PLAINTIFF'S EXHIBIT
UC-1264

ORC Asbestos Standard: A Recommendation

INTRODUCTION:

During the last ten years, public concern over asbestos related diseases has grown significantly. As asbestos law suits range into the billions of dollars in total value, the claims and counter claims of the contending groups increasingly obscure the basic facts of the problem.

Asbestos is a problem, there is no known threshold for "safe" exposure to asbestos. There are convincing data and research that document the nature of the risk associated with exposure to asbestos. In recent years, the science associated with asbestos has improved to the point that researchers can have confidence that they are able to measure the level of airborne asbestos with reasonable accuracy. Epidemiological work with asbestos workers has improved in quality as well as quantity as our understanding of the disease process has grown. All of these improved efforts have made it possible to better conceptualize the process of asbestos related disease.

This new understanding has made it clear that the disease is related to massive exposures which took place some 30-40 or more years ago (present day occupational exposure to asbestos is many orders of magnitude less). Also, we now understand the relationship between the kinds of asbestos used and the risk of developing a related disease. This is, at least in part, because many of the occupational exposures which created the original problem no longer exist. Increasingly, asbestos is being eliminated from commerce, and new products and processes are permanently replacing asbestos. The impact of these changes must be factored into calculations aimed at producing a formula for estimating the risk of contracting asbestos related disease.

Organization Resources Counselors, Inc. recommends that the present OSHA standard of two fibers of airborne asbestos per cubic centimeter (cc) be revised downward to a level in accord with present knowledge of the risk associated with such exposure. At the same time, it must be emphasized that when lowering the Permissible Exposure Limit (PEL), OSHA should take into account the practical realities of such an action. In most instances of occupational exposure outside of the asbestos industry, contact with asbestos comes from removal and or demolition operations. Little asbestos is being used today in new products and in many of its present uses an active search is underway for substitutes. The number of workers directly exposed to asbestos in new manufacturing operations

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is in the vicinity of 35,000. Eliminating asbestos could, however, eliminate those 35.000 jobs and an undetermined number in other industries.

In setting a PEL, it must be recognized that risk of developing an asbestos related disease is related to more than simple exposure. The kind of asbestos, the route of exposure, the characterization of the fibers, the concentration, the dose and the use of respiratory protective equipment are among the considerations involved.

In the Recommended Standard which follows, ORC has selected 0.5 fibers/cc as a level that is protective of worker health in accord with current risk assessment. At the same time, ORC recommends that OSHA take strong action to eliminate those exposures that result in risks that are unjustifiable. One documented area is the risk attendant on the use of crocidolite asbestos. Research indicates that much of the mesothelioma resulting from exposure to asbestos seems to be attributable to crocidolite fibers. OSHA should give serious consideration to eliminating any uses of this variety of asbestos. Such a decision is practical because the amount of crocidolite used in the United States is small, substitutes are available, and the number of workers exposed is small.

Another area that needs to be given serious consideration is the nature of the fibers to which a worker is exposed. Chrysotile asbestos has been less frequently implicated with mesothelioma than the amphiboles (one of the two major classifications of asbestos minerals, the other being serpentine). However, there is a well documented risk of lung cancer attendant upon exposure to chrysotile asbestos. Much of the physiological reaction that results from the inhalation of asbestos fibers is related to the length and diameter of the fibers involved. Some processes, such as the dry manufacture of asbestos textiles have been shown to generate a high proportion of fibers whose dimensions match those implicated in the disease process. ORC recommends that serious consideration be given to eliminating the manufacture of asbestos textiles by the dry process. Wet manufacturing processes exist and are in use at the present time. Given the proven risk associated with the dry manufacturing of asbestos textiles, it would not be unreasonable to eliminate such processes.

ORC emphasizes, however, that there is much more to regulating exposure to asbestos than setting a PEL and eliminating some specific varieties and uses. One concept recommeded in the Final Report of the Advisory Committee on Asbestos, to the British Health and Safety Executive (often referred to the the "Simpson Report") is that of "Control Limits". The approach

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is to set reasonable limits, and require that, where possible, employers do better than the limit. The "Simpson Report" looked at:

> "An alternative approach ... to identify the concentration of asbestos dust in the workplace at which further expenditure of effort to lower that level is out of all proportion to the reductions thereby achieved in the risk of contracting asbestos-related diseases. If this approach is applied to the processes where reductions are not difficult, the selected level will by definition be achievable there, and all other parts of industry will be able to do better. They will, moreover, be expected to do better through the requirement set out in our interim statement and considered further below to reduce exposure to the lowest limit that is reasonably practicable. It is important to remember that with this approach the control limit represents the upper limit of permitted exposure, not a 'safe' level such that, once it is attained, no further improvement in dust control is necessary." (page 72, paragraph 163, Simpson Report)

In the pages that follow, ORC has attempted to outline what it believes is a reasonable, realistic and protective approach to the regulation of occupational exposure to asbestos fibers. In writing its Recommended Standard, ORC consulted extensively with many segments of the industrial community, including users and producers of asbestos. At the same time, however, it must be noted that the responsibility for this Recommended Standard for Asbestos is entirely that of Organization Resources Counselors, Inc.

In the preparation of this Recommendation, ORC has attempted to base its actions on good science. To the extent permitted, we have concentrated on the latest work and most credible sources available.

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Discussion of the ORC Recommended Revision of 1910.1001

Definitions of Asbestos

The definition of asbestos is not limited to a single well defined entity, but rather a variety of silicate minerals, forming fibers or fibrils with high tensile strength and often good flexibility. These minerals are widely distributed in nature in many kinds of mineral formations. Other minerals may also divide into thin fragments that may be confused with asbestos fibers under the phase contrast microscope. The unambiguous identification of asbestos has always presented problems, but when a mineral must be defined for the purposes of government regulations the necessity to be precise becomes an imperative.

Asbestos is understood by mineralogists as a collective term, which refers to the crystallization of some minerals in the form of long flexible fibers. These fibers are arranged in bundles lying parallel to each other and from which individual fibers can easily be separated.

This definition, however, was modified by a decision of the U.S. District Court for Minnesota during the Reserve Mining Co. case in 1974 (498 F.2d 1073 (1974)). In this case, Judge Miles Lord held that: "Asbestos is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils."[1]

With this definition, essentially all amphiboles and many other minerals became potential sources of asbestos fibers. Because of the perfect prismatic cleavage upon crushing, amphiboles always produce acicular fragments. Of course, acicular

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fragments are not fibers and are not flexible, but they may not be easily distinguishable from true asbestos fibers under examination by phase contrast microscope.[2]

In order to get around this problem, most public health scientists went to a definition of a fiber as being three times as long as wide. This definition, however, only made things worse, for now "all acicular amphibole cleavage fragments became fibers and as indirectly implied, all amphibole minerals became asbestos."[3] Many mineralogists complained that to include all amphiboles as asbestos was wrong, so the Court in the Reserve Mining case saw the introduction of the terms "asbestiform" and "asbestos like". Thus "Asbestiform became a prefix added to the name of any mineral which is known to occur as 'asbestos' on occasion and/or produce 'fibers' when crushed."[4] Asbestos-like was defined as any hydrous silicate particle which is at least three times longer than wide, that is, which is a "fiber".[4] The use of these definitions for asbestos magnified the potential sources of asbestos in the environment, and meant that every state in the union had a potential problem.[4]

Many mineralogists objected to the use of these terms as being ambigious, misleading, and imprecise. Terms used for regulatory purposes must be capable of precise use.[5]

(b)(1) "Asbestos"

ORC in its definition of asbestos has restricted consideration to those six minerals that are exploited commercially, and that occur in concentrated deposits. These are confined to the serpentine and amphibole mineral groups. These six asbestos minerals are: Chrysotile ("serpentine"), Grunerite ("amosite"), Riebeckite ("crocidolite"), anthophyllite , tremolite and actinolite.

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Chrysotile

Chrysotile the only member of the serpentine group accounts for some 90% of the asbestos consumption worldwide. Serpentine polytypes with a composition close to $Mg_3 (SiO_2)^5$ tend to have a sheet structure with alternate layers of networks of silica and hydrated magnesia joined by shared oxygens replacing three out of four brucite hydroxyls. Because of a mismatch between the cell dimensions of the two networks, the composite sheet which is formed bends, with the brucite outermost. "The curved sheets are rolled up in the form of fine tubes or scrolls weakly cemented together by amorphous material." These constitute the basic asbestos fibrils.[6]

Grunerite (Amosite)

This amphibole, also known as "Amosite" derived its best known name from the acronym "Amosa" (Asbestos Mines of South Africa). Mineralogically it is composed mainly of grunerite asbestos with varying amounts of tremolite-actinolite. Amosite has a fiber width of about 20-40 nanometers.[6]

Riebeckite Asbestos, also known as "Crocidolite"

This member of the amphibole group, has some of the most useful (historically) properties because its fibers have a very high tensile strength and are generally finer and more flexible than other amphiboles. The smallest fibers of crocidolite have widths of less than 20 nanometers (0.02um) about the same as chrysotile.[6]

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Anthophyllite, Tremolite, and Actinolite

This group has fibers that are comparatively weak and brittle in comparison to the first three discussed, and at the present time are little used commercially.[6]

(b)(2) "Asbestos Fiber"

ORC has defined an asbestos fiber as having a length greater than five micrometers, a length to diameter ratio of at least five to one and a maximum diameter of three micrometers. This definition is based on work that has been done in many laboratories relating the length and diameter of a fiber to its ability to cause physiological problems when it is inhaled. A document currently being prepared by the American Society for Testing and Materials recommends the adoption of an aspect ratio of greater than five to one, length to width, for asbestos fibers. The ASTM finds that such a definition will assist in excluding acicular rock slivers and other non-asbestos materials while making no appreciable difference with true asbestos fibers.[7] Studies designed to determine the effect of changed aspect ratios on the accuracy of fiber count, found that overall precision of count increased with higher aspect ratio. Researchers found that 73% of fibers with an aspect ratio greater than 3:1 were also greater than 5:1, and 54% were also greater than 10:1.[8]

The 3:1 aspect ratio was not arrived at in a scientific way, but rather first as a compromise and then as a result, in the U.S. at least, of court action. In 1957 the three major British asbestos companies agreed to form the Asbestosis Research Council (ARC). This organization was designed to support research into asbestosis, particle/fiber counting methods and

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instrumentation. One of the early problems of the organization was to standardize counting methods, with some using particles, some fibers, some eliminating non-asbestos fibers and some counting them [9]

In September 1958, the group decided that it would count as asbestos only those fibers in the five to 100um range, and a fiber was defined as having an aspect ratio greater than 3:1. "The choice of the greater than 3:1 aspect ratio had no supporting evidence, but appears to have been a quite arbitrary decision in the interests of achieving harmonization between laboratories that previously had differed in variously counting particles and fibers."[10] The final action that locked the U.S. into the 3:1 aspect ratio for asbestos fibers came as discussed previously as part of the Reserve Mining case mentioned above. When the court held in the fall of 1973 that a fiber is "a mineral which is at least three times as long as it is wide" a fiber description became an asbestos fiber identification by law. Shortly after that the 3:1 aspect ratio was adopted by many U.S. scientists.[11]

In work done with the ratios of long to short fibers in several South African and Canadian asbestos mines and mills, it was found that in the dusts generated in these operations:

...96-100% of fibers with aspect ratios greater than 3:1 that were also longer than 5um, had aspect ratios greater than 5:1, and 80-90% had aspect ratios greater than 10:1. The lower figures relate to chrysotile."[12] In other work, finely milled specimens of non-asbestiform amphibole had been found to contain 15-40% of particles of aspect ratio greater than 3:1 (which would be classed as "fibers", using present definitions) and up to six percent with aspect ratio greater than 10:1. Working with non-commercial grade asbestos materials, 54% of particles

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were "fibers" with an aspect ratio greater than 3:1 and 35% of particles (65% of the fibers) had aspect ratios greater than 10:1.[13]

Working with commercial grade asbestos, more than 97% of those fibers with aspect ratios greater than 3:1 and longer then 5um had aspect ratios greater than 10:1 and at least 84% had aspect ratios greater than 20:1.[14] Using the above figures and other information, some researchers concluded that the use of an aspect ratio of greater than 20:1 in regulatory work would include most asbestos fibers and exclude most non-asbestos materials. The regulatory use of an aspect ratio of greater than 10:1 would include virtually all asbestos fibers, but would also pick up more non-asbestos, non-fibrous acicular cleavage fragments. Looking at the situation in this light, it is hard to justify the use of an aspect ratio of 3:1 for regulatory purposes.[15] Indeed, it might be argued that the use of an aspect ratio of 5:1 is not justified because of the much larger quantity of non-asbestos minerals that will inevitably be counted.

ORC in its definition of a fiber, included the requirement that to be counted as asbestos the "fiber" must be longer than five microns. This position is taken in recognition of a large and growing collection of work documenting the relation between fiber length, and retention in the lung and carcinogenesis. "Experiments in which carefully categorized fibers of different lengths and diameters and different materials were introduced into animals have strongly indicated that the carcinogenicity of the fibers is a function of their physical dimensions and not their composition, provided that they are durable."[16]

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Short asbestos fibers (less than five microns in length) are much more likely to be picked up by the alveolar macrophages and transported to ciliated airways or to the lymph system. Short asbestos fibers are not toxic to the macrophages and are cleared much as inert dust. Long fibers (greater than 10-20um) cannot be taken up by macrophages. Attempted removal by the macrophages of long fibers leaves them protruding through the cell membrane, which may promote the release of enzymes leading to fibrosis and other consequences.[17]

Work done on the retention of fibers in the lung as a function of length and diameter showed that relative lung retention was a function of fiber size. The results from this work indicated that clearance was more closely related to length than diameter, with maximum retention being found in the size range of 7 to 13 microns.[18]

Post mortem work done on the lungs of victims of asbestosis and mesothelioma to determine the kinds and lengths of asbestos fibers retained[19] showed an interesting relationship when compared to the percentage of fibers of various lengths found in airborne samples of each of the three major commercial varieties of asbestos.[20] What researchers found is that for fibers shorter than 2.5 microns there were significantly less found in the lungs than was present in airborne dusts. For fibers longer than 5 microns the lungs of those examined contained a signficantly higher percentage of fibers longer than 5 microns than had been found to be present in the air. There are, of course, many other variables that enter into such a picture, but it is a useful indication that longer fibers are retained in the lungs in numbers out of proportion to their numbers in the environment. If these and other similar studies are valid, it casts doubt on the wisdom of continuing to regard all asbestos fibers as equal.

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Other work done on the relation of fiber size and carcinogenicity found that the carcinogenicity of asbestos fibers is dependent upon the dimensional characteristics of the fibers. This same work also shows that non-asbestos minerals pose a significant risk if they meet the same dimensional criteria established for the asbestos fibers causing problems. [21] [22] [23] Statistical analysis of the probability of cancer vs. number of fibers in different size categories gave a best fit with fibers in the dimensional range greater than 8 microns and less than 0.25 microns in diameter.[24]

Another researcher has concluded that there are three factors that determine the carcinogencity of fibers, (a) a diameter smaller than 1 micron, (b) a length greater than 5 microns, and (c) durability in the lungs.[25]

A relation similar to that for carcinogenicity also holds true for the production of fibrosis of the lungs. Work done with carefully graded lengths of crocidolite and glass fibers administered to guinea pigs by intratracheal instillation, found that in every instance, the long samples produced interstitial fibrosis and the short fibers caused a brief macrophage reaction. The authors concluded that long fibers (greater than 10 microns) produce fibrosis and short fibers (less than ten microns) do not.[26]

In spite of all of the foregoing, it still cannot be said with certainty that short fibers do not cause fibrosis or cancer. It can only be said that there is considerable evidence that fibers longer than five microns cause significantly more problems in human and animal lungs.[27]

In making a recommendation as to the definition of an asbestos fiber, ORC recommended that the maximum diameter considered be three microns.

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The choice of the maximum diameter for an asbestos fiber was based on studies done on fiber deposition, clearance and long-term retention of asbestos fibers. Researchers, in one case, noted that amphibole fibers found in the lungs have a maximum diameter of 3um.[28]

Recent work done on retention rates related to fiber length and diameter found that the most critical factor was fiber length, but also that the curves of retention vs. diameter suggested a maximum retention at about 0.8 microns, with a rapidly falling retention rate as diameter approached 2.5 microns.[29] The same author reported that, in general, airborne fibers with a diameter greater than 1.5um are found in quite small numbers in lung studies. Others have reported that it is unusual to recover a fiber greater than one micron in diameter from the lung.[30]

(b)(5) "Action Level"

An action level concept is used in several aspects of this proposed standard to trigger implementation of protective programs. These are programs considered necessary for surveillance (medical exams, air monitoring, etc.) where exposures may still be well below the permissible exposure limit. This provides employees with an extra margin of safety, and assures employers of continued compliance with the P.E.L. A concentration of 0.1 fibers per cubic centimeter was chosen since this is widely recognized as the lowest level at which airborne concentrations of asbestos can be measured by the accepted methods with even a low degree of reliability.

(b)(6) "Competent Person"

This definition applies to the paragraph of the proposed standard in which initial determinations of potential exposure

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are required. Thus, the standard would require anyone making these initial determinations to be able to demonstrate competency to do so. The degree of qualification necessary under this definition could vary according to the conditions being evaluated. For example, an industrial hygienist might be required to evaluate complex operations, but a trained, experienced supervisor could evaluate a routine operation of limited scope. The burden to demonstrate competency is thus placed on the employer and the degree of competency required is left in performance language.

(b)(7) "Exposure"

This definition means that for the purposes of this regulation, OSHA should consider only the concentration of asbestos fibers per cubic centimeter of air that an employee actually inhales into his or her lungs. For too long, OSHA has maintained that exposure could reasonably be defined as being the same as the ambient concentration in the workplace air, regardless of the use of respirators. This is not to say that respirators are the answer in all situations, for they most certainly are not. An employee is exposed to asbestos fibers when and to the degree that they enter his or her respiratory system and not before. If OSHA wants to set a limit on ambient concentrations separate from the exposure levels, it should do so and defend it openly on that basis.

(b)(8) "Practical"

This permits employers to use judgement in developing control strategies. Above all, it is to be emphasized that this does not in any way imply that a cost-benefit analysis is being done in determining the levels to which an employee is exposed. It would instead, permit the employer to better use

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available resources in achieving the limit set in Paragraph (c). When used as defined here, this term would allow OSHA to retain a preference for engineering controls, without imposing any rigid hierarchy of controls.

(c) Permissible Exposure to Airborne Concentrations of Asbestos

ORC is recommending a permissible exposure limit, an eight hour time weighted average airborne concentration of asbestos fibers, of 0.5 fibers per cubic centimeter. Based on a review of the literature, present day exposure levels, feasibility for general industry, and the population potentially exposed, ORC finds that a PEL of 0.5 fibers/cc is capable of being complied with, reasonable and protective.

In making its recommendation, ORC came to the conclusion that it was neither necessary nor practical to set different levels for the major commercial varieties of asbestos. This is not to say that ORC does not recognize a difference in the relative risk of working with different varieties, but rather that outside of the asbestos producing and manufacturing industry it is rare to find a situation where employees are exposed to only one kind of asbestos. As discussed in the introduction, ORC recommends that the use of crocidolite be prohibited because of overwhelming evidence of the risk that it presents to those who are exposed to it.

The only places where employees would have known exposures to a single variety or to a known mix of varieties is in the asbestos producing and manufacturing industry. The number of employees involved in asbestos producing or manufacturing operations is relatively small compared to the number in general industry. Estimates made by the U.S. Government indicate that

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the number of workers in the U S. asbestos manufacturing industries is around 35,000.[31] The three U.S. operating asbestos mines employ around 600 workers. By contrast the employee population that may occasionally come into contact with asbestos, including garage mechanics and construction workers numbers around three million.[32]

Another reason ORC chose to recommend a single level for all asbestos varieties is the nature of most of the exposure in general industry. Most manufacturing establishments are actively attempting to eliminate all use of asbestos in their operations. Where there are substitutes (and there are many), it is being replaced in new purchases. Where asbestos exists in a manufacturing establishment because of equipment installation and insulation practices of the past, it is being removed as repairs are made and equipment is replaced. It is precisely in the removal of old insulation in repair or demolition activities where the majority of U.S. industrial workers are exposed to asbestos.

The level of exposure existing in removal operations that are properly conducted is quite low, as can be seen in Appendix A-3. Wet removal operations, where the workers are using appropriate protective equipment, should result in exposures that are considerably less than 0.5 fibers/cc. The nature and the multitude of the removal operations that are conducted over the course of a year in the U.S. chemical process or petrochemical industries alone would make it difficult to adhere to a multiple level standard for exposure to asbestos.

