United States
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Agency

Region 7
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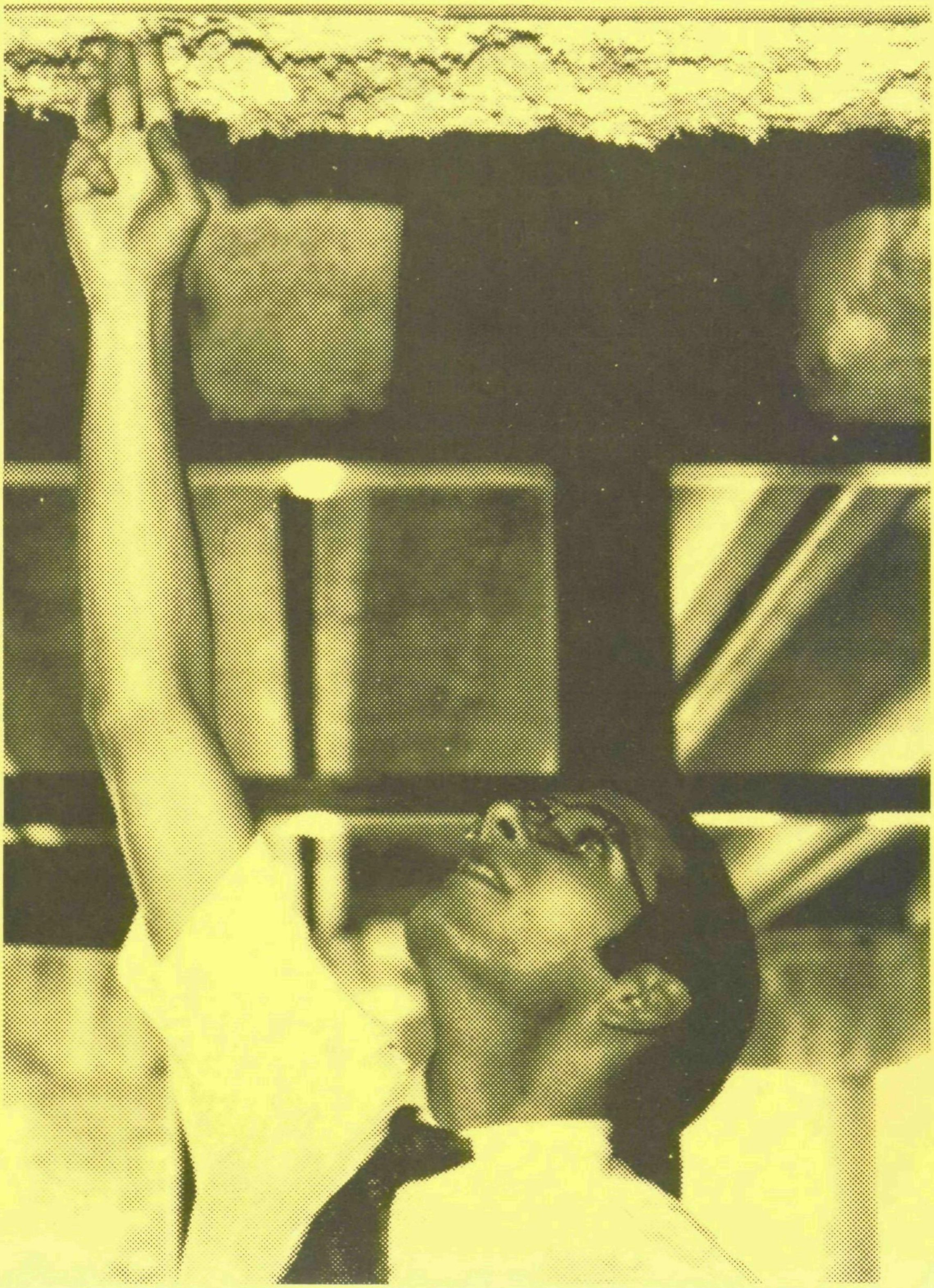
(Revised)

Toxic Substances

EPA

Asbestos Exposure Assessment In Buildings
Inspection Manual



ASBESTOS EXPOSURE ASSESSMENT IN BUILDINGS

INSPECTION MANUAL

Revised: October 1982

Prepared By

Wolfgang Brandner
Regional Asbestos Coordinator
Air and Waste Compliance Branch
Air and Hazardous Materials Division
U. S. Environmental Protection Agency - Region VII
324 East 11th Street
Kansas City, Missouri 64106
(816) 374-6538

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INTRODUCTION

Once friable asbestos-containing material has been identified in a building, the potential that the material will release asbestos fibers and contaminate the building should be evaluated. This manual will introduce you to the different types of materials found in buildings, explain some of the difficulties of ascertaining the potential of these materials to release asbestos fibers, and describe the methods for scoring the conditions you observe in buildings. This inspection manual is designed to be used in conjunction with the Environmental Protection Agency's (EPA) Guidance Documents, "Asbestos-Containing Materials in School Buildings: Part I and Part II". The Part I Guidance Document describes how to conduct visual building inspections and how to collect samples of ceiling or wall material suspected of containing asbestos. A more detailed description is presented herein on how to inspect buildings, particularly schools, for asbestos-containing material and how to evaluate the potential hazard of exposure to asbestos fibers.

BACKGROUND

During the past four years, members of the EPA Region VII office evaluated over 600 buildings in Iowa, Missouri, Kansas and Nebraska, identified as containing asbestos. Inspection of these buildings revealed basically three types of sprayed-on asbestos-containing material (See Figure 1). One was very fibrous (composed almost entirely of fibers), spongy, fluffy, loosely bonded, highly friable (easily crushed by hand pressure), and one to four inches thick. The asbestos content was usually greater than 10% with a maximum asbestos concentration of 98%. It had the appearance of cotton candy or Spanish moss hanging from the ceiling and/or walls. This material was usually a mixture of asbestos plus cellulose, rock wool, or fibrous glass which had been spray-applied and in many instances had been tamped (compressed). Several instances were found in which latex or enamel paints had been applied over the asbestos-containing material.

A second type of asbestos-containing material was an essentially non-fibrous, cementitious material commonly referred to as acoustical plaster. The major component of the cementitious, acoustical plaster was usually a dense, non-fibrous mixture of granular materials such as perlite, calcite, calcium carbonate and vermiculite. The only fibrous component was the asbestos, usually at a concentration of less than 10%. This acoustical plaster had most frequently been spray-applied; although, in a few instances it had been troweled on. This material had a coarse sand, textured appearance and was most often 1/8 inch to 1/2 inch thick, with a maximum thickness of 3/4 inch. Such materials were soft and could easily be indented by hand pressure and if rubbed, a powder residue remained on the hand. It was light tan in color if unpainted, but was frequently observed coated with latex paint.

The third type of spray-applied coating was a very hard, concrete-like asbestos-containing material. It also had a coarse sand, textured appearance and was approximately 1/8 to 3/4 inch thick. It was most often used to fireproof structural steel members and was therefore commonly referred to as fireproofing concrete. It did not leave a powder residue on the hand when rubbed and required a mechanical device to penetrate the material.

FIGURE 1.

