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PLAINTIFF'S EXHIBIT
UC-3682

Organization Resources Counselors, Inc.

May 25, 1984

RECEIVED
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H. C. LEWINSOHN, M.D.

Docket Officer
Docket No. H-033C
Room S-6212
U.S. Department of Labor
Third Street and Constitution Ave., N.W.
Washington, D.C. 20210

In Re: Notice of Proposed Rulemaking (49 FR 14116) Occupational Exposure to Asbestos.

Dear Sir or Madam:

On Tuesday, April 10, 1984, OSHA published in the Federal Register a Notice of Proposed Rulemaking (NPR) on Occupational Exposure to Asbestos. The NPR requested data and comments on OSHA's proposed revisions to its Asbestos Standard 1910.1001.

Organization Resources Counselors, Inc., (ORC) sponsors an Occupational Safety and Health Group which is composed of about 60 companies from a wide range of industries and with employment size ranging from medium to large. All of these companies have a strong commitment to employee safety and health. The members of the Group work with ORC on OSHA rulemaking activities and other aspects of employee safety and health. Although this statement was prepared in consultation with member companies, the views it presents are solely the responsibility of ORC. Independent comments may be submitted by ORC member companies.

ORC commends OSHA's action in undertaking the revision of 1910.1001. Such a revision is long overdue, because many provisions of the present standard do not reflect the increased understanding of the disease process associated with asbestos or the range of actions that can be undertaken to control potential exposure to it. ORC, recognizing the need to impose stricter controls on employee exposure to asbestos, developed and submitted to OSHA on June 6, 1983 a Recommended Revision of 1910.1001.

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It is widely recognized that exposure to asbestos fibers can be a significant source of risk to American workers. There is no known threshold for "safe" exposure to asbestos, and there are many studies that amply document the nature of the risk associated with exposure to asbestos fibers.

Recognizing the necessity to closely control employee exposure to asbestos, we must also recognize that much of the disease that we are seeing today is the result of exposures that took place 30-40 years ago. Much has changed in the industrial environment since 1944, and our understanding of the disease process has improved dramatically.

As our understanding of the risk presented by exposure to asbestos fibers has grown, the use of asbestos containing products and the concomitant exposure to it have dropped sharply. The use of improved respiratory protective equipment, coupled with prudent administrative and work-practice controls, has reduced the actual exposure of the great majority of American workers to levels approaching the limits of reliable detection.

As OSHA makes much needed revisions to its Asbestos Standard, it must recognize that the new standard will be applied to conditions of exposure existing in 1984 not 1944. OSHA's revised Asbestos Standard will be applied to reduce exposures that in a majority of cases are already below 0.5 fibers per cubic centimeter of air. Thus, calculations of benefit and risk must be based on studies which reflect today's exposures not yesterday's!

In its revised Recommendations For Revision of 1910.1001 (May 25, 1984) ORC is recommending two permissible concentrations of asbestos fibers:

(1) Permissible Airborne Concentration: (PAC) Intended to regulate ambient concentrations of airborne asbestos on the worksite to 0.5 f/cc, or less.

(2) Permissible Exposure Limit: (PEL) Intended to regulate actual employee exposures to asbestos fibers, (fibers inhaled into the lungs), to 0.2 f/cc.

In the accompanying material, ORC has submitted a modified version of its Recommended Revision of 1910.1001 along with comments and additional data concerning key elements of any asbestos standard.

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It is our hope that these comments and the accompanying data will prove to be useful, and we would be happy to answer any questions you may have concerning our submission.

Sincerely,

Richard F. Boggs

Richard F. Boggs, Ph.D.
Vice President

RFB:jkj

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Introduction

ORC has for some time been concerned with the degree of protection that is mandated by the existing OSHA Asbestos Standard, 1910.1001. ORC first expressed its concern by developing and transmitting to OSHA a recommended asbestos standard on June 6, 1983.

This recommended standard describes the elements of a responsible and comprehensive approach to controlling employee exposure to asbestos. At the time of its original submission, ORC did not discuss respiratory protection. However, a considerable body of recommendations regarding respirator use have been included in this document.

ORC has also made some modifications in its treatment of Permissible Exposure Limits to eliminate internal inconsistencies and to assure that the definitions accurately reflect its original intentions.

In the material that follows, ORC will discuss the meaning and intent of the changes that it has made to its original June 6, 1983 submission to OSHA, elements of a responsible respirator program, as well as key points for OSHA to consider in its revision of 1910.1001.

OSHA's NPR A Disappointment

OSHA's NPR, while welcomed by ORC, is nevertheless a disappointment because of its indeterminate nature. So many key points are unfocused in the present NPR that it is difficult to anticipate the kind of impact it may have on the workplace. At too many key points in OSHA's NPR, decisions have been avoided, and questions asked in their stead.

The Need For Latitude

While recognizing the need for latitude in rulemaking, and agreeing in principle with that need, ORC is concerned the present NPR allows OSHA too much latitude on a variety of crucial issues, with little or no chance given for public comment before the final standard is issued.

A Factual Misunderstanding of ORC's Previous Submission

In OSHA's discussion of the Regulatory Impact Analysis and Regulatory Flexibility Analysis Section VII, part D, Regulatory Alternatives, page 14135, under the heading, Organization Resource Counselors, Inc., Proposed Standard, OSHA indicates that the ORC proposal recommended setting different PELs for different asbestos fiber types.

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This is a regrettable misunderstanding, since ORC went to some length to discuss the reasons why it thought that it "was neither necessary or practical to set different levels for the major commercial varieties of asbestos" 1/ and used two and a half pages 2/ discussing the reasons why it chose to recommend a single level for all asbestos varieties. ORC requests that OSHA correct this error at the earliest opportunity.

Regulatory Outlook For Asbestos

Asbestos is a proven carcinogen of long standing. Volumes of scientific work attest to the fact that asbestos produces both lung cancer and mesothelioma. It must also be recognized that there is no scientifically defined threshold that can be determined, below which asbestos presents no risk.

We all live in a world in which there are many risks, and unfortunately no way has been devised to eliminate them all. Virtually nothing is done in life without some exposure to risk. Clearly the exposure to asbestos is one of those risks. It is incumbent upon all of us, employers, government and workers to determine the nature and degree of the problem existing today and then to implement controls that will reduce the current and future risks.

It does no good, and may do harm to base present regulatory actions on historical exposures which are no longer relevant. Disease that we see today, however unpleasant and unfortunate, is, for the most part, the result of exposures to asbestos that took place 30-40 years ago.

When preparing to revise regulations concerning asbestos, we must recognize that workplace conditions common in 1944 have drastically changed in 1984. In 1984 asbestos is widely recognized as a hazardous material, and few will use it where a reasonable substitute exists. The uses of asbestos, commercial and military, are shrinking rapidly and in a few more years may virtually disappear.

As a result of the lessening use of asbestos, employment in the asbestos producing and manufacturing industries is shrinking rapidly, a process that will continue to accelerate as more workable substitutes are found. We must recognize nevertheless that there are still uses of asbestos for which we have found no suitable or practical substitutes. For example, no adequate non-asbestos substitutes have been found for friction materials uses such as automotive brakes and clutches, and brakes on winches and cable drums.

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Major Sources of Occupational Exposure to Asbestos

The major sources of occupational exposure to asbestos today, rip-out, removal and demolition, are at least in part derived from the new awareness of the potential hazard that asbestos presents. Even here the problem has finite dimenisions, and is limited by the amount of asbestos materials installed in the past. Only small amounts of asbestos are still used for any purpose other than friction materials.

As the existing base of commercial plants and buildings is renovated or rebuilt, asbestos is removed and not replaced. New construction uses very small amounts of asbestos, and will soon use none. With regard to friction materials, there is new evidence that exposures to chrysotile asbestos during manufacture or installation and maintenance may not present the degree of risk previously assumed.

What Needs To Be Done

We need to recognize both the magnitude of the problem as it presently exists and the practical solutions available. Where are the problems? What are the current exposures? What is being done about it? What can be done to minimize the impact?

For the great majority of those working with asbestos today, exposures (fibers actually inhaled into the lungs) are at or below 0.5 fibers/cubic centimeter, (f/cc). ORC believes that it is inappropriate for anyone to breathe asbestos fibers, above 0.2 f/cc, and in fact there are many ways to avoid such exposures. We must, however, recognize the necessity of dealing with asbestos until it can be eliminated from our working environment.

A Practical Compromise

It seems reasonable to make a practical distinction between the ambient concentrations permitted, and the actual personal exposure that is allowed. It is possible through the use of engineering controls or other feasible technology to lower ambient concentrations of asbestos to a practical, achievable level, AND control individual exposures to a different and lower concentration.

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One must recognize the necessity of working with asbestos in many operations and should allow reasonable ambient concentrations, while refusing to allow potentially dangerous individual exposures. Modern respiratory protective equipment and improved work practices allow this to be done. In fact, as we will demonstrate, this is already the norm in most properly run operations in this country. In today's industrial environment, employee exposures to concentrations of asbestos above 0.2 f/cc need not and should not take place.

Permissible Concentrations

On June 6, 1983, ORC transmitted to OSHA its suggestions for the revision of OSHA's asbestos standard, 1910.1001. On page 62, (c)(1) ORC recommended that "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..."

The letter of transmittal to [then] Assistant Secretary Thorne G. Auchter, which accompanied ORC's request for reconsideration of the asbestos standard PEL, stated that: "ORC is recommending an eight hour time weighted average airborne concentration not to exceed 0.5 fibers per cubic centimeter." At the same time, the ORC Recommended Revision of 1910.1001 defined exposure as: "...the actual concentration of airborne asbestos fibers that are present in the inspired air." 3/

Apparently this has led to some confusion as to ORC's actual intent. It was not ORC's intent to recommend that employees be allowed to breath air contaminated with 0.5 f/cc without respiratory protective equipment.

ORC's Intent

It was ORC's intention to recommend that the ambient concentration of asbestos fibers allowable be lowered from 2 fibers to 0.5 fibers/cc.

A Problem Of Definitions

The basic problem centers around OSHA's definition of "exposure" which is defined as being "irregardless of the use of respirators". It is ORC's opinion that to define "exposure" as OSHA has, is wrong. This is so because an individual wearing a properly fitted respirator is actually exposed (inhaling into the lungs) to a

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concentration of asbestos fibers lower than ambient levels. The actual individual exposure can be determined by dividing the rated Protection Factor (PF) of the respirator into the ambient concentration.

PERMISSIBLE AIRBORNE CONCENTRATIONS AND PERMISSIBLE EXPOSURE LIMITS

In its revised Recommendations For Revision of 1910.1001 (May 25, 1984) ORC is recommending two permissible concentrations of asbestos fibers:

(1) Permissible Airborne Concentration: (PAC) Intended to regulate ambient concentrations of airborne asbestos on the worksite to 0.5 f/cc, or less.

(2) Permissible Exposure Limit: (PEL) Intended to regulate actual employee exposures to asbestos fibers, (fibers inhaled into the lungs), to 0.2 f/cc.

Permissible Airborne Concentration (PAC)

(1) Ambient worksite concentration. The eight hour time weighted average airborne (ambient) concentration of asbestos fibers in which any employee may work shall not exceed 0.5 fibers per cubic centimeter of air, except as in (2) below.

(2) If circumstances require that an employee work in ambient airborne concentrations of asbestos fibers above 0.5 f/cc, and it has been established and documented that engineering controls cannot bring this down to 0.5 f/cc or below, such circumstances shall require that all employees be equipped with air-line (supplied air) or positive pressure, Self-Contained Breathing Apparatus (SCBA).

(3) This level, 0.5 f/cc, would require that the workforce be protected by the use of respirators with a minimum PF of 5. From 0.5 f/cc down, the use of negative pressure respirators would be acceptable if they were capable of being fit-tested, either qualitatively or quantitatively, and used High Efficiency Particulate (HEPA) filters. Above 0.5 f/cc employees must be equipped with air-line respirators, or positive pressure SCBA.

Permissible Exposure Limit (PEL)

The eight hour time weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed 0.2 fibers (inhaled into the lungs) per cubic centimeter of air.

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This is the airborne concentration of asbestos fibers, at or below which employees need not wear respirators, and above which all employees must be equipped with appropriate respiratory protective equipment.

A Practical Distinction

This practical distinction depends upon the definition of "exposure" as being that which is actually inhaled into the lungs. At 0.5 fibers/cc, the use of a fit-testable respirator equipped with HEPA filters and a PF of at least 5, will bring actual employee exposure down to 0.1 fibers/cc. A protection factor of 10 would yield an actual exposure of .05 fibers/cc.

It is ORC's judgement that the PAC/PEL approach discussed above would be a practical solution to the necessity to both work with asbestos and protect employees from the proven hazard it represents.

Additionally, as we will make clear, with the use of proper work practices as part of an integrated health and safety program, the actual ambient airborne concentrations of asbestos in stripping and removal operations should not often reach a TWA of 0.5 fibers/cc.

PRACTICAL METHODS TO CONTROL ASBESTOS EXPOSURES

There is nothing mysterious about controlling employee exposure to asbestos. The basic methods and approaches have been known for many years, represent basic good industrial hygiene practice and are effective.

Many industries have developed effective ways to deal with the problems presented by the necessity to handle asbestos containing materials during maintenance and repair operations. These methods when properly implemented and enforced can assure that ambient levels remain low and that employees are not exposed above 0.2 f/cc.

Some of the basic elements of effective programs for safely handling asbestos containing materials are:

(1) The existence of an integrated health and safety program within the company.

(2) A written program for handling asbestos containing materials. This should detail standardized techniques for all aspects of such operations.

(3) Training of potentially exposed employees in the use of the standardized techniques.

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(4) Training in the use of appropriate personal protective equipment including respirators.

(5) Validation of standardized techniques through the monitoring of operations and the maintenance of records that establish a "historical" standard for ambient levels generated by such techniques.

(6) Strict enforcement of all general and specific health and safety program techniques within the company.

(7) Identification of asbestos containing materials.

(8) Isolation of the removal area where feasible and/or appropriate (ropes, signs, plastic curtains, negative air pressure, etc.).

(9) Thorough, continous wetting of the material to be removed with surfactant containing water.

(10) Careful removal of asbestos insulation to avoid unnecessary disruption of the material.

(11) Prompt disposal of removed asbestos containing material packaged to prevent the release of fibers.

(12) Proper use of appropriate protective clothing and equipment.

(13) Qualitative or quantitative fit-testing of all respirators used.

(14) Appropriate change facilities to remove contaminated protective clothing.

(15) Prompt and appropriate cleaning/disposal of contaminated protective clothing and respirators/cartridges.

(16) Prompt and thorough washing of all exposed parts of the body.

(17) Collection and appropriate disposal of asbestos debris, and contaminated water. If debris are dry they should be rewetted.

(18) Periodic monitoring of asbestos removal operations after a "historical" record has been established for levels generated by a particular technique.

(19) Insistence that all contractors establish and follow safe effective techniques for all asbestos removal operations, including monitoring.

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Results Possible With a Good Program

Application of the above recommendations and any others that are found necessary for a particular situation will generally result in low ambient levels of asbestos fibers being generated during stripping and removal operations. The Standard Oil Company (Indiana), in testimony submitted to OSHA concerning the asbestos NPR, showed that: "of 322 personal samples in our files, 259 had measured concentrations below two fibers/cc. and only 15 samples or 5 percent exceeded 10 f/cc." 4/ When only wet removal techniques are examined only 2 of 132 had concentrations over 2 f/cc. These examples are not time weighted averages (TWA).

Over the last two years, as the Company tightened its program, only one personal breathing zone sample out of 72 exceeded 0.5 fibers/cc and when converted to a TWA, none exceeded 0.5 f/cc. "It can thus be concluded that asbestos exposure in our industry for asbestos removal will not exceed 2 f/cc as a time-weighted average, under any foreseeable circumstances. Further, proper use of wet methods can bring exposures below a TWA of 0.5 f/cc and consistently prevent ceiling levels above 10 f/cc." 5/ In the operations described by Standard Oil (Indiana), a respirator with a protection factor of 5 would yield an actual exposure of 0.1, a PF of 10 would be equivalent to an exposure to 0.05 f/cc.

In a recent study done by International Paper, only 1.4% of all TWA determinations were above the OSHA PEL, and only 2.2% of the ceiling determinations. For the TWA determinations, 53.6% of the samples were below 0.1 f/cc, while for the ceiling samples 12.9% were below 0.1 of 46.8% were between 0.1 and 0.5 f/cc. 6/

Dealing With Contractors

Large companies, such as International Paper (IP), have developed integrated health and safety programs that recognize the necessity to deal effectively with asbestos removal contractors. Not all contractors are trained or skilled in asbestos removal, and it is important that the hiring company let the contractor know exactly what will be required.

International Paper notifies the contractor of its responsibilities under 1910.1001 and that it expects the requirements to be met or exceeded. The contractor is made aware that its performance will be reviewed and audited. The degree of contractor preparation for a particular job is monitored, and the company provides contractors with copies of its asbestos work practices, a copy of its asbestos removal video tape, the OSHA standard, and scheduled meetings with the contractor to discuss all aspects of the removal job. 7/

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The contractor is asked to supply all of its own equipment, to do regular monitoring, to observe all safety rules, and is informed that the job will be stopped if proper procedures are not followed. The level of training of the contractor employees is reviewed, and if there is not a large enough pool of trained employees available, the contractor may be asked to begin a training program to correct the problem. Finally, the hiring facility is provided with a checklist to make sure that all requirements are met. 8/

Shipbuilding and Repairing

The shipbuilding and repairing industry has historically had some of the worst asbestos problems of any industry. Asbestos exposures in shipyards during World War II led to much of the present day asbestos related disease. However, the application of good industrial hygiene practice has reduced to manageable levels or eliminated problems with asbestos exposures.

The control of asbestos exposures in shipyard work was discussed in detail at the March 27 & 28, 1984 ORC Asbestos Symposium. Mr. Norman Beddows looked at particular work practices in shipyards, and showed how they could be used to eliminate much of the generation of airborne asbestos fibers. For those situations where work practices or engineering controls could not control fiber release to a reasonable level, Mr. Beddows describes the requirements and implementation of a thorough and effective respirator program. Such a respirator program, once implemented is, of course, applicable to many other potential hazards besides asbestos. 9/

The Newport News Shipbuilding and Drydock Company has, over the last seven years, instituted a comprehensive, integrated health and safety program to deal with the problems involved in the shipbuilding and repairing industry. Mr. James Thornton, from the Newport News Shipbuilding and Drydock Company, has presented to OSHA an outline of the safety and health program developed by the shipyard to deal with potential asbestos exposures, and to assure the effective use of respiratory protection.

The removal of asbestos from shipboard installations represents one of the most difficult removal situations. Ship engine rooms are enclosed, cramped, cluttered, deep within the interior of the ship and present severe entry and egress problems. Yet, as demonstrated by Mr. Thornton, these problems have been overcome, employees have been and are protected from excessive exposure to asbestos, and it is done on a regular basis.

As we have seen, some shipyards, with their acknowledged problems, have developed and implemented programs to control employee exposure while performing difficult operations. The application of basic industrial hygiene and safety principles to the problems of asbestos

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exposure can reduce and control employee exposure. The same principles can be applied by any modern industry, and need not be prohibitively expensive. The key is that all such control measures, to be most effective, must be part of a comprehensive, integrated health and safety program.

Integrated Safety and Health Programs

The most basic requirement to effectively control employee exposure to asbestos is the existence of a well planned integrated program for controlling hazards in all operations within a company or a facility. The program must involve management as well as labor, and it must become an integral part of planning for every kind of operation within a company.

The program is a philosophical and ethical approach to protecting employee health and cannot be imposed from without. The passage of a regulation establishing new requirements for dealing with a substance may not markedly improve the protection that an employee receives if the philosophical commitment is not there.

No matter what PEL is set by a standard, the ultimate protection that an employee receives is directly dependent on the quality of the program within a particular organization. The consistency of the day to day enforcement, the insistence on obedience to the established rules, and care and attention to details are the determinants of the quality of protection an individual receives.

Too often, excessive attention is paid to the results of formal monitoring exercises, and too little to the day to day enforcement of the whole program. A recent article, based on the results of a 1982/83 asbestos working group report on conditions relating to asbestos handling in British industry, found that, often, even though the formal sampling numbers were below the required limits, the overall quality of the health and safety programs were poor. The author of the article indicated that the real problem was a reliance on numbers rather than common sense. Both industry and OSHA need to pay more attention to the benefits of comprehensive health and safety programs. 10/

Engineering Controls May Be Difficult

Most situations that involve exposure to asbestos in general industry involve the removal or stripping of insulation containing asbestos. One characteristic of most rip-out or removal jobs is that they are not amenable to engineering controls. Engineering controls work best where there is a fixed work site, or the work site allows the use of ventilation and isolation techniques.

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Short Term Jobs Most Common

Most industrial stripping and removal situations involve jobs lasting less than a day, with many being related to maintenance operations and lasting hours. In older plants a high percentage of pipes, boilers, reactors, etc., may contain some asbestos. In these operations it is usually not feasible or reasonable to attempt engineering controls. Yet, these short-term maintenance/repair type jobs represent a large part of the situations where employees are potentially exposed to asbestos. In one company, it is estimated that at medium to small facilities, asbestos removal operations may take place once or twice a year, and typically last less than an hour. A long job may last several days. In this company one or two man days per year of asbestos removal work would be about average for those doing such work. 11/

The Difficulty of Control

Control of personnel who may work with asbestos is difficult when the potential exposures are short and numerous. The extra time that it takes to protect against potential asbestos exposure may be resented if the perceived risk is low and the job small.

Control becomes even more difficult where it is known that a majority of insulation in the facility contains no asbestos, but it is not precisely known which does or does not. In this case, management often treats all insulation as asbestos containing, which may cause crews to become careless.

MONITORING ASBESTOS REMOVAL

As stated earlier, it is very important that those doing removal or stripping operations develop a standardized technique. It is equally important to build a record, through industrial hygiene monitoring, of the concentrations of asbestos fibers generated by each of the kinds of removal operations practiced. The historical record of concentrations of asbestos fibers built in this way validates the efficacy of a particular removal technique. Along with the historical records, one should have periodic monitoring of removal techniques to assure that they are being conducted as carefully as originally conceived.

Constant Monitoring Not Required

Once a technique has been developed and validated through the generation of an adequate historical record of industrial hygiene samples, there should be no requirement to monitor each and every removal project.

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As indicated in the Standard Oil (Indiana) submission, many of the asbestos removal jobs take only a few minutes. To require that each one of these short potential exposures be monitored is wasteful of both time and money. Worse, the additional delay represented by the necessity to schedule the availablility of technicians and equipment for the sampling operation may cause employees to do the job quickly, telling no one.

A standardized asbestos removal technique, whose details are enforced by management as part of a comprehensive health and safety program, will give the same degree of protection whether each job is monitored or not. However, human nature being what it is, there must be periodic monitoring and frequent supervisory inspection to assure that backsliding has not occurred.

ORC recommends that on the basis discussed above, the requirement for the monitoring of every asbestos removal operation be eliminated.

DISCUSSION OF THE RISK AT 0.5 FIBERS/CC

ORC believes that actual exposure to asbestos fibers should be kept as low as possible for all workers. This can be achieved through the use of good work practices, administrative controls, and adequate respiratory protective equipment. Through the application of the above and good industrial hygiene practice, no worker need be exposed to concentrations of asbestos fibers above 0.2 f/cc.

ORC recommends that OSHA allow an airborne (ambient) concentration of asbestos fibers of 0.5 fibers/cc so long as adequate respirators are used as part of a comprehensive health and safety program.

At the same time, these methods can in many situations, reduce the airborne concentrations of asbestos below 0.5 f/cc. Where such a reduction in the concentration of airborne asbestos fibers is possible, it should be reduced as low as practical, for the best exposure level for asbestos is the lowest.

With the foregoing in mind however, ORC recommends that estimates of risk be based on exposures (fibers actually inhaled into the lungs) that are relevant to 1984 workplace conditions. It is important to know as accurately as possible what the actual risk is at todays exposure levels, but this is not possible unless we recognize the factors in the risk equation that have changed from 1944 to 1984.

There are many uncertainties that bear on the production of any risk estimate. In the following paragraphs, ORC will discuss some of those uncertainties that, in our opinion, may have caused OSHA

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to overestimate the risk at the 0.5 fibers/cc as it applies to conditions existing in workplaces in 1984.