For instance, if OSHA were to enact an asbestos standard that had different levels for chrysotile, amosite and crocidolite, a company would either have to assume that all asbestos containing insulation was crocidolite, or have each

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piece tested before the removal operation was undertaken. Since over the past thirty years all three varieties of asbestos were used, often being mixed together, such a situation would require that an employer attempt to attain ambient levels of airborne asbestos fibers close to the detection level 0.2 fibers/cc for crocidolite as recommended by the British[33] or have each piece analyzed. Sample analysis for asbestos variety would be both time consuming and expensive and would accomplish little in terms of worker protection. It would make more sense to have a single level because it would be easier to understand, apply, and enforce, and it would carry with it the promise of greater worker protection from airborne asbestos fibers.

Another reason for recommending that a single permissible level be set for exposure to airborne asbestos is that even the most benign variety, chrysotile, has been implicated in some studies in the production of excess lung cancers. The International Agency for Research in Cancer (IARC) in concluding a 1977 study on human occupational exposure to chrysotile, amosite, anthophyllite and mixed fibers containing crocidolite, commented that exposure to all three asbestos varieties resulted in pleural and peritoneal mesotheliomas.[34]

There is, of course much evidence to indicate that crocidolite is more dangerous for humans than is chrysotile or amosite.[35] This same study, however, points out that in 15% of the mesotheliomas occuring in Britain, there is no evidence of asbestos exposure. More recent work has shown that in an analysis of the lungs of mesothelioma victims, amosite and crocidolite were about equally present, and that chrysotile concentration was about the same as in the controls.[36]

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An animal inhalation study using commercial grade samples of chrysotile, amosite, and crocidolite found that there were no important differences in the carcinogenic potential of the three varieties under the conditions of the experiment.[37] The fibrogenic effect of the chrysotile was, however, less that for the amphiboles. In another study, done on the relative production of fibrosis and lung cancer by the three main varieties of asbestos, it was found that more fi brosis and more lung tumors were associated with the chrysotile exposures than for the amphiboles, even for exposures where the chrysotile mass was only 2/5 of the crocidolite mass and 1/5 that of the amosite. The only lung cancers were found in animals exposed to chrysotile and evidence indicated that they were exposure related[38] Thus, studies done by a variety of researchers have found that in animals, exposure to chrysotile is at least as damaging as amosite or crocidolite at equal respirable mass exposure concentrations and much more damaging for equal amounts retained in the lungs. Researchers also found that chrysotile asbestos contained more fibers per unit mass than the amphiboles and produced more lung tumors and fibrosis in animals exposed to equal numbers of fibers.[39]

In humans, epidemiological evidence has indicated that chrysotile asbestos produces fewer mesotheliomas than either amosite or crocidolite.[40 41 42] What these studies on humans do not indicate is that crocidolsite is intrinsically more harmful for equal numbers of retained fibers. In this regard, if one compares the proportion of amphibole fibers relative to chrysotile in the size range greater than five microns, the proportion of amphibole will increase dramatically.[43] The literature discussed above suggests that there is a strong correlation between carcinogenicity and fiber length as long as fibers retain their original configuration.

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Two recent studies have examined the relationship between mesothelioma and fiber type in several asbestos manufacturing industries. The first, a preliminary report, examined mesothelioma and fiber type in three American asbestos factories, two of which used chrysotile exclusively and one which used chrysotile, crocidolite and amosite. The study "supports much other evidence that amphiboles are mainly responsible for mesothelioma, whereas chrysotile has little or no mesothelioma potential."[44]

The second study examined the mortality of workers producing friction materials using asbestos. This study was done on 13,460 workers over the period 1942-1980. The only type of asbestos used, with two brief exceptions, was chrysotile. The results, showed, that compared with British national death rates, there were no detectable excesses of deaths due to lung cancer, gastrointestinal cancer, or other cancers. Eleven deaths in the study were due to plueral mesothelioma. A case control study carried out on those with mesothelioma, found that eight of the eleven had worked with crocidolite extensively and another was thought to have had intermittent exposure. The remaining two employees had spent most of their working lives outside of the establishment in question. Their mesothelioma could not be definitely attributed to chrysotile asbestos.[45] A study done on workers in the British asbestos cement industry shows that chrysotile asbestos was used with no detectable effect on mortality, which is in sharp contrast to the excess mortality experienced by those groups working with amphibole.[46]

While there is evidence that crocidolite causes more mesothelioma in humans, animals studies indicate that chrysotile is at the least, very dangerous, and there is no justifiction for a separate higher standard for chrysotile asbestos. On

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the other hand, there is abundant support for the elimination where possible, of all exposure to crocidolite and other amphibole varieties of asbestos.

Estimating the Risk at 0.5 Fibers Per Cubic Centimeter of Air

We have already discussed some of the factors that were involved in ORC's recommendation of a PEL of 0.5 fibers per cc. The importance of selecting a PEL that is both achievable and protective has been discussed. The point has been made that, in fact, 0.5 fibers/cc is an achievable level, that the vast majority of American industry are already, or will be in the near future meeting this level for airborne asbestos fibers.

There are, however, a number of factors not yet discussed that bear heavily on any decision to recommend a PEL. It has become fashionable, in fact almost required, that one calculate to six significiant figures the estimate of any occupational risk. Yet, it must be emphasized that such numbers, for all the effort made, are still estimates. This is because they are all based upon a great number of assumptions and unknowns. The unknowns include, in many cases, the actual concentration workers were exposed to, the duration of the exposure, the characterization of fibers, the proportion of asbestos type (i.e. chrysotile, amosite, crocidolite or other) errors in sampling technology, changes in analytical technique, the inability of the optical, phase contrast microscope to "see" all of the thinest fibers, conversions from millions of particles per cubic foot (MPPCF) to fibers per cubic centimeter, differences between area and personal sampling using the same equipment, great differences in the diagnosis of asbestosis or fibrosis, the amount contributed to past studies by smoking, the effect of smoking even where its prevelance is known, the

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changing nature of exposure over the last twenty years, both in peak and average concentrations, and in the working years exposed. This list is by no means definitive, but it is a good indication that when we speak of "risk estimates" we must emphasize the estimate and not assume that we have found incontrovertible fact.

In discussing the estimation of risk, one must of necessity also address dose/response relations. The Canadian Centre for Occupational Safety and Health (CCOHS) in discussing the problem of dose versus response held that:

> "In our opinion, there are no scientific data in the reports, nor in any studies relied upon by them from which any firm conclusions can be drawn about the shape of the dose/response relation. Indeed, the scientific data are so vague that we must ask whether scientific understanding of the dose/response relations is a practical reality and not an unattainable goal of the scientific community engaged in certain fields of research."[47]

The CCOHS continues further:

> "From the definition of dose/response relations we can see that it implies a correlation between dose and the proportion of the population affected by whichever asbestos-related disease we are considering. But dose also implies a measurable quantity of asbestos inhaled or otherwise taken in by the people exposed to it. If we accept dose-response relation as a measured concept, we are accepting, in effect, that the correlation between dose of asbestos and the asbestos-related disease in

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question is sufficiently strong for whatever purposes we choose to use dose/response relations for.

"But the dose of asbestos for human beings at work or in the community at large has never been measured directly. Instead dose is inferred from the exposure known or presumed for the exposed population. Thus, for practical purposes such as risk estimation in connection with asbestos exposure, two reasonably strong correlations have to be presumed between: (a) dose and response, and (b) exposure and dose. If one or both correlations are weak then the risk assessments are likely to be so uncertain as to be misleading.

"A confusion appears to have arisen leading to a widespread and fundamental misunderstanding about dose-response relation. This misunderstanding came about and is perpetuated because:

1. Researchers report on what they call 'dose-response' relations". The idea then grows that 'dose-response relations' represent a scientific reality. The research is not false: the researchers have successfully demonstrated the existence of <u>something</u> which they term 'dose-response relation'.

2. Individuals and organizations concerned with risk assessment, or other practical matters, take the researcher's conclusions as valid, and proceed on the basis that what is needed can be deduced from something the individuals and organizations regard as 'dose-response relation'.

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3. No one has established that the two 'somethings' coincide scientifically."[48]

Risk estimates then must be regarded as something better than a guess, but less than proven fact. More useful than risk estimates are solid studies that correlate actual years of exposure to asbestos with the development of a variety of asbestos related diseases. These studies can give us an idea of the levels that will lead to disease in those exposed today. Studies such as those done by the British Occupational Hygiene Society (BOHS),[49] McDonald and Fry (1982)[44] and Berry and Newhouse (1983)[45]. These studies and others give us an idea of what has worked, what is achievable, and what we must do to lower the risk.

In recommending the 0.5 fibers/cc PEL, ORC has assumed that there is no safe threshold for exposure to asbestos fibers that can be proven by modern science. In reaching this conclusion, we follow the "Simpson Report" which stated: "For lung cancer the available data in man, all of which are derived from industry, show an increase in risk with increasing dose of dust, and we find no evidence within the range of dust levels studied for a threshold of dose below which there is no evidence of risk."[50]

There are a number of published studies that attempt to give a numerical reality to their estimates of risk. For instance, the NIOSH-OSHA Asbestos Work Group,[51] (referred to as the NIOSH-OSHA Report) recommended a level of 100,000 fibers per cubic meter of air (0.1 fibers/cc) because that was as low as they believed the optical phase/contrast method of analysis could accurately measure asbestos fibers. Another recommendation for a very low PEL came in the draft "Preliminary Risk Assessment for Asbestos" done for OSHA by Drs. Han K. Kang and

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Kenneth Chu which recommended that the highest level considered be 0.5 and the lowest 0.1 fibers/cc.

The "Simpson Report"[52] developed a table, which estimates the risk at various concentrations of asbestos fibers in the air.

> "If we take as an example the column of Table 21 showing the levels at which a 1% excess of lung cancer deaths would occur associated with chrysotile, we find a range of figures from 5 fibres per ml to 0.4 fibres per ml (for 50 years). In other words, taking the various different sets of data and using different assumptions, we calculate
>
> that any value from 5 fibres per ml to 0.4 fibers per ml might lead to a yield of 1% excess deaths from lung cancer"[53]

The critical element in the above is the conversion factor that is used to extrapolite from dust counts made using methods and equipment now considered obsolete and inaccurate. Modern fiber counting methods find far more fibers per sample for a given concentration than did older methods.

Cumulative Dose: The Concept of Fiber Years/ml or cc

An important concept used in estimating the extent of worker exposure to asbestos is fiber years per cubic centimeter. In general, one hundred fiber years is the total cumulative dose that would result from exposure to a constant dust concentration of 10 fibers per cc for eight hours per day and 10 years, or 2 fibers/cc for 50 years or 0.5 fibers/cc for 200 years.[54]

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The BOHS Committee on Asbestos, examining non-cancerous disease conditions in the lungs of exposed workers in several asbestos manufacturing facilities found, using seven well defined events as diagnosed by a panel of physicians, that

> "....for cumulative exposures up to about 25 fibers yr/ml the probability that any one of the seven defined events occurs is less than two percent. For exposures less than 50 fibers yr/ml the estimated probability is less than seven percent; for exposures up to 100 fibers yr/ml the (cumulative) probability increases to about 17-20%".55

Dr. Kenneth Crump, testifying before the Ontario Royal Commission on Asbestos, reported on lifetime risk assessment for workers in primary asbestos industries. Dr. Crump assessed the risk of developing lung cancer for a worker who was exposed for a least twenty years to a level of 2 fibers/cc. Dr. Crump used the 1980 study by McDonald of chrysotile mining operations as the basis for his calculations.56

Dr. Crump found that for non-smokers, with a lifetime occupational exposure to asbestos at the 2 fiber/cc level, the loss of life expectancy in days ranges from 0.16 to 0.20 days. For smokers, using the same sources of data, the best estimate is a loss of 1.9 days to 2.3 days. 57 58 59

There is, of course, room to criticize every study on one or another grounds, and, as we have indicated above, we do not put overwhelming confidence in risk estimates. We will not attempt to critique each study individually, as it would be unproductive. We do find it useful, however, to briefly examine some of the problems with most, if not all, of the risk estimates done over the last decade.

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Perhaps the most serious problem in our view, is the difficulty in going from the historical conditions under which the data were gathered to the present day levels of exposure. A number of authors have commented on this situation, including those who produced the "Simpson Report"[60] who caution that the long latent period associated with the development of asbestos disease means that:

> "... cases of asbestos related disease may occur many years after the workers has left the relevant job; (2) cases of disease occuring at present relate to conditions of work which are likely to have changed in the intervening period; (3) current trends in occurrence of asbestos related disease can give little indication of recent improvements or otherwise (say within the last decade) in working conditions; (4) a period of at least 30 years may have to elapse before it is possible to give a definite answer concerning the introduction or control of an asbestos-related hazard; (5) in persons currently developing disease, data about the relevant dust levels is likely to be poor; (6) there is a serious risk among the uninformed of attibuting present disease frequencies to present conditions of work."[61]

All of these problems operate to make an accurate risk estimate difficult.

A related problem is the attempt to generalize too much from a study, however excellent, that was done in one specialized industry. An excellent example of the problems this can lead to is the Dement study.[62] This study was done in a plant manufacturing textiles from chrysotile asbestos using the dry process. A number of authors have commented that the textile forming process is likely to produce fibers with characteristics

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that are different from those found in the asbestos cement or friction materials business.[63] [64] If one based the bottom line of a risk estimate on the Dement study, ignoring other work that relates to different industries, then one could justify a 0.1 fiber/cc level. To make a decision on such a narrow basis, however, is to practice bad science. The authors of the British "Simpson Report" comment that:

> "There is also uncertainty about how far it is reasonable to derive from data about asbestos textile workers conclusions extending to all situations where occupational exposure to asbestos occurs."[65]

Nature of exposure: Intensity vs. Duration

In almost all studies of past exposures, determining the actual levels and varieties of asbestos that workers may have been exposed to is difficult. Recent studies have indicated that it is important to understand the nature of the exposure in terms of how the concentrations varied over time. Were most of the exposures in the form of short periods of high concentration followed by longer intervals of relatively low level exposure or were exposures at a fairly continuous level over the time frame examined? This relation can be critical to the eventual development of disease in those exposed. Dr. Hans Weil testifying before the Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, stated that both duration and intensity of exposure are important.[66]

Predictions of risk for workers with long-term, low level exposures, from epidemiology done on workers who had intense short term exposures, is fraught with problems. Dr. Kenneth Crump testified that:

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"One should try to match the exposure patterns in the population for which you want to estimate risk... some studies, I think which have very short exposures are inappropriate for estimating risks from long-term exposures." 67

The basic asbestos clearance mechanisms, discussed above in relation to fiber characteristics, are more likely to be overwhelmed by short intense exposures than steady, lower levels of asbestos fiber inhalation. Dr. W. Nicholson testified that:

"The possibility is that intense exposures may overwhelm clearance mechanisms and thus you have more fibers retained in such circumstances.68

Dr. J. Peto testified to the Ontario Royal Commission that:

"Another possibility, which is what I was talking about there, is that, in fact, transient high exposures are in fact a major source of risk, and this hasn't been examined in proper detail. It could be very easily. It's simply a matter of doing a lot of detailed measurements, both personal and static measurements, and seeing whether the areas under the large peak actually account for a substantial fraction of the total inhaled asbestos. This is something which hasn't been very well studied, and that would certainly be one explanation for this failure."69

The CCOHS, in commenting upon the problems of risk estimation/risk prediction examined the problems associated with averaging all exposures over long periods and ignoring the potential effects of high intensity exposures.

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"For diseases with relatively long latent periods, cumulation-response relations possess the same weakness as years of exposures/employment response relation. So far, however, we have traced no studies which have adequately dealt with the question of fluctations in the course of a working day.

"Nearly all the studies which present cumulation-response relations are dependent upon asbestos measurements averaged over year-long periods. So far, we have identified not one study with data relating to averages taken over less than eight hours.[70] The procedures used for data-gathering up to the present, at least, absolutely preclude the possibility of finding out the significance of fluctations over hours or days, a potentially important factor affecting the long term risk of asbestos-related disease.

The prevalence of asbestos-related disease has been shown to increase after exposure to asbestos has apparently ceased. This observation demonstrates that any simple approach based on averages, and/or years-of-exposure/employment-response relation, and/or the cumulation-response relation are inadequate as an explanation of the nature of asbestos-related disease."[71]

Dr. Phillip Enterline testified to the Ontario Royal Commission that it was his belief that:

"High intermittent doses probably have disproportionately large effects on disease" and that they are also "about the only way that I can explain the very high cancer incidence that you observe in insulation workers".[72]

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Million Particles Per Cubic Foot to Fibers/cc Conversions from Historical Data

In order to draw reasonably accurate conclusions about past exposures, one must be able to relate the frequency of disease with particle/fiber counts. However, methods in use have changed drastically over the last 20 years. Some of the factors that may cause difficulties are:

(a) The sampling instrument used;

(b) The location of the sampling instrument relative to the worker;

(c) The nature of the dust counted (all particles, or fibers only);

(d) The evaluation technique.[73]

Before 1964 the most commonly used instrument in Britain was the thermal precipitator, while in the U.S. it was the midget impinger. Present day asbestos sampling operations use the membrane filter almost exclusively. Work has been done comparing the nature of the results from sampling conducted with the midget impinger and the membrane filter. This work pointed out that fibers a few tenths of a micrometer in diameter might not be collected in the impinger, and if collected, would not settle to the bottom of the counting cell in the allotted time, and if they did, would not be visible by the optical microscope technique. Membrane filters were counted for total fibers, for fibers longer than 10 micrometers and a proportion for fibers longer than 5 micrometers. The ratio found for comparison was for every mppcf counted by impinger, the membrane filter method found 10 per cc. If only fibers longer than 5

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micrometers were counted, the membrane method found 6 fibers/cc, or 3 fibers/cc longer than 10 micrometers for every one found by the impinger.[74]

Comparisons of the British thermal percipitator with the membrane filter method gave a ratio of 14:1. That is, for every fiber longer than five micrometers found by the thermal percipitator, the membrane filter found 14.[75] Another factor that effected British work was the fact that they started using the graticule counting method much later than the U.S. One estimate of the combined effect of these changes are that for every 2 fibers counted in 1968, present day counting might find from 4 to 10 fibers/cc.[76] The conversion factor that is selected for a particular early study is critical to the element of risk that is found. Much of the controversy over differing interpretations of early studies goes back to the method of doing mppcf to fibers/cc conversions. Most present day studies in Britain use a conversion factor of 2-3 to convert early studies to modern methods. [77] [78]

Personal Sampling vs. Static Sampling

Another factor that can introduce error or at least uncertainty into the conversion of early work even with the membrane filter is the use of personal sampling techniques. In general, it has been found that personal sampling gives higher fibers/cc counts than area (static) sampling.[79] One group made a systematic study of the information available on this problem and concluded that (a) most personal sampling results are higher than static sampling, (b) the differences are greatest when the two samples are taken far apart, or far from the source, (c) in some cases personal samples were lower than static, (d) in general, "the correlation coefficient between personal and static measurements is statistically

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significant, but even so, no consistent relationship of great practical utility could be found in the limited data available".[80]

Problems with the Membrane (Millipore) Filter Method

As more individuals and groups have attempted to compare the results of membrane sampling, it has become apparent that there are great differences, both systematic and random. between the results of different users of this method. In one study experienced laboratories were compared with novice counters, both using the same instruction from start to finish. The mean counts of the novices were about one half those of the more experienced laboratory, and one isolated laboratory not using the same instruction set found only 1/4 of the fibers of the experienced group.[81]

Recently the Asbestos Information Association of North America completed a study of the accuracy and sources of error in the asbestos analytical technique when counting low concentrations of fibers. This investigation consisted of a balanced, incomplete round-robin sample exchange among 46 participating laboratories, with 1,774 samples and 2,315 fiber counts. This study emphasized the measurement of workplace exposures to chrysotile asbestos at concentrations less than 2 fibers/cc and looked for fibers longer than 5 microns. Twenty-seven of the participating laboratories were members of the NIOSH laboratory quality assurance program. Three types of sample comparisons were made: (1) Intralaboratory-intrafilter, where counters in the same laboratory performed replicate counts on segments from the same filter. (2) Interlaboratory-interfilter where different laboratories made replicate counts on the same filter. (3) Interlaboratory-interfilter where each set from a simultaneously collected pair of samples was counted by a different laboratory. The coefficient of variation (CV) for the three was: (1) =+0.28, (2) =+0.35, (3) - +0.55.82

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These results indicate that laboratories now being operated under the best currently available quality control program have random. within-laboratory errors in sample evaluation (intralaboratory-interfilter) that give a variability several times larger than would be predicted from Poisson considerations alone. The inclusion of systematic errors in sample evaluation between laboratories resulted in only a small increase over the random errors already present. If one adds in the known random errors present in sample collection, the total gives a substantial further increase in variability.[83]

Perhaps the most significant finding of this study was that below 0.5 fibers/cc the use of confidence limits is not justified except as a qualitative indicator. The authors conclude that "Since a formal procedure for the detection limit problem is not included in NIOSH P&CAM 239, the discussion of detection limits is, of necessity, somewhat hypothetical. Nevertheless, it is apparent that it is not possible to detect workplace asbestos levels in the range of 0.1 fibers per cubic centimeter with statistical reliability."[84]

This finding was in sharp contrast to the results of a NIOSH study of the same method done in 1979. The NIOSH study concluded that the coefficient of variation did not greatly exceed that expected for a Poisson distribution.[85]

In British government laboratories using experienced counters, the coefficient of variation ranges from 1.0 for low fiber concentrations to 0.25 for counts of 50+ fibers/cc.[86] Ogden finds these results to be "consistent with a model in which a subjective variation with a standard deviation about 20% of the mean count is superimposed on the Poisson Variation."[87]

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Another group examining data from historical studies and comparing sample collection and analytical techniques with those presently in use in Britain, commented that "Results from this type of analysis are recorded as fibres/ml and are known to have a standard error of ± 40% of the mean from monthly observations of performance of the counting team."[88]

This means that using the best available modern optical, phase contrast analytical methods, it is virtually impossible to count asbestos fibers at any concentration below 0.5 fibers/cc with statistical accuracy. An OSHA standard set at a figure significantly below 0.5 fibers/cc would thus be vulnerable to charges of inaccuracy and infeasibility.

