ASBESTOS MEDICAL SURVEILLANCE AND HAZARDS TRAINING

Return to Preventive Medicine Section Welcome Page

General

Before the hazards of exposure were known, asbestos was one of the most widely used substances in the Navy. Ships and shore facilities alike used asbestos by the tons. Modern ships and facilities no longer use asbestos, but it can be readily found in almost all older facilities and buildings throughout the Navy. Covered and contained, asbestos is not much of a concern. Deteriorating, exposed and flaking surfaces are treated as a true hazardous material, requiring isolation of the area, respirators and Tyvec® suit protection by trained personnel for removal. All, as you might guess, a very expensive proposition. Because of the nature of their work, Seabees may well be exposed to asbestos in repair of damage or reconstruction of buildings, power plants and other parts of base infrastructure. While they are alert to the possibilities, exposures might occur before anybody is aware of its presence. The U.S. Navy averages about 40,000 physical exams per year, but that number is decreasing considerably for a number of reasons. There are a total of 215,000 people in the Navy Asbestos Medical Surveillance Program (AMSP). Of those, about 96% of chest x-rays are normal, with just less than 4% considered mildly abnormal, and 0.2% abnormal. Data from the AMSP goes to a central database to provide information to NAVSEA, OPNAV, BUMED and the VA. What follows is intended to provide a brief outline of the Navy's asbestos exposure program and the steps necessary to identify, report and monitor those so exposed, whether recent or from long past exposures.

Directives

- OPNAVINST 5100.23B
- OPNAVINST 5100.19B

Information

- The U.S. Navy averages 40,000 physicals per year.
- Figures will decrease considerably in this decade.
- There are a total of 215,000 people in Navy AMSP.
- Approximately 96% of chest x-rays are within normal limits
  - 4% are mildly abnormal
  - 0.2% are abnormal
- Exam information goes to central data bank to provide information to NAVSEA, OPNAV, BUMED and VA.

Categories for Asbestos Medical Surveillance Program Examinations.

- Asbestos Current Worker
- Asbestos Past Exposure

Physical Examination Requirements for <u>Current Workers</u>.

- Frequency
  - Preplacement
  - Annual
  - Termination.
- Inclusion of an employee in the AMSP shall be governed by his/her degree of current exposure, or potential exposure.
  - Airborne asbestos concentration is at or above the action level (AL of 0.1 fiber/cc as an eight hour TWA or
  - If the excursion limit (EL) for asbestos is 1.0 fibers/cc averaged over any 30 minute period
- See Medical Surveillance Procedure Manual, 4th Ed, #114
  - The only difference in program 113 and 114 is the frequency of chest x-ray.

Chest X-ray for Current Workers			
Age of employee	15-35	35-45	45+
> 10 years of asbestos work	Every 5 years	Every 3 years	Annually
< 10 years of asbestos work	Every 5 years	Every 5 years	Every 5 years

Physical Examination Requirements for Workers With <u>Prior Asbestos Exposure</u>.

- **Frequency**
  - Preplacement
  - Periodic
  - Termination

- Recall schedule is same as noted above.
- **Placement Into AMSP**
  - For past exposures to asbestos, medical personnel attempting to determine whether to place an individual in the AMSP must be guided by the exposure history in absence of more definitive exposure records. As a rule of thumb, a history of participation in any operation where visible asbestos dust was present (including rip-outs), the exposure shall be considered to be in excess of the action level.
  - In addition, an individual working in areas where the asbestos concentration did not equal or exceed the **AL**, but who believe they have been exposed to undetermined levels os asbestos fibers, can be placed in AMSP.
  - Per OPNAV 5100/15, individuals shall be placed in the AMSP if it can be reasonably concluded that their exposure(s) could have been at or above the **AL**. Often, the

assistance of Industrial Hygiene personnel is helpful in determining placement into AMSP.

- **Removal From AMSP**
  - Once on the program, they can only be removed after discussion and clarification with the worker regarding the reason for removal.
  - The medical treatment record and the problem summary sheet has to clearly state and date reason for removal. The Navy Environmental Health Center shall be notified in writing of Name, Rate, and SSN.