Factors Affecting Risk Estimates

1. Nature of early studies: Most of the early studies were based on work in the asbestos industry (mines and factories) where exposures were high, and measurements of such exposures were made with midget or Greenberg-Smith impingers. "In any case there were a number of workers at one location, many engaged in the same operation, doing the same thing with the same exposure day after day and year after year. Estimates of past exposures under these circumstances can be made with some confidence." 12/

(2) Most studies have been done in the asbestos industry. In this industry, exposures have been consistent and usually high in relation to exposures found outside the asbestos industry.

(3) There are few studies done at low levels of exposure. Risk at low levels has been extrapolated from high exposures using a simple linear relationship that may not be accurate.

(4) The exposures of the insulation workers of North America were not actually measured, but estimated from exposures made in a different plant, in another state, years later. Also the exposures of insulation workers were not consistent from day to day, and year to year. They varied sharply as discussed by Ayer. 13/ In this way they are similar to the experiences of those workers doing asbestos removal.

(5) Cumulative dose is an important concept used in estimating the extent of worker exposure to asbestos. This is often measured as fiber years per cubic centimeter.14/ If one looks at the kind of exposures to asbestos that are taking place in 1984, calculates the cumulative dose, and compares it to exposures that took place 40 years ago we see a marked change.

If we asssume a steady exposure of 8 hours per day, five days per week for 45, 25, and 10 years for each fiber concentration we see:

Fibers/cc		Years exposed	Fiber years/cc
12	X	45	540
12	X	25	300
12	X	10	120
5	X	45	225
5	X	25	125
5	X	10	50

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Fibers/cc		Years exposed	Fiber years/cc
2	X	45	90
2	X	25	50
2	X	10	20
1	X	45	45
1	X	25	25
1	X	10	10
0.5	X	45	22.5
0.5	X	25	10.5
0.5	X	10	5.0
0.2	X	45	9
0.2	X	25	5
0.2	X	10	2

These calculations of fiber years/cc show a steady drop as the fiber concentrations drop. This has occurred over the last 40 years as exposures have steadily dropped. However, the above calculations do not take into account the sharp drop in the number of hours of exposure per year, the use of respirators or the change in the occupations where most exposure takes place.

(5) Excessively high numbers used for the calculation of exposur time. In 1984 very few workers will be exposed to levels of 0.5 fibers/cc, 8 hour per day, 5 days per week, 50 weeks per year for 45 years. It is not reasonable to expect this same exposure to continue to the year 2029! The majority of 1984 exposures are intermittent, and 4-5 days per month would be on the high side for an industry wide average.

Calculations by one large U.S. corporation show that approximately 2-3 percent of employees have potential exposure to asbestos at infrequent intervals for periods of one hour or less. This same corporation reports that asbestos concentrations during removal operations ranged from non-detectable to 0.2 f/cc. Asbestos removal projects for this corporation have occurred on the average of one per year per facility and have usually lasted one week. 15/

(6) Sampling and analytical problems. These have not been sufficiently taken into account when calculating past exposures. For 40 years the principal instrument used for dust monitoring in the U.S. was the Greenberg-Smith impinger. This device was efficient for dust and silica measurements, but was not adequate for asbestos fibers. In other countries, instruments such as the thermal percipitator were used, but all were eventually replaced by the membrane filter method. The use of

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the unaided microscope with a 10X objective and 7.5 or 10X eyepiece was replaced by the 40-45X, 4 mm objective and phase-contrast illumination with the use of the graticle. 16/

The original methods and optical equipment missed many fibers, and even today, we know, by comparison to the transmission electron microscope, that the optical phase-contrast microscope misses many fibers smaller than 0.3 microns in diameter.

In its Recommended Revision of 1910.1001, ORC commented upon problems with conversions from historical data 17/ and viewed with skepticism many of the published conversions as being essentially unreliable. At the same time, 18/ ORC commented that the transmission electron microscope, compared to the optical phase contrast analytical technique, found significantly larger numbers of asbestos fibers. "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." 19/

(7) Insufficient allowance has been made for fiber type and industrial process. Recent studies by Berry and Newhouse have shown that there is a significant difference in the number of mesothelioma cases that result from exposure to amphibole fibers as opposed to those of chrysotile asbestos. 20/ In three parallel cohort studies completed by McDonald et al 21/21/23/ in which the experience at three American asbestos manufacturing operations was examined, mesothelioma was found to be almost exclusively related to the use of amphibole varieties of asbestos. This was true even in the chrysotile textile plant that had very high rates of lung cancer.21/

Asbestos textile manufacturing operations using chrysotile showed very high rates of lung cancer 21/22/, but in the chrysotile asbestos friction products plant virtually no lung cancer excess was found. 23/ Berry and Newhouse 24/ also failed to detect any increase in the risk of lung cancer in a British friction products plant using chrysotile.

Commenting on the American friction products plant study, Dr. J.C. McDonald observed: "By the same token, the negative findings for respiratory cancer in chrysotile friction products manufacture suggest that the risk is too small even after 20 or more years exposure to be detectable in epidemiological studies. It should be noted that the exposures of the friction plant employees studied were at least ten times greater than they are today". 25/

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In the conclusion to their 1983 study in an American chrysotile textile plant, while discussing differences in lung cancer incidence between textile manufacture and mining operations, McDonald et al commented that: "Noting the experimental evidence in animals, we are led to speculate that the distribution of very fine fibres, seen only by electron microscope may be different in the two situations." 26/

Reviewing the relationship between physical shape and the ability to produce disease in asbestos fibers, J.C. McDonald comments that:

> "The experimental work of Pott and Friedrichs in Germany, Stanton and Wrench in the United States, and Wagner and colleagues in Britain all point to the great importance of dimensional rather than physiochemical characteristics in determining the potential carcinogenicity of mineral fibers. Very fine fibers, less than 1 or 2 microns in diameter, appear to be the most dangerous and probably, though not certainly, the longer fibers in this range are the worst." 27/

(8) Lack of a smoking history in many of the earlier studies. The importance of the smoking habits of individuals exposed to asbestos is hard to overestimate. Any study examining lung cancer incidence that lacks this information must be discounted as being essentially incomplete.

A USEFUL RISK ANALYSIS TECHNIQUE FOR ASBESTOS EXPOSURE

During the ORC Asbestos Symposium (March 27 & 28, 1984) Howard Ayer of the University of Cincinnati presented an interesting approach to analyzing the risk involved in asbestos removal operations. 28/

Since asbestos removal operations now account for a large fraction of the total number of workers exposed to asbestos, it makes sense to examine closely their particular risk factors. Those removing asbestos insulation, like those who installed it, have exposures that vary widely. Most work in one place only briefly, and the physical location and conditions of the work can vary significantly.

Since the fibers to which those removing asbestos are exposed are similar to those which the installers were exposed to, it is appropriate to look at the installer experience as a basis for an examination of the risk factors involved in asbestos removal.

Ayer combined data developed by Nicholson et al, 29/ which suggests that the insulation workers might have been exposed to 10-15 fibers/cc), and curves constructed by Selikoff, Hammond et al for the relative risk of developing lung cancer vs time

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since their first exposure, with data from the National Center for Health Statistics (NCHS) to synthesize a risk curve for removal operations. 30/

Using the synthesized risk curve, Ayer proceeded on the basis that: "Assuming no threshold and a linear relationship between exposure and excess lung cancer, the projected excess lung cancer risk at low exposure will be reduced by the same factor as the exposure is reduced below that estimated to cause high past excesses." 31/

If we assume from the risk curve for asbestos exposed insulation workers that there is a 20 percent excess mortality for a given cohort exposed to 12 fibers/cc of asbestos fibers, then, if we reduce the asbestos exposure 100 times we also reduce the life time risk 100 times. Thus, if the 12 fiber exposure is reduced 100 times to 0.12 f/cc, the risk is also reduced from 20 percent to 0.2 percent. That is the excess mortality goes from 200 per 1000 to 2 per 1000.

Two deaths per 1000 workers is not acceptable, and it is, in fact, preventable, as previously discussed. It must be remembered, however, that the final numbers calculated in any curve are no better than the original data, and in the study of the North American insulators, hard data on actual exposures was not available.

RESPIRATORY PROTECTION

Theoretically, it is possible, through the use of engineering controls, work practices and other methods to effectively eliminate any worker exposure to airborne asbestos fibers without the use of respirators. Practically speaking however, there are many situations where engineering controls and work practices may not be adequate.

In many asbestos removal operations engineering controls are not feasible, and the protection of potentially exposed individuals must be accomplished through the use of work practices and respiratory protective equipment. In these situations it is ORC's position that respirators used as part of a comprehensive, integrated health and safety program, (including a respirator program) are capable of giving protection adequate to keep employee exposure below 0.2 fibers/cc.

ORC Recommendations For Respirator Use

Recognizing that asbestos fibers will be released in even the best removal program, and that engineering controls are not always possible or practical, ORC has recommended a dual PAC/PEL and where necessary the use of respirators as follows:

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(1) Permissible Airborne Concentrations: (PAC) Intended to regulate ambient concentrations of airborne asbestos on the worksite to 0.5 fibers/cc.

(2) Permissible Exposure Limit: (PEL) Intended to regulate actual employee exposures to asbestos fibers (fibers inhaled into the lungs) to 0.2 f/cc or less.

Discussion of the Permissible Airborne Concentration (PAC)

(1) Ambient worksite concentration. The eight hour time weighted average airborne (ambient) concentration of asbestos fibers in which any employee may work shall not exceed 0.5 fibers per cubic centimeter of air, except as in (2) below.

(2) If circumstances require that an employee work in ambient airborne concentrations of asbestos fibers above 0.5 f/cc, and it has been established and documented that engineering controls cannot bring this down to 0.5 f/cc or below, such circumstances shall require that all employees be equipped with air-line (supplied air) or positive pressure, self-contained breathing apparatus (SCBA).

(3) This level, 0.5 f/cc, would require that the workforce be protected by the use of respirators with a minimum PF of 5. Below 0.5 f/cc the use of negative pressure respirators would be acceptable if they were capable of being fit-tested, either qualitatively or quantitatively, and used high efficiency particulate (HEPA) filters. Above 0.5 f/cc employees must be equipped with air-line respirators, or positive pressure SCBA.

Discussion of the Permissible Exposure Limit (PEL)

(1) The eight hour time weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed 0.2 fibers (inhaled into the lungs) per cubic centimeter of air.

This is the airborne concentration of asbestos fibers, at or below which employees need not wear respirators, and above which all employees must be equipped with appropriate respiratory protective equipment.

ORC Recommended Respirator Requirements

1. Used only where engineering controls not practical.
2. Used only as part of a complete respirator program.
3. HEPA filters only.
4. All respirators must be fit-tested.

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5. A minimum protection factor of 5 is required.
6. Above 0.5 f/cc ambient, supplied air or SCBA must be used.
7. Respirators must be worn during asbestos removal operations.

Methods of Compliance

ORC recommends that employers be required to institute engineering controls, to the extent feasible, to control employee exposures to airborne asbestos fibers to or below Permissible Airborne Concentrations (PAC). If engineering, work practice or administrative controls are not effective in reducing exposures to/or 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 recommendation, they are clarified:

> "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 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.

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The priority of control methods required by ORC's recommendation, 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 ORC's recommendations.

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 recommendation 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 de-emphasize the use of administrative controls because they not only fail to eliminate the hazard, but they also 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

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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) of ORC's Recommended Revision of 1910.1001 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. 32/

Respirator Programs

The ONLY way that respirators may be used effectively, is as part of a well organized, enforced respirator program. In turn, a respirator program is most effective as one functional part of a comprehensive, integrated health and safety program.

ORC Recommendations for a Standard Controlling the Use of Respirators Within an Organization

The first general requirement for the effective development of a respirator use program is the establishment of a written program or policy controlling the implementation of such a program. The following is ORC's recommended general standard or policy designed to govern the use of respirators within organizations large or small.

(A) Scope

This section contains requirements for selection and use of respirators in general industry workplaces. When respirators are used to protect against concentrations of toxic substances at or above PEL's or oxygen deficient atmospheres, the requirements of this standard shall be met.

(B) Objective

The objective of this section is to assure that respiratory protection is used in a manner which will protect workers from inhaling (1) air contaminants in concentrations exceeding permissible exposure limits and (2) oxygen deficient atmosphere.

(C) Permissible Practice and Responsibility

(1) General

Preventing occupational diseases caused by breathing contaminated air shall be accomplished as far as economically and technologically feasible by accepted engineering or at least

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as effective, administrative and work practice control measures. Respirators shall be used where necessary in the following circumstances:

(a) When effective engineering controls are not feasible.

(b) When less than significant improvements will result from the installation of engineering controls.

(c) During the time period necessary to install or implement feasible controls.

(d) In work operations such as construction, maintenance, repair and decontamination activities in which the employer establishes that engineering controls are not feasible.

(e) In other situations where administrative or work practice control measures are not appropriate.

(f) For jobs of short duration.

(g) In emergencies.

(2) Employer Responsibility

(a) Respirators shall be provided by the employer when such equipment is necessary for employee protection.

(b) The employer shall provide respirators which are applicable and suitable for the purpose intended.

(c) The employer shall be responsible for the establishment and maintenance of a written respiratory protection program which shall include the general requirements listed in Paragraph (d).

(3) Employee Responsibility

(a) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) The employee shall guard against damage to the respirator.

(c) The respirator shall be inspected by the wearer prior to its use to insure that it is in proper working condition.

(d) The employee shall report any malfunction of the respirator to the employee's supervisor.

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(D) Standard Operating Procedures

(1) Written standard operating procedures governing the selection and use of respirators shall be established. These procedures and any accompanying records shall be available for inspection by the employees or their designated representatives, and by the Assistant Secretary.

(2) The following is a list of requirements which must be included in establishing procedures for such a program.

(a) Program Administration

(b) Respirator Selection and Issue

(c) Respirator Protection Factor

(d) Respirator Fit Testing

(e) Training

(f) Respirator Maintenance and Inspection

(g) Work Area Surveillance

(h) Health Evaluation

(i) Air Quality

(j) Respirator Use in Dangerous Atmospheres

(a) Program Administration

The chief administrator of the Program shall be a person with knowledge in respiratory protection at least equivalent to that obtained from the NIOSH course, "Occupational Respirator Protection". This individual shall assure that for each element of the respirator program, paragraph (d), responsibilities are clearly defined and assigned.

(b) Selection of Respirators and Approved Equipment

Respirators shall be selected on the basis of the hazards to which a worker is exposed based on the following considerations:

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Approved Respirators

Only NIOSH approved (certified) respirators shall be selected. Air purifying respirators shall not be used for protection against gases and vapors with inadequate warning properties except as follows:

* When supplied air respirators are unsuitable because of limited mobility, remote or inadequate air supply or portable breathing air sources are unusable.

* Air purifying respirators may be used provided an effective program is implemented to assure that cartridges are replaced before the end of their useful service life. Such a program could consist of a documented cartridge change schedule based on breakthrough and airborne concentration /duration data effectively administered and audited.

General Considerations

The selection of a proper respirator for any given situation shall require consideration of the following factors:

* Type of hazard - oxygen deficiency and/or contaminants;

* Physical properties of the hazard;

* Chemical properties of the hazard;

* Physiological effects of contaminant(s) on the body;

* Anticipated peak and average concentration of a toxic material or airborne radioactivity level;

* Immediately dangerous to life or health: Negative pressure respirators shall not be used in IDLH atmospheres;

* Permissible time-weighted average and/or peak concentration of a toxic material or maximum permissible airborne radioactivity level; IDLH concentration of a toxic material;

* Adequate warning properties of the hazard; and

* Location of hazardous area with respect to a location having respirable air.

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Characteristics of the Operation or Process

* Operation or process characteristics

* Work area characteristics

* Materials including raw materials, end products, and by-products (actual and potential)

* Employee activities - continuous or intermittent, work rate, light, medium or heavy; routine, emergency or rescue use.

(c) Respirator Protection Factor (PF)

Respirators shall be chosen with adequate protection factors for the intended use.

(d) Respirator Fitting Tests

Facial hair shall not be permitted in the sealing area of negative pressure respirators. Nothing shall be allowed to interfere with achieving a proper respirator fit. A qualitative or quantitative fit-test shall be used to determine the ability of each individual wearer to obtain a satisfactory fit (protection factor equal to or greater than the protection factor allowed for that type of respirator by OSHA) with a negative pressure respirator. The results of fitting-tests shall be used to select specific types, makes and models of negative pressure respirators. Respirator fitting-tests shall not be required for positive pressure respirators.

Negative pressure respirators shall not be worn when there exists physical impediments to continuous contact between the respirator face seal and the wearer's face. Such physical impediments may include a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of the facepiece, as can severe facial scars or depressions, as determined by fit-testing.

In non-IDLH environments, where circumstances require the use of positive pressure, face-fitting respirators, facial hair may be allowed in the respirator seal area if a protection factor of no less than 100 is provided, and an air flow of at least 6 CFM is supplied.

(2259)

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(e) Training

(1) The employer shall insure that each individual required to wear respiratory protection equipment understands why the equipment is required, and knows how to use it correctly.

(2) The employer shall have a periodic training program in effect for employees and supervisors. The persons conducting the training shall have the additional training or experience that qualifies them as instructors. Training given shall be documented.

(3) Employees who may be required to use SCBA equipment shall receive "hands on" training in its proper use and maintenance twice a year.

(4) Training programs for employees should be designed to meet the needs of the particular organization or situation. They may be formal or informal, elaborate or simple, depending on the circumstances, as long as the requirement is met that employees understand why the equipment is needed and know how to use it properly.

In a complex situation, with many types of respirators and exposures, both employees and supervisors should be trained. The following aspects shall be considered in setting up a training program.

* Nature, extent, situation, and effects of respiratory contaminants to which the employee may be exposed.

* Need for respirator protection.

* Respirator selection.

* Operation, capabilities, and limitations of the selected respirator.

* Inspection, donning, fit checking, and wearing a respirator.

* Maintenance and storage.

* Opportunity for the respirator wearer to handle and wear the respirator in a safe atmosphere and in a test atmosphere.

* Recognizing and responding to emergency situations.

* Employee's responsibilities.

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* Training for emergency use of respiratory equipment should be performed at least annually.

* Checking the seal each time the respirator is used.

In a less complex situation, with only simple respirators and low hazard exposures, the training objectives can often be met with a simpler program. The training aids available from respirator manufacturers or distributors, with follow-up from supervisors may suffice.

(f) Maintenance

(1) A program for the maintenance of respirators shall be instituted to insure all respirators in use are functional and free of hazardous contamination. It shall include the following:

* Inspection: Each respirator shall be inspected sufficiently and frequently to assure that it is in proper working condition. Each respirator stored for emergency use should be inspected at least monthly. Respirator inspection should include a check for tightness of connections, condition of the respirator-inlet covering, head harness, facepiece, valves, breathing tubes, harness assemblies, filters, cartridges, canisters, end of service life dates(s) if applicable, and proper function of regulators, alarms and other warning systems as per manufacturers instructions.

* Storage: Respirators should be stored in a manner that will protect them against dust, direct sunlight, heat, extreme cold, excessive moisture or damaging chemicals. Emergency and rescue use respirators placed in work areas shall be quickly accessible at all times, and the storage cabinet or container shall be clearly marked.

* Air Quality: (a) Compressed air or oxygen should meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Chemically generated oxygen should meet the requirements of the United States Department of Defense Military Specification MIL-O-15633c.

(2) Cylinders should be tested and maintained in accordance with applicable Department of Transportation specifications for shipping containers (Title 49 CFR Part 173, General Requirements for Shipments and Packagings and Part 178, Shipping Containers Specifications).

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(3) Breathing gas containers should be marked in accordance with the American National Standard method of marking portable compressed gas containers to identify the material contained, Z48.1-1954 (R 1971); Federal Specification BBA-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification G-B-675d, September 23, 1976, Breathing Apparatus, Self-Contained. Further details on sources of compressed air and its safe use will be found in the Compressed Gas Association pamphlet G-7, 1976, Compressed Air for Human Respiration.

* Self Contained Breathing Apparatus: Each air or oxygen cylinder shall be inspected to insure that it is charged to a minimum of 90% rated cylinder pressure.

* Record Keeping: A record shall be kept for one year of inspection dates and findings for SCBA; maintained for emergency or rescue use.

* Cleaning and Sanitizing: Respirators shall be cleaned frequently enough to avoid hazardous exposure to residues. A respirator not assigned to an individual shall be cleaned and sanitized before reissue.

* Part Replacement and Repair: Replacement of parts or repairs shall be done only by persons trained in proper respirator assembly and correction of possible respirator malfunctions and defects. Replacement parts shall only be those designed for the specified respirator being repaired. Reducing or admission valves, regulators, and alarms should be returned to the manufacturer or to a trained technician for repair or adjustment.

(g) Work Area Surveillance

There shall be periodic inspection and evaluation to determine the continued effectiveness of the respirator program.

(h) Health Evaluation

(1) Where an employee has a health problem that interferes with his/her ability to wear a respirator, the employer's designated health professional shall determine whether or not a person may be assigned to a task requiring the use of a respirator. This determination shall be reviewed periodically.

(2) All employees who are required to wear a respirator as part of their normal job related duties shall as a minimum receive the following:

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* Prior to respirator fit-testing the employee shall be required to respond to a screening questionnaire, or submit to a medical evaluation to identify those medical conditions that may modify or preclude respirator wear. These shall be administered by a health professional, or a person who has been trained in its administration by a health professional. (See Appendix for example of questionnaire)

* Any employee who gives a yes answer on the questionnaire shall be evaluated by a health professional.

* A medical evaluation shall be administered to all employees who may be involved in emergency or rescue operations while wearing SCBA.

(3) Medical Evaluation for Respirator Wearers Giving a "Yes" Answer on the Screening Questionnaire.

* The evaluating health professional shall be familiar with the employee's work environment and the types of respirators that are required to protect the employee from exposure to potentially hazardous substances.

* The procedures used in the evaluation shall be left to the judgement of the health professional.

* Following the evaluation, the health professional shall notify both the employee and the employer of any restrictions on respirator wear that are identified by the evaluation.

(i) Air Quality

(1) Compressed air or liquid oxygen shall only be used in breathing apparatus designed for it.

(2) Breathing air compressors and distribution systems shall be designed to provide air suitable for breathing.

(3) Breathing air couplings shall be incompatible with outlets for non-respirable plant air or other gas systems to prevent inadvertent servicing of air line respirators with non-breathable gases.

(4) A minimum oxygen content of 19.5 percent shall be assured in reconstituted air (recombined oxygen and nitrogen from rare gas recovery operations) by analysis of each container.

(5) Compressed air or oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Chemically generated oxygen shall meet the requirements of the

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United States Department of Defense Military Specification MIL-O-15633c. Gaseous air shall meet at least the requirements

for Type 2, Grade D breathing air as described in the American National Standard Commodity Specification for Air, Z86.1-1973 (compressed Gas Association Commodity Specification for Air, G-7, 1973).

(6) Cylinders shall be tested and maintained in accordance with applicable Department of Transportation specifications for shipping containers (Title 49 CFR Part 173, General Requirements for Shipments and Packagings and Part 178, Shipping Containers Specifications).

(7) Breathing gas containers shall be marked in accordance with the American National Standard method of marking portable compressed gas containers to identify the material contained, Z48.1-1954 (R 1971); Federal Specification BBA-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification G-B-675d, September 23, 1976, Breathing Apparatus, Self-Contained. Further details on sources of compressed air and its safe use will be found in the Compressed Gas Association pamphlet G-7, 1976, Compressed Air for Human Respiration.

(j) Respirator Use In Atmospheres Immediately Dangerous To Life or Health

(1) In areas where the wearer, in case of failure of the respirator, may be overcome by a toxic or oxygen deficient atmosphere which is immediately dangerous to life or health, at least one standby person shall be present in a safe area.

* The standby person shall have the proper equipment to assist the respirator wearer in case of an emergency.

* Communications shall be maintained between the standby person and the respirator wearer.

* The respirator wearer shall be equipped with a safety harness and safety lines or other devices, if necessary, to permit removal in an emergency.

(2) Airline or hose type masks, if used in such situations, shall have provisions for an escape, self-contained air supply.

(3) Confined space entries shall be considered immediately dangerous to life or health unless the confined atmosphere is tested and found to be safe.

