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INTERIM PROCEDURES AND PRACTICES FOR ASBESTOS ABATEMENT PROJECTS

by

Asbestos Programs Group
Environmental, Health, and Safety Division
Economic Development Laboratory
Georgia Tech Research Institute
Atlanta, Georgia 30332

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EPA Project Officer: Stephen Schanamann

Office of Pesticides and Toxic Substances
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

PREFACE

This manual was developed to provide guidance for those who are about to undertake an asbestos abatement project. The procedures and practices detailed in these pages incorporated current technology at the time of publishing. The reader should be reminded that as technology evolves, so do the methods for conducting asbestos abatement. For this reason, the word "interim" was added to the title, emphasizing the need for the reader to obtain the most up-to-date information available.

Many of the recommended procedures discussed in this document go beyond the minimum requirements of the various regulations which have been promulgated by OSHA and EPA. Accordingly, many of the recommended practices are not mandatory requirements. Texts of the OSHA asbestos regulation (29 CFR 1910.1001) and EPA's National Emission Standards for Hazardous Air Pollutants (40 CFR 61, subpart M) are included in this manual as Appendices A and B, respectively. The reader should refer to these regulations to determine federal requirements for asbestos abatement projects. The reader should also be aware that often there exist additional procedures which may be substituted for those discussed here. Further, the practices recommended may not be appropriate for every project.

This manual was prepared by professionals in the field of asbestos abatement and control. Throughout its preparation and upon completion, the manuscript was subjected to peer review in government, academic and industry circles.

The technical expertise and common sense provided by the contractor are major components of a successful abatement project. We encourage the reader to improve further upon the techniques provided in this manual as he gains additional knowledge through field practice. This will ensure that the abatement industry continues to evolve to improve asbestos abatement work practices.

ACKNOWLEDGEMENTS

It would not be possible to acknowledge all the individuals from their respective disciplines who made this publication possible. We are extremely grateful to those people involved in asbestos abatement who generously shared their knowledge, expertise, and experience with the staff of the Georgia Tech Research Institute.

Individually, we would like to express our gratitude to Mr. Stephen Schanamann of the EPA's Asbestos Action Program. Through his efforts as Project Officer, this manual was developed at an accelerated pace while maintaining consistent quality through the peer review process. The recognition for development of the manual must go to the Asbestos Programs Group of Georgia Tech's Environmental, Health, and Safety Division. Special thanks to Eva Clay, Mark Demyanek, William Spain, and Bill Ewing for their efforts in preparing this document. We wish also to thank Mike Lowish for development of the chapter concerning safety and health considerations, other than asbestos; and Laurie Baker for her efforts in preparation of the glossary. We are greatly indebted to Mr. Alfred B. Adams, III of the law firm Greene, Buckley, DeRieux and Jones for writing the section on legal and insurance considerations. We also wish to thank Ms. Susan Vogt, Director of the Asbestos Action Program, USEPA, for her participation and support of this project.

Due to the need to quickly release this document, it became necessary to have two peer review groups. The working peer review group is acknowledged for their unselfish devotion of time to this project. As each section was written, they were asked (usually with only a week) to provide their expertise and assistance through thoughtful study of the material. This group included the following individuals to whom we are grateful.

Joseph Breen, Chief, Field Studies Branch, Exposure Evaluation Division, Office of Toxic Substances, USEPA

Elizabeth Dutrow, Field Studies Branch, Exposure Evaluation Division, USEPA

Paul Heffernan, Asbestos Coordinator, USEPA, Region I

James Littell, Asbestos Coordinator, USEPA, Region IV

David Mayer, Chief, Asbestos Technical Assistance Staff, Asbestos Action Program, USEPA

Stephen Schanamann, Project Officer, Asbestos Action Program, USEPA

Joseph Schirmer, Division of Epidemiology, New Jersey Department of Health

We wish to also acknowledge the efforts of the final peer review group who were given only two weeks to complete their task. Special recognition goes to those individuals with the National Institute for Occupational Safety and Health (NIOSH) whose efforts greatly improved the final document. The final peer review group included the following individuals.

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Kenneth M. Wallingford, Division of Surveillance, Hazard Evaluation and Field Studies, NIOSH

Ralph Zumwalde, Division of Standards Development and Technology Transfer, NIOSH

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Objective: Provide a brief discussion of the topics that will be covered and how these topics are integral components of an asbestos abatement project; acquaint participants with the types of questions on the post-course exam.

Learning Tasks: Information in this section should enable participants to:

☞ Become familiar with the contents of the notebook

☞ Learn what topics will be covered and in what sequence

☞ Become aware of the various facets of an asbestos abatement project

☞ Be introduced to a multidisciplinary approach to asbestos abatement

☞ Perform a self-evaluation of their knowledge concerning the subject via a pre-course quiz

☞ Become familiar with the format and contents of the post-course exam

This overview and the accompanying flow diagram (The Asbestos Abatement Flowchart) demonstrate how different parts of the course fit together. And, since contractors are often consulted as asbestos specialists, it will also assist them in addressing the asbestos abatement issue with the scientific community and general public.

The public is often confused about the source of asbestos. It is a mineral rock mined from the earth in much the same ways as other minerals, such as iron, lead, and copper. However, instead of crushing up into dust particles, it divides into millions of fine fibers. These fibers come in three common varieties: chrysotile, amosite, and crocidolite. All three varieties exhibit substantial resistance to heat and chemicals, and thus have been used for a variety of commercial and industrial purposes. In fact, asbestos has been used in more than 3,000 products.

The asbestos industry started during the 1870s when the first commercial chrysotile mine opened in Quebec, Canada. The crocidolite variety was first mined in South Africa during the 1890s. Amosite also comes from Africa, but its mining did not begin until 1916.

Asbestos was used some as insulation during the period 1870-1900, but its use became more common on steam pipes and boilers of ships after 1900. Until the early 1940s, most asbestos-containing insulations in the United States contained chrysotile from Canada. The 1940s marked significant changes in the American use of asbestos. Amosite became widely used in American ships and ship yards during WWII.

The use of asbestos then started expanding to include acoustical and decorative purposes, especially in buildings. After WWII ended and military demand for asbestos declined, sprayed asbestos fireproofing materials were used extensively in buildings. Estimates indicate that more than half of the large multi-story buildings constructed during the 1950-1970 period contain some form of sprayed asbestos-containing materials. These uses will be discussed and shown in the next section covering "Background Information to Asbestos Abatement." Asbestos use in the United States didn't start to decline until the 1973-1978 EPA bans on spray-applied materials, and the building recession which happened during that same period.

Diseases and deaths associated with exposure to asbestos fibers are the principle factors behind "the Asbestos Problem." The three major respiratory diseases associated with asbestos are asbestosis, lung cancer, and mesothelioma. Their medical nature are discussed in much greater detail in the section, "Health Effects of Asbestos Exposure."

While the documented health effects from exposure to asbestos are no doubt the underlying cause of the asbestos problem, the legal problems which followed and even now continue are contributing factors. Legal actions affect all parties involved in asbestos abatement in several ways and are addressed in the section, "Legal and Insurance Considerations."

During the early 1970s, the federal government attempted to respond to these health and legal problems by issuing regulations and guidelines to provide some controls for industrial exposures to asbestos fibers. Then during the late 70s and early 80s, they added guidelines and requirements to cover building occupants, especially schools. These actions, combined with the health and legal issues, prompted the need for asbestos abatement policies.

However, before an asbestos problem in a building can be controlled, it must be evaluated and a variety of decisions must be made. Those evaluating and deciding techniques are not the focus of this course, but since they can affect all involved parties, they will be reviewed during the next section of this manual.

If an asbestos problem exists, the evaluation and deciding techniques will almost always result in "Contract Specifications" for an abatement or control project. Those specifications will be discussed in a section devoted to that subject.

Once the specifications are issued and a contractor is selected to do the work, a variety of simultaneous and sequential considerations, techniques, and job phases are necessary to complete the abatement project.

These considerations, techniques, and phases are the main contents of this course. In addition to those sections already mentioned, notebook modules are included on the following topics:

o Pre-Work Activities/Considerations

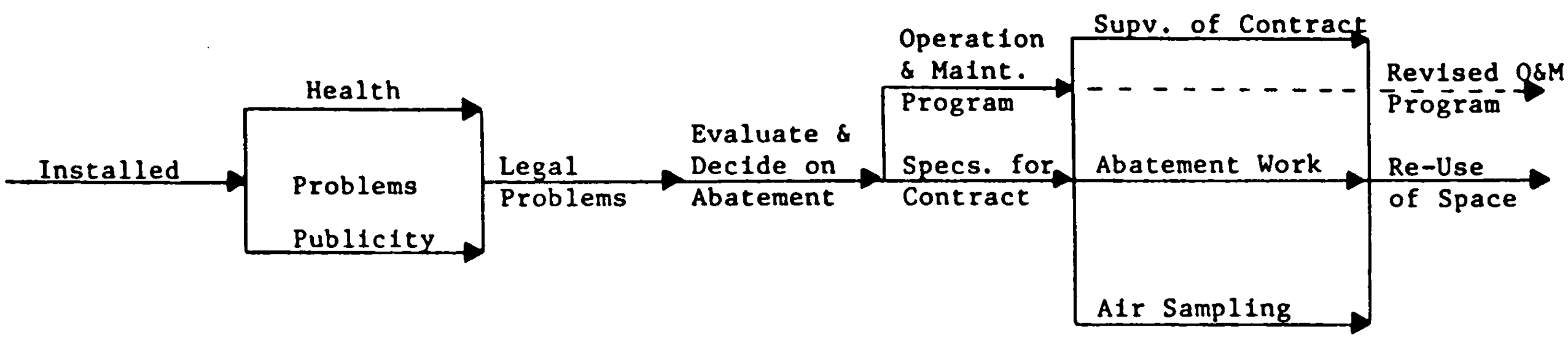
- Establishing a Medical Surveillance Program
- Protecting the Worker -- Respiratory Program/Protective Clothing
- Establishing an Air-Supplied Respirator System
- Preparing the Work Area and Establishing the Decontamination Unit
- Confining and Minimizing Airborne Fibers
- Other Safety and Health Requirements
- Air Sampling Requirements During and After the Project
- Cleaning Up the Work Area
- Waste Disposal Requirements
- Post-Removal Encapsulation and Sprayback Procedures

- o Glovebag Techniques for Removal of Pipe Insulation; and

- o New Developments in Asbestos Abatement

The accompanying pre-course quiz illustrates the type of questions which are included in the 100 question post-course exam. However, most participants find the post-course exam to be slightly more complex and difficult than the quiz. The quiz questions and answers will be discussed during a self-grading session.

ASBESTOS ABATEMENT FLOWCHART



INVOLVED PARTIES

Building Owner
Asbestos Coordinator
Architect/Engineer
Public
Legal Counsel
Medical Authority
Analytical Laboratory
Contractor
Industrial Hygienist
Government (EPA, OSHA, etc.)

CONSIDERATIONS

Safety & Health
Legal
Employee Relations
Publicity
Architectual
Engineering
Governmental
Analytical

PRE-COURSE QUIZ

INSTRUCTIONS - Circle the one answer which is <u>most</u> correct.

1. "Friable asbestos material" means any material that contains more than one percent asbestos by weight and that:

   a. Can be crumbled, pulverized, or reduced to powder, when dry, by hand pressure.
   b. Cannot release fibers into the air.
   c. Withstands a temperature of 2000°F for four hours without burning.
   d. Cannot be burned at any temperature in a normal atmosphere.

2. If the plastic which seals off the work area gets a rip in it, what should be done?

   a. Seal it at the end of the shift
   b. Stop work in area and seal with tape
   c. Prop a piece of plywood over it
   d. Stick a disposable suit in it

3. Whose ultimate legal responsibility is it to make sure that the contractor's employees are properly protected from work hazards?

   a. OSHA's
   b. The contractor's
   c. EPA's
   d. State Board of Worker's Compensation

4. Wetting agents are used in the water sprayed onto asbestos materials (to be removed) in order to:

   a. Wet the materials/asbestos more effectively
   b. Make the room cooler
   c. Make the water flow thru the sprayer better
   d. Cause the material to release and break up better

5. Which of the following factors are important for protecting the workers while they perform asbestos removal work?

   a. Hang plastic and notify OSHA
   b. Wet the material and require protective equipment
   c. Post signs and wait 24 hours before starting
   d. Remove the material dry and complete the work quickly

6. The purpose of an airlock at the perimeter of an asbestos abatement area is to:

   a. Keep air out of the work area
   b. Keep asbestos fibers in the work area
   c. Keep humidity in the work area
   d. Keep strangers out of the work area

7. Protection factors are one measure of a respirator's effectiveness. Which protection factor is incorrect for the type of respirator?

   a. Type C airline = 1000
   b. Half mask filter = 100
   c. Disposable = 5
   d. Powered air purifying = 1000

8. If an employee averages breathing 10 liters (10,000 cubic centimeters) of air per minute and the air contains 0.1 f/cc (fiber per cubic centimeter), how may fibers will the employee breath during 8 hours?

   a. 1,000
   b. 4,800
   c. 48,000
   d. 480,000

9. The person in the drawing is most likely:

   a. Checking his respirator's protection factor
   b. Showing his finger nails to an inspector
   c. Checking the fit of his respirator
   d. Giving a hand signal to a co-worker

10. The person in the drawing is wearing what type of respirator?

    a. Disposable/Air Purifying
    b. Full Face/Type C
    c. Half Mask/Air Purifying
    d. Half Mask/Air Supplied

BACKGROUND INFORMATION CONCERNING

ASBESTOS ABATEMENT

Objective: To understand some of the activities and decisions that precede an asbestos abatement project. This includes the building survey, hazard assessment, and interim control procedures.

Learning Tasks: Material presented in this section should enable participants to:

- ☞ Recognize what various types of asbestos-containing materials look like in buildings.
- ☞ Gain a brief understanding of the procedures involved when a building survey is conducted to obtain an inventory of possible asbestos-containing materials.
- ☞ Understand the criteria used by the building surveyor to conduct a hazard assessment.
- ☞ Recognize the many factors that are included in the decision-making process prior to asbestos abatement.
- ☞ Gain an overview of the many elements that are included in an operations and maintenance program.

HEALTH EFFECTS ASSOCIATED WITH ASBESTOS EXPOSURE

Objective: To provide an overview of the mechanisms of exposure and diseases associated with inhalation of asbestos fibers.

Learning Tasks: Information in this section should enable participants to:

- ☞ Gain a brief understanding of the routes-of-entry into the body for asbestos fibers

- ☞ Recognize the major diseases associated with asbestos exposure

- ☞ Understand the concept of latency period, or the length of time following exposure to asbestos before onset of disease may occur

- ☞ Understand the relationship between smoking and asbestos exposure, and the increased risk of disease

HEALTH EFFECTS ASSOCIATED WITH ASBESTOS EXPOSURE

The adverse health effects associated with asbestos exposure have been extensively studied for many years. Results of these studies and epidemiologic investigations have demonstrated that inhalation of asbestos fibers may lead to increased risk of developing one or more diseases. Exactly why some people develop these diseases and others do not remains unclear. In this discussion, each of the major diseases associated with asbestos will be examined, along with the risk and how that risk can be minimized.

It is important to recognize that the majority of people who have developed a disease as a result of asbestos exposure were asbestos workers. These workers were frequently exposed to high concentrations of asbestos fibers each working day with little or no protection. The asbestos abatement worker of today follows specific work practices and wears appropriate protection, including respirators, to minimize the risk of exposure. EPA has designed this course to help prevent future disease as a result of exposure to asbestos fibers during abatement.

THE RESPIRATORY SYSTEM

The primary diseases associated with asbestos are due to inhalation of asbestos fibers. A brief discussion of the respiratory system will help in understanding these effects. As air is breathed into the body, it passes through the mouth and nose into the windpipe or trachea. The trachea splits into two smaller airways called the bronchi. Each bronchus divides into smaller and smaller tubes which terminate into air sacs called alveoli. In these air sacs, oxygen is absorbed into small blood vessels and waste gases such as carbon dioxide pass out of the blood.

The lung itself is divided into two halves and sits in the pleural cavity. This cavity and the outside of the lung itself have a Saran-wrap type lining. The pleural cavity and lung linings are in contact with each other and are very moist. Just like two panes of glass with a drop of water between them, these linings slide easily across each other, but are very difficult to pull apart. Accordingly, as the chest cavity expands, the lungs expand and air rushes in. If these linings (mesothelia) were to become damaged, inhalation could not occur properly.

The body has several mechanisms by which it "filters" the air it breathes. First, very large particles are removed in the nose and mouth. Many smaller particles impact on the mucous-coated walls of the airways and are caught. These airways have a hair-like lining (ciliated cells) which constantly beats upward. Accordingly, particles caught in the mucous are swept up into the back of the mouth. From here they are swallowed or expelled by coughing. Cigarette smoking temporarily paralyzes these ciliated cells, inhibiting one of the body's natural defenses against unwanted dust. As the smoker sleeps, the hair-like cells start working again and carry large amounts of mucous into the back of the mouth. This causes the so-called "smoker's hack" in the morning. After the first cigarette or two, the cleansing mechanism is paralyzed again and the coughing stops. It should now be evident why cigarette smokers who are exposed to asbestos appear to be at greater risk. Other reasons will also be discussed later in this section.

Even with the above-mentioned natural defenses of the body, some dust particles inevitably reach the tiny air sacs. When this occurs, large cells (called macrophages) attempt to engulf the particle and "digest" it. For this reason, they are sometimes called the lung's garbage collectors. However, because asbestos is a mineral fiber, the macrophages are often not successful. If the cells cannot digest the fibers, they call in a secondary defense mechanism. They deposit a coating on the fibers causing scar tissue to be formed, and a condition develops known as asbestosis.

ASBESTOSIS

Asbestosis is a disease characterized by fibrotic scarring of the lung. It is a restrictive lung disease which reduces the capacity of the lung. The common symptom is shortness of breath. Asbestosis is prevalent among workers who have been exposed to large doses of asbestos fibers over a long period of time. Accordingly, there is a clear dose-response relationship between asbestos exposure and development of this disease. This means that the greater the asbestos exposure, the more likely asbestosis will develop. All forms of asbestos have demonstrated the ability to cause asbestosis. Like all diseases associated with asbestos exposure, it may take many years for the disease to develop. The typical latency period for asbestosis is 15-30 years. An asbestos abatement worker using work practices and protective equipment described in this manual will have a much smaller likelihood of developing asbestosis as a result of his or her work.

LUNG CANCER

There are many causes of lung cancer, of which asbestos is only one. While employees exposed to industrial concentrations of asbestos in years past have a five times greater risk of getting lung cancer, the risk is not as great as the cigarette smoker who has a ten times greater risk. Even more important, these two factors operate together to produce the greatest risk of all. A cigarette smoker who also works with asbestos is more than 50 times more likely to contract lung cancer than a non-smoking non-asbestos worker.

Like asbestosis, there exists a long lag time between initial exposure and the occurrence of lung cancer, typically 20-30 years. There appears to be some relationship between asbestos exposure and lung cancer, although no "safe level" has yet been determined. Again, these figures relate to past industrial situations where workers wore little or no protective equipment. Proper protection and work practices will substantially lessen the risk of abatement workers getting lung cancer due to asbestos.

MESOTHELIOMA

The asbestos-associated disease of greatest concern in asbestos abatement is probably mesothelioma. Fortunately, it is also the rarest. Mesothelioma is a cancer of the chest cavity lining (mesothelium) and can also occur in the lining of the abdominal cavity. Although exposure to asbestos has been strongly associated with most cases of mesothelioma, some cases may occur without asbestos exposure. If mesothelioma occurs in the chest cavity, it is called pleural mesothelioma. In the abdominal cavity, it is known as peritoneal mesothelioma. This type of cancer spreads very rapidly and is always fatal. The exact cause remains unknown. There does not appear to be any increased risk of mesothelioma for smokers and there does not appear to be a dose-related relationship between the amount of asbestos exposure and mesothelioma. Cases have been recorded where the person's asbestos exposure had been extremely limited. Like the other diseases of asbestos, mesothelioma takes 30-40 years after initial exposure, if it occurs.

OTHER DISEASES

Several other diseases are found more often among persons exposed to asbestos than the normal population. These include cancer of the esophagus, stomach, colon, and pancreas, pleural plaques, pleural thickening, and pleural effusion. The incidence of these health effects is much less than lung cancer. Again, the importance of using the proper work practices and protective equipment cannot be overemphasized to minimize the occurrence of these diseases due to unnecessary asbestos exposure.

LEGAL AND INSURANCE CONSIDERATIONS

Objective: To provide a brief awareness of the legal and insurance issues affecting asbestos abatement contracting.

Learning Tasks: Information in this section should enable participants to:

- ☞ Grasp an overview of common and statutory law, including tort litigation and regulatory compliance.
- ☞ Discover the value of recordkeeping and documentation.
- ☞ Learn the "State-of-the-art obligation."
- ☞ Appreciate asbestos abatement contract specifications and documents.
- ☞ Discern bonding, workers' compensation, and insurance requirements.
- ☞ Avoid legal pitfalls on asbestos abatement projects.

LEGAL PROBLEMS IN ASBESTOS ABATEMENT[1]

The owner or manager of a building facing the presence of asbestos has many problems. A major area of concern for building owners is the legal implications of asbestos present in buildings. In general, the problems can be divided into two areas. One broad area is the law of torts or legal wrongs. This could include the possibility of an owner being sued for failure to properly abate or contain asbestos. It could also include a cost recovery action by an owner who has or will perform an abatement program. The second broad area of concern to owners is the area of contracts as related to asbestos abatement programs. This is the area of emphasis in these remarks.

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[1]The remarks contained in this paper are, by nature, general and do not attempt to specifically explore the law of any state. Moreover, these remarks are not intended to constitute a specific legal opinion on any asbestos abatement project. The sole purpose of these remarks is for the general guidance of those involved in asbestos abatement work. Specific legal advice on any matter should be obtain from competent legal counsel.

TYPES OF CONTRACTS

Once a building owner has decided to engage in an asbestos abatement program, the owner is faced with many practical questions. The first of these relates to contract documents. A typical contract used for this type of work is the American Institute of Architects (A.I.A.) form contract. This will frequently consist of A.I.A. Form 101 ("Owner-Contractor Agreement Form -- Stipulated Sum"), a four-page document which typically contains the name of contracting parties, the contract amount, the start and completion date and other general data. Accompaying the A.I.A. Form 101 is the A.I.A. Form 201. This is a 19-page document which contains much of the "boiler plate" language. A.I.A. 201 has been around for many years. Its clauses have been frequently litigated and lawyers and building owners are familiar with the normal interpretation placed on the language in A.I.A. 201. This provides for a degree of certainty which is desirable. Of course, disputes do arise under these clauses. However, it is much easier for counsel and a building owner and a contractor to resolve differences in this known area than in the unknown areas of a job specification on an asbestos abatement contract.

The third document that will typically be included in an asbestos abatement contract is the job manual or job specifications. Whether the job is private and an A.I.A. contract is used or whether the job is public and an A.I.A. contract is used or whether the job is public, and for example, the General and Special Conditions, a two-inch thick book of standard specifications on a Federal project is used, any asbestos abatement project requires a set of job specifications. The fact that these job specifications have not been through the courts and have not been subject to the interpretations placed on the standard specifications in A.I.A. forms and other standard forms like the Federal forms makes architects and engineers cautious in their interpretations of asbestos abatement specifications -- and it should. Frequently, architects and engineers give very strict interpretations to these clauses and are much less permissive than in interpretation of other clauses involving less hazardous activities.

CONTRACT SPECIFICATIONS

One of the primary important areas in the specifications is the work description. Typically, if a whole building is involved, the work description may be no problem. However, if a contractor is being asked to remove only a segment of a floor of a building, or the like, a serious abatement problem may exist. When the plastic barrier is removed, will the "clean air" obtained still be clean? Another problem is illustrated by the job where the contractor was asked to remove friable material from beams over a dirt basement in a commercial building. Specifications did not call for barrier protection for the dirt. The contractor, fully in compliance with the specifications, removed the asbestos and contaminated the dirt. The result was that a second abatement effort was required for the removal of several inches of dirt in the basement. This cost, quite unnecessary, was the result of inadequately prepared specifications. Of course, drawings are of a great assistance in properly defining job boundaries and the specifications.

Another issue that frequently arises if that of furniture, fixtures, and equipment. Most asbestos abatement projects require the removal and then reinstallation of furniture, fixtures, and equipment. The owner should make a realistic assessment of whether salvage of fixtures is feasible. The age and condition of the equipment must be assessed. It will only promote contractual disputes for the owner to insist that a contractor remove and reinstall fixtures which will be damaged or destroyed by that very process. The owner should not expect to engage in a "backdoor" renovation of his building, at the contractor's expense, by placing specification requirements on the contractor which are unattainable. From a contractor's point of view, a pre-abatement job inspection is vital to determine whether or not the specifications are realistic.

SITE SECURITY

Site security is another issue that should be specifically addressed. In certain settings, such as a school or hospital, an insecure job site can have grave legal implications. Of course, any construction site can be dangerous, but an unmonitored asbestos abatement site may be an "attractive nuisance" for children or mentally disabled hospital patients or others. The issue of whether security must be maintained on a 24-hour basis is also one which must be addressed. Again, this is an area where more attention must be given if only one area of a building is being abated while other areas are occupied. If an entire building can be isolated, security is a much easier process. Certainly the regulatory warning signs required by EPA are important. However, these should be viewed as a minimum warning and further warnings or security are frequently necessary.

Each owner must participate, if only through his architect or engineer representative, in equipment requirement decisions on an asbestos abatement project. The decision about whether to require negative air pressure units, what type of respiratory protection equipment is required, what type of clothing is sufficient, what numbers of HEPA units are required and other similar equipment requirements are very important to the success and safety of the job. From a legal standpoint, it can be effectively argued that "state of the art" equipment should be employed. OSHA requirements again should be viewed as minimal requirements. If one is not going to employ "state of the art" technology, that decision must be justified. There may be instances when Type "C" respiratory protection is not required, such as during glovebag projects. The counterbalancing danger of employee accidents from the hoses on scaffolding might possibly outweigh the necessity for an air-supplied respirator. The owner and his representative must be prepared to justify such decisions. Of course, if the decision to employ less than maximum protection is justified, cost is a reasonable factor to be considered.

INSURANCE

A major issue for asbestos abatement contractors is insurance. At present, there is talk of a "crisis" and some contractors have not been able to obtain liability insurance. From the owner's or contractor's perspective, it is first important to understand what the insurance requirements may be. The first issue is who must be protected. Generally speaking, the owner will want to require protection for himself, the contractor and the workers of the contractor. This will mean that the owner will wish to be an additional insured under the contractor's policy and to be furnished a certificate of insurance. It is important that the certificate of insurance specify the types of coverage afforded. If the certificate of insurance is not completely clear, the owner should request a copy of the contractor's insurance policy. Generally, it will be better practice to review the contractor's policy. This is particularly true with asbestos work exclusions now appearing in such policies. In lieu of a review of the policy, an affirmative representation from the insurer that the work includes asbestos abatement coverage may suffice. However, in most cases, a legal opinion will be necessary.

Insurance must protect the insureds from both personal injury and property damage claims. While this is standard in liability policies, in personal injury claims, there may be an exclusion of coverage for asbestos-related claims and in property damage coverage, there may be an exclusion for the "pollution hazard," which could encompass asbestos fibers released onto the property of another. Therefore, the owner must be sure that he is protected from the real hazards presented by asbestos abatement. Of course, it is necessary to insure against the normal construction hazards as well.

Another very important point is to determine for what length of time the insurance will be in force. Clearly, the insurance should be in force during the contract. However, it is most important that the coverage continue after the contract is completed. This will insure that, if the contractor fails to completely abate the asbestos problem, and the owner fails to discover the contractor's oversight, the owner will nonetheless be protected.

Closely related to this is the need to determine whether the insurance is "claims made" or "occurrence" coverage. "Claims made" coverage will insure one for claims made during the policy period. "Occurrence" coverage will insure for an occurrence taking place during the policy period, whether or not the claim is made at that time. This is very important because of the long latency period associated with asbestos diseases. If the insurance is "claims made" insurance and the policy expires or lapses, the owner may not be protected many years later when the claim is actually made. This matter should be carefully reviewed with the insurance representative and with legal counsel.

Generally speaking, the owner needs liability insurance coverage for both personal injury and property damage risks, a builder's risk policy which protects against the particular risks occurring during construction, and, of course, workers' compensation coverage which complies with the law of the state where the work is to be done.

In most states, workers' compensation covers injuries received on the job by employees. However, firms engaged in asbestos abatement activities should be aware that some states do not cover occupational disease that arises many years after employment has terminated. Further, some states permit lawsuits to be filed against the employer by its employees. Since this complex issue exceeds the scope of this manual, employers involved in asbestos abatement should include workers' compensation when consulting with their legal counsel.

One other important aspect of specification writing and interpretation is the clean air standard to be used. The OSHA standard of 2 fibers/cc has been widely criticized and OSHA has attempted to lower that standard to 0.5 fibers/cc. Again, the safest legal path is going to be "state of the art." "State of the art," according to many industrial hygienists and other professionals, is 0.01 fibers/cc. Electron microscopy should also be employed to demonstrate "state of the art" work. If one is going to conduct an asbestos abatement program, most contractors will accept this as a standard they can attain. Whether, in a given situation, a more strict standard (i.e., not to exceed background levels) should be applied, will have to be a judgment for the professionals in an individual case.

SUPERVISION AND TRAINING

The heart of any asbestos abatement project is not the equipment, although the equipment is important, or the physical structures, although they are vital, too. The heart of the project is the care and skill exercised by the workers who remove the asbestos-containing materials. If this occurs in a professional manner, the owner can expect a good result. If the work is sloppy, good equipment will not save the job.

Many projects are conducted with both trained and untrained workers. Many asbestos abatement contractors hire local workers and train them. Unfortunately, a few contractors hire local workers and do not train them. From the owner's perspective, it is vital that the job superintendent be an experienced asbestos abatement worker. He or she must have had the experience on various projects and under various conditions. The owner should require documentation of the experience. It will behoove the owner to check on the quality of the preceding jobs. The superintendent is the key to the work.

Many jobs are sufficiently extensive to require a job superintendent and a job foreman. The latter person typically will be in the barriered area actually supervising the workers while the job superintendent may be in and out of the area at various times. If a job foreman is required, he or she, too, should be experienced and able to instruct the workers on-site and personally supervise actual preparation, removal and follow-on clean-up activities. It is desirable to contractually require that both of these positions be filled by qualified individuals.

Many owners are now asking for contractors with experienced work crews. It is possible to contractually require such, although the price of the job will probably go up. From a legal standpoint, these workers, particularly if untrained, are the weakest link in the chain. If the workers are hired by the contractor untrained, it is essential not only to meet such OSHA requirements as medical examinations, but also to conduct a program of worker training. This should be done before any worker enters the work site. The training should be conducted by someone experienced in the field. This may be the job superintendent. The training should include a description of the hazards and all warnings necessary for the worker to understand. Obviously, it should include instruction in the use of any equipment necessary. From a legal standpoint, it is most important that records be kept documenting training was given to each worker. Many contractors require testing of their workers before they allow them to proceed to the job site. If a test is administered, it should be retained. Records of all training should be kept for each worker. The owner should be permitted to inspect these records and copy them, if desired. In fact, the owner may wish to maintain a complete file on all workers who worked on his job. This will avoid the problem of the contractor going out of business later and an asbestos claim arising against the owner many years thereafter based upon an alleged failure to warn, or the like.

RECORDKEEPING

This area points to the need to maintain permanent records on all phases of the job. It is not enough to maintain these records for a few years. Asbestos disease latency periods may extend 30 or more years beyond the work date. These records should be stored and maintained permanently.

ADEQUATE TIME FOR JOB PEFORMANCE

One of the most difficult problems in asbestos abatement work is that of time. Once the owner has decided to conduct an asbestos abatement program, he is virtually always in a hurry. Many programs are specified with very short time limits of two to five days.

To avoid contractual disputes, it is desirable for the owner to specify enough time to allow the project to be completed. Questions of access, other contractors, and the owners' employees must be considered. Generally speaking, qualified abatement contractors will proceed quickly once they begin a job. Owners are frequently critical of late starts resulting in late finishes. It may therefore be in the owner's interest to provide some penalty for a late start as a means of emphasizing to the contractor that the start date is important. On the other hand, owners are frequently guilty of not providing the site at the time specified. This may result in difficulties for the contractor with his other work. The resolution is to cooperatively come up with a time for the project which will be realistic both in length and in calendar placement for the owner and the contractor.

As to delay damages, many owners choose to use liquidated damages as a vehicle to make sure that contractors finish the job. If extensive renovation work or other important use of the facility is contemplated, the liquidated damages may not suffice to cover the actual damages. In these instances, the owner may find that he is limited to damages which are less than what he wants. Most courts have limited the owner to liquidated damages if they are specified on the basis that the reason for specifying liquidated damages is the uncertainty of calculation of actual damages.

DISPOSAL OF ASBESTOS-CONTAINING WASTE

Another important issue is that of materials handling. Of course, the asbestos material must be properly containerized, labeled, and shipped to an approved dump site. The contract should so provide. The owner should obtain receipts to show the delivery of the materials. It will be desirable to have an inventory of the drums to compare to the dump site receipt. This kind of attention to detail will eliminate possible claims of improper toxic substance dumping.

USE OF IN-HOUSE PERSONNEL

Many owners are public entities and have severe budget constraints. There is a temptation to therefore use in-house staff for important functions in an asbestos abatement program. Use of in-house staff in lieu of outside experts may be a serious mistake and may result in legal liability if the in-house staff is unqualified. Issues of sovereign immunity and waiver of sovereign immunity are always, of course, involved. However, an outside expert is probably going to be desirable and needed if the public agency has a serious enough problem to spend the time to thoroughly train an in-house staff member on operations and maintenance and the like. The expert will be hired on a contractual basis and will be able to train the in-house staff person.

SELECTION OF QUALIFIED CONTRACTORS

Another problem peculiar to public works is the low bid problem. Low bid may equate to an unqualified asbestos abatement contractor. The way to resolve this problem and still comply with low bid obligations of a public agency is to pre-qualify the contractor. Pre-qualification should consist of various requirements. These may include experience, training, formal education (for instance, attending seminars), insurance, as has been discussed, and a job inspection. A public agency simply cannot afford to hire an unqualified contractor on the basis that the contractor submitted the low bid. Also, if the contractor does not have the time to visit the site and inspect it, he probably doesn't have the time to do the job correctly.

Frequently, an asbestos abatement contractor may be coupled with other renovation work. It is virtually always necessary to have some replacement structures for the asbestos-containing structures that are removed. Generally, it is going to be more desirable to have the asbestos abatement contractor function as a subcontractor under a general contractor in charge of the entire project. This will allow coordination of the trades. In a particularly dangerous job, it may be contractually necessary to require some training of the workers of the other trades of the dangers of the asbestos work. Certainly, conferences of the trade superintendents throughout the job is desirable and strict security is most important in a job of that type.

Using the prime contractor with an asbestos abatement subcontractor does raise a problem if the asbestos abatement subcontractor is unable to complete the work or is thrown off the job for some reason. In most instances, the prime contractor will not be able to complete the work himself. The owner may wish to reserve the right to select a substitute asbestos abatement subcontractor using the same criteria used in the original selection.

CLEANLINESS OF THE JOB SITE

One final note is that of the completion of the job by obtaining "clean air." Actually, the contractual requirements should be a combined requirement of clean air and clean surfaces. It is possible to have acceptable air monitoring tests and still have dangerous levels of asbestos-containing materials present within the building. In fact, once an abatement project is undertaken, the disturbing of the surfaces frequently makes the remaining material, if not removed, more friable. Therefore, the owner or his representative must be sure that the contractor has thoroughly removed all material <u>and</u> that the air is clean. In this regard, the specifications may call for disturbing the surfaces in the building, including turning on the HVAC system and simulation of normal activity within the building. The background level must be considered. Generally, it will not be necessary to specify a cleanliness standard higher than the background level. Certain settings, such as a hospital, where fibers of cotton and other materials are a regular fact of life, pose testing problems. These should be resolved with the air sampling professional.

AIR MONITORING PROFESSIONAL

In that regard, the integrity of the air monitoring person is vital. The air monitorer should be qualified and experienced. There have been a few instances of falsified tests reported. The important contractual idea is to get air monitoring under a separate contract from the abatement contractor. An owner does not normally want to have a "turn key" contract where his abatement contractor supplies the air monitoring. The owner may wish the air monitoring paid for as part of the abatement contract, but should contractually provide for his own air monitoring with a separate firm or person.

PAYMENT AND PERFORMANCE BONDS

One additional way to insure compliance with an asbestos abatement contractor is to require a payment and performance bond. The insurance industry is not very interested in this type of bond, but they can be obtained by qualified contractors. The slight additional cost of the bond is normally an insignificant part of the overall abatement contractor cost.

This is very much of an overview of the asbestos abatement contract and its workings. It is very important that each owner and contractor consult with legal counsel about specific legal problems. These cannot be answered in a general presentation such as this one.

CONTRACT SPECIFICATIONS

Objective: To provide an overview of the contract specifications used for asbestos abatement projects.

Learning Tasks: Information in this section should enable participants to:

- ☞ Recognize the importance of well-designed detailed contract specifications.
- ☞ Understand the reasons why specifications must be designed for each project.
- ☞ Become familiar with the content of guideline contract specifications.
- ☞ Be aware of key items in the contract specifications that can greatly affect project cost and performance period.
- ☞ Recognize the importance of strict enforcement of the specifications.
- ☞ Further recognize the need for an interdisciplinary approach to asbestos abatement.

CONTRACT SPECIFICATIONS

Well designed, detailed contract specifications provide the overall guidance for each asbestos abatement project. These specifications permit the contractor to provide the building owner or architect an accurate estimate or bid for completing the project. With few exceptions, two contracts are required for each project. One contract is established with the contractor performing the actual abatement work and a second contract between the building owner (or architect) and the air sampling professional.

Poorly designed specifications will result in a poorly done project. If details are omitted in the specifications or procedures are unclear, the bids will vary tremendously. Likewise, contractors must spend the necessary time to read the specifications in their entirety before the pre-bid walk-through of the intended job site.

Some key items the contractor should look for in the specifications include the following:

- Be sure that drawings and specifications match what is in the building when conducting the pre-bid survey.

- Check the criteria that will be used to judge cleanliness of the work area. Will electron microscopy be used?

The above-mentioned items are just a few of the many things that are addressed in well-written job specifications. Specifications must always be developed for each individual project, unless it is an emergency removal. Specifications from one project may not be used for another without major modification.

Attached to this section is a copy of guideline specifications developed by the State of Maryland for use on projects involving public buildings in their state. Notes have been made in the right-hand column of the pages indicating where the specifications may deviate from practices taught in this course.

Recommended Contract Specifications for Asbestos Abatement Projects

MARYLAND DEPARTMENT OF

HEALTH AND MENTAL HYGIENE

STATE OF MARYLAND
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
OFFICE OF ENVIRONMENTAL PROGRAMS
SCIENCE AND HEALTH ADVISORY GROUP

WILLIAM M. EICHBAUM
ASSISTANT SECRETARY

April, 1985

RECOMMENDED CONTRACT SPECIFICATIONS
FOR ASBESTOS ABATEMENT PROJECTS

Division of Environmental Disease Control
Science and Health Advisory Group
Office of Environmental Programs
Maryland Department of Health and Mental Hygiene

William M. Eichbaum
Assistant Secretary

In partial fulfillment of the
requirements for the United States
Environmental Protection Agency
TSCA Cooperative Agreement
Project CX812288-01-0

EPA Project Officers

Pamela R. Harris   Stephen Schanamann

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This document was developed with the assistance of:

Max Eisenberg, Ph.D.
Director
Science and Health Advisory Group

Katherine P. Farrell, M.D., M.P.H.
Chief
Division of Environmental Disease Control

Alan S. Weikert
Senior Industrial Hygienist
Division of Environmental Disease Control

Pamela Harris
Compliance Monitoring Staff
United State, Environmental Protection Agency

Stephen Schanamann
Asbestos Action Program
United States Environmental Protection Agency

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NOTICE

The material in this document has been reviewed by the Maryland Department of Health and Mental Hygiene, Office of Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Department of Health and Mental Hygiene or the United State Environmental Protection Agency, nor does mention of trade names of commerical products constitute endorsement or recommendations for use.

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PART 1 - General Information

1.1 Bidding Requirements

1.1.1 Site Investigation

1.1.1.1 By submitting a bid, the Contractor acknowledges that he has investigated and satisfied himself as to a) the conditions affecting the work, including but not limited to physical conditions of the site which may bear upon site access, handling and storage of tools and materials, access to water, electric or other utilities or otherwise affect performance of required activities; b) the character and quantity of all surface and subsurface materials or obstacles to be encountered in so far as this information is reasonably ascertainable from an inspection of the site, including exploratory work done by the Building Owner or a designated consultant, as well as information presented in drawings and specifications included with this contract. Any failure by the Contractor to acquaint himself with available information will not relieve him from the responsiblity for estimating properly the difficulty or cost of successfully performing the work. The Building Owner is not responsible for any conclusions or interpretations made by the Contractor on the basis of the information made available by the Building Owner.

1.1.1.2 No bids will be accepted from any Contractor who has not inspected the job site either in person or through a qualified designated representative.

1.1.1.3 Bidders shall attend a pre-bid meeting to be held [Insert time, place]. Attendance at this meeting by the Bidder or his qualified representative is a mandatory prerequisite for the acceptance of a bid from that Contractor.

1.1.1.4 Bidders are advised to take representative samples of the material for analysis. Abatement procedures and equipment will vary depending on material composition. This should be reflected in bid proposals.

The contractor must be aware of the type and percentage of asbestos present.

1.1.2 Discrepancies

1.1.2.1 Should a Bidder find discrepancies in the plans and/or specifications or should he be in doubt as to the meaning or intent of any part thereof, he must, no later than [ ] days prior to the bid opening, request clarification from the Building Owner. Discrepancies with regard to conflicts between the Contract Documents and applicable Federal, State or Local regulations or requirements shall be included herein. Failure to request such clarification is a waiver to any claim by the Bidder for expense made necessary by reason of later interpretation of the Contract Documents by the Building Owner.

1.1.2.2 Explanations desired by a prospective Bidder regarding the contract drawings [Insert drawings in Appendix], specifications or other bid documents shall be requested in writing from the Building Owner no later than [ ] days prior to the bid opening. Requests shall include the contract number and name and shall be directed to [insert address]

1.1.2.3 Oral explanations or instruction will not be binding. Only written addenda are binding. Any addenda resulting from these requests will be mailed to all listed holders of the Bid Document no later than [ ] days prior to the bid opening. The Bidder shall acknowledge the receipt of all addenda.

1.1.3 Modification and Withdrawal of Bids

1.1.3.1 Withdrawal or modifications to bids are effective only if written notice thereof is filed prior to time of bid opening and at the place specified in the Notice to Bidders. A notice of withdrawal or modifications to a bid must be signed by the Contractor or his designated representative.

1.1.3.2 No withdrawal or modifications shall be accepted after the time for opening of proposals.

1.1.4 Bid Security

1.1.4.1 Each Bidder must furnish a bid bond issued by a reputable security company with his proposal. The bond must be in an amount not less than [ ] percent of the amount of the base bid. Other security may be acceptable as agreed to by the Building Owner.

1.1.4.2 Insurance requirements- The Contractor shall purchase and maintain insurance that will protect him from claims that may arise out of or result from his activities under this Contract, whether those activities are performed by himself or by any Subcontractor or by anyone directly or indirectly employed by any of them or by anyone for whose acts any of them may be liable.

1.1.4.2.1 Bidders shall submit proof of coverage under the Workman's Compensation insurance system of the State of [ ] or other similar benefit acts.

1.1.4.2.2 Bidders shall submit a certificate of general liability insurance for personal injury, occupational disease and sickness or death and property damage. Insurance shall include "Occurrence" claim provisions. Minimum acceptable coverage is:

$1,000,000 Combined Single Limit for Bodily Injury and Property Damage or

$500,000 Bodily Injury and $250,000 Property Damage (each occurence)

(NOTE: Building Owner must determine the appropriate coverage for specific projects. Insurance policies of this nature routinely explicitly prohibit recovery for incidents involving toxic substances. Contractor must be able to document that he has notified his insurance carrier of the nature of his work involvement with asbestos and that the coverage in effect specifically includes an endorsement for asbestos abatement activities. The Building Owner should consult with his insurance carriers and legal representatives for any specific provisions that they may require for the abatement contract or for insurance coverage and to review Bidder submissions.)

1.1.4.2.3 The Building Owner shall provide vehicle liability and property damage insurance for the duration of the project.

1.1.4.2.4 [Any additional insurance requirements]

1.1.4.2.5 If the Owner permits the Contractor to use any of the Owner's equipment tools or facilities, such use will be gratuitous and the Contractor shall release the Owner from any responsibility arising from claims for personal injuries, including death, arising out of the use of such equipment, tools, or facilities irrespective of the condition thereof or any negligence on the part of the Owner in permiting their use.

1.1.4.3 Should the Bidder to whom the contract is awarded fail or be unable to execute the contract for any reason within [ ] days after notification of award, then an amount equal to the difference between the acceptable bid price, and that of the next highest Bidder shall be paid to the Building Owner as liquidated damages.

1.1.4.4 As a prerequisite to signing the contract and prior to the expiration of [ ] days following notification of award, the Bidder shall have furnished Performance and Payment Bonds and Certificates of Insurance.

1.1.5 Licenses and Qualifications

1.1.5.1 Bidders must be licensed as required by Construction Firm Law of [include citation from appropriate regulations] (where applicable)

1.1.5.2 Bidders must be licensed as required by the [regulatory agency] for the purpose of removal, encapsulation, enclosure, demolition and maintenance of structures or components covered by or composed of asbestos-containing materials [include citation from appropriate regulation].

1.1.5.3 Bidders shall demonstrate prior experience on asbestos abatement projects of similar nature and scope through the submission of letters of reference from the Building Owner's including the name, address and telephone number of contact person (someone specifically familiar with the Contractor's work) for at least three (3) previous users of service. Include descriptions of projects, locations, and records of all air monitoring data that were generated during the project.

1.1.5.4 Bidders shall submit a notarized statement, signed by an officer of the company, containing the following information:

1.1.5.4.1 A record of any citations issued by Federal, State or Local regulatory agencies relating to asbestos abatement activity. Include projects, dates, and resolutions.

1.1.5.4.2 A list of penalties incurred through non-compliance with asbestos abatement project specifications including liquidated damages, overruns in scheduled time limitations and resolutions.

1.1.5.4.3 Situations in which an asbestos related contract has been terminated including projects, dates and resons for terminations.

1.1.5.4.4 A listing of any asbestos-related legal procedings/claims in which the Contractor (or employees scheduled to participate in this project) have participated or are currently involved. Include descriptions of role, issue and resolution to date.

1.1.6 The Builaing Owner reserves the right to reject bids for any reason that serves the best interests of the Building Owner or building occupants. The Building Owner also reserves the right to waive any technicality or irregularity in a bid. Failure to submit requested information/documentation or the submission of incorrect information/ documentation will result in automatic disaqualification of bid package.

1.2 Definitions

1.2.1 Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, encapsulation, enclosure, repair, demolition and renovation activities.

1.2.2 ACGIH - American Conference of Governmental Industrial Hygienists
6500 Glenway Avenue Building D-5
Cincinnati, Ohio 45211

1.2.3 AIHA - American Industrial Hygiene Association.
475 Wolf Ledges Parkway
Akron, Ohio 44311

1.2.4 Airlock - A system for permitting ingress and engress with minimum air movement between a contaminated area and an uncontaminated area, typically consisting of two curtained doorways separated by a distance of at least 3 feet such that one passes through one doorway into the airlock, allowing the doorway sheeting to overlap and close off the opening before proceeding through the second doorway, thereby preventing flow-through contamination.

1.2.5 Air monitoring - The process of measuring the fiber content of a known volume of air collected during a specific period of time. The procedure normally utilized for asbestos follows the NIOSH Standard Analytical Method for Asbestos in Air P&CAM 239 or Method 7400. For clerance air monitoring, electron microscopy methods may be utilized for lower detectability and specific fiber identification.

1.2.6 Air Sampling Professional - The professional contracted or employed by the Building Owner to supervise and/or conduct air monitoring and analysis schemes. This individual may also function as the Asbestos Project Manager, if qualified. Supervision of air sampling and evaluation of results should be performed by an individual certified in the Comprehensive Practice of Industrial Hygiene (C.I.H.) and having specialized experience in air sampling for asbestos. Other acceptable

Air Sampling Professionals include Environmental Engineers, Architects, chemists and Environmental Scientists or others with equivalent experience in asbestos air monitoring. This individual shall not be affiliated inany way other than through this contract with the Contractor performing the abatement work.

1.2.7 Amended water - Water to which a surfactant has been added.

1.2.8 ANSI - American National Standards Institute
1430 Broadway
New York, New York 10018

1.2.9 Asbestos means the asbestiform varieties of serpentine (chrysotile), rie beckite (crocidolite), cummingtonite - grunerite (amosite), anthrophyllite, and actinolite, and tremolite.

1.2.10 Asbestos containing material (ACM)-Material composed of asbestos of any type and in an amount greater than 1% by weight, either alone or mixed with other fibrous or non-fibrous materials

1.2.11 Asbestos containing waste material - asbestos containing material or asbestos contaminated objects requiring disposal.

1.2.12 Asbestos Project Manager (also known as Clerk-of-the Works or Competent Person.)-An individual qualified by virtue of experience and education, designated as the Owner's representative and responsible for overseeing the asbestos abatement project. [If an Asbestos Project Manager has been selected, he may be specifically designated here.] See Section 4.3

1.2.13 ASTM - American Society For Testing and Materials
1916 Race Street
Philadelphia, Pa. 19103

1.2.14 Authorized visitor - The Building Owner [and any designated representatives] and any representative of a regulatory or other agency having jurisdiction over the project.

1.2.15 Building Owner - The Owner or his authorized representative.

1.2.16 Certified Industrial Hygienist - (CIH) - An industrial hygienist certified in Comprehensive Practice by the American Board of Industrial Hygiene. (See Section 1.2.3 for address)

1.2.17 Clean room - An uncontaminated area or room which is a part of the worker decontamination enclosure system with provisions for storage of worker's street clothes and clean protective equipment.

1.2.18 Contractor - The individual and/or business with which the Building Owner arranges to perform the asbestos abatement. It is recommended that wherever asbestos abatement is part of a larger project, the asbestos work be contracted separately and distinctly from other contract work. When this is not possible, the Contractor is responsible for the proper completion of project activities in accordance with this contract specifications even where a subcontractor has been retained to perform the actual abatement.

1.2.19 Curtained doorway - A device to allow ingress or engress from one room to another while permitting minimal air movement between the rooms, typically constructed by placing two overlapping sheets of plastic over an existing or temporarily framed doorway, securing each along the top of the doorway, securing the vertical edge of one sheet along one vertical side of the doorway and securing the vertical edge of the other sheet along the opposite vertical side of the doorway. Other effective designs are permissible.

1.2.20 Decontamination enclosure system - A series of connected rooms, seperated from the work area and from each other by air locks, for the decontamination of workers and equipment.

1.2.21 Demolition - The wrecking or taking out of any load-supporting structural member of a facility together with any related handling operations.

1.2.22 Encapsulant - A liquid material which can be applied to asbestos containing material which controls the possible release of asbestos fibers from the material either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components together (penetrating encapsulant).

1.2.23 Encapsulation - The application of an encapsulant to asbestos containing materials to control the release of asbestos fibers into the air.

1.2.24 Enclosure - The construction of an air-tight, impermeable, permanent barrier around asbestos containing material to control the release of asbestos fibers into the air.

1.2.25 EPA - U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

1.2.26 Equipment decontamination enclosure system - That portion of a decontamination enclosure system designed for controlled transfer of materials and equipment into or out of the work area, typically consisting of a washroom and holding area.

1.2.27 Equipment room - A contaminated area or room which is part of the worker decontamination enclosure system with provisions for storage of contaminated clothing and equipment.

1.2.28 Facility - Any institutional, commercial or industrial structure, installation or building.

1.2.29 Facility component - Any pipe, duct, boiler, tank, reactor, turbine or furnace at or in a facility or any structural member of a facility.

1.2.30 Fixed object - A piece of equipment or furniture in the work area which cannot be removed from the work area.

1.2.31 Friable asbestos - Asbestos containing material which can be crumbled to dust, when dry, under hand pressure.

1.2.32 Glovebag technique - A method with limited applications for removing small amounts of friable asbestos-containing material from HVAC ducts, short piping runs, valves, joints, elbows, and other non-planar surfaces in a non-contained (plasticized) work area. The glovebag assembly is a manufactured or fabricated device consisting of a glovebag (typically constructed of 6 mil transparent polyethylene or polyvinylchloride plastic), two inward projecting longsleeves, an internal tool pouch, and an attached, labeled receptacle for asbestos waste. The glovebag is constructed and installed in such a manner that it surrounds the object or material to be removed and contains all asbestos fibers released during the process. All workers who are permitted to use the glovebag technique must be highly trained, experienced and skilled in this method.

1.2.33 HVAC - Heating, ventilation and air conditioning system

1.2.34 HEPA filter - A high efficiency particulate air filter capable of removing particles >0.3 microns in diameter with 99.97% efficiency

1.2.35 HEPA vacuum - A vacuum system equipped with HEPA filtration

1.2.36 Holding area - A chamber in the equipment decontamination enclosure located between the washroom and an uncontaminated area. The holding area comprises an airlock.

1.2.37 Movable object - A piece of equipment or furniture in the work area which can be removed from the work area.

1.2.38 Negative pressure ventilation system - A portable exhaust system equipped with HEPA filtration and capable of maintaining a constant low velocity air flow into contaminated areas from adjacent uncontaminated areas.

1.2.39 NESHAPS - The National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61)

1.2.40 NIOSH - The National Institute for Occupational Safety and Health
CDC - NIOSH
Building J N.E. Room 3007
Atlanta, Ga. 30333

1.2.41 OSHA - The Occupational Safety and Health Administration
200 Constitution Avenue
Washington, D.C. 20210

1.2.42 Outside air - The air outside buildings and structures.

1.2.43 Plasticize - To cover floors and walls with plastic sheeting as herein specified.

1.2.44 Prior experience - Experience required of the contractor on asbestos projects of similar nature and scope to insure capability of performing the asbestos abatement in a satisfactory manner. Similarities shall be in areas related to material composition, project size, abatement methods required, number of employees and the engineering, work practice and personal protection controls required.

1.2.45 Removal - The stripping of any asbestos containing materials from surfaces or components of a facility.

1.2.46 Renovation - Altering in any way one or more facility components. Operations in which load-supporting structural members are wrecked or taken out are excluded.

1.2.47 Shower room - A room between the clean room and the equipment room in the worker decontamination enclosure with hot and cold or warm running water controllable at the tap and suitably arranged for complete showering during decontamination.

1.2.48 Staging area - Either the holding area or some area near the waste transfer airlock where containerized asbestos waste has been placed prior to removal from the work area.

1.2.49 Strip - To take off friable asbestos materials from any part of facility

1.2.50 Structural member - Any load-supporting member of a facility, such as beams and load-supporting walls or any non-load-supporting member, such as ceilings and non-load-supporting walls.

1.2.51 Surfactant - A chemical wetting agent added to water to improve penetration.

1.2.52 Visible emissions - Any emissions containing particulate asbestos material that are visually detectable without the aid of instruments. This does not include condensed uncombined water vapor.

1.2.53 Waste transfer airlock - A decontamination system utilized for transferring containerized waste from inside to outside of the work area.

1.2.54 Wet cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths, mops, or other cleaning utensils which have been dampened with water and afterwards thoroughly decontaminated or disposed of as asbestos contaminated waste.

1.2.55 Work area - Designated rooms, spaces, or areas of the project in which asbestos abatement actions are to be undertaken or which may become contaminated as a result of such abatement actions. A contained work area is a work area which has been sealed, plasticized, and equipped with a decontamination enclosure system. A non-contained work area is an isolated or controlled-access work area which has not been plasticized nor equipped with a decontamination enclosure system.

1.2.56 Worker decontamination enclosure - A decontamination system consisting of a clean room, a shower room, and an equipment room separated from each other and from the work area airlocks and contained doorways. This system is used fro all worker events and exist in the work area and for equipment and waste pass out for small jobs.

1.3 Scope of Work

1.3.1 This specification covers the abatement of exposure to asbestos hazards from building structures and components listed in 1.3.2 It is the intent of the Contract Documents to show all of the work necessary to complete the project.

1.3.2 [Provide a descriptive list of all locations of asbestos containing materials to be abated, including potential add-ons and deletions]. Identify preceisely, preferably with drawings, the location of asbestos -containing materials and the types of abatement to be performed. Also provide details regarding the work necessary to restore the project to some specified condition.

1.3.3 [Insert other requirements such as general conditions, supplementedary general conditions, etc. whenever applicable].

1.4. Description of Work

1.4.1 The work specified herein shall be the [removal] [and] [encapsulation] [and] [enclosure] of asbestos containing materials by competent persons trained, knowledgeable and qualified in the techniques of abatement, handling and disposal of asbestos-containing and asbestos-contaminated materials and the subsequent cleaning of contaminated areas, who comply with all applicable Federal, State, and Local regulations and are capable of and willing to perform the work of this Contract.

1.4.2 [Provide details concerning abatement measures for each area mentioned in 1.3.2, if more than one technique is to be used during the scope of the Contract].

1.4.3 The Contractor shall supply all labor, materials, services, insurance, permits a: equipment necessary to carry out the work in accordance with all appliable Federal, State and Local regulations and these specifications.

1.4.4 [Provide details on special conditions at the site which must be considered by the Contrator when performing the asbestos abatement (e.g. high temperatures, equipment that must remain in operation, other toxic substances in the air, running through pipes or contaminating surfaces).

1.4.5 The Contractor is responsible for restoring the work area and auxiliary areas utilized during the abatement to conditions equal to or better than orginal. Any damages caused during the performance of abatement activities shall be repaired by the Contractor (e.g. paint peeled off by barrier tape, nail holes, water damage, broken glass) at no additional exspense to the Building Owner.

1.4.6 Related work specified elsewhere. (This related work should be specified elsewhere but mentioned here. This would include work such as the replacement of materials for Fireproofing insulation, on soundproofing purposes, work on electrical or mechanical systems, painting, air monitoring, and the installation of new ceiling panals.

1.5 Applicable Standards and Guidelines

1.5.1 General requirements

1.5.1.1 All work under this contract shall be done in strict accordance with all applicable Federal, State and Local regulations, standards and codes governing asbestos abatement and any other trade work done in conjunction with the abatement.

1.5.1.2 The most recent edition of any relevent regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specifications exists the most stringent requirements shall be utilized.

1.5.1.3 Copies of all standards, regulations, codes and other appliable documents, including this specification and those listed in Section 1.5.2 shall be available at the worksite in the clean change area of the worker decontamination system.

1.5.2 Specific requirements

1.5.2.1 Occupational Safety and Health Administration (OSHA)

1.5.2.1.1 Title 29 Code of Federal Regulations Section 1910.1001 - General Industry Standard For Asbestos.

1.5.2.1.2 Title 29 Code of Federal Regulations Section 1910.134 General Industry Standard For Respiratory Protection.

1.5.2.1.3 Title 29 Code of Federal Regulations Section 1926 Construction Industry

1.5.2.1.4 Title 29 Code of Federal Regualtions Section 1910.2 Access to Employee Exposure and Medical Records

1.5.2.1.5 Title 29 Code of Federal Regulations Section 1910.1200 Hazard Communication

1.5.2.2 Environmental Protection Agency (EPA)

1.5.2.2.1 Title 40 Code of Federal Regulations Part 61 Subparts A and M (Revised Subpart B) - National Emission Standard For Asbestos.

1.5.2.3 [Include citations for any State or Local regulations that apply to any phase of the asbestos abatement (e.g. Licensing regulations; disposal requirements.)]

1.5.2.4 [Title of other guidelines, codes, or documents with which the abatement Contractor must comply or be familiar.]

1.6 <u>Submittals and Notices</u>

1.6.1 Contractor shall:

1.6.1.1 Prior To Commencement of Work:

1.6.1.1.1 Should abatement projects involving greater than 160 linear feet of pipe insulation or 260 square feet of sprayed, throweled or otherwise applied material or covering or composing building structures or components, send written notification in accordance with 40 CFR Part 61.146 of Subpart

M, to the appropriate State or Federal air pollution control agency responsible for the enforcement of the National Emission Standard for Asbestos at least ten (10) days prior to the commencement of any on-site project activity. Provide Building Owner with a copy of the notice. [Attach copy of notification forms and list of air pollution control agencies] [Also notfiy in writing, with a copy to the Building Owner.]

The notification requirements may vary from state-to-state. For more information see section entitled, "Waste Disposal Requirements" in this notebook.

1.6.1.1.2 Submit proof satisfactory to the Building Owner that required permits, site location and arrangements for transport and disposal of asbestos containing waste materials have been made. Obtain and submit a copy of handling procedures and list of protective equipment utilized for asbestos disposal at the landfill, signed by the landfill Owner. (Required for all abatement projects.)

1.6.1.1.3 Submit documentation satisfactory to the Building Owner that the Contractor's employees, including foremen, supervisors and any other company personnel or agents who may be exposed to airborne asbestos fibers or who may be responsible for any aspects of abatement activities, have received adequate training that includes, at a minimum, information in Part 4 Section 4.1 of this document.

NOTE: Training requirements vary greatly in different states. Contact the EPA Regional Asbestos Coordinator for up-to-date information on this.

1.6.1.1.4 Submit documentation from a physician that all employees or agents who may be exposed to airborne asbestos in excess of backgound level have been provided with an opportunity to be medically monitored to determined whether they are physically capable of working while wearing the respirator required without suffering adverse health effects. In addition, document that personnel have received medical monitoring as required in OSHA 29 CFR 1910.1001 (j). The Contractor must be aware of and provide information to the examining physician about unusual conditions in the workplace environment (e.g. high temperatures, humidity, chemical contamiments) that may impact on the employee's ability to perform work activities:

1.6.1.1.5 Submit to the Building Owner, shop drawings for layout and construction of decontamination enclosure systems and barriers for isolation of the work area as detailed in this specification and required by applicable regulations. (The Building

Owner may wish to specify these layouts in the specificat- tions.)

1.6.1.1.6 With the Building Owner, inspect the premises wherein all abatement and abatement related activities will occur and submit a statement signed by both, agreeing on building and fixture condition prior to the commencement of work.

1.6.1.1.7 Submit manufacturer's certification that HEPA vacuums, negative pressure ventilation units and other local exhaust ventilation equipment conform to ANSI Z9.2-79.

1.6.1.1.8 When rental equipment is to be used in abatement areas or to transport asbestos contaminated waste, a written notification concerning intended use of the rental equipment must be provided to the rental agency with a copy submitted to the Building Owner.

1.6.1.1.9 Document NIOSH approvals for all respiratory protective devices utilized on site. Include manufacturer certification of HEPA filtration capabilities for all cartridges and filters.

This may be obtained through the NIOSH "List of Certified Equipment", the manufacturer, or local OSHA office.

1.6.1.1.10 Submit pre-abatement air sampling results (if conducted-these samples are optional, since the Contractor rarely has access to the site prior to job initiation.) Include location of samples, name of Air Sampling Professional, equipment, and methods utilized for sampling and analysis. (See sections 1.6.2.1.2 and 4.4.3.1)

1.6.1.1.11 Submit documentation of respirator fit-testing for all Contractor employees and agents who must enter the work area. This fit-testing shall be in accordance with qualitative procedures as detailed in the OSHA Lead Standard 29 CFR 1910.1025 Appendix D Qualitative Fit Test Protocol or be quantitative in nature.

1.6.1.2 During Abatement Activities

1.6.1.2.1 Submit weekly (or as otherwise required by the Building Owner) job progress reports detailing abatement activities. Include review of progress with respect to previously established milestones and schedules, major problems and action taken, injury reports, equipment breakdown and bulk material and air sampling results conducted by Contractor's Air Sampling Professional.

1.6.1.2.2 Submit copies of all transport manifests, trip tickets and disposal receipts for all asbestos waste materials removed from the work area during the abatement process.

1.6.1.2.3 Submit daily, copies of worksite entry logbooks with information on worker and visitor access.

1.6.1.2.4 Submit logs documenting filter changes on respirators, HEPA vacuums, negative pressure ventilation units, and other engineering controls.

1.6.1.2.5 Submit results of bulk material analysis and air sampling data collected during the course of the abatement including OSHA compliance air monitoring results.

1.6.1.2.6 Submit results of materials testing conducted during the abatement for purposes of utilization during abatement activities (e.g. testing of encapsulant for depth of penetration, testing of substitute materials for adherance to encapsulated surfaces)

1.6.1.2.7 Post in the clean room area of the worker decontamination enclosure a list containing the names, addresses, and telephone numbers of the Contractor, the Building Owner, the Asbestos Project Officer, the General Superintendent, the Air Sampling Professionals, the testing laboratory and any other personnel who may be required to assist during abatement activities (e.g. Safety Officer, Building Maintenance Supervisor, Energy Conservation Officer).

1.6.2 Owner Shall

1.6.2.1 Prior to Commencement of Work:

1.6.2.1.1 Notify occupants of work areas that may be disrupted by the abatement of project dates and requirements for relocation. Arrangements must be made prior to start, for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the work area. (Note: Notification of all building occupants <u>and users</u> is recommended in order to prevent unnecessary or unauthorized access to the contaminated work area.)

1.6.2.1.2 Submit to the Contractor, results of pre-abatement air sampling (if conducted) including location of samples, names of the Air Sampling Professional, equipment utilized and method of analysis. (It is recommended that the Building Owner take the responsibility for obtaining pre-abatement air sampling.)

1.6.2.1.3 Document that Owner's employees who will be required to enter the work area during abatement have received training equal to that detailed in Part 4, Section 4.1. (This training may be provided by the Contractor's or the Owner's training consultant at the Owner's discretion.)

1.6.2.1.4 Provide to the Contractor information concerning access, shutdown and protection requirements of certain equipment and systems in the work area.

1.6.2.2 During Abatement

1.6.2.2.1 Submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. These sample results are for information only. They serve only to monitor Contractor performance during the project and shall not release the Contractor from any responsibility to sample for OSHA compliance.

1.7 <u>Site Security</u>

1.7.1 The work area is to be restricted only to authorized, trained, and protected personnel. These may include the Contractor's employees, employees of Subcontractors, Owner employees and representatives, State and local inspectors and any other designated individuals. A list of authorized personnel shall be established prior to job start and posted in the clean room of the worker decontamination facility.

1.7.2 Entry into the work area by unauthorized individuals shall be reported immediately to the Building Owner by the Contractor.

1.7.3 A log book shall be maintained in the clean-room area of the worker decontamination system. Anyone who enters the work area must record name, affiliation, time in, and time out for each entry.

1.7.4 Access to the work area shall be through a single worker decontamination system located at [designate a location at the worksite]. All other means of access (doors, windows, hallways, etc.) shall be blocked or locked so as to prevent entry to or exit from the work area. The only exceptions for this rule are the waste pass-out airlock which shall be sealed except during the removal of containerized asbestos waste from the work area, and emergency exits in case of fire or accident. Emergency exits shall <u>not</u> be locked from the inside, however, they shall be sealed with polyethylene sheeting and tape until needed.

1.7.5 Contractor should have control of site security during abatement operations whenever possible, in order to protect work efforts and equipment.

1.7.6 Contractor will have Owner's assistance in notifying building occupants of impending activity and enforcement of restricted access by Owner's employees.

1.8 <u>Emergency Planning</u>

1.8.1 Emergency planning shall be developed prior to abatement initiation and agreed to by Contractor and Owner.

1.8.2 Emergency procedures shall be in written form and prominently posted in the clean change area and equipment room of the worker decontamination area. Everyone prior to entering the work area must read and sign these procedures to acknowledge receipt and understanding of work site layout, location of emergency exits and emergency procedures.

1.8.3 Emergency planning shall include written notification of police, fire and emergency medical personnel of planned abatement activities, work schedule and layout of work area, particularly barriers that may affect response capabilities.

1.8.4 Emergency planning shall include considerations of fire, explosion, toxic atmospheres, electrical hazards, slips, trips and falls, confined spaces and heat related injury. Written procedures shall be developed and employee training in procedures shall be provided.

1.8.5 Employees shall be trained in evacuation procedures in the event of workplace emergencies.

1.8.5.1 For non-life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers if necessary, before exiting the workplace to obtain proper medical treatment.

1.8.5.2 For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker, remove him from the workplace and secure proper medical treatment.

1.8.6 Telephone numbers of all emergency response personnel shall be prominently posted in the clean change area and equipment room, along with the location of the nearest telephone.

1.9 Pre-Start Meeting

1.9.1 The successful Bidder shall attend a pre-start job meeting [insert time, location] Attending this meeting will be representatives of the Owner and the Owner's agents along with testing/monitoring personnel (eg. Asbestos Project Manager, Air Sampling Professional) who will actually participate in the Owner's testing/monitoring program.

1.9.2 The Contractor and supervisory personnel who will provide on-site direction of the abatement activities must attend. The Contractor's Air Sampling Professional shall also attend.

1.9.3 At this meeting the Contractor shall provide all submittals as required in Section 1.6. In addition he shall be prepared to provide detailed information concerning:

1.9.3.1 Preparation of work area

1.9.3.2 Personal protective equipment including respiratory protection and protective clothing

1.9.3.3 Employees who will participate in the project, including delineation of experience, training, and assigned responsibilities during the project.

1.9.3.4 Decontamination procedures for personnel, work area and equipment.

1.9.3.5 Abatement methods and procedures to be utilized

1.9.3.6 Required air monitoring procedures

1.9.3.7 Procedures for handling and disposing of waste materials.

1.9.3.8 Procedures for final decontamination and cleanup.

1.9.3.9 A sequence of work and performance schedule.

1.9.3.10 Procedures for dealing with heat stress.

1.9.3.11 Emergency procedures

PART 2 - Materials and Equipment

2.1 Materials

2.1.1 General (all abatement projects)

2.1.1.1 Deliver all materials in the original packages, containers or bundles bearing the name of the manufacturer and the brand name (where applicable).

2.1.1.2 Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Replacement materials shall be stored outside of the work area until abatement is completed.

2.1.1.3 Damaged, deteriorating or previously used materials shall not be used and shall be removed from the worksite and disposed of properly.

2.1.1.4 Polyethylene sheeting for walls and stationary objects shall be a minimum of 4-mil thick. For floors and all other uses sheeting of at least 6-mil thickness shall be used in widths selected to minimize the frequency of joints.

2.1.1.5 [Method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and Building Owner and selected to minimize damage to equipment and surfaces. Method of attachment may include any combination of duct tape or other waterproof tape, furring strips, spray glue, staples, nails, screws or other effective procedures capable of sealing adjacent sheets of polyethlyene and capable of sealing polyethlylene to dissimilar finished or unfinished surfaces under both wet and dry conditions (including the use of amended water).]

2.1.1.6 Polyethlylene sheeting utilized for worker decontamination enclosure shall be opaque white or black in color.

2.1.1.7 [Special materials required to protect objects in the work area should be detailed (e.g. plywood over carpeting or hardwood floors to prevent damage from scaffolds and falling material)].

2.1.1.8 Disposal bags shall be of 6 mil polyethylene, pre-printed with labels as required by EPA regulation 40 CFR 61.152 (b)(i)(iv) or OSHA requirement 29 CFR 1910.1001 (g)(2)(ii).

2.1.1.9 Disposal drums shall be metal or fiberboard with locking ring tops.

2.1.1.10 Stick-on labels as per EPA or OSHA requirements (see 2.1.2.7) for disposal drums.

2.1.1.11 Warning signs as required by OSHA 29 CFR 1910.1001 (g)(i)(ii) or as proposed in 29 CFR 190.1001 Asbestos Proposed Rule, Federal Register and Vol. 49, Tuesday April 10, 1984 (recommended).

2.1.2 Removal

2.1.2.1 Surfactant (wetting agent) shall be a 50/50 mixture of polyoxyethlylene ether and polyoxyethylene ester, or equivalent, mixed in a proportion of 1 fluid ounce to 5 gallons of water or as specified by manufacturer. (An equivalent surfactant shall be understood to mean a material with a surface tension of 29 dynes/cm as tested in its properly mixed concentration, using ASTM method D1331-56- "Surface and Interfacial Tension of Solutions of Surface Active Agents.") Where work area temperature may cause freezing of the amended water solution, the addition of ethylene glycol in amounts sufficient to prevent freezing is permitted.

2.1.2.2 [Specify encapsulating agent to be applied to surfaces from which asbestos containing material has been stripped.] (It will be necessary to test the adhesion if new material is to be applied to the encapsulated substrate. Some manufacturers of replacement materials will not provide a material warranty on products applied over painted, encapsulated or otherwise coated surfaces. Without proper testing, the material may "fail" and require replacement at the Owner's expense.)

2.1.2.3 Replacement spray or trowel-applied fire proofing must be [ULI] [ULC] labeled and listed, asbestos-free [mineral/fiber] [cementitious] material to provide the degree of fire protection as required by applicable building codes.

2.1.2.4 Replacement spray or trowel applied thermal insulation and acoustical material shall be asbestos-free and provide performance characteristics equal to or better than the original material, and should be evaluated and selected by the Building Owner prior to abatement. (See Section 2.1.2.2)

2.1.3 Encapsulation

2.1.3.1 Encapsulation materials shall be [specify bridging or penetrating] type and conform with the following characteristics:

2.1.3.1.1 Encapsulants should not be solvent-based or utilize a vehicle (the liquid in which the solid parts of the encapsulant are suspended) consisting of hydrocarbons.

