75 or 100 millions of particles per cubic foot of air.

B - <u>What are the Principal Insulating Operations and How Much Dust is Produced During Such Operations?</u> There is, of course, a wide variation in the amount of insulation work and the amount of dust produced. A few examples, however, will give a good general idea:

INSULATING 12" STEAM LINES: 6" x 18" x 1-1/2" blocks of 85% magnesia are tied on the steam line with 14-gauge galvanized wire and covered with roofing paper to make it waterproof. Often times this work is performed on scaffolds twelve to fifteen feet above the ground. with men lying on their backs under the line part of the time.

Considerable dust (as high as 18,124,800 particles of less than ten microns per cubic foot) results from tapping the blocks into place. Samples taken during the entire operation had an average concentration of 6,881,760 particles per cubic foot. About 90% of these dust particles were slightly angular, crystalline in appearance and above five microns or less in size (as seen under the Konimeter Microscope); 5% were rounded opaque, ten microns or more in size; and 5% were opaque scale-like, five microns or more in size. Samples taken while applying asbestos sponge felt to a 12" steam line had a dust concentration as high as 23,788,800 particles of ten microns or less in size per cubic foot. The average was 12,574,080 particles per cubic foot. These dust concentrations are considered too high for working without adequate protection.

INSULATING A 750-POUND CRACKING COIL ACCUMULATOR: 6" x 36" blocks of Johns-Manville "Fire Felt" are first applied and plastered with extra AA Rubberoid Asbestos Cement and waterproofed with Johns-Manville "Insulkote". The dustiness of handling these materials has been considerably reduced since the manufacturers began shipping the "Fire Felt" in cardboard cartons containing thirteen or twenty blocks, and the plaster in hundred-pound paper bags. Samples taken during this operation had an average dust concentration of 4,502,880 particles, ten microns or less in size per cubic foot. About 75% of these dust particles were slightly angular in appearance, five microns or less in size; 10% were scale-like; opaque; and 15% were rod-like and fibrous.

INSULATING TREATING PLANT ACID SUCTION LINE: Sections of "Sponge Felt Pipe Cover" are cut to fit pipe lengths with an ordinary carpenter's hand saw. This operation produces on an average 821,280 particles of dust, ten microns or less in size, per cubic foot. Under the Konimeter Microscope all of these particles are slightly angular, crystalline in appearance, and five microns or less in size. The blocks or sections of the pipe cover are held in place by wrapping #16 gauge galvanized wire about each one.

INSULATING CRACKING COIL HOT OIL LINES: All hot oil lines at cracking coils are insulated with 2" asbestos tubing (85% magnesia and 15% asbestos) held in place by fine copper wire. Sections of the tubing are cut to fit particular areas by means of an ordinary carpenter's hand saw. This produces 7,788,000 particles of dust, ten microns or less in size, per cubic foot. Under the microscope, 90% of these dust particles appeared to be rounded crystalline and about three microns or less in size. Each section of tubing is pounded into place with the open hand so that it fits snugly against the pipe, and then wired into position. The dust produced from both of these operations averages about 3,379,520 particles per cubic foot. Under the microscope, approximately 80% or 90% of the dust particles appear crystalline, more or less angular, and five microns or less in size; the remaining 10% or more are rounded in appearance, and over ten microns in size.

DISMANTLING OR REMOVING OLD INSULATION: As a general rule, the dismantling or removal of old insulation is a more dusty operation than the application of new insulation. The old insulation is chopped or cut with a hatchet or small hand-axe, and pried loose and pulled off with the hands. This produces dust concentrations as high as 5,890,560 particles, ten microns or less in size, per cubic foot. In dismantling an old cracking coil 4" tar line, the average dust concentration was 2,322,240 particles per cubic foot. In appearance these particles were clear crystalline, rather rounded, and five microns or less in size. No fibres were observed in any of the dust samples from dismantling operations. After a few weeks or months service, insulation on hot lines dries out and appears to disintegrate. This is probably due to the fact that such insulation is usually covered with a weather-proof material which prevents absorption of moisture from the air.

CRUSHING SCRAP ASBESTOS: Scrap asbestos insulation, usually the 85% magnesia typo, is crushed in a belt-driven Williams crusher to pass through a screen with one-inch holes or slots, and is then mixed with new asbestos to make insulating plaster. This operation, which is a very dusty one, is performed by two men, with an average service credit of about twelve years. Goggles and MSA. "Comfo" or Willson Dust Respirators are worn. Considerable dust is produced in breaking up the scrap insulation by hand prior to crushing (10,195,200 particles, ten microns or less, per cubic foot), and also when feeding the crusher which is done by shovelling the broken-up pieces into the hopper and poking them down with a short wooden stick (14,839,680 particles per cubic foot). Dust counts as high as 27,527,040 particles per cubic foot were found in samples taken from over the hopper. These dust concentrations are dangerously high. About 95% of these particles are sharply angular, crystalline in appearance and five microns or less in size; 5% are opaque scale-like, six microns or more in size. Crushing scrap asbestos is not a steady routine operation, the exposure varying from eight hours a month to about twelve hours a week.