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ORC MEDICAL SURVEILLANCE RECOMMENDATIONS

(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. 33/

(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 (0)(1) 34/, 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) 35/, 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).36/ Pulmonary function tests shall be administered and interpreted in accordance with appropriate professional specifications, (see Appendices C-1) and C-2). 37/

(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. 38/

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

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(b) The periodic evaluation shall include a questionnaire to elicit symptomatology of respiratory disease, (Appendix A-2) 39/ pulmonary function tests as in (o)(2)(a) 40/ and a chest roentgenogram (posterior-anterior 14 x 17 inches). The frequency of each procedure shall be as required in Table 1. 41/ Chest roentgenographic examinations shall be made in accordance with appropriate professional specifications, (see Appendix B-1 and 2). 42/ Pulmonary function tests shall be administered and interpreted in accordance with appropriate professional specifications, (see Appendix C-1 and 2). 43/

(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 (o)(3). 44/ 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;

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(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.

Discussion of ORC Medical Surveillance Recommendations

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. 45/

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. 46/

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. 47/

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. 48/

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

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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. 49/.

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. 50/

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.

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. 51/

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. 52/

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,

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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. 53/

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. 54/

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. 55/

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.

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.

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h. FEV_1/FVC less than 0.70. 56/

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." 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". 57/

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 should 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.

SUMMARY OF ORC COMMENTS

On the preceeding pages, ORC has tried to address several of the issues it considers of primary importance. In ORC's view perhaps the key issue in this standard setting is to develop a standard based on workplace conditions as they exist in 1984 not 1944.

The nature of the workplace has changed in the last forty years, and in 1984 a majority of the potential exposure to asbestos occurs in removal and demolition activities. Forty years ago most exposure took place in asbestos manufacturing and insulation operations. Studies done at high exposure levels in the asbestos manufacturing industry are not directly transferable to the much different conditions of exposure that exist today.

In 1944, few if any of those working with asbestos used respiratory protective equipment. In 1984 few individuals who work with asbestos are without it. In 1944 most working people did not understand the hazards associated with asbestos exposure: in 1984 there are

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few who are not aware of the dangers associated with asbestos exposure. Indeed, in 1984 asbestos related suits have become a growth industry for a variety of lawyers.

However, asbestos is hazardous and those working with it must be protected. The protection of those exposed to asbestos in 1984 can be best achieved by recognizing what the exposures are and where they occur. Knowing what and where, OSHA can tailor the requirements of a standard to more accurately meet the needs of Americas working population.

One must not forget, that regardless of the strictness of the standard OSHA finally promulgates, the protection that the individual employee receives is most directly related to the effectiveness of the health and safety program where he or she works. Federal Health Standards, while important, are abstract and theoretical to a large number of the employers in the asbestos removal business.

Therefore, it is clear to ORC that OSHA must make unprecedented efforts to reach, inform and educate the many small businesses involved in asbestos removal operations. Only in this way can the maximum number of potentially exposed workers be protected.

Finally, we urge OSHA to encourage the National Institute for Occupational Safety and Health (NIOSH) to proceed with an extensive testing and certification program for respirators that are used to protect against asbestos fibers.

For more than ten years NIOSH has been working on the revision of 30 CFR 11, modernizing the Federal Governments respirator testing and certification activities. The revision of 30 CFR 11 by NIOSH and the initiation of an active program of testing respirators against asbestos fibers is very important to the ultimate protection of the working population from unnecessary exposure to airborne asbestos fibers.

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Before The
Honorable Robert G. Mahony,
Administrative Law Judge
For the
OSHA Informal Hearing
On Asbestos

In Re: Proposed Admendment of the 1910.1001 Asbestos Standard	)))	OSHA Docket No. H-033C

Direct Testimony of
Fred W. Graham
Representing
The National Constructors Association
July 12, 1984

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NCA GENERAL TESTIMONY

YOUR HONOR AND MEMBERS OF THE REVIEW PANEL, I AM FRED GRAHAM. I REPRESENT THE SAFETY AND HEALTH COMMITTEE OF THE NATIONAL CONSTRUCTORS ASSOCIATION.

NCA IS COMPOSED OF 46 OF THE LARGEST ENGINEERING AND CONSTRUCTION FIRMS OPERATING THROUGHOUT THE NATION. OUR MEMBER COMPANIES GENERATE OVER 200 MILLION HOURS OF WORK EACH YEAR EMPLOYING CRAFT PERSONNEL AFFILIATED WITH THE BUILDING AND CONSTRUCTION TRADES DEPARTMENT OF THE AFL-CIO. TRADITIONALLY, NCA MEMBER COMPANIES HAVE BEEN LEADERS IN THE AREA OF CONSTRUCTION SAFETY AND HEALTH.

ON FEW ISSUES HAVE THE DIVERSE ORGANIZATIONS, THAT MAKE UP THE CONSTRUCTION INDUSTRY, EVER AGREED UNANIMOUSLY. IN ONE STRONG VOICE, THEY CALL FOR OSHA TO SOLVE A PROBLEM WHICH OSHA CREATED -- THAT PROBLEM BEING THE INADEQUACY OF EXISTING AGENCY POLICIES TO SAFEGUARD CONSTRUCTION EMPLOYEES FROM THE HAZARDS OF WORKING WITH ASBESTOS MATERIALS.

OUR MAJOR CONCERN WITH THE PROPOSED REVISION OF THE ASBESTOS STANDARD IS THE INTENDED USE OF A SINGLE SET OF HEALTH STANDARDS FOR CONTROLLING OCCUPATIONAL EXPOSURE TO ASBESTOS, WHICH DOES NOT DIFFERENTIATE BETWEEN MANUFACTURING PLANT PROCEDURES AND CONSTRUCTION OPERATIONS. THIS LACK OF DIFFERENTIATION IS WHY THE CONSTRUCTION INDUSTRY IS STRUGGLING TO COMPLY WITH THE CURRENT ASBESTOS STANDARD. ADDING AT THIS TIME, STRINGENT PROVISIONS AND REQUIRING COMPLIANCE METHODS THAT ARE TOTALLY INAPPROPRIATE FOR

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CONSTRUCTION, WILL SIMPLY INCREASE OUR DIFFICULTY IN THE IMPLEMENTATION OF CONTROL MEASURES WITH LITTLE DIFFERENCE IN THE REDUCTION OF RISK TO EMPLOYEES.

IN ADMENDING THE EXISTING ASBESTOS STANDARD, WE REMIND OSHA, THAT THE AGENCY MUST MEET AT LEAST FOUR REQUIREMENTS ESTABLISHED BY THE OCCUPATIONAL SAFETY AND HEALTH ACT, AND CONFIRMED BY THE COURTS. OSHA MUST SHOW WITH SUBSTANTIAL EVIDENCE:

- THAT A SIGNIFICANT RISK EXISTS IN EACH CATEGORY OF WORKPLACE, TO WHICH THE STANDARD WILL APPLY.
- THAT THE REQUIREMENTS, IMPOSED UPON EMPLOYERS IN EACH CATEGORY OF WORKPLACE, TO WHICH THE STANDARD WILL APPLY, ARE REASONABLY NECESSARY AND APPROPRIATE TO BRING ABOUT A REDUCTION IN RISK.
- THAT THE REQUIREMENTS, IMPOSED UPON EACH CATEGORY OF WORKPLACE, ARE THE MOST COST-EFFECTIVE OF THE ALTERNATIVE MEANS OF ACHIEVING THE REGULATORY OBJECTIVE.
- AND, THAT THE FINDINGS ARE SUPPORTED BY SUBSTANTIAL EVIDENCE IN THE RECORD, CONSIDERED AS A WHOLE, AND BASED UPON THE BEST AVAILABLE SCIENTIFIC DATA RELEVANT TO THE IDENTIFICATION AND EVALUATION OF A POTENTIAL CARCINOGENIC HAZARD AND THE ASSESSMENT OF RISK.

TO MEET THE FOUR REQUIREMENTS, IT IS NECESSARY, APPROPRIATE, AND COST-EFFECTIVE TO PROMULGATE A SEPARATE STANDARD FOR CONSTRUCTION. WE SUGGEST THAT THIS CAN BE ACCOMPLISHED BY SIMPLY MODIFYING THE EXISTING STANDARD TO APPLY TO CONSTRUCTION ACTIVITIES. THE PROVISIONS IN THE EXISTING STANDARD REQUIRING MODIFICATIONS ARE:

- PARAGRAPH (C) METHODS OF COMPLIANCE.
- PARAGRAPH (D) PERSONNEL PROTECTIVE EQUIPMENT.

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- PARAGRAPH (F) MONITORING.
- PARAGRAPH (H) HOUSEKEEPING.
- PARAGRAPH (I) RECORDKEEPING.
- PARAGRAPH (J) MEDICAL EXAMINATIONS.

NCA HAS DEVELOPED AN OUTLINE OF THE SPECIFIC REQUIREMENTS, WHICH WILL NEED TO BE CHANGED TO CONFORM TO THE CONSTRUCTION ENVIRONMENT. THE CONCEPT CALLS FOR A PERFORMANCE-ORIENTED STANDARD WITH RELIANCE ON A WORK PRACTICE APPROACH. NCA SUBMITS THIS OUTLINE OF RECOMMENDED MODIFICATIONS AS PART OF THIS HEARING RECORD.

WE ADDITIONALLY WISH TO ENTER INTO THE RECORD OUR DETAILED COMMENTS REGARDING THE APRIL 10TH OSHA PROPOSAL TO ADMEND THE ASBESTOS STANDARD FOR ALL INDUSTRIES. THESE COMMENTS FOR THE RECORD ARE ALSO ATTACHED.

OUR COMBINED COMMENTS SHOULD ENABLE OSHA TO COMPOSE LANGUAGE FOR A PROPOSED STANDARD TO MEET SPECIFICALLY THE NEEDS AND CONDITIONS OF THE CONSTRUCTION INDUSTRY. WE EMPHASIZE PROPOSED, BECAUSE OSHA HAS YET TO PUBLISH A CONSTRUCTION STANDARD TO BE COMMENTED-ON BY THE PUBLIC. THE AGENCY PUBLISHED IN THE APRIL 10 FEDERAL REGISTER NOTICE, ONLY GENERAL AND AMBIGUOUS QUESTIONS ON WHAT COULD BE A FORMAT FOR A CONSTRUCTION STANDARD. THUS, IT

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WOULD BE UNREALISTIC FOR OSHA TO PRESUME THAT A VIABLE AND EFFECTIVE CONSTRUCTION STANDARD CAN BE DEVELOPED AND BASED SOLELY ON THE RESULTS OF THE CURRENT RULEMAKING.

THE PROPER COURSE TO PROCEED FROM THIS RULEMAKING IS FOR OSHA TO PROPOSE FOR PUBLIC REVIEW A SPECIFIC ASBESTOS STANDARD FOR THE CONSTRUCTION INDUSTRY. NCA URGES OSHA TO PURSUE THIS APPROACH, AND STANDS READY TO ASSIST THE AGENCY IN THE DEVELOPMENT OF A PROPOSAL TO ADEQUATELY PROTECT CONSTRUCTION WORKERS FROM THE HAZARDS OF ASBESTOS.

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ATTACHMENT A

NATIONAL CONSTRUCTORS ASSOCIATION RECOMMENDED MODIFICATIONS TO THE EXISTING ASBESTOS STANDARD FOR DEVELOPMENT OF A SEPARATE CONSTRUCTION ASBESTOS STANDARD

The National Constructors Association recommends the following modifications to the existing 1910.1001 asbestos standard for development of a separate asbestos standard for the construction industry.

Paragraph (c) - Methods of compliance

- Change designation from Methods of compliance to Control measures.
- Establish three categories of Control measures to be used in any combination for achieving compliance.
  1. Wet Methods. (Use existing wording in 1910.1001 as appropriate.)
  2. Particular Tools. (Use existing wording in 1910.1001 as appropriate.)
  3. Containment and/or Encapsulation. (Allow other effective measures to control airborne concentrations.)
- Delete (c)(1)(ii).

Paragraph (d) - Personal protective equipment

- Change designation from Personal protective equipment to Respirators.
- Remove reference to shift rotation in (d)(1).
- Delete reference to ANSI standards in (d)(2)(iv)(a) and (d)(2)(iv)(b). Require compliance with existing OSHA respirator standards for construction.
- Move requirement in (d)(2)(iv)(c), concerning Medical examinations for determining employee ability to use respirators, to (j) Medical examinations.
- Delete requirement in (d)(2)(iv)(c) pertaining to job rotation and transfer of employees.

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ATTACHMENT A cont'd

- Move (d)(3), Special clothing, to new paragraph (f)(2) Regulated areas. Require special clothing when PEL is exceeded.

- Move (d)(4), Change Rooms, to new paragraph (f)(2) Regulated areas. Delete reference to fixed place of employment. Add the use of a vacuum system to remove asbestos fibers from clothing.

Paragraph (f) Monitoring

- Delete (f)(1) and (f)(2)(i). Allow the use of a historical sampling data base as an alternative to initial monitoring. Require periodic monitoring to determine reliability of work practices. If the PEL is exceeded, employers should follow sampling frequencies and patterns as currently found in (f)(2)(ii).

- Delete (f)(3), Environmental monitoring. Designate Regulated areas as (f)(2).

- Define regulated areas based as the zone exceeding the PEL in the work environment. (See Inorganic Arsenic 1910.1018 paragraph (f) for possible wording and requirements for regulated areas).

  Provisions for Regulated areas should specify:

  1. establishment of a regulated area conforming to definition.

  2. demarcation by using warning signs of paragraph (g), barricades, enclosures, etc.

  3. controlled access limiting entry to authorized persons. (Only employees qualified by training are to be allowed in regulated area).

  4. use of respirators.

  5. use of special clothing.

  6. availability of change rooms.

  7. prohibition of smoking, eating or drinking in the regulated area.

Paragraph (h) Housekeeping

- Delete (h)(1)

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ATTACHMENT A cont'd

Paragraph (i) Recordkeeping

- Update to conform with construction industry recommendations in response to OSHA's proposed modification of the Access to Employee Exposure and Medical Records standard.

Paragraph (j) Medical examinations

- Change (j)(1), (j)(2), and (j)(3) to allow employers to offer employees initial and annual medical examinations. Provide for medical examination to determine employees ability to use a respirator. State that employee's under 40 years of age should have an x-ray every five years and those 40 years old and above should have an x-ray performed annually.

- Delete (j)(4).

- Update (j)(6) to conform with construction industry recommendations in response to OSHA's proposed modification of the Access to Employee Exposure and Medical Records Standard.

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ATTACHMENT B

NATIONAL CONSTRUCTORS ASSOCIATION
SPECIFIC COMMENTS
ON THE
PROPOSED ADDITIONS
TO THE
ASBESTOS STANDARD

The following NCA comments are submitted for OSHA's consideration in developing a revised asbestos standard. These statements should be reviewed in conjunction with the general testimony and recommended modifications also entered as part of the informal hearing record.

I. Comments in Reference to the Preamble of the Proposal

(1) Pages 14119-14121 of the Federal Register notice.

In considering establishment of a new permissible exposure limit for asbestos, NCA questions OSHA's use of linear model for that purpose.

Emerging scientific knowledge indicates that linear extrapolation of high-dose cancer rates to low-doses may well be invalid. A study by the National Center for Toxicological Research suggests, where non-linear dose-response relationships exist for a toxic substance, there may be a practical threshold for that substance. For more information, we refer OSHA to pages II-27 and II-28 of the American Industrial Health Council Comments on Reevaluation of OSHA's Cancer Policy.

(2) Pages 14138-14141 of the Federal Register notice.

NCA reviewed the conclusions OSHA reached in determining the economic impact of the proposed asbestos amendments.

It is illogical for OSHA to state there will be no difference in costs to comply with a permissible exposure limit set at 0.2 as compared to the costs with the PEL set at 0.5. (See Table 7, Total Industry Costs for Achieving Compliance Using Respirators, construction.) Past experience of NCA members has shown that the lowering of the PEL by OSHA results in additional costs.

Current information from NCA members indicates a 12-16% increase in the airborne concentration of asbestos fibers between 0.5 and 0.2. Because of the higher

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concentration, it is anticipated that the costs of control measures at a PEL of 0.2 would be substantially more than costs at a PEL of 0.5.

The economic impact of these added costs should be evaluated, especially, since NCA members have found that at the current PEL of 2 fibers, construction labor costs for an asbestos project is almost twice the costs of a non-asbestos project.

(3) Pages 14132-14133 of the Federal Register notice.

Suggestions have been made to have employers report to OSHA prior to performing asbestos activities and to require employers and employees to be certified that they are capable of working with asbestos in the prescribed manner. Such requirements are unnecessary.

The Occupational Safety and Health Act provides for procedures to mandate and evaluate compliance with standards. When OSHA publishes a standard, employers are notified of the requirements to be met. The employer then must take steps to see that his personnel are trained to perform their work in accordance with these requirements. OSHA is able to "certify" whether or not an employer is complying with the requirements by performance of an inspection.

II. Specific Comments on the Proposed Addition of Paragraphs (b)(4), (k), (l), and (m).

Paragraph (b)(4) Additional exposure protection.

Regarding the establishment of a permissible exposure limit, NCA advises OSHA to judiciously review our statements previously covered in this submission.

OSHA should eliminate from proposed paragraph (b)(4) all ambiguous verbage that could be misconstrued by construction employees or by a court of law. "Notwithstanding any other requirement of this section" is one example of potentially misleading wording. Another example is the requirement for employers to "ensure" (guarantee) the health of their employees. OSHA has already determined the inappropriateness of such wording in promulgating the vertical standard for the Marine Terminals (See Federal Register, Vol 49 No. 129, July 5, 1983). Paragraph (b)(4) can be corrected by beginning the

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paragraph with "Employee exposure shall not exceed . . . . (the permissible exposure limit)."

Confusion will result from the addition of paragraph (b)(4), if it is not revised. OSHA proposes to add paragraph (b)(4), while continuing to retain in the existing standard, references to all of paragraph (b). It is impossible to determine from the proposal, whether employers would be required to comply with old paragraph (b)(2) or new paragraph (b)(4), or some of each.

Paragraph (k).

In paragraph (k), pertaining to the proposed inclusion of a table for selection of respirators, OSHA should have clarified, whether this is a revision of existing paragraph (d)(2), or an addition to it. This distinction is needed.

Paragraph (l) Employee information and training.

Concerning all of paragraph (l), it is not necessary for OSHA to continually develop a new employee training requirement for every new health standard. OSHA should use, as a model, the training requirement found in the Cotton Dust standard, 1910.1043 paragraph (i). Any new requirement should take into account the rapid turnover of construction workers, the constantly changing construction work environment, and the specialized skills that construction workers bring to a jobsite.

Paragraph (l)(4)(i) should be deleted. Providing copies of all training materials to all affected employees imposes a heavy, unnecessary economic and paperwork burden without contributing to the reduction of risk.

Paragraph (m) Warning signs.

NCA sees no overriding reasons for changing the current requirements for posting caution signs. If the existing wording for asbestos signs in (g)(l) is not proper, then properly revise it. In no case, should OSHA confuse employers by adding a requirement in paragraph (m) to have two different asbestos signs -- each saying something different.

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APPENDIX B

CARL D. RICHARDSON

BROWN & ROOT, INC.

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ASBESTOS REMOVAL

The topic of my presentation today is "Dealing With Asbestos Removal During Plant Demolition Operations; A Contractor's Point Of View".

The first part of the presentation, briefly covers how our company deals with asbestos demolition in client facilities and some of the problems we have encountered.

Secondly, I will discuss the problems contractors have with the existing asbestos standard and adopting the requirements to our asbestos demolition.

The vast majority of manufactured asbestos products used by construction contain fibers that are locked in or encapsulated, thus greatly diminishing the possibility of the release of any respirable fibers. As long as these materials are handled correctly and not abused, exposure levels are kept very low. (Figure 1.) Asbestos pipe linings and coverings are usually what one is most aware of as creating potential exposure in the construction industry. But all asbestos encapsulated products pose real problems when the demolition is necessary, whether it be on a large or small scale.

CEMENT SHEET (TRANSITE)	PAINTS
CONCRETE PIPE	COATINGS
PATCHING COMPOUNDS	GASKETS
FLOOR AND CEILING TILE	SEALANTS

PIPE LININGS AND COVERINGS

(Figure 1.)

Either by a request of the potential client or by our own management, a pre-bid meeting is usually conducted. A safety and health representative, along with management, attends the pre-bid meeting to establish the work requirements, view the work areas, and question the client representative on any safety items of concern relating to the upcoming job. Asbestos disposal requirements are also discussed to determine who will be responsible and under whose hazardous waste license the disposal will fall.

Factors to consider concerning the tearout operation pre-bid meeting are:

- Positive identification - whether the material to be removed is asbestos, including the type and percent of content.
- Friability - age and the potential to creat airborne fibers during asbestos removal.

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- Location - location of the demolition activities in relation to surrounding operations and employees.
- Conditions/Restrictions - requirements imposed on the methods of removal, i.e. wetting of the insulated equipment is not allowed in some cases.

Examples of problem situations which have occurred include:

- Positive Identification - for various reasons, contractors are given erroneous information concerning identification.
- Patch work - when a vessel or pipe structure has been declared asbestos free, we have run into previous patch work with asbestos material.
- MSDS Terminology - for example, insulation and grouting material MSDS's content have been vague and non-descriptive.
- Friable transite sheeting - the demolition of old transite sheeting material which has been exposed to chemicals could produce airborne asbestos fibers.

Normally, our company does not bid on asbestos demolition work solely, but it is usually part of an overall construction contract. We find it very important to have our industrial hygienists assist in the bid proposal stage by supplying input on costs associated with the demolition to be performed.

An example of items and costs considered for the bid proposals are:

- Physical exams - usually run around $90-$150 with possible logistics costs.
- Personal protective equipment - not only the actual costs are considered but the maintenance costs and cost of training to use the equipment.
- Monitoring - obviously involved here are analysis, equipment and manpower costs.
- Records/Microfilming - process and retention costs are considered.
- Equipment - for example, costs of asbestos vacuums, bags, encapsulating agents.
- Disposal - will vary depending on the mode of disposal and availability of facilities.

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To avoid potential problems, it is important that project management establish the plans of the asbestos demolition operation at the particular site. Problems could occur after the job is awarded if changes are made in the mode of operation described in the bid package.

Once we receive the contract, pre-placement physical exams are given to the assigned crew members performing the demolition work. The crew size is kept to a minimum to avoid unnecessary costs and potential exposures. No one is allowed to participate in the demolition work without satisfactory completion of the physical exams.

Notification is made to our company's environmental health section to arrange for air samples to be taken once the work schedule is correlated with the project management. Division and jobsite safety and health personnel are trained and qualified to institute monitoring on jobsites. Safety personnel coordinate all activities through the Corporate Safety & Health Department. All data is evaluated by the environmental health section at the completion of monitoring.

Training is conducted and documented for employees who will be involved in the demolition activities. Training includes:

- Health effects associated with asbestos exposure.
- Relationship between asbestos and smoking in producing lung cancer.
- Nature of operations which could result in asbestos exposure and the proper operating procedures to minimize exposure.
- Proper use and maintenance of respiratory protective equipment, including fit testing.
- 1910.1001 Asbestos Standard Provisions.

Asbestos demolition begins with the demolition crew members being issued personal protective equipment to include: full body coverings, respiratory protective equipment, gloves and any additional safety equipment needed for the job. Depending on the demolition operation, shower/change facilities may be utilized.

The entire asbestos work area is barricaded and a remote stripping area is set up. A remote area decreases the potential for added exposure and allows workers adequate room to complete the stripping operation. The remote stripping area contains a dumpster and is barricaded similar to the work area. Warning signs are posted around both the work area and the stripping area.

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Plastic sheeting is placed in the work areas to prevent asbestos from falling to lower levels and from contaminating the soil. By controlling the asbestos and preventing it from falling to levels below, you can decrease clean-up operations. Asbestos on concrete must be washed and collected or vacuumed. Also, asbestos contaminated soil must be removed for proper disposal.

Wetting or encapsulating agents are prepared and the method of application is readied. Spraying of agents usually occurs by portable compressors or by hand-held pump sprayers.

Instead of spraying with water, we have recently utilized an encapsulating agent which shows a substantial decrease in exposures, clean-up time and associated expenses.

An initial spray of solution is applied in the cracks and crevices of the insulation binding. As the binding is removed, additional spray is applied to wet the insulation to prevent airborne particles. The binding materials are treated as asbestos and placed in labeled bags for disposal. These bags are placed in the dumpster for later disposal along with the insulation.

A small section of the wetted insulation is removed to expose the pipe for cutting. Usually, this is hot or cold cutting or at bolted flange connections.

The pipe is cut into sections and removed from the work area and brought to the remote stripping area. Plastic bags can be used to cover open ends of piping to collect any material which might drop during transporting.

Not only piping but insulated equipment and vessels have been removed in the same manner.