2.1.3.1.2 Encapsulants shall not be flammable.

2.1.3.1.3 Other [specify additional requirements] (Note: Encapsulation may significantly alter the acoustical characteristics of a material, the fire rating of a material, or the bond of the material to the substrate These factors must be considered during the abatement method selection process)

2.1.3.2 Additional materials as necessary for removal, as specified in 2.1.2

2.1.4 Enclosure

2.1.4.1 Enclosure materials shall be [specify] and conform with the following characteristics.

2.1.4.1.1 The enclosures shall be constructed of materials such that when the enclosure is completed there is limited potential for impact damage to the enclosure and no potential for fiber release.

2.1.4.1.2 Other [Specify, where fire, thermal or sound performance related assemblies are required for enclosure projects. The applicable [ASTM] [ANSI] [CSA] [ILI] [other] material, installation, application, specifications or recommended practice should be specified]

2.1.4.2 Additional materials as necessary for removal, as specified in 2.1.2

2.2 <u>Equipment</u>

2.2.1 General (all abatement projects)

2.2.1.1 A sufficient quantity of negative pressure ventilation units equipped with HEPA filtration and operated in accordance with ANSI 29.2-79 (local exhaust ventilation requirements) and EPA guidance document EPA 560/5-83-002 <u>Guidance for Controlling Friable Asbestos-Containing Materials in Buildings</u> Appendix F: Recommended Specifications and Operating Procedures For the Use of

Negative Pressure Systems for Asbestos Abatement shall be utilized so as to provide one workplace air change every 15 minutes.

To calculate total air flow requirement:

$$\text{Total ft}^3/\text{min} = \frac{\text{Vol. of work area (in ft}^3\text{)}}{15 \text{ min}}$$

To calculate the number of units needed for the abatement:

$$\text{Number of units needed} = \frac{[\text{Total ft}^3/\text{min}]}{[\text{Capacity of unit in ft}^3/\text{min}]}$$

If air-supplied respirators are utilized, estimate the volume of supplied air and add to workplace air volume when calculating ventilation requirements. For small enclosures and glove bags, a HEPA filtered vacuum system may be utilized to provide negative air pressure.

2.2.1.2 Type "C" air supplied respirators in positive pressure or pressure demand mode with full facepieces and HEPA filtered disconnect protection are recommended by the U.S. EPA for all full shift abatement work until the successful completion of final clearance air monitoring. Powered air purifying respirators equipped with HEPA filters and full facepieces or respirators with a higher NIOSH assigned protection factor may be used for inspection or repair work of less than 1 hour duration per day. A sufficient supply of charged replacement batteries and filters and a flow test meter shall be available in the clean change area for use with powered air purifying respirators. Air purifying respirators with dual high-efficiency (HEPA) filters may be utilized during work area preparation activities. (See Section 3.3.2.3).

NOTE: Type C respirators should be worn through the completion of gross clean-up. Cartridge respirators are usually appropriate during final wipe-downs.

Air purifying respirators with dual high-efficiency (HEPA) filters may be utilized during work area preparation activities.

Spectacle kits and eyeglasses must be provided for employees who wear glasses and who must wear full facepiece respirators.

Respirators shall be provided that have been tested and approved by the National Institute of Occupational Safety and Health for use in asbestos contaminated atmospheres.

2.2.1.3 Compressed air systems shall be designed to provide air volumes and pressures to accomodate respirator manufacture's specifications. The compressed air systems shall have a receiver of adequate capacity to allow escape of all respirator wearers from contaminated areas in the event of compressor failure. Compressors must meet the requirements of 29 CFR 1910.134 (d). Compressors must have an in-line carbon monoxide monitor and periodic inspection of the carbon monoxide monitor must be evidenced. Documentation of adequacy of compressed air systems/respiratory protection system must be retained on site. This documentation will include a list of compatible components with the maximum number and type of respirators that may be used with the system. Periodic testing of compressed air shall insure that systems provide air of sufficient quality (Grade D breathing air as decribed in Compressed Gas Association Commodity Specifications G-7.1)

See section entitled "Establishing a Supplied Air System" for complete details.

2.2.1.4 Full body disposable protective clothing, including head, body and foot coverings (unless using footwear as described in 2.2.1.6) consisting of material inpenetrable by asbestos fibers (Tyvek[R] or equivalent) shall be provided to all workers and authorized visitors in sizes adequate to accomodate movement without tearing.

2.2.1.5 Additional safety equipment (e.g. hard hats meeting the requirements of ANSI Standard Z89.1-1981, eye protection meeting the requirements of ANSI Standard Z87.1-1979, safety shoes meeting the requriements of ANSI Standard Z41.1-1967,disposable PVC gloves), as necessary, shall be provided to all workers and authorized visitors.

2.2.1.6 Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

2.2.1.7 If launderable clothing is to be worn underneath disposable protective clothing, it shall be provided by the Contractor to all abatement workers. (It is recommended that launerable clothing be a unique, specific color to enable it to be distinquished from general purpose blue, gray or black coveralls which are commonly worn.) Laundering must occur in accordance with 29 CFR 1910.1001 (d) (4) (iii) however, (it is preferable that the following procedures be utilized:

2.2.1.7.1 Launderers must be trained in proper techniques for handling asbestos contaminated clothing and provided with personal protective equipment consisting of appropriate respirators and disposable clothing for use when needed.

2.2.1.7.2 Machines used for laundering asbestos contaminated clothing shall be isolated and restricted for such use.

2.2.1.7.3 Washers shall be equipped with filters to remove asbestos fibers from discharged water (See Section 3.1.2.7)

2.2.1.7.4 Dryers shall be isolated and restricted for use with asbestos contaminated fabrics and have HEPA fitered exhaust.

2.2.1.7.5 Machine maintenance shall be performed by protected individuals (as per 2.2.1.7.1.)

2.2.1.8 A sufficient supply of disposable mops, rags and sponges for work area decontamination shall be available.

2.2.2 Removal

2.2.2.1. A sufficient supply of scaffolds, ladders, lifts and hand tools (e.g. scrapers, wire cutters, brushes, utility knives, wire saws, etc.) shall be provided as needed.

2.2.2.2 Sprayers with pumps capable of providing 500 pounds per square inch (psi) at the nozzle tip at a flow rate of 2 gallons per minute for spraying amended water.

2.2.2.3 Rubber dustpans and rubber squeegees shall be provided for cleanup.

2.2.2.4 Brushes utilized for removing loose asbestos containing material shall have nylon or fiber bristles, not metal.

2.2.2.5 A sufficient supply of HEPA filtered vacuum systems shall be available during cleanup.

2.2.3 Encapsulation

2.2.3.1 Encapsulants shall be sprayed using airless spray equipment. Nozzle pressure should be adjustable within the 400 to 1500 psi range. [This can be specified depending on the encapsulant's viscosity and solids content. Tip size shall also be specified based on manufacturer's recommendations]

2.2.3.2 Additional support equipment as needed. [specify when known] (See Section 2.2.2)

2.2.3.3 The nature of the encapsulant may effect the requirements for respiratory protection. Vapors that may be given off during encapsulant application must be taken into account when selecting respirators, if types other than air supplied are used.

2.2.4 Enclosure

2.2.4.1 [Specify tools to be used to install enclosure supports and enclosures.] Hand tools equipped with HEPA filtered local exhaust ventilation shall be utilized during the installation of enclosures and supports if there is any need to disturb asbestos containing materials during this process. (As an alternative asbestos material may be partially removed following proper removal procedures prior to the installation of supports and enclosures.)

2.2.4.2 Additional support equipment as needed. [specify when known (See Section 2.2.2 and 2.2.3)]

2.3 Substitions

2.3.1 Approval Required:

2.3.1.1 The Contract is based on the materials, equipment and methods described in the Contract Documents.

2.3.1.2 The Building Owner will consider proposals for substitutions of materials, equipment and methods only when such proposals are accompanied by full and complete technical data and all other information required by the Owner to evaluate the proposed substitution.

2.3.1.3 Do not substitute materials, equipment or methods unless such substitution has been specifically approved for this work by the Building Owner.

2.3.2 "Or equal":

2.3.2.1 Where the phrase "or equal" or "or equal as approved by the Owner" occurs in the Contract Document, do not assume that materials, equipment or methods will be approved by the Owner unless the item has been specifically approved for this work by the Owner.

2.3.2.2 The decision of the Owner shall be final.

2.3.3 Separate substitute bids: Bidders may, if they wish, submit completely seperate bids using materials and methods other than those described in the Contract Documents, provided that all substitutions are clearly identified and described, and that the Bid in all other respects is in accordance with the provisions of the Contract Documents.

2.3.4 Availability of specified items:

2.3.4.1. Verify prior to bidding that all specified items will be available in time for installation during orderly and timely progress of the work.

2.3.4.2 In the event that specified items will not be so available, notify the Owner prior to receipt of bids.

2.3.4.3 Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.

Part 3 - Execution

3.1 Preparation

3.1.1 Work Areas

3.1.1.1 Post caution signs meeting the specifications of OSHA 29 CFR 1910.1001 (g) (1) (ii) at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure. Additional signs may need to be posted following construction of workplace enclosure barriers

3.1.1.2 Shut down and lock out electric power to all work areas. Provide temporary power and lighting. Insure safe installation (including ground faulting) of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. All costs for electric shall be paid for by the Owner.

This may not be feasible on all jobs. See "Other Safety and Health Considerations" for alternatives.

3.1.1.3 Shut down and lock out all heating, cooling and air conditioning system (HVAC) components that are in, supply or pass through the work area. (Note: Interiors of existing duct work may require decontamination. This may be done during the pre-cleaning phase of operations before the ductwork is sealed off or during the final cleaning phase prior to reengagement of the system. Appropriate equipment and control measures shall be utilized to prevent contamination of building spaces during this operation. Adequate cleaning of ductwork may sometimes be accomplished by drawing high volumes of air through the system using the HEPA filtered negative pressure ventilation units.) Investigate the work area and agree on preabatement condition with Building Owner. Seal all intake and exhaust vents in the work area with tape and 6-mil polytheylene Also seal any seams in system components that pass through the work area. Remove all HVAC system filters and place in labeled 6-mil polyethylene bags for staging and eventual disposal as asbestos contaminated waste.

3.1.1.4 The Contractor shall provide sanitary facilities for abatement personnel outside of the enclosed work area maintain them in a clean and sanitary condition throughout the project.

3.1.1.5 The Owner will provide water for contruction purposes. Contractor shall connect to existing Owner system.

3.1.1.6 Preclean all movable objects within the work area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the work area and carefully stored in an uncontaminated location. (Carpeting, drapes, clothing, upholstered furniture and other fabric items may be disposed of as asbestos contaminated waste or cleaned as asbestos contaminated items utilizing HEPA vacuum techniques and off-premises steam cleaning. Since adequate cleaning of severely contaminated fabric is difficult, the Building Owner must carefully consider whether this option is an appropriate one).

3.1.1.7 Preclean all fixed objects in the work area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination significant. Also pay particular attention to wall, floor and ceiling penetrations behind fixed items. After precleaning, enclose fixed objects in 4 mil polyethylene sheeting and seal securely in place with tape. Objects (e.g. permanent fixtures, shelves, electronic equipment, laboratory tables, sprinklers, alarm systems, closed circut TV equipment and computer cables) which must remain in the work area and that require special ventilation or enclosure requirements should be designated here along with specified means of protection. (Contract the manufacturer for special protection requirements). Control panels, gauges etc. in the work area may require Owner access during abatement. These shall be designated and enclosures constructed with access flaps sealed with waterproof tape.]

3.1.1.8 Preclean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos containing materials during the pre-cleaning phase.

3.1.1.9 Seal off all windows, doorways elevator openings, corridor entrances, drains, ducts, grills, grates, diffusers, skylights and any other openings between the work area and uncontaminated areas outside of the work area (including the outside of the building, tunnels and crawl spaces) with 4 mil polyethylene sheeting and tape (See Section 3.1.4 - Isolating work area from occupied areas)

3.1.1.10 Cover floors in the work area with polyethylene sheeting.

3.1.1.10.1 Floor shall be covered with two layers of 6 mil (minimum) sheeting. (Floors requiring special protection should be specified. Carpeting, hardwood flooring and tile floors may be damaged by leaks of water, ladder feet, scaffold wheels etc. Additional layers of protection such as plywood, canvas dropcloths or extra plastic sheeting may be required by the Owner.) Additional layers of sheeting may be utilitzed as drop cloths to aid in cleanup of bulk materials

3.1.1.10.2 Plastic shall be sized to minimize seams. If the floor area necessitates seams, those on successive layers of sheeting shall be staggered to reduce the potential for water to penetrate to the flooring material. A distance of at least 6 feet between seams is sufficient. Do not locate any seams at wall/floor joints.

3.1.1.10.3 Floor sheeting shall extend at least 12" up the sidewalls of the work area.

3.1.1.10.4 Sheeting shall be installed in a fashion so as to prevent slippage between successive layers of material. (Vinyl sheeting may be used for improved traction on floors.)

3.1.1.11 Cover walls in the work area with polyethylene sheeting. Walls that are non=porous and will not be damaged by water, sufactant, encapsulatn do not necessarily need protection. They can be decontaminated using HEPA vacuums and wet cleaning techniques. Walls with motor joints (e.g. tile) are considered porous. In addition, openings through these walls to uncontaminated areas of the building musst be sealed as described in Section 3.1.1.9.

3.1.1.11.1 Walls shall be covered with two layers of 4 mil polyethylene sheeting.

3.1.1.11.2 Plastic shall be sized to minimize seams. Seams shall be staggered and separated by a distance of at least 6 feet.

3.1.1.11.3 Wall sheeting shall overlap floor sheeting by at least 12 inches beyond the wall/floor joint to provide a better seal against water damage and for negative pressure.

3.1.1.11.4 Wall sheeting shall be secured adequately to prevent it from falling away from the walls. This will require additional support/attachment when negative pressure ventilation systems are utilized.

3.1.2 Worker decontamination enclosure systems.

3.1.2.1 Worker decontamination enclosure systems shall be provided at all locations where workers will enter or exit the work area. One system at a single location for each contained work over is preferred. These systems may consist of existing rooms outside of the work area, if the layout is appropriate, that can be enclosed in plastic sheeting and are accessible from the work area. When this situation does not exist, enclosure systems may be constructed out of metal, wood or plastic support as appropriate.

3.1.2.2 Plans for construction, including materials and layout, shall be submitted as shopdrawings and approved, in writing by the Building Owner prior to work initiation. Worker decontamination enclosure systems constructed at the worksite shall utilize 6 mil opaque black or white polyethylene sheeting or other acceptable materials for privacy. Detailed descriptions of portable, pre-fabricated units, if used, must be submitted for the Building Owner's approval. Plans must include floor plan (in accordance with 3.1.2.3) with dimensions, materials, size, thickness, plumbing and electrical utilities.

3.1.2.3 The worker decontamination enclosure system shall consist of at least a clean room, a shower room, and an equipment room, each separated from each other and from the work area by airlocks.

3.1.2.4 Entry to and exit from all airlocks and decontamination enclosure system chambers shall be through curtained doorways consisting of two sheets of overlapping polyethylene sheeting. One sheet shall be secured at the top and left side, the other sheet at the top and right side. Both sheets shall have weights attached to the bottom to insure that they hang straight and maintain a seal over the doorway when not in use. Doorway designs, providing equivilant protection and acceptable to the Building Owner may be utilized.

3.1.2.5 Access between any two rooms in the decontamination enclosure system shall be through an airlock with at least 3 feet separating each curtained doorway. Pathways into (from clean to contaminated) and out from (contaminated to clean) the work area shall be clearly designated

3.1.2.6 Clean room shall be sized to adequately accomodate the work crew. Benches shall be provided as well as hooks for hanging up street clothes. (lockers may be provided for valuables, however, workers may be requested to secure valuables in their cars). Shelves for storing respirators shall also be provided in this area. Clean work clothes (if required under disposables), clean disposable clothing, replacement filters for respirators, towels and other necessary items shall be provided in adequate supply at the clean room. A location for postings shall also be provided in this area. Whenever possible, a lockable door shall be used to permit access into the clean room from outside the work area. Lighting, heat and electricity shall be provided as necessary for comfort. This space shall not be used for storage of tools equipment or materials, (except as specifically) designated) or as office space.

3.1.2.7 Shower room shall contain one or more showers as necessary to adequately accomodate workers. Each shower head shall be supplied with hot and cold water adjustable at the tap. The shower enclosure shall be constructed to ensure against leakage of any kind. An adequate supply of soap, shampoo and towels shall be supplied by the Contractor and available at all times. Shower water shall be drained, collected and filtered through a system with at least 0.5-1.0 micron particle size collection capability. (Note: A system containing a series of several filters with progressively smaller pore sizes is recommended to avoid rapid clogging of filtration system by large particles.)

Filtration through 0.5 - 1.0 micron filters can only be achieved with extreme difficulty. Some states require 5 micron final filtration. Filtration of shower water is discussed in greater detail elsewhere.

3.1.2.8 The equipment room shall be used for storage of equipment and tools at the end of a shift after they have been decontaminated using a HEPA filtered vacuum and/or wet cleaning techniques as appropriate. Replacement filters (in sealed containers until used) for HEPA vacuums and negative pressure ventilation equipment, extra tools, containers of surfactant and other materials and equipment that may be required during the abatement may also be stored here as needed. A walk-off pan (a small children's swimming pool or equivilant filled with water shall be located in the work area just outside the equipment room for workers to clean off foot coverings after leaving the work area and prevent excessive contamination of the worker decontamination enclosure system. A drum lined with a labeled 6 mil polyethylene bag for collection of disposable clothing shall be located in this room. Contaminated footwear (e.g. rubber boots, other reusable footwear) shall be stored in this area for reuse the following workday.

3.1.3 Waste Container pass-out airlock (usually required only for large jobs) and emergency exits.

3.1.3.1 The waste container pass-out airlock shall be constructed at some location away from the worker decontamination enclosure system. Wherever possible, this shall be located where there is direct access from the work area to the outside of the building.

3.1.3.2 This airlock system shall consist of an airlock, a container staging area, and another airlock with access to outside the work area.

3.1.3.3 The waste container pass-out airlock shall be constructed in similar fashion to the worker decontamination enclosure system using similar materials and airlock and curtain doorway designs.

3.1.3.4 This airlock system shall not be used to enter or exit the work-site.

3.1.3.5 Emergency exits shall be established and clearly marked with duct tape arrows or other effective designations to permit easy location from anywhere within the work area. They shall be secured to prevent access from uncontaminated areas and still permit emergency exiting. These exits shall be properly sealed with polythylene sheeting which can be cut to permit egress if needed. These exits may be the worker decontamination enclosure, the waste pass-out airlock and/or other alternative exits satisfactory to fire officials.

3.1.4 Isolation of the work area from occupied areas of the building [Building owner must clearly identify all areas that will be occupied].

3.1.4.1 The contaminated work area shall be separated from uncontaminated, occupied areas of the building by the construction of air tight barriers.

3.1.4.2 Walls shall be constructed of wood or metal framing to support barriers in all openings larger than 4' x 8'.

3.1.4.3 A sheathing material (plywood, drywall) of at least 3/8" thickness shall be applied to work side of barrier.

3.1.4.4 Cover both sides of partition with a double layer of 6 mil polyethylene sheeting with staggered joints and seal in place.

3.1.4.5 Caulk edges of partition at floor, ceiling, walls and fixtures to form an air tight seal.

3.1.5 Maintenance of workplace barriers and worker decontamination enclosure systems.

3.1.5.1 Following completion of the construction of all polythylene barriers and decontamination system enclosures, allow overnight settling to insure that barriers will remain intact and secured to walls and fixtures before beginning actual abatement activities.

3.1.5.2 All polyethylene barriers inside the workplace, in the worker decontamination enclosure system, in the waste container pass-out airlock and at partitions constructed to isolate the work area from occupied areas shall be inspected at least twice daily, prior to the start of each day's abatement activities and following the completion of the day's abatement activities. Document inspections and observations in the daily project log.

3.1.5.3 Damage and defects in the enclosure system are to be repaired immediately upon discovery.

3.1.5.4 Use smoke tubes to test the effectiveness of the barrier system when directed by Building Owner.

3.1.5.5 At any time during the abatement activities after barriers have been erected, if visible material is observed outside of the work area or if damage occurs to barriers, work shall immediately stop, repairs be made to barriers, and debris/residue cleaned up using appropriate HEPA vacuuming and wet mopping procedures.

3.1.5.6 If air samples collected outside of the work area during abatement activities indicate airborne fiber concentrations greater than 0.01 f/cc or pre-measured background levels (whichever is lower) work shall immediately stop for inspection and repair of barriers. Cleanup of surfaces outside of the work area using HEPA vacuums or wet cleaning techniques may be necessary.

3.1.5.7 Install and initiate operation of negative pressure ventilation equipment as needed to provide one air change in the work area every 15 minutes. (See Section 2.2.1.1) Openings made in the enclosure system to accomodate these units shall be made air-tight with tape and/or caulking as needed. If more than one unit is installed, they should be turned on one at a time, checking the integrity of wall barriers for secure attachment and need for additional reinforcement. Insure that adequate power supply is available to satisfy the requirements of the ventilating units. Negative pressure ventilation units shall be exhausted to the outside of the building whenever feasible. They shall <u>not</u> be exhausted into occupied areas of the building. Twelve inch extension ducting shall be used to reach from the work area to the outside when required. Careful installation, air monitoring and daily inspections shall be done to insure that the ducting does not release fibers into uncontaminated building areas.

3.1.7 Once constructed and reinforced as necessary, with negative pressure ventilation units in operation as required, test enclosure for leakage utilizing smoke tubes. Repair or reconstruct as needed.

3.1.8 Clearly identify and maintain emergency and fire exits from the work area.

3.1.9 Remove, clean and enclose in polyethylene the ceiling mounted objects such as lights and other items that may interfere with the abatement process and were not previously cleaned and sealed off. Utilize localized spraying of amdended water and/or HEPA vacuums to reduce fiber dispersal during the removal of these fixtures.

3.1.10 Removal of building structural components

3.1.10.1 After isolation of work area as described in previous sections and initiation of negative pressure ventilation, remove ceiling [tiles] [panels] within the work area carefully. If panels are to be reused, vacuum them with a HEPA filtered vacuum cleaner and carefully damp sponge and wrap cleaned [tiles] [panels] in 4 mil polyethylene sheeting and seal with tape. Store as designated by building owner (preferably outside of the work area). If [tiles] [panels] are to be discarded it is not necessary to clean them, but wrap in a similar fashion and stage for disposal in the waste container pass-out airlock. (Disposal is preferred over re-use when tiles or panals are composed of porus materials because of difficulties in adequate cleaning.)

3.1.10.2 Where suspended ceiling T-grid components must be removed to perform the abatement, HEPA vacuum and wet-sponge each piece after removal from hangers. Wrap clean grid pieces in 4-mil polyethylene sheeting and seal with tape. Store as designated by Building Owner or in waste staging area if designated for disposal.

3.1.10.3 When removal of ceiling grid suspension system is not necessary for accessibility, to the asbestos containing materials leave the system in place and clean properly following completion of abatement.

3.1.10.4 [Remove plaster/drywall ceilings including lathe, furring channel system, wire mesh, ties, clips, screws, nails and other accessory items as necessary and dispose of as asbestos contaminated waste material. Plaster ceiling may actually contain asbestos. They should be tested.) As work progresses, spray ceiling materials and debris with amended water to keep wet until containerized for disposal.]

3.1.11 Commencement of work shall not occur until:

3.1.11.1 Enclosure systems have been constructed and tested

3.1.11.2 Negative pressure ventilation systems are functioning adequately

3.1.11.3 All pre-abatement submissions, notifications, postings and permits have been provided and are satisfactory to the Building Owner (See Section 1.6)

3.1.11.4 All equipment for abatement, clean-up and disposal are on hand

3.1.11.5 All worker training [and certification] is completed

3.1.11.6 Contractor receives written permission from Building Owner to commence abatement.

3.1.12 Alternative Procedures

3.1.12.1 Procedures described in this specification are to be utilized at all times.

3.1.12.2 If specified procedures cannot be utilized, a request must be made in writing to the Building Owner providing details of the problem encountered and recommended alternatives

3.1.12.3 Alternative procedures shall provide equivalent or greater protection than procedures that they replace.

3.1.12.4 Any alternative procedure must be approved in writing by the Building Owner prior to implementation.

3.2 Workplace Entry and Exit Procedures

3.2.1 Personnel entry and exit

3.2.1.1 All workers and authorized personnel shall enter the work area through the worker decontamination enclosure system

3.2.1.2 All personnel who enter the work area must sign the entry log, located in the clean room, upon entry and exit.

3.2.1.3 All personnel, before entering the work area, shall read and be familiar with all posted regulations, personal protection requirements (including workplace entry and exit procedures) and emergency procedures. A sign-off sheet shall be used to acknowledge that these have been reviewed and understood by all personnel prior to entry.

3.2.1.4 All personnel shall proceed first to the clean room, remove all street clothes and appropriately don respiratory protection (as deemed adequate for the job conditions) and launderable and/or disposable coveralls, head covering and foot covering. Hard hats, eye protection and gloves shall also be utilized if required. Clean respirators and protective clothing shall be provided and utilized by each person for each seperate entry into the work area.

3.2.1.5 Personnel wearing designated personal protective equipment shall proceed from the clean room through the shower room and equipment room to the main work area.

3.2.1.6 Before leaving the work area all personnel shall remove gross contamination from the outside of respirators and protective clothing by brushing and/or wet wiping procedures. (Small HEPA vacuums with brush attachments may be utilized for this purpose, however, larger machines may tear the suits) Each person shall clean bottoms of protective footwear in the walk-off pan just prior to entering the equipment room.

3.2.1.7 Personnel shall proceed to equipment room where they remove all protective equipment except respirators. Deposit disposable [and launderable] clothing into appropriately labeled containers for disposal [and laundering]

3.2.1.8 Reusable, contaminated footwear shall be stored in the equipment room when not in use in the work area. Upon completion of abatement it shall be disposed of as asbestos contaminated waste. (rubber boots may be decontaminated at the completion of the abatement for reuse)

3.2.1.9 Still wearing respirators, personnel shall proceed to the shower area, clean the outside of the respirators and the exposed face area under running water prior to removal of respirator and shower and shampoo to remove residual asbestos contamination. Various types of respirators will requrie slight modification of these procedures. An airline respirator with HEPA filtered disconnect protection may be disconnected in the equipment room and work into the shower. A powered air-purifying respirator facepiece will have to be disconneted formt he Filter/power pack assembly which is not waterproof, upon entering the shower. A dual cartridge respirator may be worn into the shower. Cartridges must be replaced for each new entry into the work area.

DO NOT disconnect the powerpack since the PAPR respirator will not provide any protection. Hand the powerpack to another person in the airlock, on the equipment room side of the shower. Keep motor operating unitl shower is complete. Have second person clean (wipe off) powerpack, then remove respirator.

3.2.1.10 After showering and drying off, proceed to the clean room and don clean disposable [and/or launderable] clothing if there will be later re-entry into the work area or street clothes if it is the end of the work shift.

3.2.1.11 These procedures shall be posted in the clean room and equipment room.

3.2.2 Waste container pass-out procedures

3.2.2.1 Asbestos contaminated waste that has been containerized shall be transported out of the work area through the waste container pass-out airlock [or through the worker decontamination enclosure if a separate airlock has not been constructed]

3.2.2.2 Waste pass-out procedures shall utilize two teams of workers, an "inside" team and an "outside" team.

3.2.2.3 The inside team wearing appropriate protective clothing and respirators for inside the work area shall clean the outside, including bottoms, of properly labeled containers (bags, drums, or wrapped components) using HEPA vacuums and wet wiping techniques and transport them into the waste container pass-out airlock. No worker from the inside team shall further exit the work area through this airlock .

3.2.2.4 The outside team, wearing a different color protective clothing and appropriately assigned respirators, shall enter the airlock <u>from outside the work area</u>, enclose the drums in clean, labeled, 6 mil polyethylene bags and remove them from the airlock to the outside. No worker from the outside team shall further enter the work area through this airlock.

3.2.2.5 The exit from this airlock shall be secured to prevent unauthorized entry.

3.3 <u>Personnel Protection Requirements</u>

3.3.1 Training

3.3.1.1 Prior to commencement of abatement activities all personnel who will be required to enter the work area or handle containerized asbestos containing materials must have received adequate training in accordance with Part 4 Section 4.1 of this document.

3.3.1.2 Special on-site training on equipment and procedures unique to this job site shall be performed as required.

3.3.1.3 Training in emergency response and evacuation procedures shall be provided

3.3.2 Respiratory Protection

3.3.2.1 All respiratory protection shall be provided to workers in accordance with the submitted written respiratory protection program, which includes all items in OSHA 29 CFR 1910.134 (b) (1-11). This program shall be posted in the clean room of the worker decontamination enclosure system

3.3.2.2 Workers shall be provided with personally issued, individually identified (marked with waterproof designations) respirators.

3.3.2.3 Respirators shall be selected that meet the following level of protection requirements:

Each Building Owner (in conjunction with an industrial hygienist) must decide on the levels of respiratory protection that will be required for asbestos abatement activities. Those level and specific requirements should be inserted here. (The U.S. EPA recommends that Type "C" air-supplied respirators in positive pressure or pressure demand mode with full facepieces and HEPA filtered disconnect protection be provided to all full-shift asbestos abatement workers. Powered air-purifying respirators equipped with HEPA filtration and full facepieces may be utilized for inspection or repair work of less than one (1) hour duration. (See Section 2.2.1.2)

Implementation Suggestions:

The use of engineering controls such as negative pressure ventilation units and HEPA vacuums and good work practices such as the wetting of asbestos containing material prior to abatement (when applicable), misting the work area to help fibers settle out, removal in small sections, use of glove bags and proper clean-up and containerization all help to reduce airborne fiber levels in the work area. A properly designed air monitoring program, implemented by a qualified air sampling professional and analytical laboratory, may support the use of respiratory protective devices that provide a lower factor of protection to the workers than air supplied respirators, for some abatement activities. Safety problems associated with the use of airline systems and time and financial constraints may be reduced through the use of alternative types of respiratory protection. It is imperative, however, that adequate air monitoring of fiber levels and a well designed respriatory protection program (in accordance with 29 CFR 1910.134) be implemented. Key points of the respirator program include proper selection of respirator type and size, training of personnel in the proper inspection, donning, use, cleaning and maintenance procedures for the respirator selected including their use limitations and a good fitting and fit testing program to provide proper protection. Single-use disposable respirators are not recommended for use during any asbestos abatement activities. Negative-pressure dual cartridge respirators shall be equipped with high efficiency filters and exhalation and inhalation valves to permit the performance of positive and negative pressure fit Checks.)

As a rule of thumb, cartridge respirators are usually adequate for prepping and final clean-up. Air supplied respirators are usually adequate during removal and gross clean-up.

3.3.2.4 Fit testing

3.3.2.4.1 Workers must perform positive and negative air pressure fit tests each time a respirator is put on, whenever the respirator design so permits. Powered air-purifying respirators shall be tested for adequate flow as specified by the manufacturer.

3.3.2.4.2 Workers shall be given a qualitative fit test in accordance with procedures detailed in the OSHA Lead Standard (29 CFR 1910.1025, Appendix D, Qualitative Fit Test Protocols) for all respirators to be used on this abatement project. An appropriately administered quantitative fit test may be substituted for the qualitative fit test.

3.3.2.4.3 Documentation of adequate respirator fit must be provided to the Building Owner.

3.3.2.5 No one wearing a beard shall be permitted to don a respirator and enter the work area.

3.3.2.6 Additional respirators (mimimum of 2 of each type) and training on their donning and use must be available at the work site for authorized visitors who may be required to enter the work area.

3.3.3 Protective Clothing

3.3.3.1 Disposable clothing including head, foot and full body protection shall be provided in sufficient quantities and adequate sizes for all workers and authorized visitors.

3.3.3.2 [Launderable clothing, if required, shall be provided in sufficient quantities and adequate sizes for all workers and authorized visitors].

3.3.3.3 Hard hats, protective eyewear, gloves, rubber boots and/or other footwear shall be provided as required for workers and authorized visitors. Safety shoes may be required for some activities.

3.4 <u>Removal Procedures</u>

3.4.1 Clean and isolate the work area in accordance with Section 3.1

3.4.2 Wet all asbestos containing material with an amended water solution using equipment capable of providing a fine spray mist, in order to reduce airborne fiber concentrations when the material is disturbed. Saturate the material to the substrate, however, do not allow excessive water to accumulate in the work area. Keep all removed material wet enough to prevent fiber release until it can be containerized for disposal. If work area temperatures are below 32°F and amended water is subject to freezing, dry removal permits and procedures must be utilized (See 2.1.2.1). Maintain a high humidity in the work area by misting or spraying to assist in fiber

Ethylene glycol added to the amended water will permit wetting the material during freezing conditions.

settling and reduce airborne concentrations. Wetting procedures are not equally effective on all types of asbestos containing materials but, shall none-the-less be used in all cases.

3.4.3 Saturated asbestos containing material shall be removed in manageable sections. Removed material should be containerized before moving to a new location for continuance of work. Surrounding areas shall be periodocally sprayed and maintained in a wet condition until visible material is cleaned up.

3.4.4 Material removed from building structures or components shall not be dropped or thrown to the floor. Material should be removed as intact sections or components whenever possible and carefully lowered to the floor. If this cannot be done for materials greater than 50 feet above the floor, a dust-tight chute shall be constructed to transport the material to containers on the floor or the material may be containerized at elevated levels (e.g. on scaffolds) and carefully lowered to the ground by mechanical means. For materials between 15 and 50 feet above the ground they may be containerized at elevated levels or dropped onto inclined chutes or scaffolding for subsequent collection and containerization.

3.4.5 Containers (6-mil polyethylene bags or drums) shall be sealed when full. (Wet material can be exceedingly heavy. Double bagging of waste material usually necessary. A determination of need for single or double bags must be made early in the abatement process and agreed to by the Building Owner.) Bags shall not be overfilled. They should be securely sealed to prevent accidental opening and leakage by tying tops of bags in an overhand knot or by taping in gooseneck fashion. Do not seal bags with wire or cord. (Bags may be placed in drums for staging and transportation to the landfill. Bags shall be decontaminated on exterior surfaces by wet cleaning and HEPA vacuuming before being placed in clean drums and sealed with locking ring tops).

3.4.6 Large components removed intact may be wrapped in 2 layers of 6-mil polyethylene sheeting secured with tape for transport to the landfill.

3.4.7 Asbestos containing waste with sharp-edged components (e.g nails, screws, metal lath, tin sheeting) will tear the polyethylene bags and sheeting and shall be placed into drums for disposal.

3.4.8 After completion of all stripping work, surfaces from which asbestos containing materials have been removed shall be wet brushed and sponged or cleaned by some equivalent method to remove all visible residue

3.4.9 Clean-up shall proceed in accordance with Section 3.7

3.4.10 After the work area has been rendered free of visible residues, a thin coat of a satisfactory encapsulating agent shall be applied to all surfaces in the work area including structural members, building components and plastic sheeting on walls, floors and covering non-removable items, to seal in non-visible residue. (Note: 1) High temperature components such as boilers and pipes may not permit the applicaiton of some encapsulants. 2) If insulation or acoustical materials are to be reapplied to the abated area, be certain that the encapsulant selected will permit good adhesion to the substrate. A small area should be tested before application)

3.4.11 Special circumstances (e.g. live electrical equipment, high amosite content of material, materials previously coated with an encapsulant or paint) may prohibit the adequate use of wet methods to reduce fiber concentrations. For these situations, a dry removal may be required. The contractor will have to acquire of special permits, different from those mentioned herein from the NESHAP enforcement agency.

3.5 Encapsulation Procedures

3.5.1 Clean and isolate the work area in accordance with section 3.1

3.5.2 Repair damaged and missing areas of existing [sprayed] [troweled] materials with non-asbestos containing subsitutes [specify]. Material must adhere adequately to existing surfaces and provide an adequate base for application of encapsulating agents. Filler material shall be applied in accordance with manufacturer's recommended specifications.

3.5.3 Remove loose or hanging asbestos containing materials in accordance with the requirements of Section 3.4.

3.5.4 Bridging-type encapsulants

3.5.4.1 Apply bridging-type encapsulants to provide [ ] inches of minimum dry film thickness over sprayed asbestos surfaces

3.5.4.2 When using a bridging-type encapsulant use a different color for each coat. Use [color] for final coat.

3.5.5 Penetrating-type encapsulants

3.5.5.1 Apply penetrating-type encapsulant to penetrate existing sprayed asbestos materials to a depth of [ ] inches.

3.5.5.2 Apply penetrating-type encapsulant to penetrate existing sprayed asbestos materials uniformly to substrate

3.5.5.3 During treatment with a penetrating-type encapsulant, the Contractor shall remove selected random core samples of the asbestos-containing materials in the presence of the Owner to check the depth of penetration.

3.5.6 Apply encapsulants using airless spray equipment (See Section 2.2.1.9 Equipment - Encapsulation)

3.5.7 Clean-up shall be in accordance with Section 3.7

3.5.8 Encapsulated asbestos containing materials shall be designated appropriately [specify format - labels, signs or color codes and frequency location of indicators] in order to warn building maintenance personel in the event that they are required to disturb the materials.

3.6 <u>Enclosure Procedures</u>

3.6.1 Clean and isolate the work area in accordance with Section 3.1

3.6.2 Spray areas that will be disturbed during the installation of hangers or other support/framing materials for the enclosure with water containing the specified surfactant. Keep these areas damp to reduce airborne fiber concentrations.

3.6.3 Remove loose or hanging asbestos containing materials in accordance with the requirements of Section 3.4.

3.6.4 After installation of hangers and other fixing devices and before installation of enclosure, repair damaged areas of fireproofing/thermal insulation materials as required using a non-asbestos containing replacement material. Prepare surfaces and apply replacement material in accordance with manufacturer's recommendations.

3.6.5 [Specify enclosure procedures] and include the following requirements:

3.6.5.1 Use hand tools equipped with HEPA filtered local exhaust ventilation to drill, cut into or otherwise disturb asbestos containing materials during the installation of support systems for the enclosures. (Alternatively, these areas of material could be removed prior to installation of supports.)

3.6.5.2 Use materials that are impact resistent and that will provide an air-tight barrier once construction is complete.

3.6.5.3 Lower utilities as necessary and reinstall in a manner which permits proper utilization and does not disturb the intergrity of the enclosures. Utility maintenance should not require the enclosure to be opened or disturbed. (If it does, an alternative abatement strategy is indicated)

3.6.7 Enclosed asbestos containing materials shall be designated appropriately [Specify format - sign, label, color code and frequency/location of indicators] in order to warn building maintenance personnel in the event that they are required to disturb the enclosure.

3.7 Clean-up Procedure

3.7.1 Remove and containerize all visible accumulations of asbestos containing material and asbestos contaminated debris utilizing rubber dust pans and rubber squeegees to move material around. Do not use metal shovels to pick up or move accumulated waste. Special care shall be taken to minimize damage to floor sheeting.

3.7.2 Wet clean all surfaces in the work area using rags, mops and sponges as appropriate. (Note: Some HEPA vacuums might not be wet-dry vacuums. To pick up excess water and gross wet debris, a wet-dry shop vacuum may be used. This will be contaminated and require cleaning prior to removal from the work area.)

3.7.3 Remove the cleaned outer layer of plastic sheeting from walls and floors. Windows, doors, HVAC system vents and all other openings shall remain sealed. The negative pressure ventilation units shall remain in continuous operation. Decontamination enclosure systems shall remain in place and be utilized.

3.7.4 After cleaning the work area, wait at least 24 hours to allow fibers to settle and HEPA vacuum and wet clean all objects and surfaces in the work area again.

3.7.5 Remove all containerized waste from the work area and waste container pass-out airlock.

3.7.6 Decontaminate all tools and equipment and remove at the appropriate time in the cleaning sequence.

3.7.7 Inspect the work area for visible residue. If any accumulation of residue is observed, it will be assumed to be asbestos and the 24 hour settling period/cleaning cycle repeated.

3.7.8 The work area shall be cleaned until it is in compliance with State and Local requirements and any more stringent criteria agreed upon by the Contractor and Owner prior to initiation of abatement activities (criteria should be in the form of visual inspections and airborne fiber concentrations). Additional cleaning cycles shall be provided, as necessary, at no cost to the Building Owner until these criteria have been met.

3.7.9 Following the satisfactory completion of clearance air monitoring remaining barriers may be removed and properly disposed of. A final visual inspection by the Owner shall insure that no contamination remains in the work area. Unsatisfactory conditions may require addition cleaning and air monitoring. (See section 3.10 Reestablishment of the Work Area).

3.8 Clearance Air Monitoring

3.8.1 Following the completion of clean-up operations, the Contractor shall notify the Building Owner that work areas are ready for clearance air monitoring.

3.8.2 The Owner shall then arrange for an Air Monitoring Professional to sample the air in the work area for airborne fiber concentrations.

3.8.3 (Note: The use of TEM (Transmission Electron Microscopy) is highly recommended for clearance air monitoring. Availability of this analytical service may be limited, however, and turn around time for sample analysis may be significantly longer than the NIOSH methods.) The air sampling shall otherwise be conducted using sampling pumps calibrated at a flow rate of at least two and not more than 4 liters per minute using collection media and procedures in accordance with NIOSH Standard Analytical Method P&CAM 239 or 7400, as available. Air volumes shall be sufficient to provide reliable results down to a concentration of 0.01 fibers per cubic centimeter of air (f/cc) or lower. (Minimum air volumes of 3000 liters shall be collected) for P&CAM 239 and 1000 liters for method 7400. Volume requirements for electrom microscope methods should be discussed with the analytical laboratory)

3.8.4 [The number of samples that are required and the specific locations where they shall be taken should be established by the Building Owner in conjunction with an industrial hygienist before abatement activity begins.]

3.8.5 Aggressive sampling shall be performed with [specify number] portable fans circulating air in the work area to simulate actual use conditions. Negative pressure ventilation units shall not be utilized for this purpose.

3.8.6 Air Samples shall be analyzed by [Phase Contrast Microscopy] (See Part 4 Section 4.5 Laboratory Services) [Transmission Electron Microscopy]

3.8.7 All samples at all locations shall indicate concentrations of airborne fibers less than 0.01 f/cc for release of the work area.

3.8.8 Areas exceeding this level shall be recleaned using procedures in Section 3.7 and retested until satisfactory levels are obtained.

(Implementations Suggestions:

The following is exerpted from A Review of the Scientific Basis for EPA: School Asbestos Hazard Program with Recommendations to State Health Officials. Published by the centers for Disease Control in October, 1984).

When air samples are collected after an asbestos abatement, the "action level" should conform with a policy of lowest feasible level. The concept of an environmental "action level" is not the same as that of a permissible exposrue limit that is precisely monitored for compliance with regulatory standards. As used here it is consistent with a policy of recommending that asbestos exposures be reduced to the lowest feasible level. It is readily measured by the NIOSH #7400 for asbestos in air; and it should be helpful to those who must make risk management decisions when the general public is potentially exposed to asbestos.

An "action level" of 0.01 f/c.c. may be useful as a guidelines for monitoring a building with potentially hazardous asbestos surfaces, as part of a comprehensive program or during abatement work, maintenance, etc. It is not a recommended "occupancy" or "safe" level.

Using the NIOSH Method #7400 including modified rules for counting only fibers with aspect ratios of 5:1 or more in a 1,000 liter air sample will permit detection and quantification of about 0.01 f/c.c. if a coefficient of variation of 25% is considered acceptable for risk-management decisions. This variability is reasonable, since the conversion factor used to convert mass concentration to fiber concentrations in environmental risk assessments has such a large uncertainity factor.

3.9 Disposal Procedures

3.9.1 As the work progresses, to prevent exceeding available storage capacity on site, sealed and labeled containers of asbestos containing waste shall be removed and transported to the prearranged disposal location.

3.9.2 Disposal must occur at an authorized site in accordance with regulatory requirements of NESHAP and applicable State and Local guidelines and regulations.

3.9.3 All dump receipts, trip tickets, transportation manifests or other documentation of disposal shall be delivered to the Building Owner for his records. A recommended recordkeeping format utilizes a chain of-custody form which includes the names and addresses of the Generator (Building Owner), Contractor, pickup site, and disposal site, the estimated quantity of the asbestos waste and the type of containers used. The form should be signed by the Generator, the Contractor, and the Disposal Site Operator, as the responsibility for the material changes hands. If a separate hauler is employed, his name, address, telephone number and signature should also appear on the form.

3.9.4 Transportation to the landfill

3.9.4.1 Once drums, bags and wrapped components have been removed from the work area, they shall be loaded into an enclosed truck for transportation.

3.9.4.2 When moving containers, utilize hand trucks, carts and proper lifting techniques to avoid back injuries. Trucks with lift gates are helpful for raising drums during truck loading.

3.9.4.3 The enclosed cargo area of the truck shall be free of debris and lined with 6-mil polyethylene sheeting to prevent contamination from leaking or spilled containers. Floor sheeting shall be installed first and extend up the sidewalls. Wall sheeting shall be overlapped and taped into place.

3.9.4.4 Drums shall be placed on level surfaces in the cargo area and packed tightly together to prevent shifting and tipping. Large structural components shall be secured to prevent shifting and bags placed on top. Do not throw containers into truck cargo area.

3.9.4.5 Personnel loading asbestos containing waste shall be protected by disposable clothing including head, body and foot protection and at a minimum, half-facepiece, air-purifying, dual cartridge respirators equipped with high efficiency filters.

3.9.4.6 Any debris or residue observed on containers or surfaces outside of the work area resulting from clean-up or disposal activities shall be immediately cleaned-up using HEPA filtered vacuum equipment and/or wet methods as appropriate.

3.9.4.7 Large metal dumpsters are sometimes used for asbestos waste disposal. These should have doors or tops that can be closed and locked to prevent vandelism or other disterbance of the bagged asbestos debris and wind dispersion of asbestos fibers. Unbagged material shall not be placed in these containers, nor shall be used for non-asbestos waste. Bags shall be placed, not thrown, into these containers to avoid splitting.

3.9.5 Disposal at the landfill

3.9.5.1 Upon reaching the landfill, trucks are to approach the dump location as closely as possible for unloading of the asbestos containing waste.

3.9.5.2 Bags, drums and components shall be inspected as they are offloaded at the disposal site. Material in damaged containers shall be repacked in empty drums or bags as necessary. (Local requirements may not allow the disposal of asbestos waste in drums. Check with appropriate agency and institute appropriate alternative procedures.)

3.9.5.3 Waste containers shall be placed on the ground at the disposal site, not pushed or thrown out of trucks (weight of wet material could rupture containers).

3.9.5.4 Personnel off-loading containers at the disposal site shall wear protective equipment consisting of disposable head, body and foot protection and, at a minimum, half-facepiece, air-purifying, dual cartridge respirators equipped with high efficiency filters.

3.9.5.5 Following the removal of all containerized waste, the truck cargo area shall be decontaminated using HEPA vacuums and/or wet methods to meet the no visible residue criteria. Polyethylene sheeting shall be removed and discarded along with contaminated cleaning materials and protective clothing, in bags or drums at the disposal site.

3.9.5.6 If landfill personnel have not been provided with personal protective equipment for the compaction operation by the landfill operator, Contractor shall supply protective clothing and respiratory protection for the duration of this operation.

3.10 Reestablishment of the Work Area and Systems

3.10.1 Reestablishment of the work area shall only occur following the completion of clean-up procedures and after clearance air monitoring has been performed and documented to the satisfaction of the Building Owner

3.10.2 Polyethlene barriers shall be removed from walls and floors at this time, maintaining decontamination enclosure systems and barriers over doors, windows, etc. as required.

3.10.4 The Contractor and Owner shall visually inspect the work area for any remaining visible residue. Evidence of contamination will necessitate additional cleaning requirements in accordance with Section 3.7

3.10.5 Additional air monitoring shall be performed in accordance with Section 3.8 if additional clean-up is necessary.

3.10.6 Following satisfactory clearance of the work area, remaining polyethylene barriers may be removed and disposed of as asbestos contaminated waste.

3.10.7 At the discretion of the Contractor, mandatory requirements for personal protective equipment may be waived following the removal of all barriers.

3.10.8 Resecure mounted objects removed from their former positions during area preparation activities.

3.10.9 Relocate objects that were removed to temporary locations back to their original positions.

3.10.10 Reestablish HVAC, mechanical and electrical systems in proper working order. Remove contaminated HVAC system filters and dispose of as asbestos contaminated waste. Decontaminate filter assembly using HEPA vacuums and wet cleaning techniques. Install new filters in HVAC systems. Dispose of old filters.

3.10.11 Repair all areas of damage that occured as a result of abatement activities.

Part 4 Support Activities and Personnel

4.1 Training

4.1.1 Training shall be provided by the Contractor to all employees or agents who may be required to disturb asbestos containing or asbestos contaminated materials for abatement and auxilliary purposes and to all supervisory personnel who may be involved in planning, execution or inspection of abatement projects.

4.1.2 Training shall provide, at a minimum, information on the following topics:

4.1.2.1 The health hazards of asbestos including the nature of various asbestos related diseases, routes of exposure, known dose-response relationships, the synergistic relationship between asbestos exposure and cigarette smoking, latency periods for disease and health basis for standards.

4.1.2.2 The physical characteristics of asbestos including fiber size, aerodynamic properties, physical appearance and uses.

4.1.2.3 Employee personal protective equipment including the types and characteristics of respirator classes, limitations of respirators, proper selection, inspection, donning, use, maintenance and storage of respirators, field testing the face-piece-to-face seal (positive and negative pressure fitting tests), qualitative and quantitative fit testing procedures, variations between laboratory and field fit factors, factors that affect respirator fit (e.g. facial hair), selection and use of disposable clothing, use and handling of launderable clothing, non-skid shoes, gloves, eye protection and hard hats.

4.1.2.4 Medical monitoring requirements for workers including required and recommended tests, reasons for medical monitoring and employee ac--cess to records.

4.1.2.5 Air monitoring procedures and requirements for workers including description of equipment and procedures, reasons for monitoring, types of samples and current standards with recommended changes.

4.1.2.6 Work practices for asbestos abatement including purpose, proper construction and maintenance of air-tight plastic barriers, job set-up of airlocks, worker decontamination systems and waste transfer airlocks, posting of warning signs, engineering controls electrical and ventilation system lockout, proper working techniques, waste clean-up, storage and disposal procedures.

4.1.2.7 Personal hygiene including entry and exit procedures for the work area, use of showers and prohibition of eating, drinking, smoking and chewing in the work area.

4.1.2.8 Special safety hazards that may be encountered including eletrical hazards, air contaminants (CO, wetting agents, encapsulants, materials from Owner's operation), fire and explosion hazards, scaffold and ladder hazards, slippery surfaces, confined spaces, heat stress and noise.

4.1.2.9 Workshops affording both supervisory personnel and abatement workers the opportunity to see (and experience) the construction of containment barriers and decontamination facilities.

4.1.2.10 Supervisory personnel shall, in addition, receive training or contract specifications, liability insurance and bonding, legal considerations related to abatement, establishing respiratory protection medical surveillance programs, EPA OSHA [and State] recordkeeping requirements, and other topics as requested by the Building Owner.

4.1.3 Training must be provided by individuals qualified by virtue of experience and education to discuss the topic areas in 4.2

4.1.4 Training is to have occurred within 12 months prior to the initiation of abatement activities.

4.1.5 Contractor must document training by providing date of training, training entity, course outline, and names and qualifications of trainers.

4.2 Medical Monitoring

4.2.1 Medical Monitoring must be provided by the Contractor to any employee or agent that may be exposed to asbestos in excess of background levels during any phase of the abatement project. (Due to the synergistic effects between smoking and asbestos exposure, it is highly recommended that only non-smokers be employed in positions which may require them to enter asbestos contaminated atmospheres.

4.2.2 Medical monitoring shall include at a minimum:

4.2.2.1 A work/medical history to elicit symptomatology of respiratory disease.

4.2.2.2 A chest x-ray (posterior - anterior, 14 x 13 inches) evaluated by a Certified B-reader.

4.2.2.3 A pulmonary funtion test, including forced vital capacity (FVC) and forced expiratory volume at one second $(FEV)_1$, administered and interpreted by a Certified Pulmonary Specialist.

4.2.3 Employees shall be given an opportunity to be evaluated by a physician to determine their capability to work safely while breathing through the added resistance of a respirator. (Examining physicians shall be aware of the nature of respiratory protective devices and their contributions to breathing resistance. They shall also be informed of the specific types of respirators the employee shall be required to wear and the work he will be required to perform, as well as special workplace conditions such as high temperatures, high humidity, and chemical contaminants to which he may be exposed.)

4.3 <u>Asbestos Project Manager</u>

4.3.1 The Asbestos Project Manager shall be the Owner or a designated respresentative paid by the owner. (also known as Clerk-of-the-Works or Competent Person this person could be an administrator, architect, engineer, industrial hygienist or other individuals(s) posessing the qualifications detailed in section 4.3.2.)

4.3.2 The Asbestos Project Manager shall be able to demonstrate through special education, training, skills, knowledge or experience satisfactory to the Building Owner to indicate the ability to carry out the following activities as required:

4.3.2.1 Assist in decision making regarding selection of procedures

4.3.2.2 Assist in writing contract specifications for the abatement

4.3.2.3 Assist in evaluation of bids and selection of a contractor

4.3.2.4 Enforce contract specifications

4.3.2.5 Tour work area with the Contractor and agree on pre-abatement conitions of the work area

4.3.2.6 Inspect and sign off on barriers and decontamination enclosure systems.

4.3.2.7 Observe activities at all times during the course of abatement.

4.3.2.8 Meet with the Contractor daily to review work progress and solve problems or adjust procedures as appropriate.

4.3.2.9 Perform bulk material or air sampling and all workplace inspection clearance inspections for the Building Owner.

4.3.2.10 Report on abatement to the Building Owner.

4.3.2.11 Request, review and maintain Contractor submittals.

4.3.2.12 Provide training and/or respirator fit testing to personnel.

4.3.3 The Asbestos Project Manager shall have the authority to stop any job activities if they are not being performed in accordance with applicable regulations or guidelines or the requirements of this specification. These will be reported to the Owner. with description of activity, reason for stopping it and alternatives for correcting the problem. (Note: The Asbestos Project Manager should be selected as early as possible prior to selection of the Contractor to enable participation during the pre-bid conference, walk-through, and pre-construction conference.)

4.3.4 The Asbestos Project Manager shall be covered by adequate liability insurance to protect against errors and omissions in the performance of support activities. [Building Owner may insert minimum requirements based on individual projects.]

4.4 Air Sampling Professional (ASP)

4.4.1 The Air Sampling Professional shall conduct all air sampling for the Building Owner.

4.4.2 The ASP shall conduct air sampling in accordance with the NIOSH Standard Anylytical Method for Asbestos in Air P&CAM 239 and/or Method 7400 or other acceptable methods as otherwise agreed upon.

4.4.3 It is recommended that the following schedule be utilized for air sampling during the project (in addition to OSHA compliance monitoring):

4.4.3.1 Pre-abatement sampling - A sufficient number of air samples shall be collected prior to the start of abatement activities in order to determine prevalent airborne concentrations. Samples should be taken both inside and outside of the work area and buildings to establish existing levels under normal activity conditions.

4.4.3.2 Sampling during the abatement project

4.4.3.2.1 The following schedule of samples shall be required on a daily basis, once abatement activities begin (The following are recommended minimums. The size of the abatement activity will impact on the number of samples necessary to adequately monitor the Contractor's activities. Decisions on the number of samples should be made with the advice of the Air Sampling Professional):

2 Area Samples (inside the work area)

2 Personal Samples (inside the work area)

2 Area Samples (outside the work area in uncontaminated areas of the building. One of these shall be at the entrance to the worker decontamination enclosure.)

1 Area Sample (outside the building)

1 Area Sample (at the exhaust of negative pressure ventilation equipment.)

The number and location of air samples will vary on a job-to-job and day-to-day basis. Consult the air sampling professional for guidance before the project begins.

4.4.3.2.2 Samples shall be collected at a sampling rate of 2 liters/min. A minimum acceptable air volume is 480 liters.

4.4.3.3 Post-Abatement (clearance) air sampling shall be conducted following the cleaning phase of work, once the no visible residue criteron has been met. A sufficient number of samples shall be collected aggressively (with portable fans circulating air in the work area to simulate actual use conditions) to determine post-abatement air concentrations. An adequate volume of air to provide accuracy to 0.01 fibers/cc is required.

4.4.4 The Air Sampling Professional shall be experienced and knowledgeable about the methods for asbestos air sampling and be able to select representative numbers and locations of samples.

4.5.5 The Air Sampling Professional shall have adequate liability insurance to protect against errors and omissions in the performance of support activities. [Building Owner may insert minimum requirements based on individual projects.]

4.5 <u>Laboratory Services</u>

4.5.1 Laboratory utilized for analyzing air samples by NIOSH shall be satisfactory participants in the NIOSH Proficiency Analytical testing (PAT) program asbestos analysis.

4.5.2 Laboratories used for bulk material identification shall be satisfactory participants in the EPA quality assurance program for bulk asbestos analysis.

4.5.3 The period of time permitted between the collection of air samples and the availability of results shall be less than 24 hours for samples collecting during abatement activities. Timetables for results of pre-abatement and clearance air samples shall be established by the Building Owner. (On-site analytical capabilities are preferred for immediate results of sampling. This provides the Building Owner with a timely review of Contractor performance and a more rapid awareness of hazardous exposure conditions which can be corrected. This service may not be readily available, however. Real-time monitoring instruments provide some support in this matter as long as their limitations are clearly understood and the Contractor and Building Owner agree in advance on how the results are to be used. These devices do not meet current OSHA monitoring requirements and should not be used in place of sampling as described in Section 4.4.3.2).

PRE-WORK ACTIVITIES AND CONSIDERATIONS

Objective: To review the primary tasks that should be performed by the contractor before beginning an asbestos abatement project. Also, to discuss important considerations that should be examined before agreeing on job specifications and price.

Learning Tasks: Information in this section should enable participants to:

- ☞ Understand what to look for when conducting the pre-bid walk-through survey of the job site.

- ☞ Ask specific questions relating to job site conditions and how they effect agreements under the specifications.

- ☞ Become knowledgeable in good techniques for screening and selecting abatement employees.

- ☞ Understand the type of information that needs to be covered in a training program for abatement employees.

- ☞ Understand the design and use of a project logbook and its importance during an asbestos abatement job.

I. ASSESSING THE WORK AREA

An important "rule of thumb" for any asbestos abatement contractor is to never accept, or bid a project, without first viewing and assessing the site. There is much valuable information to be gained during one of these assessments, such as determining the size of the job (number of sq. ft. of asbestos-containing material), or examining the configuration of the ceiling surface (irregular ceiling shape can increase the amount of asbestos-containing material originally believed to be present). A survey such as this also provides a basis upon which the contractor can formulate an effective strategy for asbestos removal and/or control. Some of the important items an abatement contractor will need to look for on this pre-bid survey are outlined in this section of the program.

Check Analytical Results of Bulk Samples

The first questions that a contractor probably should ask during the pre-bid walk through survey are who did the initial survey to identify the asbestos, what type of sampling was conducted, and what forms of analysis were used.

The contractor should ensure that appropriate bulk sampling was performed by qualified individuals using proper analytical methods. A laboratory that participates in the EPA bulk asbestos identification quality assurance program is a minimal requirement (accreditation by the American Industrial Hygiene Association is also preferred). The contractor should then review the analytical results of the bulk samples to determine the types and percentages of asbestos present. There are several reasons why this type of information will be of benefit to the contractor. First, the analytical reports provide excellent documentation that can be used in establishing a project file. This file can then be used as a good source of reference should any questions arise concerning the asbestos-containing materials in the building. Information contained in the analytical reports is also important because different types of asbestos will require various handling techniques. For instance, amosite is considered by some scientists to be more hazardous than chrysotile, in addition to not accepting wetting agents as well, and will require different handling procedures. Fiber counts will usually be much higher when handling amosite as opposed to chrysotile.

If analytical reports are not available prior to, or during the survey, the contractor should obtain his/her own by including it as part of the assessment. It is important that the information from these reports be used as the main criteria on which to base decisions, rather than word-of-mouth from a resident maintenance worker or other building occupant which could lead to confused facts or other misinformation.

Inspect the Nature of the Asbestos-Containing Material

The contractor should determine the hardness and texture of the asbestos-containing material to be removed (must touch it). He/she should also note whether or not it has been painted over. (Note: A high efficiency cartridge type respirator should be worn when conducting these tests.) The contractor may also wish to test a sample area of asbestos-containing material to determine its ability to absorb amended water. This can be done by using a plant sprayer. If the material cannot absorb wetting agents, other appropriate strategies will need to be developed which may increase the cost and project time.

Check Accessibility of Material

Note the accessibility of all materials for removal; that is, whether or not the asbestos-containing material is accessible enough to remove. If not, an alternative means of control might have to be used such as encapsulation or enclosure. Several factors that may enter into this determination are ceiling height, false ceilings, pipes, sprinklers, ducts, sloping floors, fixed barriers, etc.

Check for Difficulty of Isolating the Work Area

Another important concern is isolating the area in which removal will take place. Is it possible to enclose the area completely by using six mil polyethylene? Or, will other measures have to be implemented in certain areas to adequately isolate the removal site. In cases such as school buildings, it may be easiest to simply line the walls and floors with two layers of six mil polyethylene since the contractor will usually remove all desks and chairs from the work area. However, in cases such as a church or computer room, plywood and plastic enclosures may have to be constructed so that the materials left in the room will not be contaminated by the asbestos removal activities, or damaged by water. Another section of this program, "Preparing the Work Area and Establishing a Decontamination Unit," further discusses these practices.

Determine if Areas Adjacent to Abatement Activity Will Be Occupied

If areas adjacent to the abatement activity will remain occupied, several important practices should be observed. Most importantly, the HVAC system will need to be altered, or the opening of the duct into the work area should be completely sealed off. This sealing of the HVAC helps ensure that airborne fibers will not be drawn into the air return system and dispersed throughout adjacent areas, or the supply system will not place the work area under positive pressure and cause airborne fibers to escape. To provide documentation that contamination of adjacent areas has not occurred, a qualified person should take background air samples in each of the areas before abatement work begins. These results are then compared to the results of samples taken in these areas during and after the work is completed. By doing this sampling, it can be demonstrated that other areas were not contaminated as a result of the asbestos abatement work.

Determine Room Volume and Natural Air Movement in the Work Area

During this walk-through survey, consideration should be given to the number and placement of negative air units. An estimate of the air volume in the work area is necessary for determining the number of units needed to achieve the desired number of air changes per hour. Also, the way in which air will move through the work area is a consideration in placement of the negative air units. This idea is further outlined in the section entitled, "Confining and Minimizing Airborne Asbestos Fibers."

Check Items Requiring Special Protection

During the pre-bid walk-through, items requiring special protection should be noted. These items might include walnut paneling, trophy cabinets, glass piping, carpets, lab equipment, dangerous chemicals, computers, and elevators.

In the case of walnut paneling, common sense should be used when hanging polyethylene to enclose the work area. Care must be used when tacking up the plastic so that the paneling will not become damaged. The nails should be placed between the panel strips in the natural gaps as near the ceiling as possible to prevent any small holes from being visible.

For trophy cabinets that are stationary and must remain in the work area while removal is taking place, proper measures must be taken to ensure that the cabinet is adequately enclosed with six mil polyethylene. During this initial survey, the contractor should note the condition of any of these cabinets, and the exact contents of each to prevent any future conflicts that could result if someone were to claim that something was damaged or missing.

Glass piping is another item that the contractor should note during the pre-bid walk-through since special procedures must be followed to ensure that it does not become damaged. These glass/ceramic pipes will often contain hazardous materials, (i.e., acids, hazardous waste, etc.). Therefore, the pipes should be tagged and/or labeled as containing hazardous materials, and workers should avoid contacting them if possible. These glass pipes are often found in the vicinity of other pipes which have asbestos-containing lagging on them. Therefore, contingency procedures must be established to prevent and handle hazards which could develop from working around these pipes.

Determine if Existing Carpet is to be Removed

Special note should also be made of where carpeting is located in the facility. In most cases, the carpeting should be removed completely from the area in which the asbestos removal will be taking place. When fibers settle on a carpeted surface, they often penetrate through to the floor and become trapped underneath. Once this occurs, repeated traffic over the area will cause the fibers to be redispersed throughout the surrounding air. If carpet is specified for removal, assess the difficulty of removing it (i.e., the carpet may be glued in place). Also, consideration must be given to disposal requirements/procedures.

Note Any Materials or Equipment Which Will Require Special Handling

Additionally, lab equipment and/or dangerous chemicals should be examined closely by the contractor during the pre-bid walk-through survey. It may be necessary to remove much of the equipment and/or chemicals from the work area before abatement activities take place. If the contractor's employees will be moving expensive lab equipment or chemicals, the contractor should ensure that all items are appropriately handled through training and/or direct supervision. This may be a tedious process requiring extra time to complete. In some cases, the building owner may have their own maintenance personnel perform these functions before the contractor comes in to begin work.

Note Stationary Objects that Require Special Attention

As previously mentioned, if the abatement work area will be in a room that contains computers which cannot be moved, other strategies must be developed such as building an elevated platform (plywood and plastic) over the terminals.

Elevators can also be a major problem on as asbestos abatement job. The elevator, or the shaft can become contaminated with asbestos-containing materials, or their movement can cause air displacement in contaminated areas. The contractor will need to take special precautions to properly seal off the doors with six mil polyethylene (even plywood in some cases) and to key the elevator not to stop at the floor(s) on which the work area is located.

Other Considerations

To prevent any misunderstandings or conflicts, it is imperative that the job specifications spell out exactly who is to pay for the utilities used during the project. Usually, the building owner will pay these expenses, but if not, this should be clearly understood by both sides before work begins. Likewise, the waste water filtration and disposal method should be agreed upon and specified (see "Waste Disposal Requirements").

The contractor should also document all pre-existing damages in the areas in which his/her employees will be working. Photographs, video-tapes, diagrams, lists, and tape recordings may be used for these purposes. This documentation should include all surface damages (walls, tables, desks, etc.), vandalism, roof leaks, or other water damage. This consideration is important because often after a project has been completed, the building owner, or another facility operator will claim that some damages occurred as a result of the contractor's work. By utilizing the list that was developed at the beginning of the project, the contractor can verify whether the damages were pre-existing, and not a result of the contractor's work.

Other important aspects that should be considered by a contractor when conducting a pre-bid walk-through survey include an estimate of the temperature when the project is scheduled to begin. It may be that the bid is at the end of the summer, and the project is scheduled to begin in the winter, or vice versa. In these cases, appropriate climate control strategies will need to be implemented. Also, at this time, it should be decided who will provide security at night or off-hours to assure that no unauthorized entries into the contaminated work area will occur.

Additional safety hazards that need to be considered include all electrical circuits and/or receptacles, equipment, etc. Since the work area in an asbestos abatement job will commonly contain large amounts of water, the potential for electrical hazards will be greatly increased. During the pre-bid walk-through, the contractor should make note of all these potential hazards. Once the building owner is made aware of these situations, an appropriate plan of action can be implemented. It may be possible and appropriate to shut down all power to the work area while the project is going on. If not, other precautions will need to be taken. This is discussed in greater detail in the section entitled, "Safety and Health Considerations, Other than Asbestos."

Consideration must also be given as to where the contractor will be able to park vehicles or trailers. Are there adequate facilities presently available, or will other arrangements have to be made? Along with this, consideration must be given to where the contractor's equipment and supplies will be stored. If there is not adequate space available on the job site, it may be necessary to rent additional space at some nearby location. Care must be used so that the rented space will not become contaminated. (Note: Recommend lining the space with two layers of six mil polyethylene.)

Possibly, the most important aspect to consider during the pre-bid survey is whether full or partial removal will take place. If partial removal will be performed, the airborne fiber clearance levels in the contract specifications should be examined closely to determine if that level is achievable.

Another area of concern during the walk-through should be the configuration of the walls and surfaces for attaching tape. This is important to determine how the polyethylene sheeting will have to be hung to adequately enclose the work area. Care must be used when hanging polyethylene so the walls will not be damaged, but the plastic will remain in place until intentionally moved. This is an important consideration at this time since the contractor will have to estimate how much material will be needed to enclose all work areas. Many times, the building owner may want the project to be inconspicuous to the general public.

Therefore, opaque polyethylene may have to be used to construct tunnels from the work areas outside to the waste disposal trucks. Additionally, depending on the nature of the work area, special tools, equipment, and man-lifts or scissorlifts may have to be utilized during prepping of the work area.

The location and type of decontamination units should also be a major consideration before submitting a bid. Will it be possible to have one central decontamination unit, or will it be necessary to establish multiple stations? Some contractors may have their own units (i.e., trailers), but many choose to build them on-site. Many buildings in which asbestos removal takes place already contain shower facilities (i.e., school buildings, gymnasiums, etc.). Under no circumstances should the contractor ever permit his/her employees to use these as part of the decontamination sequence. Separate facilities should be constructed utilizing appropriate waste water filtration equipment. An advantage of building temporary site units is that the chance of residual contamination is reduced since they will be demolished at the end of the project and disposed.

Also, a major area of concern when assessing a facility prior to beginning work is identification of any hot surfaces (pipes) that could present a hazard to abatement workers. First, it should be noted whether the pipes will be active or inactive. If they are active, appropriate measures will have to be taken to ensure that workers will not contact these surfaces. If the lines are inactive, work may be carried out as it would on any other surface of normal temperature. The contractor should investigate the types of re-insulation that will be required on surfaces and pipes after the asbestos-containing material has been removed. The original material was there for some specific purpose; thus, a replacement material with similar properties will probably be necessary.

If type C, air supplied respirators will be used, the contractor must determine whether or not the hoses will reach the work area from the air-generating source. Low pressure air-supply lines cannot exceed 300 feet, according to OSHA regulations.

Another important aspect that must be considered by a contractor before bidding a project is who will pay for the air monitoring, and whether or not the person conducting the monitoring is qualified. This should be established in the specifications. The building owner should always be responsible for the daily air sampling, but the contractor is often responsible (and required by OSHA) to conduct personal air sampling on the asbestos abatement employees. (Note: This is discussed in greater detail in the "Air Monitoring" section.)

The contractor should ensure that the job specifications allow adequate time for their company to complete the job with a high degree of quality. If specifications call for a "hurry up" job, the contractor should inform the building owner or architect if they do not feel that adequate time is available to complete the project. Attempting to perform the job hastily may only result in sloppy work and may needlessly endanger the health and safety of employees or other building occupants.

Lastly, since there are an increasing number of asbestos abatement projects being undertaken these days, many times the people directly involved with attempting to coordinate an asbestos abatement program for a facility may not be adequately educated in what needs to be included in the job specifications. Thus, there will inevitably be cases in which specifications from other projects are photocopied and sent out for bids. These are often not applicable in the least to the particular facility of concern. The contractor should ensure that the specifications they are bidding on are designed for the work and work area of that facility. Though other specifications can usually serve as a good guideline for developing a new set of specifications, they should never be used verbatim from one project to another. No matter how similar projects may seem, each one is different in some way.

These are not <u>all</u> of the special considerations that need to be examined when conducting a pre-bid walk-through survey of an asbestos-containing facility; rather, they are some common concerns that should typically be investigated before beginning any asbestos abatement project. These aspects are important because they could cost the contractor's company a substantial amount of time and money, in addition to possibly endangering the lives of employees or other building occupants. It is imperative that the contractor and the building owner have a firm understanding as to exactly how each step of the project will be carried out.

II. MEDICAL SURVEILLANCE

Contractors are required as employers to provide, at no charge to the employee (if exposed to asbestos), a physical examination by a qualified physician. There are specific items that these physicals must entail (refer to OSHA 29 CFR 1910.1001). The contractor may use the results of these physicals to screen potential employees that may have had previous exposures to asbestos. If possible, the contractor should avoid hiring a heavy smoker as a removal worker, or anyone else that would naturally be at an increased risk from previous exposure. This topic is further detailed in the section entitled, "Medical Surveillance."

III. EMPLOYEE TRAINING

Any workers who will be in or around an asbestos abatement work area should, as a minimum, be advised of the hazards associated with asbestos exposure, be trained in how to adequately protect themselves from exposure during the course of the project, and be trained in correct job procedures for each of their positions. OSHA requires training for the use of respirators. A good way of documenting that this training has taken place is to develop a formal training session at which attendance is a mandatory condition of employment. After the training is complete, a written test should be administered. Those who pass the exam should be permitted to proceed with work, and those that fail should be held back, reviewed as to why they failed, and subsequently re-trained. A typical training program will be at least six to eight hours long, and for more complex jobs, should last two days.

A good, in-depth training program should cover many concepts dealing with the various aspects of asbestos abatement projects. Background information on asbestos. Employees should be told what it is and where it comes from. Also, they should be informed as to how asbestos was used and why. An architect, or someone else with a good technical background may be best suited to present this part of the training program.

The next phase of the training should be an outline of the dangers or health hazards associated with exposure to asbestos fibers. Someone with a good understanding of the medical hazards associated with breathing asbestos should give this part of the training session. It is important that not only the health hazards be discussed, but also how the fibers enter the body, and what happens once they are contained inside the lungs. Fiber size, visibility, and settling times are all important information. A film or slides may be helpful in illustrating these points.