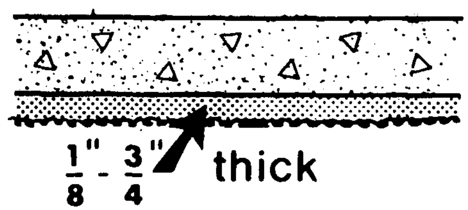
DESCRIPTION OF SPRAY-APPLIED ASBESTOS-CONTAINING MATERIAL

FIBROUS

ASBESTOS IS:

1. Highly Friable
2. Very soft
3. Fluffy & Spongy
4. Loosely bonded together
5. Composed almost entirely of fibers
6. Cotton candy/Spanish Moss appearance
7. Usually contains more than 10% asbestos

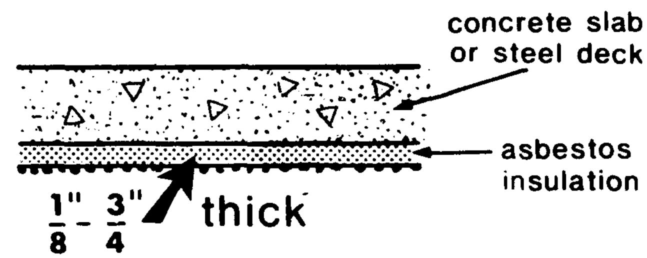
GRANULAR CEMENTITIOUS



ASBESTOS IS:

1. Friable
2. Soft, easily indented by hand pressure
3. Easily rubbed off as powder by hand pressure
4. Non-fibrous mixture of granular material, (only fibrous components are the few asbestos fibers)
5. Densely packed
6. Coarse sand, textured appearance
7. Usually contains less than 10% asbestos
8. Commonly referred to as acoustical plaster

CONCRETE LIKE



ASBESTOS IS:

1. Hard
2. Not friable; can not be damaged by hand pressure
3. Requires mechanical device to penetrate surface
4. Non-fibrous mixture of granular material, (only fibrous components are the asbestos fibers)
5. Densely packed
6. Coarse sand, textured appearance

Other types of asbestos-containing material have been observed in other parts of the United States. An asbestos-containing material having the consistency and appearance of mud is an example of a type of material observed in a Maryland school but, to date, not encountered in mid-western schools and buildings. It is therefore possible that the user of this manual may encounter an asbestos-containing material not described herein. Evaluation of such materials should be the same as illustrated in this text.

Asbestos-containing materials were most frequently encountered in the following areas: air handling room(s), boiler room, gymnasium, auditorium, stage and backstage, cafeteria, bandroom and music practice rooms, library, bathrooms, swimming pool, corridors, and above suspended ceilings. Each of these areas should be inspected and samples collected of suspect material. The highly friable, spongy, asbestos-containing material was rarely observed throughout an entire building. In most cases it was observed only in isolated rooms. For this reason, it is extremely important that each and every air handling room or music practice room, etc. be inspected. We have inspected schools with bare concrete in two air handling rooms only to find the ceiling and walls in the third air handling room coated with two-inch thick asbestos-containing material. Such air handling rooms are of particular concern because the fan can pull asbestos fibers off the ceiling and walls and blow the fibers throughout the building.

Of all the asbestos-containing buildings examined in the Midwest, approximately 80% of the coatings were acoustical plaster having the appearance of textured ceilings and having the consistency of the second type of asbestos-containing material described above. Whenever cementitious, acoustical plaster was found, it had usually been spray-applied on ceilings throughout the entire building. The predominant ceiling construction in mid-western schools was found to be a 3 coat plaster system on suspended metal lath. The final coat, or finish coat, of this 3 coat plaster system was the acoustical treatment containing asbestos fibers.

The concrete like coating was rarely located and usually did not represent an asbestos fiber exposure hazard because the material was not friable. In one instance though, this fire proofing concrete had been applied to structural steel columns which were frequently bumped by fork lifts. Pieces of fire proofing concrete were knocked to the floor and pulverized by the tires of the fork lifts thereby releasing asbestos fibers.

The use of asbestos as pipe and boiler wrapping is widespread. Damaged asbestos wrapping can easily be rewrapped in canvas or with duct tape. Since such wrapping usually has a high asbestos content, it is important to note damaged or split canvas jackets and to determine what activity caused the damage so preventive measures can be instituted.

Many other products in buildings contain asbestos. Just because asbestos is present in a product or on a ceiling or a wall does not automatically represent a hazardous situation. Only if these asbestos-containing products or coatings release asbestos fibers is there a potential for harm. To evaluate whether a potentially hazardous condition exists, a technique to assess and predict exposure to asbestos fibers had to be developed.

ASBESTOS EXPOSURE ASSESSMENT

Since early 1979 EPA has been investigating the development of an assessment inspection technique which could be used not just to measure the level of fibers in the air at any one time but rather to predict the potential for fiber release from material and subsequent contamination of the area. EPA identified eight factors which describe the condition of the material in the building, the characteristics of the activities in the vicinity of the material, and the results of analysis of the material contents. The information collected through an inspection of an area for these factors could be combined through a formula to provide a measure of the exposure potential. This information could also be used to compare different sites to one another to determine which problems are most severe and to decide the best corrective action.

All exposure assessment systems now under consideration have a similar basic format; the inspector visually inspects the area, assesses a value for each of the factors according to the severity of conditions found in each inspection area, and combines these values using the formula provided by the exposure evaluation system. By computing the weighted values in the formula, the exposure evaluation system gives an "exposure score" or indication of the appropriate corrective action. The score for each area can then be compared to other scores; the higher the score, the greater potential for fiber release and building contamination.

AIR MONITORING

When EPA first began to address the problem of evaluating asbestos exposure in buildings, one of the first techniques to be investigated was to take air samples in the area around the asbestos-containing materials and determine the concentrations of asbestos fibers. The levels found in these early examinations could then be compared with the Occupational Safety and Health Administration's (OSHA) workplace standard for asbestos. This standard was established to reduce the worker exposure in asbestos mining and processing industries. This technique has subsequently proven to be inappropriate in school buildings because of problems in both attempting to monitor the highly variable levels of fiber release found in nonindustrial situations and problems in the sampling technique.

The National Institute for Occupational Safety and Health (NIOSH) developed the method for use in measuring airborne asbestos in industry. NIOSH's air monitoring method involves drawing a measured amount of air through a filter and counting the fibers on the filter using a technique called Phase Contrast Microscopy.

Early researchers looking at asbestos exposure in buildings with friable asbestos-containing material attempted to use air monitoring with the NIOSH technique. However, several considerations made the NIOSH method unsuitable for assessing potential exposure to asbestos in schools and other buildings.

First, it is impossible for the microscopist, using phase contrast microscopy as required by the technique, to distinguish between asbestos and other fibers, so that any other fibers found in the area, such as fibers from carpets and clothing, animal hairs, or wood fiber, could be mistaken for asbestos. This is not a problem in industry where the fibers are known to be asbestos but could lead to misidentifications in other buildings where the type of fiber is not known.

Second, an analyst using the NIOSH Phase Contrast Microscopy Method cannot identify thin fibers (fiber diameter less than 0.5 micrometers) no matter the length of the fiber. The method also does not count fibers shorter than 5 micrometers. Therefore, use of the NIOSH method will not detect short/thick fibers nor long/thin fibers both of which are frequently found in buildings.

Last, and most important, is the fact that the NIOSH method uses short-term, high volume samples which are (1) inadequate to record the occasional, high-level fiber releases which occur when the material is disturbed because it is impossible to predict the location or frequency of these disturbances, and (2) inadequate to record the low levels typically found in schools during those times when disturbances of the material are not occurring in the vicinity of the sampling device.

The NIOSH technique was developed for use in industrial settings where the level of asbestos could be assumed to be constant and within the range of detectability of the technique. However, in schools, unpredictable "peak exposures" from occasional impacts are a significant source of fiber release which could result in building users' exposure to asbestos and which cannot, in most cases, be recorded by short term sampling techniques. Further research has indicated that very long term sampling (such as one to three weeks) and analysis using electron microscopy rather than phase contrast microscopy could be used to measure the low and variable concentrations of fibers in schools. This technique is, however, extremely expensive and time consuming and has therefore not proven useful in evaluating the thousands of school buildings where exposure problems are thought to exist.

Because of the highly unpredictable frequency of fiber release in schools and the limitations of the NIOSH analytical technique to identify different types and sizes of fibers, air monitoring using the NIOSH technique has proven to be an inappropriate method for evaluating asbestos exposure problems in schools and similar buildings.

FIBER RELEASE MECHANISMS

The asbestos-containing materials most likely to release asbestos fibers are those which were sprayed or troweled onto ceilings and walls or other structural elements for fireproofing, acoustic or thermal insulation, or decoration. Because of the type of mixtures used by the construction industry, these materials are commonly friable, that is easily crushed or crumbled to a powder when dry, and easily disturbed. The common application technique of pumping a dry mixture of asbestos and binder through a ring of water at the nozzle of the applicator tended to create a very friable mixture. The more friable the material, the poorer the cohesive strength of the material and the easier it is for the fibers to come loose.