For larger vessels and stationary equipment, such as a turbine which is being serviced, the wetting agent is sprayed in continual passes and again as sections of insulation are removed.

As insulation is removed, it is immediately bagged in poly bags, on which are preprinted warning labels. The bags are removed from the structure to the designated storage area and are not allowed to remain in various parts of the work area.

If insulation is being removed from more than one central location, bags are placed in several "gathering areas" and are picked up and brought to the dumpster for disposal.

Insulation, as seen in this slide, should not be allowed to accumulate on walkways to blow around the jobsite. Housekeeping is of utmost importance. In order to achieve good housekeeping, industrial asbestos vacuum cleaners are a necessity.

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During insulation removal, air sampling equipment is placed on individuals and in work areas to obtain data. Our sampling strategy is to obtain "worse case" exposures. Environmental monitoring is conducted with this in mind. Pumps are placed on employees in different job categories, i.e. strippers, baggers, sweepers, or equipment operators. Once air sampling is completed, cassettes are gathered, sampling data sheets are completed, and samples are forwarded to an AIHA approved laboratory for analysis. After the results are obtained, a report is generated to project management concerning the sampling results. From the initial sampling process through the reporting of results, takes approximately 3-4 weeks. Since our asbestos tearouts commonly last on the average of 1-2 weeks, employees may be gone before asbestos monitoring results are received.

The following are some of the problems encountered during asbestos removals:

- A slipping hazard is possible where plastic sheeting is placed on the ground or floor to prevent asbestos contamination. Also, a slipping hazard exists on wet structural iron and equipment.

- Sometimes our clients require us to work on hot equipment without prior wetting of the asbestos insulation. In many circumstances, even when insulation on hot equipment is wet, the heat quickly dries up the wetting agent.

- Labels and tags can become displaced when tied or affixed on poly bags. Our experience indicates pre-printed bags are superior.

- Heat stress may be a problem in the summer when employees wear slicker suits. On the other hand, in winter months the colder temperatures present problems with the wearing of disposable clothing.

- The use of vacuum cleaners in elevated structures presents positioning problems. Also, problems with the availability of electricity to operate vacuum cleaners has occurred.

When the contract gives us the responsibility for disposal, we subcontract to an approved hazardous waste transporter. The waste asbestos dumpster is transported to a designated approved hazardous waste site previously contracted. But in most cases, the client assumes the responsibility of waste disposal.

Our company's asbestos program, which I have briefly discussed, was developed over several years of experience with many various types of asbestos demolition operations. Feasible requirements of the current OSHA Asbestos Sandard were incorporated into the procedures. OSHA's current approach for regulating construction asbestos activities based on

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the 1910.1001 standard is impractical and largely unenforceable. What I would like to discuss with you now is the need to develop an alternative approach in regulating asbestos exposure in the construction industry.

The present OSHA Asbestos Standard, is basically designed for fixed manufacturing sites and is unsuitable for construction operations.

- Manufacturing locations are normally permanent and configurated, involving work activities that are constant and predictable. Most construction employees work in a continually changing environment, moving from one temporary worksite to another. Each worksite is unique, with exposure patterns varying with the use of different materials and processes over differing lengths of time from a few hours to several days.

- The construction industry does not follow the pattern of steady employer-employee relationships that normally occur in the manufacturing industry. The construction work force is transient and temporary in nature, with turnover rates very high. Variability is probably the only thing consistant about construction operations.

Repetitive monitoring to implement a PEL serves no useful purpose in most asbestos demolition operations. Because demolition work typically involves short term tasks, the lag time needed to complete the necessary sampling and analysis is normally longer than the job lasts.

OSHA asbestos medical surveillance requirements need careful evaluation.

- The large employee turnover is one reason for the severe problems in construction resulting from OSHA asbestos medical surveillance requirements.

- Employees may work for several employers in the course of a year. The attempt to implement pre-assignment and annual physical exams on such a pattern of employment creates severe problems for both employees and employers.

- In addition, our company has had difficulty locating qualified physicians willing to perform asbestos physical exams (in some parts of the country).

- For an asbestos medical surveillance program to be effective, one must have a correlation between environmental conditions on the job and medical information on the employee over a period of time. Achieving these objectives is difficult in the construction industry.

- Based on our experience, construction asbestos exposures are highly variable, brief, intermittent and low, with the majority of the exposed construction population being temporary and short-term.

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The requirements for creating and maintaining detailed records of asbestos exposure monitoring and medical examinations have no effective purpose in an industry where employment is temporary and the work location is highly variable. Several of the forms which are used in our program and which are retained for 20+ years include:

- Employee Waiver Form
- Request For Medical Record
- Doctor's Report
- Employee Air Monitoring Notice
- Training Class Form

As noted by industry and by OSHA's Construction Advisory Committee, repetitive monitoring, medical surveillance, record keeping and other components of traditional health standards which have been developed with a factory setting in mind do little to improve workers' health in the construction industry but, never-the-less, impose costly requirements that simply are not feasible in many construction operations.

Instead of the current requirements, the construction industry needs performance requirements utilizing the concept of identifying work practices that assure exposures in excess of the PEL will not occur under any reasonable foreseeable circumstances. These work practices would be based on legitimate measuring and monitoring data.

With such a program requiring the use of approved work practices, the construction industry could reduce workers' exposures to a safe level and eliminate the need for costly engineering controls, monitoring, and medical surveillance programs.

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CONTRACTORS SURVEY - RENOVATION

1. On average, approximately how many renovation jobs does your company undertake per year? ---------- 100

2. On average, about how many of these jobs per year involve:

	Number of Jobs
a. Plumbing work?	100
b. Electrical work?	100
c. Carpentry?	100
d. Sheet metal work?	70
e. Telephone installation?	0
f. Painting/plastering/paperhanging?	100
g. Roofing?	20
h. HVAC maintenance/repair?	20
i. Flooring?	0
j. Insulation work?	80
k. Other (specify: _____)	

Important Instructions to Respondent

The remainder of these questions deal with renovation jobs where asbestos containing materials or products were handled only when required in order to perform the primary activities of the renovation jobs (for example, removing asbestos insulation from duct work in order to reroute the ventilation system; or cutting through drywall that contains asbestos materials in order to install electrical outlets). Please restrict all remaining responses to these types of renovation jobs. Do not include renovation jobs where asbestos-containing materials or products were installed, removed, replaced, repaired, enclosed, or encapsulated, as a primary purpose of the renovation activities.

3. On average, in about how many renovation jobs per year do you work on a building (or structure) which contains asbestos materials or products? (Do not include jobs where handling asbestos is a primary purpose of the job.) ---------- 70

4. On average, in how many of these jobs are the buildings (or structures) occupied? (IF NONE, SKIP TO Q.6) ---------- 65

5. On average, in how many of these jobs are the renovation activities sealed off from the occupants? ---------- 0

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I.D. Number _____

6. On average, when asbestos is contained in these buildings (or structures), in approximately how many of these renovation jobs does your primary work activities necessitate the:

	Number of Jobs
a. Removal of asbestos material with replacement of an asbestos material?	0
b. Removal of asbestos material with replacement of non-asbestos material?	50
c. Removal of asbestos material with no replacement?	5
d. Repair, enclosure, or encapsulation of asbestos material?	5
e. Other handling of asbestos material (specify: _____)	

7. OSHA is concerned about exposure to asbestos by the workers handling these asbestos-containing materials or products, and in order to make decisions about revising regulations, OSHA needs information about the frequency and duration of exposure to asbestos. For each job activity that you do, would you please tell us: first, approximately how many workers per job are involved, on average; and second, how long the task takes to complete in hours (both the average number of hours and the maximum number of hours it could take).

Job Activity	# Workers Per Job	Duration of Activity	
		Average	Maximum
a. Removal of asbestos material with replacement of an asbestos material			
b. Removal of asbestos material with replacement of a non-asbestos material			
c. Removal of asbestos material with no replacement			
d. Repair, enclosure, or encapsulation of asbestos material			
e. Other handling of asbestos material (specify: _____)			

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I.D. Number _____

8. We would like to know what occupations are directly involved with each of the following job activities. Below the table is a list of occupations. Please insert the numbers from the list, indicating the occupations involved, into the table.

	Job Activity	Occupations Directly Involved
a.	Removal of asbestos material with replacement of an asbestos material	
b.	Removal of asbestos material with replacement of a non-asbestos material	1, 13, 14, 15
c.	Removal of asbestos material with no replacement	1, 13, 14, 15
d.	Repair, enclosure, or encapsulation of asbestos material	1, 13, 14, 15
e.	Other handling of asbestos material (specify: _____)	

Occupations:

1. Asbestos and insulation workers (including helpers)
2. Brick masons, stone masons, and cement/concrete finishers
3. Carpenters (including helpers)
4. Demolition workers
5. Electricians (including helpers)
6. Floor layers
7. Painters (including helpers)
8. Plasterers and dry wall installers (including helpers)
9. Plumbers and pipefitters (including helpers)
10. Roofers
11. Sheet metal workers and HVAC equipment installers (including helpers)
12. Telephone installers/repairmen
13. Construction laborers, not elsewhere classified
14. Supervisors and foremen, not elsewhere classified
15. Other (specify: Operators)

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I.D. Number _____

9. OSHA is also concerned about exposure to asbestos by other workers. Do other workers (that is, those not directly involved with handling the asbestos materials) generally work alongside or in the same area as the workers handling asbestos containing materials or products? ---------- YES [NO]

9a. If yes, other than those occupations which involve the actual handling of asbestos materials, what are the occupations which indirectly involve the most frequent exposure to asbestos? (Please choose occupations from those listed in Question 8 for each job activity listed below.)

Job Activity	Occupations Indirectly Involved
a. Removal of asbestos material with replacement of an asbestos material	
b. Removal of asbestos material with replacement of a non-asbestos material	
c. Removal of asbestos material with no replacement	
d. Repair, enclosure, or encapsulation of asbestos material	
e. Other handling of asbestos material (specify: _____)	

10. When you handle these asbestos-containing materials or products during renovation, are any precautions taken to control the workers' exposure to asbestos? ---------- YES NO

PLEASE ANSWER QUESTIONS 10a THROUGH 15

PLEASE CONTINUE WITH THE SECOND FORM

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10a. If yes, for each job activity you do, please tell us which of the control practices listed below the table you use. Please insert number(s) of control practices next to the appropriate job activity.

	Job Activity	Control Practice
a.	Removal of asbestos material with replacement of an asbestos material	
b.	Removal of asbestos material with replacement of a non-asbestos material	1,2,3,4,6,7,8,9,12,14,17,18,20,21
c.	Removal of asbestos material with no replacement	1,2,3,4,6,7,8,9,12,14,17,18,20,21
d.	Repair, enclosure, or encapsulation of asbestos material	1,2,3,12,14,17,18,20,21
e.	Other handling of asbestos material (specify: _____)	

Control Practices:

1. Wet handling of asbestos material
2. Disposable dust mask
3. Half mask cartridge respirator
4. Powered air purifying respirator
5. Supplied air respirator
6. Use of HEPA (EPA-approved) vacuum cleaners
7. Wet sweeping
8. Collection and disposal of waste in sealed impermeable bags or containers
9. Exposure monitoring
10. Air-tight barriers to enclose work area
11. Negative pressure or recirculating HEPA ventilation system (micro-trap)
12. Protective clothing
13. Showers and changerooms
14. Changerooms only
15. Double barriers
16. Tools equipped with vacuum cleaners
17. Training/education, specifically on hazards of asbestos handling
18. Caution signs or labels
19. Rotation of workers
20. Medical examinations
21. Recordkeeping
22. Other (specify: _____ _____)

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I.D. Number_____

10b. For those control practices that you do use, we would like to get some additional information concerning: how each control practice is actually implemented; how often each control practice is used; and an approximation of the costs associated with each control practice (on either a per-protected worker basis or a per-job basis). Please provide this information for each control practice that you use.

11. OSHA is also interested in obtaining information about the exposure levels experienced by the workers handling these asbestos-containing materials or products. Given the control practices that you have used for each job activity that you do, can you please tell us, approximately, what the monitored 8 hour time-weighted average and monitored maximum exposure levels are, on average, for each job activity that you do.

PLEASE USE TABLE ON NEXT PAGE.

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Job Activity	Monitored Exposure Levels	
	8 hour Time-Weighted Average	Maximum Exposure Levels
a. Removal of asbestos material with replacement of an asbestos material	---	---
b. Removal of asbestos material with replacement of a non-asbestos material	0.25	6.8
c. Removal of asbestos material with no replacement	NA	NA
d. Repair, enclosure, or encapsulation of asbestos material	NA	NA
e. Other handling of asbestos material (specify: _____)		

12. Have you worked on any renovation jobs involving the handling of asbestos-containing materials or products, where the location of the building (or structure) or any of its physical characteristics precluded the use of a particular control practice? ---------- [YES] NO

12a. If yes, what control practices were precluded and why were they precluded?

1. Water unavailable or limited.
2. Equipment hot, which dried wetting agent immediately.
3. No electrical source for vacuum.
4. Logistics in structure omitted vacuum system.

12b. If yes, how often do you face situations like the one(s) described above?

1. 10%
2. 20%
3. 5%
4. 25%

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13. Of the various types of control practices that you've used are there any that reduce the productivity of your workers?--- YES NO

13a. If yes, which control practices reduce productivity substantially and why?

1. Wetting - time, cold weather, slipping hazards.

2. Respiratory protection - rest periods more frequent.

14. We would like to get an estimate of the costs associated with controlling asbestos exposure for different job activities. For each of the job activities below which do you participate in, please estimate the percent of your job activity costs that you would attribute to controlling asbestos exposure.

Job Activity	Percent of Costs
a. Removal of asbestos material with replacement of an asbestos material	
b. Removal of asbestos material with replacement of a non-asbestos material	
c. Removal of asbestos material with no replacement	
d. Repair, enclosure, or encapsulation of asbestos material	
e. Other handling of asbestos material (specify: _____)	

15. In general, about what percentage of your renovation job costs is related to the handling of asbestos-containing materials or products, including asbestos control activities?

_____%

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APPENDIX C

TECHNIQUES FOR ASBESTOS ANALYSIS

UNDERSTANDING THE PROBLEM

by

GRAHAM W. GIBBS, M.Sc., PH.D., L.R.S.C.

PRESENTED AT THE

ORGANISATION RESOURCES COUNSELORS INC. SYMPOSIUM

entitled

"ASBESTOS RIP-OUT"

March 27 and 28, 1984

Washington, D.C.

12313

UCC 005819

TECHNIQUES FOR ASBESTOS ANALYSIS
UNDERSTANDING THE PROBLEM

INTRODUCTION

In the next 30 to 40 minutes, I will attempt to describe some of the problems underlying the measurement of asbestos and comment on optical and electron microscopic methods as applied to airborne asbestos fibre determinations.

There are three factors which I believe have an important bearing on the issues of "What to measure and how to measure" to control exposure to "asbestos" in the prevention of health effects. These include the type of asbestos, the index which best relates to the health effects and the size distributions of airborne fibres.

Asbestos is not the name for a single substance ... it is the "generic term" applied to naturally occurring fibrous hydrated silicates. (Figure 1). Four, chrysotile, crocidolite, amosite, and anthophyllite are of commercial importance. Until relatively recently, fibre types were rarely identified in the literature describing health effects and it was not acknowledged that the various asbestos minerals might produce different biological responses. Workers engaged in removal of asbestos can be exposed to asbestos dusts with quite different chemical and physical characteristics. It is appropriate to ask "Do all fibre types carry the same risks for the same exposure"? and "Can they all be measured using the same analytical techniques"?

It is beyond the scope of this report to give an indepth answer to the first question, but the literature supports the view that different fibre types do carry different risks especially for mesothelioma. In fact, I would suggest that there is now evidence that there can be large differences in risks of respiratory cancer for different occupational groups exposed to the same fibre type. Unfortunately, the matter remains somewhat controversial because of unanswered questions concerning the relative levels of exposure of persons working with the different fibre types and processes.

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Footnote: When views are expressed, they are those of the author and do not in any way represent those of Celanese Canada Inc., Celanese Corporation or any of its affiliates.

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INTRODUCTION (Cont'd)

Measurements of airborne asbestos concentrations in workplaces, more than 20 years ago were relatively sparse and were made using instruments and methods (e.g. Greenberg Smith and Midget Impingers) which are no longer considered appropriate for asbestos measurement. As the health effects which have been linked with asbestos exposure require long latent intervals to manifest, the only measurements available to assess exposure were made with these now obsolete methods([1],[2]). To date, eight working populations have been studied to determine exposure-response relationships. These studies have involved Quebec chrysotile Miners and Millers [3], New Jersey Factory Pensioners [4], American Textile Workers [5],[6],[7], New Orleans Cement Factory Workers [8], British Friction Plant Workers [9] and Ontario Asbestos Cement Factory Workers [10]. All of these, except the British study, involved exposure assessments made in million particles years/cubic foot. i.e. measurements were based on particle counts using the Midget Impinger Method.

Mortality from lung cancer in these studies related well to Impinger exposure assessments. It also related reasonably well to exposures expressed in fibres/ml but these exposures were calculated using factors to convert Impinger to Membrane Filter Counts and it was necessary to make certain assumptions in performing such conversions ([5],[11]). In the United Kingdom past exposures were measured using thermal precipitators and it was also necessary to convert counts to Membrane Filter Fibre Count Equivalents ([12]).

Thus, there are no mortality studies in which the phase contrast, membrane filter method, was used directly to measure exposures.

IDENTIFYING ASBESTOS

In deciding whether to "rip-out" or "encapsulate", a fundamental question is "is it asbestos"? Because it is white, brown or blue or looks fibrous, is not good enough. Being absolutely sure that the material is asbestos is not simple.

Asbestos fibres have the same chemistry as their non-fibrous counter-parts. For example, chrysotile is chemically identical to antigorite, crocidolite is chemically identical to riebeckite, and amosite is chemically identical to grunerite. Thus chemical analysis alone does not provide the solution.

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IDENTIFYING ASBESTOS (Cont'd)

Other naturally occurring minerals such as erionite, nemalite, attapulgite and many others can be or can appear to be fibrous. Man-made mineral fibres are often used for the same purposes as asbestos and are found in the same places. Thus, the identification of asbestos fibres is difficult using morphology alone.

Identification of the presence of asbestos minerals in bulk material can be achieved using the polarising microscope and dispersion staining [13]. X-ray diffraction can be used, but the non-fibrous polymorphs can interfere seriously with the analysis. Selected area diffraction (SAED) patterns can be useful in distinguishing chrysotile from amphiboles but without detailed measurements of diffraction patterns on fibres with different orientations, the different amphiboles fibre types cannot be differentiated. It is not possible to get selected area electron diffraction patterns on all fibres, especially thin ones. Transmission electron microscopy (TEM) with energy dispersive analysis (EDXA) can be used to identify asbestos fibre type.

It should be noted that because the aerodynamic properties of the fibres and non-fibrous components (for example in insulation being ripped out) are not the same, the composition of the airborne dust will not be the same as that of in the original bulk material. This is important because bulk material containing a low percentage of fibres may give rise to a significant number of fibres when rendered airborne or vice-versa.

THE MEMBRANE FILTER METHOD

Some variant of the method in which airborne fibres are collected on a membrane filter and counted on a phase contrast microscope has been adopted by most countries in the western world for the measurement of worker exposure. Fibres of length greater than 5 micrometers as seen by phase contrast microscopy have been chosen as the index of exposure to control. It should be noted that rarely do we know the specific characteristics of an airborne particle which "cause" a health effect. Thus, we are forced for practical reasons to use an index of exposure which relates to the health effects as shown by epidemiological studies and/or which makes mechanistic sense based on cell and experimental animal studies. The index for asbestos adopted has been almost universally, fibres equal to and longer than 5 micrometers.

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THE MEMBRANE FILTER METHOD (Cont'd)

The membrane filter measurement involves counting fibres. For exposure assessment purposes, a fibre has been defined as an elongated particle with an aspect (length: breadth) ratio of 3:1, although 5:1 is now proposed in NIOSH 7400 [14] and 10:1 is preferred by mineralogists.

It is recognised that the 3:1 definition (and probably 5:1) does not permit an observer to distinguish between asbestos fibres and other elongated particles (non-asbestos) Thus rectangular particles standing on edge can get counted as fibres. A question often asked is whether one can distinguish asbestos from other fibres on the phase contrast microscope while counting. While there are some materials which can be readily distinguished from asbestos, experience indicates that the routine separation of fibres into asbestos and non-asbestos is not to be recommended. There are many non-asbestos mineral fibres which may be confused with asbestos fibres and studies show that attempts at discrimination are unreliable [15]. Nowadays, most jurisdictions recommend that no attempt be made to differentiate asbestos from non-asbestos fibres in the count. Thus, the count is of all fibres. While this may not pose a problem in a work-place where asbestos is the only fibre used, it may pose considerable difficulties when used in an enviroment where other fibres materials might exist as would likely be the situation in "rip-out".

As mentioned earlier, the standards for controlling asbestos exposure were developed from epidemiological studies in which exposure assessments were converted to membrane filter fibre counts from other measurement techniques. In practice, the membrane filter method itself has undergone several changes - most of them increasing, to some extent, the count relative to the previous method. Thus methodological changes can have the effect of making the standard more stringent. More recent changes in the method such as those proposed now in the U.K. and U.S.A. will further change this relative count. For example, it can be seen in Table 1 that the modified CRS rules tends to lead to higher counts than those obtained by the Asbestos Information Association (AIA) Method [16].

When I was invited to participate in this symposium, I was asked if I would include in my talk some comments on the new NIOSH method. Let us examine some of the features of the Membrane Filter Phase Contrast Method which will give me the opportunity to comment briefly on some aspects of the proposed NIOSH method.

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THE MEMBRANE FILTER METHOD (Cont'd)

The AIA and the NIOSH 7400 methods go a long way towards standardising the analytical method for asbestos fibre determination. Some of the factors which influence what we observe and what we count on the optical microscope are shown in table 2. Let us examine these in more detail and how these are dealt with in the NIOSH 7400 method.

A - MICROSCOPES

Counting trials have revealed that many different microscopes are being used in the counting of asbestos fibres. As even the same model of microscope can vary in its optics and maintenance, the potential for variability in counts due to the use of different microscopes and optics can be substantial. The new NIOSH method recognises this problem and proposes an approach to improve consistency in what can be seen by the observer. The Health and Safety Executive (HSE)/National Physical Laboratory (NPL) test slide makes this possible. Using this slide the microscope can be "tuned" to a standard level permitting observers at different locations to see fibres of approximately the same minimum diameter. This is very important as there are considerably more fibres of a size near the limits of visibility than there are readily visible ones and small differences in the smallest fibre visible can lead to large differences in fibre count. The extent to which the proposed test-slide standardization alters the number of fibres counted over the methods used to derive the original fibre exposure standards is not clear.

B - SOURCE AND NATURE OF DUST

In the NIOSH 7400, all particles meeting the criterion defining a fibre are counted and it is recognised that the non-fibrous particles may interfere with the method. It is not clear whether it is recognised that laboratories able to count one type of asbestos fibre well do not do so well when faced with a different type of dust sample ([17]). An example of this type of problem is illustrated in Table 3 with data from South Africa. Observers in other countries have reported similar difficulties with unfamiliar samples.

C - UNIFORMITY OF DUST DEPOSIT

The reduction in the size of the filter to 25mm, to improve the uniformity of the dust deposit is probably a sound move. There was no need for a 37mm filter in the first place.

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THE MEMBRANE FILTER METHOD (Cont'd)

D - PLANE OF DUST DEPOSIT

The use of acetone to collapse the filter results in a much thinner mounted sample than with previous methods which in turn helps to reduce the error if the observer fails to focus properly through the sample.

E - NUMBER OF FIBRES PER UNIT AREA

This is adjusted by varying the sampling time and rate. This means that counts are made with the number of fibres/mm^2 of filter in a preferred range of 100-1300 fibres/mm^2. This is important in improving reproducibility, but will not eliminate difficulties when a high proportion of non-asbestos particles is present.

F - NUMBER OF NON-FIBROUS PARTICLE PER UNIT AREA

It is recognised in NIOSH 7400 that the presence of non-fibrous particles will affect the detection limit. It would be useful to know the theoretical and practical detection limits when different proportions of non-fibrous dust are present so that the conditions under which the method is valid, are clear.

G - REFRACTIVE INDEX

The refractive index of a particle relative to the mounting media influences its visibility. Thus the refractive indices of the mounting media are now well defined. However, it is noted that while NIOSH has gone a long way to standardize the method, it still offers options for mounting the sample.