After employees are made aware of the health hazards associated with asbestos exposure, the next phase of training should be on what they can do to protect themselves from this exposure (i.e., work practices and personal protective equipment). This training should include step-by-step instruction on how to perform each task associated with their jobs (i.e., glovebagging, wetting and scraping, etc.). Also, training should include a comprehensive review of the use of respiratory protection including the following aspects:

a. How to put on and take off the respirator
b. Cleaning and Maintenance of Respirators
c. Inspection of Respirators
d. Fit testing of Respirators
e. Discussion on uses and limitations of different types of respirators
f. Hands-on experience (look at various parts)

Note: The training requirements of an effective respiratory protection program are addressed in the section entitled, "Respiratory Protection."

It is also important that workers be properly trained in the use of protective clothing. They should be made aware of its limitations, and how it should be used to optimize the protection factor.

The next phase of the training program should be a discussion of all applicable EPA and OSHA regulations regarding asbestos abatement projects. Also, there may be certain state or local regulations of which employees need to be aware. This part of the program should not be extremely detailed, rather it should provide the employees with a good understanding of what they should or should not do when conducting removal of asbestos-containing materials. It should be emphasized that the main concern is the safety and health of the workers, rather than simply the concern of receiving a citation for a violation.

The fifth phase of employee training should deal with proper techniques for sealing off the work area. In this section, employees will be instructed on what to look for before sealing off the work area, and also how to construct a safe and effective enclosure. Employees should first be made aware of what an HVAC system is, and how it affects the air movement through an area. They should also be instructed on how to shut the system down and seal off outlets and inlets so that airborne fibers will not be drawn into it. Employees should then be instructed in proper techniques for erecting plastic barriers, draping the walls, floors, and furniture with six mil polyethylene. This also includes construction of airlocks and change rooms, in addition to posting appropriate warning signs, etc. Also, it is important to inform employees that if a puncture develops in the polyethylene enclosure while the work area is active, they should stop work and immediately seal the leak.

Following the session on sealing off the work area, workers should be trained in how to effectively confine and minimize airborne fiber generation. This can best be accomplished through proper use of wet methods (i.e., spray the asbestos-containing material with amended water). Workers should also be informed at this time that different forms of asbestos will react differently to the application of water. For example, chrysotile will typically accept water; while amosite is generally more resistant to wetting. Therefore, employees will have to take appropriate protective measures since airborne fiber concentrations will be potentially higher when a removal job involves amosite. Employees should be instructed in methods of misting the air with water, and also in the proper methods of using the HEPA vacuum. Additionally, the function of negative air units should be outlined and employees made aware of the need to ensure that these units are kept running so that if a rupture occurred in the enclosure, fiber leakage would be minimized.

A very important aspect of employee training that is often taken lightly is the recognition and control of safety and health hazards (other than asbestos) in an asbestos abatement work area. Proper training can help reduce employee injuries, and lost time accidents. Subject areas that should be covered in this part of the session include the proper use of scaffolding, how to recognize and/or eliminate trip/slip hazards, the proper use of ladders, the identification of any electrical hazards, and how to avoid heat stress/heat stroke situations.

The next phase of employee training should entail cleaning up the work area. This cleaning will take place after gross removal has occurred and all residual debris is ready to be disposed of. Wet cleaning techniques should be reviewed (wetting the waste and collecting it off the floor). Settling times should also be discussed.

Correct disposal of asbestos-containing debris is also an important aspect of an abatement employee training program (specifically for employees that will be directly involved with disposal operations). This part of the program should include discussions on the need to place the wetted waste in appropriately labeled six mil polypropylene bags. These bags should then be placed in airtight fiberboard drums before being loaded into the enclosed truck to be taken to the landfill. (Note: See section entitled, "Waste Disposal Requirements.") It is important that any employees who might be involved with this type of operation in some way be made aware of the proper procedures for carrying out these waste disposal activities and the protective equipment required.

Another important aspect that an employee training program should include is information on final inspections/air sampling, and why it is important. The reason that employees need to be aware of what the final inspections will entail is because when they finish work in a certain area, they can conduct a fairly thorough visual inspection themselves.

Employees should also be informed as to why air sampling is being conducted, and what the results mean. Employees should be informed that they may be asked to wear a personal air sampling pump while they are performing their job so that the fiber levels that they are exposed to can be closely monitored. They should be requested to cooperate with the industrial hygienist when it is their turn to wear the sampling equipment. It must also be emphasized to the employees not to tamper with the sampling equipment that they are wearing since the results will indicate the level of airborne fibers to which they are being exposed.

Another aspect that the training program should cover is an explanation of the personnel decontamination sequence. This should cover procedures to be followed when beginning or finishing a shift of asbestos abatement work. When beginning a shift, employees should be instructed to enter the clean room first, put on their protective equipment/clothing, proceed through the shower area and into the dirty equipment room before entering the work area. When finishing a shift, employees should be instructed to enter the dirty equipment room first, remove all of their protective clothing (except respirators), and then take showers. Respirators should be removed and washed while the employee is in the shower. After the employees complete the shower, they can then go to the clean room to change back into their street clothes. Employees should also be instructed that in emergency situations, the emergency will probably override the potential of adjacent area contamination, and good judgement should be used if someone needs to get out of the work enclosure very quickly (employee has a heart attack, fire, etc.). Emergency break-through points in the polyethylene enclosure should be clearly marked so that they will be easily accessible.

Once all of this formal classroom training is completed, ample time should be provided for employees to participate in hands-on training or workshops. Demonstration in these workshops should include proper techniques for glovebagging, wet and scrape methods, constructing work area enclosures, personal protective equipment, etc. This will be the most effective way to illustrate exactly how these typical asbestos abatement procedures should be conducted.

Throughout the training program, slides, video tapes, and hand-outs should be utilized when possible. A mixture of training techniques results in better learning. Also, employees with prior experience in asbestos abatement may have valuable input during this session. These comments should be encouraged by the instructor, and any misinformation should be immediately corrected without "putting the person down." It is important for the instructors not to get overly technical in any one area. At the end of the program, the written test should be administered. Results of these tests should be used to spot areas where employees may need further training. Also, at this time, employees should sign a form indicating that they have received training. The tests and the forms should then be place in a file so that there will be documentation that employees were trained appropriately.

IV. DESIGN AND USE OF A PROJECT LOGBOOK

Prior to the start of any asbestos abatement project, a logbook should be established. The logbook serves as a vehicle for maintaining all the records associated with a project. At a minimum, included in the book should be copies of the employees' medical reports, copies of any accident, injury, or accident reports, air sampling results, notes concerning any deviation from standard work procedures, sign-in sheets, and all other pertinent documents, permits, correspondence, photographs, or records. Many of these records will be duplicated elsewhere such as medical records in the employee's personal file, etc.

The logbook serves many important functions. It provides a ready reference for each project that can be presented at any time during the project, or long after its completion. It may be produced by the contractor to demonstrate to future clients the procedures followed during a project. The logbook can be an important tool for planning future jobs and estimating costs. When planning a project similar in nature, it can aid in estimating how long the project will take to complete, how many people will be necessary, and how to approach specific problems. The following examples may help to illustrate this point.

Example: Prior to the start of one job, the contractor probed the depth of the fireproofing and found it to be approximately three inches deep. During the removal, they discovered that approximately fifty percent of the fireproofing was over six inches deep, and in some areas, nine inches deep. A few extra minutes of probing the depth of the fireproofing would have saved much time and money during this project. Unfortunately, this was not the first time that this had happened to this company. Had it been recorded in a logbook the first time it occurred, and changes in the standard procedures for estimating the amount of material made, this problem would probably have been avoided.

Example: A removal project of twenty-four thousand square feet was two days ahead of schedule with only the sprayback of treated cellulose remaining to be completed. Three days after this sprayback material was applied, it began to fall from the ceiling. It took the contractor an extra week of work to remove this material and replace it with a different substance. The problem appears to have resulted from the inability of the material to adhere to the substrate since temperatures during application exceeded 95°F in some cases. Notes of this problem were maintained in the project logbook and corresponding instructions added to the standard operating procedures to prevent this from occurring again.

A project logbook may help in protecting a contractor from future liability concerning a specific project. A logbook indicates that the contractor performing the work actually attempts to do the best job possible using state-of-the-art techniques. The sign-in sheets maintain a record of all people entering and exiting the work area, for what purpose, for how long, and what personal protective equipment they need. This information, coupled with the air sampling data, can quickly be used to estimate how much asbestos the person was exposed to and for how long. Copies of daily inspection reports will also reveal if employees were wearing the appropriate protective equipment and whether or not it was adequate in protecting them from the airborne fiber levels documented by the air sampling results. This information would be very valuable if needed for litigation in the future. It is important to note that <u>all</u> records must be kept, not just a portion of them.

<u>Example</u>: The following is a hypothetical example. The year is 1996, a woman dies of lung cancer. Her husband recalls that she worked in a building when 20 years before, the owner had stripped asbestos-containing fire-proofing from the boiler room. A suit is filed against the building owners and the contractor who performed the removal work. Although the contractor performed air sampling throughout the projects, no records were kept regarding work practices, other people in the area, whether the air handling system was on or off, or where the waste was disposed. Since this is a hypothetical case, speculation on the outcome would not be appropriate. However, the contractor would have a better defense if proper records were maintained.

The logbook should be well organized, but in a style decided by the contractor. There are two common methods of organization. First, there is the day-by-day method such as a ship captain's log. If this method is chosen, a looseleaf or bound notebook with dividers labeled with each day should be maintained for each job. Be sure to make entries on days that no work is done including how the integrity of the jobsite was maintained.

Another more common method of organizing a logbook is by activity. Using this method, a looseleaf notebook is divided into each activity and all documentation, notes, and receipts concerning that activity is maintained in the appropriate section. The following outline is one suggestion for organizing a logbook. It should be noted that this is just one outline; depending on the requirements of each project, some sections may not apply, while additional ones may be necessary.

SECTION	CONTENTS
Pre-Work Papers	EPA or state notification forms, any necessary state licenses, county or city permits (contractor license, disposal permits, etc.). Records regarding the bonding company, size of bond, insurance coverage, etc.
Contract Specifications	Contract specifications, including all drawings/diagrams would be in this section.

Personnel	Personnel records including employment application, W-4 withholding forms, medical records, and any other records pertaining to each employee. Some firms also have their employees sign certificates stating that they have read and understand the OSHA asbestos standard (29 CFR 1910.1001), been trained in asbestos removal techniques, trained and fit tested for respirators, etc.
Sign-In Sheets	A separate section containing the daily sign-in sheets indicating when each employee went in and out of the work area, their affiliation, and their purpose for entering the work area. In this section would be a list of all authorized personnel permitted to enter the contaminated area. Also in this section is a record of each employees work hours for payroll purposes.
Subcontractors	This section would be a record of all subcontractors' activities including copies of the contract, names, dates, etc.
Air Monitoring	All air sampling for the project should be included in this section. Area air sampling and personal sampling results should be presented. Also presented in this section should be a copy of the sampling and analytical method used along with information concerning who performed the work.
Waste Disposal	Records of waste disposal activities including trip tickets should be kept in this section.
Daily Inspection Reports	Copies of daily inspection reports should be maintained. These reports, addressed elsewhere, should also indicate who performed the inspection, date and time of inspection. It is extremely important to include

comments on unusual aspects of the project, and to address any problems that arose and how they were handled.

Other Sections	Other sections may be added as necessary. Possibly injury/ illness reports, receipts for rental equipment, lodging, outside inspections, newspaper clippings, etc.

The responsibility of maintaining the logbook should be assigned to responsible personnel. Normally, this function is performed by the job site supervisor or the other person responsible for coordinating activities at the work site. Upon conclusion of the job, this person may write a one page summary of the project. This summary can then be compiled with others and produced as evidence of previous jobs performed by the contractor to perspective clients. The two attachments that follow are examples of a daily project log and a sign-in sheet, respectively.

DATE: ______________________________

DAILY PROJECT LOG

Project Name: ______________________________ Job No.: __________

Superintendent: ______________________________ (print)

NOTE - Fill in GENERAL comments on routine progress on this project on the above date. DETAIL major problems and action taken, injuries, equipment breakdown, unusual conditions or situations, inspections, hiring or firing of personnel and any other occurrence which may affect the project. This log may be utilized as a legal document.

SIGNATURE: ______________________________

Revised 11/82

DATE ____________________

PROJECT ____________________

SUPT. ____________________

All personnel must sign in or out every time they enter/exit the work area.

JOB SIGN-IN/SIGN-OUT AND
VISITORS LOG

PLEASE SIGN CLEARLY

NAME	EMPLOYER	TIME IN	TIME OUT	REASON/PPE ISSUED

ESTABLISHING A MEDICAL SURVEILLANCE PROGRAM

Objective: To provide instructions and guidelines to course participants for establishing an ongoing medical surveillance program for employees exposed to airborne asbestos fibers.

Learning Tasks: Information in this section should enable participants to:

- Understand the need for an ongoing medical surveillance program for workers exposed to asbestos.

- Understand the various elements that comprise an acceptable medical surveillance program.

- Be knowledgeable of the OSHA standards regarding respirator use.

- Understand how the medical monitoring should be conducted, what tests should be performed, and what the results mean.

- Understand procedures for maintaining appropriate records on each employee

THE IMPORTANCE OF MEDICAL SURVEILLANCE

It is important for all asbestos abatement contractors to establish an ongoing medical surveillance program for several reasons. The three major areas of concern are:

1. The safety and health of all employees
2. Regulatory requirements
3. Other legal liability concerns

Through implementation of a sound medical surveillance program, an abatement contractor will be able to verify every employee's medical status at a particular time, comply with OSHA standards on medical surveillance of workers exposed to asbestos, and also, to reduce other possible liability risks. In this section, these three concerns are addressed, in addition to several other considerations associated with medical surveillance programs.

Who Needs Medical Surveillance?

Because of the increased public awareness concerning the hazards associated with exposure to airborne asbestos fibers, and because of various regulatory requirements, employers and building owners are finding themselves in situations where they must provide for regular and periodic medical surveillance for their employees. Asbestos abatement contractors are required to provide a medical surveillance program for their employees since they are regularly exposed to airborne asbestos fibers. For these employees, a medical surveillance program is used to determine their baseline health status (health status before beginning work), to monitor their health during the duration of their employment/project, and also to provide documentation of their health status along with their work history upon completion of their employment/project.

Other employees that should be provided medical surveillance are custodial and maintenance workers who may encounter asbestos-containing materials while performing their normal duties. Examples of these duties might include working above false ceilings with asbestos-containing insulation, installing ceiling tiles, or performing maintenance on pipes or boilers that have asbestos-containing insulation on them. By law, any employees working in a building in which the airborne fiber concentrations exceed 0.1 fibers per cubic centimeter (f/cc) during an 8 hour time weighted average (TWA), are required to undergo medical surveillance with the cost to be borne by the employer/building owner. Additionally, any employee who wears a respirator as a routine part of their job, must also be medically evaluated on a regular basis. This is to ensure that the use of the respirator does not adversely affect his or her health.

OSHA Standards -- Medical Surveillance

According to the OSHA asbestos standard, 29 CFR 1910.1001, subpart J, the employer/building owner must provide, at his/her own expense, medical examinations relative to their employees' exposure to asbestos. An acceptable medical surveillance program must include pre-placement, annual, and termination examinations provided there is sufficient evidence that demonstrates that an employee has not been examined in accordance with the standard within the past one-year period. This standard also outlines the requirements for maintaining medical records on each employee.

Pre-Placement Exams

According to the OSHA standard, pre-placement examinations must take place within 30 calendar days following the worker's first employment. A comprehensive medical evaluation must be performed. This should include, as a minimum, a chest x-ray (posterior-anterior 14 x 17 inches), a medical history to determine the presence of any possible respiratory diseases, and pulmonary function tests including forced vital capacity (FVC) (the maximum amount of air that can be expired from the lung after full inhalation), and forced expiratory volume after one second ($FEV_{1.0}$) (the amount of air forcibly expired in one second after full inhalation).

The results of this examination will be used as the employee's baseline health status, and also to determine whether or not they are capable of wearing respirators. A physician's report will then be furnished to the employer/building owner for their files. If an employee requests to see the report, the employer/building owner is required to supply them with a copy. It would also be considered good practice to explain the report to the individual employee. Individual test results are normally kept by the physician or clinic to maintain confidentiality.

It is very important for the employer to be sure the clinic maintains the results of the examination on file. In the event an employee files suit at some future date claiming a disability, the employer/building owner will be able to check their records and prove whether or not the condition could have occurred as a result of employment with their company.

In addition to the medical reports, the employer/building owner should request that the physician provide a statement indicating whether or not an employee is capable of wearing a respirator, and also outlining any limitations associated with their use. This form should also indicate any other limitations (i.e., intense heat, extreme cold, etc.).

Annual Examinations

According to OSHA 29 CFR 1910.1001, subpart (J)(3), every employer must provide, or make available, comprehensive medical evaluations to each of their employees engaged in occupations which cause exposure to airborne asbestos fibers (i.e., abatement workers, maintenance people, etc.). Such annual examinations must include, as a minimum, a chest x-ray (posterior-anterior 14 x 17 inches), a study to determine the presence of any respiratory diseases, a pulmonary function test which includes FVC and

$FEV_{1.0}$. (Note: Many physicians recommend fewer x-rays than every year. It is important to consult your clinic on this matter, but recognize that OSHA currently requires annual x-ray examinations. This examination is basically the same as the pre-placement evaluation, and is used primarily as an ongoing surveillance mechanism.

The physician will be able to compare the annual examinations with the pre-placement evaluations to determine if there are any changes in an employee's health status. If there are noticeable changes, the employer and the employee should both be notified since the situation may require immediate action (i.e., transfer to another job, discontinue respirator use, etc.).

Annual examinations, in most cases, will be most applicable to custodial or maintenance workers who work in a building, and are not engaged in full-time asbestos-related work. With the exception of a long duration project (over 1 year), or an abatement contractor that continually uses the same employees on abatement jobs, most of the people used on an asbestos removal project are temporary workers, and thus annual monitoring would not be possible. Temporary workers, in particular, should be encouraged to obtain and preserve copies of their medical records.

Termination of Employment Examination

Within 30 calendar days before or after the termination of an employee, OSHA requires that each employee exposed to asbestos receive a medical examination. This examination must entail the same items as the pre-placement and annual exams. There must be a chest x-ray (posterior -- anterior 14 x 17 inches), a history to determine the presence of any respiratory diseases, and pulmonary function testing including FVC and $FEV_{1.0}$. Records of these exams must be retained by the employer/building owner for a minimum period of 30 years to provide documentation of the health status of the employee. The reason for this 30 year period is because the latency period associated with asbestos-related diseases often ranges between 15-30 years. Thus, if an employee files a claim 25 years later, the employer will have records on file for reference.

REASONS FOR SPECIFIC TESTS

All of the tests that are required to be performed during pre-placement, annual, and termination medical examinations are required in order to properly evaluate the human body systems that are most likely to be affected by exposure to elevated levels of airborne asbestos fibers. Some specific reasons for each tests are discussed as follows:

Chest X-Ray -- (Posterior -- Anterior 14 x 17 Inches): These are performed primarily to detect irregularities in the lungs or the heart, including any fibrosis or pleural plaques induced by exposure to asbestos. Chest x-rays may also be used as a baseline for comparing future x-rays. Ideally, chest x-rays should be interpreted by a certified "B Reader." A "B Reader" is a physician (often a radiologist or pulmonologist) who has received specialized training in the interpretation of chest x-rays, specifically relating to occupational lung diseases. "B Readers" are required to pass a proficiency test administered by the Centers for Disease Control (NIOSH) in Morgantown, West Virginia.

Pulmonary Function: These tests are conducted to determine if a person's lungs are expanding normally, and if there is adequate air movement in and out of the lungs. The FVC and $FEV_{1.0}$ are conducted through the use of a spirometer. If the $FEV_{1.0}$ is reduced, this may signify a possible obstruction or problem in an employees lungs. If the FVC or the ratio of $FEV_{1.0}$ to FVC is reduced, this may signify restrictive changes in the employee's lungs.

Pulmonary History: This part of the examination is simply a questionnaire that is completed by the employee. It is used to identify the potential for respiratory diseases. Several questions relate to chronic lung diseases, while others address the employee's personal habits such as smoking. There is often particular concern for the health of a person who smokes and is also exposed to asbestos. Smoking is known to have a synergistic effect relating to asbestos exposure. That is, it compounds or intensifies the effects. Recent studies indicate that an asbestos worker who smokes is more likely to develop lung cancer than non-smokers who do not work with asbestos.

Physical Examination: Criteria to be evaluated on the routine physical examination often include medical history, blood pressure, pulse, vision (depth perception, peripheral), an audiogram (hearing test), urinalysis, and follow-up classification with appropriate recommendations.

It is a good recommended practice to require individuals over 40 years of age, or other people who might be at an increased risk, to have a physical examination. Also, for these same individuals, it would be valuable to have electrocardiograms performed. It is a known fact that the use of respirators places increased strain on the cardio-pulmonary system; thus, if abnormalities show up on the electrocardiogram, appropriate actions can be taken (i.e., transfer to a job that does not require respirator use).

Costs Associated with Medical Surveillance

The costs of employee medical surveillance examinations are relatively reasonable compared to the cost of privately practicing physicians. In some cases, it may be possible to obtain group discounts if enough employees are involved. A recent poll of several occupational health clinics in the Atlanta, Georgia area indicated the following average costs:

- Chest x-ray	
posterior-anterior	$ 35-40
lateral	15-20
- Pulmonary Function	20-25
- Pulmonary History	--

-	Physical Examination	20-30
-	Electrocardiogram	20-30

SUMMARY

Important information to obtain from this section of the course includes an understanding of why a good medical surveillance program is essential for employers/building owners to ensure the safety and health of their employees, and also to reduce their liability potential for claims pertaining to asbestos exposure. Also, it is important to have a firm understanding of the OSHA requirements regarding medical surveillance programs for employees exposed to more than 0.1 f/cc of airborne asbestos determined by an 8 hour TWA sample, or others who must routinely wear respirators as a part of their job. Additionally, it is important to understand the reasons associated with each of the specific tests that comprise an acceptable medical evaluation program.

PROTECTING THE WORKER:

RESPIRATORS AND PROTECTIVE CLOTHING

Objective: To provide a detailed discussion of the use, maintenance and limitations of respiratory protection and protective clothing.

Learning Tasks: Information in this section should enable participants to:

- ☞ Identify the need for effective respiratory protection for asbestos abatement personnel.
- ☞ Understand the operating principles of selected respirators used for protection against asbestos.
- ☞ Recognize the use and limitations of various types of respirators.
- ☞ Understand the importance of properly fitting the respirator.
- ☞ Become familiar with the concept of protection factors and how they relate to respirator selection and use.
- ☞ Understand the basic requirements of an effective respiratory protection program.
- ☞ Recognize the need for and proper use of protective clothing and equipment.

Working and breathing in some environments can pose a hazard to workers' health. Inhalation of some substances can cause immediate or quick injury to the respiratory system or other major organ systems of the body. Carbon monoxide and some paint solvents are examples of relatively quick-acting substances. The injuries/illnesses caused by other contaminants may not be obvious for years or even decades. Asbestos and other cancer-causing agents fall into this category of long latency (developing) periods.

Respirators are commonly used to help protect against these inhalation hazards, especially on asbestos abatement projects. However, the protection program is not nearly as simple as choosing a respirator, giving it to an employee, and expecting them to get adequate protection. There is a need to have and apply knowledge about lung structure and function; hazard recognition, evaluation and control; government regulations; and human characteristics.

There are three ways hazardous materials can enter the body:

- Through the gastrointestinal (GI) tract

- Through the skin (or cause harmful effects to the skin)

- Through the respiratory system

Fortunately, asbestos does not appear to pose any significant degree of hazard through the skin and GI routes of entry. Unfortunately, it can cause several diseases when it enters through the lungs.

The respiratory system is a gaseous (air) pump with a series of airways leading from the nose and mouth down into the air sacs (alveoli) where there is an exchange of oxygen and carbon dioxide. At the air sacs, oxygen enters the blood and carbon dioxide exits the blood.

The main components of the respiratory system going from top to bottom are:

- Nose
- Mouth
- Throat
- Larynx (voice box)
- Trachea ("windpipe")

- o Bronchi (branches from trachea)
- o Alveoli (air sacs)
- o Diaphragm and chest muscles

Airways of the upper respiratory tract (trachea through bronchi) are lined with cilia -- hair-like protrusions covered with a sheet of mucous. These cilia are constantly sweeping upward quickly, then down slowly, and thus moving the mucous and trapped materials up at a rate of approximately one inch per minute. This is an important clearance mechanism which serves to remove large particulate matter from the lungs. Particles are brought back up to the throat where they are swallowed or expectorated.

Unfortunately, smoking retards this cleansing mechanism of the lungs by causing paralysis of the cilia. A few "puffs" on a cigarette drastically reduces the cilia motion. Smoking several cigarettes retards the cilia for several hours, often taking an overnight period for them to recover. This paralyzing effect may be one of the main reasons the combination of smoking and asbestos exposure is so hazardous.

Down past the bronchi are the alveoli. These air sacs are intimately surrounded by a vast network of blood capillaries through which gas exchange occurs (oxygen in and carbon dioxide out). Oxygenated blood is then delivered to the heart where it is pumped to millions of tissue cells throughout the body.

Thus the heart and lungs are highly dependent upon each other in the process of getting oxygen into the body. When the lungs become restricted, damaged or ineffective, the heart must work harder. Bad cases of asbestosis often result in death by heart attack. Also, the wearing of respirators can be too much of a strain for some people (a few), and thus it is necessary to check this possibility before assigning or wearing a respirator.

The body's need for oxygen varies, so the breathing rate varies as does the heart rate. Respiratory rates tend to fall into ranges according to the level of activity:

Resting: 5-7 liters per minute
(5,000-7,000 *cc per minute)

Working
Moderately: 25-30 liters per minute

(25,000-30,000 *cc per minute)

Exercising
Strenuously: 100-150 liters per minute

(100,000-150,000 *cc per minute)

*Cubic centimeters (same cc as when referring to fibers per cc).

These breathing rates are useful in determining how many fibers (asbestos) workers breath in during different periods and exposure conditions. For example, a worker (without a respirator) breathing at a rate of 25,000 cubic centimeters (cc) per minute, in an area for 480 minutes (8 hours) where the fiber levels are two fibers per cubic centimeter (2 f/cc), would breath in 24 million fibers. Calculated as follows:

25,000 cc/min x 480 min x 2 f/cc = 24,000,000 fibers

The same calculation method can be used for other breathing rates, exposure periods, and fiber counts.

Respiratory hazards are generally divided into two categories -- toxic contaminants and oxygen deficiency. The potential for either or both must be considered when addressing respiratory protection.

Normal air contains about 21 percent (20.9%) oxygen. For breathing purposes, air should not contain less than 19.5 percent or more than 23.5 percent oxygen. Oxygen deficiency generates a variety of symptoms, ranging from increased breathing and pulse rate to unconsciousness and death.

Asbestos abatement projects generally do not pose oxygen deficiency hazards. However, since there are abatement projects and circumstances where it can be a problem, it must always be considered. For example, there could be an oxygen deficiency problem while working in steam tunnels, mechanical chases, or boilers. It is also a consideration during the use of Type C supplied-air respirators (discussed in the next section of the notebook). Failing to consider oxygen deficiency could result in a quick fatality on an asbestos abatement project.

Toxic contaminants are the more common category of respiratory hazards on asbestos abatement jobs. Those toxic contaminants are generally subdivided into two categories, particulates and gaseous materials (or a combination of the two). Asbestos fibers are an example of the particulate subcategory and carbon monoxide is an example of the gaseous subcategory. It is possible to have both these hazardous substances, plus others (such as encapsulant solvents) in a work area at the same time.

As mentioned earlier, the effects of these contaminants can develop quickly or slowly, and they can be mild or fatal. For example, mesothelioma (special cancer of lung or abdomen linings) may take 20 to 45 years to develop, but once it is detected, it causes death within a year. Severe exposure to carbon monoxide can cause death within a few minutes, or may leave no residual damage if promptly detected and treated.

Acceptable limits of exposure for respiratory hazards are based on values documented through research by such organizations as the American Conference of Governmental Industrial Hygienists (ACGIH), the National Institute for Occupational Health and Safety (NIOSH), the Occupational Safety and Health Administration (OSHA), and others. These organizations publish Permissible Exposure Limits (PELs) and Threshold Limit Values (TLVs^{TM}) for a variety of toxic substances.

The limits are expressed for exposure durations, usually a full work shift. For example, the current OSHA limits for exposure to carbon monoxide are 50 parts per million (PPM) in workplace air and 20 PPM in air supplied to Type C respirators. The current limits and recommended guidelines for asbestos exposure range from 2 f/cc (OSHA) down to 0.01 f/cc or lower (generally accepted "clearance level" in abatement industry).

The control of respiratory hazards often involves three steps:

- assessing the hazards
- reducing or eliminating the hazards
- providing respiratory protective equipment

The asbestos abatement industry is actually based on these first two steps. Buildings and structures are surveyed to assess potential asbestos hazards. When a potential asbestos hazard exists, a group or contractor is called upon to reduce or eliminate the hazard through removal, encapsulation, or enclosure. Thus the third step, respirators, are generally avoided for the building occupants.

However, the removal, encapsulation, and enclosure work has a high potential for respiratory hazards. Thus, the steps of assessing hazards, reducing hazards, and providing respiratory protection must be used again.

Hazard assessment during the abatement work involves a variety of visual inspections. For example, barriers are checked for confinement, asbestos materials are checked for wetness, and surfaces are inspected for asbestos contamination. And, quite importantly, a variety of air samples are collected for asbestos fibers. Sampling locations include outside the barrier, in the work area, and on the workers. The results of the samples from the work area and workers are used to assure proper hazard reduction/elimination techniques, and more importantly, to choose proper respirators for the workers.

Several hazard reduction techniques are used inside the abatement area, including wetting with amended water, using negative air machines, prompt bagging of removal materials, wet cleaning and HEPA vacuuming. These techniques do reduce the airborne fiber concentrations during removal projects, but they cannot get them down to the 0.01 f/cc level which is generally desired and specified. Thus, the employer (contractor) must proceed to the third hazard control step and provide proper respirators and an adequate respirator program for the workers. The respirators must be selected and the program established based on OSHA standards, the actual or anticipated air sampling results, and other guidelines (i.e., respirator manufacturers).

As required by the OSHA respirator standard (29 CFR 1910.134), only approved respirators should be considered during the selection process. And, the respirators must be approved for protection against the specific hazard -- asbestos, for example. The National Institute for Occupational Safety and Health (NIOSH) is the testing agency to see if a respirator model can receive approval. If the entire respirator assembly, including cartridges/filters/ hoses, passes their test, then they and the Mine Safety and Health Administration (MSHA) issue a joint NIOSH/MSHA approval number for that specific respirator assembly. Here are two examples of approval labels printed on the literature for two respirators.

PERMISSIBLE CHEMICAL CARTRIDGE RESPIRATOR FOR ORGANIC VAPORS, DUSTS, FUMES, MISTS AND RADIONUCLIDES

MINE SAFETY AND HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

United States Department of Labor
MSHA
Mine Safety and Health Administration

APPROVAL NO.
TC-23C-243

US Department of Health and Human Services
Center for Disease Control
NIOSH
National Institute for Occupational Safety and Health

ISSUED TO

LIMITATIONS

Approved for respiratory protection against not more than 1,000 parts per million organic vapors by volume, dusts, fumes, and mists having a time weighted average less than 0.05 milligram per cubic meter, asbestos-containing dusts and mists and radionuclides.

Do not wear for protection against organic vapors with poor warning properties or those which generate high heats of reaction with sorbent material in the cartridge. Maximum use concentrations will be lower than 1,000 parts per million organic vapors where that concentration produces atmospheres immediately dangerous to life or health.

Not for use in atmospheres containing less than 19.5 percent oxygen.

Not for use in atmospheres immediately dangerous to life or health.

CAUTION

In making renewals or repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained.

Follow the manufacturer's instructions for changing cartridges.

This respirator shall be selected, fitted, used, and maintained in accordance with the Mine Safety and Health Administration, Occupational Safety and Health Administration, and other applicable regulations.

MSHA—NIOSH Approval TC-23C-243

Issued to March 10, 1983

The approved half-mask facepiece respirator assembly for organic vapors, dust, fumes, mists and radionuclides consists of the following parts: 7-201-1, 7-201-2, or 7-201-3 facepiece and 461973 (TC-23C-243) cartridges.

PERMISSIBLE RESPIRATOR FOR DUSTS, FUMES, MISTS AND RADIONUCLIDES

MINE SAFETY AND HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

United States Department of Labor
MSHA
Mine Safety and Health Administration

APPROVAL NO.
TC-21C-135

US Department of Health and Human Services
Center for Disease Control
NIOSH
National Institute for Occupational Safety and Health

ISSUED TO

LIMITATIONS

Approved for respiratory protection against dusts, fumes and mists having a time weighted average less than 0.05 milligram per cubic meter, asbestos-containing dusts and mists and radionuclides.

Not for use in atmospheres containing less than 19.5 percent oxygen.

Not for entry into atmospheres immediately dangerous to life or health.

CAUTION

In making renewals or repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained.

Follow the manufacturer's instructions for changing cartridges.

This respirator shall be selected, fitted, used, and maintained in accordance with the Mine Safety and Health Administration, Occupational Safety and Health Administration, and other applicable regulations.

MSHA—NIOSH Approval TC-21C-135

Issued to , June 29, 1983

The approved half mask facepiece respirator assembly for dusts, fumes, mists and radionuclides consists of the following parts: 449703, 7-201-1, 7-201-2, or 7-201-3 facepiece and 459322 or 465312 (TC-21C-135) filters.

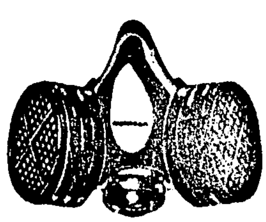
The approved half-mask facepiece with belt-mounted filter respirator assembly for dusts, fumes, mists and radionuclides consists of the following parts: 7-202-1, 7-202-2 or 7-202-3 facepiece, breathing tube and plenum assembly and 459322 or 465312 (TC-21C-135) filters.

The first label is for a respirator model with high efficiency screw in cartridges, such as might be used for protection against airborne asbestos fibers. The approval number assigned by NIOSH for this specific manufacturer and model is TC-21C-135 (see label). The "TC" indicates "tested and certified"; the "-21C" indicates what style/category of respirator it is; and, the "-135" is a unique number assigned to this specific manufacturer and model.

The second label is for a chemical cartridge respirator such as might be used during encapsulating or spray painting. Note it has both a different style/category number, and its own assigned number. There are three major classes/categories of respirators, plus subcategories for each category. The major categories are:

- o Air-Purifying
- o Air-Supplied
- o Self-Contained

AIR-PURIFYING RESPIRATOR



Air purifying respirators remove limited concentrations of air contaminants from the breathing air, but do nothing to improve (or change) the oxygen content. Thus, they can only be used in atmospheres where there is enough oxygen, and where air contaminants do not exceed the specified range of the respirator and cartridge.

These respirators generally consist of a soft, rubber facepiece and some kind of replaceable filter or cartridge. Two major subcategories of air purifying respirators are the mechanical filter type and the chemical cartridge type. The mechanical filter variety is designed to protect against particulate matter such as dust and asbestos fibers. The chemical cartridge variety is used to protect against light concentrations of chemicals, such as solvent vapors. There are even combination models approved for both types of protection. Respirator face pieces (including those for the air-purifying category) are used to further describe specific subcategories, based on the construction and face coverage. The major subcategories are:

- o Single-Use (Disposable)
- o Half Mask
- o Full Face

The following diagram shows a Single-Use (Disposable) type air-purifying respirator.

Single-Use Respirator

This type respirator is available in both approved and unapproved model. Some are even approved for asbestos. However, NIOSH has issued a notice stating that in spite of their required approval, they do not recommend them for protection against asbestos -- a proven human carcinogen. Thus, many industrial hygienists, safety professionals, manufacturers and trained individuals strongly recommend against this type respirator for protection against asbestos.

The next diagram shows a Half-Mask type air-purifying respirator. It also shows some of the common components.

Half-mask Respirator

It is called a half-mask because it covers half of the face -- from under the chin to the bridge of the nose. Most, but not all, half-mask respirators are NIOSH/MSHA approved. It is still necessary to choose the correct approved model for the identified air contaminant. Note the respirator components and the correct position for the head and neck strap.

This diagram shows a Full-face type air-purifying respirator. It also shows some of its components.

Full Facepiece Respirator

It is called a full-face type because it covers from under the chin up to the forehead. This broader coverage provides a better face fit, higher degree of protection, and gives some eye protection. Many full-face respirators have four or more straps. Regardless of the number of straps, the respirator should be put on by placing the chin into the chin cup, then tightening the straps going from the bottom to the top.

A relatively new (last 5-10 years) and special subcategory of air-purifying respirator is the Powered Air Purifying (PAPR) type. It has received considerable use on asbestos abatement proejcts, but now that use seems to be declining in favor of other types of respirators.

POWERED AIR PURIFYING RESPIRATOR

(PAPR)

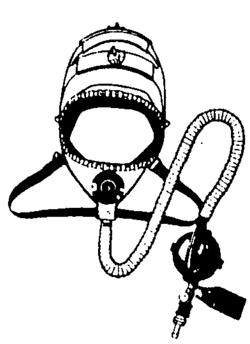
The previously described air-purifying respirators depend on breathing energy to draw the air in through the respirator cartridge or filter. However, these PAPR units use a battery-powered blower that passes the contaminated air through the cartridge or filter where the air is cleaned and forced through a hose to the facepiece. The face covering can be a half-mask, full-face mask, helmet (hat), or hood.

An advantage of using a powered air-purifying respirator is that is supplies air at a positive pressure within the facepiece, helmet, or hood, so that any leak is hopefully outward. Therefore, they provide a higher degree of protection than do half-mask and full-face air-purifying respirators.

Powered respirators must deliver at least four cubic feet of air per minute (4 CFM) to a tight-fitting facepiece and at least 7 CFM to a loose-fitting helmet or hood. They are reportedly designed to operate a full shift, but after repeated rugged use, some seem to need recharging or a new battery during the shift. This issue of operating duration has contributed to their declining use.

Air Purifying was the first listed category of respirator and Air-Supplied is the second category.

AIR-SUPPLIED RESPIRATOR



Air-supplied respirators deliver breathing air through a supply hose connected to the worker's facepiece (half mask or full face). This category of respirator is becoming the most important type on asbestos abatement jobs for several reasons:

- o the OSHA asbestos standard (29 CFR 1910.1001) requires jobs be started with them

- o they provide a very high degree of protection

- o they are often required by the contract specifications.

Because of their importance and complexity, an entire section of this notebook is devoted to "Type C Air-Supplied" respirators. Thus, there is no need for further discussion in this section, other than to mention them as the second major category of respirators.

The third and last major category is the Self-Contained Respirator.

SELF-CONTAINED RESPIRATOR

Self-contained respirators provide protection for various periods of time depending upon the amount of breathing air (air pressure and tank size) and the breathing demands of the wearer. The worker is independent of his/her surrounding atmosphere when using these devices; therefore, they can be used in environments immediately harmful to life.

However, since they have several disadvantages, they are seldom used on asbestos abatement jobs, except by some inspectors. They are heavy and awkward to wear. The air supply usually lasts only 30 to 60 minutes, thus requiring a large supply of filled tanks onsite. They require more worker training than the other types of respirators.

However, none of the respirators are simple to select and use. They all require a detailed respirator program.

RESPIRATORY PROTECTION PROGRAM

Any employer who requires or permits employees to wear a respirator must have a written respiratory protection program. This is required by OSHA in their asbestos standard (29 CFR 1910.1001, copy attached as Appendix A of this manual) and respiratory protection regulations (29 CFR 1910.134, copy included in this section). The written respirator program establishes standard operating procedures for the asbestos abatement contractor concerning the use and maintenance of respiratory equipment. In addition to having such a written program, the contractor must also be able to demonstrate that the program is enforced and updated as necessary.

The OSHA regulations spell out just what must be included in a written program. Additionally, below, those items have been highlighted and discussed with special emphasis on applications to asbestos abatement work.

Designation of a Program Administrator

A program administrator must be designated by name. This person is responsible for implementation of and adherence to the provisions of the respiratory protection program. It is usually a good idea to also designate each person who is responsible for enforcement of the procedures at the job site. This is usually the site superintendent or foreman. Procedures should also be outlined for enforcement of the program.

Enforcement procedures and the development of the program as a whole should be done in conjunction with and input from the employees and/or their representative(s). Documentation should be maintained on any enforcement actions. This might include copies of written reprimands, evidence of docking a salary or dismissal for not complying with the program. Conversely, it is a wise idea to reward those employees who adhere to the program requirements.

SELECTION AND USE OF RESPIRATORY PROTECTION EQUIPMENT

Respirators used shall be selected from those approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH) for use in atmospheres containing asbestos fibers. A NIOSH approved respirator contains the following: an assigned identification number placed on each unit; a label identifying the type of hazard the respirator is designed to protect against; additional information on the label which indicates limitations and identifies the component parts approved for use with the basic unit.

Although some single-use disposable dust masks are "approved" by NIOSH for use with asbestos, they should not be used on asbestos abatement projects. NIOSH itself has stated clearly that they do not consider this form of respirator to be adequate protection.

As a rule of thumb, air-purifying respirators may be used during the prepping stage of an abatement project and during final clean-up (wiping down walls and floors after polyethylene is removed.) Supplied-air respirators are normally used during actual removal and gross clean-up. Air-purifying may be used for glovebag work and disposal at the landfill.

MEDICAL SURVEILLANCE

Only those individuals who are medically able to wear respiratory protective equipment shall be issued one. Before being issued a respirator, an employee will receive pertinent tests for medical and physical conditions. Medical tests to be considered by a physician include: pulmonary function tests (FVC and FEV), chest X-ray, electrocardiogram, and any others deemed appropriate by the examining physician. Medical factors to be considered by a physician include: emphysema, asthma, chronic bronchitis, heart disease, anemia, hemophilia, poor eyesight, poor hearing, hernia, lack of use of fingers or hands, epileptic seizures, and other factors which might inhibit the ability of an employee to wear respiratory equipment. Establishing a medical surveillance program is discussed in greater detail in Section VII of this manual.

FIT-TESTING

Any employee who is assigned a respirator must be given the opportunity to wear the respirator and be qualitatively fit-tested. The qualitative fit-test is used to determine the fit of the respirator to the face of the individual employee. A more detailed quantitative fit-test may be conducted instead. Methods of fit-testing are discussed elsewhere in this section.

RESPIRATOR ASSIGNMENT AND MAINTENANCE

Where practicable, respirators should be assigned to individual workers for their exclusive use. A system of recordkeeping should be established to document all employees who have respiratory protection equipment, and the periodic cleaning and maintenance of equipment.

Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker shall be cleaned after each day's use, or more often, if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use. This procedure is described as follows:

1. Before leaving the work area, each user must shower with the respirator on to remove any asbestos-containing material which may have settled on the equipment.

2. Respiratory equipment shall be washed with detergent in warm water using a brush. If possible, detergents containing a bactericide should be used. Organic solvents should not be used, as they deteriorate the rubber facepiece.

If bactericide detergent is not available, the detergent wash should be followed with a disinfecting rinse. Two types of disinfectants may be made from readily available household solutions. A hypochlorite solution (50 ppm) can be made by adding two tablespoons of chlorine bleach to one gallon of water. An aqueous solution of iodine (50 ppm) can be made by adding one teaspoon tincture of iodine to one gallon of water. A two minute immersion of the respirator into either solution would be sufficient for disinfection.

3. Respiratory equipment should be thoroughly rinsed in warm clean water (120^{o}F maximum) to remove all traces of detergent, cleaner and sanitizer, and disinfectant.

4. Respiratory equipment should be allowed to air dry on a clean surface or hung from a horizontal wire.

When not in use, respiratory equipment should be sealed in plastic bags and stored in a single layer with the facepiece and exhalation valve in a non-distorted position. A metal cabinet with shelves is well suited for this purpose.

Repair or replacement of component parts must be done by qualified individuals. Substitution of parts from a different brand or type of respirator will invalidate the approval of the respirator.

Inspection for defects in respiratory equipment must be done before and after each use and during cleaning. The primary defects to look for in the inspection of component parts of the respirator and corrective actions where appropriate are itemized below:

1. Air purifying respirators (quarter-mask, half-mask, and full facepiece)

   a. Rubber facepiece - check for:
      - excessive dirt (clean all dirt from facepiece)
      - cracks, tears, or holes (obtain new facepiece)
      - distortion (allow facepiece to "sit" free from any constraints and see if distortion disappears; if not, obtain new facepiece), and
      - cracked, scratched, or loose-fitting lenses (contact respirator manufacturer to see if replacement is possible; otherwise obtain new facepiece).

b. Headstraps - check for:

- breaks or tears (replace headstraps)
- loss of elasticity (replace headstraps)
- broken or malfunctioning buckles or attachments (obtain new buckles), and
- allow the facepiece to slip (replace headstrap)

c. Inhalation valve, exhalation valve - check for:

- detergent residue, dust particles, or dirt on valve or valve seat (clean residue with soap and water)
- cracks, tears, or distortion in the valve material or valve seat (contact manufacturer for instructions), and
- missing or defective valve cover (obtain valve cover from manufacturer).

d. Filter element(s) - check for:

- proper filter for the hazard

- approval designation
- missing or worn gaskets (contact manufacturer for replacement)
- worn threads - both filter threads and facepiece threads (replace filter or facepiece, whichever is applicable)
- cracks or dents in filter housing (replace filter), and
- missing or loose hose clamps (obtain new clamps)

2. Atmosphere-Supplying Respirators

   a. Check facepiece, headstraps, valves, and breathing tube, as for air-purifying respirators.

   b. Hood, helmet, blouse, or full suit, if applicable - check for:
      - headgear suspension (adjust properly for you)
      - cracks or breaks in faceshield (replace faceshield), and
      - protective screen to see that it is intact and fits correctly over the faceshield, abrasive blasting hoods, and blouses (obtain new screen)

c. Air supply system - check for:

- breathing air quality
- breaks or kinks in air supply hoses and end fitting attachments (replace hose and/or fitting)
- tightness of connections
- proper setting of regulators and valves (consult manufacturer's recommendations), and
- correct operation of air-purifying elements and carbon monoxide or high-temperature alarms

EMPLOYEE TRAINING PROGRAM

Each employee designated to wear a respirator must receive adequate training. The training session (initial and periodic retraining) should be conducted by a qualified individual to ensure that employees understand the limitations, use, and maintenance of respiratory equipment. Copies of the NIOSH Employer Respirator Manual and the NIOSH Employee Respirator Manual are included in Appendices C and D of this notebook for guidance.

SURVEILLANCE OF WORKING CONDITIONS

Personal air sampling, discussed in Section XIII, should be conducted during each asbestos abatement project. The employer must be able to document that the respiratory protection in use provides adequate protection for the employees in the airborne asbestos levels encountered.

Employees should receive instruction regarding emergency procedures. Normally, these instructions include immediately leaving the work area should they experience difficulty in breathing or dizziness. Finally, no employee wearing a respirator should ever work alone.

RESPIRATOR PROGRAM EVALUATION AND RECORDKEEPING

The respirator program shall be evaluated at least annually with program adjustments, as appropriate, made to reflect the evaluation results. Compliance to the aforementioned points of the program should be reviewed; respirator selection, purchase of approved equipment, medical screening of employees, fit testing, issuance of equipment and associated maintenance, storage, repair and inspection, appropriate surveillance of work area conditions.

Attention should be given to proper recordkeeping. Records which should be kept include: employees who are trained in respirator use, documentation of the care and maintenance of respirators, medical reports of each respirator user, airborne concentrations of asbestos fibers during work, and any problems encountered during abatement projects with regards to respiratory equipment.

RESPIRATORY FIT-TESTING

One of the most important elements of an effective respirator program is fit-testing. In fact, the OSHA respirator standard (29 CFR 1910.134) requires that the fit of respirators be determined when the respirators are issued and that the employees check the fit each time they put the respirator on. These are valid requirements since the weakest point of protection for a respirator is leakage around the face seal/fit.

There are two major categories of fit testing, qualitative (pass/fail basis) and quantitative (scientific measure basis). Then there are several methods within both major categories. Only those considered most applicable to asbestos abatement will be presented in this section.

During any type fit-testing, the respirator straps must be properly located and as comfortable as possible. Over tightening the straps will sometimes reduce facepiece leakage, but the wearer may be unable to tolerate the respirator during the work period. The facepiece should not press into the face and shut off blood circulation or cause major discomfort. At the time of respirator issuance, a visual inspection of the fit should always be made by a second person. That person should check to see that there are not visible openings/leaks (around the nose, for example) and that the respirator appears properly adjusted and comfortable.

Qualitative (pass/fail) tests are fast, require no complicated, expensive equipment, and are easily performed. However, they depend on the wearer's response, and thus are not entirely reliable.

Negative Pressure Test. For this test, the user closes off the inlet of the cartridges or filters by covering with the palms or squeezing the breathing tube so it does not allow air to pass; inhales gently so the facepiece collapses slightly; and holds his/her breath for about 10 seconds.

NEGATIVE PRESSURE TEST

If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator probably fits tightly enough. This test, of course, can only be used on respirators with tight-fitting facepieces. It also has potential drawbacks, such as the hand pressure modifying the facepiece seal and causing false results.

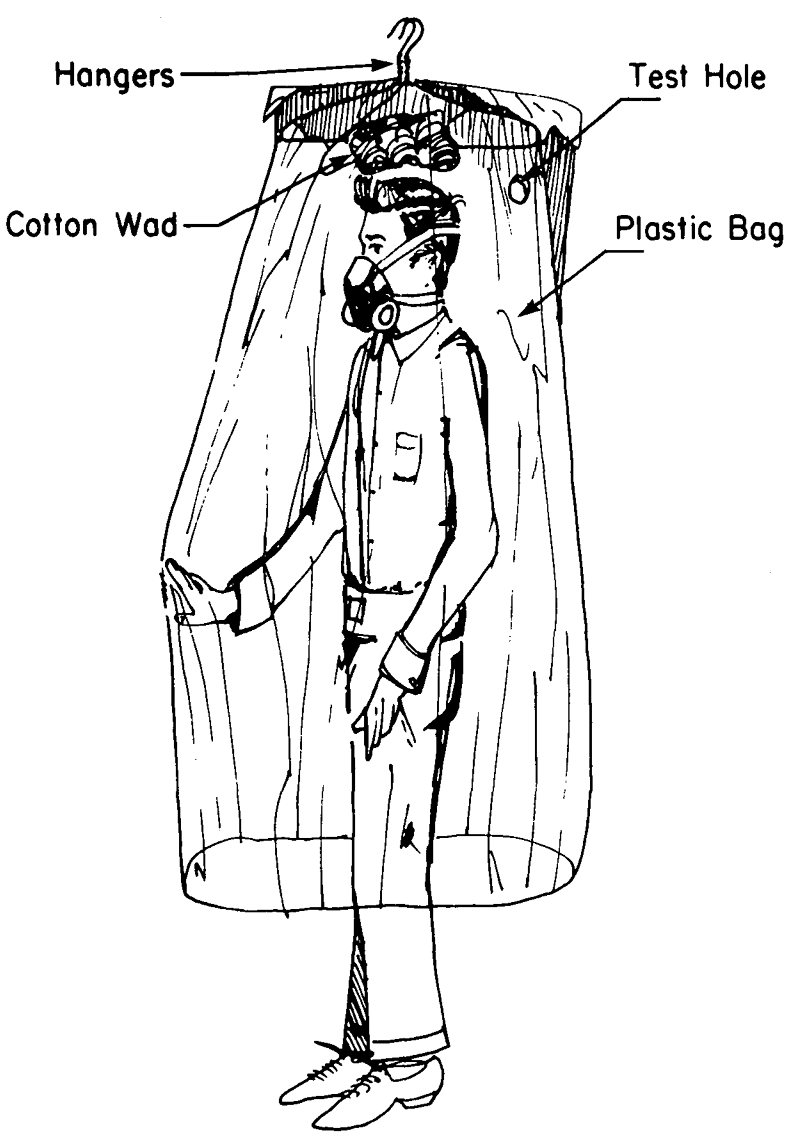
Positive Pressure Test. This test is very similar in principle to the negative pressure test. It is conducted by closing off/covering the exhalation valve and exhaling gently into the facepiece. The respirator fit is considered okay if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage around the facepiece. For some respirators, this test requires that the wearer remove the exhalation valve cover. This removal often disturbs the respirator fit if not done before the respirator is put on. The test is easy for respirators whose valve cover has a single small port that can be closed by the palm or a finger.

Irritant Smoke Test. Once the asbestos abatement worker has passed the visual, negative pressure, and positive pressure tests, they can be tested with irritant smoke. It can be used for both air-purifying and air-supplied respirators. However, an air-purifying respirator must have high-efficiency filters. The test substance is an irritant smoke (stannic chloride or titanium tetrachlorite). Sealed glass and plastic tubes with substances to generate this smoke are available from safety supply companies. When the tube ends are broken and air passed through them with a squeeze bulb, a dense irritating smoke is emitted.

For this test, the user enters the test enclosures (often a clear, suspended plastic bag) and the irritant smoke is sprayed/squeezed into the test hole. If the wearer detects any irritant smoke inside the respirator, it means a defective fit, and adjustments or replacement of the respirator is required. This test has a distinct advantage in that the wearer usually reacts involuntarily to leakage by coughing or sneezing. The likelihood of merely pretending to pass the fit test is very low.

Note: The irritant smoke test must be performed with caution because the aerosol in highly irritating to the eyes, skin and mucous membranes. With half-mask facepieces, the eyes must be kept closed.

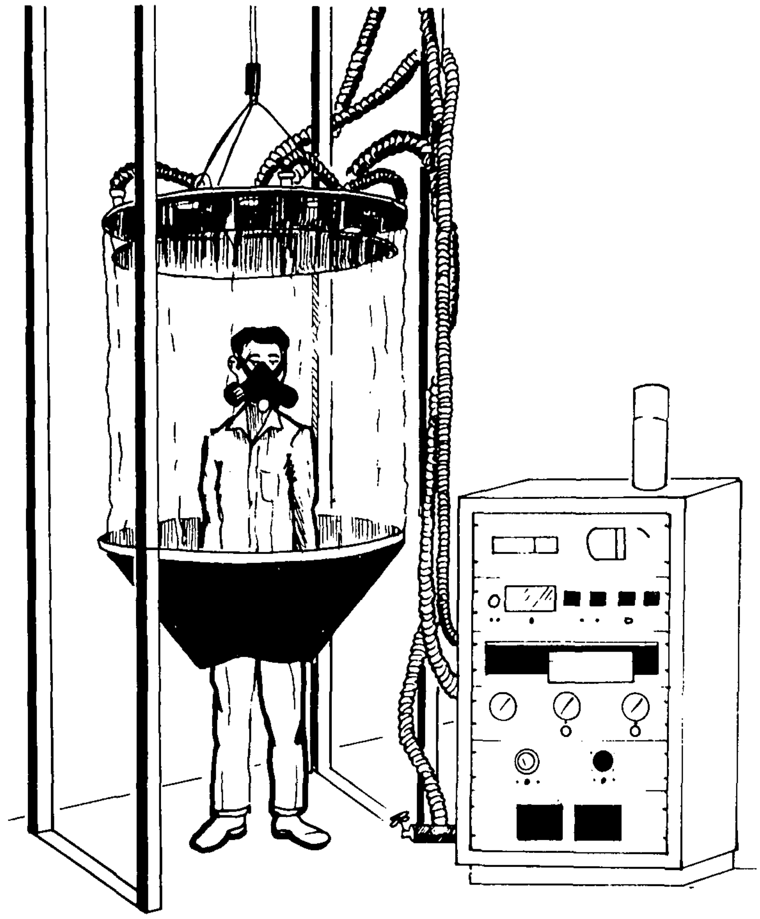
IRRITANT SMOKE TEST ENCLOSURE



The negative pressure, positive pressure, and irritant smoke fit tests are all qualitative (pass/fail) type methods. They can and should be performed at the abatement job site.

There are more scientific methods of determining the fit of a respirator. Those methods are called quantitative fit tests. In fact, these quantitative fit tests are the methods used to determine a respirator's scientific and published degree of protection (protection factor).

Quantitative fit-testing requires a test substance which can be generated into the air, specialized equipment to measure the airborne concentration of the substances and a trained tester. A sodium chloride solution (salt/water) or mineral oil are usually the substances of choice. As shown in the diagram, the test subject wearing a respirator is placed into a chamber which contains the test substance in the air. The airborne concentration of the substance is measured outside the respirator and inside the respirator while the wearer performs several work-related activities. The specific degree of protection (protection factor) can be determined for that wearer/respirator combination by performing calculations with the measured concentrations.



QUANTITATIVE FIT TESTING

Quantitative fit testing is usually performed in a laboratory under research conditions. However, portable fit-testing units are now available and some organizations will come to the job site and perform quantitative fit tests on workers. Such testing will probably become even more common because of specification requirements, insurance demands, and potential lawsuits. These tests usually show that most workers receive much better protection than the standard protection factors published and quoted for respirators. Quantitative fit-testing usually costs $25-50 per worker, depending on several factors such as how many workers are to be tested at one site.

Regardless of the type fit test, its advantages and disadvantages, it is necessary to include such a test in an effective respirator program. It is the key to detecting and correcting contaminant leakage around the facepiece to face seal. This leakage can be critical when the contaminant is a proven human carcinogen -- asbestos.

A more extensive description of fit-testing methods is included in NIOSH's publication, "Respirator Protection ... An Employer's Manual." That entire publication is reproduced and included as Appendix C of this notebook.

PROTECTION FACTORS

Respirators offer varying degrees of protection against asbestos fibers. The key to understanding the differences between types of respirators (air-purifying, powered-air purifying, air-supplied, etc.) is the amount of protection afforded the wearer. To compare these, one must understand the concept of a protection factor (PF).

A protection factor is a number obtained when the concentration of a contaminant outside the mask is divided by the concentration found inside the mask. This simple formula is illustrated below.

$$\text{Protection Factor (PF)} = \frac{\text{Conc. outside mask}}{\text{Conc. inside mask}}$$

The protection factor depends greatly on the fit of the mask to the wearer's face. Accordingly, the protection offered by any one respirator will be different for each individual person. Further, the protection constantly changes depending upon the worker's activities and even shaving habits. When a worker laughs or coughs inside a respirator, the protection factor will decrease since the mask will not "fit" as well during laughing or coughing. Similarly, a worker who forgot to shave one morning will not receive as much protection that day since the mask will not fit as well to the face. The importance of properly fitting the mask should now be obvious.

It is virtually impossible to measure the concentration inside the mask (where the worker is breathing) for each worker, all the time, during all the various activities he or she may be conducting. Accordingly, protection factors, based on extensive research, have been developed for different categories of respirators. Using these protection factors, it is easy to determine what type of respirator is appropriate to maintain the concentration of asbestos inside the mask below a certain level. If the assumption is made that 0.01 fibers per cubic centimeter (f/cc) is the re-occupancy concentration following an asbestos abatement project, then workers should never be exposed above this level inside the respirator.

Using established protection factors, the contractor may select from Table VIII-1 the appropriate respirator to maintain the concentration inside the respirator below 0.01 f/cc. It should be noted that the protection factors for powered-air purifying respirators are estimated on the most recent data available.

From this table, it should now be obvious why supplied-air respirators are recommended for actual removal and gross clean-up. Air-purifying respirators may be used for most projects during prepping and final clean-up (after the polyethylene is taken down). The importance of personal air sampling should also now be obvious. If personal air sampling has been conducted, and the employer wishes to keep the fiber concentration inside the mask below 0.01 f/cc, he/she may plug the numbers into the protection factor formula as illustrated below.

TABLE VIII-1.
SUGGESTED RESPIRATOR SELECTION FOR PROTECTION AGAINST ASBESTOS WHEN PROPERLY FITTED FOR USE AND PROPERLY MAINTAINED

Respirator Selection	PF	Maximum airborne fiber concentration outside the respirator to maintain exposure inside the respirator below 0.01 fibers/cc
High efficiency cartridge filter type (half mask)	10	0.1 fibers/cc
High efficiency cartridge filter type (full face mask)	50	0.5 fibers/cc
Powered-air purifying (PAPR) helmet type	(50-150)*	--
Powered-air purifying (PAPR) tight-fitting half mask	(100-200)*	--
Powered-air purifying (PAPR) tight-fitting full face mask	(200-300)*	--
Type C continuous-flow supplied air (half mask)	1,000	10 fibers/cc
Type C continuous-flow supplied air (full face or hood type)	2,000	20 fibers/cc
Pressure-demand self-contained breathing apparatus (SCBA)	10,000	100 fibers/cc

*Note: Studies are currently underway by NIOSH and others to estimate the protection factors for PAPRs. Values supplied are conservative estimates for properly operated units.

Example: Personal air sampling indicates the fiber concentration outside the mask is 3.5 f/cc (8-hour, time-weighted average). Then:

$$\text{Protection Factor Needed} = \frac{3.5 \text{ f/cc outside mask}}{0.1 \text{ f/cc desired inside mask}}$$

Protection Factor Needed = 350

By going to the table, any respirator with a protection factor above 350 (or 500 to leave a margin for error) should maintain the fiber concentration inside the mask below 0.10 f/cc.

Example: The employer may also use the protection factor formula to estimate concentrations inside the mask if the personal sampling results are available. If a worker's personal sample for an 8-hour workday was 2.7 fibers/cc and he wore an full-face supplied-air respirator, what is his estimated exposure <u>inside</u> the mask?

$$\text{Conc. in the mask} = \frac{\text{Conc. outside mask}}{\text{protection factor of mask}}$$

$$\text{Conc. in the mask} = \frac{2.7 \text{ f/cc (8-hour, TWA)}}{2000}$$

Conc. in the mask = 0.001 f/cc (8-hour, TWA)

Accordingly, if the worker wore the respirator properly fitted and maintained, his exposure should have been well below 0.01 f/cc (8-hour, TWA).

It should be noted that protection factors should only be used when the respirator is properly fitted, maintained, and used as intended. It should also be noted that protection factors for a specific model (and size) of respirator may be estimated for each employee if quantitative fit-testing is performed for each worker. This is discussed in the fit-testing part of this section.

PROTECTING THE WORKER: CLOTHING

It is first important to understand why protective clothing is worn during asbestos abatement work. The primary reason is to keep gross amounts of asbestos-containing debris off the body, hair, etc. The use of protective clothing and showers will minimize the chance of bringing asbestos out of the work area and into the home. Protective clothing will also minimize the chance of rashes and discomfort caused by the material being removed. In addition to the asbestos, frequently the material being removed contains mineral wool, fiberglass, and binders such as cement. Each of these may be irritating to the skin. Continued direct contact with asbestos has also been shown to cause "asbestos warts." These warts often take months to heal and occur more frequently if asbestos is trapped beneath a watchband, or in other ways kept in close contact with the skin.

Protective clothing for asbestos abatement projects usually consists of disposable coveralls, foot covering and head covering. The foot and head covering should be attached to the coveralls. This eliminates the need to tape openings between garments, etc. Tight fitting bathing suits are usually worn beneath the coveralls. Nylon suits work well and can be cleaned easily during showering. Gloves should be worn when inside the work area.

Protective clothing does <u>not</u> include street clothes (or shoes), T-shirts, blue jeans, sweat bands, kneepads, and socks. If any of these items are used inside the work area, they should remain there until the job is completed and disposed of as asbestos-contaminated waste. Jewelry such as rings and ID bracelets should not be worn in the work area.

Other protective clothing/items such as hard hats and safety shoes/boots should remain in the work area for the duration of the project. Upon project completion, these items can be cleaned, placed in a plastic bag, labeled as containing asbestos, and taken to the next project. If safety shoes/boots are not used, it is wise to have workers wear rubber soled, slip-on deck shoes. These remain in the work area and are disposed of at the end of the project as asbestos-containing waste. These deck shoes are usually of canvas construction and are inexpensive (about $10.00 per pair). It is a good idea to have each worker mark his shoes and hard hat with his/her name with permanent ink.

To summarize, listed below is a list of items normally worn by asbestos abatement employees.

- o Disposable coveralls, disposable foot covering, disposable head covering
- o Nylon swim suit
- o Slip-on deck shoes with non-skid rubber soles
- o Hard hat (as required)
- o Gloves (cotton is practical)

- Eye protection (not needed if full face-piece respirators are used)

The disposable coveralls, foot, and head coverings are available from many sources and several materials. Coveralls, with foot and head covering attached usually cost about $3.00 each when purchased in quantity. Separately, the coveralls cost approximately $2.00, head covering about $0.35, and foot covering about $0.50 per pair. It is important to realize that many "bargain" prices may not be a bargain at all. The less expensive coveralls often use less material. Accordingly, coveralls marked "XL" may be too small for many workers. Be sure to check the construction of the coveralls as well. Double stitching on seams will last longer, but cost more.

A common problem on asbestos abatement projects is a failure by contractors to purchase enough coveralls for the project. Each worker must use a new coverall (and foot and head covering if not attached) each time he/she enters the work area. Assuming two breaks and a lunch period, four coveralls will be needed each day by each worker. Additional coveralls are usually needed for authorized visitors (architect, industrial hygienist, etc.) and to replace some that are torn to the point of being unusable. As a rule of thumb, the contractor may estimate the number of suits needed for a project by the following formula.

5 x no. of workers x project duration (days) x 1.1 =
number of coveralls needed

As an example, a project lasting 48 days using a crew of 8 workers and one job foreman will need the following number of coveralls (estimated).

5 x 9 workers & foreman x 48 days x 1.1 =
2376 coveralls

Accordingly, the contractor should order 95 cases (25 per case) of coveralls for the project. It should be noted that the "1.1" factor in the above formula provides a 10% surplus. This is often necessary for project overruns. Further, when purchasing coveralls, large and extra large sizes be bought. These can always be made to fit smaller employees.

PUTTING PROTECTIVE CLOTHING ON

Protective clothing is put on in the clean room of the decontamination unit before entering the work area. The following sequence should be used.

1. All street clothes, including undergarments are removed and stored in a clean, convenient location. Bins or lockers work well for this. It is usually wise to have a lockbox or other means to protect valuables. This will discourage employees from bringing wallets, rings, keys, etc. into the work area.

2. The nylon swim suit is put on.

3. The disposable coveralls are put on.

4. If separate disposable foot coverings are used, these are put on.

5. Ankles are taped to take up slack in the suits and reduce the chance of tripping. (Tape pants over foot coverings, if separate.)

6. The respiratory equipment is inspected, put on, and the fit checked.

7. The hood or head covering is put on over the respirator head straps.

8. Worker passes through airlocks and shower to contaminated equipment room.

9. Deck shoes are put on (or safety shoes/boots, as required).

10. Gloves are put on (cotton gloves are usually worn although leather gloves should be used for handling metal lathe). The sleeves are taped over the gloves using duct tape.

11. Other protective equipment such as hard hats and safety glasses (if a half-face respirator is used) are put on.

One person should remain outside the work area at all times. It should be his/her responsibility to ensure that each person entering the work area has the proper protective clothing.

Once inside the work area, no employees, or others, should be permitted to leave without going through the decontamination sequence unless it is an extreme emergency. A common problem is employees "stepping out" for a cigareete or supervisors "stepping in" the work area to deliver a message or piece of equipment. These activities defeat the purpose of the protective equipment and the decontamination sequence.

TAKING PROTECTIVE CLOTHING OFF

Whenever an employee or other person leaves a work area for any reason, he/she must go through the decontamination sequence. This sequence should include the following steps.

1. Remove all protective garments and equipment (except respirators) in an area immediately outside the shower on the contaminated side. An area should be designated for this purpose and kept as free as practicable of asbestos-contaminated material. All disposable clothing should be placed in plastic bags inside a drum and labeled as asbestos-containing waste.

2. The person should then clean reusable protective equipment such as boots/shoes, safety glasses, hard hats, etc.

3. The person should then proceed to the shower still wearing his/her respirator. While showering, the person should be sure to soak the respirator cartridges if they are not using supplied air. The cartridges may then be discarded in a plastic bag located at the shower.

4. The person should then proceed to the clean room, dry off, dress in his/her street clothes, and disinfect, clean, and inspect his/her respirator. If air supply is not being used, new cartridges should be placed in the respirator.

ESTABLISHING A TYPE C SUPPLIED-AIR SYSTEM

Objective: To become familiar with the equipment, procedures, use, limitations, and maintenance of an air supply respiratory protection system.

Learning Tasks: Information in this section should enable participants to:

- ☞ Understand the reasons for using air-supplied respirators.
- ☞ Recognize that breathing air must be processed and not simply pumped.
- ☞ Understand the mechanism by which air is compressed and purified.
- ☞ Become familiar with the need for air storage banks and proper air delivery to the worker.
- ☞ Gain an understanding of the many regulations and recommended practices for providing breathing air.

ESTABLISHING A TYPE C SUPPLIED-AIR SYSTEM

Good practices generally require the use of type C supplied-air respirators on any asbestos removal project. The OSHA regulations (29 CFR 1910.1001) further require that type C respirators be used until it has been conclusively proven by personal air monitoring that a lesser form of respiratory protection will be adequate.

If the assumption is made that 0.01 fibers per cubic centimeter (f/cc) will be the clearance level at the conclusion of a removal project, the workers performing the abatement work should not be exposed to concentrations of asbestos fibers any greater than this. The selection of appropriate respiratory protection now becomes greatly simplified. Using established protection factors (a ratio of the concentration outside the mask to that inside the mask), maximum anticipated fiber levels outside the respirator may be used to select the proper respiratory protection to reduce the concentration inside the mask to 0.01 f/cc or below.

As a rule of thumb, cartridge filter respirators are usually adequate protection for the worker during work area preparation and final wipe-down following gross clean-up. Good practices require the use of type C supplied-air respirators once gross removal begins through gross clean-up of the work area.

A type C supplied-air system normally consists of a compressor, air delivery lines, air cleaning apparatus, a reserve air supply, and NIOSH-approved masks. At a minimum, a type C system should provide the following:

- o A continuous sufficient supply of air
- o Supplied air which meets Grade D requirements
- o Adequate escape time
- o Worker comfort and protection
- o NIOSH-approved respirators and supply hoses

GRADE D AIR

Grade D Air is the minimum quality for routine use in supplied-air (or self-contained) breathing equipment, as used in fire fighting, general industry, and asbestos abatement projects where supplied-air respirators are in use. There are other grades of air purity including Grade E (minimum requirements for sports diving to 125 feet) and Grade H. Each of these grades (E and H) are more stringent than Grade D specifications. The Grade D air specifications were established by the Compressed Gas Association, Inc. of New York and incorporated into the OSHA regulation 29 CFR 1910.134 by reference. The specifications themselves are contained in the Compressed Gas Association (CGA) Pamphlet G-7, entitled, "Compressed Air for Human Respiration." These specifications are discussed briefly below. Asbestos abatement contractors performing work in Canada should be aware that breathing air must meet considerably more stringent standards as described in the Compressed Breathing Air Standard Z180.1-1978. This may be obtained from the Canadian Standards Association in Rexdale, Ontario, Canada.

GRADE D BREATHING AIR REQUIREMENTS

Carbon Monoxide (CO)	20 parts per million
Carbon Dioxide (CO_2)	1000 parts per million
Condensed Hydrocarbons	5 milligrams per cubic meter
Objectionable Odors	None

Water Vapor	The CGA standard does not specifically establish a limit for moisture; however, a limit of 66 parts per million is necessary to assure proper function of CO scrubbing devices.

Normal air contains 20.9% oxygen. The oxygen content in breathing air should always fall between 19.5% and 23.5%. Normally, the oxygen content is only a consideration when purchasing bottled air which has been manufactured. Since the oxygen content of ambient air remains quite constant, and compressing the air does not alter the oxygen content, there is little concern that the asbestos abatement worker will be short of oxygen.

Perhaps the greatest concern when dealing with type C supplied-air systems is the generation or presence of carbon monoxide. This contaminant may be introduced into the breathing air through compressor malfunction or, more commonly, it may be drawn into the compressor directly. Carbon monoxide can be produced by the compressor if it overheats. The overheating causes the lubricating oil to break down with carbon monoxide being released. For this reason, high temperature alarms are often installed on compressors. OSHA requires that oil-lubricated compressors shall have a high-temperature or carbon monoxide alarm, or both. If only a high temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide.

One alternative is to use an oil-free compressor to eliminate the chance of oil breakdown if the compressor overheats. However, oilless compressors usually require more frequent servicing and the synthetic materials used may release gaseous contaminants if the compressor overheats. (Note: The Canadian Standards Association has established a limit of 2 ppm in compressed breathing air for each of the following: trichlorotrifluoroethane, dichlorodifluoromethane, and chlorodifluoromethane.)

To avoid drawing carbon monoxide into the compressor directly, an extension intake flexible duct should be used to place the air intake at a remote location. The location chosen should be away from any combustion sources (i.e., vehicle exhausts, smokestacks, etc.). Frequently, the best location is 15 or 20 feet up in a tree since it would be unlikely that a truck or car, lawnmower or other carbon monoxide producing vehicle could affect the supply air. Be sure to place a course filter (screen) over the air inlet to keep leaves, bugs, etc., from being drawn into the compressor.

Contractor supervisors should be aware of any other potential sources of toxic gases near the air intake. This would be especially important in industrial settings where gases are commonplace. Contaminants not listed in the specifications for Grade D air should not exceed one-tenth of the Threshold Limit Values (TLVs) for Chemical Substances in the Work Environment, adopted by the American Conference of Governmental Industrial Hygienists (ACGIH). A copy of this booklet may be obtained for a nominal charge from the ACGIH, 6500 Glenway Avenue, Bldg. D-5, Cincinnati, Ohio 45211.