CRUSHING OLD CORK INSULATION: This operation is performed approximately twice a year and takes about twenty or thirty minutes. The insulation is crushed on a belt-driven Williams crusher, by the same men who crush the scrap asbestos. This crushed cork is used for insulating lines in the cold settling plant. The average amount of dust produced is 20,016,178 particles, ten microns or less in size per cubic foot. About 80% of the particles are slightly angular, crystalline, in appearance, and five microns or less in size; 20% are round, semi-opaque, ten microns or more. There are also a large number of very small black or dark grey specks.

~~IV - GUNITING OPERATION~~

~~What is Gunite and How is it Applied? - Gunite is a mixture of approximately~~

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IV. - CRUSHING FIRE BRICK - Fire bricks are crushed in a belt-driven Williams or a Motor-driven Sturtevant Brick Crusher so that 80% will pass through a 3/8" or a 150-mesh screen - much of it is powdered during the crushing. This material is then mixed with fire clay, crushed asbestos and cement to make "Ganister" which is used in tube sheet linings, packings or as mortar in building fire boxes of furnaces. Samples taken during the crushing of fire brick had dust concentrations as high as 11,554,560 particles ten microns or less in size per cubic foot and a general average of 2,562,960 particles per cubic foot. Crushing new fire brick produces about six times as many dust particles (4,375,733 per cubic foot) as is produced when crushing old, used fire brick (736,320 particles per cubic foot). Under the konimeter microscope about 94% of the dust particles produced by crushing new fire brick appear angular crystalline, one micron or less in size; about 5% are opaque over ten microns and about 1% are dark opaque, scale-like about five microns in size. The dust particles from crushing old used fire brick are more rounded crystalline in appearance and are about five microns or less in size. An analysis of Alamo Fire-clay Brick, which is commonly used and was the new unused fire brick being crushed at the time our samples were taken, supplied by the manufacturers (Harbison-Walker Refractories Company) reports:

Silica....................	51.8	per	cent.
Alumina and Titania.......	45.4	"	"
Ferric Oxide..............	1.1	"	"
Lime......................	0.5	"	"
Magnesia..................	0.3	"	"
Alkalies..................	1.1	"	"

Fire brick is crushed by two men assigned from the Labor Department, the average service of these men is about 14 years. Two to three tons are crushed per day. The total length of exposure per month depends upon the demand for crushed fire brick and will vary from a general average of fifteen hours per man per month to as much as twelve hours a week. Goggles and M.S.A. Comfo dust respirators are worn.

V. - SHAPING FIRE BRICK ON EMERY WHEEL - Fire brick are ground to a specified shape and size on a 2" x 24" Carborundum (Grit 16, Grade 1, Bond 6C) Wheel which revolves 900 RPM. This wheel is almost completely enclosed by a hood which has a 4-inch duct to a 24-inch motor-driven fan operating at 1750 RPM., but this exhaust is evidently inadequate as samples taken while rounding off the edges of a fire clay furnace block had a dust concentration as high as 4,078,080 particles ten microns or less in size per cubic foot of air. The general average was 2,001,658 particles per cubic foot. All of these dust particles were slightly angular and slightly opaque in appearance under the microscope and five microns or less in size. One man wearing goggles and a M.S.A. Comfo respirator, with about 15 years service, spends an average of about two days a month shaping fire brick and blocks on this wheel.

VI. - DISMANTLING MASONRY - Dismantling Masonry structures such as old boiler and still settings is a very dusty operation but was not included in this dust study as there was no work of this type in progress at any of the plants at the time of our survey.

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MEASURES FOR REDUCTION OF THE DUST HAZARD

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1. To suppress dust at the point of origin in such operations as rock-drilling; handling, pulverizing, and milling rock and ore; grinding metal on grindstones; abrasive-wheel cutting of granite and sandstone.

2. To prevent the re-dispersion of dust that has settled on the floors, walls, and other surfaces such as in the granite industry and in foundries.

G. - DESIGN EQUIPMENT TO CONTROL DUST - When new machinery or other equipment is contemplated, the manufacturer can frequently be encouraged to include dust control features such as exhaust hoods as an integral part of the design and construction.

H. - PROVIDE EXHAUST SYSTEMS - In some operations, exhaust systems may be installed to remove dust at its point of origin. In many cases several small systems are preferable to a larger system. Any mechanical ventilation system should be designed to meet at least the minimum requirements of local State laws or industrial codes, or lacking such requirements, should be installed according to the best accepted practice.

> Dust Arresters - Provision of dust arresters will prevent hazardous dusts from being circulated into other parts of the plant or into the neighborhood. The location of dust arresters is very important, particularly if dry types of arresters are used. Provision should be made for removal of the collected dust without its escape into the area where the arrester is located.

I. - ESTABLISH MAINTENANCE AND GOOD HOUSEKEEPING PROCEDURE - Good housekeeping is unquestionably the cheapest single method of controlling dust. Maintenance goes with it hand in hand. The best equipment in the world will not control dust if superintendents, foremen, and workers are careless and disorderly in their work. Eight suggestions are advanced by the Conference Committee:

1. If dust-tight equipment is installed it should be inspected at regular and frequent intervals and all defects should be corrected as soon as they are detected.

2. Operations should be performed in a manner that will create the minimum amount of dust.

3. Use water under pressure where possible to clean building interiors.

4. If practicable, combine water with air for cleaning purposes. All cleaning should be done, if possible outside of working hours and men engaged in this operation should be provided with dust respirators.