H - OBSERVERS' EXPERIENCE, TRAINING AND PERSONAL FACTORS

Observers' experience, training and personal factors are not addressed in the method. The use of permanent slides will improve the training possibilities by using real samples. The effect of samples from different sources was discussed earlier. The use of the HPE/NPL slide will also help to calibrate the observer.

I - SIZE DISTRIBUTION OF FIBRES AND PARTICLES

This is a major factor in determining what is seen on the optical microscope and will be discussed in more detail later.

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THE MEMBRANE FILTER METHOD (Cont'd)

J - DEFINITION OF A FIBRE

The new definition of a fibre as having an aspect ratio of 5:1 or greater might reduce the number of particles classified as fibres. This will, to some extent, improve specificity.

K - COUNTING RULES

The existence of two sets of counting rules in NIOSH 7400 is confusing, but I presume this is a temporary provision. There is no doubt that counting fibre ends minimizes the biaises introduced by the earlier counting methods. However, I have some difficulty in understanding the choice of the counting rule in which all the individual fibres in a fibre bundle are counted separately. As the extent to which large bundles of fibres split into smaller fibre bundles and still remain visible will depend on the nature and severity of the treatment of the fibre in the process. Aerodynamically, the airborne fibres in a bundle behave as the bundle. If the fibre bundle is deposited in the lung and dispersed as fibrils, there will be many more fibrils than can be seen by light optical methods in the original bundle. Thus the count method is somewhat arbitrary and its introduction as a practical convenience could in the absence of evidence to the contrary be misleading with respect to the hazard. In my view, more information is needed before it can be concluded that it is appropriate to adopt a method in which fibres in a bundle are counted separately.

L - GRATICULE

The use of the Walton Beckett graticule is a major improvement. This graticule was designed for fibre counting, in contrast to those recommended in previous NIOSH methods.

M - NUMBER OF FIELDS / FIBRES COUNTED

This is important and is well defined in NIOSH 7400.

Can such a method be used to measure concentrations of less than 0.1 fibre/ml? The answer is probably yes if the interferences identified in the method are absent. In "rip-out" such a situation would likely be rare.

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ELECTRON MICROSCOPY

An aspect of the phase contrast method which I noted earlier needed additional consideration was the size distribution of airborne fibres and its effect on what is counted. This provides a useful way to introduce the electron microscope.

As you are aware, there is a limit to the size of particle or fibre which can be seen using light optical methods. This lies somewhere between 0.20 and 0.30 micrometers. Let us examine various airborne dust clouds and see what we would miss using optical and electron microscopic methods. The size distributions of amosite, crocidolite and chrysotile in airborne dusts from two processes are shown in Table 4. The diameters and lengths of individual fibres were measured on the transmission electron microscope [18]. If we assume that fibres seen on the phase contrast optical microscope have diameters greater than 0:3 micrometer, and that the concentration of fibres using this counting method is 1 fibre/ml, then the total concentration of fibres present in mining and bagging of amosite, crocidolite and chrysotile, respectively would be as shown in Table 5. There are substantial differencies in the total concentrations and in the concentration of fibres in specific size ranges. If all fibres were involved in the production of asbestos related health effects, the membrane filter optical count would provide maximum protection against amosite (probably even higher protection against anthophyllite) and protection would be least for crocidolite (at least for Cape crocidolite).

This suggests that for the same phase contrast fibre count, workers may be exposed to quite different concentrations of airborne fibres and different concentrations of fibres in "suspect, dangerous, sizes ranges". The implications are very important for the protection of the employees. Long narrow fibres have been identified as important in the production of mesothelioma in experimental animals. Combined with the evidence that there are differences in risk of mesothelioma for the different fibres types, it is surprising that no consideration of fibre type differences exist in the NIOSH/OSHA standard. They do exist in the British, Canadian and ACGIH criteria.

At the start of my presentation, I mentioned that I would say a few words about the use of scanning and transmission electron microscopes in asbestos analysis. Scanning electron microscopes (SEM) are relatively inexpensive compared with transmission electron microscopes (TEM) and have considerable potential for rapid counts and fibres observations. Some of the advantages of the scanning electron microscope for the analysis of asbestos are as follows:

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ELECTRON MICROSCOPY (Cont'd)

- Samples are not restricted to thin sections. (this offers little advantage for observations of airborne fibres collected on a flat surface as fibres are already "thin").
- Sample preparation is relatively easy.
- Several types of signal are simultaneously detectable - backscattered electrons, secondary electrons, x-rays and cathodoluminescence.
- The image is not projected and the three dimensional aspects of fibres can be examined.

The SEM is particularly useful in the observation of fibres in tissues, but for quantitative airborne fibre determination, there are certain limitations Some of the disadvantages or limitations are as follows:

- Sample must be collected on a flat surface for accurate visualisation. (sampling difficulties).
- It is normally necessary to put a thin conductive coating (eg.: carbon, gold or gold-palladium) on the fibres to prevent charges building up on them.
- Very fine fibres may not have adequate "contrast" to be seen by SEM.
- The resolution of SEMs is not as good as for transmission electron microscopes.
- Analysis of fibres by energy dispersive methods when low atomic number elements are needed for fibre identification is difficult because the "background" can be very high.
- Electron diffraction for fibre identification is not available.

While Nucleopore filters are ideal for SEM observations, they can be difficult to handle because of electrostatic charges.

Techniques have been developed in which filters are pre-coated with gold, thus eliminating the need for thick coats on the fibres. Such methods permit the organic components of community air samples to be incinerated (at low temperature), preserving fibres in their original airborne state. Such methods show promise but the other limitations of the SEM remain.

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ELECTRON MICROSCOPY (Cont'd)

Transmission electron microscopy is not appropriate for the routine determination of airborne fibres in the workplace, because of cost, technical expertise required and the technical difficulties of preparing samples. The advantages of the TEM for the quantitative analysis of airborne fibres in ambient air and water and for research purposes outway the disadvantages. These include:

- Resolution c 0.2 nm (i.e. all fibres can be seen),
- Selected area electron diffraction can be used for identification,
- Energy dispersive analysis applicable to lower atomic number elements than with SEM (i.e. less background).
- Actual fibre sizes can be measured

Counting fibres on the TEM is time consuming, costly and preparing a grid with fibres in a non-disrupted state presents considerable difficulty. On the other hand, the resolution is such that all fibres can be readily seen. For size determination, the grid size determines the upper limit of fibre length observed. Counts of fibres made at a magnification of 6000 x involves measurement on a very small percentage of the total filter, thus, representativity of the area of the filter examined becomes an issue. Consideration of bias in counting rules and field selection are as important in TEM and SEM counting as in optical counting.

Energy Dispersive Analysis (EDXA) and SAED can be used to assist in fibre identification, as can the "hole down the core of the fibre" in chrysotile identification.

In ambient air determinations, it is often more convenient to ash the air sample, disperse the fibres in liquid suspension, using ultra sound, filter, and then prepare a grid for analysis. When this is done, counts are made of individual fibrils and with information on the fibril lengths and diameters the mass of fibres is determined and concentrations are expressed in ng/m^3.

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CONCLUSION

In summary, the methods and techniques to observe and quantify airborne fibres have undergone considerable improvement over the last 10 years. In spite of this, the underlying issue of what is a dangerous fibre and what one should really be measuring, are still not resolved. Are we using the correct index? Is the method providing the same protection to all occupational groups?

While there might be reason to be skeptical about the ways in which certain numerical standards have been derived, the membrane filter, phase contrast fibre count is at the present time the only practicable method to measure fibre exposure in the work-place even though it may be difficult to justify its acceptance on all the characteristics of a good method, sensitivity, specificity, reproducibility, validity and easy of use.

The continual upgrading or changing of the analytical technique will in the future render the interpretation of exposure assessments, as,if not more difficult than they were with Midget Impinger Measurements.

As far as ambient air measurements are concerned, the TEM methods are to be preferred over SEM.

We have come a long way in improving techniques for asbestos fibre analysis but we still have a long way to go.

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TABLE 1

EFFECT OF COUNTING RULES ON FIBRE COUNTS

(From NIOSH 7400 - p. 7)

Sample Type	Number of Samples	Aspect ratio 3:1		Aspect ratio 5:1	
		AIA	Mod. CRS*	AIA	Mod. CRS*
Mining	10	100	127	74	92
Milling	10	100	112	84	95
Asbestos cement	14	100	146	90	137
Textile chrysotile	10	100	109	89	99
Friction material	10	100	130	87	116
Others (insulation, amosite)	6	100	127	92	118
TOTAL	60 MEAN:	100	125	86	110

*Arithmetic means of counts made by different laboratories relative to the AIA counts.

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TABLE #2
SOME FACTORS WHICH DETERMINE WHAT IS SEEN AND COUNTED
USING PHASE CONTRAST MICROSCOPY

WHAT WE SEE DEPENDS ON	NIOSH 7400
A - Microscope and optics	. Characteristics well defined. . Use of HSE/NPL tests slide to standardize fibre visibility.
B - Source and nature of dust	. Method applies to all types of asbestos. . Non-asbestos counted as asbestos. . Non-fibrous particles raise detection limit.
C - Uniformity of deposit	. Attempt to improve by reducing filter size.
D - Plane of Dust Deposit	. Acetone collapse of filter will ease focusing.
E - Number of fibres/unit area	. Adjusted by varying sampling volume.
F - Number of non-fibrous particles /unit area	. Recognized problem changing detection limits.
G - Refractive index	. Defined but options for mounting permitted.
H - Observer - experience, training, personal factors	. Not addressed directly.
I - Size distribution of fibres and particles	. Not addressed.
WHAT WE COUNT DEPENDS ON	
J - Definition of a fibre	. Two aspect ratios acceptable. (3:1 and 5:1) Length 5um.
K - Counting Rules	. Two options exist.
L - Graticule	. Walton Beckett made for microscope.
M - Number of fields/fibres counted	. Well defined.

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TABLE 3

Ratios of Counts by Different Laboratories Counting Various Types of Asbestos Fibres

(From Ref. 15)

	Chrysotile sample nos.			Amosite sample nos.			Crocidolite sample nos.		
Ratio	88	91	92	12	14	17	8	7	4
Lab I/II (mounted by Lab I)	9.11	6.05	7.89	1.21	0.98	1.05	-	1.55	1.61
Lab I/II (mounted by Lab II)	4.38	3.36	14.20	0.92	-	1.03	-	1.58	1.33
Lab I/III (mounted by Lab I)	-	3.72	1.94	1.41	0.86	1.13	-	1.92	-
Lab II/III (mounted by Lab I)	-	0.61	0.25	1.16	0.87	1.07	-	1.23	-

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TABLE #4
DIMENSIONS OF AIRBORNE ASBESTOS FIBRES
(From Ref. 18)

Diameter (μm)	Amosite		Crocidolite		Chrysotile	
	Mining	Bagging	Mining	Bagging	Mining	Bagging
			Lengths ≤ 2.50			
≤ 0.06	14.84	2.59	34.09	26.90	60.73	51.65
0.061 - 0.100	8.98	5.97	27.01	24.74	23.79	23.99
0.101 - 0.200	19.45	17.21	19.96	22.81	8.59	12.38
0.201 - 0.300	11.47	12.55	3.31	2.60	1.23	1.38
0.300 +	9.09	11.31	0.90	0.72	0.97	0.74
			Lengths 2.51 - 5.00			
≤ 0.06	0.25	-	2.16	1.88	0.57	0.62
0.061 - 0.100	0.62	0.75	2.70	3.52	0.66	1.41
0.101 - 0.200	4.99	4.63	3.99	6.29	0.66	2.04
0.201 - 0.300	5.74	5.79	1.04	1.82	0.31	0.79
0.300 +	12.20	14.68	0.81	1.27	1.19	0.88
			Lengths 5.01 - 7.50			
≤ 0.06	-	-	0.25	0.22	-	0.16
0.061 - 0.100	0.12	0.12	0.65	0.61	0.13	0.39
0.101 - 0.200	1.62	1.80	0.86	2.48	0.13	0.66
0.201 - 0.300	1.75	2.03	0.43	0.83	0.13	0.16
0.300 +	3.86	6.75	0.30	0.34	0.51	0.88
			Lengths 7.51 - 10.00			
≤ 0.06	-	-	0.04	0.11	-	0.10
0.061 - 0.100	-	0.08	0.07	0.39	0.04	0.10
0.101 - 0.200	0.37	0.90	0.43	0.77	-	0.20
0.201 - 0.300	0.87	1.01	0.11	0.22	-	0.06
0.300 +	1.86	4.33	-	0.23	0.12	0.32
			Lengths 10.01 - 20.00			
≤ 0.06	-	-	0.07	-	-	0.03
0.061 - 0.100	-	-	0.07	0.17	-	0.03
0.101 - 0.200	0.12	0.71	0.54	0.50	0.04	0.36
0.201 - 0.300	0.62	0.85	0.04	0.22	-	0.16
0.300 +	0.99	4.77	0.11	-	0.13	0.33

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TABLE 5

EQUIVALENT CONCENTRATIONS FOR AN OPTICAL FIBRE

CONCENTRATION OF 1 fibre / ml

Fibre Type	Operation	Total Concentration (Fibres / ml)	Concentrations of Fibres in specific size ranges (Fibres / ml)	
			Length (5 - 20μm)	Diameter/Length (D=<0.3μm) (L=5-20μm)
Amosite	Mining	14.9	1.8 (1.9)	0.8
	Bagging	6.3	1.5 (1.5)	0.5
Crocidolite	Mining	243.9	9.7 (10.0)	8.7
	Bagging	175.4	12.4 (12.5)	11.4
Chrysotile	Mining	131.6	1.6 (1.7)	0.6
	Bagging	65.4	2.6 (2.7)	1.6
	Twisting	23.3	2.1	1.1
	Winding	25.3	2.0	1.0
	Beaming	37.0	1.9	0.9
	Weaving s.	100.0	3.0	2.0
	Weaving l.	83.3	3.1	2.1

All fibres >5um in length ( )

D = Diameter

L = Length

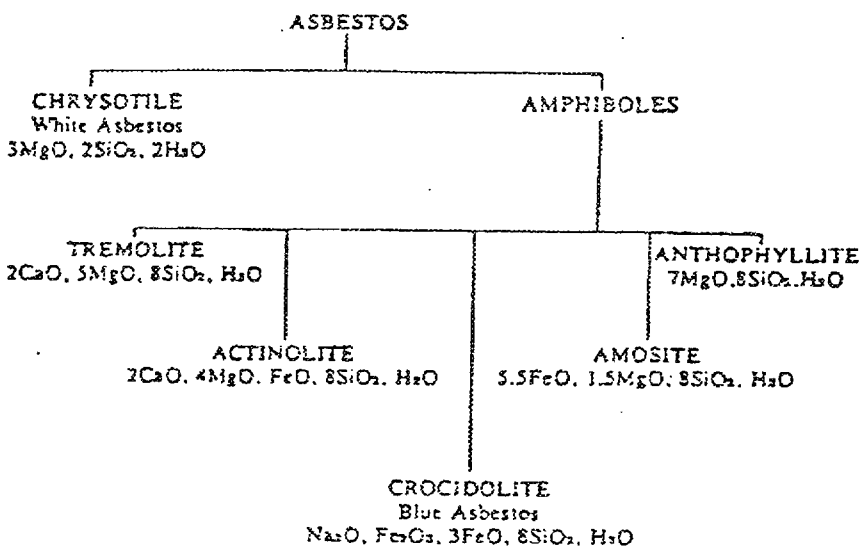
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FIGURE #1

ASBESTOS FIBRE TYPES



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Asbestos Removal in the Petrochemical Industry

T. E. Kupferer
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Today I would like to discuss the status of asbestos in the petroleum refining and petrochemical industries. While some of the details of my discussion will not necessarily be directly applicable to other companies in this industry, I think that their variations from what I will present here will be minor ones.

The main point I wish to make today is that while asbestos remains a potential problem in refineries and chemical plants, it is, in fact, not an actual hazard. By this I mean that although asbestos continues to be present in our facilities, there are programs presently in place which control exposures to such a degree as to make any health risk vanishingly small and, therefore, of no significance. To support this argument, I will present an overview of the status of asbestos in petrochemical operations, and review the type of programs which are used to control it. I will also present data regarding exposure levels seen in actual operations involving asbestos removal.

The great majority of refineries, terminals, pipeline facilities, and chemical plants are old enough that their construction predates the time when asbestos became generally recognized as a potential problem for people outside of the asbestos industry itself. In our industry asbestos is mainly found in insulating material on vessels and piping, where it was used primarily because of its excellent fire resistance and its high value as an insulating material. Most facilities have gone through an evolution of sorts over the years, with some parts of the process equipment changed, replaced, or added to. Maintenance demands cause pumps and valves to be periodically repaired or replaced, which generally calls for removal of some insulation. In many cases, the construction of the original facilities and the implementation of many changes occurred before many of the current employees were born. The result is that more often than not, it is not possible to know the nature of the insulation on a particular valve, line, or other process equipment item. Further, even the most seasoned maintenance supervisor cannot tell whether or not insulation contains asbestos by simply inspecting it. This brings us to the first stage of the asbestos program, which is identification of asbestos in the work place.

Identification of asbestos containing insulation is seriously complicated by the fact that there is generally a very wide variation in the type of material used, the time of its installation, and the degree of "wear and tear" that it has endured since being installed. Because of the tremendous variety of insulating materials present, it is not practical to actually analyze each for its asbestos content prior to the time it may be subject to removal. When it does become necessary to remove insulation, it then becomes necessary to make a determination of its asbestos content. Where there is a large amount of material to be removed, or when there is sufficient lead-time to permit sending samples, a bulk analysis is performed to determine the types and amounts of asbestos present. For small jobs, especially those maintenance tasks which do not permit a delay sufficient to perform analysis, it is presumed that insulation contains asbestos unless it is known with certainty that it does not. Field test kits are not relied upon in any case because of isolated reports of false negative test results. It is thus our presumption, unless proven otherwise, that any insulation to be removed will be treated as though it was asbestos.

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In addition to this approach to identifying asbestos containing insulation, we have also adopted a policy of never installing any new asbestos insulation during any repairs or construction. Thus any new additions or new units built within the last ten years will be entirely asbestos free. On existing units, all areas which have had insulation removed and replaced during this same period of time will also be asbestos free. Areas where asbestos has been replaced by asbestos-free material are identified by notations in maintenance records and the use of labels. Some new types of insulation also contain visual cues, such as colored chips, to indicate that it is asbestos free; however, labels and maintenance notes are still the main means of identification, since the insulation is almost always wrapped or coated after installation. Thus, there is a sort of reverse hazard warning labeling system, wherein all employees and contractors are trained to regard all unlabeled insulation as asbestos. Also, this program is resulting in a steady decrease in the presence of asbestos in our facilities. We anticipate that it will eventually be feasible to simply remove all the remaining asbestos insulation from units on a programmed basis to make them entirely asbestos free. Asbestos removal activity will, in any case, continue to decrease from past levels as progressively less of the insulation present is an asbestos type.

While our policies regarding identification and non-replacement of asbestos insulation set the stage for control of asbestos exposures, the real heart of our control effort is the individual plant program. These programs appear in different locations as "Safety Guides," "Safety Regulations," or under other titles, but each establishes local procedures which ensure proper control of asbestos hazards. These are all based upon guidance issued by the corporate industrial hygiene group and are subjected to review during routine industrial hygiene visits to the field facilities. In addition to reviews conducted by the hygiene staff, there are also periodic reviews by the corporate compliance review team.

These local programs all contain the same basic elements, which are designed to assure compliance with the OSHA standard and to give the maximum degree of employee protection. Contractors are required to meet the same standard of care when performing such work in our facilities.

Supervisors directing asbestos removal work, and the plant safety staff are responsible for assuring that procedures are followed, and routinely check on compliance by both contractor and company employees. By giving this part of the safety and hygiene programs high visibility and repeated emphasis, we have achieved excellent cooperation from supervisory personnel, which has made the overall program function.

The key elements which are the basis for the effectiveness of our program can be summarized as:

1. Development of written guides for procedures to use in removing asbestos.

2. Management commitment, especially in the form of supervisory awareness and involvement.

3. Training of those persons who must actually perform the work.

Procedures for the actual work are quite similar from site to site. These include:

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1. Techniques.
2. Protective clothing.
3. Respiratory protection.
4. Signs and labels.
5. Cleanup.
6. Monitoring.
7. Medical Surveillance.

Techniques: It is a very rare instance where any form of engineering control is feasible for asbestos removal in our industry. Generally, the work site simply does not lend itself to use of any form of local exhaust ventilation, to isolation of the employee, or to enclosure of the point of generation. In addition, because of our policy of not replacing asbestos with asbestos, such work is never done in the same place twice.

The only exception to this is in cases where large sections of the process equipment are being physically removed from the unit. In these cases, enough insulation is removed to be able to cut the sections into parts which can be removed from the unit before finishing the stripping job. These sections are carried to an isolated area where they can have all asbestos removed at ground level, and in a more controlled manner.

Where the insulated sections cannot be removed, as is normally the case, they must be stripped in place. For these jobs, work practices must be used to minimize the generation of dust. The two most important practices in this regard are wetting of the material, and just plain patience, that is, taking the time to do the job carefully.

In order to be effective, the wetting of the insulation must be continuous or nearly so. Most insulations are resistant to water penetration, and so must be kept wet as stripped since the inner layers of the material will still be dry when first exposed. Application in the form of a heavy mist seems to work best. The effectiveness of the water can be enhanced by addition of a detergent, and several are commercially available for this purpose. These are most practical when the water is drawn from a portable or transportable tank in which the detergent solution can be premixed.

Probably of more importance than the wetting procedure is the use of proper work procedures in the removal process itself. This is the area perhaps most heavily impacted by supervisory commitment and employee training. For example, if pieces of insulation are allowed to fall to the ground instead of being lowered, the impact will cause a great increase in the amount of dust released. Other examples of patient, careful practices would include cutting of retaining wires and slitting of coverings, as opposed to prying insulation loose with a wrecking bar or chipping it with a hammer. By permitting, and even insisting on, the taking of the time necessary to do a neat, clean job, the airborne dust can be lowered. Good training and supervision are essential to prevent hurrying and shortcuts from causing unnecessary exposure and more difficult cleanup.

Protective Clothing: We insist that all personnel working in close proximity to asbestos removal, whether directly involved or not, wear full protective clothing. Because of the problems involved in storing, laundering, and handling of reusable clothing

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contaminated with asbestos, all of our facilities have chosen to use disposable protective clothing, such as that made of Tyvek (a trademark of the DuPont Company). In addition to coveralls, all those in the work area are required to wear head coverings and gloves. Shoe coverings usually take the form of rubber boots, although other types are also used.

Our primary objective in the use of this clothing is not to prevent dermal contact, since we do not consider that a hazard. Our object is instead to confine the asbestos contamination to the work area, by preventing contamination of clothing which will be worn home or in other parts of the facility. Observation of a removal operation makes it clear that even though airborne fiber concentrations are kept well under control, the workers come into direct contact with wet asbestos debris which may cling to their clothing. If this clothing were to be worn outside the immediate area of the removal operations, there would be a strong possibility of releasing airborne fibers when the clothing dried.

Therefore, when the job is completed, or when workers are to leave the barricaded area, all contaminated articles of clothing are removed. Coveralls and gloves are routinely discarded along with the asbestos scrap, as are disposable head and boot coverings, if used. Hard hats are cleaned, as are boots, and any cleaning items used are also discarded with the asbestos scrap. Where rain gear is worn over the disposable coveralls, it is also cleaned before removal from the site.

Employees are provided with facilities where they can wash exposed parts of their bodies before returning to their normal work. Showers are also available, but due to the low dust levels, and use of protective outer clothing, these are not a part of mandatory programs.

Respiratory Protection: Under normal circumstances, our facilities use cartridge type respirators for protection against airborne asbestos. We feel that this is a reasonable precaution, even though exposure levels have been consistently low. Our choice of reusable, half-face respirators with cartridge filters was based primarily on the high assurance these give of a repeatable quality of fit, and the ease of performing the standard positive and negative pressure fit checks each time the device is put on by the employee. Single-use, disposable types were rejected because of the difficulty in performing a positive or negative pressure fit check, and due to the fact that most brands are "wearer formed" each time they are used and may thus offer less assurance of a consistent fit.

There are circumstances that make the use of wet removal techniques impractical or dangerous, such as subfreezing weather, or work on structures far above grade. When such conditions force use of dry removal methods, the employees use pressure-demand, air-supplied respirators with full face pieces.