AIR PROCESSING

A properly established type C supplied-air system does not simply pump air to workers. Rather, the air must also be processed. Along with air that enters the compressor, heat and water vapor are also processed. As the air is compressed, the temperature rises. When the compressed air drops back to normal ambient pressure, the temperature likewise returns to normal. Therefore, heat should be removed from the compressed air resulting in the air that reaches the worker inside the respirator being cool and comfortable.

Water vapor, when compressed, forms water droplets or condensation. If this water is not removed, it can build-up in the air lines to the workers to the point where a solid "plug" of water is formed. This plug of water will quickly be forced into the respirator of the workers. It is quite likely that the workers will immediately discard the masks, or be startled by the sudden flood of water causing an accident (fall from a scaffold or ladder, for example). Accordingly, the air processing equipment must be capable of removing moisture from the supply air.

There are four basic steps in establishing a type C supplied-air system. These are (1) compression, (2) purification, (3) storage, and (4) distribution.

Compression

Compression of air is necessary to store the air in a reduced space until needed. There are many different types of compressors available to perform this task. Some are oil-free using non-lubricated Teflon piston rings. More typical is the reciprocating multistage oil-lubricated compressor. Screw-type compressors and diaphragm compressors are also available. Compressors may be gasoline, diesel, or electric powered. In a reciprocating compressor, air is compressed in steps or stages. At each stage (or immediately following) should be a condensate trap to allow water to be expelled. The compressor should have a high air temperature shutdown switch, an automatic start-stop pressure switch, and a low oil level shutdown switch. The choice of lubricating oil will depend on the individual make and model of the compressor. Usually, however, mineral oil or a high grade synthetic oil is used. The compressor should also have appropriate pressure gauges and safety valves.

When selecting a compressor (or renting), be sure the manufacturer is aware of its intended use. Some compressors deliberately add oil to the air stream for lubricating air-driven machinery.

Further, be sure to follow manufacturer's operating instructions and service schedule.

The compressor should be located in a covered area with good ventilation. An area under a shade tree with a cool breeze is ideal, but the compressor should never be placed in an area with below freezing temperatures. The air intake should be located at least 8 feet above the ground and a coarse filter used as previously described. Gasoline should always be stored out of direct sunlight in a cool area, not accessible to visitors, etc.

Purification

The second step in air processing is purification. While the compressor may remove some water through the condensate traps, additional moisture, odors, oil, hydrocarbons, heat, and carbon monoxide must be removed. The equipment for the purification process consists of a series of filters, adsorption columns, and sieves. This equipment is normally purchased as one unit at a cost of $10,000-15,000.

The purification equipment normally has an aftercooler (radiator/fan) to remove heat, thereby cooling the air. Following the aftercooler, the air stream passes one or more coalescing filters. A coalescing filter causes aerosol droplets to join together (or coalesce) and form larger drops that impinge on the filtering surface and are too heavy to be re-entrained in the air stream. The coalescing filter removes droplets of water and oil, as well as solid particles larger than about 10 micrometers in diameter through mechanical filtration.

Two adsorption filters are usually located next in line to the coalescing filter(s). The first adsorption filter consists of a column packed with a molecular sieve to remove water vapor. This filter also removes gaseous hydrocarbons, nitrogen oxides, sulfur compounds, and other odors. Following this filter is a column containing activated charcoal, which removes additional unpleasant odors and oil vapor. Each of the sorbent materials (molecular sieve and activated charcoal) will need periodic replacement according to the manufacturer's specifications.

The next step in the purification process is eliminating carbon monoxide through oxidation. In the presence of a catalyst, carbon monoxide will combine with oxygen to form carbon dioxide, a much less harmful gas. It should be noted that water destroys the catalyst. Therefore, the removal of water and water vapor before this stage of purification is extremely important.

Following the carbon monoxide catalyst is usually a mechanical filter to remove any particles larger than 0.5 micrometers in diameter. At this point in the purification process is located the carbon monoxide monitor. This instrument, calibrated daily, measures the concentration of carbon monoxide in the supply air stream. The calibration procedure and frequency specified by the manufacturers should be followed. The carbon monoxide monitor should be equipped with a visual and audible alarm to alert the operator of a high carbon monoxide level in the supply air. The filtration unit should also have an air-powered horn to alert the operator of electrical power failure. The unit will continue to function; however, the carbon monoxide monitor and the aftercooling fan will not operate without electricity.

Storage

The air exiting the purification unit should meet the Grade D requirements already discussed. If a high pressure system (greater than about 200 psi) is used, the purified air may go directly into a high pressure storage tank or reservoir. A high pressure air line (usually a stainless steel, 1/4 to 1/2 inch line) is run into the work area to a manifold and regulator. At this point, the regulator reduces the pressure to under 125 psi for service to the workers through low pressure air lines.

If a low pressure system (less than 200 psi) is used, the purified air will usually be fed directly to a manifold in the work area via a low pressure (high volume) air line. At the manifold, several air lines will be run to the individual workers. To store air in the event of compressor shutdown, a check valve is installed between the filtration unit and the work area manifold. If the compressor shuts off, the check valve should open to provide air from a series of bottles (high pressure) containing grade D breathing air. The volume of air to provide adequate escape time will depend on the number of employees and time needed to evacuate the work area in an orderly manner. A reservoir of air for this purpose is required by OSHA (29 CFR 1910.134).

Delivery

Once the air has been compressed, purified, and an adequate reserve available for emergencies, it is ready for delivery to the asbestos abatement workers. Usually, large air lines from outside the work area are used to feed manifolds in the work area. Each manifold can usually accommodate 2-6 air lines. In this way, short air lines (about 50 feet) can be used, reducing the amount to be pulled about by the worker or tripped over by others. Each airline connects to a belt-mounted regulator which permits flow into the mask.

The amount of air actually needed will depend on many factors including the type of respirator, number of workers, and auxiliary equipment. Constant flow, tight-fitting masks must be supplied with a minimum of 4 cubic feet of air per minute (CFM). Hood-type respirators must be provided with 6 CFM at a minimum. For each of these types of masks, the maximum recommended flowrate is 15 CFM. It should be noted that the use of vortex air cooling devices will require additional air flow according to the specifications of the vortex unit chosen.

Any air-line respirators chosen must be approved by NIOSH/MSHA (National Institute for Occupational Safety and Health and/or the Mine Safety and Health Administration). These agencies approve each air-line respirator as an entire unit, including the facepiece, regulator, and the airline. No unapproved respirators may be used at any time. The maximum airline length for any approved respirator may not exceed 300 feet. The maximum inlet pressure at the mask cannot exceed 125 psi. Any alteration of the respirator or its subassemblies voids the approval. Accordingly, replacement parts must be supplied by the manufacturer for their respirators only.

Additional Information

The following items are provided merely as suggestions for work practices when using air-supplied respirator systems. Most importantly, the contractor should become fully knowledgable on the use, limitations, and maintenance of the system. The manufacturer's representative will often provide assistance in this area. It is also recommended that an industrial hygienist or other person familiar with such systems be retained for advice during initial set-up and until the job superintendent is comfortable with system operations.

The mask chosen by the contractor is often one that contains a HEPA filter back-up should the air shut down, and permits the worker to disconnect from the air line when entering and leaving the work area. While the protection factor drops from 1000 or 2000 to 50 when on the HEPA filter, the worker normally does not need the high protection of the airline when only traveling to and from the work area. This type of mask also permits workers to undress and shower without being attached to the airlines. An added benefit of this type of mask is that it permits the airlines to be tied-off atop scaffolding, allowing the worker to climb the scaffold without the airline attached. Once on the scaffold, the worker may connect onto the airline.

Plastic caps or tape should be used to cover all exposed airline connections when not in use. This will keep asbestos debris from becoming caked in the quick disconnects. The airlines and manifolds will need to be cleaned completely at the end of the project. It is a good idea to keep the manifold draped with plastic during gross removal and clean-up. Also, coiling the clean air lines and sealing them in plastic bags to be opened inside the next work area is a good practice and saves time.

Thorough training of the asbestos abatement workers is necessary. This becomes even more important when airline respirators are used. Once workers become accustomed to the airline respirators, they usually find them much more comfortable than the cartridge respirators since a cool, fresh supply of air is continuously fed into the respirator. This keeps the facepiece from fogging and helps reduce the incidence of heat stress, if applicable.

PREPARING THE WORK AREA AND ESTABLISHING THE DECONTAMINATION UNIT

Objective: Understand the proper techniques for preparing the work area and setting up a decontamination unit before abatement activity begins.

Learning Tasks: Information in this section should enable participants to:

- ☞ Understand objectives of work area preparation.
- ☞ Become familiar with the sequence and methods for accomplishing tasks in work area preparation.
- ☞ Know the functions of a decontamination unit.
- ☞ Become familiar with the basic construction of a decontamination unit.
- ☞ Know procedures for entering and leaving the work area using the decontamination unit.
- ☞ Become familiar with the necessary materials and equipment used for prepping the work area and building a decontamination unit.

PREPARING THE WORK AREA

Airborne fibers which are generated by disturbance of asbestos-containing material may remain suspended in the air for long periods of time because of their small size and aerodynamic properties. These airborne asbestos fibers can migrate via air currents to other parts of the building.

Proper preparation of the work area before an asbestos abatement project begins serves the primary purpose of containing fibers which are released within the work area. Good preparation techniques serve to protect interior finishes such as hardwood floors or carpets from water damage and reduce cleanup effort. General safety issues are also a major consideration in work area preparation (see section in Other Safety and Health Considerations).

Each project has unique requirements for effective preparation. For instance, the sequence of steps would probably be different for preparing a boiler room than preparing an area with asbestos material above a suspended ceiling. The following are general guidelines which can be modified to address specific problems encountered on an asbestos abatement project.

STEP 1 - Conduct Walkthrough Survey of the Work Area

The contractor, building owner, and architect should make a walkthrough survey to inventory and photograph any existing damages.

STEP 2 - Post Warning Signs

Warning signs should be placed at each entrance to the work area. Re-usable metal signs or disposable cardboard signs are available. Signs should inform the reader that breathing asbestos dust may cause serious bodily harm. See section (g) of the Occupational Safety and Health Administration asbestos standard for sign specification (Appendix). These signs are available from most safety supply houses and asbestos abatement contractor suppliers.

STEP 3 - Shut Down the Heating, Ventilating, and Air Conditioning System (HVAC)

The HVAC system supplying the work area should be shut down and isolated to prevent entrainment of asbestos dust throughout the building. To avoid inadvertent activation of the HVAC system while removal operations are in progress, the control panel should be tagged (advising personnel not to activate) and locked.

All vents and air ducts inside the work area should be covered and sealed with two layers of 6 mil polyethylene and duct tape. The first layer of polyethylene should be left in place until the area has passed final visual inspection and clearance air monitoring.

HVAC filters which may be contaminated with asbestos dust should be removed and disposed of in the same manner as the other asbestos-containing materials (see Disposal of Waste).

STEP 4 - Clean and Remove Furniture and Non-Stationary Items from the Work Area

Workers wearing half-mask high efficiency filter cartridge respirators and disposable clothing should remove all non-stationary items that can feasibly be taken out of the work area. This prevents further contamination of the items and facilitates the removal process. Before storing the items outside the work area, they should be cleaned with a high efficiency particulate air (HEPA) filtered vacuum and/or wet-wiped to remove any asbestos-containing dust. Drapes should be removed for dry cleaning or disposal. Carpet should be disposed of as asbestos-containing waste.

STEP 5 - Seal Stationary Items with Polyethylene

Items not being removed from the work area, such as large pieces of machinery, blackboards, pencil sharpeners, water fountains, toilets, etc., should be wet-wiped or HEPA vacuumed and wrapped in place with 6 mil polyethylene and sealed with duct tape.

Water fountains should be disconnected, covered with two layers of polyethylene, and labeled non-operational to discourage anyone from cutting through the polyethylene to get a drink.

Electrical outlets should be shut down, if possible, and sealed with tape or covered with polyethylene and then taped.

STEP 6 - Tape and Seal Windows with Polyethylene

The edges of all the windows should be sealed with 3" wide high quality duct tape. After the edges have been taped, the windows should be covered and sealed with 6 mil polyethylene and duct tape.

STEP 7 - Cover the Floor with Polyethylene

Six mil polyethylene sheets should be used to cover the floor in the work area. Several sheets may be seamed together with spray adhesive and duct tape. Blue or red carpenter's chalk placed beneath the seam line will darken in color if water leaks through. Any leaks which occur should be promptly cleaned up. The polyethylene floor sheets should be cut and peeled back to allow access to the wet area. After mopping up the water and any contamination that leaked through, the area should be wet-wiped with clean rags. The peeled-back sheets are put back in place and sealed with duct tape after the area drys. An additional "patch" sheet can be placed over this area and sealed with tape to provide extra protection.

After joining the sheets of polyethylene together, the floor covering should be cut to the proper dimensions, allowing the polyethylene to extend twenty-four inches up the wall all the way around the room. The polyethylene should be flush with the walls at each corner to prevent damage by foot traffic.

When the first layer of polyethylene has been secured in place, a second layer should be installed with the seams of the first and second layers offset. The second layer of polyethylene should extend a few inches above the first layer on the wall and secured with three-inch duct tape.

When covering stairs, ramps, or other potential slippery spots with polyethylene, care must be taken to provide traction for foot traffic. Wet polyethylene is very slippery and can create serious tripping hazards. To provide better footing, masking tape or thin wood strips can be placed on top of the polyethylene to provide rough surfaces in these areas.

STEP 8 - Cover the Walls with Polyethylene

After the floors and stationary objects have been covered with polyethylene, one or two layers of 4 mil polyethylene are used to cover the walls. The lighter weight 4 mil is easier to hang and keep in place than the heavier 6 mil.

The sheets of 4 mil polyethylene should be hung from the top of the wall a few inches below the asbestos material and should be long enough to overlap the floor sheets by twenty-four inches. The vertical sheets should be overlapped and seam-sealed with adhesive duct tape.

The sheets should be hung using a combination of nails and furring strips (small wood blocks), or adhesive and staples, and sealed with four-inch duct tape. Duct tape alone will not support the weight of the polyethylene after exposure to the high humidity which often occurs inside the work area. Nails may cause some minor damage to the interior finish; however, it is usually more time efficient to touch up the nail holes than to repeatedly repair fallen barriers.

STEP 9 - Locate and Secure the Electrical System to Prevent Shock Hazards

Amended water is typically used to saturate asbestos-containing sprayed-on material prior to removal. This creates a humid environment with damp to very wet floors. The electrical supply to the work area should be de-energized and locked out before removal operations begin to eliminate the potential for a shock hazard.

Before removal begins:

- Identify and de-energize electrical circuits in the work area.

- Lock the breaker box after the system has been shut down and place a warning tag on the box.

- Make provisions for supplying the work area with electricity from outside the work area which is equipped with a ground-fault-interrupt system.

- If the electrical supply cannot be disconnected, energized parts must be insulated or guarded from employee contact and any other conductive object.

STEP 10 - Removing or Covering Light Fixtures

Light fixtures may have to be removed or detached and suspended (bailing wire works well) to gain access to asbestos-containing material. Before beginning this task, the electrical supply should be shut off. Light fixtures should be wet wiped before they are removed from the area. If it is not feasible to remove the light fixtures, they should be wet wiped, then draped with plastic or completely enclosed.

STEP 11 - Securing the Work Area

When the work area is occupied, padlocks must be removed to permit emergency escape routes. Arrows should be taped on the polyethylene-covered walls to indicate the location of exits. All entrances should be secured when removal operations are not in progress. Provisions must also be made to secure the decontamination station entrance when no one is on the job site. Security guards may be a reasonable precaution, depending on the nature of the project.

Nonessential personnel should not be permitted to enter the work area. An on-site job log should be maintained for recording who enters the work area and the time each person enters and exits the work zone.

ESTABLISHING A DECONTAMINATION UNIT

The decontamination station is designed to allow passage to and from the work area during removal operations with minimal leakage of asbestos-containing dust to the outside. A typical unit consists of a clean room, a shower room, and an equipment room separated by airlocks. The airlocks are formed by overlapping two sheets of polyethylene at the exit of one room, and two sheets at the entrance to the next room with three feet of space between the barriers (see Figure X-1). There are various methods for constructing airlocks including a hatch type construction and a slit and cover design.

Materials used to construct a typical unit include 2-inch by 4-inch lumber for the frame, 1/4 inch to 1/2 inch plywood or 6 mil polyethylene for the walls, duct tape, staples and nails. The floor should be covered with three layers of 6 mil polyethylene. The decontamination unit can be built in sections to allow for disassembly and re-use at another area of the building. The design of the decontamination station will vary with each project depending on the size of the crew and the physical constraints imposed by the facility.

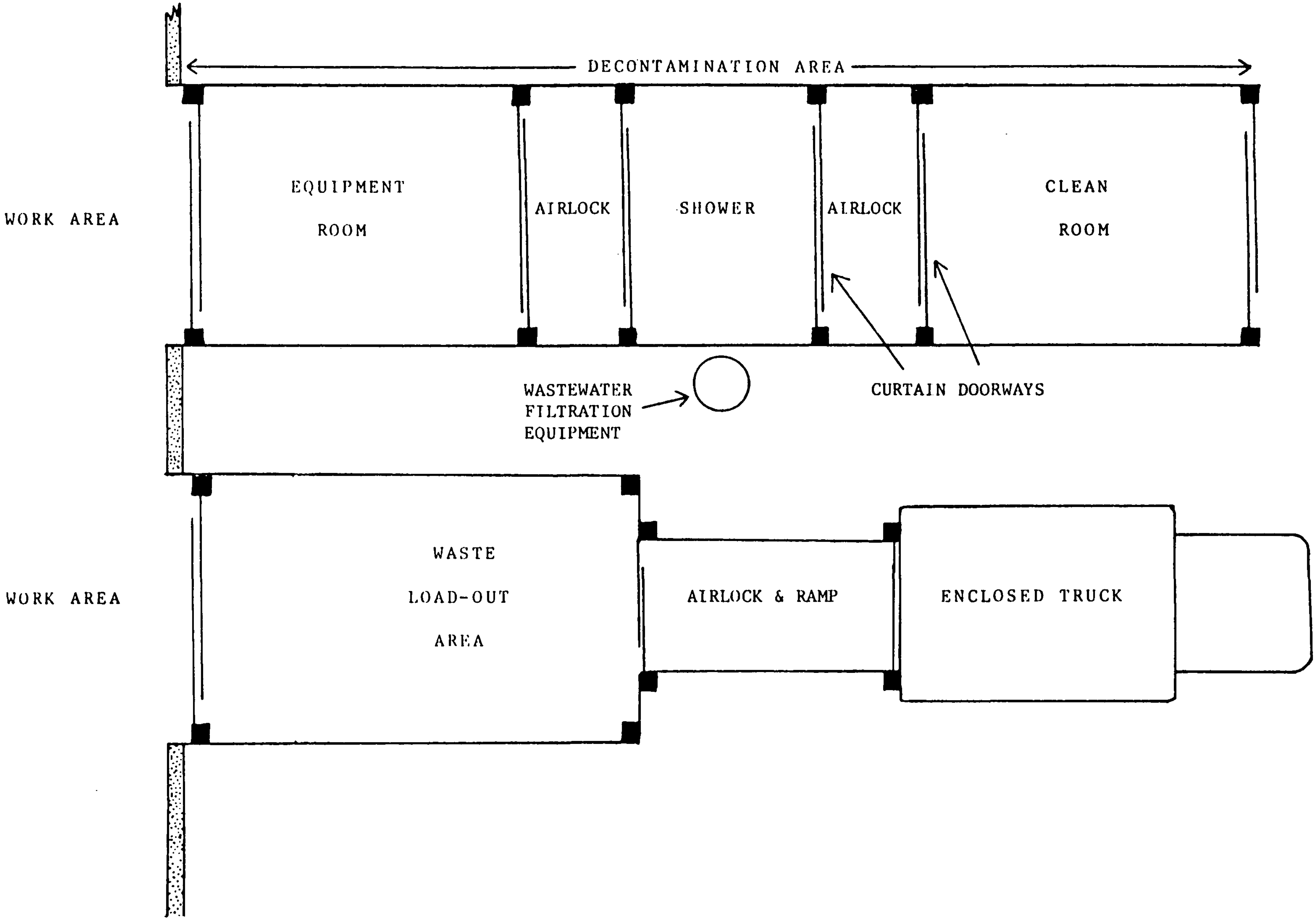


Figure X-1. Sketch of Typical Decontamination Area and Waste Load-out Area

Customized trailers which can be readily moved from one location to the next are also used as decontamination stations. These units typically cost \$20,000 - \$50,000 depending on the size and features. A company conducting work at many different locations would probably recover this initial investment over time.

Whether a decontamination station is constructed on-site or is in the form of a trailer, the basic design is the same. The major components and their uses are discussed below and illustrated in the following diagrams (Figures X-1 and X-2).

<u>Clean Room</u> - No asbestos-contaminated items should enter this room. Workers use this area to suit up, store street clothes, and don respiratory protection on their way to the work area, and to dress in clean clothes after showering. This room should ideally be furnished with benches, lockers for clothes and valuables, and nails for hanging respirators.

<u>Shower Room</u> - Workers pass through the shower room on their way to the removal area, and use the showers on their way out after leaving contaminated clothing in the equipment room. Although most job

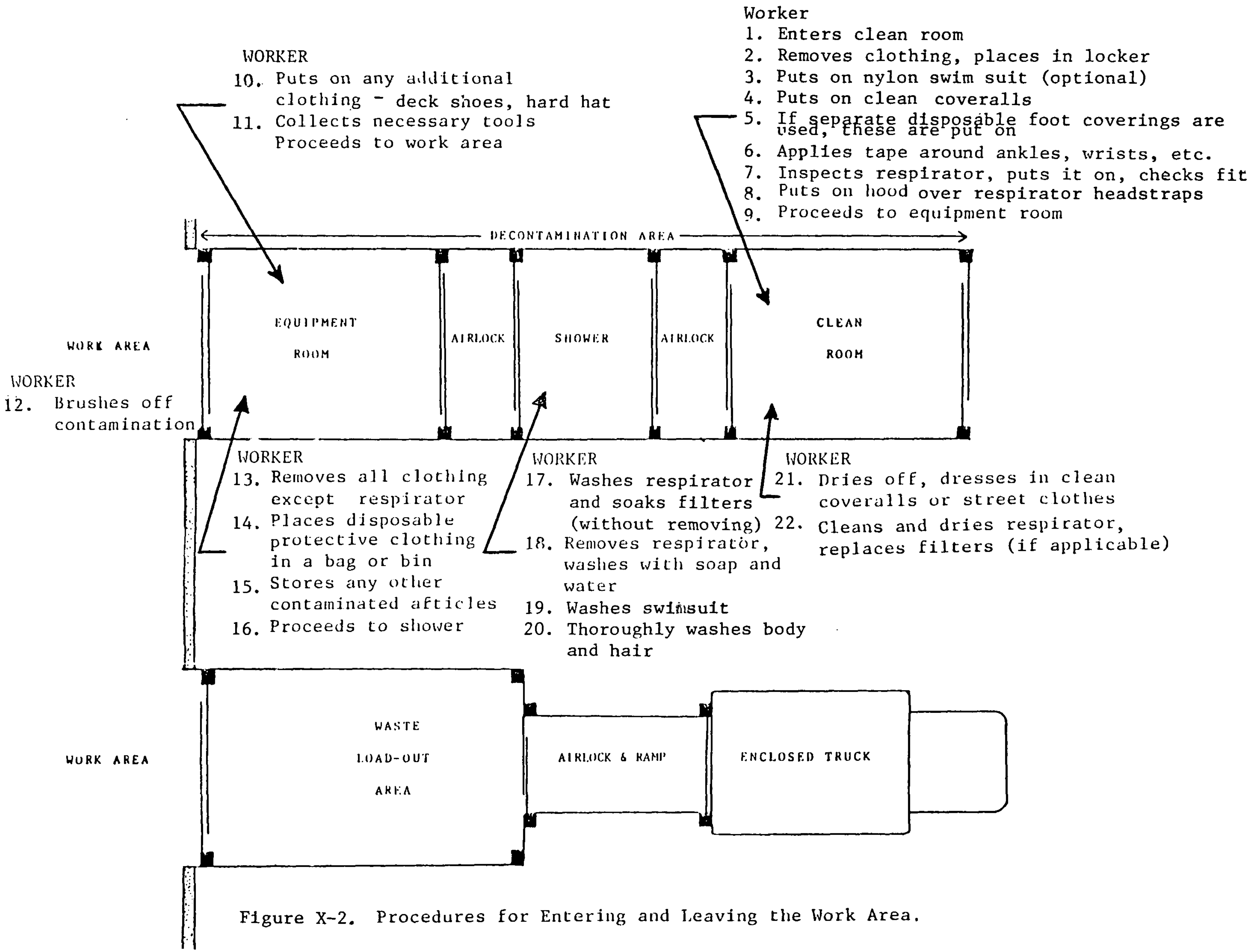


Figure X-2. Procedures for Entering and Leaving the Work Area.

specifications require only a single shower head, installation of multiple showers may be time and cost effective if the work crew is large. Shower wastewater should be collected and treated as asbestos-containing material or filtered before disposal into the sanitary sewer. State and local requirements on methods of shower wastewater disposal vary. For example, Alabama, Georgia, Maryland, and New Jersey each have written specifications for handling shower wastewater.

Equipment Room - This is a contaminated area where equipment, boots or shoes, hardhats, goggles, and any additional contaminated work clothes are stored. Workers place disposable clothing such as coveralls, booties and hoods in bins before leaving this area for the shower room. Respirators are worn until workers enter the shower and thoroughly soak them with water. The equipment room may require cleanup several times daily to prevent asbestos material from being tracked into the shower and clean rooms.

Waste Load-Out Area - This is an area separate from the decontamination unit which is used as a short term storage area for bagged waste and as a port for transferring waste to the truck. An enclosure can be constructed to form an airlock between the exit of the load-out area and an enclosed truck (see Figure X-2).

The outside of the waste containers should be free of all contaminated material before removal from the work area. Gross contamination should be wiped or scraped off containers before they are placed in the load-out area. Any remaining contamination should be removed by wet wiping or the bagged material can be placed in a second clean bag. To save cleanup time, fiber drums can be covered with an outside bag of polyethylene before they are taken into the work area which can be removed before taking the drum into the load-out area.

MATERIALS AND EQUIPMENT LIST FOR PREPARATION OF THE WORK AREA AND ESTABLISHING THE DECONTAMINATION STATION

Polyethylene Sheeting Material

Used to:

Seal off work areas and items within work areas; protect surfaces in the work area other than those being altered; construct decontamination and enclosure systems.

Types:

4 mil thickness	12' x 100' rolls	20 lbs
6 mil thickness	20' x 100' rolls	60 lbs

Duct Tape

Used to: Seam polyethylene sheets together; form airtight seal between polyethylene and wall; provide some support for vertical sheets.

Adhesive Spray

Used to: Seal seams; provide additional support to vertical sheets.

Furring Strips (cut into blocks)

Used to: Support vertical sheets of polyethylene.

Nails

Used to: Attach furring strips to top edge of polyethylene and then to the wall; construct the frame of the decontamination unit.

Staples & Staple Gun

Used to: Attach polyethylene to wood frame.

Retractable Razor Knives

Used to: Slice polyethylene and tape.

Warning Signs

Used to: Post entrances to building and decontamination unit.

Vacuum Cleaner Equipped with a High Efficiency Particulate Air (HEPA) Filter

Used to: Clean non-stationary items before removing them from the work area.

Ladders and/or scaffolding

Carpentry tools such as hammers, saws, etc.

Prefab shower stalls or materials for shower construction

CONFINING AND MINIMIZING AIRBORNE FIBERS

Objective: Provide instruction to participants on the most effective methods for containment of asbestos fibers during an asbestos abatement project.

Learning Tasks: Information in this section should enable participants to:

- ☞ Understand the primary methods used to contain and minimize airborne fiber concentrations during an asbestos abatement project.
- ☞ Know principles and procedures for setting up a negative air filtration system on an abatement project.
- ☞ Become familiar with the use and limitations of negative air filtration units.
- ☞ Understand the application and use of wet removal techniques.
- ☞ Become familiar with proper procedures and equipment for removal of asbestos-containing sprayed and troweled-on friable insulation material.
- ☞ Become familiar with proper procedures and equipment for removal of asbestos-containing insulation from pipes, tanks, and boilers.

CONFINING AND MINIMIZING AIRBORNE FIBERS

The preparation phase of an abatement project is directed toward containing the airborne fibers which will be generated during removal, primarily by constructing barriers with polyethylene sheeting. This containment effort, along with measures to minimize airborne fiber concentrations, is continued throughout the removal phase. The primary methods for contaminant control are the use of wet removal techniques and the use of negative air filtration systems accompanied by frequent clean up in a work area sealed with polyethylene.

Negative Air Filtration Systems

The planning strategy for the use of negative air systems in abatement work includes two main goals.

- Changing air within the containment area approximately every 15 minutes.

- Establishing conditions in which air from all portions of the sealed zone is being pulled toward the negative air filters.

Negative air systems can be used on an abatement project to accomplish several positive effects.

- Containment of airborne fibers even if the barrier is ripped or punctured.

- Lower concentration of airborne fibers in the work area.

- Worker comfort and increased productivity.

- Improved efficiency in final cleanup.

Negative air filtration units are known by several different names including Micro-Trap,™ Red Baron,™ Hog,™, micro-filter, HEPA units and negative pressure system. Prototypes were developed in the latter 1970's and the concept of air filtration systems as a primary control technique was adopted by EPA in 1983. A general discussion on negative air systems is provided in the following pages which are reproduced with some modifications from EPA report number 560/5-83-002, Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, March 1983.

RECOMMENDED SPECIFICATIONS AND OPERATING PROCEDURES FOR THE USE OF NEGATIVE PRESSURE SYSTEMS FOR ASBESTOS ABATEMENT*

INTRODUCTION

This section provides guidelines for the use of negative pressure systems in removing asbestos-containing materials from buildings. The manufacturer's instructions for equipment use should be followed for negative air filtration units, as well as all other equipment discussed in this manual. A negative pressure system is one in which the static pressure in an enclosed work area is lower than that of the environment outside the containment barriers.

The pressure gradient is maintained by moving air from the work area to the environment outside the area via powered exhaust equipment at a rate that will support the desired air flow and pressure differential. Thus, the air moves into the work area

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*Reproduced from EPA Report Number 560/5-83-002, Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, March 1983.

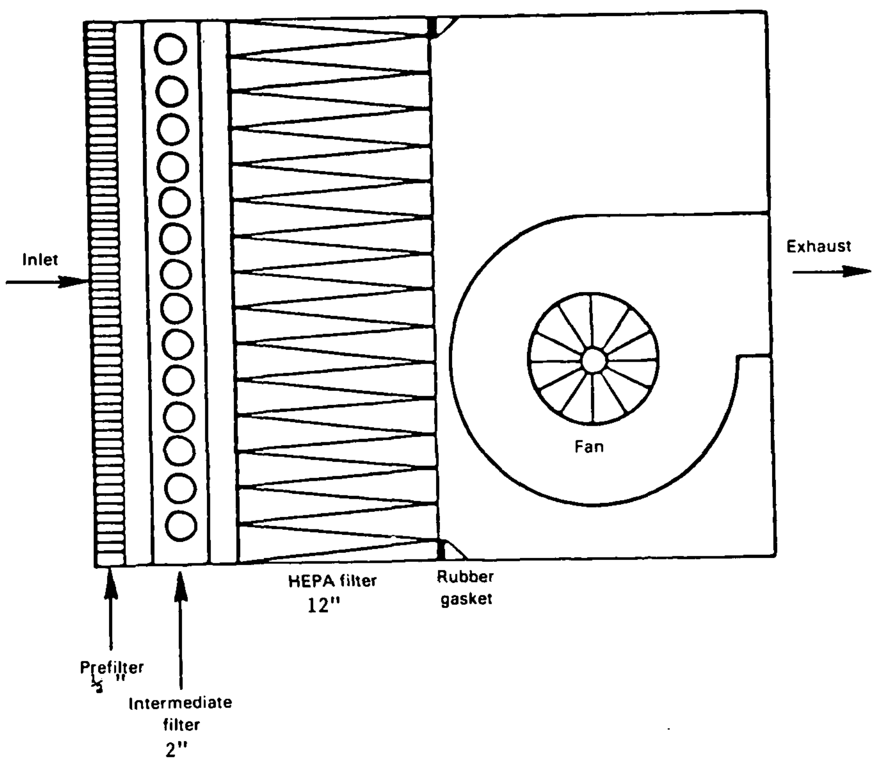
through designated access spaces and any other barrier openings. Exhaust air is filtered by a high-efficiency particulate air (HEPA) filter to remove asbestos fibers.

The use of negative pressure during asbestos removal helps protect against the large-scale release of fibers to the surrounding area in case of a breach in the containment barrier. A negative pressure system also can reduce the concentration of airborne asbestos in the work area by increasing the dilution ventilation rate (i.e., diluting contaminated air in the work area with uncontaminated air from outside) and exhausting contaminated air through HEPA filters. The circulation of fresh air through the work area reportedly also improves worker comfort by increasing the cooling effect, which may aid the removal process by increasing job productivity.

MATERIALS AND EQUIPMENT

THE PORTABLE, HEPA-FILTERED, POWERED EXHAUST UNIT

The exhaust unit establishes lower pressure inside than outside the enclosed work area during asbestos abatement. Basically, a unit consists of a cabinet with an opening at each end, one for air intake and one for exhaust. A fan and a series of filters are arranged inside the cabinet between the openings. The fan draws contaminated air through the intake and filters and discharges clean air through the exhaust.



Sketch of HEPA-filtered exhaust unit.

(Note: Other designs are available.)

Portable exhaust units used for negative pressure systems in asbestos abatement projects should meet the following specifications.

STRUCTURAL SPECIFICATIONS

The cabinet should be ruggedly constructed and made of durable materials to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. The cabinet must be appropriately sealed to prevent asbestos-containing dust from being emitted during use, transport, or maintenance. There should be easy access to all air filters from the intake end, and the filters must be easy to replace. The unit should be mounted on casters or wheels so it can be easily moved. It also should be accessible for easy cleaning.

MECHANICAL SPECIFICATIONS

FANS

The fan for each unit should be sized to draw a desired air flow through the filters in the unit at a specified static pressure drop. The unit should have an air-handling capacity of 1,000 to 2,000 ft^3/min (under "clean" filter conditions). The fan should be of the centrifugal type.

For large-scale abatement projects, where the use of a larger capacity, specially designed exhaust system may be more practical than several smaller units, the fan should be appropriately sized according to the proper load capacity established for the application, i.e.,

$$\text{Total ft}^3\text{/min (load)} = \frac{\text{Volume of air in ft}^3 \times \text{air changes/hour}}{\text{60 min/hour}}$$

Smaller-capacity units (e.g., 1,000 ft^3/min) equipped with appropriately sized fans and filters may be used to ventilate smaller work areas. The desired air flow could be achieved with several units.

FILTERS

The final filter must be the HEPA type. Each filter should have a standard nominal rating of at least 1,100 ft^3/min with a maximum pressure drop of 1 inch H_2O clean resistance. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame and cross-braced as required. The exact dimensions of the filter should correspond with the dimensions of the filter housing inside the cabinet or the dimensions of the filter-holding frame. The recommended standard size HEPA filter is 24 inches high x 24 inches wide x 11-1/2 inches deep. The overall dimensions and squareness should be within 1/8 inch.

A continuous rubber gasket must be located between the filter and the filter housing to form a tight seal. The gasket material should be 1/4 inch thick and 3/4 inch wide. This gasket should be checked periodically for cracks and gaps. Any break in this gasket may permit significant leakage of contaminated air.

Each filter should be individually tested and certified by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3 um dioctylphthalate (DOP) aerosol. Testing should be in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Each filter should bear a UL586 label to indicate ability to perform under specific conditions.

Each filter should be marked with: the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.

Prefilters, which protect the final filter by removing the larger particles, are recommended to prolong the operating life of the HEPA filter. Prefilters prevent the premature loading of the HEPA filter. They can also save energy and cost. One (minimum) or two (preferred) stages of prefiltration may be used. The first-stage prefilter should be a low-efficiency type (e.g., for particles 10 um and larger). The second-stage (or intermediate) filter should have a medium efficiency (e.g., effective for particles down to 5 um). Various types of filters and filter media for prefiltration applications are available from many manufacturers. Prefilters and intermediate filters should be installed either on or in the intake grid of the unit and held in place with special housings or clamps.

INSTRUMENTATION

Each unit should be equipped with a Magnehelic gauge or manometer to measure the pressure drop across the filters and indicate when filters have become loaded and need to be changed. The static pressure across the filters (resistance) increases as they become loaded with dust, affecting the ability of the unit to move air at its rated capacity.

ELECTRICAL

GENERAL

The electrical system should have a remote fuse disconnect. The fan motor should be totally enclosed, fan-cooled, and the nonoverloading type. The unit may use a standard 115-V, single-phase, 60-cycle service. All electrical components must be approved by the National Electrical Manufacturers Association (NEMA) and Underwriter's Laboratories (UL).

FANS

The motor, fan, fan housing, and cabinet should be grounded. The unit should have an electrical (or mechanical) lockout to prevent the fan from operating without a HEPA filter.

INSTRUMENTATION

An automatic shutdown system that would stop the fan in the event of a major rupture in the HEPA filter or blocked air discharge is recommended. Optional warning lights are recommended to indicate normal operation, too high of a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge). Other optional instruments include a timer with automatic shut-off and an elapsed time meter to show the total accumulated hours of operation.

SETUP AND USE OF A NEGATIVE PRESSURE SYSTEM

DETERMINING APPROXIMATE VENTILATION REQUIREMENTS FOR A WORK AREA

Experience with negative pressure systems on asbestos abatement projects indicates a recommended rate of one air change every 15 minutes. The volume (in ft^3) of the work area is determined by multiplying the floor area by the ceiling height. The total air flow requirement (in ft^3/min) for the work area is determined by dividing this volume by the recommended air change rate (i.e., one air change every 15 minutes).*

*The recommended air exchange rate is based on engineering judgment.

Total ft^3/min = Volume of work area (in ft^3)/15 min

The number of units needed for the application is determined by dividing the total ft^3/min by the rated capacity of the exhaust unit.

The number of units needed for the application is determined by dividing the total ft^3/min by the rated capacity of the exhaust unit.

Number of units needed =

(Total ft^3/min)/(Capacity of unit (ft^3/min)

LOCATION OF EXHAUST UNITS

The exhaust unit(s) should be located so that makeup air enters the work area primarily through the decontamination facility and traverses the work area as much as possible. This may be accomplished by positioning the exhaust unit(s) at a maximum distance from the worker access opening or other makeup air sources.

Wherever practical, work area exhaust units can be located on the floor in or near unused doorways or windows. The end of the unit or its exhaust duct should be placed through an opening in the plastic barrier or wall covering. The plastic around the unit or duct should then be sealed with tape.

Each unit must have temporary electrical power (115V A.C.). If necessary, three-wire extension cords can supply power to a unit. The cords must be in continuous lengths (without splice), in good condition, and should not be more than 100 feet long. They must not be fastened with staples, hung from nails, or suspended by wire. Extension cords should be suspended off the floor and out of workers' way to protect the cords from damage from traffic, sharp objects, and pinching.

Exhaust units must be vented to the outside of the building. This may involve the use of additional lengths of flexible or rigid duct connected to the air outlet and routed to the nearest outside opening. Windowpanes may have to be removed temporarily.

Additional makeup air may be necessary to avoid creating too high of a pressure differential, which could cause the plastic coverings and temporary barriers to "pull in". Additional makeup air also may be needed to move air most effectively through the work area. Supplemental makeup air inlets may be made by making openings in the plastic sheeting that allow air from outside the building into the work area. Auxiliary makeup air inlets should be as far as possible from the exhaust unit(s) (e.g., on an

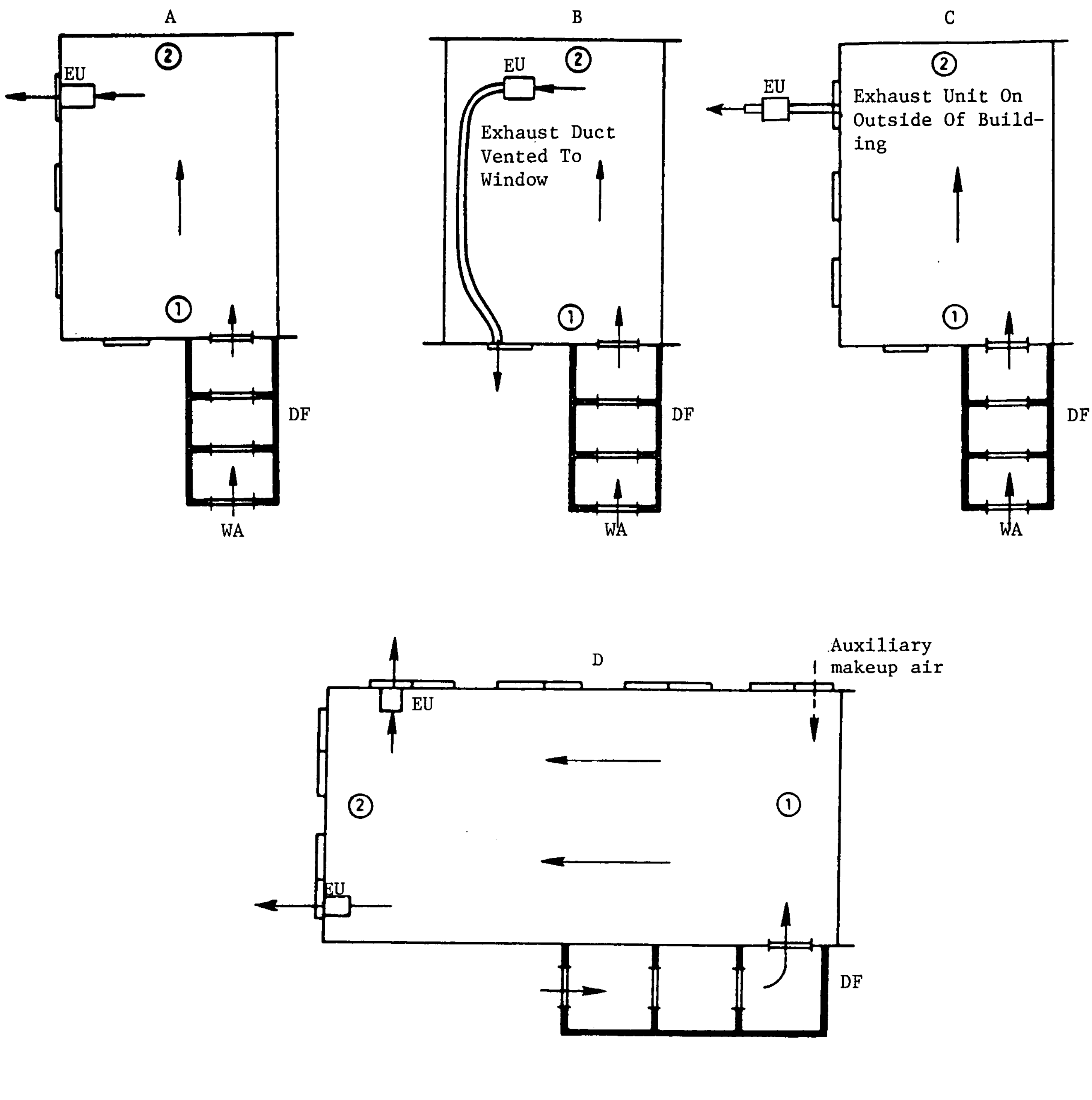


Figure XI-1. Examples of negative pressure systems.
DF, Decontamination Facility; EU, Exhaust Unit; WA, Worker Access; A, Single-room work area with multiple windows; B, Single-room work area with single window near entrance; C, Single-room work area with exhaust unit placed on the outside of the building; D, Large single-room work area with windows and auxiliary makeup air source (dotted arrow). Arrows denote direction of air flow. Circled numbers indicate progression of removal sequence.

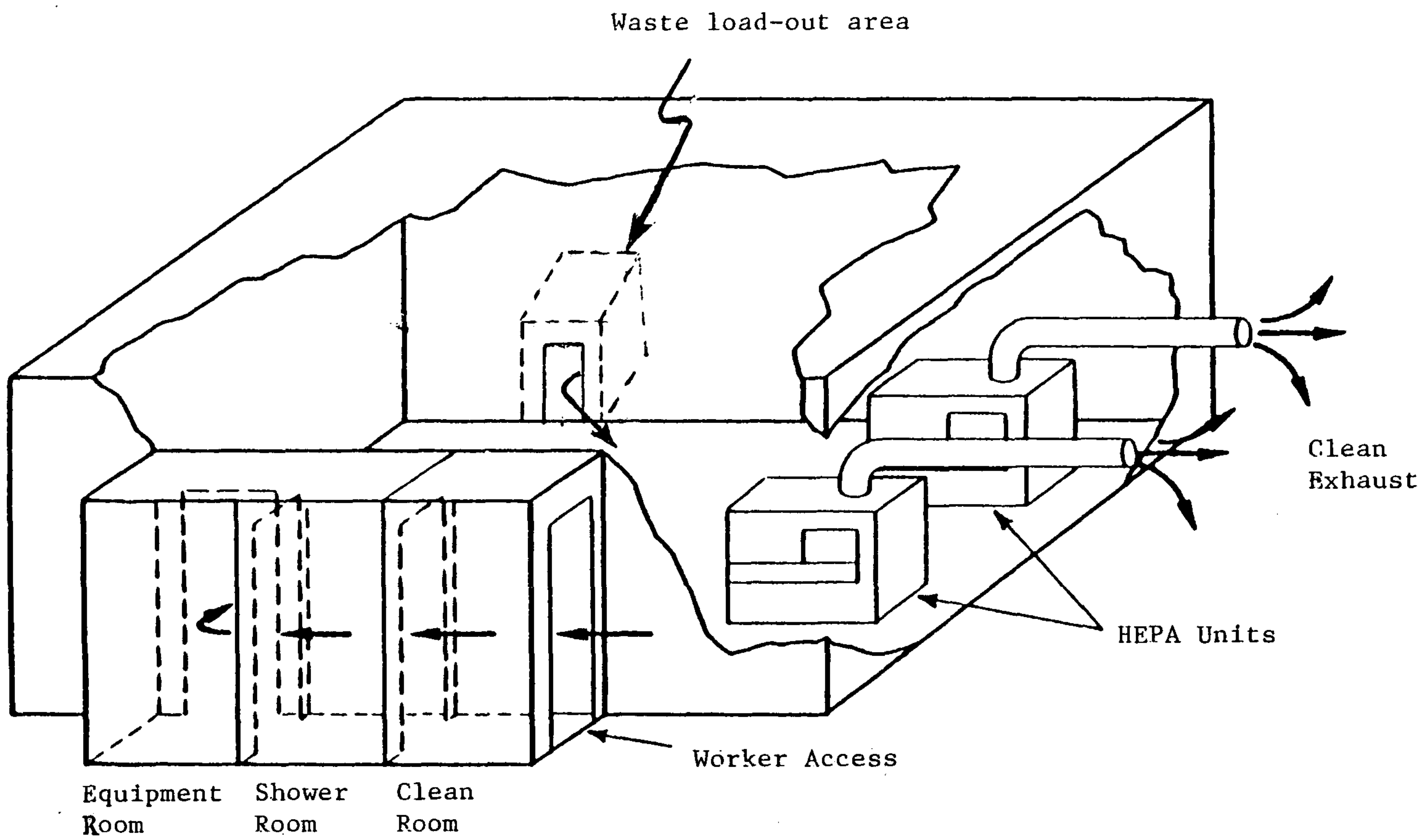


Figure XI-2. Schematic representation of negative air HEPA system in place.

opposite wall), off the floor (preferably near the ceiling), and away from barriers that separate the work area from occupied clean areas. They should be resealed whenever the negative pressure system is turned off after removal has started. Because the pressure differential (and ultimately the effectiveness of the system) is affected by the adequacy of makeup air, the number of auxiliary air inlets should be kept to a minimum to maintain negative pressure. Figure XI-1 presents examples of negative pressure systems denoting the location of HEPA-filtered exhaust units and the direction of air flow. Figure XI-2 is a schematic representation of negative air HEPA system in place.

USE OF THE NEGATIVE PRESSURE SYSTEM

TESTING THE SYSTEM

The negative pressure system should be tested before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, the unit(s) should be started (one at a time). Observe the barriers and plastic sheeting. The plastic curtains of the decontamination facility should move slightly in toward the work area. The use of ventilation smoke tubes and a rubber bulb is another easy and inexpensive way to visually check system performance and direction of air flow through openings in the barrier. For example, smoke emitted on the inside of the work area at a barrier should not leak outward. Smoke emitted in the shower room of the decontamination unit should move inward to the work area. Smoke tubes can also be used to check if air flow is moving inward at high and low levels of the work area.

Another test method for negative pressure is to use a Magnehelic gauge (or other instrument) to measure the static pressure differential across the barrier. The measuring device must be sensitive enought to detect a relatively low pressure drop. A Magnehelic gauge with a scale of 0 to 0.25 or 0.50 inch of H_2O and 0.005 or 0.01 inch graduations is generally adequate. The pressure drop across the barrier is measured from the outside by punching a small hole in the plastic barrier and inserting one end of a piece of rubber or Tygon tubing. The other end of the tubing is connected to the "low pressure" tap of the instrument. The "high pressure" tap must be open to the atmosphere. The pressure is read directly from the scale. After the test is completed, the hole in the barrier must be patched.

Instruments are now being tested which can monitor the pressure drop on a twenty-four hour basis and be connected to a strip chart recorder. An audible and/or visible alarm may be used to alert the project manager of a severe drop in pressure. Typically, a pressure drop of 0.03 inches of water should be maintained throughout the asbestos abatement project.

USE OF SYSTEM DURING REMOVAL OPERATIONS

The exhaust units should be started just before beginning removal (i.e., before any asbestos-containing material is disturbed). After removal has begun, the units should run continuously to maintain a constant negative pressure until decontamination of the work area is complete. The units should not be turned off at the end of the work shift or when removal operations temporarily stop.

Employees should start removing the asbestos material at a location farthest from the exhaust units and work toward them. If an electric power failure occurs, removal must stop immediately and should not resume until power is restored and exhaust units are operating again.

Because airborne asbestos fibers are microscopic in size and tend to remain in suspension for a long time, the exhaust units must keep operating throughout the entire removal and decontamination processes. To ensure continuous operation, a spare unit should be available.

After asbestos removal equipment has been moved from the work area, the plastic sheeting has been cleaned, and all surfaces in the work area have been wet-cleaned, the exhaust units can be allowed to run for at least another 4 hours to reduce airborne fibers that may have been generated during wet removal and cleanup and to purge the work area with clean makeup air. The units may be allowed to run for a longer time after decontamination, particularly if dry or only partially wetted asbestos material was encountered during removal.

FILTER REPLACEMENT

All filters must be accessible from the work area or "contaminated" side of the barrier. Thus, personnel responsible for changing filters while the negative pressure system is in use should wear approved respirators and other protective equipment. The operating life of a HEPA filter depends on the level of particulate contamination in the environment in which it is used. During use, filters will become loaded with dust, which increases resistance to air flow and diminishes the air-handling capacity of the unit. The difference in pressure drop across the filters between "clean" and "loaded" conditions is a convenient means of estimating the extent of air-flow resistance and determining when the filters should be replaced.

When the pressure drop across the filters (as determined by the Magnehelic gauge or manometer on the unit) exceeds 1.0 inch of H_2O, the prefilter should be replaced first. The prefilter, which fan suction will generally hold in place on the intake grill, should be removed with the unit running by carefully rolling or folding in its sides. Any dust dislodged from the prefilter during removal will be collected on the intermediate filter. The used prefilter should be placed inside a 6 mil plastic bag, sealed and labeled, and disposed of as asbestos waste. A new prefilter is then placed on the intake grill. Filters for prefiltration applications may be purchased as individual precut panels or in a roll of specified width that must be cut to size.

If the presure drop still exceeds 1.0 inch of H_2O after the prefilter has been replaced, the intermediate filter is replaced. With the unit operating, the prefilter should be removed, the intake grill or filter access opened, and the intermediate filter removed. Any dust dislodged from the intermediate filter during removal will be collected on the HEPA filter. The used intermediate filter should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste. A new replacement filter is then installed and the grill or access closed. Some brands of negative air machines require removal of the prefilter to gain access to the intermediate filter. This filter should be replaced as the last step of replacing the intermediate filter.

The HEPA filter should be replaced if prefilter and/or intermediate filter replacement does not restore the pressure drop across the filters to its original clean resistance reading or if the HEPA filter becomes damaged (HEPA filters will fail if they absorb too much moisture). The exhaust unit is shut off and disconnected from the power source to replace the HEPA filter, which requires removing the HEPA filter from the unit. Used HEPA filters should be placed in a sealable plastic bag (appropriately labeled) and disposed of as asbestos waste.

The gasket between the filter and the housing should be inspected for any gaps or cracks. Worn gaskets should be replaced as needed. A new HEPA filter (structurally identical to the original filter) should then be installed. The intake grill and intermediate filter should be put back in place, the unit turned on, and the prefilter positioned on the intake grill. Whenever the HEPA filter is replaced, the prefilter and intermediate filter should also be replaced.

When several exhaust units are used to ventilate a work area, negative pressure can be maintained during the HEPA filter replacement and the direction of air flow into the work area will be maintained. Thus, the risk of asbestos fiber release to the outside environment is controlled.

Any filters used in the system may be replaced more frequently than the pressure drop across the filters indicates is necessary. Experience has shown that prefilters, for example, should be replaced two to four times a day or when accumulations of particulate matter become visible. Intermediate filters must be replaced once every day or so, and the HEPA filter may be replaced at the beginning of each new project. (Used HEPA filters must be disposed of as asbestos-containing waste).

Conditions in the work area dictate the frequency of filter changes. In a work area where fiber release is effectively controlled by thorough wetting and good work practices, fewer filter changes may be required than in work areas where the removal process is not well controlled. It should also be noted that the collection efficiency of a filter generally improves as particulate accumulates on it. Thus, filters can be used effectively until resistance (as a result of excessive particulate loading) diminishes the exhaust capacity of the unit.

DISMANTLING THE SYSTEM

As gross removal nears completion, filters should be checked for loading and replaced if necessary. If a prefilter is being used on the outside of the exhaust unit, it should be removed before final cleanup begins. When the negative air system is shut down at the end of the project, the filters should be left in the negative air filtration unit and the openings sealed with polyethylene and duct tape. **Filters in the exhaust system should not be replaced after final cleanup is complete in order to avoid any risk of re-contaminating the area.**

TIPS FOR USING NEGATIVE AIR PRESSURE SYSTEMS

- Check the integrity of the gasket between the HEPA filter and housing each time the filter is changed or after the unit has been transported to a new location.

- A general rule of thumb for filter life during "average" removal is:

  2 hours for the 1/2" pre-filter

  24 hours for the 2" pre-filter

  700 hours for the 12" HEPA filter

  Changing out the 1/2" prefilter frequently (every 20-30 minutes) during "heavy" removal will prolong the life of the much more expensive HEPA filter.

- Before removal begins, check the availability of a 20 amp circuit. Most negative air machines require 18 amps for start-up and 15 amps during normal operation.

- Negative air units usually pull less volume than the rating assign by the manufacturer. For instance, a unit rated at 2,000 cfm will pull 1300-1500 cfm. Also, as filters load, the cfm is reduced.

- Start the negative air system before beginning work and check to see if it is functioning properly. Make sure there is adequate makeup air. Otherwise the polyethylene may be pulled away from the walls.

- Smoke tubes are useful for checking airflow inside the containment.

- Use heavy duty extension cords to energize the negative air filtration units. If a series of cords are connected, take necessary precautions to avoid shock hazards. Make sure the temporary electrical system is properly grounded.

- As a rule of thumb, the containment area should be no larger than 10,000 square feet for efficient use of a negative air filtration system.

- The negative air system is most effective in reducing fiber concentrations when laborers start removal at the farthest point from the negative air units and work toward them.

- When venting the negative air filtration exhaust outside a window, a good seal can be formed by placing a piece of plywood with a hole cut for the flex duct in the window and sealing it with duct tape. Another seal can be formed by placing a piece of 6 mil polyethylene over the plywood template and cutting a slit in it for insertion of the exhaust duct. Tape is used to seal the space around the slit in the polyethylene and the duct.

- The use of supplied air respirators will increase the air pressure in the work area. Negative air filtration units should always be used in conjunction with type C respirators to prevent build-up of positive pressure.

Wet Removal Techniques

EPA regulations which cover the removal of asbestos material (40 CFR, Part 61, Subparts A&B, 1973) require wetting the material before removal begins and keeping it wet as it is removed and while it is being bagged. Dry removal, which requires specific EPA approval, is appropriate for some types of asbestos-containing materials which have been previously encapsulated and will not absorb amended water. Also, there are special conditions which preclude the use of water such as a room containing electrical supply lines which cannot be de-energized during the removal project.

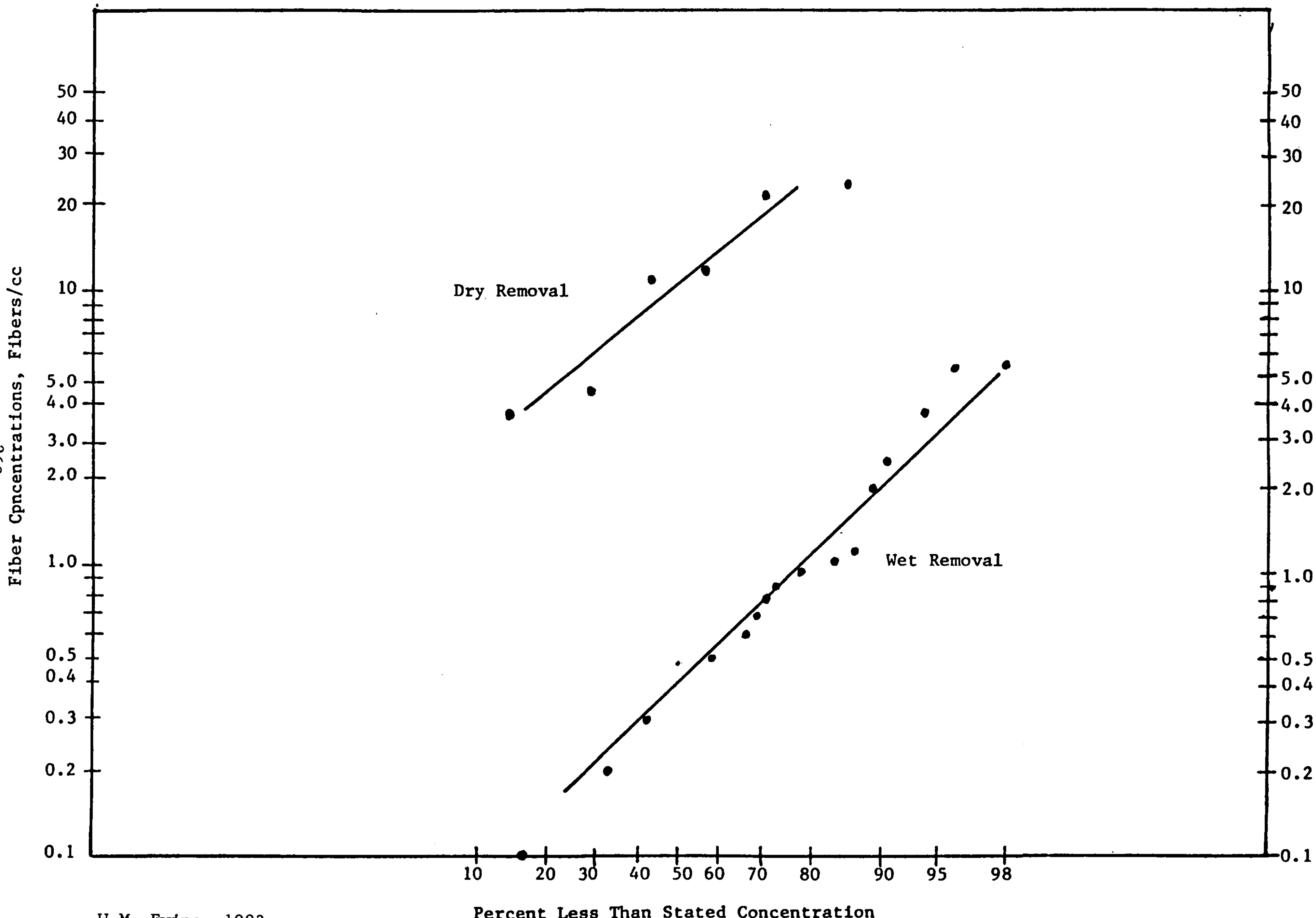
Table XI-1.

GEOMETRIC MEAN (GM) AND GEOMETRIC STANDARD DEVIATION (GSD) VALUES USING WET AND DRY REMOVAL METHODS (FIBERS/CC)

Work Area Air Samples	GM (50th Percentile)	84th Percentile	GSD
All Work Areas	0.74	3.7	5.0
Wet Removal Only	0.48	1.1	2.3
Dry Removal Only	11.9	24.0	2.0

Excerpted from W.M. Ewing. Air Sampling AT 52 Asbestos Abatement Projects. American Incustrial Hygiene Conference, Philadelphia, PA. May 24, 1983.

Figure XI-3. Fiber Concentrations Generated During Dry and Wet Removal



W.M. Ewing, 1983.

Two advantages to the use of wet methods for removing asbestos materials include a reduction in airborne fiber concentrations which are generated during removal and a reduction in the effort required to remove the material. Wet removal is based on the ability of water to lower the ability of the asbestos-containing material to release airborne asbestos fibers and increase the settling rate of fibers that are released. As indicated in Table XI-1 and Figure XI-3, airborne fiber concentrations may be reduced significantly by using wet removal techniques rather than dry.

The positive effects of wet removal can be further enhanced by adding a wetting agent to the water. The wetting agent is a combination of chemicals which aids in the penetration of the material and increases the probability of individual fiber wetting. Various wetting agents are available which have been used in the agriculture industry and fire fighting profession for many years. EPA recommends a wetting agent consisting of 50% polyoxyethylene ester and 50% polyoxyethylene ether in a ratio of 1 ounce to 5 gallons of water. This wetting agent is not as effective with materials which contain a high percentage of amosite asbestos.

Removal of Sprayed or Troweled Friable Insulation Materials from Ceilings

At this point of the abatement project, the work area has been sealed off with two layers of 6 mil polyethylene on the floors and two layers of 4 mil polyethylene on the walls (see section on Preparation of Work Area). The decontamination unit and negative air filtration units are in place, and the scaffolding, ladders, various sizes of short- and long-handled scrapers, and other removal equipment have been brought into the work area. (See the Removal Equipment List, Table XI-2.)

Table XI-2

EQUIPMENT USED FOR REMOVAL OF FRIABLE INSULATION MATERIALS

Portable High Efficiency Particulate Air (HEPA) filtered, exhaust units

Replacement filters

Flexible or rigid ducts

HEPA vacuum cleaner

Electrical extension cords

Garden hose

Garden spray bottle attachments for the water hose

Hand pump garder sprayer

Wetting agent (50% polyoxyethylene ether and 50% polyoxyethylene ester or equivalent)

Stiff scraper, ranging in size from narrow, putty-knife type to 4 inch wide blades and 6 inch width scrapers mounted on 6 foot long wooden handles

Nylon brushes of various sizes

Plastic dust pans

Plastic snow shovels

Brooms - standard house and push brooms

Scaffolds with railing

6 mil polyethylene bags for holding water

Wood stepladders of appropriate height

Glovebags (for pipes) - see glovebag section equipment list

Duct tape

Temporary lighting

Ventilation smoke tubes and bulbs

The first step in the removal process is to thoroughly wet the ceiling material with a low pressure spray of amended water. The material should be sprayed with a light coat of amended water to initially wet the surface, then a saturation coat is applied. The material can be wetted using a low pressure pump system or water hose with garden sprayer attached which can mix the wetting agent with the water. A hand pump garden sprayer can be used for small projects. Application with large pump systems or airless sprayers may cause leakage behind the barrier seals resulting in contamination of the walls and floors. Also, the initial impact of water applied with high pressure may cause elevated airborne fiber concentrations, therefore low pressure and careful technique in application should be used. Time should be allotted between spraying with amended water and removal to provide for maximum penetration into the material. If the time frame allows, the ceiling material should be thoroughly saturated with amended water the night before removal starts.

Removal of ceiling material is carried out in two stages -- gross and secondary removal. Gross removal is typically conducted with a three or four man team. Two men working from a mobile scaffold with rails remove the friable material using scrapers. Wide blades can be used if the material comes off easily. Workers of approximately the same height should be paired together on the scaffolds. One or two workers on the ground package the moist material before it has time to dry out in 6 mil plastic bags or plastic-lined fiber drums. Rubber dust pans, plastic snow shovels, push brooms, and standard house brooms should be used to collect and bag the material. Avoid using metal shovels or dust pans to prevent inadvertent tears in the polyethylene floor barriers. The crew that bags the material also repositions the scaffold as needed, relocking the wheels after each move. If several crews are removing material, it may be time efficient to designate a "spray" person who walks from one area to the next, keeping the material on the ceiling and the floor wet and misting the air to maintain low airborne fiber concentrations. The spray person can also check for damaged floor barriers and promptly repair them.

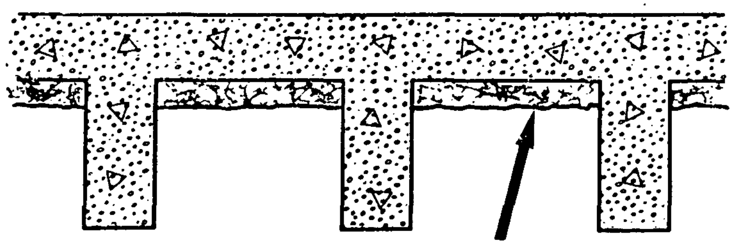
Bags containing the waste material are processed for waste load-out, either by wet wiping, placing in another "clean" bag, or depositing into fiber drums. (See Waste Disposal Requirements.) All bags should be removed from the work area at least by the end of the work day. Removal of bags on a continual basis provide for easier movement (particularly if workers are wearing air-supplied respirators) in the work area.

After removing as much of the sprayed-on material as possible with scrapers, crews begin secondary removal. Depending on the type of substrate (material underneath the friable insulation), various techniques and tools may be required. Common types of ceiling construction to which friable insulation materials may be applied include concrete, 3 coat plaster system, suspended metal lath, concrete joists and beams, metal deck, corrugated steel, steel beam or bar joist. Figure XI-4 illustrates some of these ceiling types. The surface substrate may be smooth, rough, or pitted and will affect the difficulty of secondary removal. Typically a combination of brushing and wet wiping are used to remove the remaining residue. Nylon bristled brushes should be used instead of wire brushes which may break the small fibers into smaller fibers. The rags used for wet wiping should not leave any fabric fibers on the substrate which might be mistaken as visual contamination. High efficiency particulate air vacuum cleaners are also useful for removing "hard-to-get-to" residue.

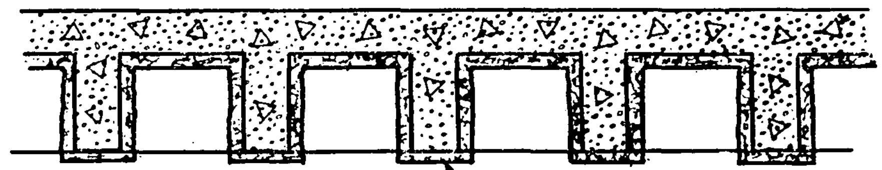
Figure XI-4.

TYPES OF CEILING CONSTRUCTION

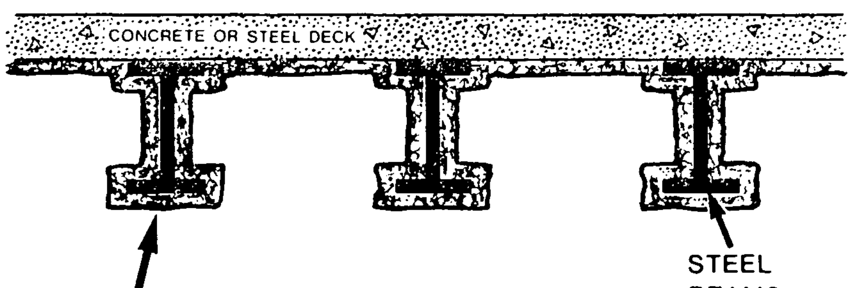
CONCRETE JOIST AND BEAM CONSTRUCTION



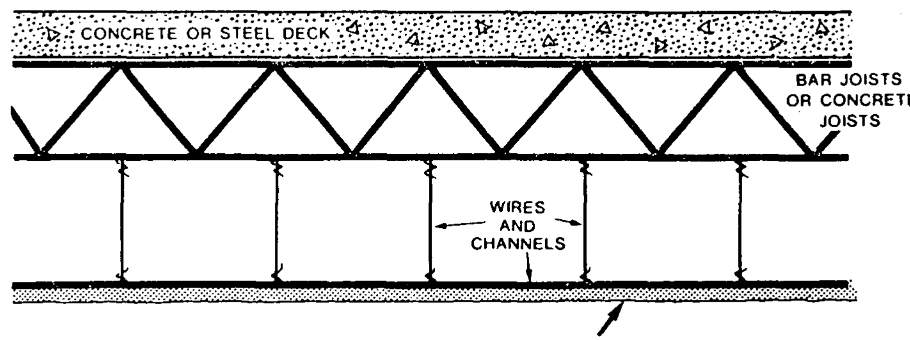
CONCRETE WAFFLE SLAB CONSTRUCTION



STEEL BEAM CONSTRUCTION



SUSPENDED CEILING CONSTRUCTION



Excerpted from Asbestos Exposure Assessment In Buildings, Inspection Manual, EPA. October, 1982.

While crews are working from scaffolds or ladders to remove all remaining residue from the ceilings, workers should also be cleaning material off the polyethylene wall barriers and any stationary objects in the area. Brooms, wet rags, or squeeges are good for this purpose. Secondary removal is finished when all visual contamination is removed from the ceilings. The next phase is final cleanup.

Removal of Insulation from Pipes, Boilers, and Tanks

There is a wide variation in the types of asbestos-containing insulation used on pipes, boilers, and tanks. Pipes may be insulated with preformed fibrous wrapping, corrugated paper, chalky mixture containing magnesia, fiber felt, and insulating cement. (Note: There are older materials labelled "magnesia" which contain asbestos and new materials also labelled "magnesia" which contain glass fiber rather than asbestos.) Usually a protective jacket, which may also contain asbestos, made of paper, tape, cloth, metal, or cement covers the insulation materials. Boilers and tanks may be insulated with asbestos "blankets" on wire lath, preformed block, or the chalky magnesia mixture which is typically covered with a finishing cement.

Different approaches are required for removing these asbestos-containing materials than sprayed on or troweled-on ceiling insulation, but the same protective measures are used. Careful handling and packaging is required in many cases because of the metal jackets, bands, or wire associated with the insulation materials.

Glovebags, which can be sealed around sections of pipe to form "mini-containment areas" may be used in some situations for removing pipe insulation (see Glovebag Section). Insulated objects which are not readily accessible or are too large or hot for application of the glovebag technique, require a more conventional approach.

Because insulation on pipes, boilers and tanks often contains 70% asbestos and areas where these materials are being removed are often confined, high airborne fiber concentrations may occur. Also, these materials are more difficult to saturate with water and they often contain amosite, which is not controlled as well with water as other types of asbestos. For these reasons, Type C airline respirators are recommended for removal workers engaged in removal of asbestos from pipes and boilers.

Removal of insulation from pipes, tanks or boilers can be accomplished by two-person teams. Cuts or slits are made in the insulation material, a spray nozzle is inserted, and the material is wetted to the extent feasible. One man cuts away the insulation and bags it while the other continuously sprays the material with amended water. Any metal bands or wire that is removed should be folded or rolled and placed in polyethylene to avoid lacerating personnel.

After the gross material is removed, nylon brushes are used to thoroughly clean the pipes, tanks, or boilers. Particular care must be taken to clean the fittings and joints where a cement-plaster type material has been removed. After brushing, the surfaces are wet-wiped and the final cleanup phase begins.

Special Considerations

Amended water is not totally effective in controlling fibers emitted from material containing amosite asbestos. Some contractors reportedly use ethylene glycol and/or oils to help reduce amosite emissions. Others have tried an encapsulant which is diluted so that it drys slowly and does not harden before the asbestos material can be removed from the pipes or boilers. No data is available from comparative testing of these wetting methods to determine which is the most effective.

Steam or hot water distribution networks should be shut down, if at all possible, when insulation is being removed. If these systems must stay on line, special consideration must be given to heat stress by workers and measures to avoid skin burns.

When airline respirators are being used by workers, care must be taken not to let the airlines come into contact with hot pipes which might burn a hole in the rubber line. When airlines are worn by persons working from scaffolds, care must be taken not to wrap the airlines around objects on the ground or the scaffold. See section on type C respirators which addresses safety considerations.

SAFETY AND HEALTH CONSIDERATIONS

(OTHER THAN ASBESTOS)

Objective: Provide an overview of non-asbestos related safety and health problems encountered during asbestos abatement projects and provide information necessary to manage these problems.

Learning Tasks: Information in this section should enable participants to:

- ☞ Identify, eliminate, avoid, or safely work around potential electrical safety hazards.

- ☞ Become familiar with proper procedures and equipment used during asbestos abatement to avoid hazardous conditions and work practices.

- ☞ Identify, eliminate, avoid, or safely work around potential fire/life safety hazards.

- ☞ Establish effective emergency action plans/procedures specific to the abatement project.

- ☞ Identify and eliminate hazards associated with ladders, scaffolds, walking and working surfaces.