Counting Fibers with the Electron Microscope

Scientifically, there is little question that the optical, phase contrast method for counting asbestos fibers lacks accuracy when the fiber concentration is low, that is below about 0.5 fibers/cc. Studies of asbestos samples that have been counted using a variety of optical methods and then checked using several electron microscope methods have consistently demonstrated that the optical methods fail to detect a significatnt number of fibers. The practical limit of detection for phase contrast optical microscopy has been reported to be between 0.36 um and 0.21um.[89,90]

The electron microscope has much greater resolution capability than the optical microscope. Additionally, this instrument has the capability to incorporate other refinements such as Selected Area Electron Diffraction (SAED) that enable it to do crystal structure analysis. The Transmission Election Microscope (TEM) is capable of resolution down to 0.1 um or less with the best equipment, but even so is not capable of

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giving unequivocal identification of all asbestos fibers. This is particularly so when attempting to make the distinction between asbestiform amphiboles and their polymorphs. A success rate of only 50% in this differential identification has been reported in the literature.[91,92]

The Scanning Electron Microscope (SEM) has been reported to be capable of resolving down to the region of five nanometers. This fine resolution is, however, adversely affected by factors such as poor contrast, instability, and "noise" in the image which make the detection of very fine fibers difficult. One author, comparing the capability of the TEM and SEM came to the conclusion that the SEM has a practical limit of approximately 0.1 um diameter. Down at the 0.1 um level, variations in the ability and habits of the individual operators become significant elements in detection.[93]

A recent comparison of the fiber detection ability of two widely used and accepted optical, phase contrast analytical methods with electron microscope methods showed a large consistant difference.[94] The TEM instrument, used with two different methods of sample preparation, found significantly larger numbers of asbestos fibers than the optical phase contrast methods. This difference was particularly marked for fibers longer than 5 microns in length and less than 0.3 microns in diameter, the most dangerous category for mesothelioma. For fibers longer than 5 microns in length and greater than 0.3 microns in diameter, the findings of the TEM and the optical phase contrast methods have a high correlation coefficient of 0.87.[95]

This suggests that the historical concentrations may have been from 2 to 4 times higher than calculated in most conversion methods.[96] Additionally, this work suggests that the only way that OSHA could justify a PEL for asbestos of 0.1

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fibers/cc would be by requiring the use of the electron microscope for all counting. However, it must be noted that such a requirement for the use of the TEM OR SEM at a PEL of 0.1 fibers/cc, would be the same as requiring a PEL, at least 2X lower or 0.05 actual fibers/cc. It is doubtful that such a drop in PEL could be justified as either cost effective or reasonable.

There are other drawbacks to requiring the use of the electron microscope for the counting of asbestos fibers for regulatory purposes. The first and most obvious is the need for a vastly expanded number of instruments. This equipment is expensive, costing in the range of from $25-50,000 dollars for a minimum machine, not counting the costs of operators, support and training. Additionally, the time requirements and difficulty of specimen preparation would make the routine use of the TEM prohibitively time consuming and thus expensive. The SEM has fewer drawbacks than does the TEM. However, the direct on-screen viewing mode, which allows the most rapid evaluation, is also the least sensitive in terms of fiber size and the most sensitive to noise and operator variation. Additionally, there has been little work done comparing counts found by various laboratories using the SEM or TEM.[97]

In summary, the use of the TEM or SEM have significant advantages in terms of scientific and technical precision in counting. At the same time, both electron microscope methods would be much more expensive than the phase contrast optical microscopy. If OSHA should reduce the PEL for asbestos to 0.1 fibers/cc, it cannot use the optical phase contrast microscopy method for fiber counting because of large inaccuracies below 0.5 fibers/cc. At the same time, work done with the TEM and SEM has indicated that even the best modern fiber counts done with the optical phase contrast mehtod are from 2-4 times

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too low for long thin fibers. This means that risk estimates done using conversion factors based on optical microscopy methods underestimated the exposure by a factor of from 2-4 times, and thus have found too high a risk at the stated fiber/cc concentration. At the same time, a PEL of 0.1 fibers/cc, using the electron microscope, has the same effect as lowering the PEL from 2-4 times.

The Actual Exposure Levels of Employees at Risk

Before any reasonable regulatory framework can be constructed for exposure to asbestos, it is necessary to ascertain with a high degree of certainty exactly what present exposure levels are. Most exposures to asbestos fibers no longer take place in the asbestos producing or manufacturing industry. Rather, most exposure to asbestos in general industry comes during removal, maintenance and demolition operations. These are not continous operations, and the great growth in consciousness of the dangers of asbestos, means that such operations will not often be taken casually.

Another factor that bears heavily on the exposure of an individual worker is the general level of compliance that is achieved within his or her workplace. The British have examined this problem in the "Simpson Study", and have come to the conclusion that:

> "A comparison with the health standard for ionising radiations (5 rems per annum) may be helpful. The standard is such that there is likely to be an increase in cancer mortality from 20% (which is the probability of a member of the general population dying from cancer from all causes) to 22% of all deaths if workers are exposed to this level annually for 50 years. However, the great majority of

workers are only exposed to much lower levels, and it is estimated that the overall excess mortality from cancer is thus reduced to an average of 0.2%. If we assume that the exposure pattern for asbestos workers is roughly the same as for workers exposed to ionising radiation (that is the average exposure will in practice be about one-tenth of the limit set), then we should look for the exposure level associated with a 2% excess mortality among the most highly exposed. Since very approximately half the mortality attributable to chrysotile is due to lung cancer and half to asbestosis, this suggests that we should look in the column headed 1% in table 21, which deals with lung cancer only. The chrysotile levels in this column range from 5 fibers/ml to 0.4 fibers/ml."[98]

Thus, if a PEL is set at 0.5 fibers/cc, the actual exposure of the great majority of workers will be one tenth of that or .05 fibers/cc. This analysis does not take into account the effect of modern respiratory protective equipment that will give a protection of factor of at least 5 in almost all cases, and the fact that most workers are not exposed to asbestos above ambient levels when not actually handling asbestos. To reiterate, the average asbestos worker is not exposed to the levels found historically in the asbestos insulation industry or mining and manufacturing. Nor does the average worker who occasionally handles asbestos have the unprotected, consistent exposures, year after year, that are assumed in most risk estimates.

The length of time that a worker is employed in industries where asbestos exposure is a problem also needs to be considered. In 1983, few employees have working careers with the same employer or even industry of 50 years, which is the standard assumption that most risk estimates make. As Julian Peto noted

in testimony given to the Ontario Royal Commission, "25 years would be a more realistic estimate of working lives."99 Of course, an estimate of 25 years instead of fifty years would drastically reduce the estimate of risk, and to do so would be more in accord with the reality of the working world than 50 years.

The Effect of Smoking on Asbestos and Lung Cancer

When it comes to the detrimental effect of smoking on the health of asbestos workers, there is something close to unanimity of opinion.

The CCOHS Report found that all four of the risk estimates/reports evaluated agree on the following in regard to the effects of smoking:

"(a) The effects of tobacco and asbestos are known to interact synergistically (cause an effect above and beyond separate effects) in smokers exposed to asbestos and result in an increased incidence of lung cancers.

(b) Smoking has little or no effect on the occurance of mesothelioma.

(c) Smoking has little or no effect on the occurrence of asbestosis although a smoking history may lead to pulmonary complications."100

There is less agreement over whether the effects are additive or in fact multiplicative. The BOHS study committee found that the effect of smoking cigarettes is one of the main contributing factors to malignancy of the lungs among asbestos workers. and that its effect was not simply additive.101

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Another study found that asbestos workers who smoke are 53 times more likely to develop lung cancer than the general population. Heavy smoking asbestos workers have a risk 87 times greater that the general population. Non smoking asbestos workers have a risk of developing lung cancer 5 times higher than the general population.[102]

For an epidemiology study to be instructive and useful, it should include the smoking history of the individual participants. Studies that are unable to do this because of a lack of data, should be discounted severely when making risk estimates for factors other than mesothelioma.

(d) Compliance Policy

A written compliance program to reduce employee exposures to levels at or below both the PEL and the ceiling limit is an integral part of any overall asbestos control program. The written program must be individually structured to address the specific problems, sources of exposure, and unique circumstances that characterize each employer's particular situation.

The wording proposed in section (d) is performance oriented to allow employers sufficient flexibility to adapt compliance programs for their specific work places that are effective, practical and cost-efficient. The important measure of the written compliance program is not length, complexity, or adherence to a mandated structure, but rather whether or not it accomplishes the desired goal; namely, reducing employee exposures to or below the PEL and the ceiling limit.

There is little constructive value in requiring an employer to prepare a written compliance program if no employees are exposed to airborne asbestos fibers at levels above the

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action level. The action level, even though below the PEL, was chosen as the trigger mechanism for a written compliance program for several reasons:

- While the action level is below the PEL, both the action level and the PEL are 8 hr TWA levels and do not guarantee that the ceiling limit is not exceeded.

- Monitoring results are subject to variability in actual exposure from day to day as well as errors in sample analysis.

- The action level is a recognized benchmark for other provisions of the asbestos standard; introduction of a separate benchmark to trigger a written compliance program would only add needless complexity to the standard.

(e) Methods of Compliance

This recommended standard requires employers to institute engineering controls to the extent feasible to control employee exposures to airborne asbestos fibers below Permissible Exposure Limits. If engineering/administrative controls are not effective in reducing exposures below the PEL, then respiratory protective equipment must be used to meet the PEL.

Engineering controls, work practice controls, administrative controls, and personal protective equipment are the three basic methods of exposure control utilized by industrial hygienists. These terms are frequently misused, and for purposes of this recommended standard, they are clarified:

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"Engineering Controls" employ mechanical means or process redesign to eliminate, divert, dilute, contain; and/or collect asbestos emissions at the point of generation. Examples of this type of control include process isolation or enclosure; employee isolation or enclosure; closed material handling systems; product substitution or process redesign to eliminate the contaminant, and dilution or exhaust ventilation.

"Work Practice Controls" accomplish the same results as engineering controls, but rely upon employees to repeatedly perform certain activities in a specified manner so that airborne asbestos concentrations are eliminated or reduced. This may be accomplished as simply as instructing employees to keep lids on containers, or to observe required hygiene practices. Good work practices are often required in conjunction with engineering controls; for example where employees perform an operation utilizing an exhaust hood, they must perform their work in such a way as to maximize the efficiency of the ventilation equipment.

Work practices also incorporate administrative controls within their scope. Administrative controls simply involve moving the employee to a place of lower exposure or reducing work hours so that daily, time-weighted average exposures are reduced. This type of control method does not act in any way on the source of the emissions.

"Personal protective equipment" is a method of exposure control that isolates the employee from the emission source. Respirators are the primary type of personal protective equipment used when the concern is protection from an inhaled air contaminant.

The priority of control methods required by this recommended standard, i.e., use of respiratory protection only

as a supplement to engineering controls and work practices or as an interim measure while engineering controls and work practices are being implemented, is consistent with the policy approach taken in all prior air contaminant standards promulgated by OSHA. The rationale behind this approach is based primarily on two principles. One is that protection of the employee is usually most effectively attained by elimination or minimization of the hazard at its source, which work practices and engineering controls are both designed to do. The other is that methods which depend upon human behavior are inherently less reliable than well-maintained mechanical methods.

Engineering control is usually the best method for effective and reliable control of employee exposure to asbestos. It acts on the source of the emission and eliminates or reduces employee exposure without reliance on the employee to take self-protective action. This method encompasses product substitution, process or equipment redesign, process or equipment enclosure, exhaust or dilution ventilation, and employee isolation. Once it is implemented, it protects the employee indefinitely, subject to periodic preventive maintenance. Work practices also act on the source of the emission, but rely upon employee behavior which in turn relies upon supervision, motivation, and education to make them effective. For this reason, work practices are usually not as desirable a method as engineering controls, but because the two methods often must be employed together to make either one effective and because they are the only methods that act to eliminate or reduce the hazard at its source, they have been given equal status in the standard.

Administrative control, as a type of work practice, is also included in the group of primary methods of exposure control that must be used before respiratory protection. The approach in this recommended standard is primarily a result of

recognizing the important role of work practices and clarifying the definition of the term "work practices" to include "administrative controls". These terms have been somewhat ambiguous in that the term "work practices" has been commonly thought to include employee rotation or other administrative types of control. However, OSHA's policy has generally been to deemphasize the use of administrative controls because they not only fail to eliminate the hazard but they expose more workers to the contaminant, although for shorter periods of time.

Respiratory protection, in most instances, may not be as effective as engineering or work practice controls in reducing employee exposures below the PEL. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate. They can provide supplementary interim, or short-term protection, if they are properly selected for the environment in which the employee will be working. This is true if they are properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required as prescribed by the employers respiratory protection program.

The language of paragraph (e)(1) is intended to impose on the employer the obligation to evaluate and implement feasible and effective engineering/work practice controls before proceeding to respiratory protection. OSHA's interpretation of "feasible" and "effective" may vary from industry to industry, since controls which are "feasible" and "effective" for one industry segment may indeed not apply to another segment.

(f) Personal Protective Clothing

This paragraph contains requirements that the employer provide protective clothing appropriate for the hazards associated

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with asbestos. The purpose is to assure that employees who are exposed in excess of the PEL's or who become contaminated with asbestos do not expose fellow employees to asbestos or carry asbestos from the workplace into the home. Also, this paragraph specifies that contaminated clothing be removed in change areas specifically established for removal of protective clothing. In most instances, this change area will be located immediately adjacent to the work area, thus administratively controlling the wearing of contaminated clothing outside the work area, and minimizing the duration of potential exposure to asbestos.

The paragraph did not specify the frequency for which protective clothing must be provided; this is dependent on a number of variables (air concentration, surface contamination, wet or dry state, etc.), and should be left to the employer for administration. The paragraph does not specify the type of clothing to be provided (e.g. synthetic, cotton). Due to the diversity of environmental conditions encountered, the scope of the work to be accomplished, work location, and other factors, the employer should be allowed the flexibility of utilizing appropriate types of clothing without compromising employee health.

Although the paragraph specifies the use of protective clothing when PEL's are exceeded, it should be recognized that asbestos is frequently worked in a wet state to reduce air levels below PEL's. "Wet" material could adhere to clothing. In this and other instances protection is required to minimize employee's exposure to asbestos (as it dries, for example), even though PEL's are not exceeded. "

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(g) Hygiene Facilities and Practices

The use of personal protective equipment and clothing will not achieve maximum protection for employees unless supplemented with facilities and practices for personal hygiene. The requirements of section (h) provide the basis for achieving this protection while still allowing the employer sufficient flexibility to adapt the basic requirements to individual facilities.

Change areas should be provided for the removal of protective equipment and clothing at fixed work locations. It is both practical and good hygiene practice to require change areas at these fixed locations. The basic object of the change area requirement is to minimize contamination of non-asbestos work areas or other facilities used by employees. In the case of non-fixed work areas, or mobile employees and crews, fixed change areas such as locker rooms are not only impractical, but may defeat their intended purpose if employees have to travel any distance in their contaminated clothing. In cases such as these, a more practical solution is to remove protective clothing such as coveralls at the completion of the task for which they were required. The contaminated clothing can then be placed in appropriate containers either for reuse, laundering or disposal. This approach will minimize contamination of public areas or vehicles in the case of mobile work forces.

The requirement for washing facilities provides those elements that are necessary for employee protection whenever employees are required to use respirators or wear protective clothing. The essential element is that employees wash all exposed areas. The small incremental gain in protection that may be afforded by requiring shower facilities and mandatory taking of showers would be negligible at best.

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The requirement for storage of clothing is flexible in that it does not mandate one method over another. The basic goal is to prevent contamination of street clothing and clothing which may be worn by another employee. This requirement may be satisfied by provision of special lockers or special containers

The requirements for laundering are straightforward and intended to provide protection for fellow employees, laundry personnel and the general public. The requirements do not preclude the use of disposable protective clothing, provided that such contaminated clothing is placed in sealed containers and appropriately labeled prior to disposal.

(h) Method of Measurement

A variety of analytical techniques have been used to quantify asbestos fibers in air samples. All of the methods that have been used have some limitations. Utilization of the membrane filter method at 400-450X magnification is recommended for a number of reasons: 1) most historical data is based on this method and relating new exposure data to old is important in evaluating control measures and epidemiological information. 2) other available methods (Electron Microscopy, X-Ray Diffraction, Differential Thermal Analysis) require highly specialized techniques and other costly equipment not generally available.

(i) Monitoring

An initial determination must be made in workplaces where asbestos is present or used to evaluate whether potentially hazardous concentrations of airborne asbestos fibers may be present. This determination may be based upon past sampling data or professional judgement, taking into account work practices, the asbestos form, engineering controls, the

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amount of asbestos present, etc. Such determinations should be kept in written form, outlining the rationale used. This initial determination is the basis for whether or not monitoring is required.

If the initial determination indicates that employees may be exposed at or above the action level, initial monitoring must be performed to determine exposure levels. This monitoring must be done to determine whether other provisions of this standard need to be followed to protect the health of the employees exposed. If sufficient sampling data exist for similar jobs performed under similar conditions such that reasonable estimates of exposure may be made based on sound statistical analysis, initial monitoring need not be performed.

If, as a result of initial monitoring, it is found that the PEL is exceeded, sampling should be repeated with such frequency that true exposures to the employees may be determined. Specific intervals for sampling are not required because of the variation in the frequency and types of exposure. It would make no sense to require the same sampling frequency for regular and infrequent exposures, for example, maintenance personnel engaged in periodic work involving asbestos containing materials.

(j) Caution Signs and Labels

1. Caution signs: This paragraph is reworded slightly, but is not substantially different from the current OSHA standard.

2. Sign specifications: This proposal simplifies the sign requirements and eliminates unnecessary detailed specifications in favor of a more performance oriented

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approach. This new specification contains a very clear warning, which is more strongly stated than the one presently required. It also allows flexibility concerning other instructions which may be included. This places the burden on the employer to make certain that the signs will be appropriate for each particular situation. This approach, when coupled with the required employee training programs will offer greater assurance of employee protection than the current one.

3. Caution labels: This paragraph is unchanged from the present standard.

4. Label specifications: The wording of the warning label has been made more explicit and upgraded from a mere "caution" to "danger". The fact that the greatest hazard is the cancer risk is specifically stated. The recommended standard also permits (and thereby encourages) additional warnings or instructions to appear on the label, provided they do not diminish the overall warning.

(k) Housekeeping

This section is designed to assure that asbestos exposures will not result from poor handling practices. Specific direction is provided to employers regarding handling and disposal of asbestos waste.

(l) Record Keeping

This section imposes on employers a duty to maintain records of personal and environmental monitoring. These requirements are more specifically defined in 29 CFR. 1910.20.

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Thus, the recordkeeping requirements therein are consistent with those generally applied by OSHA.

Employee exposure records must be provided upon request to employees, designated representatives, and the Assistant Secretary. This requirement assures that employees and their designated representatives can obtain access to these records for purposes of diagnostic investigations and to identify instances where employee exposure to asbestos many have occurred.

(m) Employee Notification

This paragraph requires that employees be notified of their exposure. The employee has a right to know to what extent he or she is exposed, and the employer has an obligation to make this information available to the employee.

Workers have an important part in the overall effort to reduce and maintain exposures at acceptable levels. When the worker is aware of personal exposure, he or she can better understand the reasoning behind the controls used to reduce exposures and make a better effort to utilize these controls to the fullest.

Although this information is available to the employee through 29 CFR 1910.20, the benefits to be gained from additional notification can outweigh the clerical or other costs of such notification.

Personal protective equipment is not taken into consideration when determining if an employee has been exposed above established limits. Personal protective equipment is less effective if it is not properly worn or if it malfunctions.

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Making employees aware of exposures will encourage them to take an active part in maintaining and properly wearing personal protective equipment as part of the overall effort.

Employees exposed to the same contaminants as those specifically monitored are to be notified of representative exposures. This will enable such persons to take an active role in the use of engineering controls and personal protective equipment.

The mechanism of, and a specific time limit for, notification are left to the discretion of the employer. Maximum benefit from employee notification will be realized when employees are notified as soon as possible. It is left to the discretion of the employer to use the most effective means of notification.