All personnel subject to using respirators are included in our respiratory protection program, and are individually examined and fit tested for each type of respirator they may be using. In addition, there is normally a review session on the respirators to be used before any major asbestos removal job. We also insist that contractors involved in asbestos removal in our facilities follow these same guidelines for respiratory protection.

At the conclusion of the job or at any time the respirator is to be changed, the cartridges are removed and discarded with the asbestos scrap. The respirator itself is

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maintained by a central plant facility or by a designated individual trained in the inspection and repair procedures applicable to the type respirator being used.

Signs and Labels: Whenever asbestos is to be removed from some part of a facility, our standard procedures call for "roping off" the work area and posting of signs to warn non-essential personnel to keep out. Wording of these signs is generally verbatim from the OSHA standard. Employees are instructed to stay out of the barricaded area unless their presence is essential, and all those who do enter are required to wear the same protective clothing as those working on the removal itself. We have monitored from time to time to determine fiber concentrations at the periphery of these areas, and have found that it is not necessary to restrict access to a very great extent, especially outdoors.

All scrap is normally placed in heavy-gauge plastic bags preprinted with a label taken directly from the OSHA standard. For large jobs, a special "dumpster" is used, and this is similarly labeled.

Cleanup: The main technique for making cleanup effective after an asbestos removal is in controlling the degree of contamination during the actual removal. This includes use of wetting to control dust, and training and supervision of employees to use care in the handling of the debris being generated. Another useful technique that is especially useful when working above a perforated metal deck is covering of the deck with heavy-gauge plastic sheeting. This both simplifies cleanup and prevents falling debris from contaminating levels below the work level. This technique is also useful at grade level for simplifying cleanup, especially on relatively rough surfaces.

The usual cleanup requires picking up or scooping up the larger pieces and then wet-sweeping of the area where practical. On occasion, a vacuum cleaner with HEPA filters is used for cleanup, but this is usually unnecessary. Dry sweeping is not permitted, and any insulation which has dried since its removal is rewetted before disposal. Those performing cleanup are required to follow the same precautions as those doing removal work.

Once again, all potentially contaminated clothing is removed at the work site and either cleaned or disposed of at that point.

Monitoring: It is our practice to monitor for asbestos concentrations at least once every six months, unless a longer period elapses between asbestos jobs. When there is no asbestos work occurring when the six months have passed, monitoring is arranged for the next available asbestos work. More extensive monitoring is often performed during special operations such as turnarounds or demolition of a unit.

Although we have occasionally monitored contractor employees, we generally restrict our measurements to our own people. We do, however, insist that contractors also monitor their employee's exposures.

Medical: All employees involved in asbestos work are given annual physical examinations which far exceed the requirements of the OSHA standards for either asbestos or respiratory protection.

EXPOSURE DATA

Because of our routine concern for determining exposure levels in the work place, we have accumulated a considerable number of measurements for asbestos removal operations. These data I will present here today are all personal, breathing zone samples, reported

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without regard to the use of respiratory protection. The operations cover every type of removal operation from simple removal of insulation on valves to removal of the entire covering of large process vessels. It even includes measurements during cleanup of debris left from a catastrophic explosion and fire in a major facility. Although we do not always do a bulk analysis with each monitoring, we have performed a fairly large number of these (see figure 1). On this basis we can state also that our samples cover essentially the entire range of expected insulation types in regard to asbestos content. The types of asbestos found have always been chrysotile and amosite, with chrysotile being, by far, the dominant type. Crocidolite has not been found in our bulk samples.

When these samples are broken out by concentration measured and the characteristics of the operation, a number of clear patterns emerge. First, of the 322 personal samples in our files, 259 had measured concentrations below two fibers per cubic centimeter (f/cc) and only 15 samples, or 5 percent, exceeded 10 f/cc (see figure 2). It can also be seen that indoor operations produce higher concentrations than outdoor ones. For example, indoor operations account for 12 of the 15 samples over 10 f/cc, or 80 percent, while indoor samples account for only 49 of the total of 322 samples, or 15 percent. Of the indoor operations, the measured concentrations exceeded 2 f/cc in 27 of 49 samples, or 55 percent, whereas only 36 of 273 outdoor samples, or 13 percent were found to have measured concentrations greater than 2 f/cc.

When dry removal techniques are compared to wet methods a very significant and useful pattern emerges. It is immediately clear that, in spite of its problems, the wet technique for removal greatly reduces the potential for exposure. Where dry methods were used, the measured concentrations exceeded 10 f/cc in 15 of 190 samples, or 8 percent, however, none of the 132 samples using wet methods exceeded 10 f/cc (see figure 3). Further only 2 of 132 samples using wet methods had concentrations measured above 2 f/cc, compared to 61 out of 190 for dry methods. Thus, it can be seen that the ceiling level was never exceeded in any sample collected during asbestos removal using the wet method. An even more important pattern has emerged in the last two years as our emphasis on technique has paid off. Of the 72 personal samples on file for the last two years, only one had a measured concentration in excess of 0.5 f/cc.

Perhaps the most significant pattern emerges when one converts these measured concentrations to time-weighted averages (TWA). Out of 322 samples, there were none that had a TWA above 2 f/cc (see figure 5). Review of data from the last two years experience shows that there were no time-weighted average exposures above 0.5 f/cc out of 72 samples (see figure 6).

It can thus be concluded that asbestos exposure in our industry for asbestos removal will not exceed 2 f/cc as a time-weighted average, under any forseeable circumstances. Further, proper use of wet methods can bring exposures below a TWA of 0.5 f/cc and consistently prevent ceiling levels above 10 f/cc.

To these low exposure levels must then be added the typical exposure pattern of our employees. Asbestos removal does not occur on a daily pattern in any of our facilities, not even in our largest. In our moderate and small facilities, removal of asbestos insulation may occur less than twice per year. Further, these operations may be performed by any of a fairly large number of employees. A typical asbestos removal operation lasts only a few minutes, and even the largest lasts only a few days. Thus it would be rare for any employee, whether one of our own, or that of a contractor, to have more than one or two mandays per year of asbestos removal work.

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Beyond this must be considered the steadily decreasing amount of asbestos present in our facilities due to our non-asbestos replacement policy. Thus, the exposure frequency has been steadily declining and must continue to do so in the future.

In addition, we continue to require respiratory protection for all of these operations. Even given the very health conservative protection factor of 10, the cartridge type respirators in use would reduce the typical TWA exposure to below 0.05 f/cc and the ceiling exposure to below 1.0 f/cc. If a more realistic protection factor, such has been seen in quantitative fit tests, is applied, the typed exposure drops to less than 0.005 f/cc as a TWA.

We thus find ourselves in a position of having achieved what we believe to be an excellent degree of control, yet still facing the strong probability of more stringent regulation. For example, the current regulation has been interpreted in some cases as requiring the use of supplied air respirators for any asbestos insulation removal operation, regardless of the exposure level. This interpretation would thus impose a requirement for use of the most burdensome and complicated form of respiratory protection for an infrequent exposure well within the prescribed permissible exposure limit while permitting workers in other types of operations to be exposed every day to levels an order of magnitude greater, without benefit of any respiratory protection at all. Fortunately, OSHA has informed us that they would accept the cartridge respirator as sufficient protection, where we have ample historical data to assure its adequacy.

While we do not feel that it is possible to generate a credible quantitative risk factor for development of chronic disease as a result of exposures of the type described here, it is possible to make at least a qualitative one. The basic considerations in this evaluation are that exposures are typically very low without regard to respirators and are much lower yet when even a very conservative protection factor is considered. In addition, exposures are very infrequent, short in duration, and are progressively decreasing in frequency of occurrence. When these factors are considered, it is obvious that with current levels of control, asbestos removal in the refining and petrochemical industry is not likely to cause any increased incidence of any illness.

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Figure 1

% Asbestos in Bulk Material	1-3%	4-9%	10-39%	40+ %
% of Bulk Samples	5	30	35	20

Figure 2

	Concentration (f/cc)*			
	<2	2 < and < 5	5 < and < 10	> 10
Indoors	22	7	8	12
Outdoors	237	25	8	3
Total	259	32	16	15

Grand Total 322 Samples

*As Measured, Not Time-Weighted Average

Figure 3

	Concentration (f/cc)*			
	<2	2 < and < 5	5 < and < 10	> 10
Dry	129	31	15	15
Wet	130	1	1	0

Grand Total 322 Samples

*As Measured, Not Time-Weighted Average

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Figure 4

Last Two Years Only
(All Wet Method)

	Concentration (f/cc)*	
	≤0.5	>0.5
Total	71	1

*As Measured--Not Time-Weighted Average

Figure 5

	Concentration (f/cc)--TWA	
	≤ 2	≥2
Total	322	0

Figure 6

Last Two Years Only
(All Wet Method)

	Concentration (f/cc)--TWA	
	≤0.5	>0.5
Total	72	0

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APPENDIX E

WORKING WITH ASBESTOS-CONTAINING MATERIALS, AND THE USE OF RESPIRATORS TO PROTECT AGAINST ASBESTOS FIBERS

Norman A. Beddows, CSP,CIH

ASBESTOS SYMPOSIUM
March 27 & 28, 1984
Washington, D.C.

ORGANIZATION RESOURCES
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WORKING WITH ASBESTOS-CONTAINING MATERIALS, AND THE USE OF RESPIRATORS TO PROTECT AGAINST ASBESTOS FIBERS

Norman A. Beddows

INTRODUCTION

At the outset, let me say that my work with asbestos has been mainly in connection with ship repairing--in particular, large-scale stripping. This is similar to construction industry work, but is usually different from handling asbestos in general industry. Basically, stripping is done in confined or enclosed spaces which oftentimes are hot, humid and awkward to work in. The work is difficult and seems to take three times longer than expected. A great deal of preparatory time is needed for isolating work spaces, and creating transition zones and clean zones, using plastic sheeting, to ensure that asbestos workers and others in their vicinity are safeguarded. Also, material and tools have to be organized; plastic "glove boxes" may have to be made for use around pipes and elbows; and surfaces and permanent equipment must be covered securely with plastic sheeting. Most importantly, each affected worker must be formally trained in handling asbestos-containing material and qualified for such work [1] by a physician and a person with industrial hygiene skills.

MATERIALS AND IDENTIFICATION

Prior to the late 1960's, asbestos-containing material was used extensively on ships as thermal insulation, electrical insulation and in decorative panels in living quarters. Chrysotile, or white asbestos, is the most common asbestos mineral that is encountered, but grunerite mineral--Amosite, or brown asbestos, is quite common, especially in panels. All too often, asbestos minerals and other insulating materials exist side-by-side or one-over-the-other. Older repairs and patches can lead to problems of exposure unless a comprehensive testing program is ongoing or accurate records of repairs exist (which is not often). Practically, all insulating material to be treated should be regarded as asbestos unless proven otherwise by a skilled person. In our Department we use a polarized light microscope and dispersion staining [2] to identify and differentiate fine fibers in bulk samples of materials. Before large-scale stripping starts, hundreds of samples are taken and analysed to make sure all material which contains asbestos is handled properly. Before I leave this point, I might mention that light (polarized light) microscopy is usually fully satisfactory for asbestos identification when bulk samples of insulation are available. The limit of polarized light microscopy for identifying asbestos fibers is a diameter of approximately 1.5 micrometer (μm). Also, dispersion staining with polarized light microscopy is an increasingly popular method for conclusively identifying small

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(a few weight-percent) quantities of fine asbestos fibers in bulk samples of materials. The procedure is rapid and inexpensive, but it requires skill in optical crystallography. Dispersion staining is based on the phenomenon of characteristic colors being observable under a polarizing microscope, equipped with a dispersion staining objective, when a difference exists between the dispersion of refractive index for a particle and the liquid in which the particle is suspended. In sampling a composite material for identification, a "core" sample of all the layers is required. The sample should be double-wrapped and sealed in plastic or equivalently contained, and labelled "ASBESTOS(?)" before it is mailed or given to an analyst.

WORK PRACTICES

High fiber content, low density asbestos insulating material and other asbestos-containing materials which are friable or powdery may be treated by stripping (with appropriate transportation and disposal of the waste), encapsulation or covering, when the options exist. Asbestos-containing material which is firm and likely to remain so with normal activities occurring--for example, asbestos cement--may not require treatment. When a decision is made to defer treatment, a program of periodic inspections and monitoring for asbestos fibers in air should be implemented. It is a good practice to color-code or otherwise identify known asbestos-containing material for which treatment is deferred.

Stripping involves removing the asbestos material completely off the underlying surface. It requires the use of special procedures, complete personal protection and careful safety practices. HVAC systems are closed and sealed. Equipment is removed where possible or otherwise covered with plastic. Water, containing a wetting agent,[3] is sprayed on the asbestos during stripping to minimize the liberation of fibers. Plastic "curtains" (6 mil) are used for area isolation. HEPA (high efficiency) filtered vacuums are used to control dust, and to create negative room pressures in some instances. A respirator program,[4,5] disposable full-body coveralls (the respirator straps go beneath the head cover), and a changing room and clothes containers to contain contamination are used; and personal and environmental asbestos monitoring are performed extensively.

The best way of stripping asbestos is to use a 2-man team; one man cuts, the other periodically sprays a mist of water/wetting agent over the cut parts. Plastic sheeting (6 mil) is used to catch falling material and protect equipment. "Glove boxes", made of long rubber gloves and plastic, are used on pipes and elbows. Plastic-lined drums are used for waste. A HEPA-filtered vacuum.

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equipped with a slotted hood, is used close to the cutting area. These practices, careful work (ripping-out is not allowed) and good housekeeping are very effective in controlling fiber liberation and the spreading of asbestos.

Transporting and disposing of asbestos waste requires special precautions.[6] To render waste "non-hazardous" or "special material", for the purpose of disposal at an approved site, it must be wetted down, double-bagged or equivalently contained, sealed and labelled with an asbestos caution sign. The outside of the containers must be dust-free before transportation. Permission of the local Board of Health, and notification to the regulatory agency initially is required to dispose of waste. Notification to the approved landfill operator is required prior to each disposal.

Encapsulation involves applying a thixotropic latex to the friable asbestos by brush or airless, low pressure spraying. The latex should penetrate the surface material to bond the fibers. Pre-wrapping with gauze may be useful. The dried coating should be impact-resistant, fire-resistant, permeable to water vapor and non-toxic. Encapsulation adds weight; treated material must be capable of supporting itself under all likely conditions, including water damage.

Covering is performed using conventional materials. The constructional methods employed depend on the prevailing activities, location and conditions. Typically, friable asbestos on steam pipes and valves is wet wrapped or seal-coated and covered with fiberglass or corrugated aluminum. Also, asbestos-containing plaster and tiles are seal-coated or plastic-lined and overlayed with sheetrock or plywood, respectively.

Stripping permanently prevents future exposures, whereas encapsulation and covering are temporary solutions. In most circumstances, stripping creates higher exposures than encapsulation or covering. Stripping (and replacement with a suitable material) is higher in cost than encapsulation or covering. When encapsulation or covering is employed, periodic inspections and asbestos evaluations should be conducted.

In all methods of treatment, personal exposures to airborne asbestos fibers can arise. Treatment of asbestos insulating boards and lagging should be performed by workers who have received special training and instruction. They must use approved respirators, full body protective coveralls and gloves. The workers should be carefully supervised. Monitoring at the workers' breathing zones and within the work area should be performed to determine actual or

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potential 8-hour, time-weighted, average exposures, and ceiling concentrations of asbestos fibers. The frequency and pattern of the monitoring should be such as to reasonably and accurately represent exposure levels. Records of the monitoring must be preserved for 20 years.

Draft-free conditions should exist wherever friable asbestos-containing material is present or being treated. After asbestos has been treated, the affected spaces should be cleaned using special vacuuming equipment which employs a high efficiency, particle (HEPA) filter on the exhaust. Upon completion of the work, the affected spaces should be "cleared" for normal occupancy using the membrane test method or a fibrous aerosol monitor when it is permitted. Commercial and institutional spaces may be cleared at the urban background level. The concentration range* for asbestos fibers, evaluated by the NIOSH method, in urban areas, is approximately 0.001-0.008 fibers per cubic centimeter.[7] Industrial spaces may be cleared below 0.1 f/cm^3, which corresponds to the 8-hour, time-weighted, average (8 hr., TWA) concentration for initiating and continuing occupational asbestos medical examinations.[8] Such evaluations are made using high volume sampling to facilitate counting, when possible, about 30 fibers using a phase contrast microscope, to obtain acceptable accuracy. The real time fibrous aerosol monitor (FAM) operates in a statistically similar way (i.e., a short term--a minute--"readout" is no guarantee of acceptable accuracy!).

USE OF RESPIRATORS

Whenever friable asbestos-containing material is removed or treated, the person doing the work should use an approved respirator. It might be argued that exposures are controlled and respirators are not required to meet the appropriate standard; this may be true in some instances, however, for assurance, a reliable respirator should be worn.

The amended emergency asbestos standard[9]--the temporary standard** issued by OSHA on November 4, 1983--would permit the use of approved respirators to attain compliance with the proposed, time-weighted daily permissible exposure limit of

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* This range relates to fibers visible with the light microscope. Reportedly, a reasonable estimate of the total number of fibers present in the air sample is obtained by multiplying the figures by 3 or 4.

** The emergency standard was struck down by the U.S. Court of Appeals for the Fifth Circuit, on March 7, 1984 on the basis that the record failed to show a "grave" risk existed which made the emergency standard necessary. The Court also stated, however, that its finding that substantial evidence does not exist to support a six-month ETS "should not be construed as a prediction that a lower asbestos PEL would fail under judicial scrutiny if OSHA promulgates it pursuant to proper notice-and-comment rule-making procedures."

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0.5 f/cm^3, while requiring an employer to take an engineering approach to controlling asbestos fiber release. In the latter regard, if the hazards of asbestos are to be maximally controlled, careful work, HEPA-filtered vacuuming equipment, water misting, water penetration of asbestos-containing material, and other safeguards must be employed.

The term "approved" applies to the construction of the respirator itself and to the conditions of use. According to the NIOSH terms of approval, respirators (filters) used to protect against asbestos-containing dusts in atmospheres which are not immediately dangerous to life or health and do not contain less than 19.5 percent oxygen are designated by "Approval No. TC-21-C----". All air-purifying, disposable dust respirators, and half-mask and full facepiece respirators for protection against asbestos are described in the manufacturers' data sheets as having this approval.

As previously mentioned, conditions bear on "approval". The respirator required for use in an atmosphere with a particular airborne concentration of asbestos, based on a permissible exposure level of 0.5 f/cm^3, is listed in Table 1 which is excerpted from the emergency temporary standard of November 4, 1983.

Table 1
Respiratory Protection
For Airborne Concentrations of Asbestos

Airborne Concentration of Asbestos (TWA)	Required Respirator[1]
Not in excess of 5 f/cc (10 X PEL)	Reusable or single use air-purifying respirator.
Not in excess of 50 f/cc (100 X PEL)	Full facepiece air-purifying respirator, or a powered air-purifying respirator.
Greater than 50 f/cc	A type "C" continuous flow or pressure demand, supplied air respirator.

1 Respirators specified for high concentrations may be used at lower concentrations of asbestos fibers longer than 5 microns.

When alternative respirators reliably provide the required performance of respiratory protection, selection might better be left to the user. Some workers prefer a full facepiece at all times, others prefer a half-mask--both types, preferably, having HEPA filtration. Also, any approved respirator should be tried and selected by the wearer for comfort, whenever feasible.

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At this juncture, it is obvious that we need to know with a good deal of certainty what we can expect as airborne concentrations in asbestos treatment. Experience and reams of data provide this information. It is my experience that a well-trained, instructed and supervised crew can repeatedly perform stripping in confined, difficult-to-work-in spaces without exceeding five fibers per cubic centimeter, as a time-weighted average concentration. Accordingly, with suitable auditing and testing being performed, trained employees can be allowed to use a half-mask respirator in most cases. In a well-supervised operation, the exceptions are rare. They usually involve work of asbestos removal where water cannot be used for dust control--for example, around electricals. In these cases, full facepiece, air purifying respirators, or powered or supplied air respirators would be used to protect against fibers at an expected working, airborne concentration within the range of 2 - 20 fibers, longer than 5 µm, per cubic centimeter.

Faced with deciding which respirator to use when airborne levels of asbestos are reliably known, the person making the selection or recommendation will want to consider the following information and observations (given that 0.5 f/cm^3, 8 hr. TWA is a current anticipated or expected limit of permissible exposure).

- Disposable air purifying respirators are available with NIOSH TC 21-C approval for use in asbestos-containing atmospheres. These are basically half-masks; they may be used to protect against fibers up to 5 f/cm^3 (8 hr., TWA) concentration. However, many of these respirators do not consistently provide the level of facial seal afforded by rubber or equivalent half-masks; they are difficult to fit-check in use. For this reason, reservations on their use in asbestos working exist. While most disposable-type respirators are not preferred for use in stripping, encapsulating, or covering asbestos, they are used in sampling insulating material and in other intermittent work with low level asbestos exposure potentials. Fit factors (described later) of 10 and greater can be obtained with a well-fitted disposable-type respirator.

- The asbestos worker needs to be aware at all times that the respirator is fitting properly; rubber-type half-masks and full facepieces give the better physical perception and warning of poor fit to the busy user.

- Air supplied respirators provide higher fit factors and are less tiring to use than air purifying masks but they restrict freedom to move, and create tripping hazards in some instances. At a fixed work station, these problems may not arise. Full facepiece respirators provide higher fit factors than half-masks but preclude the use of ordinary spectacles--the frame will not fit

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in the facepiece, and the temples impair the facial seal. However, a special kit is available to overcome these problems. Also, the size and weight of full facepieces cause problems for some users. Compliants of headaches using a full facepiece are common (an excessively tight fit is usually the cause), as is the complaint of fogging of the face shield (a full facepiece with nose cup does not fog as easily as one without the cup. Also, some anti-fogging agents are effective.)

- Regardless of measured exposures, as a precaution, whenever asbestos work is performed, everyone in the work area should wear an asbestos respirator. While a single-use fabric respirator may be used by some to guard against incidental exposures, a half-mask or full facepiece respirator with replaceable HEPA filter cartridges is needed in stripping, encapsulating, or covering asbestos-containing material; consistent respirator reliability is essential in these activities.

- NIOSH has publicly stated that "it is not our position that single-use dust respirators will provide adequate protection against the cancer-causing potential of asbestos." (Notice to All Respirator Manufacturers, May, J.R. NIOSH, Am. Ind. Hyg. Assoc. Journal, -41-, Dec. 1980.)

A brief summary of advantages and limitations of various respirators is provided in Table 2.

TABLE 2. ADVANTAGES AND LIMITATIONS OF RESPIRATORS USED TO PROTECT AGAINST ASBESTOS FIBERS

TYPE	ADVANTAGES	LIMITATIONS
Single-use (disposable) fabric-type	Economical and lightweight. Do not require cleaning.	Practically limited to use with transient, low-level exposures. Fit checking difficult. Low warning of poor fit.
Rubber or equivalent half-masks with cartridge filters.	Lightweight. Easy to check fit. Reliable performance. Suitable for use in many situations.	Approved only for use up to 5 f/cm3, 8-hour TWA.
Full facepiece respirators with cartridges.	High protection. Reliable performance. Easy to check fit.	Heavy. Ordinary eyeglasses cannot be worn. Fogging.
Continuous flow, Air supplied (airline) half-mask or full facepiece respirator.	Easy breathing	Restricts movement. Possible tripping hazard.
Pressure demand, Self Contained Breathing Apparatus (SCBA)	Not usually required. Maximum protection	Cost. Limited air supply Heavy (Usually not required.)
Filtered air supply helmet-visor type. (HEPA)	Easy breathing Overall high protection Facial hair and eyeglasses accommodated	High cost. Deep breathing may cause leakage around chin

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FIT PERFORMANCE OF RESPIRATORS

"Fit Factor" (FF), often referred to as protection factor, is a measure of facial seal quality and is defined as the ratio of the mean concentration of test aerosol in the ambient atmosphere to that inside the facepiece under test conditions. These conditions include head movements, breathing changes, and talking with the respirator donned. They are intended to simulate actual working conditions. Any air purifying respirator tested should employ HEPA filters.*

A Fit Factor of 10 implies a ten-fold reduction in the test aerosol concentration. The Fit Factor, as measured, indicates the quality of the facial seal obtained with the respirator.

Our experience in fit testing is principally with rubber half-masks in the small, medium and large sizes, and a one-size rubber full facepiece.