ELECTRICAL SAFETY CONSIDERATIONS

THE HAZARD

One of the most common hazards, and one that gives the least warning, is electrical power. Incorrect wiring, improper grounding, and lack of proper shielding result in 1000 people per year being electrocuted. Many of these fatalities result from contact with only 120 volts a.c.

Three factors determine the severity of electrical shock. These are:

- o The amount of current flowing through the body.
- o The path of the current flowing through the body.
- o The time the current flows through this path.

These factors vary greatly. The path of the current depends upon the points of contact. Most often the path is from the hands, through the body, and out the feet. The amount of electrical resistance determines in part the amount of current flow. Moist skin or damp conditions greatly reduce electrical resistance and significantly increase a person's risk of serious injury if he comes in contact with a current source. In addition to the obvious shock potential, many deaths result from falls after a non-fatal electrical shock.

PRE-WORK CONSIDERATIONS/IDENTIFYING THE HAZARDS

During the pre-bid inspection, during preparation of the work site, and during removal, there are potential electrical hazards that can be identified and eliminated. Examples include:

- Identification of wiring faults in the building: Including open ground paths, reverse wiring polarity, hot-neutral or hot-ground wires reversed. These common faults can easily be identified with plug-in type circuit testers and should be corrected prior to the start up. This is particularly important if these circuits will be used to provide power inside the removal area.

- Uninsulated or exposed and energized wiring or equipment: Removal jobs are often part of renovation or remodeling projects. Overhead lighting is often removed for cleaning. Equipment or machinery may have been moved out of the area during the removal job and wiring left in place. Damaged equipment or electrical fixtures may not have not been repaired by the building owner. All of these things may be combined to create sources of contact with energized electrical circuits. When possible, circuits that will not be used during removal efforts should be turned-off and locked out. Wiring and electrical connections should always be considered energized unless tested. Unenclosed wiring junctions in overhead areas are a particularly likely point of contact for removal workers.

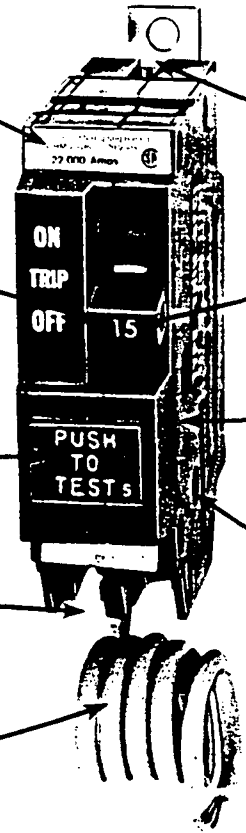
- Abatement projects where the building remains occupied: This is becoming more common as industrial and commercial projects are increasing. This can present problems where electrical circuits or control panels inside the removal area, that control other parts of the building, must remain energized. Sealing transformers or control boxes may not be possible due to heat build-up. If this situation is encountered, polyethylene will have to be kept away to allow for air circulation and dry removal around them may be necessary.

- Providing power inside the removal area: This can create hazards not associated with the building systems. Since OSHA considers abatement projects under the 29 CFR 1926 Construction Industry Safety and Health Standards, there are special requirements for supplying temporary power. This may be done by supplying power through Ground Fault Circuit Interruptors (GFCI) or having an Assured Equipment Grounding Program in effect. Use of GFCIs to protect all circuits provides the safest power source since any significant current leakage will trip the circuit. These devices prove most effective when kept outside the work area away from the high humidity. An assured equipment grounding program requires regular inspection of all tools, cords, and electrical devices with written documentation maintained.

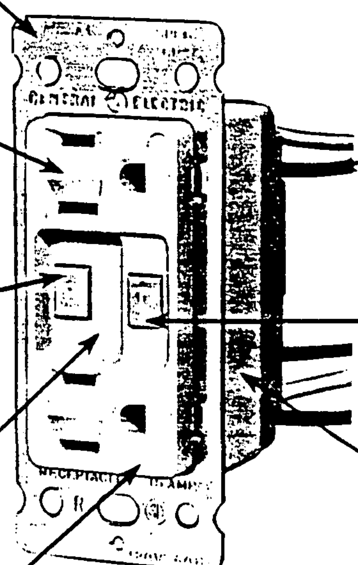
- Commonly found electrical devices on abatement projects are: Lights, vacuum cleaners,

Two Basic Forms of GFCI Devices

CB3® Circuit Breaker Type



GTR® Ground Trip Receptacle Type



negative air systems, drills, saws, heaters, sump pumps, and often, radios. All of these should be inspected regularly for damage, proper grounding, and integrity of insulation.

With the above mentioned items in place, there are still several basic items that should not be overlooked. Non-metallic tools should be used for scraping to prevent a possible shock if wiring is cut or contact is made with energized equipment. Hard rubber or plastic scrapers, while more difficult to find, perform well for removal. Wooden or fiberglass ladders reduce or eliminate a ground path if a worker contacts an energized circuit.

ELECTRICAL SAFETY REVIEW

The use of wet methods increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, computers, transformers, etc.

De-energize as much equipment as possible. Use portable flood-light systems for lighting and regularly check the system and wiring for damage.

Consider using dry removal in areas immediately adjacent to energized electrical equipment if de-energizing is not feasible.

Use non-conductive scrapers and vacuum attachments (wood, plastic, rubber).

Supply workers with heavy insulated rubber boots and/or gloves when working around energized wiring or equipment..

Utilize "hot-line" covers over energized cables and powerlines when possible.

Ensure all electrical equipment in use is properly grounded before the job starts. This means checking outlets, wiring, extension cords and power pickups. Check for the ground-pin on plugs. These checks should also be made while setting up and regularly during the job.

Use care not to violate insulated coverings with scrapers, scaffolding wheels, etc.

Avoid stringing electrical wiring across floors. Elevate wiring if possible to keep it away from water on the floor and damage from foot traffic and rolling scaffolds.

Do not allow water to accumulate in puddles on work area floors. Some specifications require damp floors, not deep water!

Ensure electrical outlets are tightly sealed and taped to avoid water spray.

Always perform a pre-work walk-through to identify potential sources of electrical hazards to abatement workers, or equipment that may be damaged by wet removal methods.

Utilize stable wooden or fiberglass ladders - not metal.

Determine operating voltages of equipment & lines before working on or near energized parts.

Electrical equipment and lines should be considered energized unless tested and determined otherwise.

Energized parts must be insulated or guarded from employee contact and any other conductive object.

Extension cords used with portable electric tools and appliances must be the three-wire type and connected to a GFI circuit.

Extension cords:

- o should be protected from accidental damage.

- o should not be fastened with staples, hung from nails, or suspended by wire (tape is an acceptable alternative).

Portable electric handtools should meet the following requirements:

- o Should be equipped with a 3-wire cord having a ground wire permanently fixed to the tool frame; or

- o Should be of double-insulated type and labeled as such.

For circuits over 600 volts, if electrical disconnects are not visible and open or locked out, the following requirements should be met:

- o Circuits to be de-energized are clearly identified and isolated from all energy sources.

- Notification received from a designated employee that all switches and disconnectors that could supply energy have been deenergized, locked out, and plainly tagged to show men at work.

- Visual inspections and tests made to assure deenergizing of lines and equipment.

- Protective grounds applied to disconnected lines or equipment.

- Separate tag and lockout attached for each crew requiring deenergizing of same line or equipment.

- Tags should not be removed from completed work until designated employees report that all crew members are clear, protective grounds they installed have been removed.

LADDERS/SCAFFOLDING/WALKING - WORKING SURFACES

(INSPECTIONS AND PROPER USE)

LADDERS AND SCAFFOLDS

Asbestos abatement projects always present risks to workers from falls, slips, or trips. The nature of the tasks necessitate the use of scaffolding and ladders.

LADDERS

The following items should be checked on a regular basis:

- o Ladders are always maintained in good condition.
- o Complete inspections are done periodically.
- o No improvised repairs are made.
- o Defective ladders are not used.
- o Safety feet spreaders and other components of ladders are in good condition. (Missing safety feet create sharp edges that will cut polyethylene floor covers.)

- o Movable parts operate freely without binding or undue play.

- o Rungs are kept free of grease or oil.

- o Ladders are not used for other than their intended purpose. (Ladders should not be used as a platform or walkboard.)

- o Extension type ladders should be used with a 1-4 lean ratio (1 foot out for every 4 feet of elevation).

- o Step ladders should only be used when fully open.

- o The user faces the ladder while going up and down.

- o Tops are not used as steps. If needed, get a longer ladder.

- o Bracing on the back legs is not used for climbing.

- o Portable ladders are used by one person at a time.

- Ladders are secured to prevent displacement during use.

- All ladders have well designed safety shoes.

- Hook or other type ladders used in structures are positively secured.

- Wood or fiberglass ladders should be selected to avoid electrical hazards of metal ladders.

SCAFFOLDING

Most asbestos abatement projects will involve the use of scaffolding. Proper set up, regular inspection, and basic maintenance should not be overlooked. In many removal projects, manually propelled mobile scaffolding provides a convenient and efficient work platform. OSHA standards require that when free standing mobile scaffolding is used, the height shall not exceed four times the minimum base dimension. This requirement is based on the fact that scaffolding is easily turned over. The figure illustrates a simple method to calculate the amount of force necessary to tip a scaffold. Since

SCAFFOLD UPSET FORMULA

(B)(f) = (W)(A)

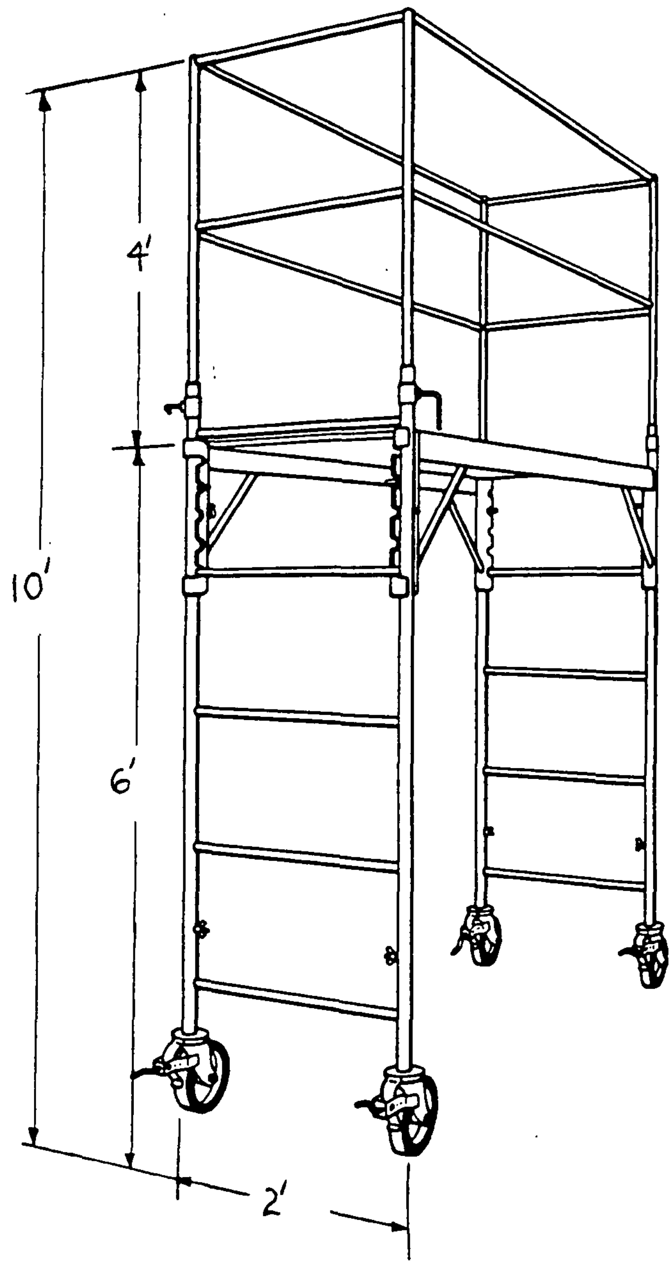
Where:

(B) = height from floor to ceiling

(f) = force required to upset scaffold

(W) = weight of scaffold and worker

(A) = 1/2 width of scaffold



Example:

(B) = 14'

(f) = x

(W) = 374 lbs.
199 lb scaffold
175 lb man

(A) = 1'

Force to upset: 26.7 lbs.

$$14\,(x) = 374 \times 1$$

$$(x) = \frac{374 \times 1}{14}$$

$$(x) = 26.7 \text{ lbs.}$$

relatively little force is required to tip a scaffold, it becomes important to make sure that wheels on mobile scaffolds move freely and are in good repair. If rented scaffolding is used, all components should be inspected prior to accepting it. Wheels should turn freely and be lubricated. All components such as cross bracing, railings, pin connectors, planking or scaffold grade lumber should be available before the units are assembled. When workers will be riding mobile scaffolding the base dimension should be at least one half of the height. Workers should be careful to keep debris bagged and obstacles off the floor where mobile scaffolds will be used. If a wheel catches on debris on the floor when the unit is moved, additional force will be required to move it. This additional force may be all that is needed to turn the unit over.

Guardrails should always be installed on scaffolding used for abatement projects. Workers are usually looking up while working and can easily step of the edge of an unprotected scaffold. OSHA requires that guardrails be used when scaffolding is from 4 to 10 feet tall and less than 45 inches wide. Scaffolding 10 feet or higher should always have guardrails.

Planking used on a scaffold should not extend farther than 12" over the edges and should always be secured to the frame.

SLIPS, TRIPS, AND FALLS

Areas sealed with polyethylene and kept damp to reduce airborne fibers become very slick. Disposable booties are a potential trip hazard. Air and electrical lines create trip hazards. All of these conditions create potential worker hazards even before removal begins. When asbestos and other debris are removed, the accumulations should be bagged and removed from the floor as soon as possible. This simple step, which may require more initial effort, will make cleanup easier and the overall job far safer.

In summary:

- Consider the height of the work, equipment in use, and numerous trip hazards. Take a look at your "walking surfaces".

- The use of disposable booties may be impractical in many removal situations. They may come apart and create a serious trip hazard. Seamless rubber boots, slip-on shoes or safety shoes with non-skid soles may be an alternative depending on the job.

- o Inspect ladders and scaffolding for condition. Ensure railings are adequate on scaffolds.

- o Minimize water on floors. Wet polyethylene is very slick and water increases the risk of electrical shock.

- o Use care around air lines and electrical cords.

- o Suspend electrical lines and cords when possible using tape.

- o No running, jumping or horseplay in work areas should ever be allowed.

- o Minimize debris on floors.

- o Pick up tools, scrapers, etc.

FIRE CONSIDERATIONS

A few of the fire safety features to be concerned with are exits, travel distances, emergency lighting, and alarm systems.

Sealing off an area and blocking entrance/exit openings conflict with OSHA, NFPA, and local fire code requirements. The contract specifications may state "one means of egress through a properly designed air lock and decontamination system"; however, emergency plans should be developed to include alternative exits in emergency situations and these must be familiar to all employees.

Perform a pre-work survey to determine potential fire hazards, sources of ignition, hot-spots, and location of exits. Coordinate this with the number of workers to be in the area, the square footage, and the types and amount of combustible/flammable materials that will remain on site.

Some protective clothing will burn and melt quickly. It can shrink, adhere to skin and drip as it burns. Heavy black smoke is a combustion by-product.

Polyethylene (it's combustible) will start to burn slowly and pick up speed as more heat is generated. It gives off heavy smoke as the fire progresses. Flame spread is slow and steady. Sheeting should be kept away from heat sources such as transformers, steam pipes, boilers, etc., that will be heated during removal. (Polyethylene should not be allowed to contact surfaces above 150°F.)

<u>To avoid fire problems in asbestos control areas:</u>

- Ensure all sources of ignition are removed. Be sure that gas and other fuel sources are cut off and that pilot lights in boilers, heaters, hot water tanks, compressors, etc., are extinguished.

- Locate "hot spots." Quite often you will have to <u>drape</u> equipment instead of sealing off to prevent overheating (i.e., computers, terminal boards, switch panels, transformers).

- Cut off supply to steam lines, electric and steam heaters, and radiators. Do not permit the polyethylene to lay against hot surfaces.

- Do not allow lighters, matches, etc., into the work area. Strictly enforce no smoking, eating, or drinking inside the work area.

- When using an oxygen/acetylene torch to cut pipe, etc., post a fire watch with an appropriate fire extinguisher such as pressurized water. Do not use CO_2 extinguishers in confined or enclosed spaces. Dry chemical extinguishers are effective, but the powder is a respiratory irritant.

- When using a cutting torch, know what is on the other side of the wall and below the floor. Use sheet metal or a treated tarp to catch sparks.

- Reduce the amount of flammable/combustible materials inside a space to minimum prior to hanging plastic. This includes removal of any chemicals, flammable liquids, heat sensitive materials, etc.

- Mark exits from work area and post directional arrows when exits are not visible from remote work areas. This can easily be done using duct tape on the polyethylene walls and barriers.

- Keep trash and debris to a minimum (i.e., tape, poly, bags, lumber, etc.).

- If the work area is large and many workers are present, several emergency exits may be needed. Choose exits that are locked from outside but can be opened from the inside. A daily inspection should be conducted to insure secondary exits are not blocked.

- Lighting of exits and exit routes should be provided.

- <u>In case of fire, the fire hazard becomes more immediate than the asbestos hazard and workers may need to violate the plastic barriers. This should be covered with workers in the emergency action plan for the job site.</u>

- Be alert for flammable vapors in industrial areas (solvents such as naphtha, toluene, xylol, etc.). This is especially critical in industrial vacuuming operations where vacuum motors are not explosion proof. Compressed air vacuums may be required.

- A telephone should be available at all times for notification of authorities in an emergency.

- Post local Fire Department and Rescue Squad phone numbers. Advise them of the operations in progress.

- Ensure that you have a monitor outside <u>at all times</u> trained in emergency procedures. Someone should be trained in first aid, and in the treatment of heat stress.

Effective December 11, 1980, the Occupational Safety and Health Administration revised its fire safety standards. OSHA now requires a written emergency action plan and fire prevention plan. The new requirements are detailed in 29 CFR 1910.38. Briefly, the essential items of the plans should include:

- The manner in which emergencies are announced.

- Emergency escape procedures and emergency escape routes.

- Procedures for employees who must remain to operate critical plant operations which may take time to shut down.

- Procedures to account for all employees after evacuation.

- Rescue and medical duties.

- Names and/or job titles of people to be contacted for additional information.

- A list of the major workplace fire hazards.

- Names and/or job titles of people responsible for maintenance of fire prevention equipment.

- Names and/or job titles of people responsible for the control of fuel source hazards.

Establish a system for alerting workers of a fire or other problem that may require evacuation of the work area. A compressed air boat horn provides an effective alarm that can be heard and does not rely on a power source. All persons entering the work area should be familiar with the evacuation alarm signal and primary and secondary exits. A simple floor plan drawing of the work area should be posted to familiarize persons entering the work area with the site and location of exits.

Written emergency procedures should cover procedures to be used in case of: fire, with heavy smoke conditions; power failure; compressor failure with the use of air-supplied respirators; accident; or employee injury.

EMERGENCY PROCEDURES/MEDICAL SERVICES AND FIRST AID

OSHA requires that all employees exposed to asbestos be offered a physical exam within 30 days of employment and within 30 days before or after termination. The examining physician or clinic should be aware that employees will be exposed to asbestos and will be required to wear respirators and work under hot and adverse conditions. During warm months, heat exhaustion and heat stroke are serious hazards faced by workers, particularly those not acclimated to the heat.

HEAT-RELATED DISORDERS

It is important for the employer to provide training in the symptoms and effects of heat stress and heat stroke. It is also important to stress the importance of drinking water and maintaining proper electrolyte levels.

HEAT EXHAUSTION:

Symptoms:

- o Fatigue, weakness, profuse sweating, normal temperature, pale clamy skin, headache, cramps, vomiting, fainting.

Treatment:

- o Medical Alert
- o Remove worker from hot area.
- o Have worker lay down and raise feet
- o Apply cool wet cloths
- o Loosen or remove clotting
- o Allow small sips of water or gatorade if victim is not vomiting

Prevention:

- o Frequent breaks
- o Increase fluid intake
- o Allow workers to become acclimatized to heat.

Causes:

- o High Air Temperature

- o High Humidity
- o Low Air Movement
- o Hard Work
- o Not enough breaks
- o Insufficient fluid intake
- o Full body clothing
- o Workers not acclimated to heat

HEAT STROKE:

Symptoms:

- o Dizziness, Nausea, Severe Headache, Hot Dry Skin, Confusion, Collapse, Delerium, Coma, & Death

Treatment:

- o Medical Emergency
- o Remove worker from Hot Area
- o Remove Clothing
- o Have them lay down
- o Cool Body
- o Do Not Give Stimulants

Causes:

- o High Air Temperature
- o High Humidity
- o Low Air Movement
- o Hard Work

- o Not Enough Breaks
- o Not Drinking Enough Water
- o Full Body Clothing
- o Not Acclimatized

Telephone numbers of the physicians, hospitals, or ambulances should be conspicuously posted.

To provide for prompt transport of an injured person to a physician or hospital either:

- o Proper equipment is provided; or
- o Telephone with emergency phone numbers is readily available.

Before beginning the project, provisions are made for prompt medical attention in case of serious injury.

Someone trained in basic first-aid should always be on the abatement project.

When airline respiratory protection is used, it is important that the outside monitor be familiar with the system and any problems associated with breathing air. Carbon monoxide poisoning is perhaps the most important of these problems. It is important to note that these symptoms are similar and may be confused with those from heat stress.

CARBON MONOXIDE POISONING

SYMPTOMS	- Dizziness, Nausea, Headache, Drowsiness, Vomiting, Collapse, Coma, & Death
SOURCES	- Oil Lubricated Compressor Internal Combustion Engine Open Flame & Fire Unvented Gas/ Kerosene Heaters
DESCRIPTION	- Colorless, Odorless & Tasteless
LIMITS	- 50 ppm (Time Weighted Average over 8 hours) 500 ppm (Short Form Exposure Limit - 15 minutes) 20 ppm (Grade D breathing air for airline respirators) (Maximum allowable concentration)

If these symptoms are observed, those persons should immediately be brought into fresh air and medical attention should be provided.

Monitor any prescription or over the counter medicines being used by employees. These may cause an adverse reaction when used by persons under adverse conditions common to removal work.

BODY PROTECTION

Provide and require use of special whole body clothing, including shoes, for any employee exposed to airborne concentrations of asbestos.

Provide gloves as part of whole body protection to employees exposed to asbestos. This is particularly important when metal lath, suspended ceiling grids, and other materials are being removed.

Scrapers, package knives, wire cutters, chisels and other sorts of bladed tools are frequently used. Always cut away from the body.

Many puncture and cut wounds occur when removing metal lath or cutting duct work. Use care and have a good first aid kit available.

Protective hardhats must be worn at all times by employees on a jobsite where there is exposure to falling objects, electric shock or burn.

Provide, require the use of, and maintain in sanitary and reliable condition protective equipment necessary to protect any employee from any hazard which could cause injury or illness.

Wear non-fogging face shields or goggles for operations involving potential eye injury.

Check with your surfactant supplier on irritant properties of your wetting agent. (Always have a material safety data sheet on all of your materials and familiarize workers with any cautions or special considerations for their safe use.)

Arrange work so workers do not have to look directly overhead. Get them up to the job!

Instruct your workers on proper lifting methods. Nothing will take the profit out of a job faster than a serious back injury.

Use the "buddy system" for lifting and moving heavy objects.

Use hand carts or rolling pallets when possible. Keep manual material handling to a minimum.

MISCELLANEOUS

OSHA requires that a poster be permanently posted on the job site notifying workers of their rights under the act. This poster, commonly known as the "Job Safety and Health Poster," is available from OSHA offices.

When an employer has 10 or more employees, he is required to maintain a record of injuries and illnesses that occur. Part of this requirement is met by filling out accident reports required by Worker's Compensation insurance carriers. The other requirement is maintenance of the "Log and Summary of Occupational Illnesses and Injuries -- OSHA Log 200." These forms and a booklet titled, "What Every Employer Needs to Know About OSHA Recordkeeping," is available from OSHA and provides information on these recordkeeping requirements.

SAMPLING AND ANALYTICAL METHODOLOGY
PERTAINING TO ASBESTOS ABATEMENT

Objective: To provide an overview of the requirements and methods for sampling and analyzing asbestos-containing materials before, during, and after an asbestos abatement project.

Learning Tasks: Information in this section should enable participants to:

☞ Become familiar with the various methods used for sampling asbestos as a bulk material, airborne fibers, or settled dust.

☞ Become familiar with the analytical methods used to analyze bulk, air, and settled dust samples.

☞ Know the common units for reporting airborne fiber concentrations.

☞ Understand the sampling strategy used for monitoring on asbestos abatement projects.

☞ Understand important aspects of re-entry air monitoring including visual inspection, aggressive monitoring and clearance criteria.

SAMPLING AND ANALYTICAL METHODS PERTAINING TO ASBESTOS-CONTAINING MATERIALS

Sampling and analytical methods are important tools for assessing and monitoring asbestos materials. The applications of sampling and analyses may range from bulk sampling of suspect materials; to estimating airborne fiber levels before, during, and after an abatement project; to checking surfaces for asbestos-containing settled dust. Collection of reliable data requires a thorough knowledge of the various sampling and analytical techniques which are available and when a particular technique should be used.

This discussion is an introduction to the types of sampling methods and various analytical techniques used for asbestos-containing materials. After these methods have been described, the applications of these methods to an asbestos abatement project will be discussed.

Sampling and Analysis - A Perspective

Sampling techniques are procedures used to collect data representative of the environment. It is analagous to testing a piece of the pie to determine what the entire pie tastes like. If you only taste the crust, then your "sample" will not be representative of the entire pie.

Analytical methods are used to determine what is in the sample. Using the pie again, let's say an adequate sample was collected (an entire wedge). Let us also use the analytical technique of "touch." This will tell us the size and shape of the sample. From this data, we can estimate the size and shape of the entire pie. "Touch" will also tell us if it is a creme pie. However, the "analytical technique" would not be adequate to determine the flavor or color of the pie.

Just like the pie, the same holds true for sampling and analyzing asbestos. There are many different methods to perform a specific task with each method revealing different bits of information. A person knowledgeable of those techniques selects the appropriate methods to obtain the desired information.

SAMPLING METHODS

Air Sampling

Air sampling is conducted to determine airborne fiber concentrations before, during, and after abatement activities. Sampling is conducted with battery-powered pumps, which are used to pull low volumes of air (0.5 - 4 liters per minute) and electric pumps which pull high air volumes (4-10 liters per minute). Pumps are calibrated before and after use. A plastic cassette which holds a filter with very small pore openings is attached to the pump with flexible tubing (Figures XIII-1 and XIII-2). With the front cover of the cassette removed, air is drawn through the filter and particles in the air are collected on the filter surface. The type of filter used for sampling depends on the technique which will be used for analysis.

The two basic types of air sampling are area and personal monitoring. Area air samples are taken with a pump that is placed at breathing zone height at some stationary location. The top cover of the plastic filter holder is removed and the filter holder is pointed downward to prevent material from falling onto the filter. The pump is turned on and the start time and sample description are recorded. The pump should be checked periodically (every 30 minutes) to make sure it is functioning properly. Also, the filter should be visibly inspected for overloading. At the end of the sampling period, the pump is turned off and the cover of the filter holder is replaced and secured with tape. The stop time and any other comments about sampling conditions are then recorded. Personal samples are collected from within the breathing zone (as close to the mouth as possible) of an individual, but outside the respirator. Personal samples are collected in the same manner as area samples except the pump is hung from a disposable tape belt around the worker's wrist and the filter holder is attached, pointing downward, to the worker's lapel or collar.

Area air samples can be collected using static or aggressive sampling techniques. Static sampling implies monitoring an area as it is without creating any additional disturbance in the air. This method is typically used during the removal phase of the abatement project. An obvious criticism of this technique for clearance sampling when no one is in the area is that the fibers that have settled out of the air are not detected. An alternative sampling technique which addresses this concern is to create an artificial disturbance in the air during sampling. Aggressive sampling can be accomplished by using electric fans, sweeping, blowers, etc. Currently, there is no standard protocol for using aggressive sampling techniques, but further guidance is available from the EPA Regional Asbestos Coordinators or the EPA-sponsored Information Centers.

Bulk Sampling

Bulk sampling is the technique used to collect samples of suspect materials such as fireproofing, pipe lagging, boiler insulation, and acoustical spray. Bulk sampling is usually conducted during the building survey/hazard assessment and provides data for decisions on control measures. If bulk sampling data is not available to the contractor during his walk-through survey, he may choose to collect some bulk samples (see section on Pre-Work Activities/ Considerations.

A small sample of suspect material is collected and placed in a container or a small jar. Further guidance may be found in Guidance for Controlling Asbestos-Containing Materials in Buildings, Appendix G (see Section II). Anyone taking bulk samples should wear a cartridge respirator and protective clothing if a large number of samples are going to be collected. Bulk samples are analyzed by an analytical laboratory, typically using polarized light microscopy, to determine if asbestos is present and the type and percentage of asbestos in the sample. Bulk samples can also be analyzed by electron microscopy.

Settled Dust

Settled dust sampling can be accomplished by scraping an area containing accumulated dust and placing the material in a small container. Alternatively, settled dust sampling can be conducted (by "suctioning" the area with a filter in a cassette which is attached to an air pump. This material is then treated like a bulk sample with analysis by polarized light or electron microscopy.

Wipe Sampling

Wipe sampling is another technique used to determine trace amounts of asbestos on surfaces. A filter material is used to wipe an area (usually a square foot) and submitted to the laboratory for analysis by electron microscopy.

Tape Sampling

Tape sampling is similar to wipe sampling except a cellophane tape is used to collect settled dust. The sample is normally analyzed by scanning electron microscopy.

ANALYTICAL METHODS

The primary analytical techniques used for analyzing airborne fibers collected on filters are phase contrast microscopy (PCM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). Table XIII-1 summarizes the advantages/disadvantages of each. Bulk samples are generally analyzed by polarized light microscopy (PLM). Other less-used techniques which may be used for analysis of bulk samples are x-ray diffraction (XAD), infrared spectroscopy (IR), and electron microscopy. The fibrous aerosol monitor is an instrument which can be used in the field to obtain an index of the airborne fiber levels. The application of each of these techniques to analyze for asbestos materials is discussed in this section.

Phase Contrast Microscopy (PCM)

Phase contrast microscopy (PCM) is a technique using a light microscope equipped to provide enhanced contrast between the fibers and the background. Samples for PCM are collected on a cellulose ester membrane filter with a 0.8 micrometer pore size. Filters are then cleared with a chemical solution so that trapped particulate material can be viewed through the microscope at a magnification of approximately 400X. PCM is inexpensive ($25-35) and can be performed on the job site in a few hours.

Phase contrast microscopy is frequently referred to as the light microscope method, the filter membrane method, or the NIOSH method. PCM is the analytical method specified in the Occupational Safety and Health Administration (OSHA) Asbestos Standard (29 CFR 1910.1001), which was developed for industrial settings. PCM was first used to monitor asbestos exposure to workers in asbestos product manufacturing or milling operations for prevention of asbestosis. This method does not distinguish between fiber types and only counts those fibers longer than 5 micrometers and wider than about 0.25 micrometers. Because of these limitations, fiber counts by PCM typically provide only an index of the total concentration of airborne asbestos in the environment monitored. As the proportion of the airborne fibers which are less than 0.25 micrometers in diameter increases (i.e., non-industrial settings such as asbestos abatement projects), PCM becomes a less reliable analytical tool.

There are two fiber counting methods for phase contrast microscopy. P&CAM 239 is the original method which was implemented for estimating airborne concentrations. The NIOSH 7400 method is an improved version of P&CAM 239 which provides for a lower limit of detection. Both methods are currently being used in the industry.

Scanning Electron Microscopy (SEM)

Scanning electron microscopy (SEM) is a technique which directs an electron beam onto the sample surface and collects those beams that are reflected. A magnified image is produced on a viewing screen. Air samples for SEM filter counting are collected on a nuclepore polycarbonate filter with a 0.45 micrometer pore size. The cost is about $150-300 per sample and several days may be required to obtain results.

SEM can identify large fibers by morphology and elemental analyses when connected to an energy dispersive x-ray analyzer. Fibers which are 0.05 micrometers in diameter are the smallest that can be detected using SEM. This method has some fiber identification problems with thin fibers and flat, platy particles that display poor contrast. Also, there is no standard protocol for this method. Currently, SEM provides somewhat better information than PCM analysis, but the method cannot be used to conclusively identify or quantify asbestos.

Transmission Electron Microscopy

Transmission electron microscopy (TEM) is a technique which focuses an electron beam onto a thin sample. As the beam transmits through certain areas of the sample, an image resulting from varying density of the sample is projected onto a fluorescent screen. Air samples are collected on nuclepore polycarbonate filter for TEM analysis. The cost is about $400-600 per sample. The analyses can be performed within several days, but due to the limited number of experienced laboratories, it often takes several weeks or more to obtain results.

Transmission electron microscopy is currently considered the best available analytical method for identifying asbestos fibers collected on air samples in non-industrial settings. TEM can identify the smallest fibers and is specific for asbestos. TEM equipped with selected area electron diffraction (SAED) capabilities can also provide information on the crystal structure of an individual particle.

Polarized Light Microscopy (PLM)

Polarized light microscopy is the most commonly accepted method for analyzing bulk materials for the presence of asbestos. This method of inexpensive ($25-50 per sample) and can be performed in a few hours. PLM is based on optical mineralogy using a light microscope equipped with polarizing filters. Identification of asbestos fiber bundles is based on the determination of optical properties displayed when the sample is treated with various dispersion staining liquids (refraction index liquids). In addition, identification can be substantiated by morphology of the fiber and the effect of polarized light on the fiber.

The reliable limit of detection for this method is about one percent asbestos. Samples of extremely fine dusts, such as brake dust should be analyzed by electron microscopy which can detect the smaller fibers.

X-Ray Diffraction (XRD)

X-ray diffraction is a method of analyzing bulk materials for asbestos. It is not as sensitive as PLM with a detection limit of about three percent asbestos. It is sometimes used to confirm the presence of asbestos in a sample already analyzed by PLM. Cost of analysis is about $50-100 per sample.

Infrared Spectroscopy

Infrared spectroscopy is another method of analyzing bulk materials for asbestos. Like XRD, its limit of detection is about three percent and is only used to confirm the presence of asbestos in a sample analyzed by PLM. The cost of analysis is about $45-75 per sample.

Fibrous Aerosol Monitor (FAM)

The fibrous aerosol monitor is an instrument which uses laser light and electrical field technologies to instantaneously analyze the fiber content of the air.

The instrument provides a continuous measurement, with direct readout of the number concentration of airborne filters. The FAM can be used in conjunction with a strip chart to provide a record of air quality conditions. The FAM is typically used as a barometer of airborne fiber levels rather than a precision testing device. Its most useful function is to alert personnel to any suddent elevation of the area fiber count. If the FAM is used on a project, it should be used in conjunction with other traditional air sampling techniques and in place of them.

This instrument does not distinguish fiber types and cannot discriminate between fibers and certain particles that have sufficient shape irregularities to possess fiber characteristics. The FAM does not detect fibers less than 0.5 micrometers in diameter. Laboratory tests indicate FAM concentration readings are generally within $\pm$ 25 percent of the optical membrane filter count.

SAMPLING STRATEGIES AND PROCEDURES FOR AN ABATEMENT PROJECT

Air Sampling Before Abatement Begins

Area air sampling conducted before abatement activities begin to estimate the existing airborne fiber concentrations inside and outside the building is termed prevalent level sampling. These results can be used as control data for comparing sample concentrations detected during and after the abatement project. Prevalent level sampling provides good data for documentation purposes. It is particularly useful when an abatement project is conducted in a portion of the building, with other areas of the building remaining occupied. Airborne fiber levels monitored in these occupied areas during the abatement project should never exceed the indicated prevalent level in these areas before the project began. Also, the airborne fiber concentrations inside the abatement area after cleanup is completed cannot be expected to be lower than the airborne fiber levels outside the building before abatement began.

Because low airborne fiber concentrations are typically found prior to abatement activities, a large volume of air should be sampled to obtain a low detection limit. Simply stated, detection limit is the lowest value that can be reliably reported for the sampling and analytical methods used. The volume of air measured to obtain a 0.01 fiber per cubic centimeter of air (fiber/cc)* detection limit should range between 1000 to 2500 liters, depending on the filter size and counting method used. Samples can be collected at a flowrate of 2-15 liters per minute.

Prevalent samples should be collected throughout the building as well as in the areas where abatement will take place. As a rule of thumb, one sample should be taken for every 50,000 cubic feet (5,000 sq. ft. with 10 ft ceilings) of building space (minimum of 3 samples). At least two samples should be collected from outside the building.

Because results of prevalent level sampling are used as baseline data, the same sampling and analytical techniques should be used for prevalent samples as will be used for samples taken outside the work area during and after the removal project.

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*1 fiber per cubic centimeter is equivalent to 1,000,000 fibers in a cubic meter (approximately 1 cubic yard) = approximately 1 cubic centimeter.

AIR SAMPLING DURING AND AFTER THE ASBESTOS ABATEMENT PROJECT

Personal Sampling

Personal sampling is conducted during a renovation or abatement project to determine employees' exposure (outside any respirator) to airborne fibers. Data from personal monitoring serves many purposes. Personal monitoring during an abatement project is required by the OSHA Asbestos Standard (29 CFR 1910.1001). Under OSHA and hazard communication laws, employees have the right to know the asbestos concentrations to which they are exposed and what measures are being taken to protect them. Also, results of personal sampling can be used to select proper respiratory protection for an employee if conditions warrant something other than Type C respirators (see Respiratory Section). Data from personal monitoring can be used as an indication of effective removal or control techniques which result in the lowest employee exposure. This, in turn, reduces the potential of asbestos-related diseases and the risk to the worker.

Personal samples should be taken during the first full day of removal activity. Additional personal samples should be taken when the type of material being removed or the location (i.e., building) changes. OSHA requires initial monitoring and monitoring every six months thereafter. Personal samples should be collected at least every two weeks during a long abatement project, assuming there are no major changes in work practices, types of asbestos, etc.

Personal samples should be collected at a flowrate of 1-2 liters per minute from at least 25% of the workers doing a particular job. Samples for asbestos exposure should be taken to determine the 8-hour, time-weighted concentration. Over an eight-hour period, filters may have to be changed several times to prevent overloading. Results of each sample are put into this equation to obtain a time-weighted average for the total sampling period.

$$\frac{C_1T_1 + C_2T_2 + C_3T_3 \ldots}{T_1 + T_2 + T_3 \ldots} = \text{Time Weighted Average}$$

$C_1, C_2 \ldots$ = Concentration of each sample

$T_1, T_2 \ldots$ = Duration of each sample

Typically, phase contrast microscopy is used to analyze personal samples collected during the removal project.

Area Air Sampling Inside the Work Area

In addition to personal samples, area air samples are collected inside the work area daily to determine the concentrations of airborne asbestos fibers. Usually, 2 to 3 samples of 60 to 120 liters of air are usually adequate to index the airborne fiber concentrations inside the work area. The data from these samples can be used on a relative basis to monitor work conditions from one day to the next. A radical increase in area concentrations would signal that work practices needed to be adjusted.

Area Air Sampling Outside the Work Area/Inside the Building

During an abatement project, samples are collected from locations outside the work area, but inside the building to determine how well asbestos fibers are being contained to the worksite. These samples are especially important in situations where unprotected people are occupying other areas of the building (see Figure XIII-3). Potential leakage points where sampling should be conducted include the clean side of the containment barriers separating the work area from occupied parts of the building and inside the shower and clean rooms of the decontamination unit. If the abatement project is being conducted in a multistory building, area air samples should be collected from floors above and below the abatement activity.

A large air volume of 1000 to 2500 liters is necessary to obtain the desired detection limit of 0.01 fibers per cubic centimeter for these samples. High volume pumps can be used to shorten the sampling time so that problems which develop can be detected relatively quickly. Phase contrast microscopy is generally the analytical method used for these air samples.

Area Air Sampling Outside the Building

Area air samples are placed in locations outside of the building during an abatement project to detect leakage of fibers from the worksite. Typically, pumps are placed at the entrance of the decontamination unit, at doors or windows, near the exhaust of negative air filtration units, and at the waste load-out area. Generally, high volume samples are collected and analyzed by phase contrast microscopy.

Air Sampling After Final Cleanup of the Work Area

Area air sampling is conducted upon conclusion of an asbestos abatement project to estimate the airborne fiber concentrations of residual fibers. The area must pass a thorough visual inspection for remaining material before final clearance sampling is initiated. Samples are placed inside the work area, and inside the building/outside the work area at approximately one sample for every 50,000 cubic feet (5,000 sq. ft. with 10 ft. ceilings), with a minimum of three in the work area. It is also important to take two to three outdoor air samples for comparison. A low limit of detection is necessary so high volume samples are collected.

Ideally, phase contrast microscopy and electron microscopy are used in combination as a two-stage process for final clearance sampling. Phase contrast analyses can be used to determine if any gross contamination remains in the work and side-by-side samples can be taken for analyses by electron microscopy. If the PCM samples indicate airborne fiber levels are below 0.01 fibers/cc using aggressive sampling techniques, then the other set of samples are submitted for analyses by electron microscopy. As discussed earlier, TEM is the analytical method recognized as having the best resolution and positive fiber identification capabilities.

The airborne fiber concentration for clearance by TEM is also 0.01 fibers/cc with aggressive sampling or the concentrations indicated by the outside air samples, whichever is higher. If the results by TEM analysis indicate the airborne fiber concentrations are higher than this clearance standard, then the area should be recleaned and retested until the criterion is met.

An argument for using only PCM to perform final clearance sampling is that the turn-around time and cost for TEM analysis is prohibitive. Contractors could be on stand-by for several days waiting for TEM results. One solution to this problem is to use the 0.01 fiber/cc by PCM and aggressive sampling as the criterion for releasing the contractor. If TEM results indicate additional cleaning is necessary, this could be done under a separate work order or the removal contractor could return to reclean the work area under a separate contract. This process does take additional time between completion of cleanup and release for reoccupancy. Proper planning should allow for at least a two week period between initial clearance monitoring and reoccupancy to accomplish any necessary recleaning and retesting which would provide a safer environment for building users.

CLEANING UP THE WORK AREA

Objective: Provide instruction on effective techniques for cleaning up the work area, addressing initial gross clean-up through final wipedown.

Learning Tasks: Information in this section should enable participants to:

- ☞ Become familiar with materials and equipment used to accomplish cleanup.
- ☞ Understand the basic procedures for conducting specific cleanup tasks.
- ☞ Recognize the importance of proper sequencing of cleanup tasks.
- ☞ Understand what to look for during a visual inspection.
- ☞ Perform proper cleanup during and after gross removal is complete.

CLEANING UP THE WORK AREA

Although cleanup is a tedious, sometimes lengthy process, it is one of the most critical tasks of the project. Successful cleanup operations require proper sequencing of tasks and great attention to detail. If these items are overlooked, much more time may be spent in the recleaning-retesting cycle than would have been spent to initially conduct a thorough, correct cleanup. Sequential steps and details for cleaning up an area where sprayed-on material has been removed are provided in the following discussion. Removal and cleanup operations in boiler rooms may vary, depending on specifications and the nature of the project.

CLEANUP DURING GROSS REMOVAL

Cleaning of the work area begins shortly after workers start removing the asbestos-containing material from the substrate. Techniques for cleaning the work area during the removal phase are addressed in the section "Confining and Minimizing Airborne Fibers." In summary, a floor crew wearing appropriate personal protective equipment is responsible for bagging the material soon after it is removed, while it is still damp. The material is collected from the floor with brooms, squeeges, plastic dust pans, or other appropriate tools and placed in 6-mil labeled bags for disposal.

INITIATE FINAL CLEANUP

The discussion on final cleanup applies to the phase of the project in which all visible asbestos-containing material has been removed from the substrate and the substrate has been brushed and wet wiped. A flow chart indicating the proper sequence of tasks for performing cleanup is provided at the end of this section.

REMOVE GROSS CONTAMINATION FROM WALL COVERING/OR REMOVE OUTER CONTAMINATED LAYER IF TWO LAYERS WERE HUNG

The next cleaning task should be the removal of any gross contamination which has splattered or collected on the polyethylene wall coverings. Preferably, two layers of polyethylene were initially hung on the walls and the outer contaminated sheets can be removed at this point instead of cleaned. Ideally, the contaminated sheet is lightly misted to minimize the release of airborne fibers. After detaching or cutting the first layer of polyethylene from the bottom of the wall, workers should mount ladders to reach the top of the wall sheet. The outer sheet should be gently detached from the top of the wall and folded inward to form a compact bundle which can be packaged in a 6-mil polyethylene bag for disposal. Any visual debris which leaked behind the outer layer of polyethylene onto the inner layer is now removed with a HEPA vacuum and/or wet wiping methods.

REMOVE GROSS CONTAMINATION FROM EQUIPMENT IN WORK AREA

The next cleaning efforts should be directed toward removing gross contamination from the exteriors of the negative air filtration units, scaffolding, ladders, extension cords, hoses, and other equipment inside the work area. Cleaning can be accomplished using a combination of scraping, brushing, HEPA vacuuming and/or wet wiping. This is also a good time to change-out any of the filters that need replacement on the negative air filtration units.

REMOVE GROSS CONTAMINATION FROM FLOOR COVERING/OR REMOVE TOP LAYER OF POLYETHYLENE IF TWO LAYERS ARE PRESENT

At this point, if two layers of 6-mil poly have been used to cover the floor area, the sheets forming the top layer should be lightly misted and carefully folded inward to form compact bundles for bagging and disposal. Any visible contamination which leaked through to the inner floor layer should be removed (i.e., squeeged, HEPA vacuumed, wet wiped). Excessive time should not be spent in cleaning the floor sheets, but any obvious contamination should be removed.

CONDUCT VISUAL INSPECTION OF ALL SURFACE AREAS/RECLEAN IF NECESSARY

After these tasks have been accomplished, a thorough visual inspection of the area should be conducted. The inspector (building owner's representative) and the contractor's representative, usually the project supervisor, should check for visual contamination on the substrate from which the asbestos-containing material has been removed, on ledges, on tops of doors, indented corners and other areas which might "catch" falling material or contain residual material. A high-intensity flashlight will prove helpful during this inspection. As the inspector and job supervisor walk through the area, the inspection and recleaning process might be facilitated by recording on paper the items or areas which need additional cleaning. The contractor's representative is responsible for correcting any of the deficiencies noted during the inspection before beginning the next phase of work.

PERFORM FINAL WIPE DOWN OF EQUIPMENT/ REMOVE FROM WORK AREA

After the work crew has completed recleaning the areas noted on the inspection list, the equipment should be thoroughly cleaned (gross contamination was removed earlier). Equipment should be wet wiped, washed off in the shower at the waste load-out area, wrapped in polyethylene, or placed in plastic bags. Tools such as scrapers, utility knives, and brushes can be placed in buckets or pans (bottoms cut off of fiber board drums work well) and then sealed in plastic bags for transport to the next project. Brooms should be discarded or sealed in plastic bags. Equipment which is not needed for completion of the project should be removed from the work area. The negative air filtration unit remains in place and operating for the remainder of the cleanup operation until clearance samples are collected.

APPLY SEALANT TO SUBSTRATE

The next phase of the project may include applying a sealant to the substrate and remaining plastic to "lock down" any tiny invisible fibrils which might remain. Also, the mist which occurs during application of the sealant adds in settling out and sticking down fibers which are still airborne. This procedure is addressed in detail in the section "Lockdown and Sprayback."

WAIT OVERNIGHT/REMOVE POLYETHYLENE FROM WALLS

An overnight waiting period (12-24 hours) should be provided after the sealant and/or sprayback material has been applied (or following recleaning after the inspection if no sealant is applied). This period allows the airborne materials to settle. The next day the polyethylene draped over lighting fixtures and covering the interior walls of the work area can be misted and carefully taken down, folded inward to form a bundle, and packaged for disposal. All coverings on doors, windows and vents remain in place.

HEPA VACUUM

After the walls are uncovered, the hard-to-reach places such as crevices around windows, doors, shelves, etc., can be cleaned using a vacuum equipped with a High Efficiency Particulate Air (HEPA) filter. On some projects, contractors may elect to vacuum all surface areas, beginning at the top of the wall and working downward. The HEPA filter retains the tiny fibers which could pass through a standard vacuum cleaner. HEPA vacuums are available with various cannister sizes and horse-power motors. Some models have an available kit for converting a dry vacuum to a wet pick-up vacuum. Also models are available which use compressed air rather than the standard direct current. Twenty to thirty feet extension hoses are available for the larger vacuums.

REMOVE POLYETHYLENE FLOOR COVERING/ REMOVE OR CLEAN CARPET

After vacuuming of these areas is completed, the polyethylene floor covering is misted, each side is detached from the wall, and folded inward to form a compact bundle for bagging and disposal. If a carpet is in the work area and specified for removal (removal instead of cleaning is the preferred practice), workers should lightly mist the entire carpet before detaching it from the floor and rolling it up. Once the carpet is rolled up, it can be wrapped with 6-mil poly, sealed with duct tape, and labeled for disposal. A note of caution: In some locations, carpet may be stuck to the floor with a glue which does not readily separate from the flooring. As the carpet is taken up, some portions of the backing may tear away and remain stuck to the floor. Several unplanned additional manhours may be required to pry or scrape up the glue-carpet spots which are left after the carpet is removed. Also, tearing of the carpet material may elevate fiber counts in air samples analyzed by phase contrast microscopy.

HEPA VACUUM

After the floor area is uncovered, corners and crevices can be cleaned with a HEPA vacuum.

WET WIPE WALLS

Next, the walls are wet wiped and the floors are mopped (or if the carpet is left in place, it should be thoroughly vacuumed with a HEPA filtered unit). Workers begin in the areas farthest away from the negative air filtration units and use amended water to wet wipe all exposed surfaces (excluding the substrate from which the asbestos material was removed). For best results, workers should use cotton rags or lint free paper towels which are disposed of after one use. Rinsing and reuse of towels may result in smearing asbestos fibers on the surfaces. Also, to avoid smearing of residual fibers, workers should wipe in one direction only. Paper towels should not be used to wipe down rough surfaces and should be discarded before they begin to deteriorate when used on smooth surfaces. Small "fibrous looking" residue which may be deposited on surfaces as a result of using deteriorated paper towels could cause a problem during the final visual inspection.

WET MOP FLOORS

After the walls are wet wiped, the floor is mopped with a clean mop head wetted with amended water.

The water should be changed frequently. Waste water from the wet wiping and mopping operations is treated as asbestos-containing water and dumped in the shower drain or placed in a barrel for disposal.

WAIT OVERNIGHT/REPEAT WET WIPE AND WET MOP PROCEDURES

After the walls and other surfaces (shelves, ledges, etc.) have been wet wiped and the floors have been mopped, activity in the area is stopped until the following day. The next day, the same wet wiping and mopping procedures are repeated. If the carpet is left on the floor, it is HEPA vacuumed again and steam cleaned. As an alternative to using amended water for the second wipe down, the cleaning efficiency may be increased by using a commercial cleaning product such as Endust^{TM} or Pledge^{TM}. Windows can also be cleaned with a commercial window cleaner.

VISUAL INSPECTION/RECLEAN IF NECESSARY

The work area should be dry before the final visual inspection is conducted. The inspection is again conducted by the owner's representative and the job supervisor. All surfaces are carefully checked for visible contamination and any areas which need further cleaning are listed on paper. Be sure that ledges, tops of beams, and all hidden locations are also inspected for asbestos-containing dust.

REINSPECT/SHUT OFF NEGATIVE AIR FILTRATION UNIT

After these designated areas have been recleaned, the inspector and job supervisor make a final walk through to assure the items listed have been addressed. The negative air filtration units are shut off and the area is now ready for final clearance air monitoring.

FINAL CLEARANCE MONITORING

Clearance monitoring is adddressed in detail in the section on "Air Sampling Requirements." When the air sampling results indicate the airborne fiber concentration meets the criteria for clearance, the polyethylene can be removed from the vents, stationary objects such as water fountains, electrical outlets, etc., and any barriers can be removed. If the first set of air samples indicate airborne fiber concentrations in the area are above the specified "clearance level", the area must be recleaned followed again by clearance sampling. This cycle is repeated until results of airborne fiber concentrations indicate the clearance criteria have been attained.

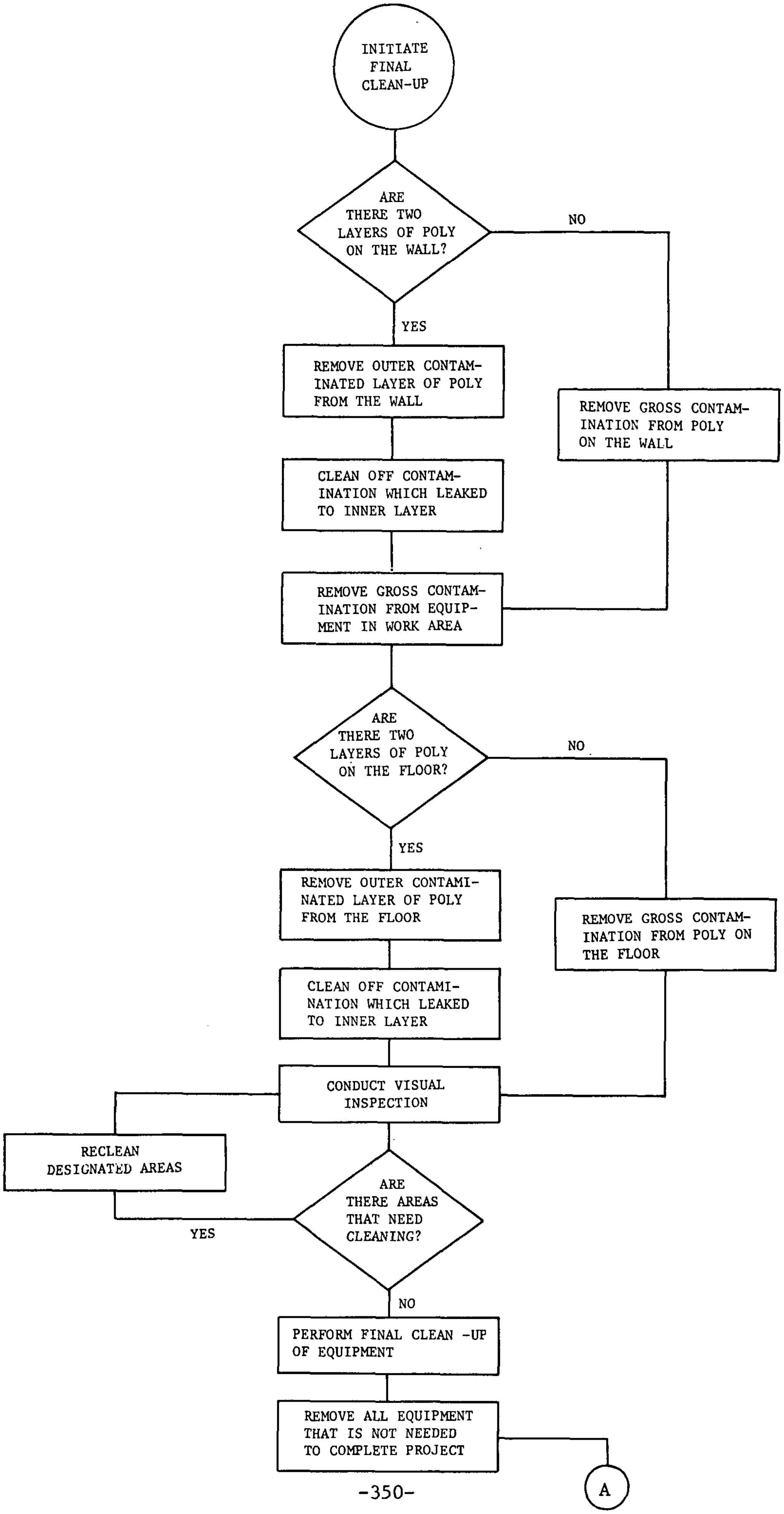
After the area has been cleared for reoccupancy by unprotected personnel, remaining renovation can be initiated (i.e., painting walls, installing suspended ceiling, or laying carpet).

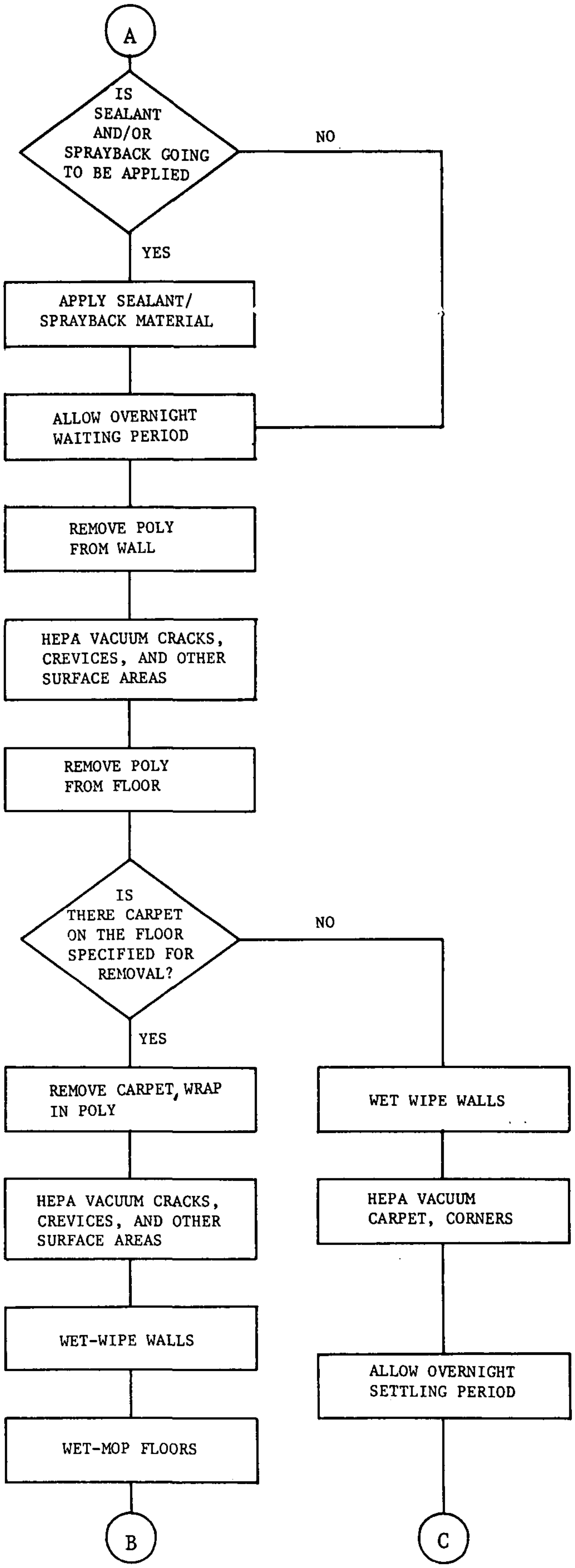
CLEANING UP THE DECONTAMINATION UNIT

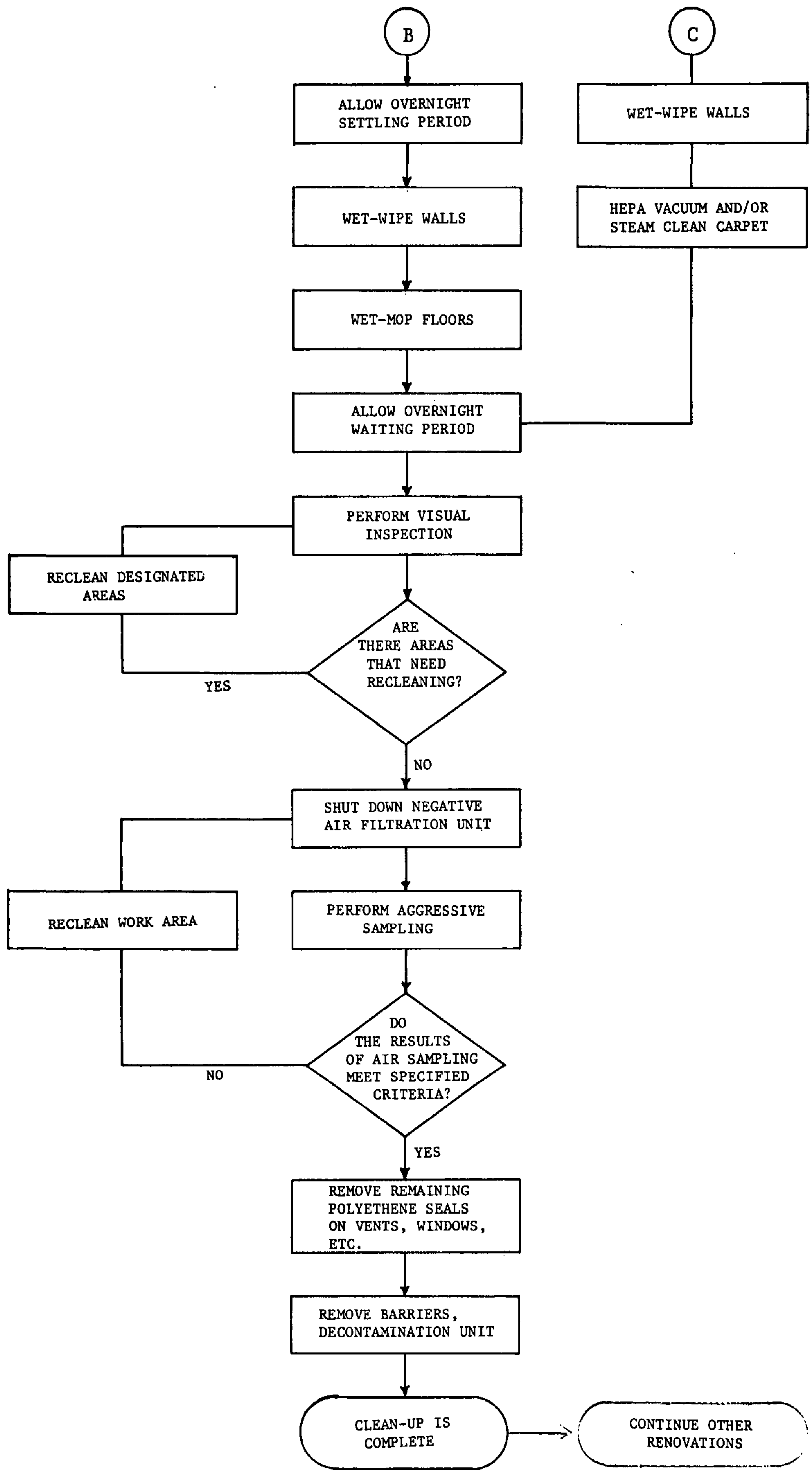
The decontamination unit is lined with three layers of polyethylene on the floor and one or two layers on the walls (at a minimum, the walls of the equipment room should be lined). The top layer of floor poly in the equipment room should be removed at the same time the top layer of floor poly in the work area is cleaned or removed, using the same procedures. This will minimize tracking contamination back into the work area. After cleanup is completed inside the work area, the polyethylene on the walls of the decontamination unit is misted and folded inward. Next, the remaining layers on the floor are removed in the same manner and packaged with the other poly for disposal. The walls should be visually checked for contamination and wet wiped if necessary. The decontamination unit can now be disassembled for transport.

CLEANING UP THE ENCLOSED TRUCK

During the last disposal run to the landfill, after the truck has been emptied of all waste materials, the polyethylene lining the inside of the truck is misted with amended water and carefully removed. Good practice should include wet wiping the floor of the truck at this time. The polyethylene removed from the truck interior and the protective clothing worn by workmen conducting disposal are bagged for disposal and placed with the other materials at the dump site.


INITIATE FINAL CLEAN-UP
ARE THERE TWO LAYERS OF POLY ON THE WALL?
NO
YES
REMOVE OUTER CONTAMINATED LAYER OF POLY FROM THE WALL
REMOVE GROSS CONTAMINATION FROM POLY ON THE WALL
CLEAN OFF CONTAMINATION WHICH LEAKED TO INNER LAYER
REMOVE GROSS CONTAMINATION FROM EQUIPMENT IN WORK AREA
ARE THERE TWO LAYERS OF POLY ON THE FLOOR?
NO
YES
REMOVE OUTER CONTAMINATED LAYER OF POLY FROM THE FLOOR
REMOVE GROSS CONTAMINATION FROM POLY ON THE FLOOR
CLEAN OFF CONTAMINATION WHICH LEAKED TO INNER LAYER
CONDUCT VISUAL INSPECTION
RECLEAN DESIGNATED AREAS
ARE THERE AREAS THAT NEED CLEANING?
YES
NO
PERFORM FINAL CLEAN -UP OF EQUIPMENT
REMOVE ALL EQUIPMENT THAT IS NOT NEEDED TO COMPLETE PROJECT
A


A
IS SEALANT AND/OR SPRAYBACK GOING TO BE APPLIED
NO
YES
APPLY SEALANT/ SPRAYBACK MATERIAL
ALLOW OVERNIGHT WAITING PERIOD
REMOVE POLY FROM WALL
HEPA VACUUM CRACKS, CREVICES, AND OTHER SURFACE AREAS
REMOVE POLY FROM FLOOR
IS THERE CARPET ON THE FLOOR SPECIFIED FOR REMOVAL?
NO
YES
REMOVE CARPET, WRAP IN POLY
HEPA VACUUM CRACKS, CREVICES, AND OTHER SURFACE AREAS
WET-WIPE WALLS
WET-MOP FLOORS
B
WET WIPE WALLS
HEPA VACUUM CARPET, CORNERS
ALLOW OVERNIGHT SETTLING PERIOD
C


B
C
ALLOW OVERNIGHT SETTLING PERIOD
WET-WIPE WALLS
WET-WIPE WALLS
HEPA VACUUM AND/OR STEAM CLEAN CARPET
WET-MOP FLOORS
ALLOW OVERNIGHT WAITING PERIOD
PERFORM VISUAL INSPECTION
RECLEAN DESIGNATED AREAS
ARE THERE AREAS THAT NEED RECLEANING?
YES
NO
SHUT DOWN NEGATIVE AIR FILTRATION UNIT
RECLEAN WORK AREA
PERFORM AGGRESSIVE SAMPLING
DO THE RESULTS OF AIR SAMPLING MEET SPECIFIED CRITERIA?
NO
YES
REMOVE REMAINING POLYETHENE SEALS ON VENTS, WINDOWS, ETC.
REMOVE BARRIERS, DECONTAMINATION UNIT
CLEAN-UP IS COMPLETE
CONTINUE OTHER RENOVATIONS

WASTE DISPOSAL REQUIREMENTS

Objective: Provide an overview of correct methods and regulatory requirements for disposal of asbestos-containing waste resulting from asbestos abatement projects.

Learning Tasks: Information in this section should enable participants to:

- ☞ Understand correct procedures regarding the disposal of asbestos-containing waste.
- ☞ Become familiar with procedures of notifying the appropriate agencies.
- ☞ Understand the appropriate labeling techniques, wet methods, and packaging procedures.
- ☞ Know requirements for effective transportation of asbestos-containing waste and actual disposal at the landfill or disposal site.
- ☞ Become familiar with appropriate OSHA and EPA regulations regarding asbestos waste disposal.
- ☞ Understand recordkeeping requirements.

PREPARATION OF ASBESTOS-CONTAINING WASTE (BEFORE TRANSPORTATION TO THE DISPOSAL SITE)

WETTING

Once the asbestos-containing waste material has been removed from the areas of concern, there are certain precautions that must be taken before disposal operations begin. The first, and probably most important, undertaking is to ensure that all of the asbestos-containing waste has been thoroughly treated with water, or "wetted." This may be accomplished by having a water supply available in any area that abatement work is taking place (i.e., a hose). As the asbestos-containing material is being removed, the material should be kept as damp as possible via a low pressure water stream. By ensuring this, the chances of airborne asbestos fiber generation are significantly reduced. The waste material will then be suitable for containerizing.

CONTAINERIZING

The safest and most effective way to ensure that the asbestos-containing waste has been properly packaged for transportation to the disposal site is to establish a standard procedure for bagging and handling the waste. The first step in this procedure would be to select the appropriate disposal bags (recommended: 6 mil polyethylene). These will be air-tight and puncture resistant. Also, these bags should be labeled with the OSHA required statement:

CAUTION
Contains Asbestos
Avoid Opening or
Breaking Container
Breathing Asbestos is Hazardous
to Your Health

Once this preparation is completed, the next step is to train the abatement workers in the proper techniques for containerizing the waste materials. Important concepts of this training should include:

a. Discussion of the importance of handling asbestos-containing waste in a careful manner to keep airborne fiber generation minimal.

b. Instruction on materials that should not be included in the bags (i.e., metal, sharp objects), and also that each bag should be considered "full" when it is half filled (since material saturated with water will be much heavier).

c. Instruction on correct procedures for sealing off waste-containing bags with duct tape. Ensure that all excess air is squeezed out of bags before they are sealed (to conserve space).

d. Discussion on the importance of ensuring that the asbestos warning label on each bag is legible, so that no bags will be disposed of mistakenly.

Once the asbestos-containing waste is securely enclosed inside the bag, the best recommended practice is to hose the bag down, wet wipe, or HEPA vacuum them clean. The bags should then be placed in fiberboard drums with locking rims. These drums should be labeled in the same manner as the bags. The most efficient method is to place 4 or 5 bags in each drum. Important concepts that should be included when instructing workers in drum utilization are:

a. Prior to the time drums are to be used, while they are still in the waste load-out area, an effective method of contamination control is to line the outside of each drum with a plastic (garbage) bag.

b. This outside bag should be kept on the drum while it is being filled with the asbestos-containing waste bags.

c. Once the drum is filled, the lid or rim should be locked into place. The drum will then be ready for transportation out of the work area.

d. Before leaving the work area (at the doorway to the waste load-out area), the plastic bag on the outside of the drum should be removed and placed in the next drum to be filled with waste.

e. Before the drum enters the load out area, it should be hosed down and/or wet wiped to ensure that there is no residual contamination present on the outside of the drum.

f. Immediately after this bag transfer is accomplished, the sealed drum should be moved into the waste load-out area, and subsequently into the enclosed truck.

(Note: Drums may not be used in some states for asbestos removal since many of their landfills will not accept them.)

For a sketch of a typical waste load-out area, see Figure 1.

WASTE LOAD-OUT PROCEDURE

The most effective method to use in a waste load-out procedure is to utilize two teams of workers; an inside team and an outside team. The inside team, wearing appropriate respirators and protective clothing, will be responsible for ensuring that the drums are properly packed, lids locked into place, and plastic bags removed from the outside of each drum before it is sent through the waste load-out area and into the enclosed truck. (The plastic bags should then be placed in the next drum to be disposed of.) It is important that no workers from the inside team exit the work area through the airlock.

In cases where the drums are not being covered with plastic bags, it becomes necessary for the inside team to assure that each drum exiting the work area be free of any dust. This may be accomplished by inspecting and wet-wiping every drum leaving the area.

The outside team (in the waste load-out area), wearing dual-cartridge respirators and appropriate protective clothing, will post themselves at the entrance to the work area. The inside team will then pass the drums into the load-out area. From here, the outside team will load them into the enclosed truck. The entrance into the waste load-out area from the work area should then be secured to prevent any unauthorized entry or exit.

The outside team will bring the drums into the airlock and up the ramp so the drums can be safely stored in the enclosed truck. Drums should be placed on level surfaces in the cargo area and packed tightly together to prevent shifting and tipping. Under no circumstances should containers ever be thrown into the cargo area. Also, when moving the containers, hand trucks, dollies, or pull carts should be utilized. In addition to this, it is important to instruct workers in proper lifting techniques in order to avoid back injuries. Where ramps are not possible, trucks with lift gates would be helpful for raising drums during loading.

To assure that the truck is properly enclosed, the inside or "bed" area should be lined with 2 layers of 6 mil polyethylene. First, the floor should be completely covered with a six-inch overlap of each piece. The same method should also be used when lining the sides and top of the cargo area also. Duct tape should be used to properly secure the sheets of polyethylene. This will not only ensure additional enclosure of the asbestos-containing waste, but it will also provide for easier clean-up operations. It should be noted here that any debris or residue observed on containers or surfaces outside of the work area resulting from disposal activities should be immediately cleaned by using HEPA filtered vacuum equipment and/or wet wiping, as appropriate.

OTHER FORMS OF ASBESTOS-CONTAINING WASTE

In any asbestos abatement project, not all of the waste material that needs to be disposed of will be loose or broken apart. There are many cases in which it will be necessary to dispose of materials such as asbestos-containing floor, wall, or ceiling tiles, shingles, rugs, etc. The rule of thumb to follow in these instances is simply good common sense. This may include neatly banding together tiles or shingles with care not to expose sharp edges or any other protruding objects that could possibly puncture the polyethylene enclosure. Once the materials are banded together, each bundle should be wrapped in 2 layers of 6 mil polyethylene. When this is complete, the bundles should be neatly stacked in the cargo area of the truck. Care should be used so that tipping or shifting of the load is prevented.

TRANSPORTATION TO THE ASBESTOS-CONTAINING WASTE DISPOSAL SITE

As work progresses, and to prevent exceeding available storage capacity on-site, sealed and labeled containers of asbestos-containing waste should be removed and transported to the pre-arranged disposal location. Regulations may vary from state to state, but there are standard procedures that must be followed in any operation involving asbestos waste disposal. Disposal must occur at an authorized site in accordance with regulatory requirements of NESHAP (National Emission Standard for Hazardous Air Pollutants) and applicable local guidelines. It is best to check with state officials on these requirements.