5. Vacuum cleaning removes dust without dispersing it elsewhere.

6. Brushing is particularly adaptable for cleaning buildings of the older type of construction.

7. Low-pressure steam can sometimes be used to advantage.

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8. A responsible person should be assigned the task of supervising maintenance and housekeeping activities. Among other things he should make tests from time to time to make sure that the dust control program is achieving the desired results.

J. - PROVIDE RESPIRATORS - The Conference Committee was of the unaminous opinion that "dust elimination must be given primary consideration in solving the silicosis problem". Nevertheless, when known methods of elimination are not applicable or are ineffective, respirators should be provided as "a last resort and for occasional exposure only. Rotation of personnel under these conditions is advisable." The report definitely states that there will always be places where other methods will be inapplicable and ineffective, and respirators will be required for doing the work, also that there will be situations where respirators will be the primary means of protecting the workmen. The scope of good use of respirators is considerably beyond that of occasional exposure. The need of rotating personnel depends on the type of work done and the supervision given the workmen. In some operatins, respirators are as much a part of the workman's equipment as his tools. Certainly, it cannot be expected that a person can wear a respirator for several hours continuously - but how many jobs are there that would require a person to keep the respirator on continuously for an extended period of time. The common practice in the majority of industrial occupations is that the person is intermittently exposed and is afforded many opportunities for the periodic removal of the respiratory protective device. The two general types of respirators which the Committee considered suitable for protection against silica dust are:

(a) Air-purifying respirators that filter out the dust particles.

(b) Supplied-air respirators in which dust-free air breathed by the worker comes to him from an uncontaminated outside source.

Most respirator manufacturers have submitted their devices for testing and approval by the U.S. Bureau of Mines, and only those which have been approved should be used.

(a) Air-Purifying Types of Respirators - Of the air-purifying class, the type most commonly used is the mechanical filter respirator for mechanically-generated dust. These respirators give no protection from gases and vapors. They generally consist of half facepieces to which are attached an exhaust valve and a filtering medium that removes the dust from the inhaled air; some are equipped with a filter medium that removes paint mists and some fumes. They are light in weight and inexpensive. Filter pads must be changed at certain intervals, depending on the concentration of dust. Some types restrict the field of vision. The general requirements of a safe and suitable Mechanical filter respirator are (1) adequate protection, (2) reasonable comfort and convenience, (3) an acceptable service life period of protection, (4) easy cleaning and sterilization, and (5) low cost of maintenance in good serviceable condition.

Studies of mechanical filtration by fibrous materials made by such agencies as the United States Bureau of Mines (U.S.Bur.of Mines, Tech.Paper No.394 (1926) and U.S.Pub.Health Bull.No.177 (1928)) and the Harvard School of Public Health (Journ. Indust.Hyg.9,26 (1927)) revealed that filtering efficiency varies with the particle size and the amount of solid particulate matter retained; also that the resistance to air flow varies with the amount of solid particulate matter retained and the rate of air flow. After all, the fundamental basis for judging the suitability of a respirator is whether or not the amount of dust that is unretained or escapes through the filter under conditions of practical use is below the amount that would be harmful to breathe. This is not related to any percentage efficiency. In order to meet the Bureau of Mines requirements for approval, a respirator must satisfactorily remove

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dusts of the following size characteristics:

99	per	cent	smaller	than	2.80	microns
95	"	"	"	"	1.80	"
90	"	"	"	"	1.40	"
80	"	"	"	"	1.00	"
70	"	"	"	"	0.85	"
60	"	"	"	"	0.72	"
50	"	"	"	"	0.60	"

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It will be noted that 80 per cent of the dust used in these approval tests is below one micron (1/25,000th of an inch) and 50 per cent is below 0.6 microns. Canisters will not remove dusts of these characteristics and should not be used as dust respirators.

In order to obtain the desired protection, it is essential that the facepieces of the mechanical-filter respirators fit the face of the workman snugly but with a minimum of head-band tension. A simple practical test, suggested by Carlton E. Brown of the U.S. Bureau of Mines Experiment Station in Pittsburgh, Pennsylvania (Jour. Indust. Hyg. Feb. 1937 Vol. 19, No. 2, p. 98), that anyone can run to determine whether a respirator facepiece is making a tight seal, is to wear it in a high concentration of coal dust. The time of the test can be shortened by blowing a stream of air containing a high concentration of coal dust around the edges of the facepiece. The location and approximate magnitude of the leaks are shown by streaks of coal dust on the part of the face covered by the facepiece. Another test, according to Mr. Brown, consists of plugging the intakes of the respirator and then attempting to inhale. This type of test could well be supplemented by the Coal dust test.

(b) Supplied Air Respirators - Industrial processes such as pneumatic drilling, abrasive blasting and spray coating have introduced atmospheric conditions for which the air-purifying type of respirators are not particularly suitable. Certain kinds of pneumatic drilling are responsible for dust concentrations so high that they would rapidly overload a dust respirator. The operator of an abrasive blasting outfit must be protected not only against the inhalation of air containing high concentrations of dust, but also against impact and abrasion of the head and shoulder by the rebounding abrasive and loosened abraded material. Spray coating is responsible frequently for pollution of the surrounding atmosphere by a combination of particulate matter (mists that are liquid particles or a combination of solid and liquid particles) and harmful vapors resulting from the evaporation of the liquid vehicle of the coating used in the spray gun.