ASBESTOS MEDICAL SURVEILLANCE FORMS FOR CURRENT WORKERS		
DD 2493-1 (OSHA)	Initial Medical Questionnaire	0102-LF-002-2435
DD 2493-2 (OSHA)	Periodic Medical Questionnaire	0102-LF-002-4940
NAVMED 6150/20	Problem Summary Sheet	0105-LF-206-1600
NAVMED 6250/5	Periodic Health Eval (AMSP)	0105-LF-009-9800
NAVMED 6260/7	ASMP X-ray Interpretation	0105-LF-009-9900
OPNAV 5100/15	Occupational Medical History	0107-LF-010-1400
SF 600	Medical Surveillance Procedure Manual, 4th Ed	#113 & #114
	Physician Written Opinion	
	Pulmonary Function Test	
ASBESTOS MEDICAL SURVEILLANCE FORMS FOR WORKERS WITH PAST EXPOSURE		
NAVMED 6150/20	Problem Summary Sheet	0105-LF-206-1600
NAVMED 6260/5	Periodic Health Eval (AMSP)	0105-LF-009-9800
NAVMED 6260/7	ASMP X-ray Interpretation	0105-LF-009-9900
OPNAV 5100/15	Occupational Medical History	0107-LF-010-1400
SF 600	Medical Surveillance Procedure Manual, 4th Ed	#115 & #116
	Pulmonary Function Test	

COUNSELING INDIVIDUALS WITH ABNORMALITIES ON ASBESTOS EXAMINATIONS

- Generally will be abnormalities in the B-reading or spirometry

- This is a counseling session; the main focus is to have the employee understand the results of his screening tests in the setting of an occupational exposure; you are not diagnosing diseases

- Document on the SF 600; use SOAP format; employee co-signs

  - **Subjective (S)**: Go over exposure history, latency, symptoms such as dyspnea, chest pain, cough, decreased exercise tolerance; smoking history

  - **Objective (O)**:
    - Review previous exam, lung exam in some cases
    - Review PFT; trend over time
    - Result of current B-reading and radiologist screening; summary of past B-readings
    - Review the B-reading with local radiologist
    - Trend and consistency of B-reading is the key

  - **Assessment (A)**: Restate abnormality noted; generally do not "diagnose" asbestos related conditions

  - **Plan (P)**:
    - For most cases this will be just to continue surveillance
    - Note that the worker was counselled
    - Refer to specialist when asbestos conditions suspected
    - Can resubmit same film for second B-reading
    - Removing from exposure?

  - Level of "work-up" may vary depending on the expertise of the counseling physician; e.g. Occupational Medicine specialist may order full PFTs with diffusion capacity; oblique X-rays

  - Refer those with question of compensation to the civilian personnel office

INTERNATIONAL CLASSIFICATION OF RADIOGRAPHS OF THE PNEUMOCONIOSES AND RECOMMENDED TERMINOLOGY

In response to a growing need for an internationally acceptable system for coding the changes seen on chest roentgenograms of individuals exposed to asbestos, a committee of I'Union Internationale Contre le Cancer (the International Union Against Cancer, UICC) and other groups met in Cincinnati in 1967 for the purpose of developing a new classification. This was subsequently adopted and became known as the UICC/Cincinnati (UC) classification. Shortly thereafter, the ILO 1958 classification was revised (based in part on the U/C 1968 classification) and became known as the ILO 1968 classification. Following a period of experience with these two classifications, a meeting was convened in 1971 and it was recommended that the ILO 1968 and U/C classifications, including standard reference roentgenograms, be combined. The obvious benefits to be derived from such a combination were the establishment of uniform international standards and the ability to compare results around the world. These recommendations were approved in 1971 and subsequently modified once again in 1980, thus giving official recognition to the classification now widely used throughout the world, the ILO 1980 international classification of radiographs of the pneumoconioses (see Table).

The object of the classification is to codify the roentgenographic changes of the pneumoconioses in a simple, reproducible manner. It does not define pathologic entities but possesses the considerable advantage of providing a uniform method of reporting the type and extent of pneumoconiosis, thus leading to international comparability of pneumoconiosis statistics. The classification (Table 12-1) is intended primarily for a comprehensive and semiquantitative description of the roentgenographic changes of all the principal features, including those of the pleura; it is likely to be particularly useful for epidemiologic studies.

GLOSSARY OF TERMS

Small Rounded Opacities

These are well-circumscribed opacities or nodules ranging in diameter from barely visible up to 10 mm. The qualifiers p, q, and r subdivide the predominant opacities into three diameter ranges - up to 1.5 mm, 1.5 to 3 mm, and 3 mm to 10 mm.

Small Irregular Opacities

This term is employed to describe a pattern which, elsewhere is this book, has been designated "linear" or "reticular" - in other words, a netlike pattern. Although the nature of these opacities is such that the establishment of quantitative dimensions is considerably more difficult than with rounded opacities, the ILO has seen fit to establish three categories - s(width up to about 1.5 mm), t(width exceeding 1.5 mm and up to about 3 mm) and u(width exceeding 3 mm and up to about 10 mm).

To record shape and size, two letters must be used. Thus, if the reader considers that all or virtually all opacities are of one shape and size, this should be noted by recording the symbol twice, separated by an oblique stroke (for example, q/q). If, however, another shape or size is seen, this should be recorded as the second letter (for example, q/t). The designation q/t would mean that the predominant small opacity is round and of size q, but that there are, in addition,

significant numbers of small irregular opacities of size t. Thus, any combination of small opacities may be recorded.