When transporting asbestos-containing waste to any disposal location, it is important that the drivers of the vehicles be properly trained in correct waste handling procedures. It is important that they not use excessive speeds or unusually rough roads to avoid load slippage or tipping. It will also be the responsibility of the drivers to retain all dump receipts, trip tickets, transportation manifests, or other documentation of disposal. These should then be given to the building owner for his/her records.

DISPOSAL AT THE LANDFILL

Once the asbestos-containing waste truck arrives at the landfill, the driver should approach the disposal location as closely as possible for unloading of the waste materials. Bags should then be taken out of the drums along with the other waste components. They should be inspected as they are off-loaded. In the event a bag has been damaged, the material should be repacked in another bag as appropriate. There may be some instances in which the drums can be buried at the landfill; however, it is usually more economical to reuse the drums.

Waste bags should be placed on the ground at the disposal site, not pushed or dropped out of the trucks, as the weight of the wetted material could rupture the containers. Personnel off-loading the containers should wear proper protective equipment which includes disposable head, body, and foot protection. Also, minimum respiratory protection requirements should include the use of half-face, air-purifying, dual-cartridge respirators equipped with high-efficiency filters.

Upon complete removal of all containerized waste, the truck cargo area should be decontaminated using HEPA vacuums and/or wet wiping methods to comply with the OSHA "no visible residue" and EPA "no visible emission" criteria. The polyethylene sheeting should be removed and discarded along with contaminated cleaning materials and disposable protective clothing in other bags and/or drums at the disposal site. The landfill personnel should have their own personal protective equipment; however, if this is not the case, the contractor should supply them with protective clothing and respiratory protection.

The bags or drums should be placed intact in a excavated area and covered with a minimum of six inches of earth at the end of each working day. These areas must be clearly marked to prevent future disturbance of the waste.

The EPA Regional Asbestos Coordinator in the area that the asbestos abatement work is taking place (see Figure 2) can usually provide a list of approved sites for disposal of asbestos-containing waste.

OTHER CONSIDERATIONS FOR ASBESTOS-CONTAINING WASTE DISPOSAL

An aspect that must not be overlooked when devising an asbestos-containing waste disposal strategy is that of filtering the run-off from showers in the worker decontamination area. It is now generally accepted that filtration of asbestos-contaminated water through a five micron filter is the state of the art for asbestos removal from water. Discharge of the filtered water should be to a sanitary sewer system, or in its absence, to a septic tank and field system with adequate capacity.

If there is any uncertainty regarding water regulations in a particular area, the best course of action to follow would be to contact the state department of environmental management.

REGIONAL ASBESTOS COORDINATORS

Mr. Paul Heffernan
EPA, Region I
Asbestos Coordinator
Air & Hazardous Materials Div.
JFK Federal Bldg.
Boston, MA 02202
(617) 223-0585

Mr. Arnold Freiberger
EPA, Region II
Asbestos Coordinator
Woodbridge Ave.
Edison, NJ 08837
(201) 321-6668

Ms. Pauline Levin
EPA, Region III (3SA-00)
Asbestos Coordinator
Curtis Building
6th and Walnut Streets
Philadelphia, PA 19106
(215) 597-9859

Mr. Jim Littell
EPA, Region IV
Asbestos Coordinator
345 Courtland Street
Atlanta, GA 30365
(404) 881-3864

Dr. Tony Restaino
EPA, Region V
230 S. Dearborn Street
Chicago, IL 60604
(312) 886-6879

Mr. John West
EPA, Region VI
Asbestos Coordinator
First Internat'l Bldg.
1201 Elm Street
Dallas, TX 75270
(214) 767-2734

Mr. Wolfgang Brandner
EPA, Region VII
Asbestos Coordinator
726 Minnesota Ave.
Kansas City, KA 66101
(913) 236-2835

Mr. Steve Farrow
EPA, Region VIII
Asbestos Coordinator
1860 Lincoln Street
Denver, CO 80295
(303) 293-1730

Ms. Jo Ann Semones
EPA, Region IX
Asbestos Coordinator
215 Fremont Street
San Francisco, CA 94105
(415) 974-8137

Mr. Walter Jasper
EPA, Region X
Asbestos Coordinator
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2632

Figure 2

POST REMOVAL LOCKDOWN AND SPRAYBACK PROCEDURES

Objective: Discuss various methods and decision criteria used in lockdown and sprayback operations.

Learning Tasks: Information in this section should enable participants to:

- Become familiar with the terms "lockdown" and "sprayback."

- Understand procedures for spraying back, or replacing asbestos-containing materials with asbestos-free substitutes.

- Become familiar with the criteria used in selecting which types of materials should be used as lockdown and asbestos-free substitutes (sprayback).

- Understand various factors that may influence the use of an asbestos-free sprayback material.

DEFINITIONS

1) Lockdown

Lockdown is the procedure of applying a protective coating or sealant to a surface from which asbestos-containing material has been removed. Its primary function is to control and minimize the amount of airborne asbestos fiber generation that might result from any residual asbestos-containing debris on the substrate. Though the substrate may appear to be clean, miniscule fibers may have become lodged in cracks or crevices that were inaccessible.

2) Sprayback

Sprayback is the process of replacing the asbestos-containing material that was originally removed with an effective substitute. This material should have architectural properties and capabilities adequate to meet specifications and requirements originally set for the space (i.e., acoustical insulation, fireproofing). Caution should be used when choosing a sprayback material to ensure that other adverse problems will not result (i.e., potentially harmful vapors generated during application).

3) Substrate

The surface from which the asbestos was originally removed; the subsurface.

LOCKDOWN

Every asbestos removal project ultimately involves the stripping away of some asbestos-containing material from a permanent substrate or subsurface. Dependent upon the surface structure of this substrate, or the cohesive strength of the asbestos-containing material to the substrate, there will always be some residual fibers left behind after gross removal has taken place.

Some of the most common materials found as substrates in buildings include cement, corrugated sheet metal, wire mesh, metal piping, plaster, and wood. These materials each have different characteristics pertaining to surface structure and cohesive strength. For example, cement substrates are often porous and pitted (many small grooves on the surface). This type of surface is extremely difficult to clean for two reasons. First, the pits in the surface may have become filled with asbestos-containing material when it was originally sprayed or troweled on the surface and then not removed by wet and scrape methods. Secondly, when the material is scraped away during removal, asbestos-containing materials will be packed tightly into these grooves or pits. Most of the material can then be removed through tedious brushing; however, some fibers will remain. For this reason, it is necessary to develop and follow a lockdown strategy which will effectively control the future release of air-borne fibers from porous or non-porous surfaces from which removal has already taken place.

VARIOUS LOCKDOWN METHODS

It is required that all asbestos removal projects be performed using wet methods (see Confining and Minimizing). In certain instances (i.e. high amosite content), it may be necessary to perform dry removal since the material will not absorb water very well. In cases such as this, specific approval must be obtained from EPA. "Wet methods" involve wetting the material to be removed via a low pressure amended water spray. This will keep the amount of airborne fiber generation minimal, and it will also facilitate removal of the asbestos-containing material since it will be more pliable.

The recommended method for brushing or cleansing a substrate after gross removal has taken place is to use a nylon brush. This will aid in getting to fibers that may have become lodged in grooves or crevices in the substrate surface. Wetting of the substrate should also take place while this brushing is being performed since the chance of airborne fiber generation is still present. Use of a wire brush would cause a mechanical break down of larger asbestos fibers or fiber bundles into fibrils of minute size which are easily dispersed throughout the surrounding air (heavy dispersion can make final cleaning very difficult). In either case, wire or nylon brushing will generate airborne fibers to some degree. Once this brushing is completed, a final wipedown of the substrate with wet, lint-free rags should take place in order to ensure that all loose fibers are eliminated. It may be necessary to wipe the surface with a lint-free rag and dusting agent once it has dried.

After the substrate has completely dried and passed a thorough inspection for visible residual contamination, application of the lockdown material can begin.

The polyethylene barriers should be cleaned of gross contamination before applying the sealant to the substrate. It may be more time efficient to place a double layer of polyethylene on the walls and floors during preparation so that one layer can be removed before lockdown begins. Workers performing lockdown should wear disposable protective clothing and respirators suitable for asbestos and/or organic vapors (if applicable) because the area is still contaminated. (Note: Organic vapor respirators may be needed if the lockdown material is volatile in liquid form when being applied.)

There are a variety of products that can be used for locking down the substrate. These products can usually be applied as sprayed-on liquid type sealants (alternatives for certain situations are latex paint, encapsulating solutions, and concrete sealant). This lockdown material should be applied using a low pressure or airless spray-type mechanism. It is important that the lockdown material be compatible with the substrate. Thus, it is important to ensure that cohesion occurs between the two surfaces (substrate and lockdown material), and in some cases, three surfaces (substrate, lockdown, and sprayback). For example, latex paint would work well in locking down a cemented surface, whereas it would not be acceptable for use on metal piping since it will peel and crack. Caution should also be used so that the lockdown material does not present a new hazard during application and anticipated use/conditions. Contractors should obtain all available information on the substance (i.e., toxicity, volatility, fire ratings, and acoustics). Material Safety Data Sheets are one good source of information on a potential product. They should be available from both the manufacturer and distributor of the material. It may be necessary to request additional data on the fire ratings and acoustics of the material. All information should be obtained and considered prior to beginning the project.

A good, recommended practice is to use color tinting when applying lockdown materials. This will make it easier to visually check that all areas of the substrate have been covered with the lockdown substance. One coat of lockdown substance will usually be adequate to prevent the generation of airborne residual fibers. In some cases, additional coats may be needed for cosmetic purposes. Also, if the lockdown material is being applied to irregular, grooved, or corrugated surfaces, it should be administered from the opposing side, or at a right angle to the direction of previous application.

SPRAYBACK

Once the lockdown sealant has been applied, the next step is often to reapply an adequate substitute for the asbestos-containing material that was originally present. In most cases, the original asbestos-containing material was probably used as fireproofing, thermal insulation, condensation control, or acoustical insulation. Therefore, it is imperative that the substitute material (sprayback) be capable of the same functions and have similar functional properties relative to the original asbestos-containing material. This material should also be chosen during the planning stage of the project. Additionally, it is important that the sprayback not introduce another potential health hazard itself. Any material chosen must be thoroughly investigated. Once a substitute is selected, a trial application should be conducted on a small sample area of the substrate to determine whether or not it will be adequate.

The architect or engineer, as a member of the project team, should have the capacity to investigate and recommend various types of sprayback materials. This person will be most familiar with the chemical and physical properties of the various substances available. The architect or engineer will also be familiar with the building structure; specifically, the acoustics and fire ratings. Additionally, the industrial hygienist, who is also a member of the project team, will be able to evaluate the sprayback material for potential health hazards such as toxicity. Working in conjunction with one another, these two members of the project team should be able to decide on an adequate sprayback material while the job specifications are being drawn up.

In many instances, the non-asbestos-containing substitute will be applied as a sprayed-on coating. There are several types available, depending on what the specific purpose will be. Exfoliated vermiculite and perlite, a volcanic rock, are two common substitutes for asbestos. Other materials frequently used as substitutes for a variety of situations include mineral wool, treated cellulose, and fibrous glass. Depending on the situation, cork, and asbestos-free fiber reinforced cement board may also be used as a substitute material.

SUMMARY

In almost every case that requires asbestos removal from a building, locking down the residual material to the substrate and choosing an effective sprayback will be integral aspects in the successful completion of the project. The most important concepts involved in these types of operations are to:

1) Ensure that the lockdown is compatible (cohesive) with the substrate; and that the sprayback material is compatible (cohesive) with the lockdown substance.

2) Ensure that the lockdown and sprayback materials do not present a new health hazard.

3) Ensure that the sprayback has similar desirable properties and capabilities relative to the original asbestos-containing material.

GLOVEBAG TECHNIQUE FOR PIPE LAGGING REMOVAL

Objective: Become familiar with the procedures used and materials necessary for the glovebag technique.

Learning Tasks: Information in this section should enable participants to:

- Understand the concept of localized glovebag removal.
- Become familiar with the necessary materials to perform the job.
- Recognize the importance of proper pipe lagging preparation.
- Understand the basic procedures and sequence for glovebag operations.
- Be aware of necessary precautions, work practices and personal protective equipment.
- Perform proper clean-up and disposal of asbestos-containing waste generated by this technique.

OVERVIEW OF THE GLOVEBAG PROCEDURE

The glovebag consists of a 6-12 mil bag fitted with long sleeve gloves, a tool pouch and a two-inch opening used for water application. Although glovebags can be fabricated by the user for each project, most contractors prefer to purchase ready-made bags. The size, quality, style and cost vary depending on the manufacturer. The cost per glovebag is in a range of $10-40 apiece. In addition to the glovebag, several other tools and materials are commonly required to perform the project successfully. These materials, listed below, are readily available from most asbestos abatement contractor suppliers.

MATERIALS

1. Glovebag (one or more depending on project size)

2. Pump-up garden sprayer (2-3 gallon size)

3. Amended water (surfactant)

4. Duct tape (3-inch width)

5. Polyethylene disposal bags (6 mil)

6. Smoke tubes with aspirator bulb

7. HEPA-filtered vacuum cleaner

8. Bone saw

9. Utility knife with retractable blade

10. Wire cutters

11. Tin snips (if aluminum jacket is present)

12. Polyethylene plastic (roll of 4 or 6 mil)

13. Dual cartridge respirators with high efficiency cartridges

14. Disposable full-body suits with hood and feet covering

15. Small scrub brush

16. Stapler

17. Several rags

18. Wettable cloth

19. Asbestos caution signs and labels

20. Reinsulation materials as necessary

BEFORE STARTING THE PROJECT

Two persons are required to perform the glovebag removal project. A third person is often available, however, to assist with supplies, keep unwanted visitors out of the area, and to conduct the air monitoring. Each of these team members should have received training on the use and limitations of glovebag removal projects. They should also be included in the respiratory protection program and medical surveillance program.

Before any work begins, all necessary materials and supplies should be brought into the work area. This work area should be roped off and warning signs posted on the perimeter to minimize the chance of visitors entering this area. Barrier tape (3-inch) with a preprinted asbestos warning works well for this purpose. The HVAC serving the work area should be shut down, if possible. Employees should be trained in emergency procedures should the glovebag rupture. This usually includes wet cleaning and/or HEPA vacuuming procedures and a shower available at a remote location. With this phase completed, the following generic guidelines may be used for most pipe lagging projects. REMEMBER! NEVER PERFORM GLOVEBAG REMOVAL ON HOT PIPES (OVER 150°F.) This may cause the bag or gloves to melt over the workers' hands and arms.

REMOVAL PROCEDURES

1. Following the manufacturer's directions, mix the surfactant with water in the garden sprayer.

2. Have each employee put on a cartridge respirator and check the face-fit.

3. Have each employee put on a disposable full-body suit. Remember, the hood goes over the respirator straps.

4. Check the pipe where the work will be performed. If it is damaged (broken lagging, hanging, etc.), wrap the entire length of the pipe in polyethylene plastic and "candystripe" it with duct tape. A common error when doing

glovebag work is forgetting that loose pipe lagging several feet or even several yards away from the glovebag work may be jarred loose by the activity. This is one of the common causes of high airborne fiber concentrations during glovebag work. The other problem is failure to clean up debris on the floor and other surfaces which has accumulated and contains asbestos. If the pipe is undamaged it is still necessary to place one layer of duct tape around the pipe at each location where the glovebag will be attached. This serves two purposes. First, it gives a good surface on which to seal the ends of the glovebag. Second, it minimizes the chance of releasing fibers when the tape at the ends of the glovebag is peeled off at the completion of the job.

5. Slit the top of the glovebag open (if necessary) and cut down the sides to accommodate the size of the pipe (about two inches longer than the pipe diameter). One brand has a zipper top and straps at each end facilitating installation of the bag on the pipe.

6. Place the necessary tools into the pouch located inside the glovebag. This will usually

include the bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and wettable cloth. Note: It is easiest to pre-cut the wettable cloth at this point. Cut out a donut shape with the inner diameter 1/2-inch smaller than the diameter of the pipe beneath the insulation. The outer diameter of the donut should be three inches longer than the diameter of the pipe insulation being removed. Finally, cut a slit in each of the two donuts so they can be slipped around the pipe.

7. Place one strip of duct tape along the edge of the open top slit of the glovebag for reinforcement.

8. Place the glovebag around the section of pipe to be worked on and staple the top together through the reinforcing duct tape. Staple at intervals of approximately one inch. Next, fold the stapled top flap back and tape it down with a strip of duct tape. This should provide an adequate seal along the top. Next, duct tape the ends of the glovebag to the pipe itself, previously covered with plastic or duct tape (see step 4).

9. Using the smoke tube and aspirator bulb, place the tube into the water sleeve (two-inch opening to glovebag). By squeezing the bulb, fill the bag with visible smoke. Remove the smoke tube and twist the water sleeve closed. While holding the water sleeve tightly, gently squeeze the glovebag and look for smoke leaking out, especially at the top and ends of the glovebag. If leaks are found, they should be taped closed using duct tape and the bag should be re-tested with smoke.

10. Insert the wand from the water sprayer through the water sleeve. Using duct tape, tape the water sleeve tightly around the wand to prevent air leakage.

11. One person places his hands into the long-sleeved gloves while the second person directs the water spray at the work.

12. If the section of pipe is covered with an aluminum jacket, this is removed first using the wire cutters to cut any bands and the tin snips to remove the aluminum. It is important to fold the sharp edges in to prevent cutting the bag when it is placed in the bottom. <u>Use caution to prevent cuts - these edges are sharp!</u>

13. With the insulation exposed, use the bone saw to cut the insulation at each end of the section to be removed inside the glovebag. Note: A bone saw is a serrated heavy-gauge wire with ring-type handles at each end. Throughout this process, water is sprayed on the cutting area to keep dust to a minimum.

14. Once the ends are cut, the section of insulation should be slit from end to end using the utility knife. The cut should be made along the bottom of the pipe and water continuously supplied. Again, care should be taken when using the knife not to puncture the bag. Some insulation may have wire to be clipped as well.

15. Spray all tools with water inside the bag and place back into pouch.

16. The insulation can now be lifted off the pipe and gently placed in the bottom of the bag.

17. Using the scrub brush, rags and water, scrub and wipe down the exposed pipe inside the glovebag. Note: The inexpensive horse rub-down mittens work well for this.

18. Wet the donut-shaped pieces of wettable cloth over the exposed ends of insulation remaining on the pipe. Wettable cloth is a plaster impregnated fiberglass webbing available at many hardware and/or plumbing supply stores.

19. Remove the water wand from the water sleeve and attach the small nozzle from the HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.

20. Remove the vacuum nozzle and twist the water sleeve closed and seal with duct tape.

21. From outside the bag, pull the tool pouch away from the bag and twist it to separate it from the bag. Place duct tape over the twisted portion and then cut the tool bag from the glovebag, cutting through the twisted/taped section. In this manner, the contaminated tools may be placed directly into the next glovebag without cleaning. Alternatively, the tool pouch with the tools can be placed in a bucket of water, opened underwater, and the tools cleaned and dried without releasing asbestos into the air. Note: Rags and the scrub brush cannot be cleaned in this manner and should be

discarded with the asbestos waste. If more than one adjacent section of pipe is to be removed, the glovebag may be loosened at each end and slid along the pipe to the next section. In this case, the tools would remain in the bag for continued use.

22. With the removed insulation in the bottom of the bag, twist the bag several times and tape it to keep the material in the bottom during removal of the glovebag from the pipe.

23. Slip a 6 mil disposal bag over the glovebag (still attached to the pipe). Remove the tape and open the top of the glovebag and fold it down into the disposal bag.

24. Remove the disposable suits and place these into the bag with the waste.

25. Twist the top of the bag closed, fold this over, and seal with duct tape. Label the bag with a warning label.

26. Using a clean damp rag, wipe the exterior of the respirator and leave the work area. Remove the respirator.

27. Asbestos-containing material must be disposed of at an approved landfill in accordance with EPA regulations.

28. Air sampling should be conducted during and after completion of glovebag projects to determine if undetected leakage occurred. Sampling should be done by qualified persons with immediate analyses provided. Once the area has met the criteria for re-entry by unprotected personnel, the barriers may be removed and reinsulation completed. For further information concerning sampling procedures and clearance criteria, see the section entitled, "Air Sampling Requirements."

NEW DEVELOPMENTS

Objective: Material in this section should reflect new developments in asbestos abatement procedures.

Learning Tasks: Information in this section should enable participants to:

☞ Remain current on changing regulations which affect asbestos abatement procedures.

☞ Keep up-to-date on changes in asbestos abatement technology.

☞ Be aware of specific requirements for the local area, state, or region in which this course is taught as they pertain to asbestos.

APPENDIX A

U.S. DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Title 29 CFR Part 1910.1001

ASBESTOS
(OSHA Standard)

OSHA

1910.1001 - ASBESTOS

(a) Definitions

For the purpose of this section.

(1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) PERMISSIBLE EXPOSURE TO AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS

(1) Standard effective July 7, 1972. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) Standard effective July 1, 1976. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) Ceiling concentration. No employee shall be exposed at any time to airborne concentration of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimer of air, as determined by the method prescribed in paragraph (e) of this section.

(c) METHODS OF COMPLIANCE

(1) ENGINEERING METHODS

(I) Engineering controls. Engineering controls, such as but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) LOCAL EXHAUST VENTILATION

(a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI-A9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(iii) PARTICULAR TOOLS

All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) WORK PRACTICES

(i) Wet methods. Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) Particular products and operations. No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) Spraying, demolition, or removal. Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d) (2) (iii) of this section and with special clothing in accordance with paragraph (d) (3) of this section.

(d) PERSONAL PROTECTIVE EQUIPMENT

(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivision (i) and (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health Department, of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 P.R. 6244, March 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) Air purifying respirators. A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) Powered air purifying respirators. A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) Type "C" supplied-air respirators, continuous flow or pressure-demand class. A type "C" continuous flow or pressure-demand, supplied air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) ESTABLISHMENT OF A RESPIRATOR PROGRAM

(a) The employer shall establish a respirator program in accordance with the requirements of the American National Standard Practices for respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of the respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special Clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms:

(i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering:

(a) Laundering of asbestos-contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

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

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) METHOD OF MEASUREMENT

All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 x (magnification) (4 millimeter objective) with phase contrast illumination.

(f) MONITORING

(1) Initial determinations. Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitoried in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) Personal Monitoring

(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) Environmental monitoring

(i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) CAUTION SIGNS AND LABELS

(1) Caution Signs

(i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in Section 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

LEGEND

LEGEND	NOTATION
Asbestos	1" Sans Serif, Gothic or Block
Dust Hazard	3/4" Sans Serif, Gothic or Block
Avoid Breathing Dust	1/4" Gothic
Wear Assigned Protective Equipment	1/4" Gothic
Do Not Remain in Area Unless Your Work Requires It	1/4" Gothic
Breathing Asbestos Dust May be Hazardous to Your Health	14 Point Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution Labels

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

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

CAUTION
Contains Asbestos Fibers
Avoid creating Dust
Breathing Asbestos Dust May Cause
Serious Bodily Harm

(h) HOUSEKEEPING

(1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

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

(i) Recordkeeping

(1) Exposure records. Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) Employee access. Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) Employee notification. Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) MEDICAL EXAMINATIONS

(1) General. The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) Preplacement. The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(3) Annual examinations. On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(4) Termination of employment. The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(5) Recent examinations. No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) Medical records.

(i) Maintenance. Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) Access. Records of the medical examinations required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a)-(e) and (g)-(i). These records shall also be provided upon the request to the Director of NIOSH. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

APPENDIX B

U.S. ENVIRONMENTAL PROTECTION AGENCY

Subpart M - National Emission Standard
For Asbestos

(EPA ASBESTOS STANDARD)

USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations

AUTHORITY: Secs. 112 and 301(a) of the Clean Air Act, as amended (42 U.S.C. 7412, 7601(a)).

SOURCE: 49 FR 13661, Apr. 5, 1984, unless otherwise noted.

§ 61.140 Applicability.

The provisions of this subpart are applicable to those sources specified in §§ 61.142 through 61.153.

§ 61.141 Definitions.

All terms that are used in this subpart and are not defined below are given the same meaning as in the Act and in Subpart A of this part.

Active waste disposal site means any disposal site other than an inactive site.

Adequately wetted means sufficiently mixed or coated with water or an aqueous solution to prevent dust emissions.

Asbestos means the asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite.

Asbestos-containing waste materials means any waste that contains commercial asbestos and is generated by a source subject to the provisions of this subpart. This term includes asbestos mill tailings, asbestos waste from control devices, friable asbestos waste material, and bags or containers that previously contained commercial asbestos. However, as applied to demolition and renovation operations, this term includes only friable asbestos waste and asbestos waste from control devices.

Asbestos material means asbestos or any material containing asbestos.

Asbestos mill means any facility engaged in converting, or in any intermediate step in converting, asbestos ore into commercial asbestos. Outside storage of asbestos material is not considered a part of the asbestos mill.

Asbestos tailings means any solid waste that contains asbestos and is a product of asbestos mining or milling operations.

Asbestos waste from control devices means any waste material that contains asbestos and is collected by a pollution control device.

Commercial asbestos means any asbestos that is extracted from asbestos ore.

Demolition means the wrecking or taking out of any load-supporting structural member of a facility together with any related handling operations.

Emergency renovation operation means a renovation operation that was not planned but results from a sudden, unexpected event. This term includes operations necessitated by nonroutine failures of equipment.

Fabricating means any processing of a manufactured product that contains commercial asbestos, with the exception of processing at temporary sites for the construction or restoration of facilities.

Facility means any institutional, commercial, or industrial structure, installation, or building (excluding apartment buildings having no more than four dwelling units).

Facility component means any pipe, duct, boiler, tank, reactor, turbine, or furnace at or in a facility; or any structural member of a facility.

Friable asbestos material means any material containing more than 1 percent asbestos by weight that hand pressure can crumble, pulverize, or reduce to powder when dry.

Inactive waste disposal site means any disposal site or portion of it where additional asbestos-containing waste material will not be deposited and where the surface is not disturbed by vehicular traffic.

Manufacturing means the combining of commercial asbestos—or, in the case of woven friction products, the combining of textiles containing commercial asbestos—with any other material(s), including commercial asbestos, and the processing of this combination into a product.

Outside air means the air outside buildings and structures.

Particulate asbestos material means finely divided particles of asbestos material.

Planned renovation operations means a renovation operation, or a number of such operations, in which the amount of friable asbestos material that will be removed or stripped within a given period of time can be predicted. Individual nonscheduled operations are included if a number of such operations can be predicted to occur during a given period of time based on operating experience.

Remove means to take out friable asbestos materials from any facility.

Renovation means altering in any way one or more facility components. Operations in which load-supporting structural members are wrecked or taken out are excluded.

Roadways means surfaces on which motor vehicles travel. This term includes highways, roads, streets, parking areas, and driveways.

Strip means to take off friable asbestos materials from any part of a facility.

Structural member means any load-supporting member of a facility, such as beams and load supporting walls; or any nonload-supporting member, such as ceilings and nonload-supporting walls.

Visible emissions means any emissions containing particulate asbestos material that are visually detectable without the aid of instruments. This does not include condensed uncombined water vapor.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.142 Standard for asbestos mills.

Each owner or operator of an asbestos mill shall either discharge no visible emissions to the outside air from that asbestos mill or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

§ 61.143 Standard for roadways.

No person may surface a roadway with asbestos tailings or asbestos-containing waste material on that roadway, unless it is a temporary roadway on an area of asbestos ore deposits.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.144 Standard for manufacturing.

(a) *Applicability.* This section applies to the following manufacturing operations using commercial asbestos.

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, and sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine.

(10) The manufacture of shotgun shell wads.

(11) The manufacture of asphalt concrete.

(b) *Standard.* Each owner or operator of any of the manufacturing operations to which this section applies shall either:

(1) Discharge no visible emissions to the outside air from these operations or from any building or structure in which they are conducted; or

(2) Use the methods specified by § 61.154 to clean emissions from these operations containing particulate asbestos material before they escape to, or are vented to, the outside air.

§ 61.145 Standard for demolition and renovation: Applicability.

The requirements of §§ 61.146 and 61.147 apply to each owner or operator of a demolition or renovation operation as follows:

(a) If the amount of friable asbestos materials in a facility being demolished is at least 80 linear meters (260 linear feet) on pipes or at least 15 square meters (160 square feet) on other facility components, all the requirements of §§ 61.146 and 61.147 apply, except as provided in paragraph (c) of this section.

(b) If the amount of friable asbestos materials in a facility being demolished is less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, only the requirements of paragraphs (a), (b), and (c) (1), (2), (3), (4), and (5) of § 61.146 apply.

(c) If the facility is being demolished under an order of a State or local governmental agency, issued because the facility is structurally unsound and in danger of imminent collapse, only the requirements in § 61.146 and in paragraphs (d), (e), (f), and (g) of § 61.147 apply.

(d) If at least 80 linear meters (260 linear feet) of friable asbestos materials on pipes or at least 15 square meters (160 square feet) of friable asbestos materials on other facility components are stripped or removed at a facility being renovated, all the requirements of §§ 61.146 and 61.147 apply.

(1) To determine whether paragraph (d) of this section applies to planned renovation operations involving individual nonscheduled operations, predict the additive amount of friable asbestos materials to be removed or stripped over the maximum period of time a prediction can be made, not to exceed 1 year.

(2) To determine whether paragraph (d) of this section applies to emergency renovation operations, estimate the amount of friable asbestos materials to be removed or stripped as a result of the sudden, unexpected event that necessitated the renovation.

(e) Owners or operators of demolition and renovation operations are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.146 Standard for demolition and renovation: Notification requirements.

Each owner or operator to which this section applies shall:

(a) Provide the Administrator with written notice of intention to demolish or renovate.

(b) Postmark or deliver the notice as follows:

(1) At least 10 days before demolition begins if the operation is described in § 61.145(a);

(2) At least 20 days before demolition begins if the operation is described in § 61.145(b);

(3) As early as possible before demolition begins if the operation is described in § 61.145(c);

(4) As early as possible before renovation begins.

(c) Include the following information in the notice:

(1) Name and address of owner or operator.

(2) Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.

(3) Estimate of the approximate amount of friable asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities described in § 61.145(b), explain techniques of estimation.

(4) Location of the facility being demolished or renovated.

(5) Scheduled starting and completion dates of demolition or renovation.

(6) Nature of planned demolition or renovation and method(s) to be used.

(7) Procedures to be used to comply with the requirements of this Subpart.

(8) Name and location of the waste disposal site where the friable asbestos waste material will be deposited.

(9) For facilities described in § 61.145(c), the name, title, and authority of the State or local governmental representative who has ordered the demolition.

(Approved by the Office of Management and Budget under control number 2000-0264.)

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.147 Standard for demolition and renovation: Procedures for asbestos emission control.

Each owner or operator to whom this section applies shall comply with the following procedures to prevent emissions of particulate asbestos material to the outside air:

(a) Remove friable asbestos materials from a facility being demolished or renovated before any wrecking or dismantling that would break up the materials or preclude access to the materials for subsequent removal. However, friable asbestos materials need not be removed before demolition if:

(1) They are on a facility component that is encased in concrete or other similar material; and

(2) These materials are adequately wetted whenever exposed during demolition.

(b) When a facility component covered or coated with friable asbestos materials is being taken out of the facility as units or in sections:

(1) Adequately wet any friable asbestos materials exposed during cutting or disjointing operations; and

(2) Carefully lower the units or sections to ground level, not dropping them or throwing them.

(c) Adequately wet friable asbestos materials when they are being stripped from facility components before the members are removed from the facility. In renovation operations, wetting that would unavoidably damage equipment is not required if the owner or operator:

(1) Asks the Administrator to determine whether wetting to comply with this paragraph would unavoidably damage equipment, and, before beginning to strip, supplies the Administrator with adequate information to make this determination; and

(2) When the Administrator does determine that equipment damage would be unavoidable, uses a local exhaust ventilation and collection system designed and operated to capture the particulate asbestos material produced by the stripping and removal of the friable asbestos materials. The system must exhibit no visible emissions to the outside air or be designed and operated in accordance with the requirements in § 61.154.

(d) After a facility component has been taken out of the facility as units or in sections, either:

(1) Adequately wet friable asbestos materials during stripping; or

(2) Use a local exhaust ventilation and collection system designed and operated to capture the particulate asbestos material produced by the stripping. The system must exhibit no visible emissions to the outside air or be designed and operated in accordance with the requirements in § 61.154.

(e) For friable asbestos materials that have been removed or stripped:

(1) Adequately wet the materials to ensure that they remain wet until they are collected for disposal in accordance with § 61.152; and

(2) Carefully lower the materials to the ground or a lower floor, not dropping or throwing them; and

(3) Transport the materials to the ground via dust-tight chutes or containers if they have been removed or stripped more than 50 feet above ground level and were not removed as units or in sections.

(f) When the temperature at the point of wetting is below 0°C (32°F):

(1) Comply with the requirements of paragraphs (d) and (e) of this section. The owner or operator need not comply with the other wetting requirements in this section; and

(2) Remove facility components coated or covered with friable asbestos materials as units or in sections to the maximum extent possible.

(g) For facilities described in § 61.145(c), adequately wet the portion of the facility that contains friable asbestos materials during the wrecking operation.

§ 61.148 Standard for spraying.

The owner or operator of an operation in which asbestos-containing materials are spray applied shall comply with the following requirements:

(a) Use materials that contain 1 percent asbestos or less on a dry weight basis for spray-on application on buildings, structures, pipes, and conduits, except as provided in paragraph (c) of this section.

(b) For spray-on application of materials that contain more than 1 percent asbestos on a dry weight basis on equipment and machinery, except as provided in paragraph (c) of this section:

(1) Notify the Administrator at least 20 days before beginning the spraying operation. Include the following information in the notice:

(i) Name and address of owner or operator.

(ii) Location of spraying operation.

(iii) Procedures to be followed to meet the requirements of this paragraph.

(2) Discharge no visible emissions to the outside air from the spray-on application of the asbestos-containing material or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(c) The requirements of paragraphs (a) and (b) of this section do not apply to the spray-on application of materials where the asbestos fibers in the materials are encapsulated with a bituminous or resinous binder during spraying and the materials are not friable after drying.

(d) Owners and operators of sources subject to this section are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(Approved by the Office of Management and Budget under control number 2000-0264.)

§ 61.149 Standard for fabricating.

(a) *Applicability.* This section applies to the following fabricating operations using commercial asbestos:

(1) The fabrication of cement building products.

(2) The fabrication of friction products, except those operations that primarily install asbestos friction materials on motor vehicles.

(3) The fabrication of cement or silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture, bulkheads, partitions, and ceilings for marine construction; and flow control devices for the molten metal industry.

(b) *Standard.* Each owner or operator of any of the fabricating operations to which this section applies shall either:

(1) Discharge no visible emissions to the outside air from any of the operations or from any building or structure in which they are conducted; or

(2) Use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

§ 61.150 Standard for insulating materials.

After the effective date of this regulation, no owner or operator of a facility may install or reinstall on a facility component any insulating materials that contain commercial asbestos if the materials are either molded and friable or wet-applied and friable after drying. The provisions of this paragraph do not apply to spray-applied insulating materials regulated under § 61.148.

§ 61.151 Standard for waste disposal for asbestos mills.

Each owner or operator of any source covered under the provisions of § 61.142 shall:

(a) Deposit all asbestos-containing waste material at waste disposal sites operated in accordance with the provisions of § 61.156; and

(b) Discharge no visible emissions to the outside air from the transfer of asbestos waste from control devices to the tailings conveyor, or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air. Dispose of the asbestos waste from control devices in accordance with § 61.152(b) or paragraph (c) of this section; and

(c) Discharge no visible emissions to the outside air during the collection, processing, packaging, transporting, or deposition of any asbestos-containing waste material, or use one of the disposal methods specified in paragraphs (c) (1) or (2) of this section, as follows:

(1) Use a wetting agent as follows:

(i) Adequately mix all asbestos-containing waste material with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, before depositing the material at a waste disposal site. Use the agent as recommended for the particular dust by the manufacturer of the agent.

(ii) Discharge no visible emissions to the outside air from the wetting operation or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(iii) Wetting may be suspended when the ambient temperature at the waste disposal site is less than −9.5°C (15°F). Determine the ambient air temperature by an appropriate measurement method with an accuracy of ±1°C(±2°F), and record it at least hourly while the wetting operation is suspended. Keep the records for at least 2 years in a form suitable for inspection.

(2) Use an alternative disposal method that has received prior approval by the Administrator.

§ 61.152 Standard for waste disposal for manufacturing demolition, renovation, spraying, and fabricating operations.

Each owner or operator of any source covered under the provisions of §§ 61.144 and 61.149 shall:

(a) Deposit all asbestos-containing waste material at waste disposal sites operated in accordance with the provisions of § 61.156; and

(b) Discharge no visible emissions to the outside air during the collection, processing (including incineration), packaging, transporting, or deposition of any asbestos-containing waste material generated by the source, or use one of the disposal methods specified in paragraphs (b)(1), (2), or (3) of this section, as follows:

(1) Treat asbestos-containing waste material with water:

(i) Mix asbestos waste from control devices with water to form a slurry; adequately wet other asbestos-containing waste material; and

(ii) Discharge no visible emissions to the outside air from collection, mixing, and wetting operations, or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air; and

(iii) After wetting, seal all asbestos-containing waste material in leak-tight containers while wet; and

(iv) Label the containers specified in paragraph (b)(1)(iii) as follows:

CAUTION

Contains Asbestos-
Avoid Opening or
Breaking Container
Breathing Asbestos is Hazardous
to Your Health

Alternatively, use warning labels specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.1001(g)(2)(ii).

(2) Process asbestos-containing waste material into nonfriable forms:

(i) Form all asbestos-containing waste material into nonfriable pellets or other shapes; and

(ii) Discharge no visible emissions to the outside air from collection and processing operations, or use the methods specified by § 61.154 to clean emissions containing particulate asbestos material before they escape to, or are vented to, the outside air.

(3) Use an alternative disposal method that has received prior approval by the Administrator.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.153 Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations.

Each owner or operator of any inactive waste disposal site that was operated by sources covered under § 61.142, § 61.144, or § 61.149 and received deposits of asbestos-containing waste material generated by the sources, shall

(a) Comply with one of the following:

(1) Either discharge no visible emissions to the outside air from an inactive waste disposal site subject to this paragraph; or

(2) Cover the asbestos-containing waste material with at least 15 centimeters (6 inches) of compacted nonasbestos-containing material, and grow and maintain a cover of vegetation on

the area adequate to prevent exposure of the asbestos-containing waste material; or

(3) Cover the asbestos-containing waste material with at least 60 centimeters (2 feet) of compacted nonasbestos-containing material, and maintain it to prevent exposure of the asbestos-containing waste; or

(4) For inactive waste disposal sites for asbestos tailings, apply a resinous or petroleum-based dust suppression agent that effectively binds dust and controls wind erosion. Use the agent as recommended for the particular asbestos tailings by the manufacturer of the dust suppression agent. Obtain prior approval of the Administrator to use other equally effective dust suppression agents. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

(b) Unless a natural barrier adequately deters access by the general public, install and maintain warning signs and fencing as follows, or comply with paragraph (a)(2) or (a)(3) of this section.

(1) Display warning signs at all entrances and at intervals of 100 m (330 feet) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements for 51 cm×36 cm (20"×14") upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site	2.5 cm (1 inch) Sans Serif, Gothic or Block
Do Not Create Dust	1.9 cm (3/4 inch) Sans Serif, Gothic or Block
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) Fence the perimeter of the site in a manner adequate to deter access by the general public.

(3) Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access by the general public.

(c) The owner or operator may use an alternative control method that has received prior approval of the Administrator rather than comply with the requirements of paragraph (a) or (b) of this section.

§ 61.154 Air-cleaning.

(a) The owner or operator who elects to use air-cleaning, as permitted by §§ 61.142, 61.144, 61.147(c)(2), 61.147(d)(2), 61.148(b)(2), 61.149(b), 61.151(b), 61.151(c)(1)(ii), 61.152(b)(1)(ii), and 61.152(b)(2) shall:

(1) Use fabric filter collection devices, except as noted in paragraph (b) of this section, doing all of the following:

(i) Operating the fabric filter collection devices at a pressure drop of no more than .995 kilopascal (4 inches water gage), as measured across the filter fabric; and

(ii) Ensuring that the airflow permeability, as determined by ASTM Method D737-75, does not exceed 9 $m^3/min/m^2$ (30 $ft^3/min/ft^2$) for woven fabrics or $11^3/min/m^2$(35 $ft^3/min/ft^2$) for felted fabrics, except that 12 $m^3/min/m^2$ (40 ft^3min/ft^2) for woven and 14 $m^3/min/m^2$ (45 ft $^3min/ft^2$) for felted fabrics is allowed for filtering air from asbestos ore dryers; and

(iii) Ensuring that felted fabric weighs at least 475 grams per square meter (14 ounces per square yard) and is at least 1.6 millimeters (one-sixteenth inch) thick throughout; and

(iv) Avoiding the use of synthetic fabrics that contain fill yarn other than that which is spun.

(2) Properly install, use, operate, and maintain all air-cleaning equipment authorized by this section. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

(b) There are the following exceptions to paragraph (a)(1):

(1) If the use of fabric creates a fire or explosion hazard, the Administrator may authorize as a substitute the use of wet collectors designed to operate with a unit contacting energy of at least 9.95 kilopascals (40 inches water gage pressure).

(2) The Administrator may authorize the use of filtering equipment other than that described in paragraphs (a)(1) and (b)(1) of this section if the owner or operator demonstrates to the Administrator's satisfaction that it is equivalent to the described equipment in filtering particulate asbestos material.

[49 FR 13661, Apr. 5, 1984; 49 FR 25453, June 21, 1984]

§ 61.155 Reporting.

(a) Within 90 days after the effective date of this subpart, each owner or operator of any existing source to which this subpart applies shall provide the following information to the Administrator, except that any owner or operator who provided this information prior to April 5, 1984 in order to comply with § 61.24 (which this section replaces) is not required to resubmit it.

(1) A description of the emission control equipment used for each process; and

(2) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage; and

(i) If the fabric device uses a woven fabric, the airflow permeability in $m^3/min/m^2$ and; if the fabric is synthetic, whether the fill yarn is spun or not spun; and

(ii) If the fabric filter device uses a felted fabric, the density in g/m^2, the minimum thickness in inches, and the airflow permeability in $m^3/min/m^2$.

(3) For sources subject to §§ 61.151 and 61.152:

(i) A brief description of each process that generates asbestos-containing waste material; and

(ii) The average weight of asbestos-containing waste material disposed of, measured in kg/day; and

(iii) The emission control methods used in all stages of water disposal; and

(iv) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(4) For sources subject to § 61.153:

(i) A brief description of the site; and

(ii) The method or methods used to comply with the standard, or alternative procedures to be used.

(b) The information required by paragraph (a) of this section must accompany the information required by § 61.10. The information described in this section must be reported using the format of Appendix A of this part.

(Approved by this Office of Management and Budget under control number 2000-0264)

(Sec. 114. Clean Air Act as amended (42 U.S.C. 7414))

§ 61.156 Active waste disposal sites.

To be an acceptable site for disposal of asbestos-containing waste material under §§ 61.151 and 61.152, an active waste disposal site must meet the requirements of this section.

(a) Either there must be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, or the requirements of paragraph (c) or (d) of this section must be met.

(b) Unless a natural barrier adequately deters access by the general public, either warning signs and fencing must be installed and maintained as follows, or the requirements of paragraph (c)(1) of this section must be met.

(1) Warning signs must be displayed at all entrances and at intervals of 100 m (330 ft) or less along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited. The warning signs must:

(i) Be posted in such a manner and location that a person can easily read the legend; and

(ii) Conform to the requirements of 51 cm × 36 cm (20" × 14") upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph; and

(iii) Display the following legend in the lower panel with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend	Notation
Asbestos Waste Disposal Site.	2.5 cm (1 inch) Sans Serif, Gothic or Block.
Do Not Create Dust	1.9 cm (¾ inch) Sans Serif, Gothic or Block.
Breathing Asbestos is Hazardous to Your Health.	14 Point Gothic.

Spacing between any two lines must be at least equal to the height of the upper of the two lines.

(2) The perimeter of the disposal site must be fenced in a manner adequate to deter access by the general public.

(3) Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access by the general public.

(c) Rather than meet the no visible emission requirement of paragraph (a) of this section, an active waste disposal site would be an acceptable site if at the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period is covered with either.

(1) At least 15 centimeters (6 inches) of compacted nonasbestos-containing material, or

(2) A resinous or petroleum-based dust suppression agent that effectively binds dust and controls wind erosion. This agent must be used as recommended for the particular dust by the manufacturer of the dust suppression agent. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

(d) Rather than meet the no visible emission requirement of paragraph (a) of this section, an active waste disposal site would be an acceptable site if an alternative control method for emissions that has received prior approval by the Administrator is used.

(Secs. 112 and 301(a) of the Clean Air Act as amended (42 U.S.C. 7412, 7601(a))

APPENDIX C

RESPIRATORY PROTECTION...

AN EMPLOYER'S MANUAL

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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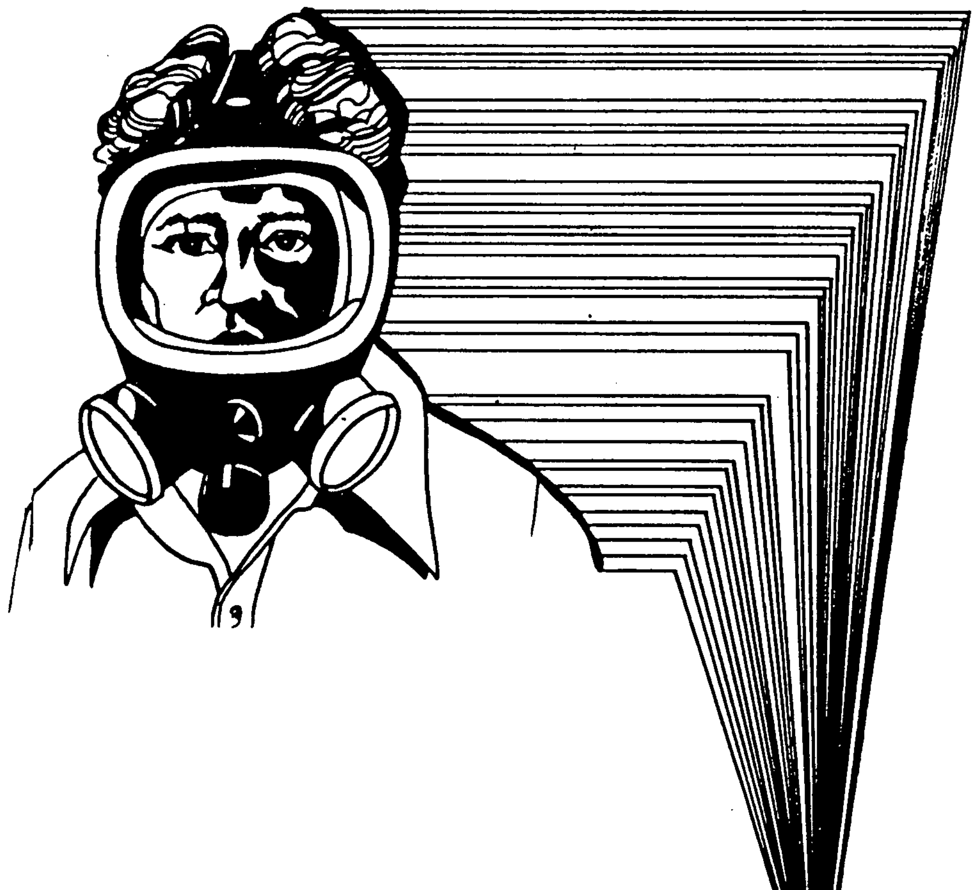
Respiratory Protection...

An Employer's Manual



U. S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

RESPIRATORY PROTECTION:
AN EMPLOYER'S MANUAL

U.S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
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PREFACE

The Occupational Safety and Health Act of 1970 describes legal requirements for both the selection and maintenance of respiratory protective equipment and the instruction of employees in its use. The National Institute for Occupational Safety and Health (NIOSH) in the Department of Health, Education, and Welfare (DHEW) has written this manual to aid employers in setting up a respirator program.

The manual discusses respiratory protection requirements as they apply to the General Industry Standards, i.e., 29CFR1910. Not included are respiratory protection requirements as mandated by 29CFR1915-17 (ship repairing, ship building, ship breaking), 29CFR1918 (longshoring) and 29CFR1926 (construction). Readers desiring information pertaining to respiratory protection for these activities should consult the appropriate titles listed.

This manual discusses the major components of an acceptable program — as described by Federal law. A section is also included which can be used as the basis for an employee training program.

The manual is written especially to aid the small or non-technically oriented employer in complying with the OSHA requirements for respiratory protection. It is meant to complement, not to replace, other publications which may be available including NIOSH Publication 76-189, "A Guide to Industrial Respiratory Protection," and materials prepared by the American Industrial Hygiene Association (AIHA) and the American Conference of Governmental Industrial Hygienists (ACGIH).

DHEW (NIOSH) Publication No. 78-193A

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I. GENERAL OVERVIEW: THE EMPLOYER AND RESPIRATORY PROTECTION

A. WHY RESPIRATORY PROTECTION IS REQUIRED

The Occupational Safety and Health Administration (OSHA) has set maximum exposure standards for many airborne toxic materials. If employee exposure to these substances exceeds the standard, the law requires that feasible engineering controls and/or administrative controls be installed or instituted to reduce employee exposure to acceptable levels. If these controls do not prove feasible, or while they are being installed/instituted, the *employer is required* to provide appropriate respiratory protection for the employee. Respiratory protection is also *required* when working in oxygen deficient atmospheres, i.e., where the oxygen content in the breathable air is insufficient. Respiratory protection may also be necessary for routine but infrequent operations, for non-routine operations in which the employee is exposed briefly to high concentrations of a hazardous substance, e.g., during maintenance or repair activities, or during emergency conditions.

B. THE RESPIRATORY PROTECTION PROGRAM

Providing respiratory protective equipment to the employee, however, is only one aspect of the employer's responsibility pertaining to the use of respiratory protective equipment as a control measure. A respiratory protection program must be implemented.

The basic elements of a program are outlined briefly in the following text.

The program is "established" by management, and an individual is designated to head the program. This person develops the standard operating procedure. This operating procedure describes the following program aspects:

- The basis for selection of a specific type of respiratory protective equipment.
- Provision for medical screening of each employee assigned to wear respiratory equipment to determine if he/she is physically or psychologically able to wear a respirator.
- Provisions for assigning respiratory protective equipment to employees for their exclusive use, where practical.
- Provisions for testing for the proper fit of the respiratory protective equipment.
- Provisions for regularly cleaning and disinfecting the respiratory protective equipment.
- Provisions for proper storage of respiratory protective equipment.
- Provisions for periodic inspection and repair of respiratory protective equipment.
- A periodic evaluation by the administrator of the program to assure its continued functioning and effectiveness.
- An employee training program in which the employee can become familiar with the respiratory protective equipment, and be trained in the proper use and the limitations of the equipment.

The above "program" *must* be instituted as a control measure only after it has been determined that: (1) employee exposure to chemical agents exceeds established limits (OSHA standards), and (2) engineering controls to alleviate the exposure are not feasible, or (3) while engineering controls are being implemented. However, even if you do not have operations in which employee exposure to a substance will exceed the standards, a respirator protection program *should* be developed to address the *infrequent necessary* use of respirators.

The following sections discuss, in some detail, each of the above aspects. The Exhibits referenced provide *examples* of what might be included in a company's safety manual. See Appendix IX.

II. ESTABLISHMENT OF THE RESPIRATORY PROTECTION PROGRAM

Designation of Responsible Person to Administer the Program. This individual is responsible for coordinating the various aspects of the program. The person's technical and professional background should enable him or her to make sound decisions based on an evaluation and understanding of workplace hazards. Preferably, the individual should be a safety engineer, industrial hygienist, or physician. In a small company, especially where respirator usage is limited, the program may be directed by the company owner, foreman, or other supervisory personnel. Regardless of who assumes responsibility for the program, the individual should have the full support of high level management.

III. RESPIRATOR SELECTION PROCEDURE

The proper selection of respiratory protective equipment involves three *basic* steps: (1) the identification of the hazard, (2) the evaluation of the hazard, and (3) finally the selection of the appropriate approved respiratory equipment based on the first two considerations.

A. IDENTIFICATION OF THE HAZARD

Identification (and evaluation) of the hazard forms the basis for a decision on the need for the respirator program. If a survey of operations and work environments indicates that no employees are being exposed to contaminant concentrations exceeding established limits (OSHA standards) then a respirator program is not required. However, your company may be using unregulated substance(s) for which there is no standard. An "in-house" evaluation may have indicated the *need* for respiratory protection equipment for this substance.

Whether management is undertaking a survey (and evaluation) to determine the need for a program, or has already determined (from in-house or outside consultants) the need for respiratory equipment, this section will provide insight for both management and employees into the selection process.

When a survey to determine the need for respirators is to be undertaken, it is important, initially, to know something about the different kinds of hazardous atmospheres which may require the use of respirators.

1. Gaseous Contaminants

Gaseous contaminants add another invisible material to what is already a mixture of invisible gases — the air we breathe. These contaminants are of two types.

a. Gases are the normal form of some substances, e.g., carbon dioxide. Such substances are solids or liquids only at much lower temperatures or much higher pressures than are commonly found in an industrial environment. Carbon dioxide, for instance, is a gas at room temperature. But it also occurs as solid "dry ice" at low temperatures, or as a liquid in pressurized tanks.

b. Vapors are like gases except that they are formed by the evaporation of substances, such as acetone or trichloroethylene, which ordinarily occur as liquids.

2. Particulate Contaminants

Particulate contaminants are made up of tiny particles or droplets of a substance. Many of these particles are so small that they float around in the air indefinitely and are easily inhaled. There are three types of particulates:

a. Dusts are solid particles produced by such processes as grinding, crushing, and mixing of powder compounds. Examples are sand and plaster dust.

b. Mists are tiny liquid droplets given off whenever a liquid is sprayed, vigorously mixed, or otherwise agitated. Acid mists around diptanks used for metal cleaning, and oil mists near newspaper printing presses are two examples.

c. Fumes are solid condensation particles of extremely small particle size. Fumes are found in the air near soldering, welding, and brazing operations, as well as near molten metal processes such as casting and galvanizing.

3. Combination Contaminants

The two basic forms — gaseous and particulate — frequently occur together. Paint spraying operations, for example, produce both paint mist (particulate) and solvent vapors (gaseous).

4. Oxygen Deficient Atmospheres

In an oxygen deficient atmosphere, the problem is not the presence of something harmful, but the absence of something essential. These atmospheres are most commonly found in confined and usually poorly ventilated spaces. Oxygen deficient atmospheres are classified as immediately dangerous to life (see following discussion). Examples are silos, petrochemical tanks, and the holds of ships. In some situations, an oxygen deficient atmosphere is purposely maintained. For instance, fruit is sometimes kept in warehouses with a high carbon dioxide concentration and a small oxygen concentration. Oxygen deficient atmospheres occur in two different ways:

a. Oxygen may be "used up" by a chemical reaction. This is what happens when fire burns.

b. Oxygen is replaced by another gas. If a room with normal air (approximately 21% oxygen) fills up with another gas, e.g., helium, there will be a smaller amount of oxygen available for breathing because some of it will have been displaced by the helium gas.

A more detailed discussion of oxygen deficient atmospheres can be found in Appendix II.

5. *Immediately Dangerous to Life or Health*

This is a term which is used to describe very hazardous atmospheres where employee exposure can:

a. Cause serious injury or death within a short time. Examples are employee exposure to high concentrations of carbon monoxide or hydrogen sulfide.

b. Cause serious delayed effects. Employee exposure to low concentrations of radioactive materials or cancer-causing agents are examples.

B. EVALUATION OF THE HAZARD

A walk-through survey of the plant to identify employee groups or processes, or worker environments where the use of respiratory protective equipment may be required, is the next step in the respirator selection process.

1. *The Hazard Survey*

The walk-through survey to identify and quantify the hazardous substances or conditions that require respiratory protective equipment can be facilitated by reference to the below listed Appendices and by use of the Hazard Evaluation Form (see Figure 1).

a. Appendix I: This Appendix discusses some typical methods and instruments used in determining the concentration of airborne contaminants. However, only qualified individuals must use these instruments and interpret the results. If the facility does not have in-house qualified personnel, outside consultation will be required (see Appendix V).

b. Appendix II: This Appendix discusses oxygen deficient atmospheres and points out some of the "definitions" of an oxygen deficient atmosphere.

c. Appendix III: This Appendix itemizes specific OSHA standards where the use of respiratory protective equipment is required.

d. Appendix VII: This Appendix describes some of the various types of respiratory protective equipment used in reducing and

Figure 1

Respiratory Protective Equipment
Hazard Evaluation Form

Company ______ Date ______

Division ______ By ______

Department ______ Page ______

Employee	Job Description	Respiratory Equipment Required by OSHA Standard (see Appendix III)	Exposure Substances	Oxygen Deficient Atmosphere (see Appendix II)		Measured Concentration (see Appendix I)	OSHA Limit (see Appendix V)	Respiratory Protection Required		Respiratory Equipment Type-SCP (see Appendix IV & VII)	Remarks
				YES	NO			YES	NO		

preventing exposure to air contaminants. The Appendix does not attempt to cover all makes and models of available respiratory protective equipment.

The Hazard Evaluation Form (see Figure 1) should be filled out, as completely as possible, during the walk-through survey. Be sure to enter any details about the work environment which could (ultimately) affect the choice of (or negate the requirement for) respiratory protective equipment.

Exhibit II illustrates a statement governing the procedure for selection of respiratory protective equipment.

C. PURCHASE OF RESPIRATORY EQUIPMENT

If the evaluation of results of the walk-through survey indicate the need for corrective action, and if the decision has been made to use respiratory protective equipment, the next step is the actual purchase of the equipment. The program administrator should have the authority to approve the purchase of respiratory protective equipment.

1. Approval

When purchasing respiratory protective equipment, be sure to purchased *approved* equipment for the particular contaminant. An approved respirator is one that has been tested and found to meet minimum performance standards by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH). OSHA requires that approved respirators be used if they are available. If only one brand of respirator is approved for a particular hazard, then that brand is considered to be "available" and must be used.

a. A *NIOSH* approved respirator contains the following:
- An assigned identification number placed on each unit, e.g., TC-21C-101.
- A label identifying the type of hazard the respirator is approved to protect against.
- Additional information on the label which indicates limitations and identifies the component parts approved for use with the basic unit.

b. In the past, the Bureau of Mines (BOM) approved respirators. The BOM no longer grants approval; however, some older respirators which were BOM-approved may still be used.
- BOM-approved self-contained breathing apparatus (SCBA) may be used until March 31, 1979.
- BOM-approved supplied air respirators may be used until March 31, 1980.
- BOM-approved gas masks may be used until a date as yet not established.

IV. MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

The use of any type of respirator may impose some physiological stress on the user. *Air-purifying respirators,* for example, make breathing more difficult because the filter or cartridge impedes the flow of air. The special exhalation valve on an *open circuit pressure demand respirator* requires the wearer to exhale against significant resistance. The bulk and weight of an SCBA can be a burden. If the wearer is using an *airline respirator,* he/she might have to drag up to 300 feet of hose around. All of the above factors can significantly increase the employee's workload. The wearer should at least have a cursory medical examination to determine if he/she is medically able to wear respiratory protective equipment without aggravating a pre-existing medical problem. Some medical aspects to be considered by an examining physician are detailed in Appendix VI.

While a medical examination by a physician is the preferred screening mechanism for respirator usage, the following checklist will give a good indication of the prospective user's ability to wear a respirator.

- Lung —History of asthma or emphysema.
  —Difficulty in breathing.
  —Previously documented lung problems.

- Heart: —High blood pressure.
  —Artery diseases.
  —Documented heart problems.
- Other —Missing or arthritic fingers.
  —Facial scars.
  —Claustrophobia.
  —Poor eyesight.

A "yes" answer to any of the preceding questions would constitute a warning sign regarding the use of respirators. A medical opinion to confirm any of the above situations (answered "yes") should then be obtained.

Exhibit IV illustrates a policy statement concerning the medical aspect of respirator usage.

V. ISSUANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

Where practical, the user should be given respiratory protective equipment for his/her exclusive use. A system of user cards and a journal can be established to keep track of all employees who are issued respiratory protective equipment. The administrator issues a wallet-sized card to the user showing what respirator the user is to wear and what the contaminant is. A record of issuance of the card is kept in the journal. The user can only obtain the respirator specified on his card. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark must not affect the fit or performance in any way.

Exhibit V illustrates a policy statement and a use card and journal scheme.

VI. RESPIRATORY PROTECTIVE EQUIPMENT FITTING

It is essential that respiratory protective equipment be properly fitted to the employee when it is issued. All the care that went into the design and manufacture of a respirator to maximize protection will not protect the wearer fully if there is an improper match between facepiece and wearer, or improper wearing practices. There are two considerations with respect to proper fit.

- Assuming that there are several brands of a particular type of *facepiece* available (you should provide several to choose from), which *one* fits best?
- How does the *user* know when the respirator fits properly?

The answers to the above questions can be determined by the use of a fitting test.

A. TYPES OF FITTING TESTS

There are two types of fitting tests: qualitative and quantitative tests. *Qualitative* tests are fast, usually simple, but not as accurate an indicator of improper fit as the quantitative test. The *quantitative* test, although more accurate, requires the purchase of expensive equipment, requires a specially trained operator, and in many instances is of limited use due to its complexity and bulk.

Two other qualitative fit tests, the positive pressure fit test and the negative pressure fit test, can be used as a quick check of the fit of the respirator facepiece before beginning or during work in the hazardous atmosphere. These tests would apply only to the air-purifying respirators.

Appendix VIII presents a discussion on the various types of fitting tests — both qualitative and quantitative. The program administrator should choose the best method(s) suited for the program and demonstrate and explain the method(s) to the respiratory protective equipment users.

B. FREQUENCY OF FITTING TESTS

Fitting tests should be repeated at appropriate intervals, particularly when there is a change in the wearer's physical status — such as growth of facial hair or change in face contours.

C. SPECIAL PROBLEMS IN RESPIRATOR FITTING

Facial hair lying between the sealing surface of a respirator facepiece and the wearer's skin will prevent a good seal. Items such as beards and sideburns can prevent satisfactory sealing. The sealing problem is especially critical when non-powered air-purifying respirators are used. The negative pressure developed in the facepiece of these respirators during inhalation can lead to leakage of contaminant into the facepiece when there is a poor seal. Some atmosphere supplying respirators of the *airline type*, due to their mode of operation, can also lead to leakage at the sealing surface. Therefore, individuals who have stubble (even a few days' growth may permit excessive leakage of contaminant), a moustache, sideburns, or a beard that passes between the skin and the sealing surface should not wear a respirator.

Corrective lenses that have temple bars or straps should not be used when a full-facepiece respirator is worn since the bars or straps could pass through the facepiece to face seal. Manufacturers of respiratory protective equipment can provide kits for installing eyeglasses in their respirator facepieces. These glasses or lenses must be mounted by a qualified individual to insure proper fitting.

Contact lenses should not be worn while wearing a respirator, especially in a highly contaminated atmosphere. A properly fitted respirator (primarily a full facepiece respirator) may stretch the skin around the eyes, thus increasing the possibility that the contact lens will fall out. Also, contaminants that do penetrate the respirator may get underneath the contact lens and cause severe discomfort. The user's first reaction would be to remove the facepiece to remedy the situation — which could be fatal in a lethal environment.

Exhibit VI illustrates a policy statement concerning equipment fitting procedures.

VII. MAINTENANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

On-going maintenance of respiratory protective equipment is an important part of the program. Wearing poorly maintained or malfunctioning equipment may be, in a sense, as dangerous as not wearing a respirator. Employees wearing a malfunctioning respirator think they are protected, when, in reality, they are not. The consequences of this situation can be fatal.

While OSHA places strong emphasis on the importance of an adequate maintenance program, it does permit the tailoring of the maintenance program to the type of plant and hazards involved. All maintenance programs should follow manufacturer's instructions and should include provisions for:

- Cleaning and disinfecting of equipment;
- Storage;
- Inspection for defects; and
- Repair

Exhibit VI illustrates a policy statement concerning respiratory protective equipment maintenance.

A. CLEANING AND DISINFECTING

In large programs where respiratory protective equipment is used routinely, respirators should be cleaned and disinfected daily. In small programs where respirators are used occasionally, periodic cleaning and disinfecting is appropriate. Individual workers who maintain their own respirator should be trained in the cleaning of respirators.

1. Methods

The actual cleaning may be done in a variety of ways.

a. The respiratory protection equipment should be washed with detergent in warm water using a brush, throughly rinsed in clean water, and then air dried in a clean place. Care should be taken to prevent damage from rough handling. This method is an accepted procedure for a small respirator program or where each worker cleans his/her own respirator.

b. A standard domestic-type clothes washer may be used if a rack is installed to hold the facepieces in a fixed position. (If the facepieces are placed loose in a washer, the agitator may damage them.) This method is especially useful in large programs where respirator usage is extensive.

2. Detergents and Disinfectants

If possible, detergents containing a bactericide should be used. Organic solvents should not be used, as they can deteriorate the rubber facepiece.

a. If the above combination is not available, a detergent may be used, *followed by a disinfecting rinse*. Reliable disinfectants may be made from some available household solutions.

- Hypochlorite solution (50ppm of chlorine) made by adding approximately 2 tablespoons of chlorine bleach per gallon of water. A 2-minute immersion disinfects the respirators.
- Aqueous solution of iodine (50ppm made by adding approximately 1 teaspoon of tincture of iodine per gallon of water). Again, a 2-minute immersion is sufficient and will not damage the rubber and plastic in the respirator facepieces. Check with the manufacturer to find out the proper temperature for the solutions.

b. If the respirators are washed by hand, a separate disinfecting rinse may be provided. If a washing machine is used, the disinfectant must be added to the rinse cycle, and the amount of water in the machine at that time will have to be measured to determine the correct amount of disinfectant to be added.

B. RINSING

The cleaned and disinfected respirators should be rinsed thoroughly in clean water (120°F maximum) to remove all traces of detergent, cleaner and sanitizer, and disinfectant. *This is very important to prevent dermatitis.*

C. DRYING

The respirators may be allowed to dry by themselves on a clean surface. They also may be hung from a horizontal wire, like drying clothes, but care must be taken not to damage the facepieces.

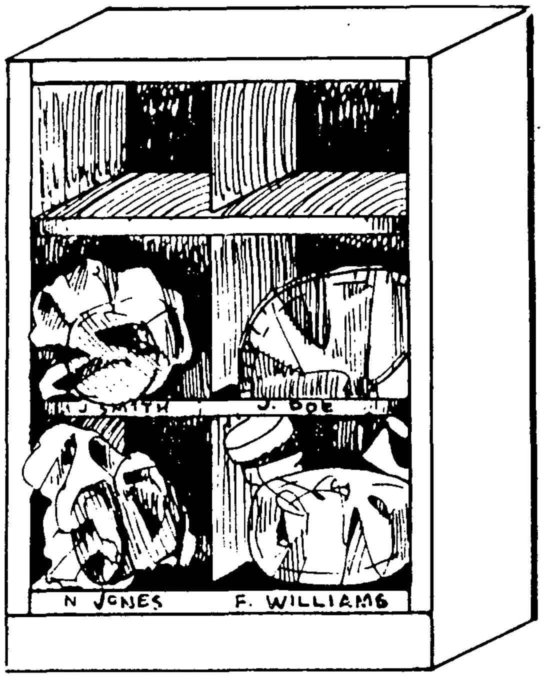
D. STORAGE OF EQUIPMENT

All the care that has gone into cleaning and maintenance of a respirator can be negated by improper storage. Respiratory protective equipment must be stored so as to protect it from dust, sunlight, heat, extreme cold, excessive moisture, and damaging chemicals. Leaving a respirator unprotected, as on a workbench or in a tool cabinet or tool box among heavy wrenches, can lead to damage of the working parts or permanent distortion of the facepiece, thus making it ineffective.

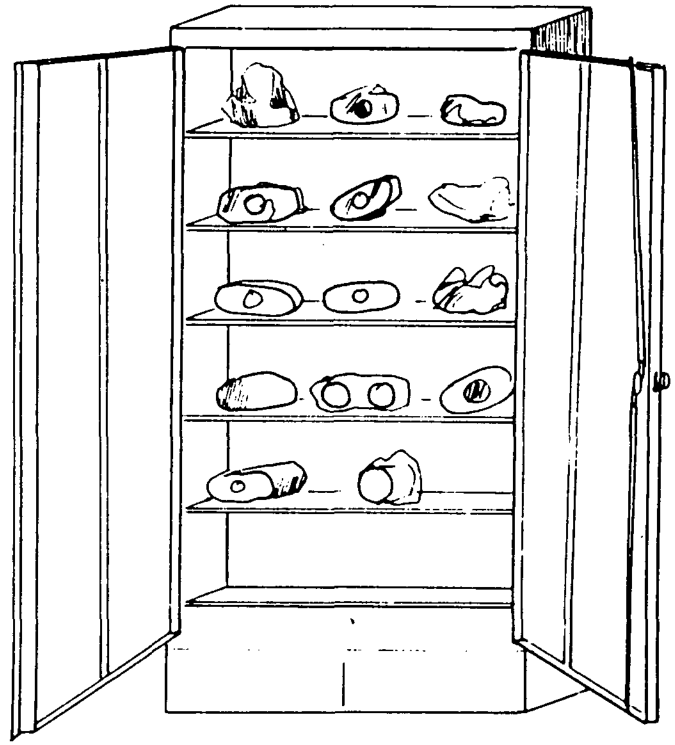
After cleaning and disinfecting the respirators, they should be placed individually in heat-sealed or resealable plastic bags until reissue. They should be stored in a single layer with the facepiece and exhalation valve in a more or less normal position to prevent the rubber or plastic from taking a permanent distorted "set."

1. Air-purifying Respirators

Air-purifying respirators kept ready for nonroutine or emergency use should be stored in a cabinet in individual compartments. A steel wall-mounted cabinet with six compartments is shown below.



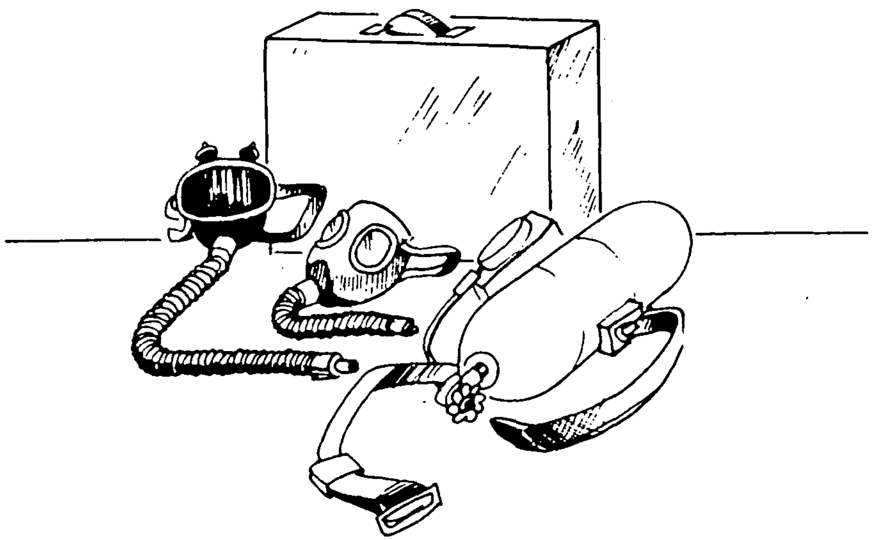
Note that each compartment is clearly labeled with the user's name and that the respirators are in plastic bags.



Another acceptable method of storage in a standard steel storage cabinet is shown above. Note that the respirators are stored in a single layer.

2. Air-supplying Respiratory Protective Equipment

A storage chest for self-contained breathing apparatus (SCBA) may be purchased from the respirator manufacturer.



Storage Chest for SCBA

Storage cabinets should be located in noncontaminated, but readily accessible, areas.

E. REPAIR OF RESPIRATORY PROTECTIVE EQUIPMENT

Continued usage of respiratory protective equipment may require periodic repair or replacement of component parts of the equipment. Such repairs and parts replacement must be done by a qualified individual(s).

Replacement of parts and repair of *air-purifying* respirators should, in most cases, present little problem. Most, if not all, equipment manufacturers supply literature which detail the component parts of their respirator and also include servicing information. The manufacturer will also provide replacement parts. Replacement parts for respiratory protective equipment *must* be those of the manufacturer of the equipment. *Substitution of parts from a different brand or type of respirator will invalidate the approval of the respirator.*

Defective air-supplying respiratory protective equipment, with the exception of the SCBA, can be repaired and worn if broken parts are replaced by a qualified individual — again with the aid of the manufacturer's literature and parts. Maintenance of SCBA equipment, however, is more difficult, primarily because of the valve and regulator assembly. Because of this, regulations *require* SCBA equipment to be returned to the manufacturer for adjustment or repair.

VIII. INSPECTION FOR DEFECTS

An important part of a respirator maintenance program is the inspection of the devices. If performed carefully, inspections will identify damaged or malfunctioning respirators.

Exhibit VII illustrates a policy statement concerning inspection procedures.

A. INSPECTION SCHEDULES

All respiratory protective equipment must be inspected:
- before and after each use; and
- during cleaning.

Equipment designated for emergency use must be inspected:
- after each use;
- during cleaning; and
- at least monthly.

Self-contained breathing apparatus must be inspected
- at least monthly.