Since these operations are carried out frequently in isolated places and at different locations at various times, they do not lend themselves always to general control measures. Therefore, supplied air respirators perform a definite service. The types in general use are those commonly known as hose masks, air-line respirators, and abrasive blasting respirators such as sand blast masks, helmets, and hoods.

Supplied-air respirators have the following advantages for routine non-emergency use over those of the air-purifying respirators such as gas masks, mechanical-filter respirators and the combination of gas mask with a mechanical filter:

1. NO resistance to inhalation.

2. Freedom from inward leakage of contaminated air.

3. Protection against all kinds of contaminants and even against atmospheres deficient in oxygen which will not poison or irritate the skin.

4. The Inflowing air reduces excessive perspiration and tends to cool the face.

5. When a hand-operated blower is used a second person is always present. (With an approved mask, provided the facepiece is tight, the wearer can inhale enough air through the hose to escape if the blower should stop).

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<u>The Air-Line Respirator</u> consists of a tight-fitting facepiece, a loosely fitting facepiece or even a helmet or hood covering the head and extending down over the neck or shoulders. The air supplied to these respirators has been largely that obtained from the compressed air source used in the performance of the work, as in sand blasting, pneumatic drilling and spray painting. This air is frequently contaminated with objectionable and, in some instances, harmful substances which, to some extent, can be removed by means of air-purifying appurtenances. In discussing "Respiratory Protective Devices" in the February (1937) issue of the Journal of Industrial Hygiene and Toxicology, Mr. C. E. Brown of the United States Bureau of Mines wrote:

"Using air from the ordinary compressed air system found in industry to supply respirators is not to be indiscriminately recommended. These compressed air systems are usually of the high pressure, internally lubricated, reciprocating-compressor type. The air supplied by these systems is contaminated frequently with malodorous constituents such as vapors, mists and products of decomposition of the compressor lubricant, slugs of water, and rust from the pipe line. All or most of these contaminants can be removed probably by some of the commercial air purifiers sold for this purpose. A pressure-reducing mechanism should be used also in the line to prevent any possibility of sudden accidental blasts of high-pressure air from injuring the lungs of the wearer of the respirator. With a compressor of this type there is always the possibility, however rare it may be in well-kept systems, of the generation of carbon monoxide due to overheating of the compressor lubricant (Jour. Indust. Hyg. 18,461 (1936)). This danger can be minimized or eliminated by the use of temperature controls or carbon monoxide alarms on the compressor which, of course, should be so maintained as to prevent the generation of carbon monoxide.

"The trend in supplied-air respirators is to use special low-pressure, externally lubricated, positive-pressure air-supply devices. Most of the objections to the high-pressure reciprocating-type compressor do not apply to an air-supply of this kind. Since these devices are not common in industry, however, it is usually necessary to purchase a special one for use with the respirator. Since air purifiers, pressure-reducing mechanisms, and special compressor-control or alarm mechanisms are not necessary, the price of this respirator complete with air-supply device should not exceed that of the other type of respirator without the air supply system.

"The use of a special air-conditioning unit to regulate the temperature and humidity of the air supplied to the respirator wearer is desirable."

The minimum air supply for a respirator designed to use all the air for respiratory needs at a high degree of efficiency is generally agreed among Industrial Hygienists to be at least four to six times the air breathed per minute. As a general class, respirators with loose-fitting facepieces, hoods, or helmets require more air than those with tight fitting facepieces.

There is some difference of opinion among users of respirators as to whether or not adjustments should be provided whereby the wearer can vary the flow of air to meet variations in his requirements. It was the opinion of the National Silicosis Conference Committee that definite recommendations for all situations cannot be made, but for many situations, and particularly where tight-fitting facepieces are used, an adjustable flow is desirable and may even be necessary; also, most workmen can learn to adjust the air properly. On the other hand fixed-flow procedures require a minimum amount of instruction and supervision and are the most conducive to safety under all conditions.

While Hose Masks and Air-Line Respirators have many definite advantages the area of travel of the wearer is limited to the length of the hose, and movements are handicapped to some extent by the hose. Manifestly, the air for the hose and the mask should be fresh and pure, but unfortunately this is not always so.

Abrasive Blasting Respirator - Abrasive blasting respirators consist essentially of a hood, with windows, that fits loosely over the head and shoulders and designed to withstand and protect the wearer's head, neck and shoulders from abrasion by the rebounding of particles of sand or grit; and a supply of fresh air, at least six cubic feet per minute, blown into the hood. Only equipment which has met the United States Bureau of Mines test requirements and which is approved by the Medical and Safety Departments should be used.

(c) Acceptance and Use of Personal Respiratory Protection by Workmen - As stated in a paper by G. M. Kintz and H. C. Fowler of the United States Bureau of Mines (I.C.6915 No.v1936) presented at the International Petroleum Exposition and Congress, Tulsa, Oklahoma, May 21 1936, selecting respiratory protective equipment is simple compared with getting men to wear it after it is supplied. Generally workmen will wear masks readily in places where they have seen others asphyxiated, or in some similar trouble, but they are likely to resist wearing protective equipment where the dust cannot be seen or where the fumes and mist have no objectionable odor. There are three main reasons for such resistance:

First, inbred objection to any new idea;

Second, the feeling that the individual is a superman and can "take it" without protection; and,

Third, the inconvenience of wearing the equipment.