Profusion
This term denotes the number of small rounded or small irregular opacities per unit area or zone of lung. There are four basic categories:

Category 0: Small opacities absent or less profuse than in category 1.

Category 1: Small opacities definitely present but few in number. The normal markings are usually visible.

Category 2: Numerous small opacities. Normal lung markings are usually partly obscured.

Category 3: Very numerous small opacities. The normal lung markings are usually totally obscured.

These categories can be further subdivided by employing a 12-point scale by which the classification recognizes the existence of a continuum of changes from complete normality to the most advanced category or grade. The 12-point scale is listed as follows:

0/-	0/0	0/1
1/0	1/1	1/2
2/1	2/2	2/3
3/2	3/3	3/+

Employing this scale, profusion of opacities is categorized as follows: the Xray is classified in the usual way into one of the four categories, 0, 1, 2, or 3. If during the process the category above or below is considered as a serious alternative, this is recorded, e.g. a roentgenogram in which profusion is considered to be category 2 but for which category 1 was seriously considered as an alternative would be category 2/1. If no alternative was considered (*i.e.*: the profusion was definitely category 2), it would be classified 2/2.

Large Opacities
This includes opacities that are larger than the maximum permitted for small rounded opacities, i.e., greater than 10 mm. Three categories are recognized:

Category A: An opacity having a greatest diameter exceeding 1 cm and up to and including 5 cm, or several opacities each greater than 1 cm, the sum of whose greatest diameters does not exceed 5 cm.

Category B: One or more opacities larger or more numerous than in category A whose combined areas do not exceed the equivalent of the right upper zone.

Category C: One or more opacities whose combined areas exceed the equivalent of the right upper zone.

Extent

Each lung is divided into three zones - upper, middle, and lower - by horizontal lines drawn at one-third and two-thirds of the vertical distance between the apex of the lung and the dome of the diaphragm. All other terms used in the classification are self-explanatory and are identical in context to the same terms used elsewhere in this book. Standard reference roentgenograms have been selected to illustrate the ILO 1980 classification.

ILO 1980 INTERNATIONAL CLASSIFICATION OF RADIOGRAPHS OF PNEUMOCONIOSES

FEATURE	CODE	DEFINITION
SMALL OPACITIES		
Shape and Size		
Rounded		The nodules are classified according to the approximate diameter of the predominant opacities.
	p q r	p = rounded opacities up to about 1.5 mm in diameter. q = rounded opacities exceeding about 1.5 mm and up to about 3 mm in diameter. r = rounded opacities exceeding about 3 mm and up to about 10 mm in diameter.
Irregular	s t	u s = width up to about 1.5 mm. t = width exceeding 1.5 mm and up to about 3 mm. u = width exceeding 3 mm and up to about 10 mm.
		To record shape and size, two letters must be used. Thus if the reader considers that all or virtually all opacities are of one shape and size, then this should be noted by recording the symbol twice, separated by an oblique stroke (for example, q/q). If, however, another shape or size is seen, then this should be recorded as the second letter (for example, q/t). The recording q/t would mean that the predominant small opacity is round and size q, but that there are significant numbers of small irregular opacities of size t. In this way any combination of small opacities may be recorded.

Profusion				The category of profusion is based on assessment of the concentration (profusion) of opacities in the affected zones. The standard radiographs define the midcategories (1/1, 2/2, 3/3).
	0/-	0/0	0/1	Category 0 = small opacities absent or less profuse than in category 1.
	1/0	1/1	1/2	Category 1 = small opacities definitely present, but few in number. The normal lung markings are usually visible.
	2/1	2/2	2/3	Category 2 = small opacities, numerous. The normal lung markings are usually partly obscured.
	3/2	3/3	3/4	Category 3 = small opacities, very numerous. The normal lung markings are usually totally obscured.
Extent	RU	RM	RL	The zones in which the opacities are seen are recorded. Each lung
	LU	LM	LL	is divided into three zones - upper, middle, and lower.

LARGE OPACITIES

Size	A	B	C	Category A = an opacity having a greater diameter exceeding about 1 cm and up to and including about 5 cm, or several opacities each greater than about 1 cm the sum of whose greatest diameters does not exceed about 5 cm.
				Category B = one or more opacities or more numerous than in category A whose combined areas do not exceed the equivalent of the right upper zone.
				Category C = one or more opacities whose combined areas exceed the equivalent of the right upper zone.

PLEURAL THICKENING

Costophrenic Angle	R	L	Obliteration of the costophrenic angle is recorded

separately from thickening over other sites. A lower limit standard radiograph is provided.