B. RECORDKEEPING

A record must be kept of inspection dates and findings for *respirators maintained for emergency use.*

C. INSPECTION CONSIDERATIONS

This section itemizes some of the primary defects to look for in inspection of the components of the respirator. When appropriate, information within the parentheses are suggested actions to be taken. In many cases, you will have to contact the manufacturer of the equipment or the equipment vendor.

1. Disposable respirator — check for:

- holes in the filter (obtain new disposable respirator);
- straps for elasticity and deterioration (replace straps — contact manufacturer); and
- metal nose clip for deterioration, if applicable (obtain new disposable respirator).

2. Air-purifying respirators (quarter-mask, half-mask, full facepiece; and gas mask)

a. Rubber facepiece — check for:
- excessive dirt (clean all dirt from facepiece);
- cracks, tears, or holes (obtain new facepiece);
- distortion (allow facepiece to "sit" — free from any constraints and see if distortion disappears; if not, obtain new facepiece); and
- cracked, scratched, or loose fitting lenses (contact respirator manufacturer to see if replacement is possible; otherwise, obtain new facepiece).

b. Headstraps — check for:
- breaks or tears (replace headstraps);
- loss of elasticity (replace headstraps);
- broken of malfunctioning buckles or attachments (obtain new buckles); and
- excessively worn serrations on the head harness which might allow the facepiece to slip (replace headstrap).

c. Inhalation valve, exhalation valve — check for:
- detergent residue, dust particles, or dirt on valve or valve seat (clean residue with soap and water);

- cracks, tears, or distortion in the valve material or valve seat (contact manufacturer for instructions); and
- missing or defective valve cover (obtain valve cover from manufacturer).

d. Filter element(s) — check for:
- proper filter for the hazard;
- approval designation;
- missing or worn gaskets (contact manufacturer for replacement);
- worn threads — both filter threads and facepiece threads (replace filter or facepiece, whichever is applicable);
- cracks or dents in filter housing (replace filter);
- deterioration of gas mask cannister harness (replace harness); and
- service life indicator, or end of service date — for expiration, gas mask (contact manufacturer to find out if your filter element has one; if not, ask what will indicate the "end of service").

e. Corrugated breathing tube (gas mask) — check for:
- cracks or holes (replace tube);
- missing or loose hose clamps (obtain new clamps); and
- broken or missing end connectors (obtain new connectors).

3. Atmosphere Supplying Respirators

a. Check *facepiece, headstraps, valves, and breathing tube*, as for air-purifying respirators.

b. Hood, helmet, blouse, or full suit, if applicable — check for:
- rips and torn seams (if unable to repair the tear adequately, replace);
- headgear suspension (adjust properly for you);
- cracks or breaks in faceshield (replace faceshield); and
- protective screen to see that it is intact and fits correctly over the faceshield, abrasive blasting hoods, and blouses (obtain new screen).

c. Air supply system — check for:
- breathing air quality;

• breaks or kinks in air supply hoses and end fitting attachments (replace hose and/or fitting);
• tightness of connections;
• proper setting of regulators and valves (consult manufacturer's recommendations); and
• correct operation of air-purifying elements and carbon monoxide or high-temperature alarms.

d. Self-contained breathing apparatus (SCBA)
• consult manufacturer's literature.

IX. RESPIRATOR USE UNDER SPECIAL CONDITIONS

A. DANGEROUS ATMOSPHERES

If respiratory protective equipment usage in atmospheres "immediately dangerous to life or health" (see page 5 for definition) is anticipated, special preparations must be made. A standard operating procedure for work in high hazard areas must be written.

The standard operating procedure must cover at least the following:

• Individuals designated to enter into dangerous atmospheres must have training with the proper equipment, i.e., self-contained breathing apparatus (SCBA). These individuals *must* be equipped with safety harnesses and safety lines so that they can be removed from the atmosphere if necessary.
• Designation and provision of a standby individual, equipped with proper rescue equipment, who *must* be present in a *nearby* safe area for possible emergency rescue.
• Provision for communication between persons in the dangerous atmosphere and the standby person *must* be made. Communication may be visual or by voice, signal line, telephone, radio, or other suitable means.

Other important data such as toxicologic information and emergency phone numbers should also be included.

B. CONFINED SPACES

Confined spaces are defined as enclosures that are usually difficult to get out of, such as storage tanks, tank cars, boilers, sewers, tunnels, pipelines, and tubs. In many cases, confined spaces contain toxic air contaminants, are deficient in oxygen (see Appendix II), or both. As a result, special precautions must be taken:

• Before entering a confined space, tests should be made to determine the *presence* and *concentration* of any flammable gas, toxic airborne particulate, vapor, gas, and oxygen concentration (see Appendix I).
• If a flammable substance in the *explosive range* is present, the confined space must be force ventilated to keep the concentration well below the lower explosive limit. The concentration of contaminant or oxygen percent should be continuously monitored while individuals are working in the confined space.
• Only individuals specially trained should be allowed to enter confined spaces and the *proper* respiratory protective equipment must be worn.

—Air-purifying respirators and airline and hose mask-type supplied-air respirators may be worn in a confined space only if the tests show that the atmosphere contains adequate oxygen and that air contaminants are well below levels immediately dangerous to life or health. While individuals wearing these types of respirators are in a confined space, the atmosphere must be monitored continuously.

—If the atmosphere in a confined space is immediately dangerous to life or health due to a high concentration of air contaminant or oxygen deficiency, those entering the space must wear a positive pressure SCBA or a combination airline and a positive pressure self-contained breathing respirator.

• A standby individual with proper rescue equipment, including an SCBA, must be present outside the confined space for possible emergency rescue. Communication must be maintained via voice, signal line, telephone, etc., between individuals in the confined space and the standby person. Those individuals inside the confined space must be equipped with safety harnesses and safety lines to allow removal in case of emergency.

C. LOW AND HIGH TEMPERATURE

Use of respiratory protective equipment in low temperatures can create several problems. The lenses of the full facepiece equipment may fog due to condensation of the water vapor in the exhaled breath. Coating the inner surface of the lens with an anti-fogging compound will reduce fogging. Nose cups that direct the warm, moist exhaled air through the exhalation valve without touching the lens are available from the manufacturer for insertion into the full facepiece. At low temperatures, the *exhalation* valve can freeze onto the valve seat due to the moisture in the exhaled air. The user will be aware when this situation occurs by the increased pressure in the facepiece. When unsticking the valve, be careful so as not to tear the rubber diaphragm.

Respirator usage in hot environments can put additional stress on the user. The stress can be minimized by using a light-weight respirator with low breathing resistance. In this respect, an *airline* type atmosphere-supplying respirator equipped with a vortex tube can be used. Since the vortex tube may either cool or warm the supplied air (depending on the connection and setting), this protection scheme can be used in both hot and cold environments.

X. RESPIRATORY PROTECTION PROGRAM: SURVEILLANCE EVALUATION

Two important aspects of the respirator program are the periodic surveillance of the work areas requiring usage of respirators, and an evaluation of the overall respirator program for effectiveness.

Exhibit IX illustrates a policy statement concerning program evaluation.

A. SURVEILLANCE OF WORK AREA CONDITIONS AND WORKER EXPOSURE

Many things such as changes in operation or process, implementation of engineering controls, temperature, and air movement can affect the concentration of the substance(s) which originally required the use of respirators. To determine the continued necessity of respiratory protection or need for additional protection, measurements of the contaminant concentration should be made whenever the above changes are made or detected. (See Appendix I.) A record of these measurements should be kept.

B. PROGRAM EVALUATION

In general, the respirator program should be evaluated at least annually, with program adjustments, as appropriate, made to reflect the evaluation results. Program function can be separated into administration and operation.

1. Program Administration

a. Is program responsibility vested in one individual who is knowledgeable and who can coordinate all aspects of the program?

b. What is the present status of the implementation of engineering controls, if feasible, to alleviate the need of respirators?

c. Are there *written* procedures/statements covering the various aspects of the respirator program?

—designation of administrator;
—respirator selection;
—purchase of approved equipment;
—medical aspects of respirator usage;
—issuance of equipment;
—fitting;
—maintenance, storage, repair;
—inspection; and
—use under special condition.

2. *Program Operation*

a. Respiratory protective equipment selection

- Are work area conditions and employee exposures properly surveyed?
- Are respirators selected on the basis of hazards to which the employee is exposed?
- Are selections made by individuals knowledgeable of selection procedures?

b. Are only approved respirators purchased and used and do they provide adequate protection for the *specific* hazard and *concentration* of the contaminant?

c. Has a medical evaluation of the prospective user been made to determine their physical and psychological ability to wear respiratory protective equipment?

d. Where practical, have respirators been issued to the users for their exclusive use, and are there records covering issuance?

e. Respiratory protective equipment fitting

- Are the users given the opportunity to try on several respirators to determine whether the respirator they will subsequently be wearing is the best fitting one?
- Is the fit tested at appropriate intervals?
- Are those users who require corrective lenses properly fitted?
- Are users prohibited from wearing contact lenses when using respirators?
- Is the facepiece to face seal tested in a test atmosphere?

f. Maintenance of respiratory protective equipment

Cleaning and Disinfecting
- Are respirators cleaned and disinfected after each use when different people use the same device, or as frequently as necessary for devices issued to individual users?

- Are proper methods of cleaning and disinfecting utilized?

Storage
- Are respirators stored in a manner so as to protect them from dust, sunlight, heat, excessive cold or moisture, or damaging chemicals?
- Are respirators stored properly in a storage facility so as to prevent them from deforming?
- Is storage in lockers and tool boxes permitted only if the respirator is in a carrying case or carton?

Inspection
- Are respirators inspected before and after each use and during cleaning?
- Are qualified individuals/users instructed in inspection techniques?
- Is respiratory protective equipment designated as "emergency use" inspected at least monthly (in addition to after each use)?
- Is a record kept of the inspection of "emergency use" respiratory protective equipment?

Repair
- Are replacement parts used in repair those of the manufacturer of the respirator?
- Are repairs made by knowledgeable individuals?
- Are repairs of SCBA made only by *certified* personnel or by a manufacturer's representative?

Special Use Conditions
- Is a procedure developed for respiratory protective equipment usage in atmospheres immediately dangerous to life or health?
- Is a procedure developed for equipment usage for entry into confined spaces?

Training
- Are users trained in proper respirator usage?
- Are users trained in the basis for selection of respirators?

XI. EMPLOYEE TRAINING PROGRAM

NOTES TO THE INSTRUCTOR

A. OUTLINE FORMAT

The suggested outline format allows the instructor to adapt the training program to the individual requirements of the facility. This may be accomplished in the following way:

- Where indicated in the outline, record the appropriate information for your facility, e.g., in what locations of your operations are respirators required, or which chemical exposures necessitate the use of respirators?
- Refer to specific information in the individual Appendices. For example, one Appendix contains a discussion of the various types of respirators available. Employees need not be aware of all the types, but only the one(s) they will be required to wear. Therefore, when the outline indicates that information from an Appendix is to be inserted at that point in the presentation, only that portion of the Appendix pertinent to your facility need be covered.

B. TRAINING FORMAT

When planning the training session, remember that trainees usually retain only about 20 percent of what they hear, about 40 percent of what they see, and about 70 percent of what they both see and hear. For best results, therefore, a program of lectures, supplemented by audiovisual materials and demonstrations, is recommended. Some suggestions are presented in the following text.

- Cover the material presented in the outline.
- Break the lecture at 30-45 minute intervals to allow the trainee to stand up and move around.
- Use blackboard, chart pad, or flip chart for emphasizing subject sequence and major points.
- Obtain slides and/or films from the National Safety Council, your trade association, or the manufacturer/supplier of the equipment you use and intersperse in the presentation, as appropriate.
- Illustrate specific areas with personal experiences or examples related to your operations.
- Have examples, as appropriate, of the respirators used in your facility available in the classroom.
- Highlight areas concerned with their operation or requirements.
- Supplement the material in this manual by covering company operating procedures and/or instructional material supplied by the equipment manufacturer/supplier.

C. INSTRUCTIONS TO TRAINEES

An integral part of the training program is the free exchange of information — and questions — between instructor and trainees. Therefore, the following comments (made by the instructor) are suggested at the beginning of the training session.

"During this session your full participation is needed.
- If you don't understand what's being discussed, ask questions.
- If you have been involved in or are aware of accidents pertaining to specific areas covered, share them with us.
- If you are aware of better approaches to reduce hazardous conditions, give us the benefit of your experience.
- Finally, if there is additional information or guidance we can provide, identify the areas for us."

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

A. Why is respiratory protective equipment required?

1. *The Occupational Safety and Health Administration*

OSHA has set maximum exposure standards for many airborne toxic materials and has set standards governing specific working environments to protect your health. A recent evaluation of your working environment revealed that:

Name work area
List substances
Describe activities
Describe chemical exposure

Describe areas

Name storage areas
Describe emergency situation which could exist in your plant

a. In work areas (****), atmospheric concentrations of substances (****) were found to be above acceptable limits.
b. Maintenance activities (****) during which you are exposed to (****) a high concentration for a short period of time, lead to excessive exposure.
c. Several areas (****) were found to be "oxygen deficient." (see Appendix II)
d. Hazardous substances are stored at (****) and if these substances spill, etc., an emergency condition will exist, or (****).

2. *Status of Engineering Controls*

Suggested phraseology

Plan to have . . .
Describe what controls are to be/being implemented
Discuss administrative controls (rotating work schedules, spreading work over two shifts, etc.)

(****) Since the company recognizes that respiratory protection is not the accepted method for control of airborne hazards, we are taking steps to implement *engineering* control solutions.
a. We (****) installed the following engineering controls (****)

b. And the following administrative controls (****).
However, while the above steps are being implemented, respiratory protection will be required.

B. Respirator Selection and Procedure

Selection procedure of the proper equipment normally involves three steps: the *identification* of the hazard: the *evaluation* of the hazard; and finally the *selection* of the appropriate respiratory equipment based on the first two steps.

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

1. Identification of the Hazard

Before we get into the "specifics" about the respiratory protective equipment you will be wearing, a few statements about hazard identification.

Discuss only those contaminant atmospheres representing problems in your facility. See following discussion.

There are several kinds of hazardous atmospheres which may require the use of respirators. (****)

a. Gaseous Contaminants

Gases are the normal form of substances like carbon dioxide or hydrogen sulfide. These substances are solids or liquids only at very low temperatures or extremely high pressures. Carbon dioxide, for instance, is a gas at room temperature. But it also occurs as solid "dry ice" formed at low temperatures.

Vapors are exactly like gases except that they are formed by the evaporation of substances, such as acetone or trichlorethylene, which ordinarily occur as liquids.

b. Particulate Contaminants

Particulates are tiny particles, solid or liquid, generated by such processes as grinding, crushing, and mixing of a compound, either a solid or a liquid. There are three types of particulates.

Dusts are solid particles produced by such processes as grinding, crushing, and mixing of powder compounds. Examples are sand and plaster dust. By comparison to the following two types of particulates, dust particles are usually large.

Mists are tiny liquid droplets, usually formed whenever a liquid is sprayed, vigorously mixed, or otherwise agitated. Acid mists around diptanks used for metal cleaning, and oil mists near newspaper printing presses, are two examples.

Fumes are solid condensation particles of extremely small particle size. Fumes are found in the air near soldering, welding, and brazing operations, as well as near molten metal processes such as casting and galvanizing.

Two basic forms — gaseous and particulate — frequently occur together. Paint spraying operations, for example, produce both paint mist (particulate) and solvent vapors (gases).

A further discussion of ODA's can be found in Appendix II.

a. Oxygen Deficient Atmospheres (****). Oxygen deficient atmospheres (ODA) are most commonly found in confined spaces which have poor ventilation. Examples are silos, petrochemical tanks, degreasers, and the holds of ships.

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

After explaining to the employee the *type* of hazardous atmosphere (*a* and/or *b* and/or *c*) requiring respiratory protection, you should then discuss the hazard specifics. Check vendor literature, toxicologic references, or Material Safety Data Sheet (or contact OSHA or NIOSH regional offices).

2. *Hazard Specifics (****)*
   a. Hazard Name
   - Organic vapor (name)
   - Particulate (name)
   - Gas (name)

   b. Toxicity Data (****)
   - Effects

See Figure I.
Refer to Appendix I to describe the type instrument used (optional).
See Appendix V.

3. *Evaluation of the Hazard (****)*
   a. To determine the concentration of the hazard, as identified above, measurements were made. (****) The concentration and/or work environment examined were compared with the published Federal Standards (****).
4. *Selection of the Respirator*
   a. After it was determined that respirators were required, the Standards Completion Program (SCP) was consulted to find out the required respiratory protection equipment (****).

See Appendix IV.

C. Use and Proper Fitting of Respiratory Protective Equipment

1. *Use of Respiratory Protective Equipment*

Using Appendix VII and information supplied by the manufacturer, show the employee how to put on the selected respirator. Show the various components of the respirator, and how the respirator functions to remove the contaminants.

2. *Proper Fitting*

So that respiratory protective devices, which use tight fitting facepieces, give maximum protection, there must be a proper "match" between the facepiece and your face. A poor face seal can cause contaminants to be inhaled through the respirator sealing surfaces, instead of through the canister, filter, or air supply system. (****)

At this time, you should have available at least two different types (different manufacturers) of selected respiratory equipment — for the employee to try on.

a. In most cases, there are several different brands of the same type of respiratory protection equipment approved for use against a specific hazard or work environment. (****)

NOTES TO INSTRUCTOR

EMPLOYEE TRAINING PROGRAM

Refer to Appendix VIII for discussion of fitting tests. The qualitative fit tests can be used as a quick test to ascertain the proper fit. However, if respirator use will be in an extremely hazardous atmosphere, or for emergencies, the quantitative fit test should be used. Demonstrate how the qualitative fit test works. Show illustration of a quantitative test set-up (if there is not an actual set-up on the premises).

b. However, just because a respirator "feels comfortable" it does not mean that it is protecting you to the fullest extent from the hazard. The key word is *proper* fit. To determine if the fit is proper, several tests can be used. (****)

Consult Appendix VII and the specific respiratory protective equipment — under Limitations.

D. Limitations of Respiratory Equipment (****)

However, the respiratory protective equipment that you will use does have some limitations on its usage.

E. Maintenance and Storage of Respiratory Equipment

To maintain the proper functioning of respirators requires that they be regularly cleaned and disinfected, and stored in a convenient and clear location.

Refer to Section VII(A) for details concerning cleaning of equipment. Several suggested cleaning methods are given. Discuss provisions.

1. Cleaning (****)

Your respiratory protective equipment should be cleaned daily after use. The company has made provisions for doing this. (****)

Refer to Section VII(B) and discuss storage provisions by company.

2. Storage (****)

Equipment must be stored properly at the conclusion of the work shift.

Refer to Section VIII for discussion on inspection for defects.

3. Inspection for Defects (****)

This is one of the most important functions associated with respirator usage. These inspections can identify damage to malfunctioning respiratory protective equipment.

APPENDIX I

MECHANISMS FOR DETERMINATION OF CONCENTRATIONS OF HAZARDOUS SUBSTANCES

Once the hazard has been recognized and the hazardous substance identified, it is necessary to determine the *amount* (concentration) of contaminant present. The company may have qualified individuals in-house to make these measurements; however, if personnel are not availabe, it is best to seek outside assistance (see Appendix V).

A. EVALUATION METHODS

If the company has individuals capable of making determinations of the presence and concentrations of hazardous substances, there are several types of instrumentation available which can measure airborne contaminants. In evaluating a hazard for the purpose of respirator selection, it is usually sufficient to obtain a close estimate of the concentration rather than an *exact* level of the contaminant. This can, in many cases, be accomplished by the use of indicator tubes or direct-reading instruments, as opposed to collection of a sample on a media with subsequent laboratory analysis.

1. Gaseous and Vapor Contaminants

Gaseous contaminants are usually measured in parts per million (ppm) — parts of contaminants *per* million parts of air, or parts of contaminants per billion parts of air (ppb). A common *screening* device used is the detector tube. These tubes are available for many of the gases found in the work environment — from several different manufacturers. If possible, only detector tubes approved by NIOSH for the specific contaminant should be used for determination of gas and vapor concentrations. When using

NOTES TO INSTRUCTOR

Before you discuss this section with the user, you should first prepare the summary — as it applies to your usage.

F. Summary(****)

A summary of those aspects of the proper use of respiratory protective equipment. Reasons for Respiratory Protective Equipment.

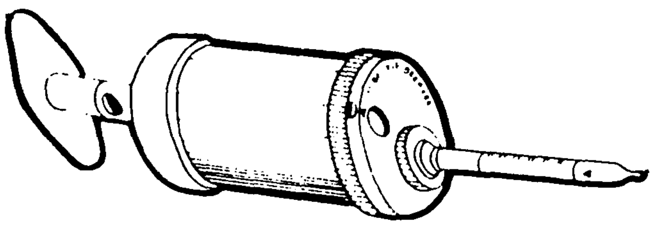
1. Respirator Selection Procedure
- *a.* Identification of hazard.
- *b.* Hazard specifics.
- *c.* Evaluation of the hazard.
- *d.* Selection of the respirator.

2. Proper Fitting and Usage
- *a.* Use.
- *b.* Fitting.

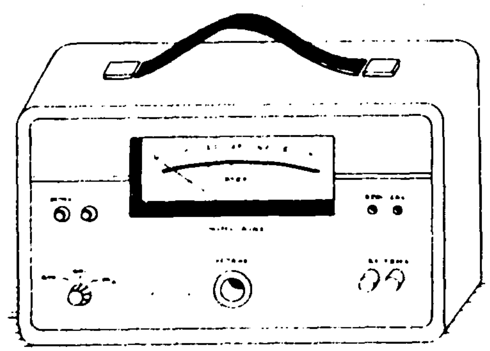
3. Limitations

4. Maintenance and Storage

detector tubes, it is important to remember that the sample taken (into the tube) represents the concentration at a point in time and place and does not necessarily reflect the 8-hour time-weighted average (TWA) 40-hour week upon which the OSHA limits are based. Consequently, several samples at scheduled intervals through the 8-hour workday are recommended. As new detector tubes are approved, the reader can keep up to date by requesting *Cumulative Supplement - NIOSH* Certified Equipment (see Appendix XI). Direct-reading instruments are also available to measure many gases and vapors.



Detection Tube Measurement Equipment



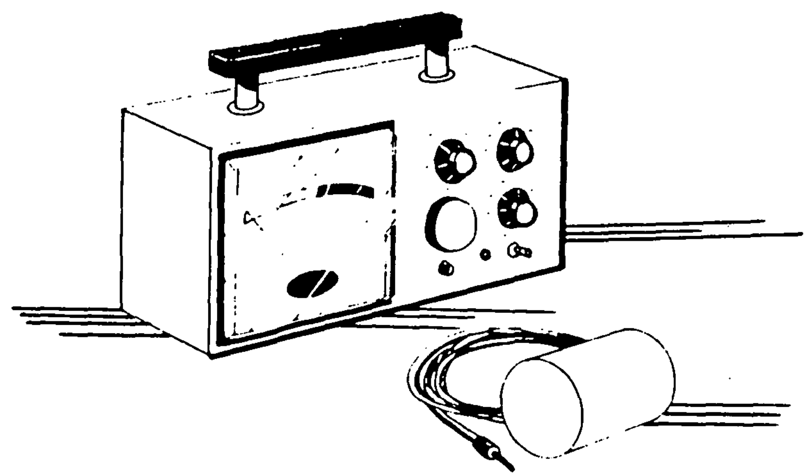
Direct-Reading Instrument for Carbon Monoxide

2. Particulate Contaminants

A majority of regulated particulate contaminants are usually measured in milligrams per cubic meter (mg/m^3) — milligrams of contaminant per cubic meter of air, million particles per cubic foot (mppcf) — millions of particles per cubic feet of air, e.g., 5mppcf would be five million particles per cubic foot of air, or fibers per cubic centimeter (fibers/cc) — fibers of contaminant per cubic centimeter of air. In contrast to the availability of measuring devices for gas and vapor contaminants, few direct-reading instruments are available for measurement of particulates. Those that are available indicate the *total* dust or *respirable dust concentration* and do not distinguish between the various materials making up the total dust concentration. To assess a specific particulate contaminant exposure, other than for nuisance dust, for respirator selection, in many cases it will usually be necessary to collect a sample on a filter with subsequent laboratory analysis.

3. Oxygen Deficient Atmospheres

There are several direct-reading instruments for measurement of oxygen content. One type is shown below:



Oxygen Indicator

B. INTERPRETATION OF MEASUREMENTS

The measured concentration (in appropriate units) is then compared with either the permissible exposure level (PEL), mandated in OSHA regulations, or the threshold limit value (TLV), recommended by the American Conference of Governmental Industrial Hygenists (ACGIH). These values, as determined by these groups, are the maximum concentration to which a worker may be exposed day after day without adverse affects.

APPENDIX II

OXYGEN DEFICIENT ATMOSPHERES

An atmosphere that does not contain enough oxygen to support the body metabolic process is called "oxygen deficient."

A. GENERAL PRINCIPLES

1. Normal Atmosphere

Earth's atmosphere has an essentially fixed composition of the following gases in the dry state.

Gas	*Volume*
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.04

Normal air always contains small amounts of other gases such as neon, helium, and krypton. Water vapor, an important constituent of the normal atmosphere, may be up to 5% of the total volume.

2. Definition of Oxygen Deficient Atmosphere

An accurate description of an oxygen deficient atmosphere (ODA) is important for strictly physiological reasons and also for proper respirator selection. However, no one definition (value) has been universally accepted. The following table is a partial listing of definitions, based primarily on the volume percent (vol. %) of the oxygen in the atmosphere at sea level.

Definitions of Oxygen Deficient Atmosphere

Source	Oxygen Content (vol%)	Conditions for Determination
ACGIH Threshold Limit Values For 1973	18.0	". . . under normal atmosphere pressure . . ."
Federal Regulations 29 CFR Part 1915.81 (Maritime Standards)	16.5	(not specified)
29 CFR Part 1910.94 (Ventilation Standards)	19.5	(not specified)
(Respirator Approval Tests)	19.5	". . . by volume at sea level . . ."
ANSI Standards Z88.2-1969 (Respirator Practices)	16.0	". . . normal air . . ."
Z88.5-1973 (Firefighting)	19.5	". . . where oxygen partial pressure is less than 148 mm Hg at sea level
K13.1-1973 (Marketing of air-purifying canisters and cartridges)	19.5	". . . at sea level . . ."

Note ANSI Standard Z86.1-1972, "Commodity Specification for Air," as revised in October 1974, specified 19.5-23.5 vol% O_2 for all grades of breathing air.

With the "acceptable" oxygen levels ranging from 16-19.5 vol% to choose from, the user's only guide is to follow the guidelines listed in the regulation by which his work is governed.

3. *Effects*

The symptoms of oxygen deficiency depend on the oxygen concentration present. The table below indicates physiological effects for varying oxygen content.

Effects of Oxygen Deficiency

O_2 Vol% At Sea Level	Physiological Effect
16-12	Increased breathing volume. Accelerated heartbeat. Impaired attention and thinking. Impaired coordination.
14-10	Very faulty judgment. Very poor muscular coordination. Muscular exertion causes rapid fatigue that may cause permanent heart damage. Intermittent respiration.
10-6	Nausea. Vomiting. Inability to perform vigorous movement, or loss of all movement. Unconsciousness, followed by death.
Less than 6	Spasmatic breathing. Convulsive movements. Death in minutes.

It is difficult to visualize the effect of ODA. The individual is not aware of the nature of his situation. Gradual depression of the central nervous system affects powers of discrimination, logic, and auditory acuity, with muscular weakness and lack of coordination. Since no distressful sensations are produced, the entire experience is comfortable and even pleasant. In reality, however, breathing in an ODA is like breathing under water.

APPENDIX III

RESPIRATOR REQUIREMENTS AS REQUIRED BY SPECIFIC OSHA STANDARDS

Several standards promulgated by OSHA require the use of a specific respirator type:

A. Abrasive Blasting
1. 1910.94 (a) (5-6)
(d) (iv)

B. Spray Finishing
1. 1910.94 (c) (6) (iii)

C. Open Surface Tanks
1. 1910.94 (d) (a) (vi)
(d) (11) (v)
(d) (11) (vi)

D. Storage and Handling of Anhydrous Ammonia
1. 1910.111 (b) (10) (ii)

E. Welding, Cutting, and Brazing
1. 1910.252 (f) (1)
(f) (4)
(f) (5-10)

F. Pulp, Paper, and Paperboard Mills
1. 1910.261 (b) (2) (g) (10)
(d) (1) (i) (g) (11) (ii)
(f) (6) (iii) (g) (15) (ii)
(g) (2) (g) (15) (v)
(g) (4) (h) (2) (iii-iv)
(g) (6) (ii-iii)

G. Textiles
1. 1910.262 (qq) (1-2)

H. Sawmills
1. 1910.265 (c) (17) (ii-iii)

I. Pulpwood Logging
1. 1910.266 (c) (1) (v)

J. Asbestos
1. 1910.1001 (d) (1-2)

K. Cotton Dust
1. 1910.1043 (f) (2)
2. 1910.1046 (d)

L. Carcinogens
1. 1910.1003-1016 (c) (4) (iv)
(c) (5) (i)
(c) (6) (vii) (a)
2. 1910.1017 (g) (4)
3. 1910.1029 (g) (2)

M. General Respirator Requirements
1. 1910.134

NOTE: Any of the above specific requirements may be modified or deleted by OSHA in response to the legislative process. Additions to the list are also possible. The reader can find out the status of the above requirements by contacting the nearest OSHA regional office.

APPENDIX IV

RESPIRATOR REQUIREMENTS AS SUGGESTED BY THE STANDARDS COMPLETION PROGRAM AND NIOSH CRITERIA DOCUMENTS

The Standards Completion Program (SCP), a joint OSHA/NIOSH venture undertaken to provide additional information (toxicity, handling requirements, sampling collection and analysis, fire data, etc.) for all presently regulated substances contained in OSHA Standards, has also determined respiratory protection "requirements"* for these substances. NIOSH Criteria Documents, which are transmitted to OSHA as recommended standards, also contain respiratory protection "requirements"† for the substance in question.

Respiratory protective equipment requirements under the SCP may be obtained by contacting the nearest OSHA regional office (see Appendix V).

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*The SCP information has not been promulgated into law and so respirator requirements, at this time, are not *required*.

†NIOSH Criteria Documents are *recommended* standards, and do not carry legal status.

APPENDIX V

SOURCES OF ASSISTANCE

Outside assistance may be required to determine the present OSHA standard for a substance, the protective equipment requirements suggested under the SCP, or the requirements recommended by NIOSH Criteria Documents. In addition, if in-house qualified personnel are not available, outside assistance will be necessary to determine the extent of employee exposure to hazardous substance.

Depending upon the employee's specific needs, several sources for such information or services are available: (a) Occupational Safety and Health Administration (OSHA-DOL); (b) National Institute for Occupational Safety and Health (NIOSH-DHEW); (c) State Occupational Safety and Health Programs; and (d) private consultants.

The following code system indicates which information or services can be obtained from a particular source:

CODE	INFORMATION
#1	OSHA Standards
#2	SCP Requirements
#3	Criteria Document Recommendation
#4	Consultative Services

A. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
Information/Services Available: #1, #2

Persons may call the nearest OSHA regional office to obtain respiratory protective information. (This will not result in a citation or inspection.) Federal OSHA personnel cannot make on-site consultative visits; however, Federal OSHA has contracted with several educational institutions to perform on-site consultative services — without citation. Contact the OSHA regional office for information concerning these services.

OSHA REGIONAL OFFICES

Region I
U.S. Department of Labor
Occupational Safety and Health Administration
JFK Building, Room 1804
Boston, Massachusetts 02203 — Telephone: 617/223-6712/3

Region II
U.S. Department of Labor
Occupational Safety and Health Administration
1515 Broadway (1 Astor Plaza) Room 3445
New York, New York 10036 — Telephone: 212/971-5941/2

Region III
U.S. Department of Labor
Occupational Safety and Health Administration
15220 Gateway Center 3535 Market Street
Philadelphia, Pennsylvania 19104 — Telephone: 215/596-1201

Region IV
U.S. Department of Labor
Occupational Safety and Health Administration
1375 Peachtree Street N.E. Suite 587
Atlanta, Georgia 30309 — Telephone: 404/526-3573/4 or 2281/2

Region V
U.S. Department of Labor
Occupational Safety and Health Administration
230 S. Dearborn 32nd Floor
Chicago, Illinois 60604 — Telephone: 312/353-4716/7

Region VI
U.S. Department of Labor
Occupational Safety and Health Administration
555 Griffin Square Building Room 602
Dallas, Texas 75202 — Telephone: 214/749-2477/8/9 or 2567

Region VII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building Room 3000 911 Walnut Street
Kansas City, Missouri 64106 — Telephone: 816/374-5861

Region VIII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building Room 15010 1961 Stout Street
Denver, Colorado 80202 — Telephone: 303/837-3883

Region IX
U.S. Department of Labor
Occupational Safety and Health Administration
9470 Federal Building 450 Golden Gate Avenue
Post Office Box 36017
San Francisco, California 94102 — Telephone: 415/556-0584

Region X
U.S. Department of Labor
Occupational Safety and Health Administration
6048 Federal Office Building 909 First Avenue
Seattle, Washington 98174 — Telephone: 206/442-5930

B. NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Information/Services Available: #3

Persons may contact NIOSH regional offices to obtain technical information about respiratory protective equipment.

NIOSH REGIONAL OFFICES

DHEW, Region I
JFK Federal Bldg.
Room 1401
Boston, Massachusetts 02203
617/223-6668

DHEW, Region II
26 Federal Plaza, Room 3300
New York, New York 10007
212/264-2485

DHEW, Region III
P. O. Box 13716
Philadelphia, PA 19101
215/596-6716

DHEW, Region IV
101 Marietta Tower
Atlanta, GA 30323
404/221-2396

DHEW, Region V
300 South Wacker Dr.
33rd Floor
Chicago, IL 60606
312/886-3651

DHEW, Region VI
1200 Main Tower Bldg.
Dallas, Texas 75202
214/655-3081

DHEW, Region VII
601 E. 12th St.
5th Floor West
Kansas City, Missouri 64106
816/374-5332

DHEW, Region VIII
11037 Federal Bldg.
Denver, Colorado 80294
303/837-3979

DHEW, Region IX
50 United Nation Plaza, Rm. 231
San Francisco, CA 94102
415/556-3781

DHEW, Region X
1321 Second Ave., Mail Stop 502
Seattle, Washington 98101
206/442-0530

C. STATE OCCUPATIONAL SAFETY AND HEALTH PROGRAMS
Information/Services Available: #1, #4.

Employers who are interested in the following services but do not know which state agency provides which service, should contact the nearest OSHA or NIOSH regional office for information.

1. State with Approved OSHA Plan

Presently, all states which have an approved OSHA plan, except Utah, have a consultative service program. This program, which is separate from the compliance program, provides on-site consultation to *employers* requesting assistance. Such consultations will not result in a citation or penalty.

2. States under Agreement with OSHA to Provide Consultative Service

Several states that do not have an OSHA plan have elected to enter into an agreement with OSHA to provide consultation. This program, conducted by an agency designated by the governor of each state, provides on-site consultation to employers requesting assistance. Such consultations will not result in a citation or penalty.

D. PRIVATE CONSULTATIVE SERVICES Information/Service Available: #4

A list of consultants can be obtained by writing the American Industrial Hygiene Associates; 475 Wolf Ledges Parkway; Akron, Ohio 44311.

APPENDIX VI

MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

A. GENERAL INFORMATION

So that the examining physician can render a qualified opinion regarding respirator usage by an employee, the physician, initially, should obtain from the employer the following information.

- Type of respiratory protection equipment to be used, and its modes of operation;
- The tasks that the employer will perform while wearing the respirator;
- Estimation of the energy requirements of the task (see Table 1);
- Visual and audio requirements associated with the task;
- Length of time that the user will wear the respiratory protective equipment; and
- The substance(s) to which the employee will be exposed, and the related toxicity data.

B. MEDICAL TESTS

The following medical tests might be considered by the examining physician in his/her evaluation:

- Pulmonary function test;
  - —FVC
  - —FEV_1
- Chest X-ray;
- Electrocardiogram;

- Blood tests;
- Eye test;
- Hearing test;
- Observation of the fit of the respirator on the employee; and
- Medical tests specific to the substance to which the employee will be exposed.

TABLE 1

Some Selected Types of Work Classed According to Estimated Workload Level*

Workload	*Energy expenditure range*
Level 1 — Resting	100 kcal/hr or less
Level 2 — Light	101 to 200 kcal/hr
Sitting at ease: light hand work (writing, typing, drafting, sewing, bookkeeping); hand and arm work (small bench tools, inspecting, assembly or sorting of light materials); arm and leg work (driving car under average conditions, operating foot switch or pedal). *Standing:* drill press (small parts); milling machine (small parts); coil taping; small armature winding; machining with light power tools; casual walking (up to 2 mph).	
Level 3 — Moderate	201 to 300 kcal/hr
Hand and arm work (nailing, filing); arm and leg work (off road operation of trucks, tractors or construction equipment); arm and truck work (air hammer operation, tractor assembly, plastering, intermittent handling of moderately heavy materials, weeding, hoeing, picking fruits or vegetables); pushing or pulling light-weight carts or wheelbarrows; walking 2-3 mph.	
Level 4 — Heavy	Above 301 kcal/hr
Heavy arm and truck work; transferring heavy materials; shoveling; sledge hammer work; sawing, planing or chiseling hardwood; hand mowing, digging, ax work; climbing stairs or ramps; jogging, running, walking faster than 4 mph; pushing or pulling heavily loaded hand carts or wheelbarrows; chipping castings; concrete block laying.	

*For accurate determination of a worker's energy expenditure on the job by measuring oxygen uptake of the man, refer to "Ergonomics Guides," *American Industrial Hygiene Association Journal*, 32 (8): Aug. 1971, p. 560-564.

C. MEDICAL FACTORS

Some factors to be considered by the examing physician in determining the prospective user's ability to wear a respirator are:

- Emphysema — individual may be unable to breathe adequately against the additional resistance of a respirator;
- Asthma — if the user suffers an asthma attack he would be likely to remove the respirator because of being unable to breath properly;
- Chronic bronchitis;
- Heart disease;
- Anemia;
- Hemophilia;
- Poor eyesight;
- Poor hearing;
- Hernia — can be aggravated by wearing/carrying respiratory protective equipment (SCBA);
- Lack of use of fingers or hands — respirators such as gas masks, supplied-air respirators, and self-contained breathing apparatus require connection and disconnection of parts and manipulation of valves and fittings during use. Persons with missing or disabled fingers may have difficulty in using these devices, particularly in an emergency where there is no one present to assist them; and
- Epileptic seizures.

D. EMOTIONAL/MENTAL FACTORS

Mental factors must also be taken into consideration when employees are required to wear respirators. Some individuals become claustrophobic when wearing a respirator. These individuals should not be required to wear respirators if the condition is severe enough to cause panic.

E. OTHER FACTORS

Scars, hollow temples, very prominent cheekbones, deep skin creases, and lack of teeth or dentures may cause respirator facepiece sealing problems. Dentures or missing teeth may cause problems in sealing a mouthpiece in a person's mouth. Full dentures should be retained when wearing a respirator, but partial dentures may or may not have to be removed, depending upon the possibility of swallowing them. With full lower dentures, problems in fitting quarter-masks can be expected, as the lower part of the mask tends to unseat the denture.

APPENDIX VII

RESPIRATORY PROTECTIVE EQUIPMENT

I. AIR-PURIFYING — PARTICULATE REMOVING FILTER RESPIRATORS

A. Description

These are generally called "dust," "mist," or "fume" respirators, and by a "filtering" action remove particulates before they can be inhaled.

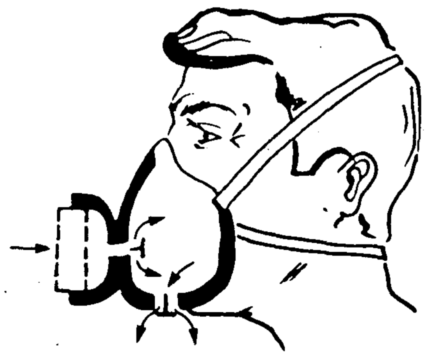
1. Single-use, dust

Single-Use Respirator

The single-use respirator is a respirator which is completely disposed of after use. They are for individual use and should be discarded when resistance becomes excessive or the respirator is damaged. Generally, these respirators are approved only for pneumoconiosis or fibrosis producing dust such as coal dust, silica dust, and asbestos.

2. *Quarter-mask dust and mist, half-mask dust and mist*

The quarter-mask covers the mouth and nose; the half-mask fits over the nose and *under the chin.* The half-mask usually produces a better facepiece to face seal than does the quarter-mask and is therefore preferred for use against more toxic materials. Dust and mist respirators are designed for protection against dusts and mists whose TLV is greater than .05mg/M^3 or 2 mppcf.



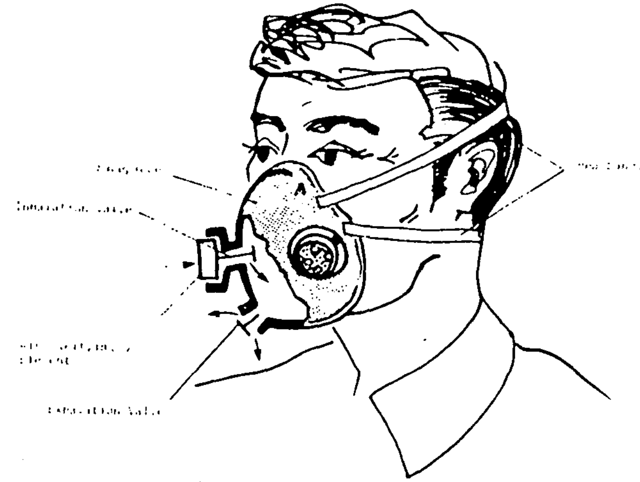
Quarter-mask Respirator

3. *Quarter-mask fume; half-mask fume*

These masks, similar to those in 2 above, utilize a filter element which can remove metal *fumes* in addition to dusts and mists from the inhaled air. The filters are approved for metal fumes having a TLV *above* .05mg/M^3 or 2 mppcf.

4. *Half-mask, high efficiency*

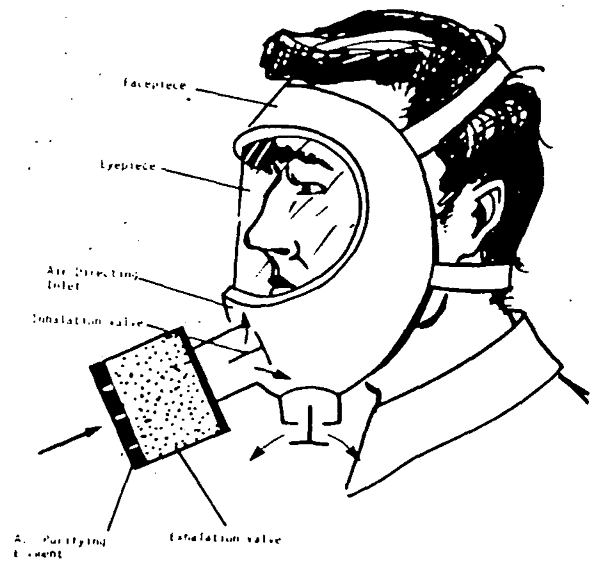
These masks are the same as in 2 and 3, above, but use a high efficiency filter. Because of this high efficiency filter, they can be used against dusts, mists, fumes and combinations of those whose TLV is *less* than .05mg/M^3 or 2 mppcf.



Half-mask Respirator

5. *Full facepiece*

Full facepiece respirators cover the face from the hairline to below the chin. In addition to providing more protection to the face, the full facepiece gives a better seal than do the half- or quarter-masks. These respirators provide protection against dusts, mists, fumes, or any combination of these contaminants depending upon the type of filter used.



Full Facepiece Respirator

6. Powered dust, mist, and fume respirators

These respirators use a blower that passes the contaminated air through the cartridge or canister where the contaminant is removed and passes the purified air into the facepiece. The air purifying element can be a filter to remove particulates, a cartridge or canister to remove gases or vapors, or a combination to remove both. The face covering can be a half-mask, full-face mask, or hood or helmet.

Powered Air-Purifying Respirator — Front View

The advantage to using a powered air-purifying respirator is that it supplies air at a positive pressure within the facepiece, hood, or helmet, so that any leakage is outward. The protection provided depends on the air-purifying element and the type and concentration of the contaminants.

Powered respirators must deliver at least 4 cubic feet per minute (cfm) to a tight fitting facepiece such as a mask and at least 7 cfm to a loose fitting helmet or hood. If the powered respirator is battery operated, it should provide the airflows mentioned for at least 4 hours without having to recharge the battery.

Powered Air-Purifying Respirator — Back View

B. Approvals

NIOSH approves air-purifying and powered air-purifying particulate removing respirators to protect the wearer against one or more of the following hazards:

- Dust exposure, where the OSHA allowable daily exposure for the dust is not less than 0.05mg/M³;

• Mist exposure, where the OSHA allowable daily exposure for the mist is not less than 0.05 mg/M^3 or 2 mppcf;

• Metal fume exposure, where the OSHA allowable daily exposure for the fume is not less than 0.05 mg/M^3;

• Dust, fume and mist exposure, where the OSHA allowable daily exposure for the dust, fume, or mist is less than 0.05 mg/M^3;

• Exposure to radon daughters (radioactive material) and radon daughters attached to dusts, fumes, and mist;

• Exposure to asbestos containing dusts or mists; and

• Exposure to dusts or mists which cause the formation of scar tissue in the lungs (pneumoconiosis and fibrosis producing).

NOTE: No approved dust, fume, or mist respirator can be worn with the "facelets" or other cloth or plastic cover between the facepiece and face. These covers introduce excessive leakage, and also negate the approval.

C. Limitations

1. Air-purifying respirators do *not* provide oxygen, so they must *never be worn in oxygen deficient atmospheres.*

2. Particulate removing air-purifying respirators offer *no* protection against atmospheres containing contaminant gases or vapors.

3. These respirator types should not be used for abrasive blasting operations.

D. Problems

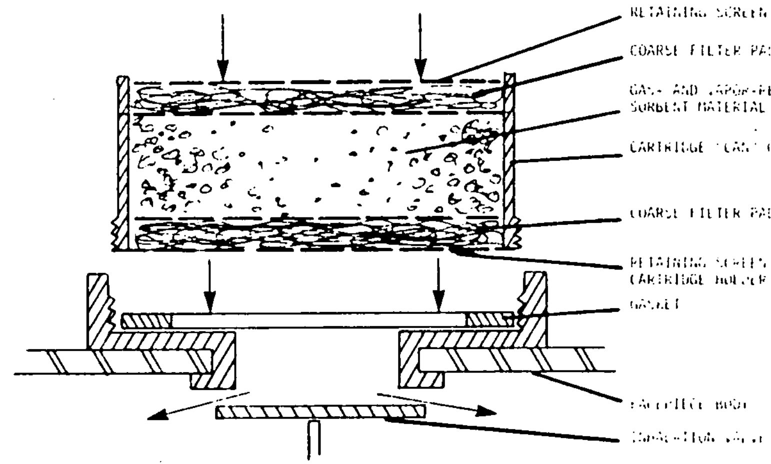
1. The air flow resistance of a particulate-removing respirator filter element increases as the quantity of particles it retains increases, thus increasing the breathing resistance. *As a rule of thumb,* when comfortable breathing is impaired because of dust build-up, the filter should be replaced.

2. Performance of some filter materials is affected by open storage in very humid atmospheres. Care should be taken in storing filter elements.

II. AIR-PURIFYING — CHEMICAL CARTRIDGE AND CANISTER RESPIRATORS, GAS AND VAPORS

A. Description

Vapor and gas-removing respirators use cartridges or canisters containing chemicals to trap or react with specific vapors and gases and remove them from the air breathed. The basic difference between a cartridge and a canister is the volume of the sorbent. Generally, a "cartridge" refers to a chemical filtering element which attaches directly to the facepiece, whereas a "canister" refers to the chemical filter element held in a harness and which is connected to the facepiece via a corrugated breathing tube. Some typical cartridge and canister respirators are discussed below.



Typical Chemical Cartridge

1. Half-mask and quarter-mask respirators

These are available for protection against single chemicals such as ammonia or against entire classes such as organic vapors. Be sure to read the label on the cartridge or canister since it tells what the cartridge or canister protects against, what the maximum concentration in which the element can be used, and in some instances, the service life or expiration date of the element.

2. Full facepiece

The full facepiece respirator may use a canister or cartridge(s) as the protective element. The front, back, and chin-mounted full-facepiece canister respirators are also referred to as "gas masks."

B. Approvals

NIOSH approves chemical cartridge or canister respirators to protect the wearer against many of the organic vapors, acid gases, and gaseous contaminants encountered in the work environment. Consult with a manufacturer or distributor of respiratory protective equipment to determine what type of cartridge or canister is appropriate for the contaminant and concentration.

C. Limitations — Chemical Cartridge or Canister

1. These respirators do not supply oxygen, so they must *never be worn in oxygen deficient atmospheres.*
2. They must not be used if the chemical to be protected against lacks adequate warning properties — odor, taste, or irritation, unless their use is permitted by applicable OSHA or MHSA standards. Warnings such as these are necessary to alert you that the sorbent is saturated, and the contaminant is passing through the cartridge or canister, and you are breathing contaminated air.
3. They must not be used in atmospheres immediately dangerous to life or health, except for escape.
4. They provide protection only from the specific gases or vapors they were designed to protect against (they may be worthless for other gases or vapors).

III. ATMOSPHERE SUPPLYING RESPIRATORS — SUPPLIED-AIR

Atmosphere supplying respirators, rather than removing the hazardous material from the air, exclude the workplace air altogether and provide clean air from an independent source. There

are two kinds of atmosphere supplying respirators: a *supplied-air respirator* in which the user is supplied with respirable air through a hose, and a *self-contained respirator* in which the user carries a supply of respirable air.

A. Description — Supplied-air Respirator

Supplied-air respirators use a central source of breathing air that is delivered to the wearer through an air supply line or hose. There are essentially two major groups of supplied-air respirators — the airline device and the hose mask with or without a blower.

1. Airline Devices

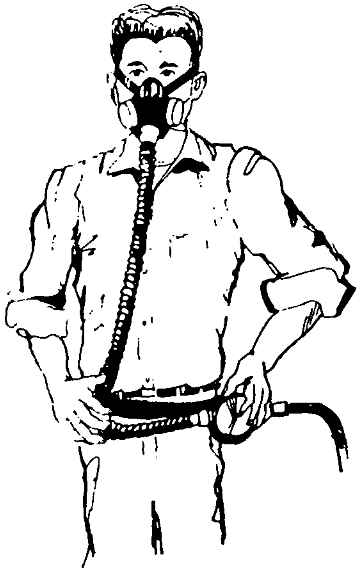
The distinction of airline devices is that they use a stationary source of compressed air delivered through a high-pressure hose. Airline devices can be equipped with half- or full-face masks, helmets, or hoods, or the device can come as a complete suit. Airline respirators can be used for protection against either particulates, gases, or vapors. They provide a high degree of protection against these contaminants but they *cannot be used in atmospheres immediately dangerous to life or health* because the user is completely dependent on the integrity of the air supply hose and the air source. If something happens to either the hose or air supply, he cannot escape from the contaminated area without endangering his life.

A great advantage of the airline respirator is that it can be used for long continuous periods. There are three types of airline respirators.

a. Demand Airline Device

In a demand device, the air enters the facepiece only on "demand" of the wearer, i.e., when the person inhales. This is due to the nature of the valve and pressure regulator. An example of a demand, half-mask airline device is shown below.

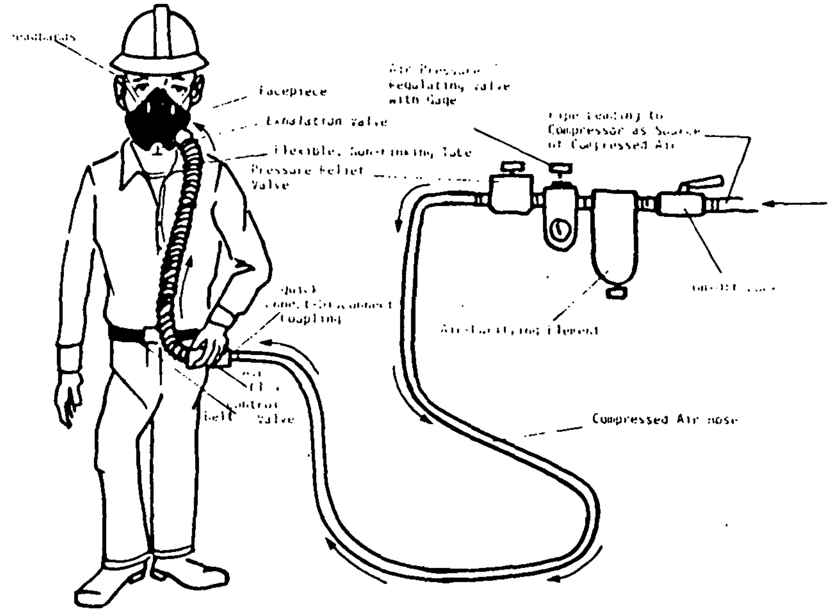
During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air may enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Demand devices are also available with a full-face mask, which provides a better seal than does the half-mask.



b. Pressure Demand Airline Devices
The pressure demand device has a regulator and valve design such that there is a continuous flow (until a fixed static pressure is attained) of air into the facepiece at all times, regardless of the "demand" of the user. The airflow into the mask creates a positive pressure outward. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of this type of device.

c. Continuous-flow Airline Device
The continuous-flow airline respirator maintains a constant airflow at all times and doesn't use a regulator, but uses an airflow control valve or orifice which regulates the flow of air. A continuous-flow full facepiece device is shown below.

The continuous-flow device creates a "positive" pressure in the facepiece, and as a result, does not have the problem of inward leakage of contaminant.



A special type of continuous-flow device that provides protection against flying particles of abrasive materials is also available. The abrasive blasting airline respirator, shown below incorporates a *loose fitting* facepiece.

d. Air Supply System

Supply air sources (compress or tanks) for the above respirator types must meet the following requirements.

i. The air compressor must be located where contaminated air cannot enter the system.

ii. The air receiver must be of sufficient capacity to enable the wearer to escape in the event of compressor failure.

iii. Alarms indicating compressor failure and overheating must be installed into the system.

iv. If the compressor is oil-lubricated it must have a high temperature and/or carbon monoxide (CO) alarm. If there is no CO alarm, frequent carbon monoxide tests of the air must be made to insure that the CO level does not exceed 20 parts per million.

v. All airline couplings must be incompatible with outlets for other gas systems.

vi. Breathing air quality must meet the requirements of Grade D breathing air as described by the Compressed Gas Association. Grade D requirements are:

- *The oxygen content of the compressed air should be between 19.5-23.5% oxygen and the rest mainly nitrogen;*
- *Hydrocarbon concentrations must not exceed 5 parts per million;*
- *Carbon monoxide concentration must not exceed 20 parts per million;*
- *Carbon dioxide concentrations must not exceed 1000 parts per million; and*
- *There must not be any pronounced odor present.*

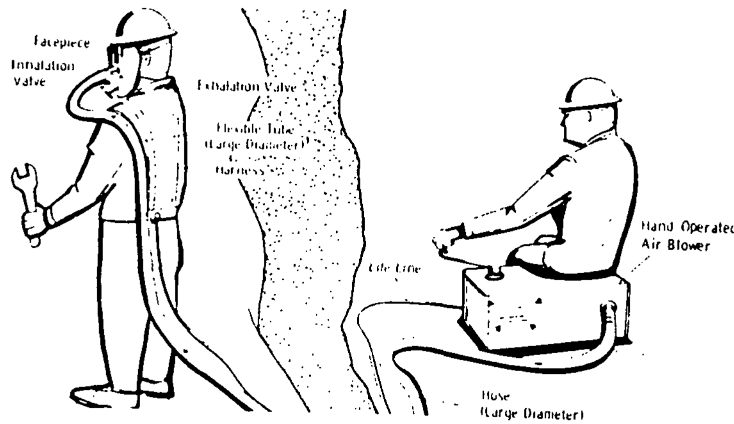
2. Hose Masks

Hose masks supply air from an uncontaminated source through a strong, large diameter hose to the facepiece, and do *not* use compressed air or have any pressure regulating devices. (An advantage of the hose mask *with* a blower is its minimal resistance to breathing.) Advantages of the hose mask *without* a blower are its theoretically long use periods and its simple construction, low bulk, easy maintenance, low initial cost, and minimal operating cost. Two types are available:

a. Those masks with hand or motor operated air blowers have a full facepiece mask. The hose length can be up to 300 feet. It

must not be used at atmospheres immediately dangerous to life or health.

b. Hose masks without blowers must have a *tight fitting* full facepiece. Helmets and hoods cannot be used. The hose mask without a blower can have up to 75 feet of hose.



Hose Mask Respirator with Hand-operated Blower

Air Line Continuous Flow Respirator with Full Facepiece

B. Approvals

1. Airline Devices
Airline supplied air respirators are approved for use at a *specific air pressure* (at the point of attachment of the air-supply hose to the air-supply system) and a specific *range of air supply hose length.* For example, a supplied air respirator might be approved for use with compressed air at pressures from 40-80 pounds per square inch *and* with air-supply hose length of between 15 and 250 feet. Approvals are not made for specific contaminants.
2. Hose Mask Devices
An approved hose mask *with* a blower may have up to 300 feet of air supply hose in multiples of 25 feet, but one *without* a blower may have only up to 75 feet in multiples of 25 feet. The hand- or motor-operated blower must deliver at least 50 liters per minute (lpm) of air through the maximum length of hose.

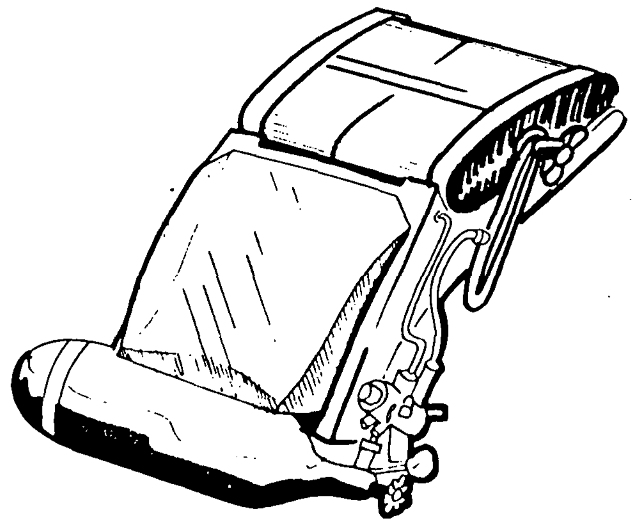
C. Limitations

1. Airline Devices
a. These devices *must not* be used in atmospheres immediately dangerous to life or health since the user is dependent upon an air hose which, if cut, crushed, or damaged, leaves him with little or no protection.
b. The trailing air supply hose of the airline respirator severely restricts the wearer's mobility. This may make the airline respirator unsuitable for those who must move frequently between widely separated work stations.
2. Hose Mask
a. The hose mask with a blower cannot be used in atmospheres immediately dangerous to life or health because the low air volume flow may result in a negative pressure being produced in the mask during inhalation allowing contaminated air to leak into the mask. Also, if the air hose is cut or obstructed, the user will be unprotected.
b. The trailing air supply hose of the hose mask severely limits mobility, so it may be unsuitable if frequent movement among separated work stations is required.
c. A severe restriction of the hose mask *without a blower* is that it is limited to a maximum hose length of 75 feet. Also, it

requires the wearer to inhale against the resistance to air flow offered by the air hose which may become significant during heavy work. Inhaling against this resistance may cause fatigue.

IV. ATMOSPHERE SUPPLYING RESPIRATORS — SELF-CONTAINED BREATHING APPARATUS (SCBA)

The self-contained breathing apparatus (SCBA) allows the user to carry a respirable breathing supply with him/her, and does not need a stationary air source such as a compressor to provide breathable air. The air supply may last from 3 minutes to 4 hours depending on the nature of the device.



Self-contained Breathing Apparatus (SCBA)

A. Description — SCBA

1. Closed Circuit SCBA
Another name for closed circuit SCBA is "rebreathing" device. The air is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a com-

pressed oxygen source or an oxygen-generating solid. These devices are designed primarily for 1-4 hour use in toxic atmospheres. Because negative pressure is created in the facepiece during inhalation, there is increased leakage potential. Therefore, the devices should be used in atmospheres immediately hazardous to life and health only when their long-term use is necessary, as in mine rescue. Two types of closed circuit SCBA are available.

a. Compressed Oxygen Cylinder Type

In this device, breathable air is supplied from an inflatable bag. Exhaled air from the wearer is filtered to remove carbon dioxide and the oxygen consumed is replenished from an oxygen cylinder.

b. Oxygen-generating Type

This type of closed circuit SCBA uses an oxygen-generating solid which, when mixed with water vapor and carbon dioxide in the exhaled breath, or when burned (a chlorate candle), releases oxygen. The oxygen then passes to the inflatable bag. This closed circuit apparatus is lighter, simpler, and cheaper than the cylinder type. However, it is useful for only about 1 hour and, once initiated, cannot be turned off.

Oxygen-generating SCBA (closed circuit)

2. Open Circuit SCBA

An open circuit SCBA exhausts the exhaled air to the atmosphere instead of recirculating it. A tank of compressed air carried on the back supplies air via a regulator to the facepiece. Because there is no recirculation of air, the service life of the open circuit SCBA is shorter than a closed circuit system. Two types of open circuit SCBA are available, "demand" or "pressure demand."

a. Demand SCBA

In a demand SCBA, air flows into the facepiece only on "demand of the wearer," i.e., when the person inhales. This is due to the nature of the valves and pressure regulator. An example of a demand open circuit is show below. During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air can enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Because of this problem, a demand type open circuit SCBA should not be used in atmospheres immediately dangerous to life or health.

b. Pressure Demand SCBA

The pressure demand open circuit SCBA has a regulator and valve design which maintains a positive pressure in the facepiece at all times regardless of the "demand" of the user. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of the pressure demand device. A pressure demand SCBA is identical in appearance to a demand SCBA, but has a different regulator assembly and facepiece exhalation valve design.

3. Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

Designed primarily as a long duration device, this respirator combines an airline respirator with an auxiliary air supply (usually compressed air) to protect against the possible failure of the primary air supply (the airline). The additional supply can be approved for 15 minutes or even longer. The choice depends upon how long it would take to escape from the toxic atmosphere if the primary air supply failed.

B. Approvals — All SCBA's

Because they provide a respirable breathing supply, all SCBA's (closed circuit, open circuit) may be used in *oxygen deficient at-*

mospheres as well as against *particulates, vapors, and gases.* However, *approvals* for SCBA's are based on: (1) entering into and escaping from; (2) escape only, from a hazardous atmosphere (oxygen deficient or contaminated), and (3) the work setting. If you have to use an SCBA, check the approval label to ascertain the conditions of use.

Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

C. Limitations

1. The air supply is limited to the amount in the cylinder (SCBA's using a compressed air tank) and therefore the respirator cannot be used for extended periods without recharging or replacing the cylinders.
2. Because these respirators are bulky and heavy, they are often unsuitable for strenuous work or use in confined spaces.
3. Because of the *short* service time of the auxiliary air supply, the escape portion of the combination unit can be used only for escape from atmospheres immediately hazardous to life or

health unless the escape portion has a minimum of 15 minutes service life. Such devices can then be used for entry in IDLH atmospheres provided not more than 20% of the available breathing supply is used. These devices may always be used for entry into IDLH atmospheres when utilized with the external air supply.

APPENDIX VIII

RESPIRATOR FIT TESTS

The proper fitting of respiratory protective equipment requires the use of some type of fit test. The fit test is needed to determine a proper match between the facepiece of the respirator and face of the wearer.

A. TEST ATMOSPHERES

Regulations require that the user be allowed to test the facepiece to face seal of the respirator and wear it in a test atmosphere. The test atmosphere amounts to an enclosure in which 1) the user can enter with the equipment on, and 2) a "test" contaminant (of low toxicity) can be placed. While elaborate enclosures are available commercially, the employer can put together a "do it yourself" qualitative fit test enclosure by the use of a plastic bag (a dry cleaning bag), several hangers, and some cotton. Figure 3 shows this enclosure scheme.

B. TEST METHODS

There are two types of tests: qualitative tests and quantitative tests. The use of one or both types of tests depends on, among other considerations, the severity and extent of the respiratory hazard, and the size of the company. During any fitting test, the respirator headstraps must be as comfortable as possible. Tightening the straps will sometimes reduce facepiece leakage, but the wearer may be unable to tolerate the respirator for any length of time.

TEST ENCLOSURE

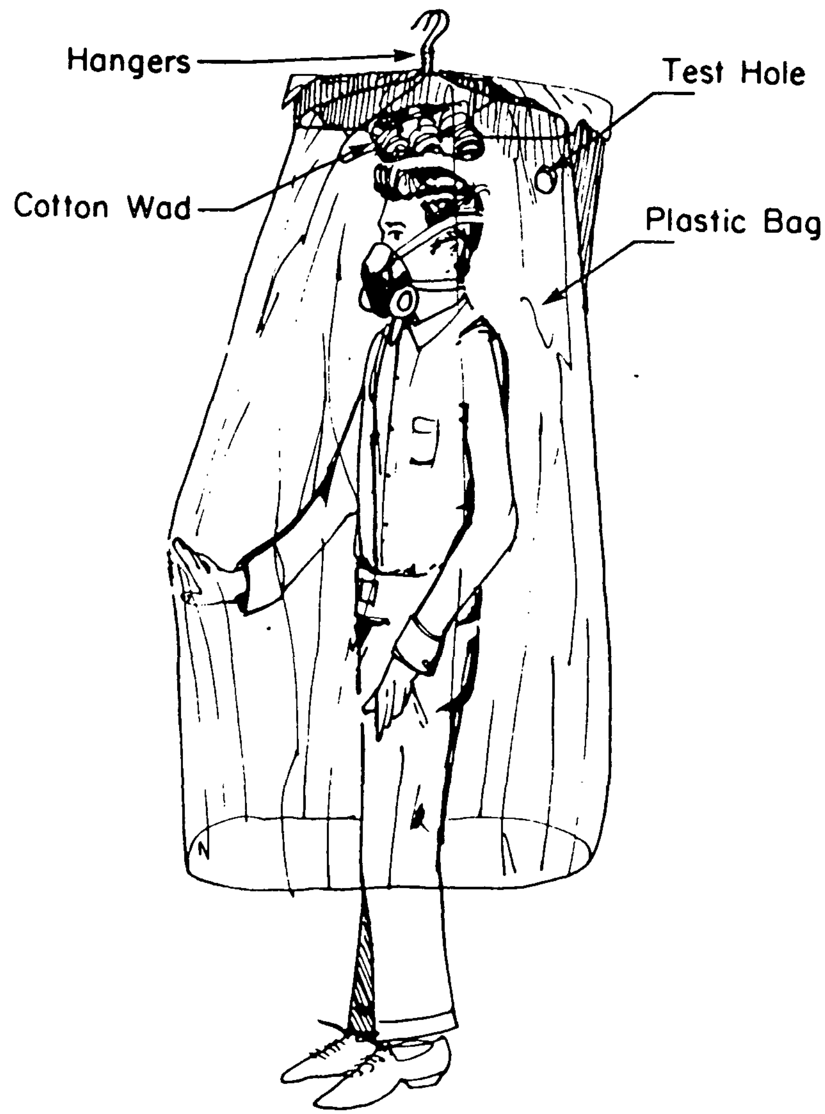


Figure 3

1. Qualitative Tests

Qualitative tests are fast, require no complicated expensive equipment, and are easily performed. However, these tests rely on the wearer's subjective response, and so are not entirely reliable. There are two major qualitative tests:

a. Isoamyl Acetate Test

Isoamyl acetate, a low toxicity substance with a banana like odor, is used widely in testing the facepiece fit *organic vapor* cartridge/canister respirators. The substance is applied to the cotton wad inside the enclosure (see Figure 3). The perspective user should put on the respiratory protection equipment in an area away from the test enclosure so that there is no prior contamination of the cartridges on "pre-exposure" to the isoamyl acetate. The user should perform the following:

- Normal breathing.
- Deep breathing, as during heavy exertion. This should not be done long enough to cause hyperventilation.
- Side-to-side and up-and-down head movements. These movements should be exaggerated, but should approximate those that take place on the job.
- Talking. This is most easily accomplished by reading a prepared text loudly enough to be understood by someone standing nearby.
- Other exercises may be added depending upon the situation. For example, if the wearer is going to spend a significant part of his time bent over at some task, it may be desirable to include an exercise approximating this bending.

The major drawback of the iosamyl acetate test is that the odor threshold varies widely among individuals. Furthermore, the sense of smell is easily dulled and may deteriorate during the test so that the wearer can detect only high vapor concentrations. Another disadvantage is that isoamyl acetate smells pleasant, even in high concentrations. Therefore, a wearer may say that the respirator fits although it has a large leak. This is usually because the wearer likes the fit of the particular respirator or is following the respirator selection of someone else. Conversely, a wearer may claim that a particular respirator leaks if it is uncomfortable, etc. Therefore, unless the worker is highly motivated toward wearing respirators, the results of this test must sometimes be suspect.

b. Irritant Smoke Test

The irritant smoke test, similar to the isoamyl acetate test in concept, is used widely in testing the facepiece fit of *particular filter* respirators. This test can be used for both air-purifying and atmosphere-supplying respirators, *but an air-purifying respirator must have a high-efficiency filter(s).* The test substance is an irritant (stannic chloride or titanium tetrachloride) which is available commercially in sealed glass tubes. When the tube ends are broken and air passed through them (usually with a squeeze bulb), a dense irritating smoke is emitted. In this test, the user steps into the test enclosure and the irritant smoke is "sprayed" into the test hole. If the user detects any of the irritant smoke, it means a defective fit, and adjustments or replacement of the respirator is required. *The irritant smoke test must be performed with caution because the aerosol is highly irritating to the eyes, skin, and mucous membrane.* As a qualitative means of determining respirator fit, this test has a distinct advantage in that the wearer usually reacts involuntarily to leakage by coughing or sneezing. The likelihood of giving a false indication of proper fit is reduced.

Irritant Smoke Test

c. Negative Pressure Test

This test (and the positive pressure test) should be used only as a very gross determination of fit. The wearer should use this test just before entering the hazardous atmosphere. In this test, the user closes off the inlet of the canister, cartridge(s), or filter(s) by covering with the palm(s) or squeezing the breathing tube so that it does not pass air; *inhales* gently so that the facepiece collapses slightly; and holds breath for about 10 seconds.

If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator is probably tight enough. This test, of course, can only be used on respirators with tight-fitting facepieces.

Although this test is simple, it has severe drawbacks; primarily that the wearer must handle the respirator after it has supposedly been positioned on his face. This handling can modify the facepiece seal.

Negative Pressure Test

d. Positive Pressure Test

This test, similar to the negative pressure test, is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage. For some respirators, this method requires that the wearer remove the exhalation valve cover; this often disturbs the respirator fit even more than does the negative pressure test. Therefore, this test should be used sparingly if it requires removing and replacing a valve cover. The test is easy for respirators whose valve cover has a single small port that can be closed by the palm or a finger.

2. Quantitative Tests

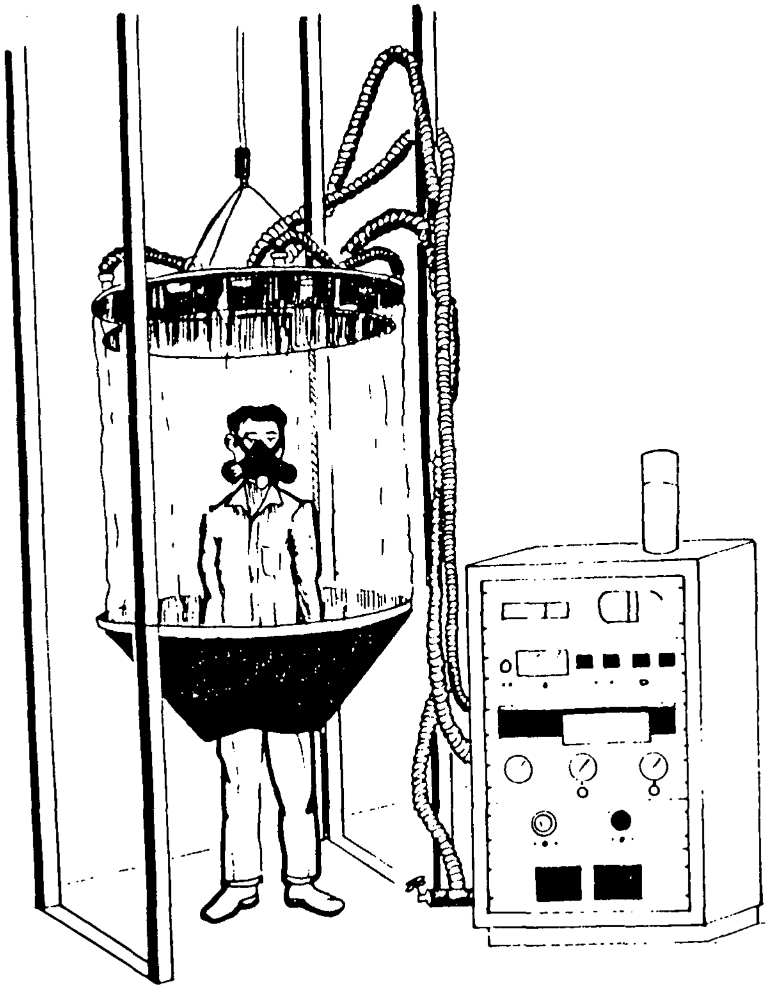
Quantitative respirator performance tests involve placing the wearer in an atmosphere containing an easily detectable, relatively nontoxic gas, vapor, or aerosol. The atmosphere inside the respirator is sampled continuously through a probe in the respiratory-inlet covering. The leakage is expressed as a percentage of the test atmosphere outside the respirator, called "percent of penetration," or simply "penetration." The greatest advantage of a quantitative test is that it indicates respirator fit numerically, and does not rely on a subjective response. The quantitative fit test is highly recommended when facepiece leakage must be minimized for work in highly toxic atmospheres or those immediately dangerous to life or health. However, these tests require expensive (up to $10,000) equipment that can be operated only by highly trained personnel. Also, it is difficult to use because of its complexity and bulk. Each test respirator must be equipped with a sampling probe to allow continual removal of an air sample from the facepiece so the same facepiece cannot be worn in actual service, since the test orifice negates the approval of the respirator.

a. Sodium Chloride (NaCl) Test

In this test, a liquid aerosol is generated continuously from a salt water solution (using a nebulizer), dried to produce discrete submicron salt particles, and dispersed into a test chamber or hood. A means is provided for sampling the atmosphere in the chamber or hood and inside the respirator. These samples are fed to the analyzing section where the aerosol's penetration inside the respirator is determined. The amount of penetration is displayed on a meter or recorder.

b. Dioctyl Phthalate (DOP) Test

The dioctyl phthalate (DOP) quantitative fitting test, which uses an air-generated DOP aerosol, differs from the NaCl test only in that the aerosol particle is liquid. The aerosol is generated using a nozzle-type atomizer, but, being an oil, DOP does not dry into solid particles when injected into a diluting air stream.