In a survey conducted among the employees of the Colgate-Palmolive-Peet Company by Mr. F. H. Wallner of that Company's Insurance Department, it was found that the men didn't like the disfiguring appearance of a "muzzle" over their faces. This survey also disclosed that some workers objected to the respirator because they thought it made breathing difficult when the real trouble was that they were not breathing correctly. Breathing through a respirator should be done deeply and slowly and after the proper habit has been acquired much discomfort may be eliminated. Quoting Mr. Wallner:

"Foremen should appreciate that the position of the straps that hold the respirator in place has much to do with comfort. They should learn whether the straps should be worn over the head or around the neck. Some types have two straps, one to be worn around the neck, the other around the head."

Probably the most effective plan in getting respirators worn is first to "sell" the supervising personnel who in turn should "sell" the worker by education, possibly accompanied by strict and fair supervision and discipline. Employees exposed to dust hazards requiring the wearing of respirators should be convinced that it is essential to sacrifice some comfort and dignity to avoid serious cases of disability and suffering. Every worker should have his own respirator. It requires time and effort to adjust this protective device so it contacts the face snugly with a minimum of head-band tension. It cannot be expected that the average workman will readjust a different respirator each day. Also, the psychological effect of using a respirator worn previously by another workman is not unimportant. Although he may not say anything about it, it is naturally revolting to most men's principles of bodily sanitation to have to clamp over his face a device that has been soaked with sweat and dirt of another man's face and into which one or more men have breathed day after day! It is too much like using the other fellow's tooth brush. The best practice is to mark every respirator so each workman can identify his own.

(d) Use, Maintenance and Care of Respirators - Personal respiratory protective devices must be maintained in a condition substantially the same as when received from the manufacturer. Depending on the density of the dust replaceable filters should be changed frequently to prevent their becoming clogged and usually it is desirable to use a respirator without a facelet. However, if they are considered necessary, the facelets should be changed often to avoid skin irritation. A clean facelt gives the respirator a clean appearance and removes one objection to wearing it.

The Colgate-Palmolive-Peet Company found that the habit of some workers of removing their respirators at intervals caused skin irritation. Everytime they did this, dust settled on the surfaces that lay next to the worker's face and irritating particles were transferred to the skin when the device was replaced. It is, therefore, best to have the employee wear his respirator constantly while under exposure. In some cases, ointments or petroleum jelly has helped to overcome the irritating effect of points that contact the skin.

Where a considerable number of respirators are used, it is good practice to have a "Respirator Room" with an attendant who issues the respirators and cleans, sterilizes and otherwise keeps them in good condition. Respirators may be cleansed by washing and brushing them with an antiseptic soap and warm water. They should be checked for damaged or improperly functioning parts such as rubber valve seats and head-bands. If defective, these should be replaced by new parts.

WHAT MEDICAL CONTROL SHOULD BE EXERCISED IN THE SELECTION AND SUPERVISION OF MEN WORKING ON DUSTY JOBS? - It is essential that adequate medical control be exercised. Such control should include the examination, prior to initial working on dusty jobs of the worker to insure that he is a suitable physical subject. This examination should preferably include X-ray examination of the lungs which permits closer control with subsequent X-ray tests as well as being a protection to the employer in the event of any later legal action.

A worker, to be classed as physically suitable, should be in addition, determined to be a nose-breather rather than a mouth-breather and the natural filtering capacity of the hose should be found to be satisfactory. G. Lehmann (J. Ind. Hyg. 17,37 - 1935) indicates that the "Silicotic susceptibility of workers with poor nasal filtration is much greater than that of men with good nasal filters". He advises that jobs with a silicosis hazard be held only by men with good nasal filters" and that mouth breathers are an especially bad risk. He suggests that the "dust retaining capacity of the nose be used as an index of the individual's qualification for working in a silicosis producing atmosphere". It is possible that Sternstein's technique for measuring nasal resistance ("Industrial Dusts - p.65) could be developed into a simple procedure for selecting men best adapted to dust exposure.

According to Drinker and Hatch ("Industrial Dust" p.32) it is wise to select for dusty jobs men who are past the age of 40 and not young men just taking up a trade.

All workers engaged in harmful dusty operations should be periodically thoroughly re-examined, including X-ray tests. Particular emphasis should be placed on any indication of shortness of breath and chest pains

Regulations should be enforced concerning the time limitation of work of any employees involved in a dust producing operation. Such Company regulations concerning sandblasting calling for a fixed six-month maximum period on such work, after which a minimum six-month period away from dust producing work should be followed more closely.

For protection from a legal angle, the worker should be given a final thorough examination including X-ray before being permanently transferred to some other type of work, laid off or discharged.