Summarily, in a set of recent tests on a predominantly (99 percent) male group, the subjects were received at the test station randomly; individuals who had facial hair, which might have interfered with a seal, were excluded from testing. Each individual, before testing, had to have achieved a satisfactory performance in the FEV_1/FVC spirometry test which is part of the medical examination.

In 1,066 tests with half-mask facepieces, 99.8 percent exceeded a factor of 10, 95 percent exceeded 20; and 50 percent exceeded 200. In 56 tests with full facepieces, all exceeded 50; 95 percent exceeded 100 and 50 percent exceeded 1,000. In 10 percent of the fit tests with either facepiece type, factors of 2,500 or greater were measured.

Ninety-six percent of the successful fittings with half-masks were made with the medium-size facepiece. A failure rate of 0.2 percent (equivalent 10 factor criterion) occurred using half-mask facepieces (none of the failed individuals could be satisfactorily fitted with any of the three sizes of half masks). No failures (equivalent 50 factor criterion) occurred in the tests with the full facepiece.

A summary of these HEPA-cartridge respirator fit test data is provided in Table 3

* A HEPA filter is capable of retaining 99.97 percent of a 0.3 micron aerosol. Practically, a face fit test value of about 500 or more will not be measured unless a HEPA-filter is employed.

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TABLE 3. RESPIRATOR FIT TEST DATA

A. HALF-MASK FACEPIECE (HEPA) TESTING

% SUBJECTS	FIT FACTOR	N = 1066
10	> 2500	
50	> 200	
95	> 20	
99.8	> 10	

B. FULL FACEPIECE (HEPA) TESTING

% SUBJECTS	FIT FACTOR	N = 56
10	> 2500	
50	> 1000	
95	> 100	
100	> 50	

In conclusion, our experience in quantitative face fit testing is that the vast majority of a large number of males was fitted satisfactorily with the medium size, half-mask facepiece, and the small and large sizes accommodated almost everyone else. The very small percentage of individuals who could not be fitted by any size of half-mask facepiece was fitted satisfactorily with a full facepiece mask. Also, both types of facepieces generally (95 percent of the cases) performed better (by two times or more) in the tests than is implied by the nocinal 10 and 50 "protection factors" which apply, respectively, to these two types of respirators, per the standard.

Finally, any worker who needs a respirator should be instructed in its use and limitations. The provisions of the general industry respirator standard (at 29 CFR 1910.134) should be followed. Asbestos workers, particularly, need to be drilled in careful working, thorough cleaning practices, the use of respirators, and other important matters. This is best done by holding formal training sessions which are based on the asbestos and respirator standards' requirements, and the use of pipes and valves which are lagged with simulated asbestos material (calcium sulphate). Only when the workers have demonstrated the required competency (including passing the physician's examination) and knowledge should they be permitted to work with asbestos. This can be controlled by the issuance of time-limited "asbestos badges" which must be worn by the worker.

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References and Notes

1. The Code of Federal Regulations at Title 29 Part 1910, Section 1001 provides the standard for Asbestos work.

2. McCrone, W.C. Dispersion Staining. American Laboratory, pp 52-55, (December 1983).

3. Most commercial wetting agents appear to perform satisfactorily. Household dishwashing liquid works well.

4. Respirators approved by NIOSH/MSHA and bearing an approval number (TC-21C-XXX) on the packaging material.

5. Described in detail in "Respiratory Protection - A Manual and Guideline" by L. R. Birkner, published by the American Industrial Hygiene Association.

6. Described in detail in the EPA Emission Standards (for Asbestos) at 40 CFR 61.22. Federal Register, 38; 66. (April 6, 1973).

7. John, W., Berner, A., Smith, C., and Wesolowski, J. J., Experimental Determination of the Number and Size of Asbestos Fibers in Ambient Air. Calif. State Department of Health, Rept. AIHL/SP-1, 36 pp. (January 1976).

8. Required by and specified in the OSHA Standard for Asbestos at 29 CFR 1910.1001.

9. Federal Register, 48; 215 (Nov. 4, 1983).

N.A.B. 3/20/84

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APPENDIX F

ASBESTOS REMOVAL TECHNIQUES IN THE PAPER INDUSTRY

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I. Introduction

International Paper Co. (IP) has banned the installation of new asbestos products since 1976 (except brake shoes and clutch plates, etc., where adequate substitutes have not been found). Existing insulation products in IP pulp and paper mills are our main problem, particularly when maintenance jobs have to be performed. IP has made a major effort to protect any workers that may be exposed to asbestos, and the Industrial Hygiene Department (IH) has issued administrative and work practice guidelines for all IP facilities. In addition, an excellent (we think) video tape training program was prepared explaining the hazards of exposure to asbestos and the IP work practices for employees. Outside contractors are occassionally used on jobs that may include asbestos removal but, although IP dealings with contractors were outlined in the IH guidelines, a problem still exists in enforcing the use of appropriate practices and in contractors not having some equipment or the expertise to perform air sampling. These problems are currently being addressed, and I will discuss them again later in this talk.

IP does not recommend removal of asbestos unless it is in poor condition (crumbling) or needs replacement to allow other work to be performed.

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II. IP Administrative Guidelines

IH structured its "Administrative and Work Practices for Short Term Maintenance Work with Asbestos" in two sections:

- Administrative and Monitoring Requirements of the Asbestos Standard, and
- Safety Practices for Short Term Maintenance Work with Asbestos.

The Administrative and Monitoring Requirements were directed at management to highlight the preparation, planning, monitoring, notification, etc., and ensure that compliance is maintained. The Safety Practices were directed at workers to explain the specifics of the work practices.

The Administrative and Monitoring Requirements cover the following points:

A. 1. Notify any contractors of their requirements to comply with 1910.1001.
   2. Make sure that the contractor is aware of and promises to comply with 1910.1001.
   3. Include the commitment in the contract or a separate written acknowledgement before any work is done.
   4. Review and audit the contractor's compliance.

B. If possible, perform bulk sampling before work starts to determine if asbestos is present. We provided bulk sampling instructions and illustrated the procedure in our video tape. We also recommended that mills attempt to survey all areas at one time and record and label the areas that contain asbestos; however, few if any facilities took this approach because of the sometimes hundreds of miles of pipes involved and the complexity of the job. We still sometimes get last minute calls for rush determinations of asbestos in insulation. All of our work is sent to outside AIHA approved laboratories.

C. We make it an administrative responsibility to ensure that the safety practices (to be discussed later) are followed by supervisors and workers.

D. We have determined, through OSHA, that air monitoring is required every time asbestos work is being performed. The reason given is that no two jobs are exactly alike. IH has done some of the air monitoring, and we have trained some of the mill safety supervisors to perform their own air monitoring. Up until recently, we have also had to

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monitor for most contractors. Again, all of our asbestos samples are sent to outside laboratories for counting.

E. Notify employees in writing if results are above the PEL (TWA or ceiling). We have also informed contractors of this responsibility when results are received.

F. Initiate medical surveillance according to 1910.1001, and we inform contractors of this requirement.

G. Notify the EPA local office if the job fits the following criteria:

1. more than 260 linear feet of pipe, or
2. more than 160 square feet on duct, boiler, tanks, etc.

H. Follow local, state, or federal EPA regulations for disposal of waste that contains asbestos.

K. Prohibit purchase or use of new materials that contain asbestos, unless in a fully bound state such as brake shoes or linings, clutch plates, etc.

III. IP Safety Practices for Short Term Maintenance Work with Asbestos

We asked that these rules be posted in shops and in the general office. They are directed at employees involved in maintenance work, and serve to remind them of the practices more fully illustrated in our video tape training program. IP regards any maintenance job that requires the handling of any insulation material that contains asbestos as "asbestos removal," and our work practices and personal protective equipment requirements are designed accordingly.

A. Notify the Safety Supervisor before beginning any work with insulation.
B. Determine if the material contains asbestos.
C. Follow the asbestos work practices if asbestos is present or has not been identified.
D. Rope off or barricade the area.
E. Post the caution signs. We spell out the OSHA required wording. These signs have been purchased from suppliers.
F. Wear personal protective equipment in the work area:
   1. Disposable clothing
   2. Foot covering
   3. Head covering
   4. Gloves
   5. NIOSH approved Type "C" supplied air respirator.

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We have specified and used the pressure-demand supplied air respirator because we classify the jobs as "asbestos removal", and we have stayed with them even though more than 95% of all our results have been below the PEL's. Only on one job that I am aware of have half-mask respirators been used, and in that case with OSHA concurrence because the air lines themselves would have been a safety hazard.

G. Cover the work area with plastic drop cloths to prevent tracking around or falling through grates to a lower floor, and to aid in clean-up.

H. Wet down the insulation before and during the work. This has been emphasized in our video tape as "Wet it Down and Keep it Wet", and we think this has been the key in keeping airborne fibers at low levels. We recommended a low pressure spray from a garden hose, but find that large hoses in the mills have been used. Sometimes we get too much water.

I. Bag and tag the waste material as it is removed. Don't let it lie around or drop to a lower floor. We try to prevent accumulation of asbestos material lying around. Sealed plastic bags or other containers are labelled with OSHA required tags, and we spell out the wording.

J. Clean up using a vacuum or wet sweep. No compressed air blowing is allowed.

K. Dispose of protective clothing with the asbestos waste. We warn employees not to take contaminated clothing home.

L. Dispose of waste asbestos material following the appropriate regulations.

IV. Bulk Sampling

Our bulk sampling instructions, at a minimum, call for a dust mask and gloves. We ask that a 1" x 1" plug be taken all the way to the core of the insulation, carefully packaged and labelled, and sent to a laboratory for analysis of type and percent of asbestos. IP has had no problem with this procedure, except that sometimes enough lead time is not given prior to starting a job. It is very difficult to get 1/2 or 1 day turnaround for analysis. As mentioned above, many facilities have not yet analyzed and labelled all of their insulation. For some facilities, so many changes have been made since the original construction that too many samples would have had to be taken to characterize all the insulation. However, on large jobs that require a lot of planning, bulk sampling and analysis have been performed uniformly.

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V. Some IP Monitoring Data

I have summarized approximately 350 monitoring points taken by IH and mill personnel, including 209 TWA and 139 ceiling determinations. Most of the data are from personal samples.

Only 1.4% of all the TWA determinations were above the OSHA PEL, and only 2.2% of the ceiling determinations. I think that this speaks very well for the IP work practices, and certainly points to the success of the wetting-down procedure. For the TWA determinations, 53.6% of the samples were below 0.1 fiber/cc, while for the ceiling samples 12.9% were below 0.1 and 46.8% were between 0.1 and 0.5 fibers/cc. If we look more closely at the data and separate those taken by IH or by mill personnel, it appears that all samples above the PEL's were taken by mill personnel. Further examination of the data in arbitrarily chosen concentration ranges (<0.1 fibers/cc, 0.1-0.50, 0.51-1.0, 1.1-2.0, etc.) shows that, in general agreement, the IH data forms a distribution in lower concentration ranges than does the mill data. For the TWA determinations, 98% of the 99 IH points were below 1 fiber/cc, while only 92.8% of the 110 mill points were. For the ceiling determinations, 84.4% of the 96 mill points were below 2 fibers/cc, but 100% of the 43 IH points were.

I can't say for sure why the data should come out this way. Perhaps it was because IH took better and more accurate samples, but I suspect a more likely cause is that when IH was present the work practices were followed more closely. If that is the case, we have to try harder still for mill and contractor work practices and provide the education to bring that about.

VI. Asbestos Substitutes

IP has been 100% successful in switching away from asbestos-containing insulation. Some substitutes have been found for brake shoes and clutch plates on lift trucks and other machinery, and the facilities that have switched are very happy with the performance, claiming that they are getting longer wear and are saving money. Brakes and clutches on our very large equipment have not been changed, partially because the original manufacturers have moved slowly. Gasketing is in a similar state, with much of the work being done at the facilities.

VII. Contractors

Unfortunately, not all of the contractors arriving at IP facilities have been asbestos removal experts or knowledgeable in the ways of OSHA. In fact, at least one job had to be held up until equipment could be brought on site and one of our IH's could be present to perform monitoring. So we are making an

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effort to strengthen dealings with contractors by providing local facilities with more explicit instructions on what the contractor's responsibilities should be.

Going back to the points I made earlier, IP notifies the contractor of the requirements to comply with 1910.1001 and obtains a written committment from the contractor. It is made clear that the facility has the responsibility to review and audit the contractor's performance. We are now stressing more complete preparation before work is begun including providing our asbestos work practices, a copy of our video tape, the OSHA standard, and meeting with the contractor to discuss the procedures. We now ask that the contractor supply all equipment and perform his own monitoring, and we make it clear that work will stop if proper procedures are not followed. And to put this all together, we are devising an asbestos safety checklist to aid the facility to make sure that all the requirements are met.

VIII. A Typical Contractor Job

Somehow the typical asbestos job does not appear to be in the super clean and aseptic environment depicted on our video tape. When a contractor is called in, it may be a large, difficult, and dirty job. Some of the equipment may still be in service, hot, and difficult to keep wet. Obviously, if a contractor does not have a pool of well trained employees, more careful training of employees may be called for. Also, as the job becomes more complex, there is an obvious difficulty in trailing airlines all over the place. It is jobs like these that have convinced us that contractors have to be watched more closely.

IX. Conclusion

We are convinced that we have developed an effective program to reduce airborne asbestos concentrations and protect employees. The Administrative Guidelines, Safety Practices stressing "Wet it Down and Keep it Wet", use of personal protective equipment, video tape training program, and the bulk sampling protocol have worked. We are still addressing the identification of asbestos substitutes for all applications, and we are attempting to strengthen our dealings with contractors. Finally we are developing enforcement and audit criteria both on the facility and corporate level.

#5130v

C22350

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International Paper Company

Asbestos Monitoring Summary

A. TWA Data

	fibers/cc					
	<0.1	0.1 - 0.50	0.51 - 1.0	1.1 - 2.0	>2.0	Total
Mill Data	64 (58.2%)	31 (28.2%)	7 (6.4%)	5 (4.5%)	3 (2.7%)	110
IH Data	48 (48.5%)	39 (39.4%)	10 (10.1%)	2 (2.0%)	—	99
Total	112 (53.6%)	70 (33.5%)	17 (8.1%)	7 (3.3%)	3 (1.4%)	209

B. Ceiling Data

	fibers/cc						
	<0.1	0.1 - 0.50	0.51 - 1.0	1.1 - 2.0	2.1 - 10	>10	Total
Mill Data	4 (4.2%)	43 (44.8%)	17 (17.7%)	17 (17.7%)	12 (12.5%)	3 (3.1%)	96
IH Data	14 (32.6%)	22 (51.2%)	5 (11.6%)	2 (4.7%)	—	—	43
Total	18 (12.9%)	65 (46.8%)	22 (15.8%)	19 (13.7%)	12 (8.6%)	3 (2.2%)	139

C23851

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Biography - E.A. Pinzer, Program Coordinator, Industrial Hygiene, International Paper Co., 77 West 45th St., NY, NY 10036

B.S. - Chemistry, City College of New York, 1960

M.S. - Chemistry (Analytical), Arizona State Univ., 1967

Chemist - Shell Chemical Co. Woodbury, NJ, 1962-1967

Chemist, IH - CIBA-GEIGY Corp., Ardsley, NY, 1967-1979

Program Coord., I.H. - International Paper Co., NY 1979 - present

Responsible for developing work practices and compliance programs for the fifteen pulp and paper mills and approximately 100 other facilities of International Paper Co. Member AIHA; member AIHA Confined Spaces Committee. Developed video tape program for IP - "Short Term Maintenance Work With Asbestos." Participated in development of a safety training program on hydrogen sulfide for the American Paper Institute and member companies.

C23032

UCC 005868

RESPIRATOR HEALTH EVALUATION QUESTIONNAIRE

Introduction

I understand that I am being given this questionnaire to determine my ability to safely wear a respirator during the normal performance of duties associated with my employment with this organization.

(NOTE: FOR ANY YES - SEE A PHYSICIAN)

	NO	YES
1. Are you usually short of breath on exertion such as: (a) climbing one flight of stairs, (b) walking up a slight hill or (c) walking with other people of your own age at an ordinary pace on the level?		
2. Have you now, or have you within the last three years had a cough that produced phlegm and lasted for three months or more?		
3. Have you ever had severe chest pains?		
4. Have you ever had asthma?		
5. Do you frequently have difficulty breathing through your nose?		
6. Have you ever had a heart attack or other heart condition?		
7. Do you have chronic skin problems of the face?		
8. Do you faint, blackout, or have you had any periods of unconsciousness in the last three years? (For example epilepsy).		
9. Do you know of any reason why you are not able to wear a respirator?		

I understand the questions above and have answered to the best of my knowledge.

I understand that I have the right to request a health evaluation by a physician.

Signed_____ Date_____
(Employee)

Signed_____ Date_____
(Person administering questionnaire)

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APPENDIX H

CELANESE

May 14, 1984
JFS-50-84

Re: Comments on OSHA NPR for Asbestos

Celanese has reviewed its experience with asbestos and offers the following data in response to your request of April 13, 1984.

1. Employee turnover for the last twenty five years excluding layoffs has ranged between 2 and 5%. Employees in mechanical trades have experienced an even lower turnover. If we include layoffs, the average turnover rate has been 10%.

2. Approximately 60% of Celanese employees indicate on medical history questionnaires that they have been exposed to asbestos at sometime. This includes exposure in previous jobs, in home, and military service. Approximately 2-3% of our current employees have potential exposure to asbestos at infrequent intervals for periods of one hour or less.

3. Asbestos removal operations in our facilities are infrequent. Since 1978 one of our Tech centers reports three removal jobs. Removal was done by outside contractors in accordance with established protocol. Post removal sample data results yielded less than 0.1 f/cc levels in all areas. In our manufacturing facilities, asbestos removal is very sporadic and usually of short duration. Most of the jobs are handled by outside contractors.

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4. Levels of asbestos throughout most of our operations are less than 0.2 f/cc. In many cases sample data shows non-detected TWA exposure levels during the handling of asbestos and demolition work.

5. We have no data on exposure levels during the changing out of protective clothing and respirators.

6. Asbestos removal jobs in the past have occurred on the average of (1) per year/per facility and lasting usually one week. The average number of asbestos removal jobs throughout the Celanese per year is approximately 5.

Sincerely,

Joseph F. Stelluto
Corporate Manager
Industrial Hygiene

JFS:sl

C42365

UCC 005871

The Asbestos Standard - Recommended Medical Surveillance Requirements

(m) Medical Surveillance (1) General. (i) The employer shall institute a medical surveillance program for all employees who are, or may be, exposed to airborne concentrations of asbestos fibers in excess of the action level for more than 30 days per year.

(ii) The employer shall assure that all medical examinations and procedures are performed by duly certified and approved persons under the supervision of a licensed physician with special knowledge and training in the diagnosis of asbestos-related conditions. The minimal training requirements for physicians supervising the medical surveillance of asbestos exposed persons is briefly outlined in Appendix A.

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

(2) Preplacement. (i) The employer shall provide or make available to each employee who is, or may be, exposed to airborne concentrations of asbestos fibers greater than the prescribed action level, a comprehensive medical examination prior to first employment (or reassignment for the first time from other duties in such conditions) no later than 30 days from the date of first employment (or re-assignment).

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(ii) Such examinations shall include, as a minimum, a questionnaire to elicit symptoms of respiratory disease (Appendix B(1)), pulmonary function tests of ventilatory capacity such as forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$), and a chest roentgenogram (posterior-anterior view 14 x 17 inches). Chest roentgenographic examinations shall be made in accordance with the specifications stipulated in Appendix C [(1) & (2)]. Pulmonary function tests shall be administered and interpreted in accordance with the specifications stipulated in Appendix D [(1) & (2)].

(iii) Employees with 10 or more years of prior exposure to airborne concentrations of asbestos fibers in occupations where the action level was or could have been exceeded, who are 45 years of age or older and who also smoke more than 5 cigarettes (or the equivalent amount of tobacco in other form) per 24 hour period, shall be given the opportunity to provide a sputum sample for cytologic examination.

(3) Periodic examinations. (i) Every employer shall provide or make available comprehensive medical examinations to each employee who was required to have a preplacement (pre-employment of pre-assignment) examination under the provisions of this paragraph, the periodicity to be determined in accordance with the schedule in Table 1.

(ii) Every employer shall provide, or make available comprehensive medical examinations to each employee determined to nave been exposed to airborne concentrations of asbestos fibers in excess of

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the prescribed action level for more than thirty days, where such exposure was intermittent and not incurred as part of the employees described occupation, that is, the employee is not an "asbestos worker" but is engaged in some other trade or skill which results in such intermittent exposure. The periodicity of such examinations will be determined in accordance with the schedule in Table 1.

(iii) The periodic examination shall include, as a minimum, a questionnaire to elicit symptomatology of respiratory disease, pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$) and a chest roentgenogram (posterior-anterior 14 x 17 inches). Chest roentgenographic examinations shall be made in accordance with the specifications stipulated in Appendix C [(1) & (2)]. Pulmonary function tests shall be administered and interpreted in accordance with the specifications stipulated in Appendix D [(1) & (2)].

(iv) For employees with 10 or more years of exposure to airborne concentrations of asbestos fibers in excess of the prescribed action level who are 45 years of age or older, and who habitually smoke more than 5 cigarettes in 24 hours, a sputum cytology examination shall be made available in addition to the above procedures.

(4) Termination of employment. The employer shall provide, or make available, a comprehensive medical examination within 30 calendar days

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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 prescribed action level for more than 30 days in the preceding twelve month period. The examination shall be in accordance with and comparable to the requirements of the Periodic examinations stipulated in (m)(3)(i)-(iv).

(5) Recent examinations. No medical examination is required of any employee who has been exposed to airborne concentrations of asbestos fibers in excess of the prescribed action level for more than 30 days in the preceding twelve month period, if adequate medical records show that the employee has been examined in accordance with this section of the rules within the past one year period.

(6) Employee notification. (i) Any employee found to exhibit any of the effects which the examining physician attributes to the documented exposure of such employee to airborne concentrations of asbestos fibers in excess of the prescribed action level, shall be immediately notified in writing of the results of the medical examination. The physician's opinion will be in the format prescribed in 6(iii)(A)-(C).

(ii) Any employee who has been medically examined, and who, in the opinion of a physician qualified to interpret the results of such examination administered in accordance with the specifications in

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Appendices C & D, based upon the evaluation of the work history, respiratory symptoms and signs, pulmonary function tests and one or more of the employees's chest roentgenograms, exhibits significant effects of asbestos exposure, shall be afforded the option of transferring from his or her position to another position in an area of the workplace where the concentration of respirable airborne asbestos fibers does not exceed the action level prescribed in these regulations.

(iii) With respect to each examination required by this paragraph, the employer shall obtain a written opinion from the examining physician, containing the following:

(A) The physician's opinion as to whether the examined employee has any medical conditions which would place the employee at increased risk of material impairment of his or her health from exposure to asbestos fibers, or which would, directly or indirectly, be aggravated by such exposure;

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

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

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(iv) The written opinion shall not reveal specific findings or diagnoses unrelated to occupational exposure to asbestos fibers.

(7) Medical Records. The employer shall keep an accurate medical record for each employee subject to medical surveillance required by paragraph ( ) of this section.

(i) A record shall include:

(A) Physician's written opinion;

(B) Any employee medical complaints related to exposure to asbestos;

(C) A signed statement of any refusal to be examined, in accordance with paragraph ( )(i) this section.

(ii) Each record shall be maintained for at least 40 years, or for the duration of the employee's employment plus 20 years, whichever period is longer.

(8) Access. Access to employee medical records shall be in accordance with the relevant paragraphs of CFR 29, 1910.1001 (j)(6)(iii), effective August 21, 1980, as corrected.

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Appendix A

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

1. Introduction

(i) The employer is responsible 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.

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

(1) provision of audio-visual training material

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

(3) provision of contact 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 physican responsible for the medical surveillance of asbestos-exposed persons.

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APPENDIX B(1) : INITIAL MEDICAL EXAMINATION
PRIVATE AND CONFIDENTIAL

QUESTIONNAIRE – SELF-COMPLETION

Thank you for your willingness to participate; your cooperation is very important to the success of our medical program.

This is a questionnaire you are asked to fill out. Please answer the questions as frankly and accurately as possible. 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.

The questions can be answered by checking the best answer or by filling in a blank with a number or word.

Example: Do you live in the United States 1. Yes ✓
2. No. ____

If you desire help in answering a question, please put a check (✓) in *front* of the question number. You will be helped with these questions at the time of your appointment.