Quantitative Test

APPENDIX IX

LIST OF EXHIBITS

EXHIBIT I

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

Policy Statement: A respiratory protection program is hereby established so as to coordinate the use and maintenance of respiratory protective equipment as determined necessary to (1) reduce employee exposure to toxic chemical agents; and (2) allow employees to work safely in hazardous work environments, e.g., sand blasting and oxygen deficient atmospheres.

I. DESIGNATION OF PROGRAM ADMINISTRATOR

Management has designated ______________________ to be responsible for the respiratory program at this facility. He/she has been delegated authority by top management to make decisions and implement changes in the respirator program anywhere in this facility.

______________________ has been charged with the following responsibilities:

A. Supervision of respirator selection procedure;
B. Establishment of training sessions about respiratory equipment for employees;

C. Establishment of a continuing program of cleaning and inspection of equipment;
D. Designation of proper storage areas for respiratory equipment;
E. Establishment of issuance and accounting procedures for uses of respiratory equipment;
F. Establishment of medical screening program/procedures for employees assigned to wear respiratory equipment;
G. Establishment of a periodic inspection schedule of those workplaces/conditions — requiring respiratory equipment — to determine exposure and/or changing situations; and
H. A continuing evaluation of the above aspects to assure their continued functioning and effectiveness.

Any questions or problems concerning respirators or their use should be addressed to ______________________.

EXHIBIT II

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

Policy Statement: Management is concerned not only with meeting federal and/or state regulations, but also maintaining employee health.

II. PROCEDURE FOR SELECTION OF RESPIRATORY PROTECTIVE EQUIPMENT

A. Evaluation of the Hazard

Surveys of employee groups and/or processes pertinent to company operations shall be conducted by

______________________, Safety Director, ________ Company. The Hazard Evaluation Form shall be used in the formation of a decision to implement the use of respiratory protective equipment.

B. The Selection of Respiratory Protective Equipment

Upon completion of the walk-thru survey, the Safety Director, in consultation with the Vice-President-Engineering, shall review the results to determine the feasibility of engineering and/or administrative control techniques.

The Industrial Hygienist shall submit monthly reports to the Vice-President-Engineering as to the status of development of engineering controls, if required.

EXHIBIT III

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

III. PURCHASE OF RESPIRATORY PROTECTIVE EQUIPMENT

The program administrator shall have authority to purchase respiratory protective equipment. Respiratory equipment shall be selected only from current NIOSH approved listings.

EXHIBIT IV

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

IV. MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

Policy Statement: Only those individuals who are medically able to wear respiratory protective equipment shall be issued one.

EXHIBIT V

________ COMPANY

RESPIRATORY PROTECTION PROGRAM

V. ISSUANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

Policy Statement: All individuals who are assigned to wear respiratory protective equipment shall be provided respiratory protective equipment for their exclusive use.

A system of respiratory wearer cards and journals shall be established to facilitate the accounting of users and equipment. The following user card and journal scheme has been adopted by ________ COMPANY.

The program administrator shall approve the issuance of all respirators and/or respiratory protective equipment.

RESPIRATOR USER CARD

CARD NUMBER ____________________

NAME ____________________

OPERATION ____________________

CONTAMINANTS/HAZARD PROCESS ________

RESPIRATOR TYPE ____________________

DATE OF ISSUANCE ____________________

DATE OF EXPIRATION ____________________

APPROVED BY ____________________

______ COMPANY
RESPIRATORY PROTECTION PROGRAM
USER CARD JOURNAL

CARD NUMBER	ISSUED TO	HAZARD	RESPIRATOR TYPE	DATE ISSUED	DATE OF EXPIRATION	APPROVED BY

EXHIBIT VI

______ COMPANY

RESPIRATORY PROTECTION PROGRAM

VI. FITTING PROCEDURES FOR RESPIRATORY PROTECTIVE EQUIPMENT

Policy Statement: The proper fitting of respiratory equipment to the user shall follow one or more methods as outlined in Appendix VIII in the NIOSH Employer Respirator Manual, or as stated in other equivalent publications.

EXHIBIT VII

______ COMPANY

RESPIRATORY PROTECTION PROGRAM

VII. RESPIRATORY PROTECTIVE EQUIPMENT MAINTENANCE

Policy Statement: Respiratory equipment maintenance and storage shall be carried out in accordance with the instructions of the equipment manufacturer (and/or guidelines established by the NIOSH Employer Respirator Manual).

EXHIBIT VIII

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

VIII. INSPECTION PROCEDURES

Policy Statement: The program administrator shall develop a field inspection checklist for respiratory protective equipment. (The checklist, as itemized in the NIOSH Employer Manual, may be used as a guideline.) The administrator shall institute a continuing review of the inspection procedure so as to cover all uses of respiratory protective equipment at _________ COMPANY.

EXHIBIT IX

_________ COMPANY

RESPIRATORY PROTECTION PROGRAM

IX. PROGRAM EVALUATION

Policy Statement: The program administrator shall develop a procedure to evaluate the effectiveness of the program. Program review shall be done on a continuing basis. (Program review aspects may follow guidelines suggested by the NIOSH Employer Manual.)

APPENDIX X

REFERENCES

1. *A Guide to Industrial Respiratory Protection.* NIOSH pub 76-189.
2. *NIOSH Certified Equipment,* December 15, 1975. NIOSH pub 76-145.
3. *NIOSH Cumulative Supplement,* June 1977. NIOSH pub 77-195.
4. *Respiratory Protection: OSHA and the Small Businessman,* W. E. Ruch and B. H. Held (available from Ann Arbor Science Publishers, Inc., P.O. Box 1425, Ann Arbor, Michigan 45106).

APPENDIX XI

READER SERVICE CARD

The continued effective use of this manual will require the user to keep abreast of new developments in the field of respiratory protection, particularly as it relates to the introduction of new and/or updated equipment, and approvals issued for respiratory protective equipment. As a minimum, the user should be aware of NIOSH publication *Cumulative Supplement — NIOSH Certified Equipment,* which lists the approvals issued by NIOSH (to a specified date) for respiratory protective equipment.

The reader can obtain: (1) the initial publication of the *NIOSH Certified Personal Protective Equipment-1974* (Pub. No. 74-112), which details the requirements for approval of equipment; and (2) the updated *Cumulative Supplement (June 1977) NIOSH Certified Equipment* (Pub. No. 77-195) by being placed on the NIOSH mailing list.

I would like to be placed on the NIOSH mailing list.

Name ______________________________

Address ______________________________

City ______________________________

State ______________________ **Zip** ________

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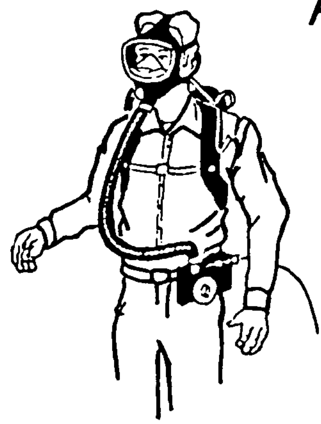
APPENDIX D

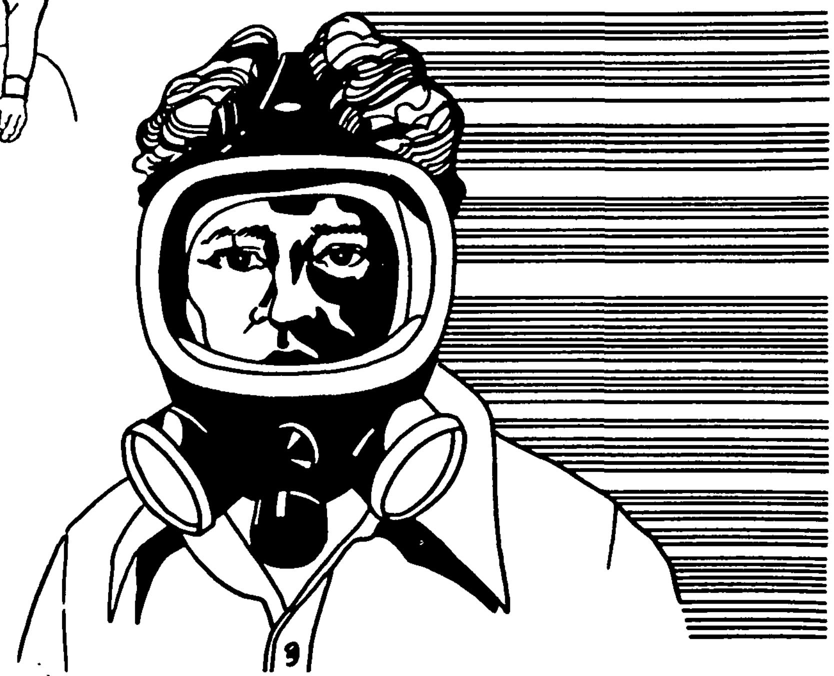
RESPIRATORY PROTECTION...

A GUIDE FOR THE EMPLOYEE

NIOSH

Respiratory Protection...
A Guide for the Employee





U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

RESPIRATORY PROTECTION

A Guide for the Employee

U. S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
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October 1978

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PREFACE

Respiratory protective equipment can be effective in protecting you from the inhalation of hazardous amounts of airborne contaminants. However, this effectiveness is dependent on the respirator being properly fitted, maintained in good condition, and most importantly, on your knowing its proper uses and limitations. If the contaminants in your work environment require you to wear a respirator, then wear it; the alternatives are not worth the risk. Exposure to high concentrations of a toxic substance, even for a short time, can cause serious injury or death; and even exposure to lower concentrations of certain toxic substances for long periods of time can cause permanent damage to critical body organs such as lungs, liver, and kidneys. Work environments where the oxygen content of the air you breathe is below acceptable levels can also be hazardous.

As a user of respiratory protective equipment, you have the right:

1. To know what hazards you are being exposed to and the reasons why a particular respirator was selected;
2. To be instructed in the use of equipment;
3. To be allowed to wear the equipment in a test atmosphere so as to check for leakage and proper fit;
4. To be advised of the capabilities and limitations of the equipment; and
5. To be instructed in the proper maintenance of the respiratory protective equipment.

This guide, prepared for you, discusses the above aspects in some detail to enable you to understand the do's and don'ts of respirator usage to safeguard your health from airborne hazards encountered in the work environment.

INTRODUCTION

The Occupational Safety and Health Administration (OSHA) has set maximum levels for many airborne toxic materials. If you are exposed to amounts of these materials in excess of the standard, the law requires that your employer install, implement, or institute feasible engineering or administrative controls so as to reduce your exposure to acceptable levels. If these controls do not prove feasible, or while they are being installed/instituted, your employer is required to furnish appropriate respiratory protection to each exposed employee. You may also have to wear respiratory protective equipment during cleaning and maintenance activities where you are briefly exposed to high concentrations of a hazardous substance. Further, your employer is required to establish a respiratory protection program with written standard operating procedures which detail, among other aspects, how the respirators were chosen and how they are to be used and maintained.

You should be familiar with the respirator selected and the proper maintenance procedures for the equipment.

I. RESPIRATORY PROTECTIVE EQUIPMENT SELECTION

The selection of the proper respiratory protective equipment involves, for the most part, three basic steps:

- Identification of the hazard;
- Evaluation of the hazard; and
- Selection of the proper respiratory protective equipment.

A. IDENTIFICATION OF THE HAZARD

Hazards may take many different forms. Since the selection of a respirator is based on the specific hazards to which you are exposed, JUST ANY RESPIRATOR WON'T DO, It is important to know something about the different kinds of hazardous materials which may exist within your facility requiring the use of respirators.

1. Gaseous Contaminants

Gaseous contaminants add another invisible material to the air we already breathe. There are two types of gaseous contaminants:

a. Gases include substances, e.g., carbon dioxide, which are solids or liquids only at very low temperatures and/or high pressures. Carbon dioxide is a gas at room temperature, but it also occurs as a solid, dry ice at low temperatures, and as a liquid in presurrized tanks.

b. Vapors are exactly like gases except that they are formed by evaporation of substances, such as acetone or trichloroethylene, which ordinarily exist as liquids.

2. Particulate Contaminants

Particulate contaminants are made of tiny particles or droplets of a material. There are three types of particulates:

a. Dusts are solid particles produced by such processes as grinding, crushing, and mixing of powder compounds. Examples are sand and plaster dust.

b. Mists are tiny liquid droplets given off whenever a liquid is sprayed, vigorously mixed, or otherwise agitated. Acid mists around diptanks used for metal cleaning and oil mists near newspaper printing presses are two examples.

c. Fumes are tiny metallic particles given off when metals are heated. Fumes are found in the air near soldering, welding, and brazing operations as well as near molten metal processes such as casting and galvanizing. The two basic forms — gaseous and particulates — frequently occur together. Paint spraying operations, for example, produce both paint mist (particulate) and solvent vapors (gaseous).

3. Oxygen Deficient Atmosphere

This condition is most commonly found in confined spaces with very poor ventilation. Examples are silos, petrochemical tanks, and the holds of ships. (In some situations an oxygen deficient atmosphere is purposely maintained. For instance, fruit is sometimes kept in warehouses with a lot of carbon dioxide and very little oxygen.) Oxygen deficient atmospheres occur in two different ways.

a. Oxygen is "used up" by a chemical reaction in which it is combined with other elements. This is what happens when fire burns or iron rusts.

b. Oxygen is "pushed out" by another gas. If a room with "normal" air (which contains about 21% oxygen) fills up with another gas, e.g., helium, there will be less oxygen in every breath you take because the oxygen is being steadily "displaced" by the helium.

Oxygen deficient atmospheres have been classified as immediately dangerous to life. Typical early symptoms are dizziness and euphoria — like being slightly drunk. Lack of oxygen affects the brain very quickly, so you might not be aware of what is wrong until you are too confused to escape. Oxygen starvation can cause serious injury to the brain.

4. Atmospheres Immediately Dangerous to Life or Health

This is a term which is used to describe very hazardous atmospheres in which exposure will:

a. Cause serious injury or death within a matter of minutes. Examples are exposure to high concentrations of carbon monoxide or hydrogen sulfide.

b. Cause serious delayed effects. Exposure to critical levels of radioactive materials or cancer-causing agents are examples.

B. EVALUATION OF THE HAZARD

Once a potential hazard has been recognized and the hazardous substance or particulate identified, it is then necessary to determine the amount of contaminant (concentration) present. The measured concentration can be stated in various "units," depending on the form of the contaminant. The two most widely used units are (1) mg/M^3 — milligrams of contaminant in air per cubic meter of air and (2) ppm — parts of contaminant in air per million parts of air. The measured concentration (in appropriate units) is then compared with either the permissible exposure level (PEL), mandated in OSHA regulations, or the threshold limit value (TLV), recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). These values, as determined by these groups, are the maximum concentration to which a worker may be exposed day after day without adverse affects. It is your employer's responsibility to determine the concentration of the contaminant you are exposed to.

C. SELECTION OF THE RESPIRATORY PROTECTIVE EQUIPMENT

After the hazard(s) has been recognized and measured, the other factors still need to be considered.

- Is the contaminant recognized the *only* contaminant present?
- Does the contaminant have adequate warning properties? (Warning properties are especially important when *air-purifying* respirators are used against gases and vapors.)
- Will the contaminant irritate the eyes at the estimated concentration to which the user will be subjected?
- Can the contaminant be absorbed through the skin? If it can, will it result in a serious injury?

Now the proper respirator can be chosen.

What types are available?

1. Respirator types:

Respiratory protective devices can be divided into two general categories:

a. Air-purifying respirators
These devices remove the contaminant from the breathing air before it is inhaled. For each model of air-purifying respirator, there are usually many air-purifying filters available for protection against specific contaminants. These filters fall into two subgroups: particulate removing filters and vapor and gas removing filters called cartridges or canisters. These are discussed in Appendices I and II. Combination filters for protection against both particulates and organic vapors are also available.

b. Atmosphere Supplying Respirators
These devices supply uncontaminated breathing air to the user from a source other than the surrounding atmosphere. These types are usually complex and come in many configurations.

Atmosphere Supplying Respirators can be broken down into two subgroups.

Air Respirators, in which breathable air is conveyed to the user via a compressed air line or hose, and Self-contained Breathing Apparatus (SCBA), in which the user carries the breathing air sources which can be a compressed air tank or an oxygen generating device. See Appendices III and IV.

2. Selection Procedures

Selecting the proper respirator must be based on the hazard present, its concentration, and the form of the hazard (vapor, particulate, etc.).

3. Approved Respiratory Protective Equipment

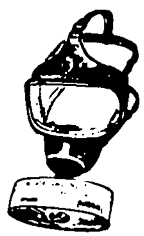
OSHA requires that *approved* respirators be used if they are available. If only one brand of respirator on the market is approved for a particular hazard, then that brand is considered to be "available" and must be used.

An approved respirator is one that has been tested and found to meet minimum performance standards by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). An approved respirator (by NIOSH) contains the following:

- An assigned identification number placed on each unit, e.g., TC-21C-101. The TC designation will always precede the identification number.

- A label identifying the type of hazard the respirator is approved to protect against.

- Additional information on the label which indicates limitations and identifies the component parts approved for use with the basic unit.



II. MEDICAL ASPECTS OF RESPIRATORY PROTECTIVE EQUIPMENT

The use of any type of respirator imposes some physiological stress on the user. *Air-purifying respirators,* for example, make breathing more difficult because the filter or cartridge can reduce the flow of air. The special exhalation valve on an *open circuit pressure demand* SCAB requires you to exhale against resistance. The bulk and weight of an SCBA can be a burden. If you are using an *airline respirator,* you might have to drag up to 300 feet of hose around. All of these factors can increase the "total" workload. If you have lung or heart problems, wearing a respirator could present an unacceptable risk. You should have some type of medical examination to determine if you are able to wear a respirator without it affecting your health.

A medical examination by a physician is the preferred screening mechanism. The following conditions may affect your ability to wear a respirator, and if they exist, you should get a medical opinion.

- Lung
  1. Do you have a history of asthma or emphysema?
  2. Do you have difficulty in breathing?
  3. Do you have any documented lung problems?

- Heart
  1. Do you have high blood pressure?
  2. Do you have artery diseases?
  3. Do you have documented heart problems?

- Other
  1. Do you have missing or arthritic fingers?
  2. Do you have facial scars?
  3. Do you have claustrophobia?

III. PROPER FITTING OF RESPIRATORY PROTECTIVE EQUIPMENT

Once a respirator has been selected for the contaminant to which you are exposed, and is appropriate for the airborne concentration, you are fully protected, right? Wrong! A respirator won't protect you unless the air you breathe goes through the "business end" — the canister, filter, or air supply system. If the face seal isn't tight or the connections are lose you may think you're breathing through it, but you will actually be breathing *around* it.

You may have to try on several different respirators before you find the one that fits properly. Your employer should have several types of respirators to choose from. Your employer must show you how to put the respirator on and how to adjust the straps for the best fit. The respirator should fit snugly, but it should not leave red marks, deep indentations on your face, or make it difficult to turn your head.

Beards and bushy sideburns may have to go, since respirator facepieces won't seal over them. Similarly, gum and tobacco chewing cannot be allowed since excess facial movement can break the faceseal.

If you wear prescription glasses, you must wear a respirator facepiece which will accommodate the glasses (this is especially critical for full facepiece respirators). Contact lenses should not be worn while wearing a respirator. A properly fitted respirator — primarily a full facepiece respirator — will stretch the skin at the temples slightly so that the contact lens might pop out. Also, contaminants that do leak in around the sealing surface may get underneath the contact lens thus causing severe discomfort. Your first reaction would be to remove the facepiece to remedy the situation — which would be fatal in a lethal environment.

Two types of fitting tests are used to determine the proper fit of respiratory protective equipment: qualitative tests and quantitative tests. *Qualitative* tests are fast, usually simple, but not as accurate an indicator for improper fit as the quantitative test. The *quantitative* test, though more accurate, requires the purchase of expensive equipment, requires a specially trained operator, and is of limited use due to its complexity and bulk.

IV. MAINTENANCE OF RESPIRATORY PROTECTIVE EQUIPMENT

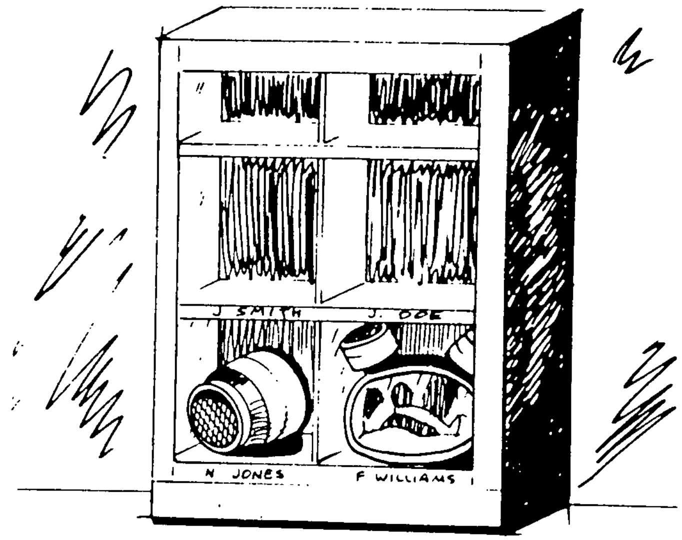
If you wear a respirator routinely it should be cleaned, inspected, and stored in a convenient location *after each use.*

A. CLEANING AND STORAGE

At the end of the workshift the respirator should be cleaned and stored in a convenient, clean location. If the respirator is shared, it should be cleaned *and* disinfected between users. In a large respirator program there may be a central facility for cleaning. In a small program, you may be expected to clean your own respirator. If so, the following method may be used.

- Wash with a detergent or a combination detergent and disinfectant, in warm water using a brush.
- Rinse in clean water, or rinse once with a disinfectant and once with clean water. (The clean water rinse is particularly important because traces of detergent or disinfectant left on the mask can cause skin irritation or dermatitis.)
- Dry on a rack or hang from a clothes line. In either case position the respirator so that the facepiece rubber won't "set" crooked as it dries.

Proper storage of a respirator is very important. The law requires that respirators be protected from dust, sunlight, heat, extreme cold, excessive moisture, and damaging or contaminating chemicals. A storage cabinet for air-purifying respiratory protective equipment is shown below.



B. INSPECTION

Inspection of the respirator is an important part of usage. You can further safeguard your health by performing (as appropriate) the below listed checks.

1. Disposable respirators, check for:

- Integrity of the filter (for holes);
- Straps for elasticity and deterioration;
- Metal nose clip for deterioration (if applicable).

2. Air-purifying respirators (quarter-mask, half-mask, full-facepiece, and gas mask):

a. Rubber Facepiece, check for:
- excessive dirt;
- cracks, tears, or holes;
- distortion from improper storage;
- cracked, scratched or loose fitting lens (full-facepiece);
- broken or missing mounting clips.

b. Headstraps, check for:
- breaks;
- loss of elasticity;
- broken or malfunctioning buckles or attachments;
- excessively worn serrations of the head harness which might allow the facepiece to slip (full-facepiece only).

c. Inhalation Valve, Exhalation Valve, check for:
- Detergent residue, dust particles, or dirt on valve or valve seat;
- Cracks, tears, or distortion in the valve material, or valve seat;
- Missing or defective valve cover.

d. Filter Element(s), check for:
- Proper filter for the hazard;
- Approval designation;
- Missing or worn gaskets;
- Worn threads — both filter threads and facepiece threads;
- Cracks or dents in filter housing;
- Deterioration of harness (gas mask canister);
- Service life indicator, or end of service date — for expiration (gas mask).

e. Corrugated Breathing Tube (gas masks), check for:
- Cracks;
- Missing or loose hose clamps;
- Broken or missing connectors.

3. ***Atmosphere-Supplying Respirators***

a. Check facepiece, headstraps, valves, and breathing tube as discussed previously.

b. Hood, Helmet, Blouse, or Full Suit (if applicable), check for:
- Rips and torn seams;
- Headgear suspension;
- Cracks or breaks in faceshield;
- Protective screen to see that it is intact and fits correctly over the faceshield (abrasive blasting hoods and blouses).

c. Air Supply System, check for:
- Breaks or kinks in air supply hoses and end fitting attachments;
- Tightness of connections;
- Proper setting of regulators and valves (consult manufacturer recommendations);
- Correct operation of air purifying elements and carbon monoxide or high-temperature alarms.

d. Self-contained Breathing Apparatus (SCBA):
- Consult manufacturer's literature.

If defects are observed in a respirator, it must be removed from use until adequately repaired, or it must be replaced.

C. REPAIR

Sooner or later your respirator will need a new part or some other repair. The law requires that the people who repair respirators be well trained. And it is important for everyone to realize that respirator parts from different manufacturers are not interchangeable. The NIOSH approval will not hold if an air hose or a gasket or any other part has been replaced by one from a different brand of respirator. This is true even if the respirator seems to work just as well with the substitute part.

V. EMPLOYEE RESPONSIBILITIES

As a user of respiratory protective equipment, you also have responsibilities.

- Use respiratory protective equipment as instructed.
- Guard against damaging the respirator.
- Go immediately to an area of "clean" air if your respirator malfunctions.
- Report any malfunctioning of respiratory protective equipment to your supervisor. This would include but not be limited to:

— Discomfort;
— Resistance to breathing;
— Fatigue due to respirator usage;
— Interference with vision or communication;
— Restriction of movement.

It is impossible to cover briefly all the considerations that you should be familiar with because of the many types of respirators available. The manufacturer can supply much of the needed information. However, to be of value, it must be fully read and applied.

The appendices in this guide provide specific information on the general types of respirators most commonly in use. They are not all-inclusive, but do provide the basic information an employee should know about his particular respirator.

APPENDIX I

AIR-PURIFYING, PARTICULATE-REMOVING FILTER RESPIRATORS

A. DESCRIPTION

These are generally called "dust," "mist," or "fume" respirators, and by a "filtering" action remove particulates before they can be inhaled.

1. Single-use, dust

Side view showing
proper position of straps

The single-use respirator is a respirator which is completely disposed of after use. They are for individual use and should be discarded when resistance becomes excessive or the respirator is damaged. Generally, these respirators are approved only for pneumoconiosis- or fibrosis-producing dust such as coal dust, silica dust, and asbestos.

2. *Quarter-mask, dust and mist, and half-mask, dust and mist*

The quarter-mask covers the mouth and nose; the half-mask fits over the nose and *under the chin*. The half-mask usually produces a better facepiece-to-face seal than does the quarter-mask and is therefore preferred for use against more toxic dusts and mists.

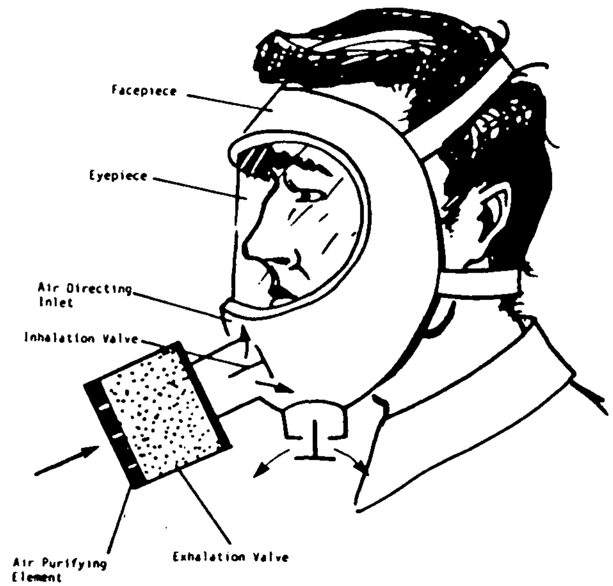
These dust and mist respirators are designed for protection against dusts and mists whose TLV is greater than .05 mg/M^3 or 2 mppcf.

3. *Half-mask, high efficiency*

This mask uses a high efficiency filter. Because of this high efficiency filter, this respirator can be used in atmospheres containing dusts, mists, fumes, or combinations of these forms where the TLV is *less* than .05 mg/M^3 or 2 mppcf.

4. *Full facepiece*

Full facepiece respirators cover the face from the hairline to below the chin. In addition to providing more protection to the face, the full facepiece gives a better seal than do the half- or quarter-masks. These respirators provide protection against dusts, mists, fumes, or any combination of these contaminants depending upon the type of filter used.



Typical full facepiece respirator.

B. LIMITATIONS

- Air-purifying respirators do *not* provide oxygen, so they must *never be worn in oxygen-deficient atmospheres.*
- Particulate-removing air-purifying respirators offer *no* protection against atmospheres containing contaminant gases or vapors.
- These respirator types should not be used for abrasive blasting operations.

C. PROBLEMS

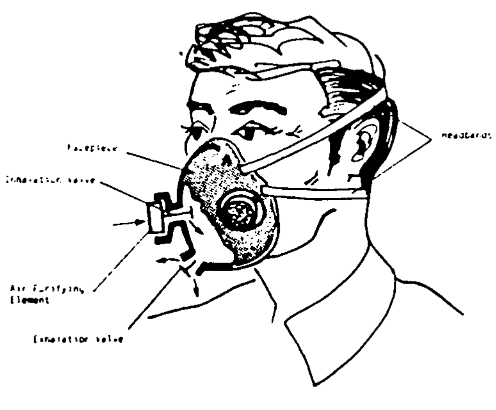
- The air flow resistance of a particulate-removing respirator filter element increases as the quantity of particles it retains increases, thus increasing the breathing resistance. *As a rule of thumb*, when comfortable breathing is impaired because of dust build-up, the filter should be replaced.
- Performance of some filter materials is affected by open storage in very humid atmospheres. Care should be taken in storing filter elements.

APPENDIX II

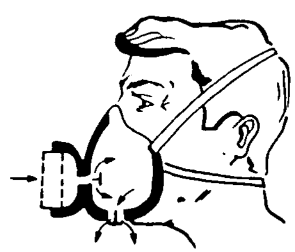
AIR-PURIFYING, CHEMICAL CARTRIDGE AND CANISTER RESPIRATORS FOR GASES AND VAPORS

A. DESCRIPTION

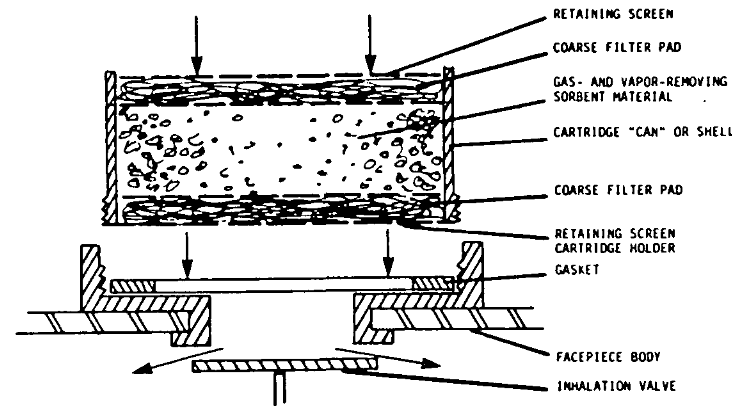
Vapor and gas-removing respirators use cartridges or canisters containing chemicals to trap or react with specific vapors and gases and remove them from the air breathed. The basic difference between a cartridge and a canister is the volume of the sorbent. Generally, a "cartridge" refers to a chemical filtering element which attaches directly to the facepiece, whereas a "canister" refers to the chemical filter element held in a harness and which is connected to the facepiece via a corrugated breathing tube. Some typical cartridge and canister respirators are shown below.



Typical half-mask respirator.



Typical quarter-mask respirator.



Typical chemical cartridge.

1. *Half-mask and Quarter-mask Chemical Cartridge or Canister Respirators*

These are available for protection against single chemicals such as ammonia or against entire classes such as organic vapors. Be sure to read the label on the cartridge or canister since it tells what the cartridge or canister protects against, the maximum concentration in which the element can be used, and in some instances, the service life or expiration date of the element.

2. *Full facepiece*

The full facepiece respirator may use a canister or cartridge(s) as the protective element. The front, back, and chin-mounted full-facepiece canister respirators are also referred to as "gas masks."

B. LIMITATIONS, CHEMICAL CARTRIDGE OR CANISTER

- These respirators do not supply oxygen, so they must *never be worn in oxygen deficient atmospheres.*

- They must not be used if the chemical to be protected against lacks adequate warning properties — odor, taste, or irritation, unless their use is permitted by applicable OSHA or MHSA standards. Warnings such as these are necessary to alert you that the sorbent is saturated, and the contaminant is passing through the cartridge or canister, and you are breathing contaminated air.

• They must not be used in atmospheres immediately dangerous to life or health, except for escape.

• They provide protection only from the specific gases or vapors they were designed to protect against (they may be worthless for other gases or vapors).

APPENDIX III

ATMOSPHERE SUPPLYING RESPIRATORS — SUPPLIED-AIR

Atmosphere-supplying respirators, rather than removing the hazardous material from the air, exclude the workplace air altogether and provide clean air from an independent source. There are two kinds of atmosphere supplying respirators: a *supplied-air respirator* in which the user is supplied with respirable air through a hose, and a *self-contained respirator* in which the user carries a supply of respirable air.

A. DESCRIPTION — SUPPLIED-AIR RESPIRATOR

Supplied-air respirators use a central source of breathing air that is delivered to the wearer through an air supply line or hose. There are essentially two major groups of supplied-air respirators — the airline device and the hose mask with or without a blower.

1. *Airline Devices*

The distinction of airline devices is that they use a stationary source of compressed air delivered through a high-pressure hose. Airline devices can be equipped with half or full-face masks, helmets, or hoods, or the device can come as a complete suit. Airline respirators can be used for protection against either particulates, gases, or vapors. They provide a high degree of protection against these contaminants but they *cannot be used in at-*

mospheres immediately dangerous to life or health because the user is completely dependent on the integrity of the air supply hose and the air source. If something happens to either the hose or air supply, he may not be able to escape from the contaminated area fast enough without endangering his life.

A great advantage of the airline respirator is that it can be used for long continuous periods. There are three types of airline respirators.

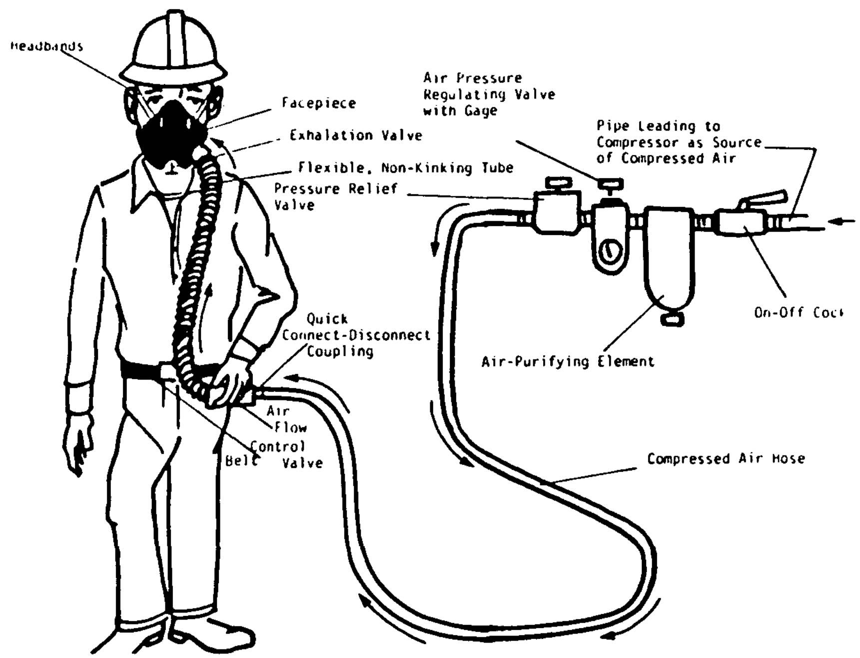
a. Demand Airline Device
In a demand device, the air enters the facepiece only on "demand" of the wearer, i.e., when the person inhales. This is due to the nature of the valve and pressure regulator. An example of a demand, half-mask airline device is shown below.

During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air may enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Demand devices are also available with a full-face mask, which provides a better seal than does the half-mask.

b. Pressure Demand Airline Devices
The pressure demand device has a regulator and valve design

such that there is a continuous flow (until a fixed static pressure is attained) of air into the facepiece at all times, regardless of the "demand" of the user. The airflow into the mask creates a positive pressure outward. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of this type of device.

c. Continuous-flow Airline Device
The continuous-flow airline respirator maintains a constant airflow at all times and doesn't use a regulator, but uses an airflow control valve or orifice which regulates the flow of air. A continuous flow-full facepiece device is shown below.



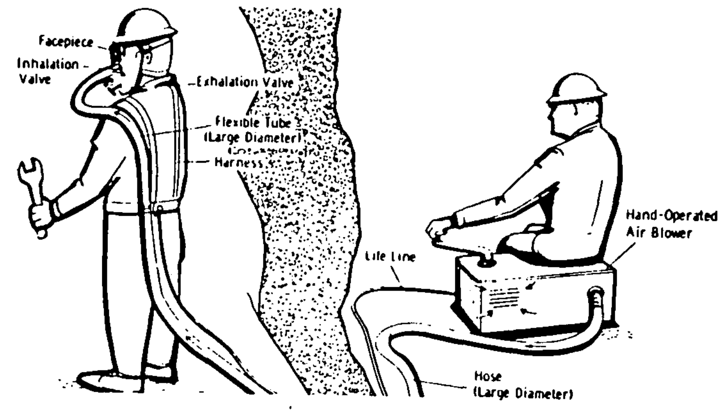
The continuous-flow device creates a "positive" pressure in the facepiece, and as a result, does not have the problem of inward leakage of contaminant.

A special type of continuous-flow device that provides protection against flying particles of abrasive materials is also available. The abrasive blasting airline respirator, shown below, incorporates a loose fitting facepiece.

2. *Hose Masks*

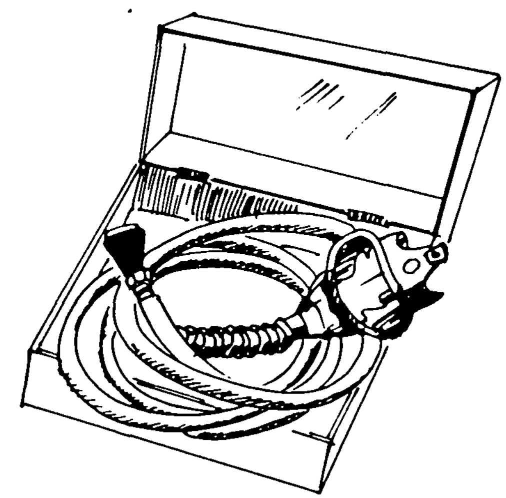
Hose masks supply air from an uncontaminated source through a strong, large diameter hose to the facepiece, and do *not* use compressed air or have any pressure regulating devices. (An advantage of the hose mask *with* a blower is its minimal resistance to breathing). Advantages of the hose mask *without* a blower are its theoretically long use periods and its simple construction, low bulk, easy maintenance, low initial cost, and minimal operating cost. Two types are available:

a. Those masks with hand or motor operated air blowers have a full facepiece mask. The hose length can be up to 300 feet. It must not be used in atmospheres immediately dangerous to life or health.



Hose mask respirator with hand operated blower.

b. Hose masks without blowers must have a tight fitting full facepiece. Helmets and hoods cannot be used. The hose mask without a blower can have up to 75 feet of hose.



Hose mask without Blower.

B. LIMITATIONS

1. *Airline Devices*

a. These devices must not be used in atmospheres immediately dangerous to life or health since the user is dependent upon an air hose which, if cut, crushed, or damaged, leaves him with little or no protection.

b. The trailing air supply hose of the airline respirator severely restricts the wearer's mobility. This may make the airline respirator unsuitable for those who must move frequently between widely separated work stations.

2. *Hose Mask*

a. The hose mask with a blower cannot be used in atmospheres immediately dangerous to life or health because the low air volume flow may result in a negative pressure being produced in the mask during inhalation allowing contaminated air to leak into the mask. Also, if the air hose is cut or obstructed, the user will be unprotected.

b. The trailing air supply hose of the hose mask severely limits mobility, so it may be unsuitable if frequent movement among separated work stations is required.

c. A severe restriction of the hose mask without a blower is that it is limited to a maximum hose length of 75 feet. Also, it requires the wearer to inhale against the resistance to air flow offered by the air hose which may become significant during heavy work. Inhaling against this resistance may cause fatigue.

APPENDIX IV

ATMOSPHERE SUPPLYING RESPIRATORS — SELF-CONTAINED BREATHING APPARATUS (SCBA)

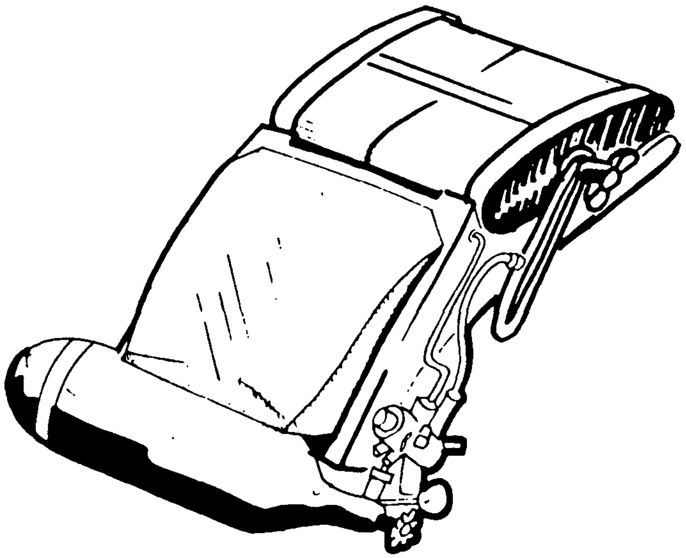
The self-contained breathing apparatus (SCBA) allows the user to carry a respirable breathing supply with him/her, and does not need a stationary air source such as a compressor to provide breathable air. The air supply may last from 3 minutes to 4 hours depending on the nature of the device.

A. DESCRIPTION — SCBA

1. *Closed Circuit SCBA*

Another name for closed circuit SCBA is "rebreathing" device. The air is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a compressed oxygen source or an oxygen-generating solid. These devices are designed primarily for 1-4 hour use in toxic atmospheres. Because negative pressure is created in the facepiece during inhalation, there is increased leakage potential. Therefore, the devices should be used in atmospheres immediately hazardous to life and health only when their long-term use is necessary, as in mine rescue. Two types of closed circuit SCBA are available.

a. Compressed Oxygen Cylinder Type
In this device, breathable air is supplied from an inflatable bag. Exhaled air from the wearer is filtered to remove carbon dioxide and the oxygen consumed is replenished from an oxygen cylinder.

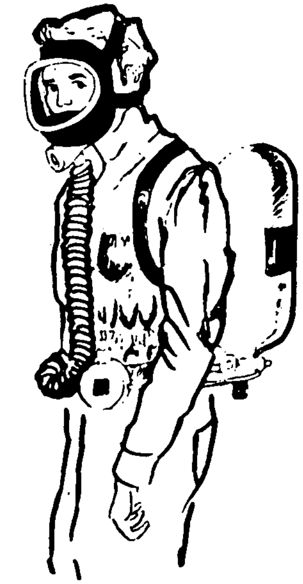


Typical oxygen-supplying closed circuit SCBA.

2. Open Circuit SCBA

An open circuit SCBA exhausts the exhaled air to the atmosphere instead of recirculating it. A tank of compressed air carried on the back, supplies air via a regulator to the facepiece. Because there is no recirculation of air, the service life of the open circuit SCBA is shorter than a closed circuit system. Two types of open circuit SCBA are available, "demand" or "pressure demand."

a. Demand SCBA
In a demand SCBA, air flows into the facepiece only on "demand of the wearer," i.e., when the person inhales. This is due to the nature of the valves and pressure regulator. An example of a demand open circuit is shown below. During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air can enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Because of this problem, a demand type open circuit SCBA should not be used in atmospheres immediately dangerous to life or health.



Typical open circuit SCBA.

b. Pressure Demand SCBA
The pressure demand open circuit SCBA has a regulator and valve design which maintains a positive pressure in the facepiece at all times regardless of the "demand" of the user. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of the pressure demand device. A pressure demand SCBA is identical in appearance to a demand SCBA, but has a different regulator assembly and facepiece exhalation valve design.

3. Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

Designed primarily as a long duration device, this respirator combines an airline respirator with an auxiliary air supply (usually compressed air) to protect against the possible failure of the primary air supply (the airline). The additional supply can be approved for 15 minutes or even longer. The choice depends upon how long it would take to escape from the toxic atmosphere if the primary air supply failed.

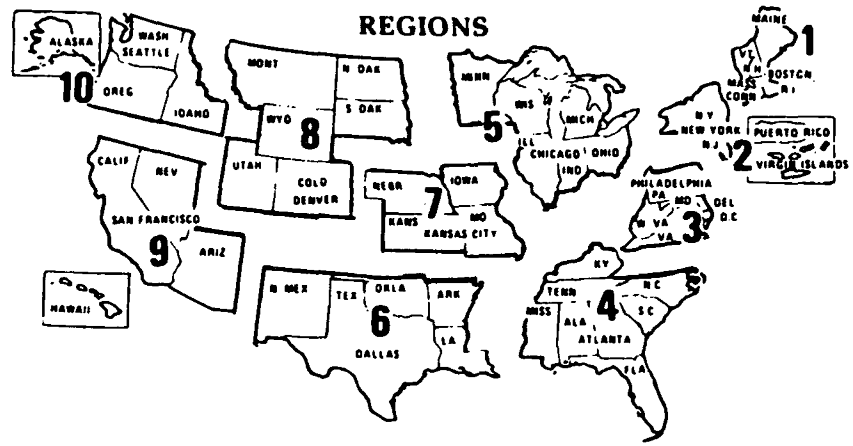
Typical combination air line and SCBA respirator.

B. LIMITATIONS

- The air supply is limited to the amount in the cylinder (SCBA's using a compressed air tank) and therefore the respirator cannot be used for extended periods without recharging or replacing the cylinders.
- Because these respirators are bulky and heavy, they are often unsuitable for strenuous work or use in confined spaces.
- Because of the *short* service time of the auxiliary air supply, the escape portion of the combination unit can be used only for escape from atmospheres Immediately Hazardous to Life or Health (IDLH) unless the escape portion has a minimum of 15 minutes service life. Such devices can then be used for entry into immediately dangerous to life or health atmospheres, provided not more than 20% of the available breathing supply is used. These devices may always be used for entry into IDLH atmosphere when utilized with the external air supply.

NIOSH AND OSHA REGIONAL OFFICES

The following pages list NIOSH and OSHA regional offices. Either of these facilities serving the state can provide information on the Occupational Safety and Health Act including questions on standards interpretations, voluntary compliance information, copies of the OSHA Standards, OSH Act, Employee Rights Posting Notice, and other OSHA publications.



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Boston, Massachusetts 02203
617/223-6668

DHEW, Region II
26 Federal Plaza, Room 3300
New York, New York 10007
212/264-2485

DHEW, Region III
P. O. Box 13716
Philadelphia, PA 19101
215/596-6716

DHEW, Region IV
101 Marietta Tower
Atlanta, GA 30323
404/221-2396

DHEW, Region V
300 South Wacker Dr.
33rd Floor
Chicago, IL 60606
312/886-3651

DHEW, Region VI
1200 Main Tower Bldg.
Dallas, Texas 75202
214/655-3081

DHEW, Region VII
601 E. 12th St.
5th Floor West
Kansas City, Missouri 64106
816/374-5332

DHEW, Region VIII
11037 Federal Bldg.
Denver, Colorado 80294
303/837-3979

DHEW, Region IX
50 United Nation Plaza, Rm. 231
San Francisco, CA 94102
415/556-3781

DHEW, Region X
1321 Second Ave., Mail Stop 502
Seattle, Washington 98101
206/442-0530

OSHA REGIONAL OFFICES

Region I
U.S. Department of Labor
Occupational Safety and Health Administration
JFK Building, Room 1804
Boston, Massachusetts 02203 .... Telephone: 617/223-6712/3

Region II
U.S. Department of Labor
Occupational Safety and Health Administration
1515 Broadway (1 Astor Plaza), Room 3445
New York, New York 10036 .... Telephone: 212/971-5941/2

Region III
U.S. Department of Labor
Occupational Safety and Health Administration
15220 Gateway Center, 3535 Market Street
Philadelphia, Pennsylvania 19104 .... Telephone: 215/596-1201

Region IV
U.S. Department of Labor
Occupational Safety and Health Administration
1375 Peachtree Street, N.E., Suite 587
Atlanta, Georgia 30309 .... Telephone: 404/526-3573/4 or 2281/2

Region V
U.S. Department of Labor
Occupational Safety and Health Administration
230 S. Dearborn, 32nd Floor
Chicago, Illinois 60604 .... Telephone: 312/353-4716/7

Region VI
U.S. Department of Labor
Occupational Safety and Health Administration
555 Griffin Square Building, Room 602
Dallas, Texas 75202 .... Telephone: 214/749-2477/8/9 or 2567

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U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 3000, 911 Walnut Street
Kansas City, Missouri 64106 .... Telephone: 816/374-5861

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U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 15010, 1961 Stout Street
Denver, Colorado 80202 .... Telephone: 303/837-3883

Region IX
U.S. Department of Labor
Occupational Safety and Health Administration
9470 Federal Building, 450 Golden Gate Avenue
Post Office Box 36017
San Francisco, California 94102 .... Telephone: 415/556-0584

Region X
U.S. Department of Labor
Occupational Safety and Health Administration
6048 Federal Office Building, 909 First Avenue
Seattle, Washington 98174 .... Telephone: 206/442-5930

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APPENDIX E

GLOSSARY OF ASBESTOS TERMS

ASBESTOS GLOSSARY

ABIH	-	American Board of Industrial Hygiene
Acoustical Insulation	-	The general application or use of asbestos for the control of sound due to its lack of reverberant surfaces.
Acoustical Tile	-	A finishing material in a building usually found in the ceiling or walls for the purpose of noise control.
Aggressive Sampling	-	Air sampling which takes place after final clean-up while the air is being physically agitated to produce a "worst case" situation.
AIA	-	Asbestos Information Association
AIA	-	American Institute of Architects
AIA	-	American Insurance Association
AIHA	-	American Industrial Hygiene Association
AIHA Accredited Laboratory	-	A certification given by the AIHA to an analytical laboratory that has successfully participated in the "Proficiency Analytical Testing" program for quality control as established by the National Institute for Occupational Safety and Health.
Airborne Asbestos Analysis	-	Determination of the amount of asbestos fibers suspended in a given amount of air.
Air Diffuser	-	A device designed to disperse an air stream throughout a given area.
Air Lock	-	A system of enclosures consisting of two polyethylene curtained doorways at least three feet apart that does not permit air movement between clean and contaminated areas.
Air Man	-	An industrial hygienist or other qualified individual who collects air samples and monitors the asbestos abatement worksite.
Air Monitoring	-	The process of measuring the airborne fiber concentration of a specific quantity of air over a given amount of time.
Air Plenum	-	Any space used to convey air in a building or structure. The space above a suspended ceiling is often used as an air plenum.

Algorithm - A universally accepted procedure developed for the purpose of solving a particular problem. Algorithms developed for asbestos provide a numerical index for evaluating a degree of hazard in a particular area. The Sawyer Algorithm and the Ferris Index are two, but neither are widely used today.

Alveolar Macrophages - Highly specialized mobile cells in the lungs that attempt to engulf and digest such lung hazards as dusts or fibers.

Alveoli - Located in clusters around the respiratory bronchides of the lungs, this is the area in which true respiration takes place.

Ambient Air - The surrounding air or atmosphere in a given area under normal conditions.

Amended Water - Water to which a chemical wetting agent (surfactant) has been added to improve penetration into asbestos-containing materials that are being removed.

Amosite - An Asbestiform mineral of the amphibole group containing approximately 50% silicon and 40% Iron (II) Oxide, and is made up of straight, brittle fibers, light gray to pale brown in color.

Amphibole - One of the two major groups of minerals from which the Asbestiform minerals are derived, distinguished by their chain-like crystal structure and chemical composition.

ANSI - American National Standards Institute

Approved Landfill - A site for the disposal of asbestos-containing and other hazardous wastes that has been given EPA approval.

Aspect Ratio - The length of a fiber vs. its width.

Asbestiform Minerals - Minerals which, due to their crystal structures and chemical composition, tend to be separated into fibers and can be classified as a form of asbestos.

Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of chrysotile (serpentine); crocidolite (riebeckite); amosite (cummingtonite-grunerite); anthophyllite; and actinolite.

Asbestos Abatement - Procedures to control fiber release from asbestos-containing materials in buildings.

Asbestos Control	-	Minimizing the generation of airborne asbestos fibers until a permanent solution is developed.
Asbestos Exposure Assessment System	-	A decision tool which can be used to determine the extent of the asbestos hazard that exists in a building, and which can also be used to develop corrective actions.
Asbestos Fibers	-	Fibers with their length being greater than five microns (length to width ratio of 3:1), generated from an asbestos-containing material.
Asbestos Standard	-	Reference to the OSHA requirements in the general industry standards regarding asbestos exposure (29 CFR 1910.1001), and EPA National Emission Standard for Hazardous Air Pollutants (NESHAP) (40 CFR 61, subpart M).
Asbestosis	-	A non-malignant, progressive, irreversible lung disease caused by the inhalation of asbestos dust and characterized by diffuse fibrosis.
Atmospheres Immediately Dangerous to Life or Health	-	A hazardous atmosphere to which exposure will result in serious injury or death in a matter of minutes, or cause serious delayed effects.
Atmosphere Supplying Respirators	-	Respiratory protection devices which exclude workplace air altogether and provide clean air from some independent source.
Bid	-	A statement of the price at which a contractor will complete a given project.
"Blue Book"	-	EPA publication of March 1983 titled, "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings." Now replaced by 1985 revised edition.
Bridging Encapsulant	-	The application of a sealant over the surface of asbestos-containing material to prevent the release of asbestos fibers.
Bronchi	-	Primary branches of the trachea (windpipe).
Bronchogenic Cancer	-	An abnormal cell growth in the primary branches of the trachea (windpipe).
Cancer	-	A cellular tumor which normally leads to premature death of its host unless controlled.
Carbon Monoxide	-	A highly toxic colorless and odorless gas.
Ceiling Concentration	-	The maximum allowable level of toxic material that can be present at any given point in time.

Cementitious - Asbestos-containing materials that are densely packed, granular and are friable.

CFM - Cubic feet per minute

Chrysotile (white asbestos) - The only asbestiform mineral of the serpentine group which contains approximately 40% each of silica and magnesium oxide. It is the most common form of asbestos used in buildings.

CIH - An industrial hygienist who has been granted certification by the American Board of Industrial Hygiene.

Cilia - Tiny hair-like structures in the windpipe and bronchi of the lung passages that help force undesirable particles and liquids up and out of the lungs.

Claustrophobia - The fear of being in enclosed or narrow spaces.

Clean Area - The first stage of the decontamination enclosure system in which workers prepare to enter the work area.

Clerk of the Works - A person who coordinates and oversees all activities on an asbestos abatement job site.

Closed Circuit SCBA - A self-contained respiratory protection device in which the air is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored.

Columns - The building components which support the structural beams.

Compressed Oxygen Cylinder Type Closed Circuit SCBA - A self-contained respiratory protection device in which air is supplied from a compressed air cylinder. The exhaled air is filtered to remove carbon dioxide, and additional breathing air is provided.

Concrete-like Asbestos - Hard, non-friable asbestos-containing material that requires a mechanical force to penetrate its surface.

Contaminated Items - Any objects that have been exposed to airborne asbestos fibers without being sealed off or isolated.

Continuous Flow Airline Device - A respirator that maintains a constant airflow to the wearer.

Contract Specifications - A set of guidelines that a contractor must follow when conducting an asbestos abatement job.

CPSC - Consumer Product Safety Commission

Criteria Document - NIOSH publications that address toxic materials, analytical methods, personal protective equipment, etc.

Decontamination Enclosure System - A series of connected rooms with polyethylene curtained doorways for the purpose of preventing contamination of areas adjacent to the work area.

Demand Airline Device - A respirator in which air enters the facepiece only when the wearer breathes in.

Dirty Area - Any area in which the concentration of airborne asbestos fibers exceeds 0.01 f/cc, or where there is visible asbestos residue.

Dispersion Staining - Used in conjunction with polarized light to identify bulk samples. A particle (fiber) identification technique based on the difference between light dispersion of a particle (fiber) and a liquid medium in which it is immersed.

Duct Tape - Heavy gauge tape capable of sealing joints or adjacent sheets of polyethylene.

Dust Mask - Single use or disposable dust respirator with a low protection factor.

Electron Microscopy - A method of asbestos sample analysis which utilizes an electron beam to differentiate between fibers.

Employee Notification - Informing employees or building occupants if asbestos is present in the building, also informing them of the hazards associated with asbestos exposure, what is being done to eliminate the problem, etc.

Employer's Liability - Legal responsibility imposed on an employer requiring him/her to pay damages to an injured employee.

Encapsulation - The coating of asbestos-containing material with a bonding or sealing agent to prevent the release of airborne fibers.

Encapsulant (sealant) - A substance applied to asbestos-containing material which controls the release of airborne asbestos-fibers.

EPA - Environmental Protection Agency

EPA Regulations - Regulatory standards which cover emissions into the outside environment from a workplace and disposal of hazardous wastes from job sites.

Epidemiology - The study of occurrence and distribution of disease throughout a population.

Equipment Room - The last stage or room of the worker decontamination system before entering the work area.

Establishing Responsibility - An asbestos program manager is designated and is given the responsibility for directing and managing asbestos control program activities.

Eyepiece - A component of a full facepiece respirator which is a gas-tight transparent window through which the wearer may see.

Facepiece - The portion of a respirator which covers the wearer's nose, mouth, and eyes in a full facepiece.

Fallout - The intermittent release of fibers which occurs as a result of weakened bonds in the material, or because of deterioration.

F/CC - Fibers per cubic centimeters of air

FEV_1 - The maximum volume of air that can be forced from an individual's fully inflated lungs in one second (Forced Expiratory Volume - one second)

Fiber Containment - Enclosing or sealing off an area having airborne asbestos fibers present so that the fibers will not migrate resulting in contamination of other areas.

Fiber Control - Minimizing the amount of airborne fiber generation through the application of amended water onto asbestos-containing material, or enclosure (isolation) of the material.

Fiber Releasability - The potential for generation of airborne fibers from an asbestos-containing source.

Fiber Reynolds Number - Refers to the diameter of a fiber.

Fibrosis - A condition of the lungs caused by the inhalation of excessive amounts of fibrous dust marked by the presence of scar tissue.

Fibrous - Composed almost entirely of fibers.

Fibrous Aerosol Monitor (FAM) - A portable survey instrument with the capability of providing instantaneous airborne fiber concentration readings.

Fireproofing - Spray- or trowel-applied fire resistant materials.

Friable Asbestos	-	Any materials that contain more than 1% asbestos by weight and can be crumbled, pulverized, or reduced to powder by hand pressure.
Full Facepiece Respirator	-	A respirator which covers the wearer's entire face from the hairline to below the chin.
FVC	-	Forced Vital Capacity. The measured quantity of air that be forcibly exhaled from a person's lungs after full inhalation.
Glovebag	-	Plastic bag-type enclosure placed around asbestos-containing pipe lagging so that it may be removed without generating airborne fibers into the atmosphere.
Glove-box (bag)	-	Plastic enclosure placed around a specific operation such as a valve to contain small areas of materials for asbestos removal.
Grade D Air	-	Breathing air which has between 19.5% - 23% oxygen, no more than 5 mg/m^3 of condensed hydrocarbons, no more than 20 ppm of carbon monoxide, no pronounced odor, and a maximum of 1000 ppm carbon dioxide.
Ground Fault Circuit Interrupter	-	A circuit breaker that is sensitive to very low levels of current leakage from a fault in an electrical system.
Ground Fault Interrupter	-	A device which automatically de-energizes any high voltage system component which has developed a fault in the ground line.
Half Mask - High Efficiency	-	A respirator which covers one-half of the wearer's face and is equipped with filters capable of screening out 99.97% of all particles larger than 0.3 microns.
Heat Cramps	-	Painful spasms of heavily used skeletal muscles such as hands, arms, legs, and abdomen which are sometimes accompanied by dilated pupils and weak pulse resulting from depletion of the salt content of the body.
Heat Exhaustion	-	A condition resulting from dehydration and/or salt depletion, or lack of blood circulation which is usually accompanied by fatigue, nausea, headache, giddiness, clammy skin, and a pale appearance.
Heat Stress	-	A bodily disorder associated with exposure to excessive heat.
Heat Stroke	-	The most severe of the heat stress disorders resulting from the loss of the body's ability to sweat which is characterized by hot dry skin, dizziness, nausea, severe headache, confusion, delerium, loss of consciousness, convulsion, and coma.

HEPA	-	High Efficiency Particulate Air (Air Filter)
HEPA Filtered Vacuum	-	A high efficiency particulate air (HEPA) filtered vacuum capable of trapping and retaining 99.97% of all particles larger than 0.3 microns.
Holding Area	-	The airlock between the shower room and the clean room in a worker decontamination system.
Homogeneous	-	Evenly mixed and similar in appearance and texture throughout.
Hose Masks	-	Respirators that supply air from an uncontaminated source through a strong, large diameter hose to the facepiece that does not use compressed air or have any pressure regulating devices.
HVAC System	-	Heating, Ventilation, and Air Conditioning system usually found in large business and industry facilities.
Industrial Hygienist	-	A professional qualified by education, training, and experience to recognize, evaluate, and develop controls for occupational health hazards.
Joists	-	The structural building component which the flooring or roof rests on.
Local Exhaust Ventilation	-	The mechanical removal of air contaminants from a point of operation.
Logbook	-	An official record of all activities which occurred during a removal project.
Lung Cancer	-	An uncontrolled growth of abnormal cells in the lungs which normally results in the death of the host.
Make-up Air	-	Supplied or recirculated air to offset that which has already been exhausted from an area.
MCEF	-	Mixed Cellulose Ester Filter which is one of several different types of media used to collect asbestos air samples.
Mechanical Filter Respirator	-	A respiratory protection device which offers protection against airborne particulates including dusts, mists, metal fumes, and smokes.
Medical Examinations	-	An evaluation of a person's health status conducted by a medical doctor.
Medical History	-	A record of a person's past health record, including all the hazardous materials that they have been exposed to and also any injuries or illnesses which might dictate their future health status.

Mesothelioma - A relatively rare form of cancer which develops in the lining of the pleura or peritoneum with no known cure.

Method 7400 - NIOSH sampling and analytical method for fibers using phase-contrast microscopy. Replaces method P&CAM 239.

Micron - One millionth of a meter

Mil - Prefix meaning one-thousandth

Millimeter - One-thousandth of a meter

·Mineral Wool - A commonly used substitute for asbestos

MSDS - Material Safety Data Sheet

MSHA - Mine Safety and Health Administration

Negative Pressure - An atmosphere created in a work area enclosure such that airborne fibers will tend to be drawn through the filtration system rather than leak out into the surrounding areas. The air pressure inside the work area is less than that outside the work area.

NESHAP - National Emission Standards for Hazardous Air Pollutants -- EPA Regulation 40 CFR subpart M, part 61.

NIOSH - The National Institute for Occupational Safety and Health which was established by the Occupational Safety and Health Act of 1970.

NIOSH/MSHA - The official approving agencies for respiratory protective equipment who test and certify respirators.

Numerical Value - Refers to the types and percentages of asbestos present in a given sample.

Oilless Compressor - An air compressor that is not oil lubricated, which does not allow carbon monoxide to be formed in the breathing air.

Open Circuit SCBA - A type of self-contained breathing unit which exhausts the exhaled air to the atmosphere instead of recirculating it.

Operations and Maintenance Plan (OMP) - Specific procedures and practices developed for the interim control of asbestos-containing materials in buildings until it is removed.

"Orange Booklets" - EPA publications issued in March 1979 titled: Asbestos-Containing Materials in School Buildings: A Guidance Document, parts I and II.

OSHA - The Occupational Safety and Health Administration which was created by the Occupational Safety and Health Act of 1970; serves as the enforcement agency for safety and health in the workplace environment.

Oxygen Deficient Atmosphere - Any atmosphere containing less than 19.5% oxygen.

PAT Samples - Proficiency Analytical Testing of asbestos samples conducted through NIOSH for laboratories involved with the analysis of asbestos samples.

Particulate Contaminants - Minute airborne particles given off in the form of dusts, smokes, fumes, or mists.

P&CAM 239 - A NIOSH sampling and analytical method for measuring airborne fibers using phase-contrast microscopy.

PEL - Permissible Exposure Limit as stated by OSHA

Penetrating Encapsulant - Liquid material applied to asbestos-containing material to control airborne fiber release by penetrating into the material and binding its components together.

Peritoneum - The thin membrane that lines the surface of the abdominal cavity.

Personal Protective Equipment (PPE) - Any material or device worn to protect a worker from exposure to, or contact with, any harmful material or force.

Personal Sample - An air sample taken with the sampling pump directly attached to the worker with the collecting filter placed in the worker's breathing zone.

Personnel Protection - Notification and instruction of all workers prior to the beginning of a project as to the hazards associated with the job and what they can do to protect themselves from these hazards.

PF - Protection factor as provided by a respirator which is determined by dividing the airborne fiber concentration outside of the mask by the concentration inside the mask.

Phase Contrast Microscopy (PCM) - An optical microscopic technique used for the counting of fibers in air samples, but which does not distinguish fiber types.

Pipe Lagging - The insulation or wrapping around a pipe.

Pleura - The thin membrane surrounding the lungs, and which lines the internal surface of the chest cavity.

Pneumoconiosis - A condition in the lungs which is a result of having inhaled various dusts and particles for a prolonged period of time.

Polarized Light Microscopy (PLM) - An optical microscopic technique used to distinguish between different types of asbestos fibers by their shape and unique optical properties.

Polyethylene - Plastic sheeting which is often used to seal off an area in which asbestos removal is taking place for the purpose of preventing contamination of other areas.

Posting - Refers to caution or warning signs which should be posted in any area in which asbestos removal is taking place, or where airborne fiber levels may present a health hazard.

Powered Air Purifying Respirator (PAPR) - Either a full facepiece, helmet, or hooded respirator that has the breathing air powered to the wearer after it has been purified through a filter.

Pre-Construction Conference - A meeting held before any work begins between the contractor and the building owner at which time the job specifications are discussed and all details of the work agreed upon.

Pre-Employment Physical - Complete medical examination of an employee before the job begins to determine whether or not he/she is fit to perform the functions of their employment.

Pressure Demand Airline Devices - A respiratory protection device which has a regulator and valve design such that there is a continuous flow of air into the facepiece at all times.

Prevalent Levels - Levels of airborne contaminants occurring under normal conditions.

Prevalent Samples - Air samples taken under normal conditions (background samples).

Progress Payments - A pre-work agreement whereby the building owner pays the contractor after completion of certain phases of the project.

Protective Clothing - Protective, lightweight garments worn by workers performing asbestos abatement to keep gross contamination off the body.

Pulmonary - Pertaining to, or affecting the lungs, or some portion thereof.

Pulmonary Function Tests - A part of the medical examination required to determine the health status of a person's lungs.

Purple Book - EPA publication of June 1985 titled, "Guidance for Controlling Asbestos-Containing Materials in Buildings, 1985 Edition." This document is a revision of the "Blue Book."

Qualitative Fit Test - A method of testing a respirator's face-to-facepiece seal by covering the inhalation or exhalation valves and either breathing in or out to determine the presence of any leaks.

Rales - An abnormal sound heard from the lungs which does not necessarily indicate any specific disease.

Random Sample - A sample drawn in such a way that there is no set pattern and is designed to give a true representation of the entire population or area.

Recordkeeping - Detailed documentation of all program activities, decisions, analyses, and any other pertinent information to a project.

Resolution - The ability to distinguish between individual objects, as with a microscope.

Respirable - Breathable

Respirator Program - A written program established by an employer which provides for the safe use of respirators on their job sites.

Resuspension - The secondary dispersal or re-entrainment of settled fibers which have previously been released by impact or fallout.

Rip-Out - The actual removal of asbestos-containing materials from a building.

Risk - The likelihood or probability of developing a disease, or being hurt, as the result of exposure to a contaminant or a condition.

Safety Glasses - Protective eye equipment.

Scanning Electron Microscopy (SEM) - A method of microscopic analysis which utilizes an electron beam directed at the sample and then collects the beams that are reflected to produce an image from which fibers can be identified and counted.

Scanning Transmission Electron Microscopy (STEM)	-	A combination of a transmission electron microscope with scanning and focusing coils so that a beam of electrons can be scanned over the sample or pinpointed in a particular area.
SCBA	-	Self-Contained Breathing Apparatus
Serpentine	-	One of the two major groups of minerals from which the asbestiform minerals are derived, distinguished by their tubular structure and chemical composition.
Shower Room	-	A room between the clean room and the equipment room in a worker decontamination system in which workers take showers when leaving the work area.
Spirometer	-	An instrument which measures the volume of air being expired from the lungs.
Steel Beams	-	Building components which support the joists.
Structural Member	-	Any load-supporting member such as beams and load supporting walls of a facility.
Structural Steel	-	A building component which is designed to support other structural members in a building.
Substrate	-	The material or existing surface located under or behind the asbestos-containing material.
Supplied Air Respirator	-	A respirator that has a central source of breathing air which is supplied to the wearer by way of an airline.
Surfactant	-	A chemical wetting agent added to water to improve its penetration abilities into asbestos-containing materials.
TLV	-	Levels of contaminants established by the American Conference of Governmental Industrial Hygienists to which it is believed that workers can be exposed to with minimal adverse health effects.
Transmission Electron Microscopy (TEM)	-	A method of microscopic analysis which utilizes an electron beam that is focused onto a thin sample. As the beam penetrates (transmits) through the sample, the difference in densities produces an image on a fluorescent screen from which samples can be identified and counted.
Treated Cellulose	-	An insulation material made of paper or wood products with fire-retarding treatment added.
Tumor	-	A swelling or growth of cells and tissue in the body which does not serve a useful purpose.

TWA	-	Time-Weighted Average, as in air sampling.
Type B Reader	-	A physician with specialized training in reading x-rays, specifically in recognizing lung disorders.
Type C Supplied-Air Respirator	-	A respirator designed to provide a very high level of protection which supplies air to the wearer from an outside source such as a compressor.
USEPA	-	United States Environmental Protection Agency
Vermiculite	-	A micaceous mineral that is sometimes used as a substitute for asbestos which is lightweight and highly water-absorbent.
Visible Emissions	-	Airborne fibers given off from an asbestos-containing source that are visible to the human eye.
Visual Inspection	-	A walk-through type inspection of the work area to detect incomplete work, damage, or inadequate clean up of a worksite.
Washroom	-	A room between the work area and the clean room in the equipment decontamination enclosure system where workers shower.
Water Damage	-	Deterioration or delamination of ceiling or wall materials due to leaks from plumbing or cracks in the roof.
WBGT	-	Wet Bulb Globe Temperature, a heat stress index.
Wet Cleaning	-	The process of eliminating asbestos contamination from surfaces and objects by using cloths, mops, or other cleaning tools which have been dampened with water.
Wetting Agents	-	Materials that are added to water which is used for wetting the asbestos-containing material in order for the water to penetrate more effectively.
Workmen's Compensation	-	A system of insurance required in some states by law, financed by employers, which provides payments to employees or their families for occupational injuries, illnesses, or fatalities resulting in loss of wage or income incurred while at work.

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7. Author(s) Eva M. Clay, Mark Demyanek, William M. Ewing, William H. Spain

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GEORGIA TECH RESEARCH INSTITUTE
Environmental Health And Safety Division
GTRI/EDL/EHSD
Atlanta, Georgia 30332

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This manual details the recommended procedures for performing asbestos abatement in buildings. The topics include contract specifications, legal and insurance considerations, pre-work activities, worker protection measures, air sampling procedures, work practices, disposal techniques, and glovebag procedures. It is intended for use by those persons who supervise asbestos abatement projects.

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