The type of building also plays a part in predicting whether the material will be disturbed and fibers released. This is particularly true in schools built in the periods from World War II up until the late 1970's when the use of spray-applied asbestos was banned. Schools were usually constructed with low ceilings and the level of user activity is high; large numbers of students use the hallways, classrooms, and other areas of the school for six to eight hours a day. The materials are often located within reach of the students and the frequent movement of the population, as well as regular cleaning and maintenance, can stir up the fallen fibers and resuspend them in the air where they can be inhaled by occupants of the building.

From this discussion, three mechanisms which describe how fibers are released and dispersed within the building can be identified:

FALLOUT and IMPACT, which cause the fibers to be released from the material, and RESUSPENSION of the fibers, which promotes the dispersal of the fibers throughout the building. These three mechanisms provided the basis for the development of the eight assessment factors.

FALLOUT

Fallout is the constant release of fibers which occurs as a result of the weak bonds in the material as it was installed or which have developed over time due to the deterioration of the bonding materials. Fallout can be caused by building vibrations and movements of people or machines in the vicinity of the material. These relatively constant disturbances can break the weak bond between the asbestos fibers and the rest of the material and release the fibers into the air. In many cases the material was not properly applied, for example the components may have been poorly mixed or not allowed to cure properly, and the material is prematurely losing its cohesive strength. In other cases the material, which may have been in place for up to 35 years, has simply outlived its useful life and deteriorated. Conditions in the area where the material was applied, such as a particularly high humidity or long exposure to the sun, can speed up the deterioration process.

The type of substrate (the material to which the friable asbestos-containing material was applied) may also contribute to the fallout. Very smooth substrates, such as concrete slabs or steel, or soft material such as wallboard, tend to offer a poor surface for bonding which may lead to a premature failure of the adhesive bond between the friable asbestos-containing material and the substrate. The entire coating of material may then pull away from the substrate and be more susceptible to failure if disturbed.

Usually, fallout is a slow, imperceptible process, but the rate of fiber release may increase with the age of the structure as the material deteriorates. The rate of fallout varies primarily due to the level of background vibration and movement and to the integrity of the material. Background vibration may be caused by heating and ventilation equipment, by structural vibration, and by human activity.

IMPACT

Impact is any direct contact with the material that knocks fibers loose. Such contact may be intentional, as when material is disturbed to install electrical systems, or when the material is damaged by vandalism. It may also be unavoidable and accidental, as in the case of maintenance activity.

The frequency of the impact depends on both the location of the material and the type of activities which occur in the area. If the material is accessible to building users, the chances of impact are obviously greater. The use of the structure where the material is located and the activities of the building users also increase or decrease the chance of impact. The amount of fibers released during impact will vary according to both the intensity of the impact as well as the quality of the installation, especially the degree of friability, the cohesive and adhesive strength of the material, and the degree of deterioration which has occurred.

Generally speaking, impact is responsible for a large release of airborne fibers in a short amount of time. Fallout is low level and relatively constant, and occurs over a long period of time.

RESUSPENSION

Resuspension is the secondary dispersal or reentrainment of fibers which have previously been released by impact or fallout. The released fibers will accumulate in the area and be easily stirred up during the course of routine activities such as maintenance and general foot traffic. Once resuspended the fibers will remain in the air for long periods of time. Because the asbestos fibers are extremely aerodynamic, that is they tend to float in the air for long periods of time, resuspension can lead to high concentrations of airborne fibers in areas where there is a source of fibers from fallout and impact.

Resuspension is caused by activities such as sweeping, dusting, and pedestrian traffic and by air current from circulation systems. As an example of the level of fibers in the air which can be caused by resuspension, in a university library where custodians continuously dusted over a mile of shelving, concentrations of airborne asbestos in the vicinity of the custodian's breathing zone reached over twice the current industrial standard for asbestos factory workers. Measurable levels were also found in the vicinity of other library users at some distance from the dusting. Generally, resuspension is proportional to the level of activity within the area.

BUILDING INSPECTION

Two evaluation forms have been developed to assist you in performing a complete building inspection and to help you assess the risk of exposure to asbestos fibers. The data you record will provide the basis for advice on asbestos control measures given to building owners. An explanation of the importance of this data and how it will be used follows.

EVALUATION FORM #1

All blanks on Evaluation Form #1 should be filled in. Some questions listing multiple answers require you to circle the appropriate term(s). This form must be completed for each building or school inspected and will require interviewing the maintenance supervisor and/or the school principal. Evaluation Form #2 should be completed only if friable material is found.

The first part of Form #1 is self-explanatory. Many state and local agencies are cooperating with EPA in this program and you should be aware of who these contacts are. In most states, the asbestos contact is in the State Health Department. Be sure to include the mailing address of the school so that suggested abatement procedures can be sent to the school officials. Line seven requests the school district number and the total number of schools in that particular district. This information is needed to assure that <u>all</u> public and private schools in each district in the state have been inspected. Line eight requires you to circle which type of building is being inspected. Circle which type of construction material was used.

The type of roof in schools is usually flat with a gravel/asphalt coating. The reason for asking about the type of roof is that often water damage to asbestos-containing ceilings can only be corrected by first repairing the roof. The date constructed and/or renovated is of concern because asbestos was sprayed in buildings mainly from 1945 to 1978. Buildings constructed and/or renovated during this period deserve special attention. The reason for requesting the number of floors is to alert you to the possibility that air-handling rooms could be on several floors. The presence of a basement usually indicates the location of the boiler room. The attic may have been sprayed with asbestos-containing insulation and sometimes air-handling rooms are located here.

Number of faculty, students, maintenance personnel and other building occupants indicates number of people being exposed. Number of other building occupants should include such individuals as secretaries, lunch-room workers, volunteer aides, etc. Frequency of building evening use, and for what purpose, provides information on the degree of activity in the building and may indicate an area receiving more damage than other areas.

The persons contacted and their telephone number should be listed. This identifies the persons familiar with the conditions in the building from whom additional information can be obtained at a later date, if needed. The section for comments is provided to record such information as the names of other schools or buildings built by the same contractor in the same time period. It is highly probable that these other buildings also contain asbestos material.

BUILDING EVALUATION FORM #1
U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII - TOXICS AND PESTICIDES BRANCH
324 EAST 11TH STREET
KANSAS CITY, MISSOURI 64106 Date:________________

Evaluator:__________________ Address:________________ Phone #_______________

State or Local Asbestos Contact: ____

EPA Asbestos Coordinator: Wolfgang Brandner, Kansas City, Missouri (816) 374-6538

Building Visited:____

Address:____

District No.________________ Number of Schools in District:___________________

Type of Building: Elementary Jr. High Sr. High Other:___________________

Type of Construction: Pre-Cast Concrete Steel Frame Wood Masonry

Cast in Place Concrete Other:___________________

Type of Roof:____

Date Constructed:______________________ Date Renovated:______________________

Areas Renovated:____

Number of Floors:________ Basement: Yes No Attic: Yes No

Number of Faculty:________________ Number of Students:_____________________

No. of Maintenance Personnel:_______ No. of other Building Occupants:__________

Number of Evenings Building Used Per Week:_________________

Parts of Building Used in Evening:________________________

Purpose of Evening Use:____

Persons Contacted and Telephone Numbers:_____________________________________

____

____

Comments:____

____

____

Friable Material Found: Yes No If yes, complete Form #2

Total Amount of Friable Material in Building:_____________sq. ft.

Evaluator's Signature:____________________________

Example

BUILDING EVALUATION FORM #1
U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII - TOXICS AND PESTICIDES BRANCH
324 EAST 11TH STREET
KANSAS CITY, MISSOURI 64106

Date: October 23, 1982

Evaluator: ROY JONES Address: EPA K.C., MO. Phone # 816-374-6538

State or Local Asbestos Contact: ______

EPA Asbestos Coordinator: Wolfgang Brandner, Kansas City, Missouri (816) 374-6538

Building Visited: NORTHWEST HIGH SCHOOL

Address: 2841 Goodfellow Blvd., St. Louis, MO.