(n) Training

1. This paragraph corrects an oversight in the current standard by adding a requirement for employee training. Training is essential to assure that employees are aware of hazards due to asbestos and are capable of performing their work in a way which will protect themselves and others.

   Formal training is to be required for all employees who have exposures above the action level, since these will be the persons most directly involved with asbestos. Formal training is not required for other employees who may also work in places where asbestos is present, but whose exposures are below the action level. This is partly due to the lower risk involved, but is mostly because asbestos is present in some shape or form in so many workplaces that it would be impossible to

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provide formal training to everyone who might at some time encounter it. The spectrum of possible exposure would range downward from the action level to zero, and some clear cutoff is needed to identify who is to be placed in the formal program.
The program should be in writing to document that it covers all the necessary points, and to assure that all the necessary training is provided to each employee.

2. The elements of the training program are listed, but all are worded in performance language. Since the program is in writing, OSHA would be able to verify the adequacy of training in each aspect. Still, the employer would be free to tailor the training to the needs of the employees for the particular operations in which they were involved. The six topics listed are considered the minimum for an effective program.

3. To assure that training stays up-to-date, some program of refresher training is necessary. Annual refresher training is the minimum to assure an on-going, effective program.

4. To assure that all exposed employees are properly trained, and that no one is overlooked, it is proposed that all training sessions be documented.

5. In keeping with OSHA's general practice of assuring employee access to standards, it is proposed that this standard be made available to them. Posting of the standard is optional, since it would not be necessary as long as a copy is readily obtainable.

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(o) Medical Surveillance

Exposure to asbestos can result in three major physiological problems for humans who have inhaled sufficient quantities. The first and least serious condition is asbestosis, which was first recognized as a scientific entity at the beginning of this century. Asbestosis takes the form of an interstitial pulmonary fibrosis, has been shown to be related to the levels of asbestos containing dust in the workplace and to be dependent upon the duration of exposure.103

Lung cancer is the second of the triad of diseases associated with occupational exposure to asbestos fibers. Persons exposed to asbestos have a much greater chance of developing lung cancer if they smoke cigarettes. According to some sources as much as 87 times more lung cancer risk can be predicted for asbestos workers who are also heavy smokers.104

The third major disease that may result from exposure to asbestos fibers is malignant mesothelioma of the pleura (or peritoneum). Unlike asbestosis and lung cancer, mesothelioma is both more difficult to diagnosis and less sensitive to dose.105

Medical surveillance, of course, does not protect an employee from the potential effects of inhaled asbestos fibers, it cannot reverse the course of any of the three diseases briefly discussed above, and there are no fail-safe means of early diagnosis. For asbestosis in particular, there are no standardized criteria for diagnosis. "In the individual case, the recognition of the presence of adverse effects of exposure to asbestos dust inhalation is a judgement of probability."106

Because of the extensive time lag between exposure and the development of symptoms, the physician is faced with a severe

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dilemma in attempting to intervene to either prevent undue exposure or suffering. This is not to say that the occupational physician charged with the care of individuals who are exposed to asbestos fibers can do nothing, but rather, that it is wrong to expect medical surveillance to circumvent the effects of exposure. The prime role of the physician dealing with an asbestos exposed population is to insure that those who are hired are suitable to the employment in the first place.[107]

The pre-placement medical evaluation should be designed to determine the suitability of the individual for the job and vice-versa. Individuals with a previous history of exposure to asbestos or a history of employment in professions such as mining or quarrying or who may have already existing chronic obstructive pulmonary disease should be counseled to avoid further exposure.

Apart from identifying the individual ill-suited to employment in a job where they may be exposed to asbestos fibers, it is important to establish baseline data for longitudinal prospective follow-up. It is important to emphasize the principle of using the medical surveillance and evaluation record of each employee in such a way that the individual acts as his or her own biological monitor. In this way, the observant physician may be able to detect the earliest signs of developing asbestos related disease.[108]

A worker's clinical, radiological and pulmonary function readings must be carefully compared to detect changes and trends. In this regard, it is particularly important to have a thorough and rigorous initial or pre-employment examination. Any deviations from past records that cannot be explained, must be carefully considered, even if there is no recognizable disease entity present.

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During the pre-placement evaluation, the physician should take the opportunity to counsel the prospective employee concerning the known facts about the hazards associated with cigarette smoking and asbestos exposure, individually or collectively.[109]

The object of periodic medical evaluation is to look for the possibility of disease, to determine any changes in the physical condition. physiological status, and radiological appearances of the individual. Additionally, the physician should re-evaluate the suitability of the employee to continue in the same job. and attempt to determine changes in workplace conditions. During the evaluation, the examining physician should concentrate upon the early physical signs associated with pulmonary fibrosis, such as bilateral end-inspiratory fine crackles at the lung bases, finger clubing and breathlessness. [110]

The aim of serial x-rays is to develop a continous record of an individuals radiographic status so that the earliest changes may be detected, and where necessary the individual advised to consider alternative employment. The most common characteristic change found is basal diffuse interstitial fibrosis. Although, pleural lesions are often the first radiological indicator of exposure to asbestos, it has been shown that pleural changes are most closely related to length of exposure, irrespective of dose.[111]

If an individual shows solid radiographic evidence of diffuse pulmonary fibrosis, even if minimal, he or she should be advised that further exposure can only lead to worsening of the condition with time. The greater the cumulative exposure, the greater the risk of progressive pulmonary fibrosis. Because the development of lung cancer in asbestos exposed persons has been firmly linked to dose, any additional exposure to asbestos can only increase the risk.[112]

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Over the last few years, the use of computed tomography (CT) for the diagnosis of asbestosis and asbestos related diseases has become more popular. Indeed, the use of CT has been shown to demonstrate the presence of asbestos related lesions in the lungs more readily than conventional roentgenograms. Although not yet in common practice, this technique can be of assistance in the early diagnosis of asbestos related changes in the lungs. By the time the changes of asbestosis have become visible on conventional chest x-rays, the changes on CT scan appear gross.[113]

Early detection of any of the signs of adverse physiological response to asbestos fibers should be a prime consideration of any medical surveillance program. One group that studied several groups of factory workers who had been exposed to asbestos, developed an index of the earliest signs that would indicate that the lungs of a worker were adversely affected, whether from asbestos exposure or not. The list is as follows:

a. Late inspiratory crackles in the lower third of the thorax which do not clear on coughing or on any subsequent examination.

b. Radiological pleural shadowing (with or without calcification).

c. Radiological parenchymal changes in the lower half of the lung fields.

d. Vital Capacity more than 20% below the predicted value, with the FEV_1/FVC remaining over 0.70.

e. Vital Capacity falling faster than predicted by 20% or more without concomitant increases in the Functional Residual Capacity.

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f. Single Breath Gas Transfer Factor 20% or more below the predicted value.

g. Gas Transfer Factor falling faster than predicted by 20% or more.

h. FEV_1/FVC less than 0.70.[114]

Of these eight symptoms the one least useful and most suspect is the FEV_1/FVC that is less than 0.70. The reason is that although the FEV_1/FVC less than 0.70 accounted for 34% to 40% of all effect occurrences. it did not correlate with exposure. Thus, these authors conclude "that FEV_1/FVC less than 0.70 is an inappropriate criterion of an adverse effect of asbestos."[116] Another author commented that, "It is recognized that the commonest cause of obstructive lung disease as measured by diminution of FEV_1/FVC is cigarette smoking"[115]

The final value of the medical surveillance efforts that an organization makes on behalf of its employees depends upon the manner and thoroughness with which it is performed. Medical surveillance for asbestos exposed persons is of necessity a life long affair, and it is thus most important to start it off properly. Without proper baseline studies, much of the value of the later work may be lessened or lost.

Every effort thould be made to standardize diagnostic techniques among all participating physicians. Standard criteria for the evaluation of radiographs should be adopted at the earliest moment and continued in use as long as reasonable to give continuity to efforts. Finally, it is very important that the physician caring for the asbestos exposed worker be aware of not only the epidemiology, etiology, pathogenesis and therapy of asbestos related disease, but that he or she should also be aware of the conditions that prevail on the job site.

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6/3/83

Recommended Revision of 1910.1001

(a) Scope and Application.

(1) This section applies to all occupational exposure to asbestos except as provided in paragraph (a)(2).

(2) This section does not apply to construction work as defined in 29 CFR 1910.12(b).

(b) Definitions.

For the purpose of this section,

(1) "Asbestos" A term applied to six naturally occuring minerals that are used commercially for their desirable physical properties which are in part derived from their asbestiform habit. These minerals are:

(a) The serpentine mineral chrysotile;

(b) The amphibole mineral grunerite asbestos (also referred to as "amosite');

(c) The amphibole mineral riebeckite asbestos (also referred to as "Crocidolite";

(d) The amphibole mineral anthophyllite asbestos;

(e) The amphibole mineral tremolite asbestos;

(f) The amphibole mineral actinolite asbestos.

(2) "Asbestos fiber" means a fibrous form of asbestos, longer than 5 micrometers with a length-to-diameter ratio of at least 5 to 1, and with a maximum diameter of 3 micrometers.

(3) "Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

(4) "Director" means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Dept. of Health and Human Services (DHHS) or designee.

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(5) "Action Level" means employee exposure to airborne asbestos at or above 0.1 fibers per cubic centimeter of air averaged over an eight hour period.

(6) "Competent Person" An individual who by virtue of education, training, or experience with asbestos is qualified to make determinations as required in this standard.

(7) "Exposure" means the actual concentration of airborne asbestos fiber that is present in the inspired air.

(8) "Practical" means capable of being applied using existing technology in a cost effective manner.

(9) "Written Policy" means a written document defining company approaches to and assigning responsibility for, reducing employee exposures to airborne asbestos.

(10) "Administrative Control" means action on the part of the employer that moves the employee to a place of lower exposure or reduce work hours so that daily time-weighted average exposures are reduced.

(11) "Engineering Controls" means the employment of mechanical methods or process redesign to eliminate, divert, dilute, contain and or collect asbestos emissions at the point of generation.

(12) "Work Practice Controls" means instructing employees to repeatedly perform certain activities in a specified manner so that airborne asbestos concentrations are eliminated or reduced.

(c) Permissible Exposure to Airborne Concentrations of Asbestos Fibers

(1) The eight hour time weighted average airborne concentration of asbestos fibers to which any employee is exposed shall not exceed 0.5 fibers per cubic centimeter of air as determined on the basis of the sampling and analytical method prescribed in this standard.

(2) For general industry, compliance with this standard shall be achieved over a period of 12 months from the effective date of this standard.

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(3) For asbestos producing or manufacturing industries compliance with this standard shall be as follows.

(a) Within one year from the effective date of this standard, a PEL of 1 fiber/cc shall be achieved.

(b) Within four years from the effective date of the standard, a PEL of 0.5 fibers/cc shall be achieved.

(4) "Ceiling level" means the level above which employees shall not be exposed. No employee shall be exposed to airborne concentrations of asbestos fibers in excess of 10 fibers per cubic centimeter of air as determined over a sampling period of 15 minutes, by the sampling and analytical method prescribed in this standard.

(d) Compliance Policy

When initial monitoring as decribed in Paragraph (i)(1) of this section indicates that employees are exposed at or above the Action Level as described in paragraph (b) (5) of this section, employers shall establish and implement a written policy to assure that exposures to airborne asbestos do not exceed the limits prescribed in paragraph (c) of this section.

(e) Methods Of Compliance

(1) Engineering controls: Engineering Controls shall be used to meet exposure limits to the extent practical.

(2) Where engineering controls are not practical or are ineffective, appropriate administrative controls, work practice controls and approved respiratory protective equipment must be used to meet the exposure limit described in paragraph (c) of this standard.

(3) Exhaust ventilation: Where local exhaust ventilation is utilized to attain compliance, an adequate maintenance schedule shall be established and sufficient inspections shall be performed to ensure that it is operating as required.

(4) Work practices, wet methods: Insofar as practical, asbestos and asbestos containing products shall be handled and worked in a wet state, except when doing so would create a hazard greater than that posed by the asbestos.

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(5) Respiratory Protective Equipment

(a) Respiratory equipment used must be of a type approved by current regulations for the certification of respirators. Use must be in accordance with 29 CFR 1910.134 and the following table:

Table 1 -- Permissible Respirators

Type of Respirator	Limits as a multiple of TWA or Ceiling PEL.
1. Disposable	Up to 5X
2. Half-face; air purifying	Up to 10X
3. Full-face; air purifying	Up to 50X
4. Full-face; powered air purifying	Up to 100X
5. Full-face; pressure demand or continous flow, air supplied.	No limit.

(1) Other types of respirators approved under applicable regulations may also be used.

(2) Establishment of a respirator program.

(a) The employer shall establish and maintain a respirator program in accordance with 29 CFR 1910.134.

(f) Personal Protective Clothing

(1) Special clothing: The employer shall provide and require the use of clothing, such as coveralls, or similar whole body clothing, head coverings, gloves and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the limits prescribed in Paragraph (c) of this section, or where personal clothing may become contaminated.

(2) Where employees clothing becomes contaminated with asbestos fibers in the course of assigned work, contaminated clothing shall not leave the workplace except as discussed in paragraph (g)(4) of this section.

(3) At fixed locations, all protective clothing and equipment shall be removed only in change areas required by paragraph (g)(1) of this section.

(g) Hygiene Facilities and Practices

(1) Change Areas: At any fixed place of employment, change areas shall be provided for any operation in which employees are exposed to asbestos fibers in excess of the PEL or where protective clothing is required by this standard.

(2) Washing Facilities: Washing facilities shall be provided for all employees required to wear respiratory protective equipment or personal protective clothing by Paragraphs (e) and (f) respectively of this section. As a minimum, such employees shall be required to wash all exposed parts of their bodies.

(3) Clothes Storage: When an employee is required to store items of work clothing for reuse, the employer shall provide separate containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes by work clothes.

(4) Laundering:

(a) Handling and laundering of asbestos contaminated clothing shall be done in such a manner as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (c) of this section.

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

(c) Contaminated clothing shall be transported in sealed impermeable containers, and labeled in accordance with paragraph (j)(3) of this section.

(h) Method of Measurement

Airborne concentrations of asbestos fibers shall be determined by the membrane filter method at 400-450 X (magnification) (4 millimeter objective) with phase contrast illumination or an equivalent method approved by the Director.

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(i) Monitoring

(1) Initial Determination: Where asbestos or asbestos containing materials are present or used in the workplace, a competent person shall determine whether employees may be exposed at or above the Action Level.

(2) Initial Monitoring: If the initial determination shows that employees may be exposed to asbestos at or above the Action Level, then the employer shall perform monitoring to determine whether any person is exposed to airborne asbestos fibers in excess of permissible limits.

(3) Past data may be used to comply with Paragraph (i)(2) provided that the data was derived using the sampling and analytical techniques prescribed in this standard, and that the operation for which the initial determination was performed has not significantly changed with respect to asbestos concentrations.

(4) Sampling frequency: If, after the initial monitoring required by subparagraph (i)(2) of this paragraph, it is found that the PEL is exceeded, sample collection shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees.

In no case shall the sampling be done at intervals greater than six months for employees whose exposure to asbestos exceeds the action level.

(5) Representative Monitoring: Sampling shall be conducted in a manner which assures that results are reasonably indicative of the employee's exposure(s).

(6) Employee Observation Of Monitoring: Affected employees, or their representative, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(j) Caution Signs and Labels

(1) Caution signs: Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the limits prescribed in Paragraph (c) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs.

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(2) Sign Specifications: The warning signs required by this subparagraph shall be clearly legible and explicitly state, ASBESTOS, DANGER, CANCER HAZARD! Other information necessary to protect employees may also be displayed, provided it in no way detracts from or diminishes the primary warning.

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

(4) Label Specifications: The caution labels required by subdivision (k)(3) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

ASBESTOS

DANGER

CANCER HAZARD!

Contains Asbestos Fibers
Avoid Creating Dust

Additional warning data may also be included provided it does not significantly detract from or diminish the primary warning.

(k) House Keeping

(1) Cleaning: All exposed surfaces in any place of employment shall be maintained as free as practical of accumulations of asbestos fibers.

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

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(i) Record Keeping

(1) Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained as in 29 CFR 1910.20 and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and their authorized representatives.

(2) Access to records: Employee exposure records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-1.

(m) Employee Notification

Any employee found to have been exposed (without regard to personal protective equipment) to concentrations of asbestos fibers in excess of limits prescribed in Paragraph (c) of this section shall, after receipt of analytical results, be notified of the exposure as soon as practical. The employee shall also be notified of corrective action being taken. Employees who the employer reasonably believes were also exposed, above the PEL (Paragraph (C)) but who were not monitored, shall also be notified.

(n) Training

(1) Each employer whose employees are exposed above the Action Level shall have a written training program.

(2) The following elements shall be addressed in any training program:

(a) The requirements of this standard.

(b) The contents of the written compliance plan.

(c) The hazardous properties of asbestos.

(d) The engineering controls and work practices established to minimize employee exposure.

(e) The effective use of personal protective equipment supplied.

(f) Safe work procedures for handling asbestos or asbestos containing materials.

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(3) Training shall be repeated annually for all exposed employees.

(4) All training given to individual employees shall be documented, to include date and content.

(5) This standard shall be posted, or otherwise made available to all exposed employees.

(o) Medical Surveillance

(1) The employer shall institute a medical surveillance program for all employees who are exposed to airborne concentrations of asbestos fibers in excess of the action level for more than a total of 30 days per year.

(a) The employer shall assure that all medical surveillance is performed by persons under the supervision of a licensed physician. Minimal training guidelines (non-mandatory) for physicians supervising the medical surveillance of asbestos exposed persons are briefly outlined in Appendix D.

(b) Persons other than such licensed physicians, who administer the pulmonary function testing required by this section, shall complete a training course in spirometry sponsored by an appropriate academic or professional institution.

(2) Preplacement: The employer shall make available to each exposed employee, at the employers cost, an appropriate medical evaluation relative to exposure to asbestos, as defined in (p)(1), prior to first employment or reassignment from other duties in such conditions, no later than 30 calendar days from the date of first employment or reassignment.

(a) Such examination shall include, as a minimum, a questionnaire, to elicit symptoms of respiratory disease (Appendix A-1), pulmonary function tests of ventilatory capacity including forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0), and a chest roentgenogram, (see Appendices B-1) and B-2)). Pulmonary function tests shall be administered and interpreted in accordance with appropriate professional specifications, see Appendices C-1) and C-2).

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(3) Periodic Evaluations: Every employer shall make available a medical evaluation relative to exposure to asbestos to each employee in accordance with the schedule in Table 1.

(a) Periodic medical evaluations shall be made available for the duration of employment, regardless of future workplace exposure levels.

(b) The periodic evaluation shall include a questionnaire to elicit symptomatology of respiratory disease, (Appendix A-2); pulmonary function tests as in (p)(2)(a) and a chest roentgenogram (posterior-anterior 14 x 17 inches). The frequency of each procedure shall be as required in Table 1. Chest roentgenographic examinations shall be made in accordance with appropriate professional specifications, see Appendix B-1 and 2. Pulmonary function tests shall be administered and interpreted in accordance with appropriate professional specifications, see Appendix C-1 and 2.

(4) Termination of employment: The employer shall make available a medical evaluation within 30 calendar days before or after the date of termination of employment of any employee who has been exposed to airborne concentrations of asbestos in excess of the action level (0.1 fiber/cc) for more than a total of 30 eight hour days in the preceding 12 month period. The evaluation shall be in accordance with and comparable to the requirements of the periodic evaluations stipulated in (p)(3). Where a periodic evaluation has been completed during the preceeding 12 months, no further evaluation is required.

(5) Recent evaluations: No medical evaluation is required of any employee who has been evaluated in accordance with this section within the past 12 months.

(6) Employee Notification: Any abnormality or evidence of disease found during the medical evaluation shall be communicated to the employee within 30 calendar days by the evaluating physician.

(7) Employer Notification: With respect to each examination required by this paragraph, the employer shall obtain a written opinion from the evaluating physician. The written opinion shall not reveal specific findings or diagnosis unrelated to occupational exposure to asbestos fibers. The physicians opinion shall contain the following:

(a) The physician shall state whether the individual is qualified to perform assigned duties.

(b) Any recommended limitations upon the employee's exposure to asbestos fibers, or upon the use of protective clothing and equipment such as respirators;

(c) A statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.

(8) Medical Records: The employer shall keep an accurate medical record for each employee subject to medical surveillance as required by this section and 29 CFR 1910.20.

(9) Employee Access to Medical Records: Employee access to medical records whall be in accordance with the relevant paragraphs of 29 CFR 1910.20.

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NON-MANDATORY

INITIAL MEDICAL EXAMINATION

PRIVATE AND CONFIDENTIAL

72

ALL INFORMATION OBTAINED IN THE STUDY WILL BE KEPT CONFIDENTIAL AND USED FOR MEDICAL PURPOSES ONLY. Your personal physician will be informed about the test results if you desire.