CHEST WALL

Types — Circumscribed (plaques) under/or diffuse

Site R L

Width a b c Grade a = up to about 5 mm thick at the widest part of any pleural shadow.

Grade b = over about 5 mm and up to about 10 mm thick at the widest part of any pleural shadow.

Grade c = over about 10 mm at the widest part of any pleural shadow.

Extent 1 2 3 Grade 1 = definite pleural thickening in one or more places such that the total length does not exceed one quarter of the projection of one lateral wall. The standard radiograph defines the lower limit of grade 1.

Grade 2 = pleural thickening whose total length exceeds one quarter but not one half of the projection of the lateral chest wall.

Grade 3 = pleural thickening whose total length exceeds one half of the projection of the lateral chest wall.

Diaphragm R L A plaque involving the diaphragmatic pleura is recorded separately as present or absent, right or left. This is illustrated by an example in the standard radiographs.

PLEURAL CALCIFICATION

Site — Chest Wall, diaphragm, other

R L

Extent 1 2 3 Grade 1 = one or more areas of pleural calcification the sum of whose greatest diameters does not exceed about 2 cm.

Grade 2 = one or more areas of pleural calcification

the sum of whose greatest diameters exceeds about 2 cm but not above about 10 cm.

Grade 3 = one or more areas of pleural calcification the sum of whose greatest diameters exceeds about 10 cm.

ADDITIONAL SYMBOLS

ax = coalescence of small pneumoconiotic opacities
bu = bulla(e)
ca = cancer of the lung or pleura
cn = calcification in small pneumoconiotic opacities
co = abnormality of cardiac size or shape
cp = cor pulmonale
cv = cavity
di = marked distortion of intrathoracic organs
ef = effusion
em = definite emphysema
ex = eggshell calcification of hilar or mediastinal lymph nodes
fr = fractured rib(s)
hi = enlargement of hilar or mediastinal lymph nodes
ho = honeycomb lung
id = ill-defined diaphragm
ih = ill-defined heart outline
kl = septal (Kerley) lines
od = other significant abnormality
pi = pleural thickening in an interlobar fissure or along the mediastinum
px = pneumothorax
rp = rheumatoid pneumoconiosis
tb = tuberculosis

ASBESTOS HAZARDS TRAINING FOR NON - MEDICAL PERSONNEL

The following is provided as a guide should you be called upon by your command to provide training to non-medical personnel in the hazards and handling of asbestos.

Requirement

1 hour/year for both Supervisory personnel/employee representatives and non-supervisory personnel. The hours given are recommendations only. More or less hours may be required. The measure of success or compliance is knowledge and understanding of subject matter, not length of training.

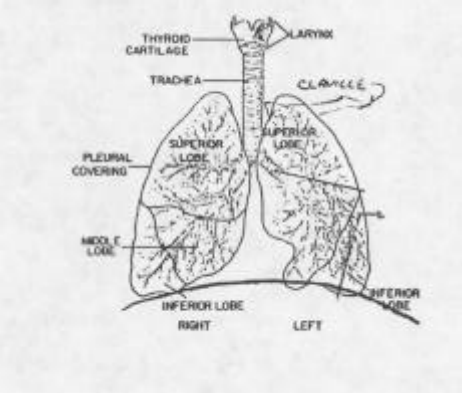
INTRODUCTIONS/DEFINITIONS

- Asbestos is:
  - Naturally occurring mineral found worldwide
  - Composition can vary - but all contain Silica and Magnesium
  - Common properties include:
    - Extremely strong and acid resistant (will never dissolve in you lungs).
    - Extremely small fibers - much smaller than fiberglass.
    - All extremely toxic.
  - We will deal with "friable" (easily turns into dust) asbestos. Over 3000 products, most asbestos is bonded.
- **Situation Afloat** - All subs and surface ships have literally miles of pipes, most insulated. Over half the insulation contains asbestos. Only a few newer boats built since 1977 are free from "friable" asbestos (Tridents, couple 688s). Often times, this insulation has to be removed or repaired because the pipe or fittings are leaking, the insulation may be damaged, or simply to make room to get at other things. This may occur underway, although the frequency may vary. We estimate an average of once per major deployment or about twice a year.