District No. 096-092-1050 Number of Schools in District: 93

Type of Building: Elementary Jr. High (Sr. High) Other: ______

Type of Construction: Pre-Cast Concrete Steel Frame Wood (Masonry) (Cast in Place Concrete) Other: ______

Type of Roof: asphalt & gravel

Date Constructed: 1953 Date Renovated: 1965

Areas Renovated: East Wing – Auditorium

Number of Floors: 3 Basement: (Yes) No Attic: Yes (No)

Number of Faculty: 64 Number of Students: 1,845

No. of Maintenance Personnel: 7 No. of other Building Occupants: 23

Number of Evenings Building Used Per Week: 5

Parts of Building Used in Evening: gymnasium & auditorium

Purpose of Evening Use: sports, meetings, plays

Persons Contacted and Telephone Numbers: Jerry Hart, Supt. of Bldgs. & Grounds, 314-642-1732. Tom Bud, Principal, 314-642-1730.

Comments: All schools in district have been inspected and sampled; 8 schools found to contain asbestos insulation on ceilings.

Friable Material Found: (Yes) No If yes, complete Form #2

Total Amount of Friable Material in Building: 28,450 sq. ft.

Evaluator's Signature: Roy Jones

Indicate whether material was found that could be crushed and pulverized by hand pressure. If such friable material was discovered, Evaluation Form #2 should be completed for each unique situation in the building. It may be necessary to consult the school's architect or review the school's floor plan in order to determine the total number of square feet of friable material in a building. The total amount of friable material provides some measure of the magnitude of the suspected problem. Be sure to sign the evaluation form.

EVALUATION FORM #2 - Front Side

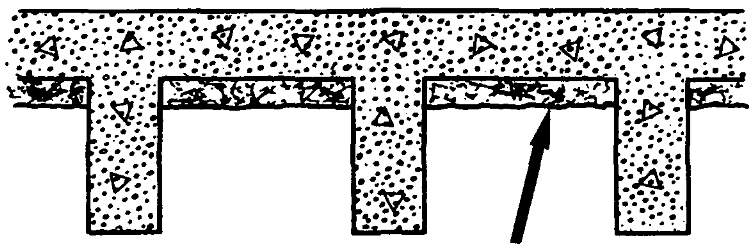
Evaluation Form #2 is to be filled out only if friable material is present. This form is used to describe the conditions in a separate room or in a part of a room; therefore, it is very likely that more than one of these forms will be filled out in a single building. This form contains a few blanks which need to be filled in. Most of the remainder of the form requires circling the appropriate description of the conditions observed.

The observations made will provide the following data: 1) What area is coated with asbestos? 2) What is the type of ceiling construction and its shape? Figure 2 presents the type of ceiling construction most frequently encountered in our inspections. Undoubtedly other types of ceiling construction will be found. 3) Height of ceiling. 4) What is the type of wall construction if the wall is coated with asbestos-containing material? 5) What is the thickness of the asbestos-containing material? 6) Is the thickness uniform over the entire sprayed surface (See Figure 3)? 7) Is it spongy and fluffy (See Figure 1)? 8) Are pieces of the coating lying on the floor or on other horizontal surfaces?

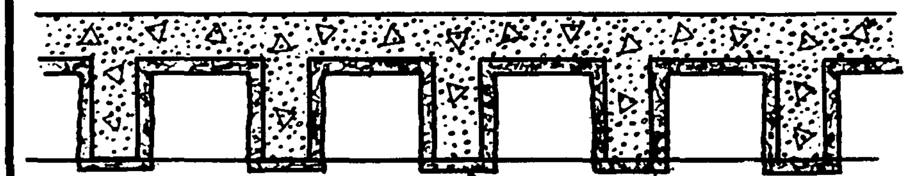
FIGURE 2.

TYPES OF CEILING CONSTRUCTION

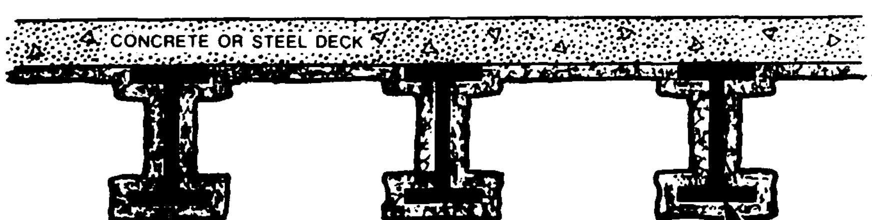
CONCRETE JOIST AND BEAM CONSTRUCTION



CONCRETE WAFFLE SLAB CONSTRUCTION



STEEL BEAM CONSTRUCTION



SUSPENDED CEILING CONSTRUCTION

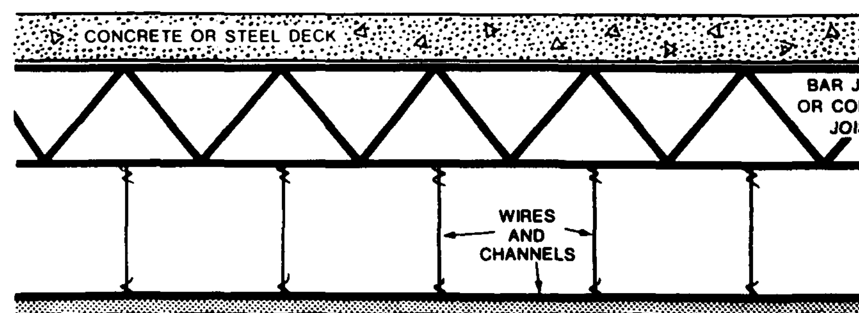
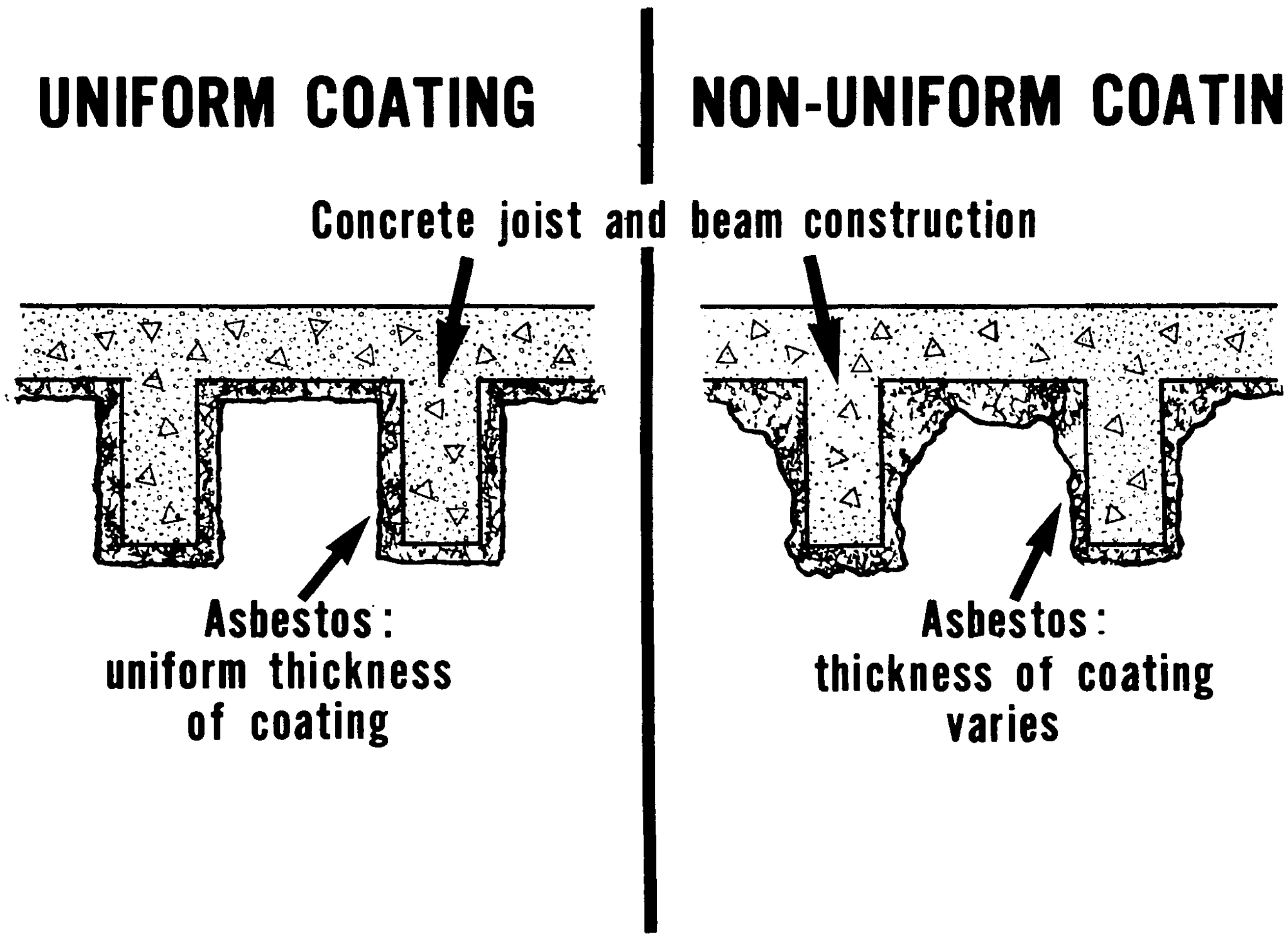


FIGURE 3.