1. NAME _____

2. SOCIAL SECURITY # _____ (1 2 3 4 5 6 7 8 9)

3 CLOCK NUMBER _____ (10 11 12 13 14 15)

4. PRESENT OCCUPATION _____

5. PLANT _____

6. ADDRESS _____

7. _____ (Zip Code)

8 TELEPHONE NUMBER _____

9 INTERVIEWER _____

10 DATE _____ (16 17 18 19 20 21)

11. Date of Birth _____ (22 23 24 25 26 27)
Month Day Year MO DAY YR

12 Place of Birth _____

13. Sex
1. Male ____
2. Female ____

14 What is your marital status?
1. Single ____
2. Married ____
3. Widowed ____
4. Separated/Divorced ____

15 Race
1. White ____
2. Black ____
3. Asian ____
4. Hispanic ____
5. Indian ____
6. Other ____

16 What is the highest grade completed in school? _____
(For example 12 years is completion of high school).

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OCCUPATIONAL HISTORY

17A. Have you ever worked full time (30 hours per week or more) for 6 months or more? 1. Yes ___ 2. No ___

IF *YES* TO 17A:

B. Have you ever worked for a year or more in any dusty job? 1. Yes ___ 2. No ___ 8. Does not apply ___

Specify job/industry _____ Total years worked ___

Was dust exposure: 1. Mild ___ 2. Moderate ___ 3. Severe ___ ?

C. Have you ever been exposed to gas or chemical fumes in your work? 1. Yes ___ 2. No ___

Specify job/industry _____ Total years worked ___

Was exposure: 1. Mild ___ 2. Moderate ___ 3. Severe ___ ?

D. What has been your usual occupation or job – the one you have worked at the longest?

1. Job occupation _____
2. Number of years employed in this occupation _____
3. Position job title _____
4. Business, field, or industry _____

(Record on lines the years in which you have worked in any of these industries, e.g. 1960-1969)

Have you ever worked	YES	NO
E • In a mine?	☐	☐
F • In a quarry?	☐	☐
G • In a foundry?	☐	☐
H • In a pottery?	☐	☐
I • In a cotton, flax or hemp mill?	☐	☐
J • With asbestos?	☐	☐

18. PAST MEDICAL HISTORY

	YES	NO
A Do you consider yourself to be in good health?	☐	☐
If "NO" state reason. _____		
B Have you any defect of vision?	☐	☐
If "YES" state nature of defect. _____		
C Have you any hearing defect?	☐	☐
If "YES" state nature of defect. _____		
D Are you suffering from or have you ever suffered from		
a Epilepsy (or fits, seizures, convulsions)?	☐	☐
b. Rheumatic fever?	☐	☐
c. Kidney disease?	☐	☐
d. Bladder disease?	☐	☐
e. Diabetes?	☐	☐
f. Jaundice?	☐	☐

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19. CHEST COLDS AND CHEST ILLNESSES

19A. If you get a cold, does it usually go to your chest? (Usually means more than ½ the time.) 1. Yes ___ 2. No ___ 3. Don't get colds ___

20A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? 1. Yes ___ 2. No ___

IF YES TO 20A:

B Did you produce phlegm with any of these chest illnesses? 1. Yes ___ 2. No ___ 8 Does not apply ___

C In the last 3 years, how many such illnesses, with (increased) phlegm, did you have which lasted a week or more? ___ Number of illnesses ___ No such illnesses 8 Does not apply ___

21. Did you have any lung trouble before the age of 16? 1. Yes ___ 2. No ___

22. Have you ever had any of the following?

1A Attacks of bronchitis? 1. Yes ___ 2. No ___

IF YES TO 1A:

B. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

C At what age was your first attack? ___ Age in years 88 Does not apply ___

2A Pneumonia (include bronchopneumonia)? 1. Yes ___ 2. No ___

IF YES TO 2A

B Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

C At what age did you first have it? ___ Age in years 88 Does not apply ___

3A Hay fever? 1. Yes ___ 2. No ___

IF YES TO 3A

B Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8 Does not apply ___

C At what age did it start? ___ Age in years 88 Does not apply ___

23A Have you ever had chronic bronchitis? 1. Yes ___ 2. No ___

IF YES TO 23A

B Do you still have it? 1 Yes ___ 2. No ___ 8 Does not apply ___

C Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8 Does not apply ___

D At what age did it start? ___ Age in years 88 Does not apply ___

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24A. Have you ever had emphysema? 1. Yes ___ 2. No ___

IF *YES* TO 24A:

B Do you still have it? 1. Yes ___ 2. No ___ 8. Does not apply ___

C. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

D At what age did it start? ___ Age in years 88. Does not apply ___

25A. Have you ever had asthma? 1. Yes ___ 2. No ___

IF *YES* TO 25A:

B Do you still have it? 1. Yes ___ 2. No ___ 8. Does not apply ___

C Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

D At what age did it start? ___ Age in years 88. Does not apply ___

E If you no longer have it, at what age did it stop? ___ Age stopped 88 Does not apply ___

26 Have you ever had

A Any other chest illness? 1. Yes ___ 2. No ___
If yes, please specify ___

B Any chest operations? 1. Yes ___ 2. No ___
If yes, please specify ___

C Any chest injuries? 1. Yes ___ 2. No ___
If yes, please specify ___

27A Has a doctor ever told you that you had heart trouble? 1. Yes ___ 2. No ___

IF *YES* TO 27A:

B Have you ever had treatment for heart trouble in the past 10 years? 1. Yes ___ 2. No ___ 8. Does not apply ___

28A Has a doctor ever told you that you had high blood pressure? 1. Yes ___ 2. No ___

IF *YES* TO 28A:

B Have you had any treatment for high blood pressure (hypertension) in the past 10 years? 1. Yes ___ 2. No ___ 8. Does not apply ___

29. When did you last have your chest X-rayed (Year)? ... ___ ___ ___ ___ 25 26 27 28

30 Where did you last have your chest X-rayed (if known)? ___

What was the outcome? ___

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FAMILY HISTORY

31. Were either of your natural parents ever told by a doctor that they had a chronic lung condition such as:

	FATHER			MOTHER		
	1. YES	2. NO	3. DON'T KNOW	1. YES	2. NO	3. DON'T KNOW
A Chronic bronchitis?	____	____	____	____	____	____
B Emphysema?	____	____	____	____	____	____
C Asthma?	____	____	____	____	____	____
D Lung cancer?	____	____	____	____	____	____
E Other chest conditions?	____	____	____	____	____	____
F. Is parent currently alive?	____	____	____	____	____	____
G Please Specify	____ Age if living ____ Age at death 8. Don't know ____			____ Age if living ____ Age at death 8 Don't know ____		
H. Please specify cause of death	____			____		

COUGH

32 Do you usually have a cough? (Count a cough with first smoke or on first going out-of-doors. Exclude clearing of throat.) [If no, skip to Question 32C.]
1. Yes ____ 2. No ____

B Do you usually cough as much as 4 to 6 times a day, 4 or more days out of the week?
1. Yes ____ 2. No ____

C Do you usually cough at all on getting up, or first thing in the morning?
1. Yes ____ 2. No ____

D Do you usually cough at all during the rest of the day or at night?
1. Yes ____ 2. No ____

IF *YES* TO ANY OF ABOVE (32A, B, C, OR D), ANSWER THE FOLLOWING:
IF *NO* TO ALL, CHECK *DOES NOT APPLY* AND SKIP TO NEXT PAGE.

E Do you usually cough like this on most days for 3 consecutive months or more during the year?
1. Yes ____ 2. No ____
8 Does not apply ____

F For how many years have you had this cough? ____
Number of years
88 Does not apply ____

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FAMILY HISTORY

31. Were either of your natural parents ever told by a doctor that they had a chronic lung condition such as:

	FATHER			MOTHER		
	1. YES	2. NO	3. DON'T KNOW	1. YES	2. NO	3. DON'T KNOW
A Chronic bronchitis?	____	____	____	____	____	____
B Emphysema?	____	____	____	____	____	____
C Asthma?	____	____	____	____	____	____
D Lung cancer?	____	____	____	____	____	____
E Other chest conditions?	____	____	____	____	____	____
F. Is parent currently alive?	____	____	____	____	____	____
G Please Specify	____ Age if living ____ Age at death 8 Don't know ____			____ Age if living ____ Age at death 8 Don't know ____		
H. Please specify cause of death	____			____		

COUGH

32 Do you usually have a cough? (Count a cough with first smoke or on first going out-of-doors. Exclude clearing of throat.) [If no, skip to Question 32C.] 1. Yes ____ 2. No ____

B Do you usually cough as much as 4 to 6 times a day, 4 or more days out of the week? 1. Yes ____ 2. No ____

C Do you usually cough at all on getting up, or first thing in the morning? 1. Yes ____ 2. No ____

D Do you usually cough at all during the rest of the day or at night? 1. Yes ____ 2. No ____

IF *YES* TO ANY OF ABOVE (32A, B, C, OR D), ANSWER THE FOLLOWING:
IF *NO* TO ALL, CHECK *DOES NOT APPLY* AND SKIP TO NEXT PAGE.

E Do you usually cough like this on most days for 3 consecutive months or more during the year? 1. Yes ____ 2. No ____
8 Does not apply ____

F For how many years have you had this cough? - ____ Number of years
88 Does not apply ____

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37. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to question 39A.
Nature of condition(s): _____

38A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ___ 2. No ___

IF YES TO 38A

B. Do you have to walk slower than people of your age on the level because of breathlessness? 1. Yes ___ 2. No ___ 8. Does not apply ___

C. Do you ever have to stop for breath when walking at your own pace on the level? 1. Yes ___ 2. No ___ 8. Does not apply ___

D Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level? 1. Yes ___ 2. No ___ 8. Does not apply ___

E Are you too breathless to leave the house or breathless on dressing or undressing? 1. Yes ___ 2. No ___ 8. Does not apply ___

TOBACCO SMOKING

39A Have you ever smoked cigarettes? (*No* means less than 20 packs of cigarettes or 12 oz of tobacco in a lifetime or less than 1 cigarette a day for 1 year 1. Yes ___ 2. No ___

IF YES TO 39A

B Do you now smoke cigarettes (as of 1 month ago)? 1. Yes ___ 2. No ___ 8. Does not apply ___

C How old were you when you first started regular cigarette smoking? ___ Age in years 88. Does not apply ___

D If you have stopped smoking cigarettes completely, how old were you when you stopped? ___ Age stopped Check if still smoking ___ 88. Does not apply ___

E How many cigarettes do you smoke per day now? ___ Cigarettes per day 88. Does not apply ___

F On the average of the entire time you smoked, how many cigarettes did you smoke per day? ___ Cigarettes per day 88 Does not apply ___

G Do or did you inhale the cigarette smoke? 1. Does not apply ___ 2. Not at all ___ 3. Slightly ___ 4. Moderately ___ 5. Deeply ___

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40A. Have you ever smoked a pipe regularly? (*Yes* means more than 12 oz of tobacco in a lifetime.) 1. Yes ___ 2. No ___

___ IF *YES* TO 40A: ___

FOR PERSONS WHO HAVE EVER SMOKED A PIPE:

B. 1. How old were you when you started to smoke a pipe regularly? ___ Age

2. If you have stopped smoking a pipe completely, how old were you when you stopped? ___ Age stopped
Check if still smoking pipe ___
88 Does not apply ___

C On the average over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week? ___ oz per week (a standard pouch of tobacco contains 1½ oz)
88 Does not apply ___

D How much pipe tobacco are you smoking now? ___ oz per week
88 Not currently smoking a pipe ___

E Do you or did you inhale the pipe smoke?
1 Never smoked ___
2. Not at all ___
3. Slightly ___
4 Moderately ___
5 Deeply ___

41A Have you ever smoked cigars regularly? (*Yes* means more than 1 cigar a week for a year.) 1. Yes ___ 2. No ___

___ IF *YES* TO 41A ___

FOR PERSONS WHO HAVE EVER SMOKED CIGARS

B 1 How old were you when you started smoking cigars regularly? ___ Age

2 If you have stopped smoking cigars completely, how old were you when you stopped? ___ Age stopped
Check if still smoking cigars ___
88 Does not apply ___

C On the average, over the entire time you smoked cigars, how many cigars did you smoke per week? ___ Cigars per week
88 Does not apply ___

D How many cigars are you smoking per week now? ___ Cigars per week
88 Check if not smoking cigars currently ___

E Do or did you inhale the cigar smoke?
1. Never smoked ___
2. Not at all ___
3. Slightly ___
4 Moderately ___
5 Deeply ___

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APPENDIX A-2
NON-MANDATORY

PERIODIC MEDICAL EXAMINATION
PRIVATE AND CONFIDENTIAL

80

All information obtained in this study will be kept confidential and used for medical purposes only. Your personal physician will be informed about the test results if you desire.

1. NAME: _____

2. SOCIAL SECURITY # _____ (1 2 3 4 5 6 7 8 9)

3 CLOCK NUMBER _____ (10 11 12 13 14 15)

4 PRESENT OCCUPATION: _____

5. PLANT: _____

6. ADDRESS: _____

7. _____ (Zip Code)

8. TELEPHONE NUMBER: _____

9. INTERVIEWER: _____

10. DATE: _____ (16 17 18 19 20 21)

11. Date of Birth: _____ (22 23 24 25 26 27)
Month Day Year MO DAY YR

12. Place of Birth _____

14. What is your marital status?
1. Single ___
2. Married ___
3. Widowed ___
4. Separated/Divorced ___

17J Total years exposed to asbestos _____ _____

17K Date of first exposure to asbestos _____ _____

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PAST MEDICAL HISTORY

		YES	NO
18A.	Do you consider yourself to be in good health?	☐	☐
	If "NO" state reason. _____		
B.	Have you any defect of vision?	☐	☐
	If "YES" state nature of defect. _____		
C.	Have you any hearing defect?	☐	☐
	If "YES" state nature of defect. _____		
D.	Are you suffering from or have you ever suffered from:		
	a. Epilepsy (or fits, seizures, convulsions)?	☐	☐
	b. Rheumatic fever?	☐	☐
	c. Kidney disease?	☐	☐
	d. Bladder disease?	☐	☐
	e. Diabetes?	☐	☐
	f. Jaundice?	☐	☐

19. CHEST COLDS AND CHEST ILLNESSES

19A. If you get a cold, does it usually go to your chest? (Usually means more than ½ the time.) 1. Yes ___ 2. No ___ 3. Don't get colds ___

20A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? 1. Yes ___ 2. No ___

IF *YES* TO 20A

B Did you produce phlegm with any of these chest illnesses? 1. Yes ___ 2. No ___ 8. Does not apply ___

C In the last 3 years, how many such illnesses, with (increased) phlegm, did you have which lasted a week or more? ___ Number of illnesses ___ No such illnesses 8. Does not apply ___

22. Have you had any of the following in the past year?

1A Attacks of bronchitis? 1. Yes ___ 2. No ___

IF *YES* TO 1A

B Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

C. At what age was your first attack? ___ Age in years 88 Does not apply ___

2A Pneumonia (include bronchopneumonia)? 1. Yes ___ 2. No ___

IF *YES* TO 2A

B Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply ___

C At what age did you first have it? ___ Age in years 88 Does not apply ___

3A Hay fever? 1. Yes ___ 2. No ___

IF *YES* TO 3A

B Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8 Does not apply ___

C At what age did it start? ___ Age in years 88 Does not apply ___

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26. Have you had:

A. Any other chest illness? 1. Yes ___ 2. No ___
If yes, please specify _____

B. Any chest operations? 1. Yes ___ 2. No ___
If yes, please specify _____

C. Any chest injuries? 1. Yes ___ 2. No ___
If yes, please specify _____

27A Has a doctor told you that you had heart trouble? 1. Yes ___ 2. No ___

IF *YES* to 27A:

B Have you ever had treatment for heart trouble in the past 10 years? 1. Yes ___ 2. No ___ 8. Does not apply ___

28A. Has a doctor told you that you had high blood pressure? 1. Yes ___ 2. No ___

IF YES TO 28A:

B. Have you had any treatment for high blood pressure (hypertension) in the past 10 years? 1. Yes ___ 2. No ___ 8. Does not apply ___

29A. When did you last have your chest X-rayed (Year)? ... ___ ___ ___ ___ (25 26 27 28)

30. Where did you last have your chest X-rayed (if known)?

_____

What was the outcome? (explain) _____

FAMILY HISTORY

31. Were either of your natural parents ever told by a doctor that they had a chronic lung condition such as

	FATHER			MOTHER		
	1. YES	2. NO	3. DON'T KNOW	1. YES	2. NO	3. DON'T KNOW
A Chronic bronchitis?	___	___	___	___	___	___
B Emphysema?	___	___	___	___	___	___
C Asthma?	___	___	___	___	___	___
D Lung cancer?	___	___	___	___	___	___
E Other chest conditions?	___	___	___	___	___	___
F. Is parent currently alive?	___	___	___	___	___	___
G. Please Specify						
	___ Age if living			___ Age if living		
	___ Age at death			___ Age at death		
	8 Don't know ___			8. Don't know ___		
H. Please specify cause of death	_____			_____		

Card Number

COUGH

32A. Do you usually have a cough? (Count a cough with first smoke or on first going out-of-doors. Exclude clearing of throat.) [If no, skip to Question 32C.] 1. Yes ___ 2. No ___

B. Do you usually cough as much as 4 to 6 times a day, 4 or more days out of the week? 1. Yes ___ 2. No ___

C. Do you usually cough at all on getting up, or first thing in the morning? 1. Yes ___ 2. No ___

D. Do you usually cough at all during the rest of the day or at night? 1. Yes ___ 2. No ___

IF *YES* TO ANY OF ABOVE (32A, B, C, OR D), ANSWER THE FOLLOWING:
IF *NO* TO ALL, CHECK *DOES NOT APPLY* AND SKIP TO NEXT PAGE.

E Do you usually cough like this on most days for 3 consecutive months or more during the year? 1. Yes ___ 2. No ___ 8. Does not apply ___

F. For how many years have you had this cough? _____ Number of years 88. Does not apply ___

PHLEGM

33A Do you usually bring up phlegm from your chest?
(Count phlegm with the first smoke or on first going out-of-doors Exclude phlegm from the nose Count swallowed phlegm.)
[If no, skip to 33C.] 1. Yes ___ 2. No ___

B Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week? 1. Yes ___ 2. No ___

C. Do you usually bring up phlegm at all on getting up, or first thing in the morning? 1. Yes ___ 2. No ___

D Do you usually bring up phlegm at all during the rest of the day or at night? 1. Yes ___ 2. No ___

IF *YES* TO ANY OF THE ABOVE (33A, B, C, OR D),
ANSWER THE FOLLOWING:
IF *NO* TO ALL, CHECK *DOES NOT APPLY* AND SKIP TO 34A.

E Do you bring up phlegm like this on most days for 3 consecutive months or more during the year? 1. Yes ___ 2. No ___ 8. Does not apply ___

F. For how many years have you had trouble with phlegm? _____ Number of years 88 Does not apply ___

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EPISODES OF COUGH AND PHLEGM

34A. Have you had periods or episodes of (increased*) cough and phlegm lasting for 3 weeks or more each year?
*(For persons who usually have cough and/or phlegm)
1. Yes ___ 2. No ___

IF YES TO 34A

B For how long have you had at least 1 such episode per year?
___ Number of years
88. Does not apply ___

WHEEZING

35A Does your chest ever sound wheezy or whistling

1. When you have a cold? 1. Yes ___ 2. No ___
2. Occasionally apart from colds? 1. Yes ___ 2. No ___
3. Most days or nights? 1. Yes ___ 2. No ___

IF YES TO 1, 2, OR 3 IN 35A

B For how many years has this been present?
___ Number of years
88. Does not apply ___

36A Have you ever had an attack of wheezing that has made you feel short of breath? 1. Yes ___ 2. No ___

IF YES TO 36A

B How old were you when you had your first such attack? ___ Age in years
88 Does not apply ___

C Have you had 2 or more such episodes? 1. Yes ___ 2. No ___
8. Does not apply ___

D Have you ever required medicine or treatment for the(se) attack(s)? 1. Yes ___ 2. No ___
8. Does not apply ___

BREATHLESSNESS

37. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to Question 39A.
Nature of condition(s) ___

38A Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ___ 2. No ___

IF YES TO 38A

B Do you have to walk slower than people of your age on the level because of breathlessness? 1. Yes ___ 2. No ___
8. Does not apply ___

C Do you ever have to stop for breath when walking at your own pace on the level? 1. Yes ___ 2. No ___
8 Does not apply ___

D Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level? 1. Yes ___ 2. No ___
8 Does not apply ___

E Are you too breathless to leave the house or breathless on dressing or undressing? 1. Yes ___ 2 No ___
8 Does not apply ___

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TOBACCO SMOKING

39A. Have you ever smoked cigarettes? (*No* means less than 20 packs of cigarettes or 12 oz of tobacco in a lifetime or less than 1 cigarette a day for 1 year.