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CONCLUSION

There is still a tremendous amount to be learned about pneumoconiosis and dust-producing operations. One thing, however, is certain -there is a very definite tendency to require compensation for industrial or occupational diseases. If these compensation costs are to be kept to a minimum and the health and safety of workman are to be promoted it will be necessary to make further studies and to promptly adopt adequate precautionary measures. Many of these are now in effect, the others should be put in force as soon as possible. After years of study and direct contact with the Dust Problem, Mr. Dan Harrington, Chief, Health and Safety Branch, United States Bureau of Mines, has come to this conclusion (Eng. & Min. Jour. March 1937 pps. 119-21) with which we are heartily in accord

> "In the maze of uncertainties connected with almost all phases of the causation and diagnosis of dust disease, about the only really well-determined fact available is that breathing large quantities of dust (or possibly of certain dust) over extended periods is likely under some conditions to be harmful to health and that subsequent alleviation or cure is difficult or impossible. Therefore, it would seem to be logical to try to prevent dust formation thus preventing it from harming workers through respiration or otherwise. Here is a real job for the engineer, and little or no help can be expected in these vital functions from any agency except the engineers and operating officials.
>
> "The most harmful of the ordinary dusts to breath is probably silica dust, but, on the other hand, not even free silica, supposedly the most detrimental of the silica dusts, is harmful unless it is breathed, in considerable quantities and over extended periods. No human being ever lived any considerable time on this earth of ours without breathing silica dust (free silica dust), yet by no means all of the people of the world have or have had silicosis. In other words, the <u>quantity</u> of dust taken into the respiratory organs is a controlling factor in dust respiratory harmfulness.
>
> "One common-sense answer is that any atmosphere in which dust is visible to the naked eye is certainly too dusty to be breathed with safety by human beings, and the wise, farsighted, human employer will immediately start to decrease the dust content in any atmosphere where dust is visible. After he has eliminated visible dust, there may

still remain enough very small invisible dust to cause harm to the health of those who breath it, but in any event if he has exerted sufficient well-directed effort to remove the visible dust it is certain that much of the smaller invisible, and probably most harmful dust has also been removed.

"Manifestly, if dust is kept out of the air breathed by workers, the latter cannot succumb to dust disease of a respiratory character."

In closing, we acknowledge with gratitude the support and cooperation of Dr. W. J. Denno, General Medical Director, Standard Oil Company (New Jersey) whc vision and active interest in Medico-Safety problems made this Dust Study possit We also appreciate the advice and assistance rendered by:

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National Institute of Health, Washington, D.C.

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United States Bureau of Mines, Washington, D.C.

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R S Bonsib

New York, N.Y.
July Fifteenth
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R. S. Bonsib
Chief Safety Inspector
Standard Oil Co. (N.J.)

ITEM # 3

1. The value for Mica dust shall be 20 M.P.P.C.F.
2. The value for Radium 226 in air shall be 8 $\times 10^{-4}$ micro curies per cubic meter.
3. The value for Polonium 210 in air shall be 1×10^{6} micro curies per cubic meter.

Committee members:

W. G. Fredrick, *Chairman*
K. E. Charron
K. E. Markuson
Arthur Vorwald

1952

changes from 1951

The following new threshold limit values are recommended for addition to the 1951 list (NV).

Cresol	5 ppm
Di-ethyl amine	25 ppm
Ethyl amine	25 ppm
Methylal	1000
Phenol	

Deletions

Radon (curies per cubic meter)	10^{-4}
Thoron (curies per cubic meter)	10^{-4}
Radium 226 (microcuries per cubic meter)	10^{-6}
Polonium 210 (microcuries per cubic meter)	10^{-6}

Committee members:

Allan L. Coleman, *Chairman*
D. H. Byers
L. T. Fairhall
Kingsley Kay
Arthur J. Vorwald
L. F. Weller

1953

changes from 1952

The following is the first proposed preface for the MAC values.

"Values are given in the following tables for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an eight-hour working day without injury to health.

"These values are based on the best available information from industrial experience, from experimental studies and, when possible, from the combination of both. They are not fixed values, but are reviewed annually by the Committee on Threshold Limits for changes, revisions or additions as further information becomes available. Threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent conditions only within which it is felt that workers may be repeatedly exposed, day after day, without adversely affecting their health. It is felt, at the present time, that workers should not be exposed to a working environment containing any of these substances in excess of the value indicated."

New Values

1,2-Dibromoethane (ethylene dibromide) — 25 ppm
Fluorine (gas) — 0.1 ppm 1,1,1-Trichloroethane (methyl chloroform) — 500 ppm
O,O-Diethyl-O-p-nitrophenyl thiophosphate (parathion) — 0.1 ppm
Uranium (soluble compounds) — 0.05 mg/m^3
Uranium (insoluble compounds) — 0.25 mg/m^3

Revised Values

Acetone — 1000 ppm
Carbon tetrachloride — 25 ppm
1,2-Dichloroethane (ethylene dichloride) — 100 ppm
Tetrachloroethylene — 200 ppm
Trichloroethylene — 200 ppm

Committee members:

Allan L. Coleman, *Chairman*
William L. Ball
L. T. Fairhall
Kingsley Kay
H. E. Stokinger
A. J. Vorwald
Louis F. Weller

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ITEM # 4

ASBESTOS

CAS: 1332-21-4

TLV-TWA, Appendix A1a — Recogniz... Human Carcinogen

Amosite

CAS: 12172-73-5

TLV-TWA, 0.5 fiber/cc*

Chrysotile

CAS: 12001-29-5

TLV-TWA, 2 fibers/cc*

Crocidolite

CAS: 12001-28-4

TLV-TWA, 0.2 fiber/cc*

Other forms

TLV-TWA, 2 fibers/cc*

According to recent mineralogical definitions,[1] asbestos is:

"1) A collective mineralogical term encompassing the asbestiform varieties of various minerals; 2) An industrial product obtained by mining and processing primarily asbestiform minerals."