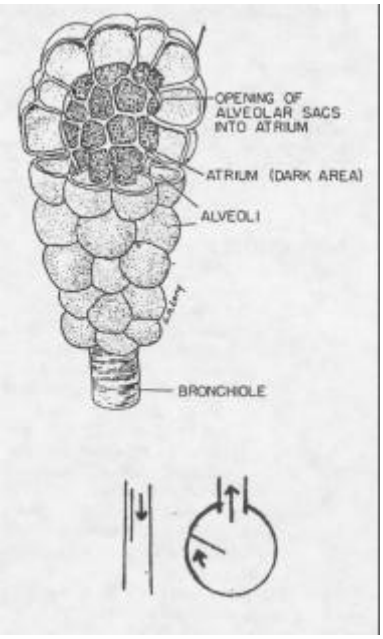
- **Common Problems Ashore** - Tunnels, boilers and pipe insulation are sources of friable asbestos ashore. While friable asbestos is replaced during repair/removal with a suitable substitute it will take years to get rid of all of the asbestos present.
  - You cannot tell asbestos from non-asbestos insulation. Individual fibers are invisible to the naked eye. Also, asbestos is often mixed with other common insulators (fiberglass, paper, diatomaceous earth, magnesia) and often in small concentrations (1-3%)
  - If the insulation is removed without precautions, this dust can become airborne, and asbestos fibers are so small (high surface are to mass), they can remain suspended in air currents for days and contaminate the whole ship.
- **Solutions**
  - Assume all insulation contains asbestos unless proven otherwise.
    - Most tenders and Navy Hospitals have the capability to identify "bulk" samples for you with special "polarizing microscope". Only need a small sample. recommend small zip-lock bag and label with all information plus completion of DD 1222.
    - Navy has a program that all non-asbestos insulation is supposed to have a "pink or red" undercoat. Simply scrape away surface. Unfortunately, not always dependable because some boats were painted pink by accident. So have all samples tested.
  - If one utilizes the procedures and equipment noted here exposure will be virtually undetectable - key all precautions have to be followed fastidiously.

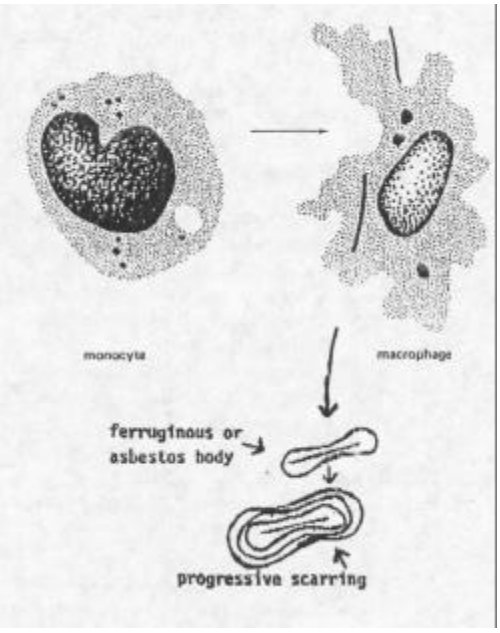
HEALTH HAZARDS &
DEGREE OF RISK

- **Asbestos**
  - The lungs are cone-shaped organs which completely fill the pleural spaces, extending from the diaphragm to about 1 1/2 inches above the clavicle.



  - The alveoli are the functional units of the lungs. **NOTE** Gaseous exchange between blood and air occurs only in the alveoli.





- Asbestos fibers are actually longer than the width of the canals, but line up in direction of the air flow. When they get into alveoli, air flow reverses and some get stuck (most go back out). Doesn't dissolve, so body attacks it with a blood cell called "phagocytes". Unfortunately, the powerful enzymes can't dissolve asbestos and these enzymes are then released into the surrounding tissue causing scar tissue to form. One reason why asbestos wasn't treated as serious as it should have been was that most cases in the past were unrecognized because, during autopsy, the fibers weren't visible (so small and covered with tissue). Unless tissue is stained with Prussian Blue, even the asbestos bodies were unrecognized.

- Major use did not start till 1940s. Latency period (time from exposure to symptoms) averaged 15-20 years and, for the other diseases, up to 40 years so we are just seeing peak of the epidemic (90,000/year die of asbestos diseases according to Dr. Silicoff).

- Usually found in people with prolonged exposure. Usually found in smokers (**NOTE**: some people have gotten asbestosis with shorter exposures after just a few years, including children (i.e. father's work clothes), but not that common).
- Unfortunately, some people will experience progressive scarring even after exposure stops (after latency period)., All this non-functional tissue interferes with O_2 intake just like emphysema and will eventually incapacitate, then kill, victim.

- **Lung cancer**
  - Exposure increases risk of getting all types of lung cancer. These cancers are the same in people who have not been exposed to asbestos, so there is no way of proving it was absolutely caused by asbestos.
  - Rate increases very interesting.
    - Asbestos Worker - 5 x normal
    - Smoker - 10 x normal rate
    - Asbestos Worker Who Smokes - 54 x normal rate
    - 45% of all asbestos workers die from cancer.
    - Only 10% of lung cancers identified early enough to be successfully treated, but odds are improving.
    - It should be noted that a one-month exposure can double the rate of cancer so small exposures should be taken seriously. (Based on industry that operated one month and shut down. People were followed twenty years later to see what they died from).
  - **Theories**
    - Lungs normally catch and remove most dust. Cilia line lungs and are coated with thin layer of mucous. The cells beneath the cilia vibrate in an upward motion creating a wave which carries the dust back out and is swallowed or spit out in sputum. This is called the "mucosal escalator". Looks like field waving in wind.