1. Yes ___ 2. No ___

IF *YES* TO 39A:

B Do you now smoke cigarettes (as of 1 month ago)?
1. Yes ___ 2. No ___
8. Does not apply ___

C. How old were you when you first started regular cigarette smoking?
___ Age in years
88 Does not apply ___

D If you have stopped smoking cigarettes completely, how old were you when you stopped?
___ Age stopped
Check if still smoking ___
88 Does not apply ___

E How many cigarettes do you smoke per day now?
___ Cigarettes per day
88. Does not apply ___

F. On the average of the entire time you smoked, how many cigarettes did you smoke per day?
___ Cigarettes per day
88. Does not apply ___

G Do or did you inhale the cigarette smoke?
1. Does not apply ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

40A Have you ever smoked a pipe regularly? (*Yes* means more than 12 oz of tobacco in a lifetime.)

1. Yes ___ 2. No ___

IF *YES* TO 40A:

FOR PERSONS WHO HAVE EVER SMOKED A PIPE:

B 1. How old were you when you started to smoke a pipe regularly?
___
Age

2 If you have stopped smoking a pipe completely, how old were you when you stopped?
___ Age stopped
Check if still smoking pipe ___
88 Does not apply ___

C On the average over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week?
___ oz per week (a standard pouch of tobacco contains 1½ oz)
88. Does not apply ___

D How much pipe tobacco are you smoking now?
___ oz per week
88 Not currently smoking a pipe ___

E Do you or did you inhale the pipe smoke?
1. Never smoked ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

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APPENDIX A-3

Work Done by Standard Oil (Indiana)

For Further information Contact:
W.R. Quanstrom
Director, Industrial Hygiene
& Toxicology
200 East Randolph Drive
Chicago, Illinois 60601

MONITORING DATA ON ASBESTOS REMOVAL AND DEMOLITION ACTIVITIES IN REFINERIES AND CHEMICAL PLANTS

The monitoring data demonstrate that a half-face cartridge is adequate protection for demolition, removal, and similar operations involving asbestos insulation. It is more apparent that these exposures are minimal if one considers the following:

a. These results are not time weighted averages (TWA's) but are, instead the concentration measured over the time necessary to perform the task or less. TWA's would be considerably lower.

b. In the great majority of these operations, the individual exposed in any one instance would not again work with asbestos for many months. Also, since asbestos is not being installed in any new or repaired facilities, the frequency of exposure will continue to decrease.

c. In these samples, all fibers were counted as if they were asbestos, thus artificially inflating the results to some undetermined degree.

d. Given the expected variation introduced by the statistical variation inherent in the analysis of samples, there is serious doubt that the three samples that are reported to above 20 fibers/cc are even "real". This is, they are just as likely to be statistical anomalies.

This monitoring was done in Amoco Oil Company refineries and at chemical manufacturing and polymerization operations. Monitoring was conducted during installation, removal clean-up, demolition, and handling of asbestos containing insulation.

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A total of 251 personal (breathing zone) samples and 180 environmental (area) samples were collected during a four-year period. All monitoring and analysis were conducted by the precedure recommended by OSHA in 29 CFR 1910.1001. In addition, the asbestos content of the material was obtained from the manufacturer or by laboratory analysis where possible. A review of the data will reveal that only 11 of the 180 area samples exceeded two fibers per cubic centimeter of air (f/cc). Only one of these 11 exceeded 10 f/cc and that was during dry removal.

Table 1 is a compilation of personal monitoring results versus asbestos content. Results were segregated by wet or dry handling criteria as well as indoor or outdoorwork Where historical records did not distinguish wet or dry handling, the assumption was made that wet procedures were used. This was done in order to assume the worst exposure possibility under the best work practice procedure and thus make any error a conservative one. Based on the surveys conducted and estimated exposure times, no employee's exposure exceeded the allowable eight hour TWA of 2 f/cc. However, the permissible ceiling limit of 10f/cc as exceeded in 15 cases. Table 2 is a summary of these results.

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Table 1

Data Analysis for 251 Personal Breathing Zone Samples

Dry Operation

Fibers Per cc / Asbestos Content % wt.	Outdoors				Indoors				Total			
	<2	2 to 5 to <5 <10		≥10	<2	2 to 5 to <5 <10		≥10	<2	2 to 5 to <5 <10		≥10
0 - < 3	7	2							7	2		
3 - 9	33	5	3		12	1			45	6	3	
10 - 25	15	3	1		1	2	4	9	16	5	5	9
26 - 39												
40 - 100	25	10	3	3	2		3	3	27	10	6	6
Unknown	28	5	—	—	6	3	1	—	34	8	1	—
Subtotal	108	25	7	3	21	6	8	12	129	31	15	15
% of Total (approx.)	75	17	5	2	45	13	17	26	68	16	8	8

Wet Operation

	<2	2 to 5 to <5 <10		≥10	<2	2 to 5 to <5 <10		≥10	<2	2 to 5 to <5 <10		≥10
0 - < 3	1								1			
3 - 9												
10 - 25					1				1			
26 - 39												
40 - 100	3					1			3	1		
Unknown	54	—	1	—	—	—	—	—	54	—	1	—
Subtotal	58		1		1	1			59	1	1	
% of Total	98		2		50	50			97	<2	<2	

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Table 2

Asbestos Samples Exceeding 10 f/cc

Short-Term Personal Sample Results

Facility	f/cc	
BM	20.6	
	13.3	
	14.4	
CW	11.3	
	17.8	
	24.5	
	11.7	
WR	19.4	
	10.5	
	12.9	
	11.7	
	12.6	
	18.0	
SL	20.1	
	11.2	
NC	15.5	- Area Sample

Appendix B-1

NON-MANDATORY

Recommendations for Chest Roentgenographic Examinations for use in the Medical Surveillance of Persons Exposed to Asbestos.

(a) Every employer should have a written policy for chest roentgenographic examinations of persons exposed to asbestos.

(b) Every chest roentgenogram should be a single posteroanterior projection at full inspiration on a 14- by 17- inch film. the film and cassette should be capable of being positioned both vertically and horizontally so that the chest roentgenogram will include both apices and costophrenic angles. If a person is too large to permit the above requirements, then the projection should include both apices with minimum loss of the costophrenic angle.

(c) The employee should be disrobed from the waist up at the time the roentgenogram is given. The facility should provide a dressing area and for those persons who wish to use one, the facility should provide a clean gown. Facilities should be heated to a comfortable temperature. Pelvic and gonadal shielding shall be provided

(d) Roentgenograms should be made only with a diagnostic x-ray machine having a rotating anode tube with a maximum of a 2 mm. source (focal spot).

(g) Except as provided in paragraph (h) of this section, roentgenograms should be made with units having generators which comply with the following; (1). The generators of existing roentgenographic units acquired by the examining facility prior to July 27, 1973, should have a minimum rating of 200 mA at 100 kVp,; (2) generators of units acquired subsequest to that date should have a minimum rating of 300 mA at 125 kVp.

(h) Roentgenograms made with battery-powered mobile or portable equipment should be made with uinits having a minimum rating of 100 mA at 110 kVp. at 500 Hz. or of 200 mA at 110 kVp, at 60 Hz.

(i) Roentgenograms should be given only with equipment having a beam-limiting device which does not cause large unexposed boundaries. The beam limiting device should provide rectangular collimation and should be of the type described in part F of the suggested state regulations for the control of radiation of (for beam limiting devices manufactured after August 1, 1974) of the type specified in 21 CFR 1020.31. The use of such a device should be discernible from an examination of the roentgenogram.

NOTE: A generator with a rating of 150 kVp, is recommended.

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(j) To insure high quality chest roentgenograms:

(1) The maximum exposure time should not exceed 1/20 of a second except that with single phase units with a rating less than 300 mA at 125 kVp. and subjects with chests over 28 cm. posteroanterior, the exposure may be increased to not more than 1/10 of a second;

(2) The source of focal spot to film distance should be at least 6 feet;

(3) Medium--speed film and medium speed intensifying screens should be used;

(4) Film-screen contact should be maintained and verified at 6 month or shorter intervals;

(5) Intensifying screens should be inspected at least once a month and cleaned when necessary by the method recommended by the manufacturer;

(6) All intensifying screens in a cassette should be of the same type and made by the same manufacturer;

(7). When using over 90 kV., a suitable grid or other means of reducing scattered radiation should be used;

(8) The geometry of the radiographic system shall insure that the central axis (ray) of the primary beam is perpendicular to the plane of the film surface and impinges on the center of the film;

(9) A formal quality assurance program should be established at each facility.

(k) Radiographic processing:

(1) Either automatic or manual film processing is acceptable. A constant time-temperature technique should be meticulously employed for manual processing.

(2) If mineral or other impurities in the processing water introduce difficulty in obtaining a high-quality roentgenogram, a suitable filter or purification system should be used.

(l) Before the employee is advised that the examination is concluded, the roentgenogram should be processed and inspected and accepted for quality by the physician, or if the physician is not available, acceptance may be made by the radiologic

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technologist. In a case of a substandard roentgenogram, another should be immediately made. All substandard roentgenograms should be clearly marked as rejected and promptly sent for disposal.

(m) An electrical power supply should be used which complies with the voltage, current, and regulation specified by the manufacturer of the machine.

(n) A densitometric test object may be required on each roentgenogram for an objective evaluation of film quality.

(o) Each roentgenogram made hereunder should be permanently and legibly marked with the name and address or approval number of the facility at which it is made, the social security number of the employee and the date of the roentgenogram.

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Appendix B-2

NON-MANDATORY

INTERPRETATION AND CLASSIFICATION

Interpreting and classifying chest roentgenograms.

(a) Chest roentgenograms should be interpreted and classified in accordance with a professionally accepted classificaton system and recorded on a Roentgenographic Interpretation Form *Form CSD/NIOSH (M) 2.8).

(b) Roentgenograms should be interpreted and classified only by a a board eligible/certified radiologist or physician who regularly reads chest roentgenograms.

(c) All interpreters, whenever interpreting chest roentgenograms made under the Act, should have immediately available for reference a complete set of the ILO-U/C international Classification of Radiographs for Pneumoconiosees, 1980.

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Appendix C-1

Appendix C(1) - Pulmonary Function

Standards for Asbestos Standard

NON-MANDATORY

The spirometric measurements of pulmonary function should conform to the following minimum standard, and these standards are not intended to preclude additional testing or alternate methods which can be determined to be superior.

I. APPARATUS

(a) The instrument should be accurate to within ± 50 milliliters or within ± 3 percent of reading , whichever is greater.

(b) The instrument should be capable of measuring vital capacity from 0 to 7 liters BTPS.

(c) The instrument should have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less that 1.5 cm H_2O/(liter/sec).

(d) The zero time point for the purpose of timing the FEV_1 should be determined by extrapolating the steepest portion of the volume time curve back to the maximal inspiration volume (1,2,3,4) or by an equivalent method.

(e) Instruments incorporating measurements of airflow to determine volume should conform to the same volume accuracy stated in (a) of this section when presented with flow rates from at least 0 to 12 liters per second.

(f) The instrument or user of the instrument should have a means of correcting volumes to body temperature saturated with water vapor (BTPS) under conditions of varying ambient spirometer temperatures and barometric pressures.

(g) The instrument used should provide a tracing or display of either flow versus volume or versus time during the entire forced expiration. A tracing or display is necessary to determine whether the patient has performed the test properly. The tracing should be stored and available for recall and should be of sufficient size that hand measurements may be made within the requirement of paragraph (a) of this section. If a paper record is made, it should have a paper speed of at least 2 cm/sec and a volume sensitivity of at least 10.0 mm of chart per liter of volume.

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(h) The instrument should be capable of accumulating for a minimum of 10 seconds and should not stop accumulating volume before (1) the volume change for a 0.5 second interval is less than 25 milliliters, or (2) the flow is less than 50 milliliters per second for a 0.5 second interval.

(i) The forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV 1) measurements should comply with the accuracy requirements stated in paragraph (a) of this section. That is, they should be accurately measured to within ± 50 ml or within ± 3 percent of reading, whichever is greater.

(j) The instrument should be capable of being calibrated in the field with respect to the FEV_1 and FVC. This calibration of the FEV_1 and FVC may be either directly or indirectly through volume and time base measurements. The volume calibration source should provide a volume displacement of at least 2 liters and should be accurate to within ± 30 milliliters.

II. TECHNIQUE FOR MEASUREMENT OF FORCED VITAL CAPACITY MANEUVER

(a) Use of a nose clip is recommended but not required. The procedures should be explained to the patient in simple terms who should be instructed to loosen any tight clothing and stand in front of the apparatus. The subject may sit, but care should be taken on repeat testing that the same position be used and, if possible, the same spirometer. Particular attention shall be given to insure that the chin is slightly elevated with the neck slightly extended. The patient should be instructed to make a full inspiration from a normal breathing pattern and then blow into the apparatus, without interruption, as hard, fast, and completely as possible. At least three forced expirations should be carried out. During the maneuvers, the patient should be observed for compliance with instructions. The expirations should be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts should be judged unacceptable when the patient:

1. has not reached full inspiration preceding the forced expiration,

2. has not used maximal effort during the entire forced expiration,

3. has not continued the expiration for at least 5 seconds or until an obvious plateau in the volume time curve has occurred,

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4. has coughed or closed his glottis,

5. has an obstructed mouthpiece or a leak around the mouthpiece (obstruction due to tongue being placed infront of mouthpiece, false teeth falling in front of mouthpiece, etc.),

6. has an unsatisfactory start of expiration, one characterized by excessive hesitation (or false starts), and therefore not allowing back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less that 10 percent of the FVC),

7. has an excessive variability betwwee the three acceptable curves. The variation between the two largest FVC's and FEV_1's of the three satisfactory tracings should not exceed 10 percent or $\pm$ 100 milliliters, whichever is greater.

(b) Periodic and routine recalibration of the instrument or method for recording FVC and $FEV_{1.0}$ should be performed using a syringe or other volume source of at least 2 liters.

(c) Performance of the testing including subject coaching, recognition of improperly performed maneuvers and corrective systems.

(d) Data quality, with the emphasis on reproducibility.

(e) Actual use of the equipment under supervised conditions.

(f) Measurements of tracings and calculations of results.

III. INTERPRETATION OF SPIROGRAM

(a) The first step in evaluating a spirogram should be to determine whether or not the patient has performed the test properly or as described in II above. From the three satisfactory tracings, the forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV 1.0) should be measured and recorded. The largest observed FVC and largest observed FEV_1 should be used in the analysis regardless of the curve(s) on which they occur.

(b) The following guidelines are recommended for the evaluation and management of workers exposed to asbestos dust. It is important to note that employees who show reductions in FEV 1 and FVC below 75% of the predicted values, or re-

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ductions in both measured values of 5 percent or greater from their initial screening exam, should be reevaluated within a period of one month. Those who show a consistent decrease in lung function, as compared to the predicted values in Tables 2-5, should be assessed by the physician taking into account all other clinical findings. A recommendation should be made with regard to suitability of the employee to continue in an asbestos related occupation.

IV. QUALIFICATIONS OF PERSONNEL

ADMINISTERING THE TEST
NON-MANDATORY

Technicians who perform pulmonary function testing should have the basic knowledge required to produce meaningful results. Training consisting of approximately 16 hours of formal instruction shall cover the following areas.

(a) Basic physiology of the forced vital capacity maneuver and the determinants of airflow limitation with emphasis on the relation to reproducibility of results.

(b) Instrumentation requirements including calibration procedures, sources of error and their correction.

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Appendix D

Non-Mandatory

Minimal training guidelines for physicians supervising the medical surveillance of persons who are or have been exposed to asbestos.

1. Introduction

(i) The employer is repsonsible for the selection and training of medical advisors.

(ii) The physician needs to be familiar with the product, the processes involved in manufacture and the controls present in the workplace which have been designed to prevent unnecessary exposure to asbestos.

(iii) Educational material and attendance at appropriate meetings and courses should be available to the physicians concerned. The information learned should be communicated to the employer and employees to enable them to be fully aware of the nature of the effects of exposure to asbestos.

2. Objectives

(i) To improve health care in industry.

(ii) To arrive at common standards of medical practice.

(iii) To maintain adequate surveillance of asbestos-exposed employees.

3. Methods

(i) Training should include instruction in pulmonary physiology, toxicology and clinical assessment in relation to occupational health.

(ii) Physicians should be given leave of absence to attend special courses and mini-residencies:

(1) at academic centers providing instruction in occupational health; or

(2) at specialist centers for training in the radiology of asbestos-related disease; or

(3) at both the above.

(iii) Special arrangements should be made for physicians unable to leave their appointments for post-graduate training. Such arrangements should include:

(1) provision of audio-visual training material.

(2) provision of the standard radiographs produced by the International Labor Office (ILO), Geneva [International Classification Radiographs of Pneumoconioses (Revised 1980)] as a guide to interpreting radiological appearances.

(3) provision of contract with the nearest expert in radiology of the pneumoconioses, pulmonary physiologists versed in the diagnosis of occupational lung disorders and board certified chest physicians, capable of resolving problems or doubtful opinions.

(4) instructional reading material should be provided for the library of every physician responsible for the medical surveillance of asbestos-exposed persons.

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APPENDIX - D-2

SOURCE REFERENCES FOR APPENDICES A - D

(1) Appendices A1 and A2

Modification of the "Recommended Respiratory Diseases Questionnaires for use with Adults and Children in Epidemiological Research." These questionnaires were published as follows:

"Epidemiology Standardization Project." Benjamin G. Ferris, M.D.: Principal Investigator. American Review of Respiratory Diseases, 118 (#6) (Part 2 of 2 parts): pages 7-53; December 1978.

NB: The questionnaires attached to the draft document on medical surveillance are based on those of the Raymark Corporation. Modified by Hilton C. Lewinsohn, MB, BCH, FCCP.

(2) Appendices B1 and B2

Appendix B1: This is based upon Title 42 - Public Health Service. Chapter 1 - Public Health Service, Department of Health, Education and Welfare. Subchapter C - Medical Care and Examinations.

Part 37 - Specifications for Medical Examinations of Underground Coal Mines Subpart - Chest Roentgenographic Examinations. Published in Federal Register, 43(148): 33713-33720, 1978.

Appendix B2: This is derived form 42 CFR Part 37, CDC/NIOSH, Specifications for Medical Examinations of Underground Coal Miners, the relevant sections are 37.50 interpreting and classifying chest roentgenograms.

37.51 proficiency in the use of systems for classifying the pneumoconioses. This was published in the Federal Register, 48(8): 1321-1323, 1983.

(3) Appendices C1 and C2

Both these appendices are derived from 29CFR, 1910.1043 Cotton Dust, published in Federal Register, 43(122): 27395-27418, 1978. The relevant paragraphs will be found in Appendix D (of the standard) on page 27418. The Tables in Appendix C2 are to be found on pages 27414-27417.

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(4) Appendix D

This is based upon a document prepared by the Medical Advisory Panel of the Asbestos International Association and suitably modified by Dr. Hilton C. Lewinsohn.