THICKNESS OF COATING



9) Has it been painted? If painted then an attempt should be made to identify the paint used. 10) Has material been tamped (compressed)? 11) Does the coating cover the entire ceiling and/or wall or only the beams and joists, or only the spaces between the beams (See Figure 2)? 12) Is the coating a granular, cementitious surface having a textured appearance (See Figure 1)? 13) If cementitious material, does it leave a powder on the hands when rubbed or is powder on furniture and the floor? 14) Are curtains, drapes, expandable partitions, etc., being pulled across the asbestos-containing surface. 15) What type of floor and air circulation is present? 16) How are the lights mounted and how many lights are present? The space for comments is provided to record any of these findings in more detail.

The information collected on Evaluation Form #2 provides the detailed data upon which suggestions for corrective action can be made to a school or building owner. Ceiling construction and height may determine whether a suspended ceiling can be installed or whether removal is the best option. The texture of the surface upon which an asbestos coating has been applied will determine if the cleaned wall or ceiling has to be sealed with an encapsulant after the asbestos has been removed.

The type of heating/cooling system needs to be identified as to whether it is central air or unit ventilators or some other kind. We have observed some schools with no asbestos in any of the classrooms, corridors or gymnasium, but found severely damaged asbestos-containing material on the ceiling and walls of the fan room. A central air duct system connected to the fan served as the conduit for spreading asbestos fibers throughout the entire building. Whether the lights are surface mounted to the asbestos-containing material, suspended (hang below the asbestos) or recessed (submerged into the asbestos-containing material) may affect the choice of abatement methods. If an enclosure system were chosen, recessed and surface mounted lights would have to be lowered and rewired.

The type of floor is important to note because instructions must be provided on how to remove asbestos fibers from carpet if any is present. Tile and wood floors can easily be damaged if water containing a wetting agent is allowed to contact such floors during asbestos removal. The building owners need to be alerted to this potential problem so that they can make certain the contractor takes appropriate steps to protect these types of floors.

The question about what is above the room being evaluated is significant when the possibility of ceiling vibration exists. Some schools have been evaluated in which classrooms were in the basement and the gymnasium was directly above these rooms. The floor of the gymnasium vibrated frequently from ball impacts and other sports activities, causing asbestos fibers to shake loose from the coating on the basement classroom ceilings.

EVALUATION FORM #2 - Reverse Side

On the reverse side of Form #2 is a numerical system (algorithm) for evaluating the asbestos exposure hazard in a room. This algorithm was developed for EPA and evaluated in several large urban and statewide school systems. It has been used in both the Iowa and Kansas school inspection efforts by state inspectors. The remainder of this manual describes this evaluation system and how to determine which numerical values to assign to each of the factors being evaluated.

Recent comparisons of this algorithm with long-term air sampling data revealed that the algorithm did not provide accurate and reliable exposure information. For example, some instances were observed in which low numerical scores were recorded indicating no need for abatement actions yet air samplings revealed significant levels of asbestos fibers in the air. Research is continuing in an effort to develop more reliable hazard evaluation systems. In the meantime, this algorithm along with the other information collected on Evaluation Forms #1 and #2 is the best available tool for measuring potential risk.

BUILDINGS EVALUATION FORM #2

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII - TOXICS AND PESTICIDES SECTION — Date: ________
324 EAST 11TH STREET
KANSAS CITY, MISSOURI 64106 — Dist. No.: ________

Room: ______________________________ Sample Number(s): ______________

Building: ______________________ Address: ______________________________

Evaluator: ____________________________ Phone No.: ______________________

Coated Area: Ceiling Wall(s) Structural Members Above Suspended Ceiling

Pipe Lagging Boiler Insul. Other: ______________

Type of Ceiling: Concrete 3 Coat Plaster System Suspended Metal Lath

Concrete Joists and Beams Tile Suspended Lay-In Panels

Metal Deck Corrugated Steel Steel Beam or Bar Joists

Ceiling Height: __________ ft.

Ceiling Shape: Flat  Dome Other (draw):

 Folded Plate  Barrel

Type of Wall (If Coated): Smooth Concrete Rough Concrete Masonry

Plasterboard Other: ______________

Amount of Friable Material in Area being Evaluated: ____________ sq. ft.

Description of Coating: Fibrous (highly friable) Granular/Cementitious (soft) Concrete Like (hard)

Thickness: ______ inch(s) Is thickness uniform: Yes No

Coating debris on Floor/Furniture/Work Surfaces: Yes No

Curtains, expandable partitions, etc. being pulled across coating: Yes No

Coatng is Painted: Yes No Coating is tamped: Yes No

Type of Lighting: Surface Mounted Suspended Recessed

No. of Lights: ________ Type of Heating/Cooling System: ____________

Type of Floor: Concrete Tile Wood Carpet Other: __________

What is above the room being evaluated? ______________________________

Comments: ____

____

Evaluator's signature: ____________________

(continue on back)

BUILDINGS EVALUATION FORM #2
U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII - TOXICS AND PESTICIDES SECTION
324 EAST 11TH STREET
KANSAS CITY, MISSOURI 64106

Example

Date: 10-23-81

Dist. No.: 096-092-1050

Room: AUDITORIUM STAGE Sample Number(s): ____________

Building: NORTHWEST HIGH SCHOOL Address: 2841 Goodfellow Blvd., St. Louis, MO.

Evaluator: Roy Jones Phone No.: 816-374-6538

Coated Area: Ceiling Wall(s) Structural Members Above Suspended Ceiling

Pipe Lagging Boiler Insul. Other: ____________

Type of Ceiling: Concrete 3 Coat Plaster System Suspended Metal Lath

Concrete Joists and Beams Tile Suspended Lay-In Panels

Metal Deck Corrugated Steel Steel Beam or Bar Joists

Ceiling Height: 20-30 ft.

Ceiling Shape: Flat Dome Other (draw):

Folded Plate Barrel

Type of Wall (If Coated): Smooth Concrete Rough Concrete Masonry

Plasterboard Other: ____________

Amount of Friable Material in Area being Evaluated: 10,000 sq. ft.

Description of Coating: Fibrous (highly friable) Granular/Cementitious (soft) Concrete Like (hard)

Thickness: 2-3 inch(s) Is thickness uniform: Yes No

Coating debris on Floor/Furniture/Work Surfaces: Yes No

Curtains, expandable partitions, etc. being pulled across coating: Yes No

Coatng is Painted: Yes No Coating is tamped: Yes No

Type of Lighting: Surface Mounted Suspended Recessed

No. of Lights: 12 Type of Heating/Cooling System: central air

Type of Floor: Concrete Tile Wood Carpet Other: ____________

What is above the room being evaluated? Roof

Comments: Asbestos wall coating gauged because props stored against wall. Ceiling debris on floor and on stage curtains. Normal clean up is by sweeping.