- When you smoke, the irritant gases paralyze the cells and the tar mats down the hairs, so you have nice, smooth unobstructed airways which allow dust to penetrate. Once there, they damage cells and interfere with normal processes, thus reducing the lungs ability to defend itself against carcinogens in the cigarette smoke. Some people theorize that we are always being bombarded by carcinogens but that normal healthy immunologic systems can attack foreign bodies and even identify and attack malignant cells and remove this risk. As we get older, our ability to do this diminishes and risk of cancer climbs dramatically in older ages.

- **MESOTHELIOMA**
  - Cancer of the lining of the lung or abdomen.
  - Very rare and always fatal.
  - Not associated with smoking.
  - 10% of all asbestos workers (based on past heavy exposures) will die from this.
  - Also found in individuals without exposure.
  - Two thin membranes surround the lungs and act as lubricants, otherwise it would be painful to breathe in and out. What happens is that some asbestos fibers migrate through the alveolar membrane and stick out into the lung lining. This causes a buildup of scar tissue or plaque, and it, in itself is not dangerous. But these damaged cells are apparently not used to this abuse and are very susceptible to malignant growth.
  - Even children who have gotten asbestosis and have died by the time they were 20 either from asbestos in schools or work clothes from their fathers.

- **Physicals required** for asbestos work and respirator users (X-ray. PFT, history, listen to lungs).
  - A biopsy will not mean much since most people have some fibers in their lungs.
  - Diseases are mostly irreversible, except if lung cancer is identified early enough.

REMOVAL PRECAUTIONS: There are three basic elements to controlling asbestos exposure from rip-outs.

- **CONTAINMENT** - Requires Most Planning and Work; minimizes the number of potentially exposed personnel to airborne dust and minimizes the cleanup area - can save a lot of time.
- **DUST CONTROL** - Most Important; keeps the dust from becoming airborne. If the dust doesn't get into the air, it can't be inhaled.
- **PERSONAL PROTECTIVE EQUIPMENT**: Prevents exposure if some dust does become airborne.

CONTAINMENT

- **Glove Bag** - ideal (can buy or make yourself)

- Must be made of heavy plastic - > 5 mil
- Should be reenforced with supports
- Adequate holes for gloves, vacuum hose, waste bag chute
- Use negative pressure - vacuum hose inside will provide negative pressure
- Smoke test if possible
- Use drop cloth beneath it
- Make sure all tools inside before you start including spray bottle, tape and wet wiping rags
- Double tape all seals
- Use drop cloth below glove bag
- Use tyveks, gloves, and appropriate respirator

- **Tents**
  - **Main Tent** - Primary Control Area
    - Need heavy plastic
    - Reinforced structure with sticks, rope, etc., as needed
    - Don't forget to cover floor, particularly gratings (herculite is recommended)
    - Cover all ventilation openings, equipment openings, and nooks and crannies where asbestos could fall and be difficult to remove

  - **Secondary Tent** (semi-isolatable area). Usually only need for jobs requiring more than one entry and exit - needed for vacuuming and changing clothes, staging equipment, etc.
    - Allow sufficient area for two people
    - Locate vacuum cleaner just outside, with hose running into tent
    - Can be designed to be reused (heavy herculite construction, double stitched with velcro strips on doors

DUST CONTROL

- **Wetting** - Most important aspect of all precautions. Good wetting can keep levels non-detectable.
  - **Wetting Agents** Water alone is not as effective as water with a "wetting agent". Asbestos and fiberglass are "hydrophobic"; they repel water although the binders, including paper fibers, may absorb water. By adding a wetting agent, which basically reduces the surface tension making the water softer, the water can better cling to the fibers.

  - **Typical Wetting Agents and Mixtures**
    - Neosolve or penetone - 1 to 20
    - Ethylene glycol - 1 to 5
    - Liquid soap - 1 to 40

  NOTE: Use specific manufacturer's recommendations for mixtures ratios of commercial

wetting agents. More is not better, and could be worse. Ethylene glycol ration should not vary from 1 to 5 since that is ideal ratio. Soap ratio should be varied to keep sudsing down (use experience with different soaps).