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TABLE I. PREDICTED FVC FOR FEMALES (KNUDSON, ET AL. AM REV RESPIR DIS. 1976. 113. 587.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
52.0	2.45	2.64	2.63	2.61	2.56	2.52	2.47	2.43	2.39	2.34	2.30	2.25	2.21	2.17	2.12	2.08	2.03	1.99	1.95	1.90	1.86	1.81	1.77	1.73	1.68
52.5	2.50	2.68	2.70	2.65	2.61	2.57	2.52	2.48	2.43	2.39	2.35	2.30	2.26	2.21	2.17	2.13	2.08	2.04	1.99	1.95	1.91	1.86	1.82	1.77	1.73
53.0	2.54	2.72	2.74	2.70	2.66	2.61	2.57	2.52	2.48	2.44	2.39	2.35	2.30	2.26	2.22	2.17	2.13	2.08	2.04	2.00	1.95	1.91	1.86	1.82	1.78
53.5	2.58	2.76	2.79	2.75	2.70	2.66	2.62	2.57	2.53	2.48	2.44	2.40	2.35	2.31	2.26	2.22	2.18	2.13	2.09	2.04	2.00	1.96	1.91	1.87	1.82
54.0	2.62	2.81	2.84	2.79	2.75	2.71	2.66	2.62	2.57	2.53	2.49	2.44	2.40	2.35	2.31	2.27	2.22	2.18	2.13	2.09	2.04	2.00	1.96	1.91	1.87
54.5	2.66	2.85	2.89	2.84	2.80	2.75	2.71	2.67	2.62	2.58	2.53	2.49	2.45	2.40	2.36	2.31	2.27	2.22	2.18	2.13	2.09	2.05	2.00	1.96	1.92
55.0	2.71	2.89	2.93	2.89	2.84	2.80	2.76	2.71	2.67	2.62	2.58	2.54	2.49	2.45	2.40	2.36	2.32	2.27	2.23	2.18	2.14	2.09	2.05	2.01	1.96
55.5	2.75	2.93	2.98	2.94	2.89	2.85	2.80	2.76	2.72	2.67	2.63	2.58	2.54	2.50	2.45	2.41	2.36	2.32	2.28	2.23	2.19	2.14	2.10	2.05	2.01
56.0	2.79	[illegible]	3.03	2.98	2.94	2.89	2.85	2.81	2.76	2.72	2.67	2.63	2.59	2.54	2.50	2.45	2.41	2.37	2.32	2.28	2.23	2.19	2.14	2.10	2.06
56.5	2.83	[illegible]	3.07	3.03	2.99	2.94	2.90	2.85	2.81	2.77	2.72	2.68	2.63	2.59	2.55	2.50	2.46	2.41	2.37	2.33	2.28	2.24	2.19	2.15	2.11
57.0	2.87	3.06	[illegible]	3.08	3.03	2.99	2.94	2.90	2.86	2.81	2.77	2.72	2.68	2.64	2.59	2.55	2.50	2.46	2.42	2.37	2.33	2.28	2.24	2.20	2.15
57.5	2.91	3.10	3.17	3.12	3.08	3.04	2.99	2.95	2.90	2.86	2.82	2.77	2.73	2.68	2.64	2.60	2.55	2.51	2.46	2.42	2.37	2.33	2.29	2.24	2.20
58.0	2.96	3.14	3.21	3.17	3.13	3.08	3.04	2.99	2.95	2.91	2.86	2.82	2.77	2.73	2.69	2.64	2.60	2.55	2.51	2.47	2.42	2.38	2.33	2.29	2.25
58.5	3.00	3.18	3.26	3.22	3.17	3.13	3.09	3.04	3.00	2.95	2.91	2.87	2.82	2.78	2.73	2.69	2.64	2.60	2.56	2.51	2.47	2.42	2.38	2.33	2.29
59.0	3.04	3.22	3.31	3.26	3.22	3.18	3.13	3.09	3.04	3.00	2.96	2.91	2.87	2.82	2.78	2.74	2.69	2.65	2.60	2.56	2.51	2.47	2.43	2.38	2.34
59.5	3.08	3.27	3.36	3.31	3.27	3.22	3.18	3.14	3.09	3.05	3.00	2.96	2.92	2.87	2.83	2.78	2.74	2.70	2.65	2.61	2.56	2.52	2.47	2.43	2.39
60.0	3.12	3.31	3.40	3.36	3.31	3.27	3.23	3.18	3.14	3.09	3.05	3.01	2.96	2.92	2.87	2.83	2.79	2.74	2.70	2.65	2.61	2.56	2.52	2.48	2.43
60.5	3.17	3.35	3.45	3.41	3.36	3.32	3.27	3.23	3.19	3.14	3.10	3.05	3.01	2.97	2.92	2.88	2.83	2.79	2.75	2.70	2.66	2.61	2.57	2.52	2.48
61.0	3.21	3.39	3.50	3.45	3.41	3.36	3.32	3.28	3.23	3.19	3.14	3.10	3.06	3.01	2.97	2.92	2.88	2.84	2.79	2.75	2.70	2.66	2.61	2.57	2.53
61.5	3.25	3.43	3.54	3.50	3.46	3.41	3.37	3.32	3.28	3.24	3.19	3.15	3.10	3.06	3.02	2.97	2.93	2.88	2.84	2.80	2.75	2.71	2.66	2.62	2.58
62.0	3.29	3.48	3.59	3.55	3.50	3.46	3.41	3.37	3.33	3.28	3.24	3.19	3.15	3.11	3.06	3.02	2.97	2.93	2.89	2.84	2.80	2.75	2.71	2.67	2.62
62.5	3.33	3.52	3.64	3.59	3.55	3.51	3.46	3.42	3.37	3.33	3.29	3.24	3.20	3.15	3.11	3.07	3.02	2.98	2.93	2.89	2.85	2.80	2.76	2.71	2.67
63.0	3.38	3.56	3.68	3.64	3.60	3.55	3.51	3.46	3.42	3.38	3.33	3.29	3.24	3.20	3.16	3.11	3.07	3.02	2.98	2.94	2.89	2.85	2.80	2.76	2.72
63.5	3.42	3.60	3.73	3.69	3.64	3.60	3.56	3.51	3.47	3.42	3.38	3.34	3.29	3.25	3.20	3.16	3.12	3.07	3.03	2.98	2.94	2.90	2.85	2.81	2.76
64.0	3.46	3.64	3.78	3.73	3.69	3.65	3.60	3.56	3.51	3.47	3.43	3.38	3.34	3.29	3.25	3.21	3.16	3.12	3.07	3.03	2.99	2.94	2.90	2.85	2.81
64.5	3.50	3.69	3.83	3.78	3.74	3.69	3.65	3.61	3.56	3.52	3.47	3.43	3.39	3.34	3.30	3.25	3.21	3.17	3.12	3.08	3.03	2.99	2.95	2.90	2.86
65.0	3.54	3.73	3.87	3.83	3.78	3.74	3.70	3.65	3.61	3.56	3.52	3.48	3.43	3.39	3.34	3.30	3.26	3.21	3.17	3.12	3.08	3.04	2.99	2.95	2.90
65.5	3.59	3.77	3.92	3.88	3.83	3.79	3.74	3.70	3.66	3.61	3.57	3.52	3.48	3.44	3.39	3.35	3.30	3.26	3.22	3.17	3.13	3.08	3.04	3.00	2.95
66.0	3.63	3.81	3.97	3.92	3.88	3.83	3.79	3.75	3.70	3.66	3.61	3.57	3.53	3.48	3.44	3.39	3.35	3.31	3.26	3.22	3.17	3.13	3.09	3.04	3.00
66.5	3.67	3.85	4.01	3.97	3.93	3.88	3.84	3.79	3.75	3.71	3.66	3.62	3.57	3.53	3.49	3.44	3.40	3.35	3.31	3.27	3.22	3.18	3.13	3.09	3.05
67.0	3.71	3.89	4.06	4.02	3.97	3.93	3.88	3.84	3.80	3.75	3.71	3.66	3.62	3.58	3.53	3.49	3.44	3.40	3.36	3.31	3.27	3.22	3.18	3.14	3.09
67.5	3.75	3.94	4.11	4.06	4.02	3.98	3.93	3.89	3.84	3.80	3.76	3.71	3.67	3.62	3.58	3.54	3.49	3.45	3.40	3.36	3.32	3.27	3.23	3.18	3.14
68.0	3.79	3.98	4.15	4.11	4.07	4.02	3.98	3.93	3.89	3.85	3.80	3.76	3.71	3.67	3.63	3.58	3.54	3.49	3.45	3.41	3.36	3.32	3.27	3.23	3.19
68.5	3.84	4.02	4.20	4.16	4.11	4.07	4.03	3.98	3.94	3.89	3.85	3.81	3.76	3.72	3.67	3.63	3.59	3.54	3.50	3.45	3.41	3.37	3.32	3.28	3.23
69.0	3.88	4.06	4.25	4.20	4.16	4.12	4.07	4.03	3.98	3.94	3.90	3.85	3.81	3.76	3.72	3.68	3.63	3.59	3.54	3.50	3.46	3.41	3.37	3.32	3.28
69.5	3.92	4.10	4.30	4.25	4.21	4.16	4.12	4.08	4.03	3.99	3.94	3.90	3.86	3.81	3.77	3.72	3.68	3.64	3.59	3.55	3.50	3.46	3.42	3.37	3.33
70.0	3.96	4.15	4.34	4.30	4.25	4.21	4.17	4.12	4.08	4.03	3.99	3.95	3.90	3.86	3.81	3.77	3.73	3.68	3.64	3.59	3.55	3.51	3.46	3.42	3.37
70.5	4.00	4.19	4.39	4.35	4.30	4.26	4.21	4.17	4.13	4.08	4.04	3.99	3.95	3.91	3.86	3.82	3.77	3.73	3.69	3.64	3.60	3.55	3.51	3.46	3.42
71.0	4.05	4.23	4.44	4.39	4.35	4.30	4.26	4.22	4.17	4.13	4.08	4.04	4.00	3.95	3.91	3.86	3.82	3.78	3.73	3.69	3.64	3.60	3.56	3.51	3.47
71.5	4.09	4.27	4.48	4.44	4.40	4.35	4.31	4.26	4.22	4.18	4.13	4.09	4.04	4.00	3.96	3.91	3.87	3.82	3.78	3.74	3.69	3.65	3.60	3.56	3.52
72.0	4.13	4.31	4.53	4.49	4.44	4.40	4.35	4.31	4.27	4.22	4.18	4.13	4.09	4.05	4.00	3.96	3.91	3.87	3.83	3.78	3.74	3.69	3.65	3.61	3.56
72.5	4.17	4.36	4.58	4.53	4.49	4.45	4.40	4.36	4.31	4.27	4.23	4.18	4.14	4.09	4.05	4.01	3.96	3.92	3.87	3.83	3.79	3.74	3.70	3.65	3.61
73.0	4.21	4.40	4.62	4.58	4.54	4.49	4.45	4.40	4.36	4.32	4.27	4.23	4.18	4.14	4.10	4.05	4.01	3.96	3.92	3.88	3.83	3.79	3.74	3.70	3.66
73.5	4.26	4.44	4.67	4.63	4.58	4.54	4.50	4.45	4.41	4.36	4.32	4.28	4.23	4.19	4.14	4.10	4.06	4.01	3.97	3.92	3.88	3.84	3.79	3.75	3.70
74.0	4.30	4.48	4.72	4.67	4.63	4.59	4.54	4.50	4.45	4.41	4.37	4.32	4.28	4.23	4.19	4.15	4.10	4.06	4.01	3.97	3.93	3.88	3.84	3.79	3.75
74.5	4.34	4.52	4.77	4.72	4.68	4.63	4.59	4.55	4.50	4.46	4.41	4.37	4.33	4.28	4.24	4.19	4.15	4.11	4.06	4.02	3.97	3.93	3.89	3.84	3.80
75.0	4.38	4.57	4.81	4.77	4.72	4.68	4.64	4.59	4.55	4.50	4.46	4.42	4.37	4.33	4.28	4.24	4.20	4.15	4.11	4.06	4.02	3.98	3.93	3.89	3.84
75.5	4.42	4.61	4.86	4.82	4.77	4.73	4.68	4.64	4.60	4.55	4.51	4.46	4.42	4.38	4.33	4.29	4.24	4.20	4.16	4.11	4.07	4.02	3.98	3.93	3.89
76.0	4.47	4.65	4.91	4.86	4.82	4.77	4.73	4.69	4.64	4.60	4.55	4.51	4.47	4.42	4.38	4.33	4.29	4.25	4.20	4.16	4.11	4.07	4.03	3.98	3.94
76.5	4.51	4.69	4.95	4.91	4.87	4.82	4.78	4.73	4.69	4.65	4.60	4.56	4.51	4.47	4.43	4.38	4.34	4.29	4.25	4.21	4.16	4.12	4.07	4.03	3.99
77.0	4.55	4.73	5.00	4.96	4.91	4.87	4.82	4.78	4.74	4.69	4.65	4.60	4.56	4.52	4.47	4.43	4.38	4.34	4.30	4.25	4.21	4.16	4.12	4.08	4.03

Non-Mandatory

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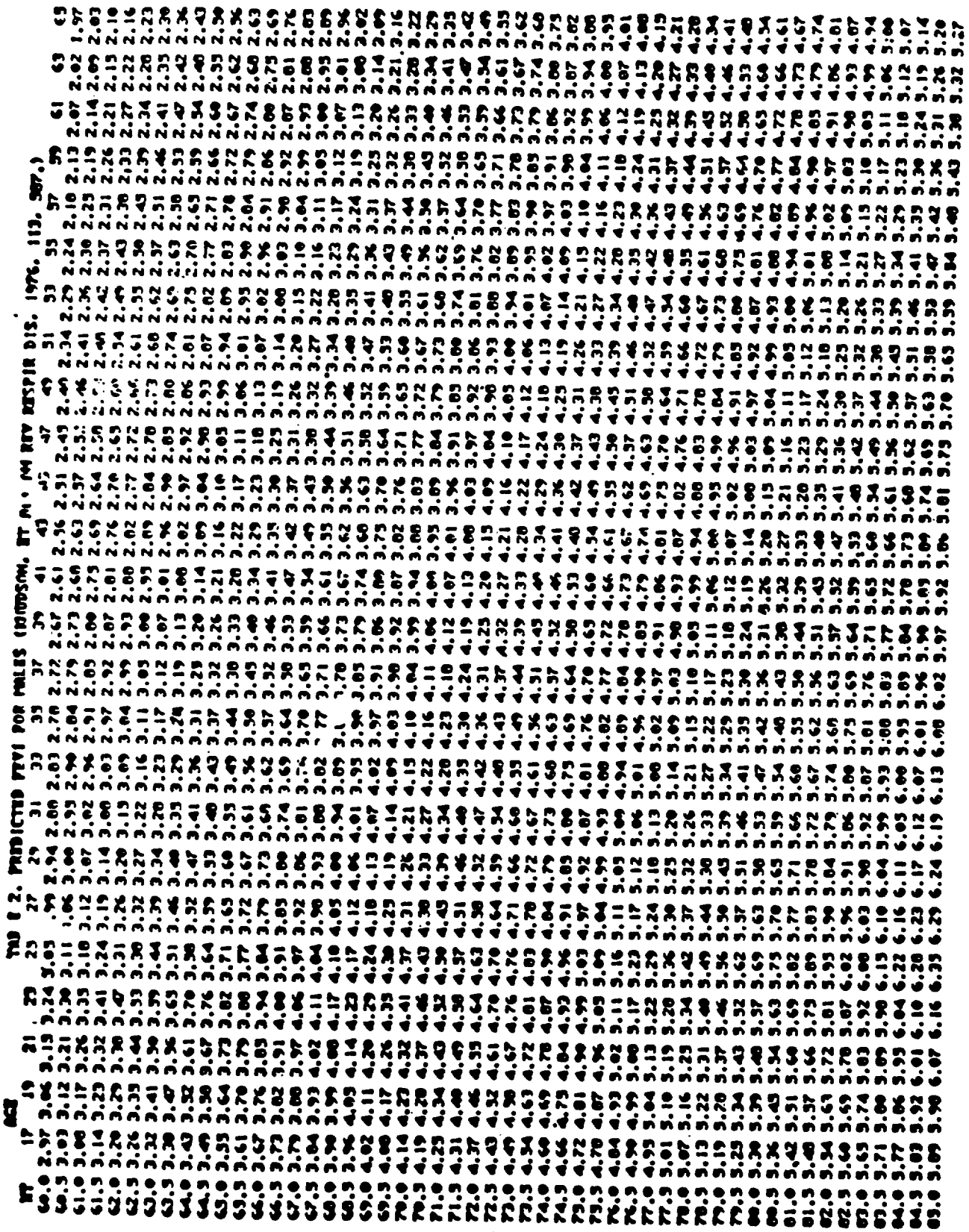
TABLE . PREDICTED FEV1 FOR FEMALES (KNUDSON, ET AL. AM REV RESPIR DIS. 1976. 113. 587.)

AGE	HT	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
	52.0	2.31	2.40	2.33	2.25	2.21	2.16	2.12	2.08	2.04	2.00	1.95	1.91	1.87	1.83	1.79	1.74	1.70	1.64	1.62	1.58	1.53	1.49	1.45	1.41
	52.5	2.34	2.51	2.37	2.32	2.28	2.20	2.16	2.11	2.07	2.03	1.99	1.95	1.91	1.87	1.83	1.79	1.74	1.70	1.64	1.62	1.58	1.53	1.49	1.44
	53.0	2.38	2.55	2.40	2.36	2.32	2.27	2.23	2.19	2.15	2.11	2.07	2.03	1.99	1.95	1.91	1.87	1.82	1.78	1.74	1.69	1.65	1.61	1.57	1.53	1.48	1.44
	53.5	2.41	2.58	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.02	1.98	1.94	1.90	1.85	1.81	1.77	1.73	1.69	1.64	1.60	1.56	1.52	1.48
	54.0	2.45	2.62	2.47	2.42	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.96	1.92	1.88	1.84	1.80	1.76	1.72	1.68	1.64	1.59	1.55	1.51
	54.5	2.48	2.65	2.50	2.46	2.42	2.38	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96	1.91	1.88	1.84	1.80	1.75	1.71	1.67	1.63	1.59	1.54
	55.0	2.51	2.68	2.54	2.49	2.45	2.41	2.37	2.33	2.29	2.24	2.20	2.16	2.12	2.08	2.03	1.99	1.95	1.91	1.87	1.83	1.79	1.74	1.70	1.66	1.62	1.58
	55.5	2.55	2.72	2.57	2.53	2.49	2.45	2.40	2.36	2.32	2.28	2.24	2.20	2.15	2.11	2.07	2.03	1.98	1.94	1.91	1.87	1.83	1.78	1.74	1.70	1.65	1.61
	56.0	2.58	2.75	2.61	2.56	2.52	2.48	2.44	2.40	2.36	2.32	2.28	2.23	2.19	2.15	2.11	2.07	2.02	1.98	1.94	1.90	1.86	1.82	1.78	1.73	1.69	1.65
	56.5	2.62	2.79	2.64	2.60	2.56	2.51	2.47	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.02	1.98	1.94	1.90	1.85	1.81	1.77	1.72	1.68
	57.0	2.65	2.82	2.68	2.63	2.59	2.55	2.51	2.47	2.43	2.39	2.34	2.30	2.26	2.22	2.18	2.13	2.09	2.05	2.01	1.97	1.93	1.88	1.84	1.80	1.76	1.72
	57.5	2.69	2.86	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.20	2.16	2.12	2.08	2.04	1.99	1.95	1.91	1.88	1.83	1.79	1.75
	58.0	2.72	2.89	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20	2.15	2.11	2.07	2.03	1.98	1.94	1.91	1.87	1.83	1.78
	58.5	2.75	2.92	2.78	2.73	2.69	2.64	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.31	2.27	2.23	2.19	2.15	2.10	2.06	2.02	1.98	1.94	1.90	1.86	1.82
	59.0	2.79	2.96	2.81	2.77	2.72	2.68	2.64	2.60	2.56	2.51	2.47	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.02	1.98	1.94	1.90	1.85
	59.5	2.82	2.99	2.85	2.80	2.76	2.71	2.67	2.63	2.59	2.54	2.50	2.46	2.42	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.97	1.93	1.89
	60.0	2.86	3.03	2.88	2.84	2.80	2.75	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96	1.92
	60.5	2.89	3.06	2.92	2.87	2.83	2.79	2.74	2.70	2.66	2.62	2.58	2.53	2.49	2.45	2.41	2.37	2.33	2.28	2.24	2.20	2.16	2.12	2.08	2.04	1.99	1.96
	61.0	2.93	3.10	2.95	2.91	2.86	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.44	2.40	2.36	2.32	2.28	2.23	2.19	2.15	2.11	2.07	2.03	1.99
	61.5	2.96	3.13	2.98	2.94	2.90	2.85	2.81	2.77	2.73	2.69	2.65	2.60	2.56	2.52	2.48	2.44	2.39	2.35	2.31	2.27	2.23	2.18	2.14	2.10	2.07	2.02
	62.0	3.00	3.16	3.02	2.97	2.93	2.89	2.84	2.80	2.76	2.72	2.68	2.64	2.60	2.55	2.51	2.47	2.43	2.39	2.35	2.31	2.27	2.23	2.18	2.14	2.10	2.06
	62.5	3.03	3.20	3.05	3.01	2.96	2.92	2.88	2.83	2.79	2.75	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.42	2.38	2.34	2.30	2.26	2.22	2.18	2.13	2.09
	63.0	3.06	3.23	3.09	3.04	3.00	2.96	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.61	2.57	2.53	2.49	2.45	2.41	2.37	2.33	2.29	2.25	2.21	2.17	2.13
	63.5	3.10	3.27	3.12	3.08	3.03	2.99	2.94	2.90	2.86	2.82	2.77	2.73	2.69	2.65	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.32	2.28	2.24	2.20	2.16
	64.0	3.13	3.30	3.16	3.11	3.07	3.02	2.98	2.93	2.89	2.85	2.81	2.76	2.72	2.68	2.64	2.60	2.56	2.52	2.48	2.43	2.39	2.35	2.31	2.27	2.23	2.19
	64.5	3.17	3.34	3.19	3.15	3.10	3.06	3.02	2.97	2.93	2.88	2.84	2.80	2.75	2.71	2.67	2.63	2.59	2.55	2.51	2.47	2.43	2.39	2.35	2.31	2.26	2.22
	65.0	3.20	3.37	3.23	3.18	3.14	3.09	3.05	3.01	2.97	2.92	2.88	2.83	2.79	2.75	2.71	2.66	2.62	2.58	2.54	2.50	2.46	2.42	2.38	2.34	2.30	2.25
	65.5	3.24	3.41	3.26	3.22	3.17	3.13	3.09	3.04	3.00	2.96	2.92	2.87	2.83	2.79	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.37	2.33	2.29
	66.0	3.27	3.44	3.30	3.25	3.21	3.17	3.12	3.08	3.04	2.99	2.95	2.91	2.87	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.45	2.41	2.37	2.33
	66.5	3.31	3.48	3.33	3.29	3.24	3.20	3.16	3.12	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.77	2.73	2.69	2.65	2.61	2.57	2.53	2.49	2.45	2.41	2.37
	67.0	3.34	3.51	3.37	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.85	2.81	2.77	2.73	2.69	2.65	2.61	2.57	2.53	2.49	2.45	2.41
	67.5	3.37	3.54	3.40	3.36	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85	2.81	2.77	2.73	2.69	2.65	2.61	2.57	2.53	2.49	2.45
	68.0	3.41	3.58	3.44	3.39	3.35	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.96	2.92	2.88	2.84	2.80	2.76	2.72	2.68	2.64	2.60	2.56	2.52	2.48
	68.5	3.44	3.61	3.47	3.43	3.38	3.34	3.29	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92	2.87	2.83	2.79	2.75	2.71	2.67	2.63	2.59	2.55	2.51
	69.0	3.48	3.65	3.51	3.46	3.42	3.37	3.33	3.29	3.24	3.20	3.16	3.12	3.08	3.03	2.99	2.95	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.62	2.58	2.54
	69.5	3.51	3.68	3.54	3.50	3.45	3.41	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.86	2.82	2.78	2.74	2.70	2.66	2.62	2.58
	70.0	3.55	3.72	3.58	3.53	3.49	3.44	3.40	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85	2.81	2.77	2.73	2.69	2.65	2.61
	70.5	3.58	3.75	3.61	3.57	3.52	3.48	3.43	3.39	3.35	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.96	2.92	2.88	2.84	2.80	2.76	2.72	2.68	2.64
	71.0	3.62	3.78	3.64	3.60	3.56	3.51	3.47	3.42	3.38	3.34	3.30	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92	2.88	2.84	2.80	2.76	2.72	2.68
	71.5	3.65	3.82	3.67	3.63	3.59	3.54	3.50	3.46	3.41	3.37	3.33	3.29	3.24	3.20	3.16	3.12	3.08	3.03	2.99	2.95	2.91	2.87	2.83	2.79	2.75	2.71
	72.0	3.69	3.85	3.71	3.67	3.62	3.58	3.53	3.49	3.45	3.40	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.78	2.74
	72.5	3.72	3.89	3.74	3.70	3.66	3.61	3.57	3.52	3.48	3.44	3.39	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.98	2.94	2.90	2.86	2.82	2.78
	73.0	3.75	3.92	3.77	3.73	3.69	3.64	3.60	3.56	3.51	3.47	3.43	3.39	3.34	3.30	3.26	3.22	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85	2.81
	73.5	3.78	3.95	3.81	3.77	3.72	3.68	3.63	3.59	3.55	3.50	3.46	3.42	3.38	3.33	3.29	3.25	3.21	3.17	3.13	3.09	3.04	3.00	2.96	2.92	2.88	2.84
	74.0	3.82	3.99	3.84	3.80	3.76	3.71	3.67	3.63	3.58	3.54	3.50	3.45	3.41	3.37	3.33	3.29	3.24	3.20	3.16	3.12	3.08	3.04	3.00	2.96	2.92	2.88
	74.5	3.85	4.02	3.88	3.83	3.79	3.75	3.71	3.66	3.62	3.58	3.54	3.49	3.45	3.41	3.37	3.33	3.28	3.24	3.20	3.16	3.12	3.08	3.04	3.00	2.96	2.92
	75.0	3.88	4.05	3.91	3.87	3.82	3.78	3.74	3.70	3.65	3.61	3.57	3.53	3.48	3.44	3.40	3.36	3.32	3.28	3.24	3.19	3.15	3.11	3.07	3.03	2.99	2.95
	75.5	3.92	4.08	3.94	3.90	3.85	3.81	3.77	3.73	3.69	3.64	3.60	3.56	3.52	3.48	3.44	3.39	3.35	3.31	3.27	3.23	3.19	3.15	3.11	3.07	3.02	2.98
	76.0	3.95	4.12	3.98	3.93	3.89	3.84	3.80	3.76	3.72	3.68	3.63	3.59	3.55	3.51	3.47	3.43	3.39	3.35	3.31	3.26	3.22	3.18	3.14	3.10	3.06	3.02
	76.5	3.99	4.16	4.01	3.97	3.93	3.89	3.84	3.80	3.76	3.72	3.68	3.63	3.59	3.55	3.51	3.47	3.42	3.38	3.34	3.30	3.26	3.21	3.17	3.13	3.08	3.04
	77.0	4.02	4.19	4.05	4.00	3.96	3.92	3.88	3.84	3.79	3.75	3.71	3.67	3.63	3.58	3.54	3.50	3.46	3.42	3.37	3.33	3.29	3.25	3.21	3.16	3.12	3.08