Evaluator's signature: Roy Jones

(continue on back)

NUMERICAL EXPOSURE ASSESSMENT

	FACTORS		SCORES		
+	1. CONDITION	(0,2,5)			
	2. WATER DAMAGE	(0,1,2)			
	3. EXPOSED SURFACE	(0,1,4)			
	4. ACCESSIBILITY	(0,1,4)			
	5. ACTIVITY/MOVEMENT	(0,1,2)			
	6. AIR PLENUM/AIR STREAM	(0,1)		SUM	
X	7. FRIABILITY	(0,1,2,3)			
	8. % CONTENT	(0,2,3)		PRODUCT	X
				EXPOSURE NUMBER	

Additional Comments and/or Illustrations:

NUMERICAL EXPOSURE ASSESSMENT

Example

	FACTORS		SCORES
	1. CONDITION	(0,2,5)	5
	2. WATER DAMAGE	(0,1,2)	2
	3. EXPOSED SURFACE	(0,1,4)	4
+	4. ACCESSIBILITY	(0,1,4)	4
	5. ACTIVITY/MOVEMENT	(0,1,2)	2
	6. AIR PLENUM/AIR STREAM	(0,1)	1
	7. FRIABILITY	(0,1,2,3)	3
X	8. % CONTENT 98% Amosite	(0,2,3)	3

SUM: 1 8

PRODUCT X 9

EXPOSURE NUMBER: 1 6 2

Additional Comments and/or Illustrations:

Raising and lowering of some curtains and props rubs asbestos coating off walls.

EXPOSURE ASSESSMENT - A NUMERICAL SYSTEM

An asbestos exposure assessment system is a decision tool which can be used to determine the level of exposure to asbestos which exists in a building and which can also indicate what, if any, corrective action is required to control the problem. Chapter 7 "Exposure Assessment" of EPA's manual "Asbestos-Containing Materials in School Buildings: A Guidance Document-Part I" presents eight factors which must be considered by the building inspector when determining whether a hazardous condition exists due to the presence of asbestos. Presented is a method for numerically combining these factors to obtain an "Exposure Number" which, when compared to a "Corrective Action Scale" will indicate whether (and in some cases which) abatement action is necessary.[1] The actual characteristics of the asbestos-containing material and the activities in the vicinity of the material provided the basis for the selection of the eight assessment factors.

The numerical system has been prepared taking into consideration fiber characteristics, asbestos risk factors, and experience with school exposure situations. It is intended as a guide by which officials can determine the appropriate level of concern for an exposure problem. It will also aid in the selection of appropriate corrective methods. Chapter 7 points out limitations of exposure assessment, which apply to numerical as well as unquantified methods.

[1] A true exposure assessment must consider factors such as duration of exposure and population characteristics. This numerical method does not include such factors.

The numerical system has three steps: (1) the eight factors are assigned a numerical value by the inspector of the building; (2) the numerical values are combined by a mathematical formula to produce the Exposure Number; and (3) the Exposure Number is compared to the Corrective Action Scale. These three steps should be performed for each area of the building in which asbestos has either been found or is believed to be present. The three steps of the exposure assessment are described below.

Step 1: Factor Score Selection

Table I presents a list of the eight factors, a brief description of the range or extent to which a particular condition applies, and a numerical "Factor Score" corresponding to that description. The building inspector must first select the description best fitting the situation in that area. Only the scores indicated can be assigned to a factor. For example, "1", "3", and "4" are not acceptable scores for material condition. The selected score must then be written in the appropriate box (1 through 8) of Form #2 which initiates Step 2.

The area to be evaluated may be any part of the building where the factors remain uniform. For example, an auditorium with both an inaccessible ceiling surface in the stage area and a very accessible and damaged surface in the audience area constitutes two different areas. The scores for the two areas may exhibit a wide variation in exposure numbers, a different exposure assessment, and possibly different corrective actions.

A detailed description of the eight factors and photographs representing each of the numerical values has been assembled from actual building

TABLE I

ASBESTOS EXPOSURE ASSESSMENT
FACTOR SCORES

Factor	Range or Extent	Score
1. Material Condition (Deterioration/ Damage)	None	0
	Moderate; small areas	2
	Widespread; severe; pieces dislodged	5
2. Water Damage	None	0
	Minor	1
	Moderate to major	2
3. Exposed Surface Area	Not exposed. Located above suspended ceiling. None visible without removing panels or ceiling sections	0
	10% or less of the material is exposed	1
	10% to 100% of the material is exposed	4
4. Accessibility	Not accessible	0
	Low: Rarely accessible	1
	Moderate to high: Access may be frequent	4
5. Activity and Movement	None or low: Libraries, most classrooms	0
	Moderate: Some classrooms, corridors	1
	High: Some corridors and cafeterias, all gymnasiums	2
6. Air Plenum or Direct Air Streams	None	0
	Present	1
7. Friability	Not Friable	0
	Low friability. Difficult but possible to damage by hand.	1
	Moderate friability. Fairly easy to dislodge and crush.	2
	Highly friable. Fluffy, spongy, flaking, pieces hanging. Falls apart when touched.	3
8. Asbestos Content (total % present)	Trace to 1%	0
	1% to 50%	2
	50% to 100%	3

inspections conducted in the four state area. The photographs have been included to provide graphic images of the type of conditions described by each of the numerical values and to provide some uniformity to the assigning of these values when different inspectors rate suspected asbestos-containing material.

ASSESS EACH OF THE FACTORS

Carefully consider each of the following seven factors (the eighth factor, asbestos content, must be determined from laboratory reports) and record your observations:

FACTOR ONE. MATERIAL CONDITION:

The condition of the asbestos-containing material is the most important indicator of whether fibers have been released in the past or may be released in the future.

An assessment of the condition should evaluate: the quality of the installation, the adhesion of the friable material to the underlying substrate, deterioration, destruction of the material by water, vandalism which has damaged the material, and any other damage. Evidence of debris on horizontal surfaces, material hanging, dislodged chunks, scrapings, indentations, or cracking are indicators of poor material condition.

Condition is closely related to other factors considered in the assessment inspection: if the asbestos-containing material is accessible, it is likely to be damaged; if the activity level is high in the area, the level of damage may be high; and materials which are exposed may be more likely to sustain damage.

Accidental or deliberate physical contact with the friable material can result in damage to the asbestos-containing material. Inspectors should look for any evidence that the asbestos-containing material has been disturbed such as finger marks in the material, graffitti, pieces dislodged or missing, scrape marks from movable equipment or furniture, or accumulation of the friable material on floors, shelves, or other horizontal surfaces.

Asbestos-containing material may deteriorate as a result of the quality of the installation as well as environmental factors which affect the cohesive strength of the asbestos-containing material or the strength of the adhesion to the substrate. Deterioration can result in dusting of the surface of the asbestos-containing material, delamination of the material (i.e. separating into layers), or an adhesive failure of the material where it pulls away from the substrate and either hangs loosely or falls to the floor and exposes the substrate. Inspectors should touch the asbestos-containing material and determine if dust is released when the material is lightly brushed or rubbed.

If the coated surface "gives" when slight hand pressure is applied or the material moves up and down with light pushing, the asbestos-containing material is no longer tightly bonded to its substrate.

This factor is comprised of three levels:

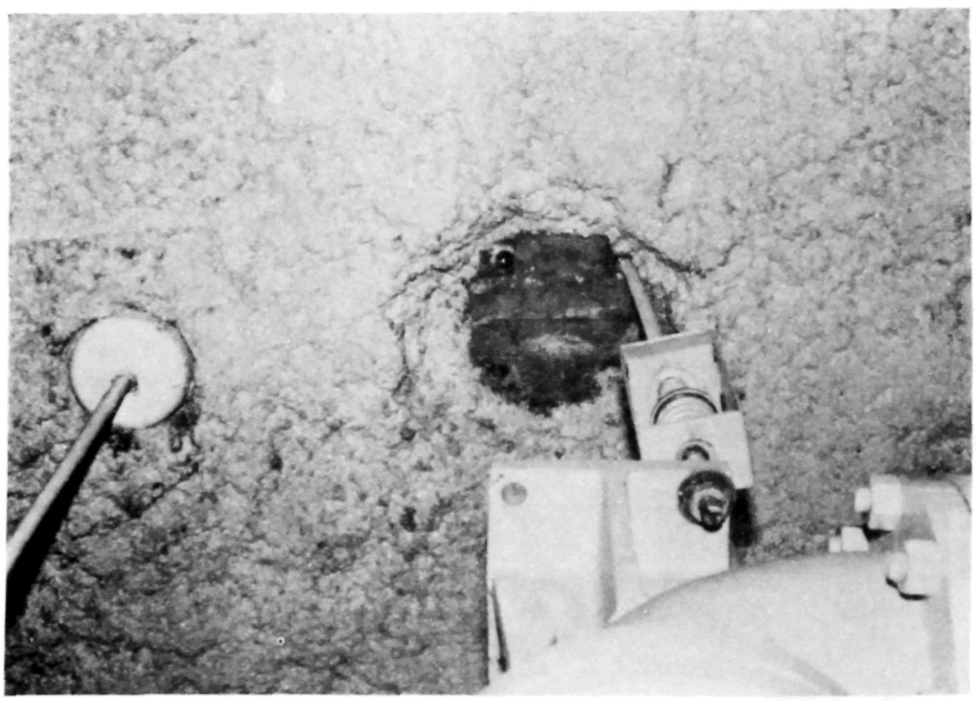
A. NO DAMAGE: Material is intact and shows no sign of deterioration. No pieces larger than a half-dollar have been dislodged.