- In the RC compartment, only,m "pure water" can and should be used.
- **Methods of Wetting**. To be effective the water mixture must have time to soak in and penetrate the insulation.
  - As a minimum, the surface should be heavily misted at least one hour ahead. Good wetting agents can penetrate even paint.
  - When possible, it is recommended that the water mixture be injected beneath the surface. This can be done by modifying the sprayer nozzle on the sprayers that are part of the kit. Usually a piece of extruded aluminum pipe cut at an angle.
  - First someone pokes holes with an awl or ice pick every 14 inches on the section to be removed. The distances can be varied based on experience with different insulation diameters and mixtures.
  - Then someone inserts nozzles and slowly injects a stream beneath the surface. The amount will vary, and experience will dictate speed and quantity. You don't want large quantities squirting back out on you or on the floor.
  - **Needs time for saturation**
  - 5 hours recommended - overnight ideal 1 hour in emergency.
  - Also still need misting as insulation is cut in case there are dry pockets in the insulation. Spray bottles are good for this

- **Minimizing Force** - Minimizing force ensures that any dry dust lefty will not get the energy needed to come apart and get airborne.
  - Slow, deliberate movements
  - Sharp tools minimize force to cut
  - Correct Tools
    - Cast Cutter. Only designed to cut hard surface (designed to cut casts off of patients without blood shed). Not designed to cut wire or softer insulation inside. If you penetrate deeply, the vibration motion of the blade can kick up dust.
    - Follow up with a sharp knife or linoleum cutter. Some people carry sharpening stones. (**NOTE:** One worker stabbed himself)
  - Minimize the drop - use two people, one to hold as it is cut so it doesn't fall. Even better, use catch cloths which also keeps insulation from being crushed into the floor.

- **Special Cleanup Techniques**. It's important to follow these steps fastidiously the first time so you don't have to go back and do it again.
  - No dry sweeping - imparts energy away from the broom pushing some dust into the air.
  - Pick up large pieces by hand (can use dust pans, scrapers, hoes, flat shovels).
  - Vacuum remaining dust and debris on all surfaces including bottom of your own feet.
    - Only special "HEPA" type vacuums allowed. Normal vacuums break up dust and

throw it back out in the air. Because the fibers are so fine, they go through normal filters.

- The vacuum's filters are so fine they should be used only for fine dust, not large debris, to reduce loading and increase life of the filters. The filters are expensive ($120.00).
- Filters should be checked and "shook down" (demonstrate) and the bags emptied while still in the containment and fully suited. Before leaving containment, HEPAs should be replaced annually is used steadily throughout the year or more often if motor starts laboring.
- Don't forget to vacuum outside of vacuum and cover tape end of hose or outlet to vacuum if hose is removed. Exhaust outlet doesn't have to be sealed because fibers are trapped in the filter.

- Wet-wipe down all surfaces particularly horizontal surfaces. (Wet dust will not be removed by vacuuming alone, but vacuuming is still important because you don't want to just spread the dust when wet-wiping. Some people have prewetted rags, or you can spray and wipe as you go).
- Before you leave, make one final inspection. Look in cracks and crevices, ensure all exposed ends of insulation have been taped and sealed, and all equipment has been cleaned. You don't want to leave to come back later or build another tent.

- **Maintenance of Negative Pressure**. Ideally you don't want any dust escaping from your containment, so it should be under "negative" pressure. This means the air pressure is lower inside the tent so air will come into the tent is there are any leaks. This is done by having exhaust hoses inside the containment that carry the air, after being filtered, outside the containment. This is normally done in shipyards by having large blower motors with exhaust HEPA filters on the pier (on pullets or wheels) and running numerous trunk ventilation lines into the tent or compartment. For smaller jobs, you should have one large vacuum cleaner outside the tent running into the main containment area (in addition to leaving one completely inside since you may have to empty the one doing the cleanup). Also, one should be located outside the secondary containment with a hose long enough to be used to vacuum each other off thus killing two birds with one stone. So you need three vacuums (also gives you a backup in emergencies). Located outside, it also reduces air currents in staging areas.

- **Air Sampling**
  - Purpose: part of dust control because it does two things:
    - Sampling during the rip-out gives an indication of how well dust was controlled, which is useful in evaluating techniques and performance.
    - Sampling after the rip-out determines if the air is acceptable to remove the containment. If the levels are too high, it is because cleanup was not satisfactory.
  - Method: requires use of a calibrated sampling pump (vacuum pump) to draw air through a fine filter for recorded periods of time. Filters, which should be in the breathing zone, collect any particulates in the air. The filter paper is mounted on slide

in a special liquid that makes the filter invisible so that the fibers can be counted under microscope. Because we know the flow-rate and time, the total volume sampled is known. The estimated number of fibers on the filter are then divided by the volume sampled to give us fibers/cc of air. The method is time-consuming and not that precise (+/- 50%), but we will know is fibers are present, and there should be few, if any, in well controlled rip-out (based on many studies).