For Office Use

Card 1

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: _____ (28 - 31)

13. Sex: 1. Male ____ (32)
2. Female ____

14. What is your marital status? 1. Single ____ (33)
2. Married ____
3. Widowed ____
4. Separated/Divorced ____

15. Race: 1. White ____ (34)
2. Black ____
3. Oriental ____
4. Other ____

16. What is the highest grade completed in school? _____ (35 - 36)
(*For example*: 12 years is completion of high school).

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For Office use

OCCUPATIONAL HISTORY

17A. Have you ever worked full time (30 hours per week or more) for 6 months or more? 1. Yes ____ 2. No ____ (37)

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 ____ (38)

Specify job/industry _____ Total years worked _____ (39-40)

Was dust exposure: 1. Mild ____ 2. Moderate ____ 3. Severe ____ ? (41)

C. Have you ever been exposed to gas or chemical fumes in your work? 1. Yes ____ 2. No ____ (42)

Specify job/industry _____ Total years worked _____ (43-44)

Was exposure: 1. Mild ____ 2. Moderate ____ 3. Severe ____ ? (45)

D. What has been your usual occupation or job—the one you have worked at the longest? (46-47)

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?	☐	☐	(48)
F. * In a quarry?	☐	☐	(49)
G. * In a foundry?	☐	☐	(50)
H. * In a pottery?	☐	☐	(51)
I. * In a cotton, flax or hemp mill?	☐	☐	(52)
J. * With asbestos?	☐	☐	(53)

18. PAST MEDICAL HISTORY

	YES	NO	
A. Do you consider yourself to be in good health?	☐	☐	(54)
If "NO" state reason. _____			
B. Have you any defect of vision?	☐	☐	(55)
If "YES" state nature of defect. _____			
C. Have you any hearing defect?	☐	☐	(56)
If "YES" state nature of defect. _____			
D. Are you suffering from or have you ever suffered from:			
a. Epilepsy (or fits, seizures, convulsions)?	☐	☐	(58)
b. Rheumatic fever?	☐	☐	(59)
c. Kidney disease?	☐	☐	(60)
d. Bladder disease?	☐	☐	(61)
e. Diabetes?	☐	☐	(62)
f. Jaundice?	☐	☐	(63)

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UCC 005882

For Office Use

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 ____ 8. Don't get colds ____ — (64)

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 ____ — (65)

IF *YES* TO 20A:

B. Did you produce phlegm with any of these chest illnesses? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (66)

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 ____ — (67)

21. Did you have any lung trouble before the age of 16? — 1. Yes ____ 2. No ____ — (68)

22. Have you ever had any of the following?

1A. Attacks of bronchitis? — 1. Yes ____ 2. No ____ — (69)

IF *YES* TO 1A:

B. Was it confirmed by a doctor? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (70)

C. At what age was your first attack? — ____ Age in years 88. Does not apply ____ — (71 - 72)

2A Pneumonia (include bronchopneumonia)? — 1. Yes ____ 2. No ____ — (73)

IF *YES* TO 2A:

B. Was it confirmed by a doctor? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (74)

C. At what age did you first have it? — ____ Age in years 88. Does not apply ____ — (75 - 76)

3A. Hay fever? — 1. Yes ____ 2. No ____ — (77)

IF *YES* TO 3A:

B. Was it confirmed by a doctor? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (78)

C. At what age did it start? — ____ Age in years 88. Does not apply ____ — (79 - 80)

23A. Have you ever had chronic bronchitis? — 1. Yes ____ 2. No ____ — (1) CARD 2.

IF *YES* TO 23A:

B. Do you still have it? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (2)

C. Was it confirmed by a doctor? — 1. Yes ____ 2. No ____ 8. Does not apply ____ — (3)

D. At what age did it start? — ____ Age in years 88. Does not apply ____ — (4 - 5)

UCC 005883

For Office Use
ID Dup 1-5

24A. Have you ever had emphysema? 1. Yes ____ 2. No ____ (6)

IF *YES* TO 24A:

B. Do you still have it? 1. Yes ____ 2. No ____ (7)
8. Does not apply ____

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

D. At what age did it start? ____ Age in years (9 - 10)
88. Does not apply ____

25A. Have you ever had asthma? 1. Yes ____ 2. No ____ (11)

IF *YES* TO 25A:

B. Do you still have it? 1. Yes ____ 2. No ____ (12)
8. Does not apply ____

C. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ (13)
8. Does not apply ____

D. At what age did it start? ____ Age in years (14 - 15)
88. Does not apply ____

E. If you no longer have it, at what age did it stop? ____ Age stopped (16 - 17)
88. Does not apply ____

26. Have you ever had:

A. Any other chest illness? 1. Yes ____ 2. No ____ (18)
If yes, please specify ____

B. Any chest operations? 1. Yes ____ 2. No ____ (19)
If yes, please specify ____

C. Any chest injuries? 1. Yes ____ 2. No ____ (20)
If yes, please specify ____

27A. Has a doctor ever told you that you had heart trouble? 1. Yes ____ 2. No ____ (21)

IF *YES* TO 27A:

B. Have you ever had treatment for heart trouble in the past 10 years? 1. Yes ____ 2. No ____ (22)
8. Does not apply ____

28A. Has a doctor ever told you that you had high blood pressure? 1. Yes ____ 2. No ____ (23)

IF *YES* TO 28A:

B. Have you had any treatment for high blood pressure (hypertension) in the past 10 years? 1. Yes ____ 2. No ____ (24)
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? ____

U2078

UCC 005884

For Office Use
Card 2.

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?	____	____	____	____	____	____	(29) (30)
B. Emphysema?	____	____	____	____	____	____	(31) (32)
C. Asthma?	____	____	____	____	____	____	(33) (34)
D. Lung cancer?	____	____	____	____	____	____	(35) (36)
E. Other chest conditions?	____	____	____	____	____	____	(37) (38)
F. Is parent currently alive?	____	____	____	____	____	____	(39) (40)
G. Please Specify							
____ Age if living				____ Age if living			(41) (42)
____ Age at death				____ Age at death			(43) (44)
8. Don't know ____				8. Don't know ____			
H. Please specify cause of death.							
____				____			(45) (46)

These questions pertain mainly to your chest. Please answer *yes* or *no* if possible. If a question does not appear to be applicable to you, check the *does not apply* space. If you are in doubt about whether your answer is *yes* or *no*, record *no*.

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 ____ (47)

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 ____ (48)

C. Do you usually cough at all on getting up, or first thing in the morning? 1. Yes ____ 2. No ____ (49)

D. Do you usually cough at all during the rest of the day or at night? 1. Yes ____ 2. No ____ (50)

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 ____ (51)
8. Does not apply ____

F. For how many years have you had this cough? ____ Number of years (52-53)
88. Does not apply ____

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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 ____ (54)

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 ____ (55)

C. Do you usually bring up phlegm at all on getting up, or first thing in the morning? — 1. Yes ____ 2. No ____ (56)

D. Do you usually bring up phlegm at all during the rest of the day or at night? — 1. Yes ____ 2. No ____ (57)

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 ____ (58)

F. For how many years have you had trouble with phlegm? ____ Number of years; 88. Does not apply ____ (59 - 60)

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 ____ (61)

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 ____ (62 - 63)

WHEEZING

35A. Does your chest ever sound wheezy or whistling:

1. When you have a cold? — 1. Yes ____ 2. No ____ (64)
2. Occasionally apart from colds? — 1. Yes ____ 2. No ____ (65)
3. Most days or nights? — 1. Yes ____ 2. No ____ (66)

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 ____ (67 - 68)

36A. Have you ever had an attack of wheezing that has made you feel short of breath? — 1. Yes ____ 2. No ____ (69)

IF *YES* TO 36A:

B. How old were you when you had your first such attack? ____ Age in years; 88. Does not apply ____ (70 - 71)

C. Have you had 2 or more such episodes? — 1. Yes ____ 2. No ____ 8. Does not apply ____ (72)

D. Have you ever required medicine or treatment for the(se) attack(s)? — 1. Yes ____ 2. No ____ 8. Does not apply ____ (73)

020580

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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): _____ (74)

38A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ____ 2. No ____ (75)

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 ____ (76)

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 ____ (77)

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 ____ (78)

E. Are you too breathless to leave the house or breathless on dressing or undressing? 1. Yes ____ 2. No ____ 8. Does not apply ____ (79)

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 ____ (1) CARD 3

IF YES TO 39A:

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

C. How old were you when you first started regular cigarette smoking? ____ Age in years 88. Does not apply ____ (3 - 4)

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 ____ (5 - 6)

E. How many cigarettes do you smoke per day now? ____ Cigarettes per day 88. Does not apply ____ (7 - 8)

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 ____ (9 - 10)

G. Do or did you inhale the cigarette smoke? 1. Does not apply ____ 2. Not at all ____ 3. Slightly ____ 4. Moderately ____ 5. Deeply ____ (11)

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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 ____ (12)

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 (13 - 14)

2. If you have stopped smoking a pipe completely, how old were you when you stopped? ____ Age stopped (15 - 16)
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) (17 - 18)
88. Does not apply ____

D. How much pipe tobacco are you smoking now? ____ oz per week. (19 - 20)
88. Not currently smoking a pipe ____

E. Do you or did you inhale the pipe smoke? (21)
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 ____ (22)

IF *YES* TO 41A:

FOR PERSONS WHO HAVE EVER SMOKED CIGARS:

B. 1. How old were you when you started smoking cigars regularly? ____ Age (23 - 24)

2. If you have stopped smoking cigars completely, how old were you when you stopped? ____ Age stopped (25 - 26)
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 (27 - 28)
88. Does not apply ____

D. How many cigars are you smoking per week now? ____ Cigars per week (29 - 30)
88. Check if not smoking cigars currently ____

E. Do or did you inhale the cigar smoke? (31)
1. Never smoked ____
2. Not at all ____
3. Slightly ____
4. Moderately ____
5. Deeply ____

020582

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APPENDIX B

APPENDIX B(2) : PERIODIC MEDICAL EXAMINATION
PRIVATE AND CONFIDENTIAL

QUESTIONNAIRE – SELF-COMPLETION

Thank you for your willingness to participate; your cooperation is very important to the success of our medical program.

This is a questionnaire you are asked to fill out. Please answer the questions as frankly and accurately as possible. 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.*

The questions can be answered by checking the best answer or by filling in a blank with a number or word.

Example: Do you live in the United States 1. Yes ✓
2. No. ____

If you desire help in answering a question, please put a check (✓) in *front* of the question number. You will be helped with these questions at the time of your appointment.

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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Card 1

(28-31)

(33)

C23683

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Card 1

PAST MEDICAL HISTORY

		YES	NO	
18A.	Do you consider yourself to be in good health?	☐	☐	(54)
	If "NO" state reason. _____			
B.	Have you any defect of vision?	☐	☐	(55)
	If "YES" state nature of defect. _____			
C.	Have you any hearing defect?	☐	☐	(56)
	If "YES" state nature of defect. _____			
D.	Are you suffering from or have you ever suffered from:			
	a. Epilepsy (or fits, seizures, convulsions)?	☐	☐	(58)
	b. Rheumatic fever?	☐	☐	(59)
	c. Kidney disease?	☐	☐	(60)
	d. Bladder disease?	☐	☐	(61)
	e. Diabetes?	☐	☐	(62)
	f. Jaundice?	☐	☐	(63)

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 ____ 8. Don't get colds ____ (64)

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 ____ (65)

IF YES TO 20A:

B. Did you produce phlegm with any of these chest illnesses? 1. Yes ____ 2. No ____ 8. Does not apply ____ (66)

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 ____ (67)

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

1A. Attacks of bronchitis? 1. Yes ____ 2. No ____ (69)

IF YES TO 1A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____ (70)

C. At what age was your first attack? ____ Age in years 88. Does not apply ____ (71 - 72)

2A Pneumonia (include bronchopneumonia)? 1. Yes ____ 2. No ____ (73)

IF YES TO 2A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____ (74)

C. At what age did you first have it? ____ Age in years 88. Does not apply ____ (75 - 76)

3A. Hay fever? 1. Yes ____ 2. No ____ (77)

IF YES TO 3A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____ (78)

C. At what age did it start? ____ Age in years 88. Does not apply ____ (79 - 80)

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Card 2

26. Have you had:

A. Any other chest illness? 1. Yes ____ 2. No ____ (18)
If yes, please specify _____

B. Any chest operations? 1. Yes ____ 2. No ____ (19)
If yes, please specify _____

C. Any chest injuries? 1. Yes ____ 2. No ____ (20)
If yes, please specify _____

27A. Has a doctor told you that you had heart trouble? 1. Yes ____ 2. No ____ (21)

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 ____ (22)

28A. Has a doctor told you that you had high blood pressure? 1. Yes ____ 2. No ____ (23)

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 ____ (24)

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	8. DON'T KNOW	1. YES	2. NO	8. DON'T KNOW	
A. Chronic bronchitis?	____	____	____	____	____	____	(29) (30)
B. Emphysema?	____	____	____	____	____	____	(31) (32)
C. Asthma?	____	____	____	____	____	____	(33) (34)
D. Lung cancer?	____	____	____	____	____	____	(35) (36)
E. Other chest conditions?	____	____	____	____	____	____	(37) (38)
F. Is parent currently alive?	____	____	____	____	____	____	(39) (40)
G. Please Specify	____ Age if living ____ Age at death 8. Don't know ____			____ Age if living ____ Age at death 8. Don't know ____			(41) (42) (43) (44)
H. Please specify cause of death.	_____			_____			(45) (46)

02085

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These questions pertain mainly to your chest. Please answer *yes* or *no* if possible. If a question does not appear to be applicable to you, check the *does not apply* space. If you are in doubt about whether your answer is *yes* or *no*, record *no*.

For Office Use

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 ____ (47)

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 ____ (48)

C. Do you usually cough at all on getting up, or first thing in the morning? 1. Yes ____ 2. No ____ (49)

D. Do you usually cough at all during the rest of the day or at night? 1. Yes ____ 2. No ____ (50)

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 ____ (51)

F. For how many years have you had this cough? ____ Number of years 88. Does not apply ____ (52 - 53)

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 ____ (54)

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 ____ (55)

C. Do you usually bring up phlegm at all on getting up, or first thing in the morning? 1. Yes ____ 2. No ____ (56)

D. Do you usually bring up phlegm at all during the rest of the day or at night? 1. Yes ____ 2. No ____ (57)

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 ____ (58)

F. For how many years have you had trouble with phlegm? ____ Number of years 88. Does not apply ____ (59 - 60)

U20356

UCC 005892

For Office Use

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 ____ (61)

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 ____ (62 - 63)

WHEEZING

35A. Does your chest ever sound wheezy or whistling:

1. When you have a cold? 1. Yes ____ 2. No ____ (64)
2. Occasionally apart from colds? 1. Yes ____ 2. No ____ (65)
3. Most days or nights? 1. Yes ____ 2. No ____ (66)

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

B. For how many years has this been present?
____ Numbers of years
88. Does not apply ____ (67 - 68)

36A. Have you ever had an attack of wheezing that has made you feel short of breath?
1. Yes ____ 2. No ____ (69)

IF *YES* TO 36A:

B. How old were you when you had your first such attack?
____ Age in years
88. Does not apply ____ (70 - 71)

C. Have you had 2 or more such episodes?
1. Yes ____ 2. No ____
8. Does not apply ____ (72)

D. Have you ever required medicine or treatment for the(se) attack(s)?
1. Yes ____ 2. No ____
8. Does not apply ____ (73)

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 ____ (74) (75)

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 ____ (76)

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 ____ (77)

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 ____ (78)

E. Are you too breathless to leave the house or breathless on dressing or undressing?
1. Yes ____ 2. No ____
8. Does not apply ____ (79)

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CARD 3

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 ____ — (1)

IF *YES* TO 39A:

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

C. *How old were you when you first started* regular cigarette smoking? — ____ Age in years 88. Does not apply ____ — (3 - 4)

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 ____ — (5 - 6)

E. How many cigarettes do you smoke per day now? — ____ Cigarettes per day 88. Does not apply ____ — (7 - 8)

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 ____ — (9 - 10)

G. Do or did you inhale the cigarette smoke? — 1. Does not apply ____ 2. Not at all ____ 3. Slightly ____ 4. Moderately ____ 5. Deeply ____ — (11)

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

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 — (13 - 14)

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 ____ — (15 - 16)

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 ____ — (17 - 18)

D. How much pipe tobacco are you smoking now? — ____ oz per week. 88. Not currently smoking a pipe ____ — (19 - 20)

E. Do you or did you inhale the pipe smoke? — 1. Never smoked ____ 2. Not at all ____ 3. Slightly ____ 4. Moderately ____ 5. Deeply ____ — (21)

022388

UCC 005894

For Office Use

41A. Have you ever smoked cigars regularly? (*Yes* means more than 1 cigar a week for a year.) 1. Yes ____ 2. No ____ (22) CARD 3

IF *YES* TO 41A:

FOR PERSONS WHO HAVE EVER SMOKED CIGARS:

B. 1. How old were you when you started smoking cigars regularly? ____ Age (23 - 24)

2. If you have stopped smoking cigars completely, how old were you when you stopped? ____ Age stopped (25 - 26)
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 (27 - 28)
88. Does not apply ____

D. How many cigars are you smoking per week now? ____ Cigars per week (29 - 30)
88. Check if not smoking cigars currently ____

E. Do or did you inhale the cigar smoke? (31)
1. Never smoked ____
2. Not at all ____
3. Slightly ____
4. Moderately ____
5. Deeply ____

02283

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MEDICAL SURVEILLANCE OF PERSONS EXPOSED TO ASBESTOS: PERIODICITY

TYPE OF PROCEDURE	PRE-EMPLOYMENT OR PRE-ASSIGNMENT	PERIODIC AGE			PERIODIC EXPOSURE			TERMINATION	POST-EMPLOYMENT RETIREES BY MAIL ONLY	OTHERS
		35	35-45	45	5	5-10	10			
		A	A	A	A	A	A			
		N	N	N	N	N	N			
		N	N	N	N	N	N			
		U	U	U	U	U	U			
		A	A	A	A	A	A			
		L	L	L	L	L	L			
Medical History (Respiratory Symptoms Questionnaire	Obligatory							Obligatory as in Preplacement Examination	Annual 1) Reminder to continue with medical checks. 2) Questionnaire	Advisory Letter at Termination Continue Medical Check
Physical Examination	Obligatory To include examination of Respiratory System and Digestive System	Every 5 Years	Every 2 Years	A N N U A L	Every 5 Years	Every 2 Years	A N N U A L	Obligatory as in Preplacement Examination	Voluntary By Own Physician	•
Chest Radiology (PA view 14" x 17")	Obligatory (Not required if recent film available, i.e., within preceding 12 months)	Every 5 Years	Every 2 Years	A N N U A L	Every 5 Years	Every 2 Years	A N N U A L	Obligatory as in Preplacement Examination	Voluntary By Own Physician	•
Pulmonary Function (FVV_1, FVC, FEV_1/FVC %)	Obligatory	Every 5 Years	Every 2 Years	A N N U A L	Every 5 Years	Every 2 Years	A N N U A L	Obligatory as in Preplacement Examination	Voluntary By Own Physician	•
Other e.g., Sputum Cytology	Voluntary	N/A	N/A	A N N U A L	N/A	N/A	A N N U A L	Voluntary	Voluntary	•

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Appendix C

Appendix C (1)

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

(a) Every plan for chest roentgenographic examinations of persons exposed to asbestos shall be submitted for approval by the Assistant Secretary of Labor or designated representative within 120 calendar days after (insert the effective date of these regulations).

(b) The name, address and telephone numbers of the employer(s) submitting the plan shall be provided to the Assistant Secretary of Labor or designated representative.

(c) The name, address and telephone numbers of the physician who will interpret and classify the roentgenograms shall be provided to the Assistant Secretary of Labor or the Secretary's designated representative.

(d) Every chest roentgenogram shall be a single posteroanterior projection at full inspiration on a 14- by 17-inch film. The film and cassette shall 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 shall include both apices with minimum loss of the costophrenic angle.

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

(f) Roentgenograms shall 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 shall 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, shall have a minimum rating of 200 mA at 100 kVp,; (2) generators of units acquired subsequent to that date shall have a minimum rating of 300 mA at 125 kVp.

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

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

(i) Capacitor discharge and field emission units may be used if the model of such units is approved by OSHA for quality, performance, and safety. OSHA will consider such units for approval when listed by a facility seeking approval.

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(j) Roentgenograms shall be given only with equipment having a beam-limiting device which does not cause large unexposed boundaries. The beam limiting device shall provide rectangular collimation and shall 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 shall be discernible from an examination of the roentgenogram.

(k) to insure high quality chest roentgenograms:

(1) The maximum exposure time shall 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 or focal spot to film distance shall be at least 6 feet;

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

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

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(5) Intensifying screens shall 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 shall 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 shall 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 shall be established at each facility.

(l) Radiographic processing:

(1) Either automatic or manual film processing is acceptable. A constant time-temperature technique shall 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 shall be used.

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(m) Before the employee is advised that the examination is concluded, the roentgenogram shall 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 technologist. In a case of a substandard roentgenogram, another shall be immediately made. All substandard roentgenograms shall be clearly marked as rejected and promptly sent for disposal.

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

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

(p) Each roentgenogram made hereunder shall 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 C

Appendix C(2)

SPECIFICATIONS FOR INTERPRETATION,

CLASSIFICATION, AND SUBMISSION OF

CHEST ROENTGENOGRAMS

Interpreting and classifying chest roentgenograms.

(a) Chest roentgenograms shall be interpreted and classified in accordance with the ILO-U/C classification system and recorded on a Roentgenographic Interpretation Form (Form CSD/NIOSH (M) 2.8).

(b) Roentgenograms shall be interpreted and classified only by a physician who regularly reads chest roentgenograms and who has demonstrated proficiency in the use of the ILO-U/C classification system.

(c) All interpreters, whenever interpreting chest roentgenograms made under the act, shall have immediately available for reference a complete set of the ILO-U/C International Classification of Radiographs for Pneumoconioses, 1980.

(d) Proficiency in evaluating chest roentgenograms for roentgenographic quality and in the use of the ILO-U/C classification for interpreting

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chest roentgenograms for pneumoconiosis and other diseases shall be demonstrated by those physicians who desire to be "B" readers by taking and passing a specially designed proficiency examination given on behalf of or by NIOSH at a time and place specified by NIOSH. Each physician must bring a complete set of the ILO-U/C standard reference radiographs when taking the examination.

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Appendix D

Appendix D - Pulmonary Function

Standards for Asbestos Standard

The spirometric measurements of pulmonary function shall 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 shall 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 shall have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less than 1.5 cm H_2O/(liter/sec).

(d) The zero time point for the purpose of timing the FEV_1 shall 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.

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(e) Instruments incorporating measurements of airflow to determine volume shall 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 must 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 shall provide a tracing or display of either flow versus volume 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 must be stored and available for recall and must be of sufficient size that hand meaurements may be made within requirement of paragraph (a) of this secrion. If a paper record is made it must have a paper speed of at least 2 cm/sec and a volume senesitivity of at least 10.0 mm of chart per liter of volume.

(h) The instrument shall be capable of accumulating for a minimum of 10 seconds and shall 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.

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(i) The forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) measurements shall comply with the accurance 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 must 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 shall be explained in simple terms to the patient who shall 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 shall be instructed to make

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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 shall be carried out. During the maneuvers, the patient shall be observed for compliance with instructions. The expirations shall be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts shall 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,

4. has coughed or closed his glottis,

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

6. has an unsatisfactory start of expiration, one characterized by excessive hesitation (or flase starts), and therefore not allowing

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back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less than 10 percent of the FVC),

7. has an excessive variability between 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 prformed using a syringe or other volume source of at least 2 liters.

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 ($FEV_{1.0}$) shall be measured and recorded. The largest observed FVC and largest observed FEV_1 shall be used in the analysis regardless of the curve(s) on which they occur.

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(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 $FEV_{1.0}$ and FVC below 75% of the predicted values, or reductions in both measured values of 5 percent or greater from their initial screening exam, should be re-evaluated within a period of one month. Those who show consistent decrease in lung function, as compared to the predicted values in Tables 2-5, should be assessed by the physician and a recommendation given with regard to suitability of the employee to continue in an occupation where the potential exists for exposure to airborne concentrations of asbestos fibers in excess of the prescribed action level.

IV. QUALIFICATIONS OF PERSONNEL ADMINISTERING THE TEST

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 should cover the following areas. Persons who successfully complete the course will be certified by OSHA or their designee.

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

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