NUMERICAL VALUE: 0

FACTOR ONE: MATERIAL CONDITION:

B. MODERATE DAMAGE - SMALL AREAS: Through visual inspection and physical contact there are indications that 10% or less of the material is breaking up into layers or beginning to fall. There may be small areas where the material is deteriorating. There may be signs of accidental or intentional damage.

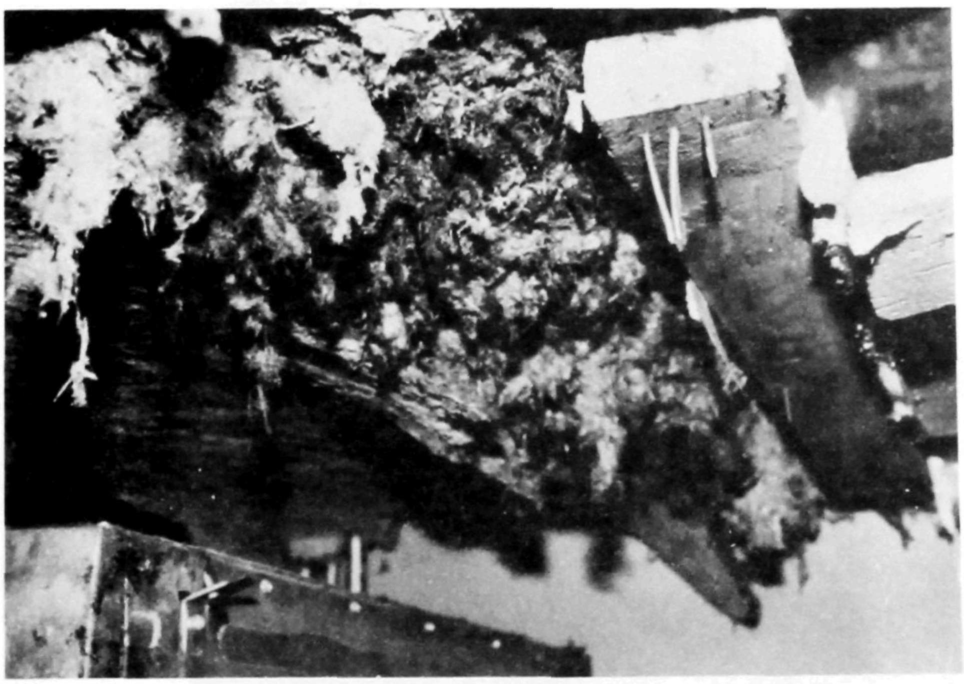
NUMERICAL VALUE: 2



FACTOR ONE. MATERIAL CONDITION:

C. WIDESPREAD SEVERE DAMAGE: Greater than 10% of the material is damaged. Large pieces are dislodged and/or debris in the area is evident. Parts of the material may be suspended from the ceilings or may have fallen to the floor. Evidence of severe accidental or intentional damage.

NUMERICAL VALUE: 5

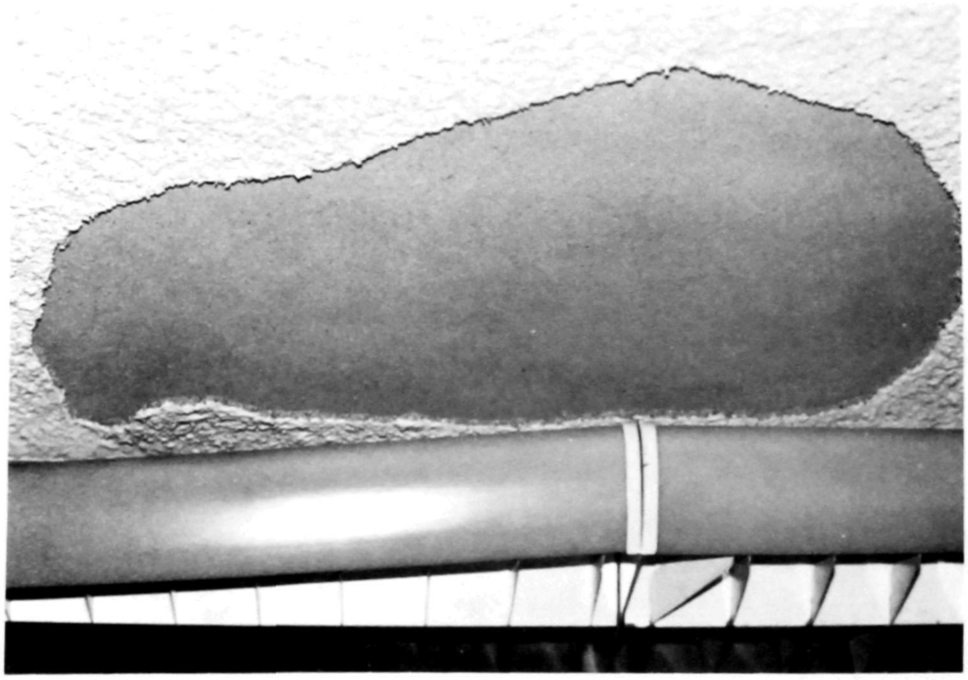


Severely deteriorated and damaged asbestos-containing ceiling insulation. Note the material is composed entirely of fibers.

Asbestos-containing wall insulation deteriorated and falling to the floor.

FACTOR ONE. MATERIAL CONDITION:

C. WIDESPREAD SEVERE DAMAGE: (continued)



Large pieces of granular/cementitious, asbestos-containing acoustical plaster have seperated from the ceiling and fallen to the floor.

Pieces of asbestos-containing, acoustical plaster lying on the floor and being pulverized by foot traffic.

FACTOR TWO. WATER DAMAGE:

Water damage is usually caused by roof leaks, particularly in schools with flat roofs or a concrete slab and steel beam construction. Skylights can also be significant sources of leaks. Water damage can also result from plumbing leaks and water in the vicinity of pools, locker rooms, and lavatories.

Water can dislodge, delaminate, or disturb friable asbestos-containing materials that are otherwise in good condition and can increase the potential for fiber release by dissolving and washing out the binders in the material. Materials which were not considered friable may become friable after water has dissolved and leached out the binders. Water can also carry fibers as a slurry to other areas where evaporation will leave a collection of fibers that can become resuspended in the air.

Inspect the area for visible signs of water damage such as discoloration of the asbestos-containing material, stains on the asbestos-containing material, adjacent walls, or floor, buckling of the walls or floor, or areas where pieces of the asbestos-containing material have separated into layers (delaminated) or come loose and fallen down thereby exposing the substrate.

Close inspection is required. In many areas staining may only occur in a limited area while water damage causing delamination may have occurred in a much larger area. In addition, the water damage may have occurred since the original inspection for friable material was conducted causing new areas to become friable and require an assessment inspection.

Delamination is particularly a problem in areas where the substrate is a very smooth concrete slab. Check to see if the material "gives" when pressure is applied from underneath.

This factor is comprised of three levels:

A. NO WATER DAMAGE: No water stains or evidence of the material being disturbed by water. No stains on the floor or walls to indicate past water damage.