For the purpose of considering a recommendation for a threshold value of asbestos dust in the workplace, only the second definition above is applicable. Although there are four types of natural mineral fibers that have been in industrial use, only three have been used in the United States: chrysotile, amosite, and crocidolite. The fourth, anthophyllite, is mined and used in Finland. Of the three types of asbestos that have been used in North America, Canadian chrysotile has formed 95% of all natural mineral fibers used, with amosite and crocidolite (both imported from South Africa) constituting the other 5%. It should be noted that chrysotile is classified as a serpentine mineral, whereas the other three types of asbestos are amphiboles.

It is now generally recognized that excessive inhalation of asbestos dust causes chronic inflammations of lung tissue and pleural membranes as well as cancers. Whereas identification of asbestos dust as a cause of fibrosing inflammation of lung tissue occurred as early as 1907,[2] it was not until 1930 that a more definitive study by Merewether and Price[3] resulted in the regulations which greatly improved hygienic conditions in abestos factories in the United Kingdom. The development of lung cancer in asbestos workers, first reported by Wood and Gloyne[4] in the U.K. in 1934 and by Lynch and Smith[5] in the U.S. in 1935, was not firmly established until 1955 by the publication of Doll[6] of a study of workers in an English asbestos textile factory, and in the United States by the paper of Selikoff et al[7] in 1964 concerned with cancers in insulation workers. In 1960 the relationship between the inhalation of asbestos dust and mesothelioma was demonstrated by Wagner et al.[8]

Asbestosis is a diffuse but nonuniform fibrosis of the lungs that is generally most severe in the basilar portions. As a result of the fibrosis some of the airspaces (alveoli) are not perfused with blood and alveoli that are perfused with blood may not be adequately ventilated because of stiff, thickened alveolar walls. The fibrosis makes the lungs less compliant, thereby increasing the energy requirement of breathing. There is increasing impairment in diffusion of gases leading to increasing breathlessness.

It is not uncommon to find thickening of the visceral pleura, sometimes very severe, by extension of the parenchymal inflammation. This causes an additional increase in the effort of breathing.

The parietal pleura may show patches of severe thickening, particularly over the diaphragm and the lower portions of the chest wall — resulting in the so-called pleural hyaline plaques. These may become visible in X-ray films of the chest — particularly, if they become impregnated with calcium salts. Such pleural plaques may develop from asbestos exposure in the absence of asbestosis. They cause no symptoms.

A study of the members of an asbestos insulators union published in 1964 revealed that deaths from lung cancer in this population was much greater than expected.[7] A later investigation published in 1973 by Hammond and Selikoff of a much larger number of these workers (17,800) showed that nearly all cancers occurred in cigarette smokers.[9] The conclusion of these authors was as follows:

> *"It seems clear, then, that lung cancer is uncommon among asbestos insulation workers who have no history of cigarette smoking, and that if the risk is increased such an increase is not great."*

The total lung cancer rate in this cohort of workers was 4.8 times the expected. The asbestos insulators who had a history of cigarette smoking had a lung cancer rate 5.4 times the expected rate; but compared to the lung cancer rate of the nonsmoking workers, the smoking insulators' lung cancer rate was 14 times greater.

All types of asbestos are known to cause the inflammatory changes in the lungs and pleurae described above and lung cancer. However, there is experimental and epidemiologic evidence that there may be differences in the potential of the different asbestos types to produce disease. Thus, it has been suggested that crocidolite has the greatest potential to produce disease; chrysotile, the smallest; with amosite occupying an intermediate position.[10] In a study of 1348 retirees from the asbestos industry by Enterline and Henderson,[11] the respiratory cancer rate of men exposed only to chrysotile was 2.4 times the expected, whereas this rate was 5.3 times the expected for men who had been exposed to a combination of chrysotile and crocidolite. In the asbestos cement industry a similar difference was observed. Workers exposed only to chrysotile and cement (shingles and sheets) had a respiratory cancer rate of 1.4 times the expected, whereas workers exposed to both, chrysotile and crocidolite and cement (asbestos cement pipes), had a respiratory cancer rate 6.1 times the expected.

Mesotheliomas are rare, usually rapidly fatal cancers that originate from the surface lining the chest or abdominal cavity. From 1960 through 1975, 4539 mesotheliomas have been reported worldwide.[12] The vast majority of these cancers were in people exposed to crocidolite alone or in combination with other types of asbestos. McDonald and McDonald[12] tabulated those reports of mesothelioma where the type of asbestos exposure was known. Although the number of such cases is small, where the exposure was to crocidolite alone or in combination with other types of asbestos, death from mesothelioma constituted 6.1% of the deaths from all causes, with a range of 2.42% to 16.07%. In contrast, deaths from mesothelioma in workers exposed only to chrysotile constituted only 0.3% of the deaths from all causes, with a range of 0.24% to 0.87%. An even greater contrast is found in the Finnish statistics of workers exposed to anthophyllite. Meurman et al[13] investigated 216 deaths that occurred among approximately 900 miners and millers of anthophyllite during the 32-year period 1936-1967 and found not one case of mesothelioma.