- Current standards are:
  - OSHA/NAVY/PEL - 0.2 fibers/cc (set to prevent asbestosis)
  - OSHA/NAVY/STEL - 1.0 fibers/cc (30 minute)
  - NAVY/MSAL - 0.1 fibers/cc (Medical Surveillance Action Level)
  - NIOSH - 0.01 fibers/cc (lowest level detectable)
- The standards are TLV-TWAs (threshold limit values for time weighted averages). This means the average concentration that nearly all workers can be exposed to day after day without adverse affects, based on a 40-hour workweek. Under these standards, since we breathe in 2-4 million cc's of air each eight hours, we can inhale 1 million fibers.
- We consider anything above 0.1 to be unacceptable since it indicates dust was not controlled as well as it could be and dust is still airborne. Technically, 0.1 is the standard to use to determine is the containment can be removed since no medical monitoring will be required for subsequent exposure.

- **Personal Protective Equipment**
  - **Removal of Your Own Clothing** - Don't be lazy - you don't want to chance bringing home any dust on your clothing or contaminate the rest of your wash.
  - **Full Body Protection** - Purpose is to prevent asbestos fibers from contaminating reusable coveralls and skin, so that the fibers don't become airborne and inhaled later. (Not to protect skin).
    - Standard coveralls donned first (lightweight best).
    - Then "tyvek" coveralls with built-in boots, hood, and elastic sleeve openings.
    - Two pairs of gloves are needed: rubber to be impervious and a cloth overglove to keep rubber glove from ripping.
    - Boots are to keep "tyvek" from tearing.
    - Tape all openings
    - Small tears during the job are not emergencies, but should be taped if noticed.
    - Removal is conducted the same way Anti- C's are removed (inside out).
    - Reusable clothing, boots, and coveralls should be bagged and cleaned separately.
    - Personnel should not leave site for breaks or lunch while wearing "tyvek" coveralls once the rip-out has started. They must be vacuumed and removed.

  - **Respiratory Protection**
    - For actual rip-out team, only positive pressure Airline respirators are approved for afloat rip-outs. EABs can be used but the regulator should be converted positive pressure with a small kit (you can make yourself)

- For ashore removal positive pressure airline respirators or full-face HEPA must be worn, on a case by case basis with the final decision made by IHD.
- For incidental exposure such as a watchstander in some compartments (but not in primary containment), or for brief non-routine inspections, half-mask HEPA respirators can be used.

- **Fitting Respirators** - People's faces vary. All personnel should be trained and fitted with the type that will be available. This includes: a positive and negative pressure test conducted each time a respirator is used and a qualitative fit test which should be conducted semi-annually by a qualified safety or health professional.
  NOTE: Facial hair normally interferes with a good fit if it contacts the respirator (this includes stubble). Clean shaven face is recommended.

- **Maintenance and Storage**. After each use, airline respirators should be washed with soap and water, rinsed, air-dried and then stored in plastic bags in a clean location separate from contaminated equipment.

- **Air Quality**. EAB system in submarines has satisfactory air for breathing. If it is not operational, than other sources may be needed. You cannot use oil-lubricated compressors unless they have high temperature alarms and carbon monoxide monitors. The Wilson AABA system is one way to get around this because it is a carbon vane compressor (non-oil lubricated) that uses compressed air to drive it. As long as it is located in an area with good air, it provides an acceptable source.

- **Showers** - Showers are recommended after each rip-out to remove any traces of asbestos. Should be mandatory if suit was ripped during rip-out.

IN REVIEW

- **Step-by-step planning**
  - Check out the job, mark off areas, take samples.
  - Plan containment - make drawings and list of supplies needed.
  - Construct containment - inspect and smoke test.
  - Pre-wet insulation, allow to soak.
  - Assemble all equipment on site in tent or secondary enclosure, and test all equipment.
  - Review instruction or check-off list before starting.
  - Try to start with fresh people (at least two) who can stay and complete job without breaks.
  - Don equipment.
  - Conduct rip-out using all dust control measures.
  - Inspect one last time before finishing to ensure all exposed insulation is contained (tape exposed insulation on piping and look in nooks and crannies for pieces).
  - Take air samples, remove containment if levels acceptable.

  - Dispose of bagged waste and remove bagged reusable equipment and clothing.

- Check-off list

- Equipment list

- **Final Comments on Disposal**
  - Double or Triple-bag waste.
  - Label.
  - Use fiber-drums or herculite if heavy or if insulation contains wire.
  - Dispose in special storage sites for asbestos only.
  - Locally, you need a permit to bring asbestos waste to the landfill. You check in with the operator. He logs it in, inspects, and directs you to location. It will be buried that day.
  - Don't put it in a regular dumpster. They will be compacted, and some people will scrounge around in them.