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Appendix C-2

Non-Mandatory



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Appendix C-2

Non-Mandatory

TABLE 1. PREDICTED FVC FOR MALES (ANDERSON, ET AL. AM REV RESPIR DIS, 1976, 119, 387.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
58.0	3.44	3.56	3.75	3.91	3.72	3.66	3.61	3.55	3.49	3.43	3.37	3.32	3.26	3.20	3.14	3.08	3.03	2.97	2.91	2.85	2.79	2.74	2.68	2.62	2.56
58.5	3.46	3.58	3.77	3.93	3.74	3.68	3.63	3.57	3.51	3.45	3.39	3.34	3.28	3.22	3.16	3.10	3.05	2.99	2.93	2.87	2.81	2.76	2.70	2.64	2.58
59.0	3.48	3.60	3.79	3.95	3.77	3.71	3.65	3.59	3.53	3.47	3.41	3.36	3.30	3.24	3.18	3.12	3.07	3.01	2.95	2.89	2.83	2.78	2.72	2.66	2.60
59.5	3.50	3.62	3.81	3.97	3.80	3.74	3.68	3.62	3.56	3.50	3.44	3.38	3.33	3.27	3.21	3.15	3.09	3.03	2.98	2.92	2.86	2.80	2.74	2.68	2.62
60.0	3.52	3.64	3.83	3.99	3.82	3.76	3.70	3.64	3.58	3.52	3.46	3.40	3.35	3.29	3.23	3.17	3.11	3.05	3.00	2.94	2.88	2.82	2.76	2.70	2.64
60.5	3.54	3.66	3.85	4.01	3.84	3.78	3.72	3.66	3.60	3.54	3.48	3.42	3.37	3.31	3.25	3.19	3.13	3.08	3.02	2.96	2.90	2.84	2.78	2.72	2.66
61.0	3.56	3.68	3.87	4.03	3.86	3.80	3.74	3.68	3.62	3.56	3.50	3.44	3.39	3.33	3.27	3.21	3.15	3.10	3.04	2.98	2.92	2.86	2.80	2.74	2.68
61.5	3.58	3.70	3.89	4.05	3.88	3.82	3.76	3.70	3.64	3.58	3.52	3.46	3.41	3.35	3.29	3.23	3.17	3.12	3.06	3.00	2.94	2.88	2.82	2.76	2.70
62.0	3.60	3.72	3.91	4.07	3.90	3.84	3.78	3.72	3.66	3.60	3.54	3.48	3.43	3.37	3.31	3.25	3.19	3.14	3.08	3.02	2.96	2.90	2.84	2.78	2.72
62.5	3.62	3.74	3.93	4.09	3.92	3.86	3.80	3.74	3.68	3.62	3.56	3.50	3.45	3.39	3.33	3.27	3.21	3.16	3.10	3.04	2.98	2.92	2.86	2.80	2.74
63.0	3.64	3.76	3.95	4.11	3.94	3.88	3.82	3.76	3.70	3.64	3.58	3.52	3.47	3.41	3.35	3.29	3.23	3.18	3.12	3.06	3.00	2.94	2.88	2.82	2.76
63.5	3.66	3.78	3.97	4.13	3.96	3.90	3.84	3.78	3.72	3.66	3.60	3.54	3.49	3.43	3.37	3.31	3.25	3.20	3.14	3.08	3.02	2.96	2.90	2.84	2.78
64.0	3.68	3.80	3.99	4.15	3.98	3.92	3.86	3.80	3.74	3.68	3.62	3.56	3.51	3.45	3.39	3.33	3.27	3.22	3.16	3.10	3.04	2.98	2.92	2.86	2.80
64.5	3.70	3.82	4.01	4.17	4.00	3.94	3.88	3.82	3.76	3.70	3.64	3.58	3.53	3.47	3.41	3.35	3.29	3.24	3.18	3.12	3.06	3.00	2.94	2.88	2.82
65.0	3.72	3.84	4.03	4.19	4.02	3.96	3.90	3.84	3.78	3.72	3.66	3.60	3.55	3.49	3.43	3.37	3.31	3.26	3.20	3.14	3.08	3.02	2.96	2.90	2.84
65.5	3.74	3.86	4.05	4.21	4.04	3.98	3.92	3.86	3.80	3.74	3.68	3.62	3.57	3.51	3.45	3.39	3.33	3.28	3.22	3.16	3.10	3.04	2.98	2.92	2.86
66.0	3.76	3.88	4.07	4.23	4.06	4.00	3.94	3.88	3.82	3.76	3.70	3.64	3.59	3.53	3.47	3.41	3.35	3.30	3.24	3.18	3.12	3.06	3.00	2.94	2.88
66.5	3.78	3.90	4.09	4.25	4.08	4.02	3.96	3.90	3.84	3.78	3.72	3.66	3.61	3.55	3.49	3.43	3.37	3.32	3.26	3.20	3.14	3.08	3.02	2.96	2.90
67.0	3.80	3.92	4.11	4.27	4.10	4.04	3.98	3.92	3.86	3.80	3.74	3.68	3.63	3.57	3.51	3.45	3.39	3.34	3.28	3.22	3.16	3.10	3.04	2.98	2.92
67.5	3.82	3.94	4.13	4.29	4.12	4.06	4.00	3.94	3.88	3.82	3.76	3.70	3.65	3.59	3.53	3.47	3.41	3.36	3.30	3.24	3.18	3.12	3.06	3.00	2.94
68.0	3.84	3.96	4.15	4.31	4.14	4.08	4.02	3.96	3.90	3.84	3.78	3.72	3.67	3.61	3.55	3.49	3.43	3.38	3.32	3.26	3.20	3.14	3.08	3.02	2.96
68.5	3.86	3.98	4.17	4.33	4.16	4.10	4.04	3.98	3.92	3.86	3.80	3.74	3.69	3.63	3.57	3.51	3.45	3.40	3.34	3.28	3.22	3.16	3.10	3.04	2.98
69.0	3.88	4.00	4.19	4.35	4.18	4.12	4.06	4.00	3.94	3.88	3.82	3.76	3.71	3.65	3.59	3.53	3.47	3.42	3.36	3.30	3.24	3.18	3.12	3.06	3.00
69.5	3.90	4.02	4.21	4.37	4.20	4.14	4.08	4.02	3.96	3.90	3.84	3.78	3.73	3.67	3.61	3.55	3.49	3.44	3.38	3.32	3.26	3.20	3.14	3.08	3.02
70.0	3.92	4.04	4.23	4.39	4.22	4.16	4.10	4.04	3.98	3.92	3.86	3.80	3.75	3.69	3.63	3.57	3.51	3.46	3.40	3.34	3.28	3.22	3.16	3.10	3.04
70.5	3.94	4.06	4.25	4.41	4.24	4.18	4.12	4.06	4.00	3.94	3.88	3.82	3.77	3.71	3.65	3.59	3.53	3.48	3.42	3.36	3.30	3.24	3.18	3.12	3.06
71.0	3.96	4.08	4.27	4.43	4.26	4.20	4.14	4.08	4.02	3.96	3.90	3.84	3.79	3.73	3.67	3.61	3.55	3.50	3.44	3.38	3.32	3.26	3.20	3.14	3.08
71.5	3.98	4.10	4.29	4.45	4.28	4.22	4.16	4.10	4.04	3.98	3.92	3.86	3.81	3.75	3.69	3.63	3.57	3.52	3.46	3.40	3.34	3.28	3.22	3.16	3.10
72.0	4.00	4.12	4.31	4.47	4.30	4.24	4.18	4.12	4.06	4.00	3.94	3.88	3.83	3.77	3.71	3.65	3.59	3.54	3.48	3.42	3.36	3.30	3.24	3.18	3.12
72.5	4.02	4.14	4.33	4.49	4.32	4.26	4.20	4.14	4.08	4.02	3.96	3.90	3.85	3.79	3.73	3.67	3.61	3.56	3.50	3.44	3.38	3.32	3.26	3.20	3.14
73.0	4.04	4.16	4.35	4.51	4.34	4.28	4.22	4.16	4.10	4.04	3.98	3.92	3.87	3.81	3.75	3.69	3.63	3.58	3.52	3.46	3.40	3.34	3.28	3.22	3.16
73.5	4.06	4.18	4.37	4.53	4.36	4.30	4.24	4.18	4.12	4.06	4.00	3.94	3.89	3.83	3.77	3.71	3.65	3.60	3.54	3.48	3.42	3.36	3.30	3.24	3.18
74.0	4.08	4.20	4.39	4.55	4.38	4.32	4.26	4.20	4.14	4.08	4.02	3.96	3.91	3.85	3.79	3.73	3.67	3.62	3.56	3.50	3.44	3.38	3.32	3.26	3.20
74.5	4.10	4.22	4.41	4.57	4.40	4.34	4.28	4.22	4.16	4.10	4.04	3.98	3.93	3.87	3.81	3.75	3.69	3.64	3.58	3.52	3.46	3.40	3.34	3.28	3.22
75.0	4.12	4.24	4.43	4.59	4.42	4.36	4.30	4.24	4.18	4.12	4.06	4.00	3.95	3.89	3.83	3.77	3.71	3.66	3.60	3.54	3.48	3.42	3.36	3.30	3.24
75.5	4.14	4.26	4.45	4.61	4.44	4.38	4.32	4.26	4.20	4.14	4.08	4.02	3.97	3.91	3.85	3.79	3.73	3.68	3.62	3.56	3.50	3.44	3.38	3.32	3.26
76.0	4.16	4.28	4.47	4.63	4.46	4.40	4.34	4.28	4.22	4.16	4.10	4.04	3.99	3.93	3.87	3.81	3.75	3.70	3.64	3.58	3.52	3.46	3.40	3.34	3.28
76.5	4.18	4.30	4.49	4.65	4.48	4.42	4.36	4.30	4.24	4.18	4.12	4.06	4.01	3.95	3.89	3.83	3.77	3.72	3.66	3.60	3.54	3.48	3.42	3.36	3.30
77.0	4.20	4.32	4.51	4.67	4.50	4.44	4.38	4.32	4.26	4.20	4.14	4.08	4.03	3.97	3.91	3.85	3.79	3.74	3.68	3.62	3.56	3.50	3.44	3.38	3.32
77.5	4.22	4.34	4.53	4.69	4.52	4.46	4.40	4.34	4.28	4.22	4.16	4.10	4.05	3.99	3.93	3.87	3.81	3.76	3.70	3.64	3.58	3.52	3.46	3.40	3.34
78.0	4.24	4.36	4.55	4.71	4.54	4.48	4.42	4.36	4.30	4.24	4.18	4.12	4.07	4.01	3.95	3.89	3.83	3.78	3.72	3.66	3.60	3.54	3.48	3.42	3.36
78.5	4.26	4.38	4.57	4.73	4.56	4.50	4.44	4.38	4.32	4.26	4.20	4.14	4.09	4.03	3.97	3.91	3.85	3.80	3.74	3.68	3.62	3.56	3.50	3.44	3.38
79.0	4.28	4.40	4.59	4.75	4.58	4.52	4.46	4.40	4.34	4.28	4.22	4.16	4.11	4.05	3.99	3.93	3.87	3.82	3.76	3.70	3.64	3.58	3.52	3.46	3.40
79.5	4.30	4.42	4.61	4.77	4.60	4.54	4.48	4.42	4.36	4.30	4.24	4.18	4.13	4.07	4.01	3.95	3.89	3.84	3.78	3.72	3.66	3.60	3.54	3.48	3.42
80.0	4.32	4.44	4.63	4.79	4.62	4.56	4.50	4.44	4.38	4.32	4.26	4.20	4.15	4.09	4.03	3.97	3.91	3.86	3.80	3.74	3.68	3.62	3.56	3.50	3.44
80.5	4.34	4.46	4.65	4.81	4.64	4.58	4.52	4.46	4.40	4.34	4.28	4.22	4.17	4.11	4.05	3.99	3.93	3.88	3.82	3.76	3.70	3.64	3.58	3.52	3.46
81.0	4.36	4.48	4.67	4.83	4.66	4.60	4.54	4.48	4.42	4.36	4.30	4.24	4.19	4.13	4.07	4.01	3.95	3.90	3.84	3.78	3.72	3.66	3.60	3.54	3.48
81.5	4.38	4.50	4.69	4.85	4.68	4.62	4.56	4.50	4.44	4.38	4.32	4.26	4.21	4.15	4.09	4.03	3.97	3.92	3.86	3.80	3.74	3.68	3.62	3.56	3.50
82.0	4.40	4.52	4.71	4.87	4.70	4.64	4.58	4.52	4.46	4.40	4.34	4.28	4.23	4.17	4.11	4.05	3.99	3.94	3.88	3.82	3.76	3.70	3.64	3.58	3.52
82.5	4.42	4.54	4.73	4.89	4.72	4.66	4.60	4.54	4.48	4.42	4.36	4.30	4.25	4.19	4.13	4.07	4.01	3.96	3.90	3.84	3.78	3.72	3.66	3.60	3.54
83.0	4.44	4.56	4.75	4.91	4.74	4.68	4.62	4.56	4.50	4.44	4.38	4.32	4.27	4.21	4.15	4.09	4.03	3.98	3.92	3.86	3.80	3.74	3.68	3.62	3.56
83.5	4.46	4.58	4.77	4.93	4.76	4.70	4.64	4.58	4.52	4.46	4.40	4.34	4.29	4.23	4.17	4.11	4.05	4.00	3.94	3.88	3.82	3.76	3.70	3.64	3.58
84.0	4.48	4.60	4.79	4.95	4.78	4.72	4.66	4.60	4.54	4.48	4.42	4.36	4.31	4.25	4.19	4.13	4.07	4.02	3.96	3.90	3.84	3.78	3.72	3.66	3.60
84.5	4.50	4.62	4.81	4.97	4.80	4.74	4.68	4.62	4.56	4.50	4.44	4.38	4.33	4.27	4.21	4.15	4.09	4.04	3.98	3.92	3.86	3.80	3.74	3.68	3.62
85.0	4.52	4.64	4.83	4.99	4.82	4.76	4.70	4.64	4.58	4.52	4.46	4.40	4.35	4.29	4.23	4.17	4.11	4.06	4.00	3.94	3.88	3.82	3.76	3.70	3.64
85.5	4.54	4.66	4.85	5.01	4.84	4.78	4.72	4.66	4.60	4.54	4.48	4.42	4.37	4.31	4.25	4.19	4.13	4.08	4.02	3.96	3.90	3.84	3.78	3.72	3.66

Union Carbide trial exhibit UC-1264: Organization Resources Counselors, Inc., ORC Asbestos Standard: A Reco...
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Ich Albertson
Corp Ben Plans Dept

Retirement assumptions

15% of employees - at N
before 58

½ balance 42½% at age 62

½ balance 42½% at age 65

No distinction found toward
people working longer.
±1000 in UCC over 65
By age 67 most gone.

12236

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Hyatt

Page 7 (3) 3. There should be a separate standard for construction industry only applicable to achieving PEL + implementation of medical surveillance program.

(4) Definition should be clearly re-stated in terms of fiber identity, length, diameter and ~~the~~ manufacturing process.

Page 8 6. Medical surveillance – 7

9. C + E — insufficient evidence

10. Unsure method.

11. Yes

12 – I think so – possible minority

14 – Yes.

16 – Maybe

19 – definitely

Hyatt

① Page 2

Only length stipulated – diameter more important factor in determining respirability and carcinogenicity.

② page 6

OSHA reserves right to adopt 0.5; 0.2 or 0.1 PEL after conclusion of rulemaking. What does this mean? Will it merely delay implementation to procrastinate in this way? ORC should seriously study this issue and submit a proposed standard based upon a meaningful scientifically valid risk assessment.

Hyatt

Page 28.

Page 24

Page 31 – different PELs for fiber varieties

Page 35 – 0.2 the action level.

Page 37 – Important question on measurability below action level

Page 39 – smoking + lung – Regulated Areas

Page 46 – OSHA believes asbestos a potent human carcinogen.

Hyatt

Page 10 – smoking + lung cancer.

Page 11 – no mention of decline & slow decline in severity or relationship of severity to dose. Asbestosis in rare!

Page 19 – risk estimate based on 45 years exposure. No account taken of less work.

Page 25 – chemically treated and/or altered.

Page 26 – 8/11 length – Stanton (Is 3:1 appropriate?)

Hyatt

Page 47 – Medical surveillance.

Page 53 – good 13.

Page 54 – What about "No SMOKING"

Page 59 – Yes – definitely have ceiling level in construction industry, preferably PEL

Medical surveillance in construction.

02238

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