*Fibers longer than 5 μm and with an aspect ratio equal to or greater than 3:1 as determined by the membrane filter method at 400-450X magnification (4-mm objective) phase contrast illumination

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The Work Environment of Insulating Workers

J. LeROY BALZER and W. CLARK COOPER, M.D.

Division of Environmental Health Sciences, School of Public Health, University of California, Berkeley, California 94726

With the cooperation of the asbestos workers' union and insulating contractors, a study is being made of the environmental exposures and the health of insulating workers in the western United States. Surveys have been made in a number of work situations, including small commercial building, major industrial construction and marine operations. Major emphasis has been on exposures to asbestos-containing materials, fiber glass, cork, plastics, and adhesives. Trends in product usage are presented, as well as illustrative dust counts, based on membrane filter and impinger samples, for various components of the insulator's job, e.g., prefabrication, application, finishing, mixing and tearing out of old insulation.

Introduction

WORKERS IN THE insulating trade make up an occupational group known to have exposures to asbestos that are varied and difficult to control. In recent years, investigators have shown that the relationship between asbestos minerals and human disease extends beyond a disabling pneumoconiosis produced in some workers. Evidence has accumulated that asbestos workers have a higher incidence than average of malignancies of the lungs, pleura, and peritoneum.

Asbestosis in insulating workers has been reported in England by Ellman[1] in 1934 and by Leathart and Sanderson[2] in 1963; in the United States by Fleischer *et al.*[3] in 1946, Pendergrass[4] in 1958, Marr[5] in 1958, and by Selikoff *et al.*[6] in 1964; in Sweden by Ahlmark *et al.*[7] in 1960; and in Finland by Ahlman[8] in 1966. Selikoff[6] reported lung cancer deaths in insulating workers in New York-New Jersey to be over six times expected; Dunn and Weir[9] in 1965 reported a higher than expected incidence of lung cancer in California; and Keane and Zavon[10] in 1966 in their descriptive report of the insulating trade in Cincinnati also described an excess of lung cancer.

Because asbestos may be a widespread environmental contaminant and the established threshold limit may need re-examination, there is need for a thorough appraisal of the work environment of the insulating worker. We are now in the process of doing a study of San Francisco area insulating workers in order to determine the incidence of pneumoconiosis and malignancies and make observations and measurements on the work environment. This report summarizes our preliminary environmental findings on the materials used, methods of application, and dust and fiber concentrations.

Background Information on Union Membership

This study was made possible by the wholehearted cooperation of the International Association of Heat and Frost Insulators and Asbestos Workers (both from their national headquarters and from the officers of their various locals), and by insulating contractors, individually and through the Western Asso-

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TABLE V

Dust Concentrations Based on Impinger Samples by Job Classification

Job Classification	Number of Samples	mppcf Mean	Median	Range
Prefabrication	15	6.5	4.8	0.8–28.8
Application	17	3.5	2.5	0.8–8.2
Finishing	9	2.6	2.4	1.2–6.2
Tearing out	8	5.2	5.1	2.5–8.6
Mixing	6	9.1	8.4	2.8–16.0
General	9	1.4	1.4	0.6–1.8

TABLE VI

Fiber Concentration Based on Membrane Filter Samples by Job Classification

Job Classification	Number of Samples	Fibers/cc Mean	Median	R
Prefabrication	22	8.5	8.4	0.1
Application	45	6.4	1.4	0.1
Finishing	31	2.7	0.8	0.1
Tearing out	17	8.9	4.9	0.2
Mixing	22	2.6	1.4	0.2
General	16	4.8	0.8	0.1

States industries where asbestos exposures occur, chrysotile asbestos has not yet supplanted the use of amosite asbestos in the manufacturing of insulation materials. Amosite exposures are the most significant in the insulating trade.

The breathing-zone dust levels found in the dustiest operations observed were not as high as the incidence of pneumoconiosis may have led us to expect. Some sample areas exceeded the present threshold limit value (TLV) recommended by the ACGIH; however, these samples were not for extended periods of time. Although we attempted to sample the dustiest operations, the time-weighted averages for dust samples containing asbestos would probably not exceed the TLV in most situations, even on ships. This conforms to findings by Fleischer *et al.*,[3] by Marr[5] and by Leathart and Sanderson[2] and to recently reported findings by Ferris[14] who last year reported studies in the same shipyards earlier appraised by Fleischer.[3]

The present TLV for asbestos was recommended by Dreessen *et al.*[15] in 1938, after epidemiologic studies in textile mills using chrysotile asbestos. It was not intended for extrapolation to all forms of asbestos use under all circumstances of exposure. The proven occurrence of pneumoconiosis in insulating workers exposed intermittently as described in this paper and by the authors previously cited suggests that the TLV for asbestos is too high. Our studies are, however, not yet complete enough to warrant a final conclusion. We cannot eliminate the possibility that other components of the insulating materials may be synergistic. The incidence of pneumoconiosis in these workers, the need for better environmental control measures, and medical surveillance will be the subjects of more detailed later reports.

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