NUMERICAL VALUE: 0

FACTOR TWO. WATER DAMAGE:

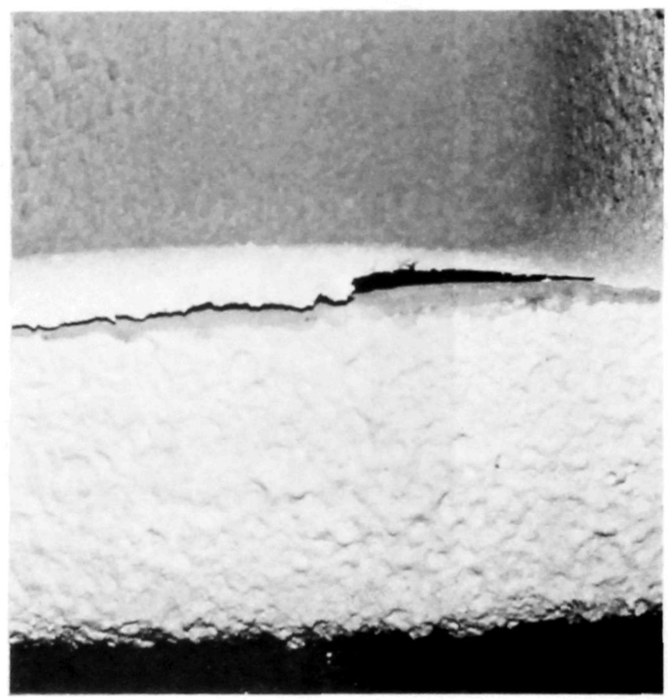
B. MINOR WATER DAMAGE: Small areas of the material or adjacent floor and/or walls show water stains and ceiling material may be slightly buckled. However, pieces have not fallen from the ceiling and the damage affects 10 percent or less of the material.

NUMERICAL VALUE: 1

FACTOR TWO. WATER DAMAGE:

C. MODERATE TO MAJOR WATER DAMAGE: Water has dislodged some of the material and caused the material to break away, or has become saturated and has the potential to fall, and/or greater than 10 percent of the material has been affected. Asbestos fibers have been carried from the asbestos-containing material by water, evaporation has occurred, and the fibers have been deposited on other surfaces.

NUMERICAL VALUE: 2

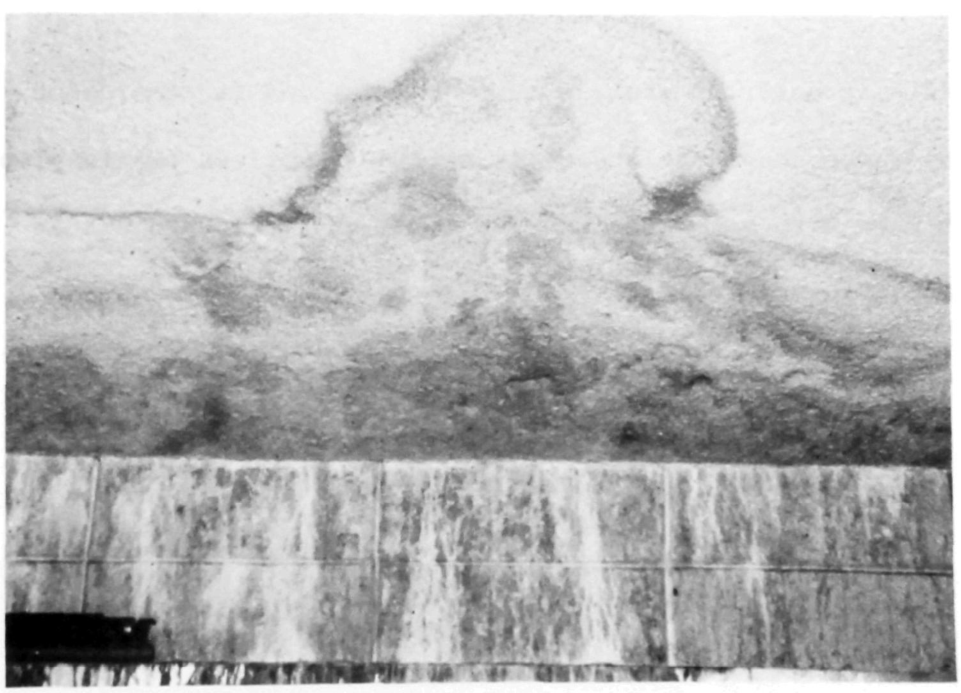


Water has destroyed the bond between the acoustical plaster and the substrate. Note delamination of ceiling coating.

FACTOR TWO. WATER DAMAGE:

C. MODERATE TO MAJOR WATER DAMAGE: (continued)

Water damage particularly severe around sky lights.



Water has leached asbestos fibers from the acoustical plaster ceiling, carried these fibers down the wall and evaporated leaving a deposit of asbestos fibers on the wall.

FACTOR THREE. EXPOSED SURFACE AREA:

The amount of asbestos-containing material exposed to the area occupied by people can increase the likelihood that the material may be disturbed and determines whether the fibers can freely move through the area. An asbestos-containing material is considered exposed if it can be seen, i.e. if there are no physical barriers which must be moved in order to get to the material. For a material not to be exposed, the barrier must be complete, undamaged, and not likely to be removed or dislodged. An asbestos-containing material should be considered exposed if it is visible, regardless of the height of the material.

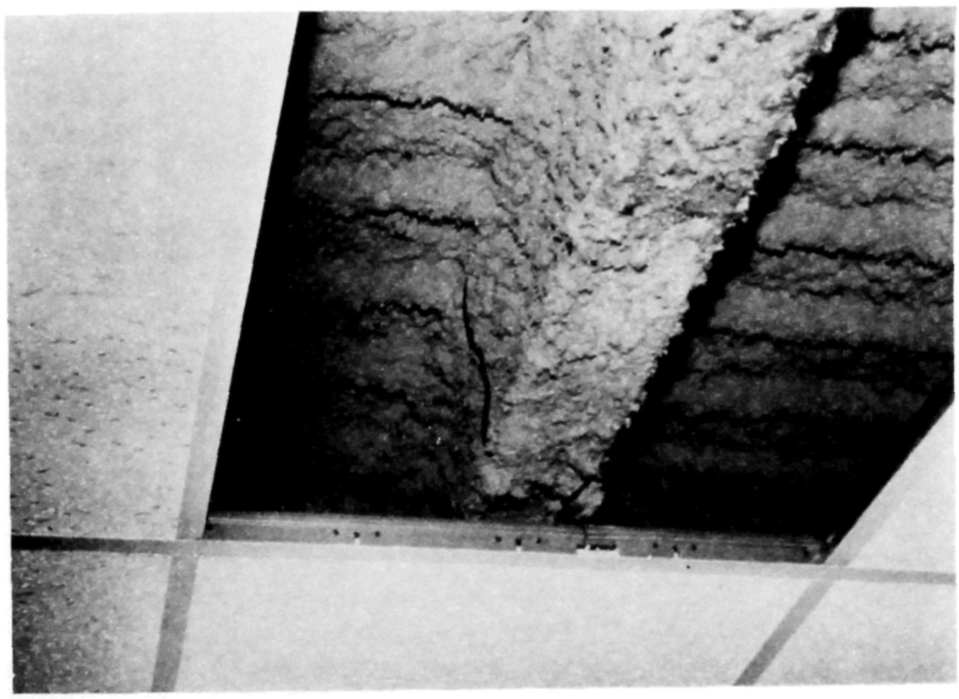
If the asbestos-containing material is located behind a suspended ceiling with movable tiles, a close inspection must be made of the condition of the suspended ceilings, the likelihood and frequency of access into the suspended ceiling, and whether the suspended ceiling forms a complete barrier or is only partially concealing the material.

Asbestos-containing material above a suspended ceiling is considered exposed if the space above the suspended ceiling comprises an air plenum. Suspended ceilings with numerous louvers, grids or other open spaces should be considered exposed.

This factor is comprised of three levels:

A. MATERIAL NOT EXPOSED: Located above suspended ceiling. None visible without removing panels or ceiling sections. Suspended ceiling is not damaged.

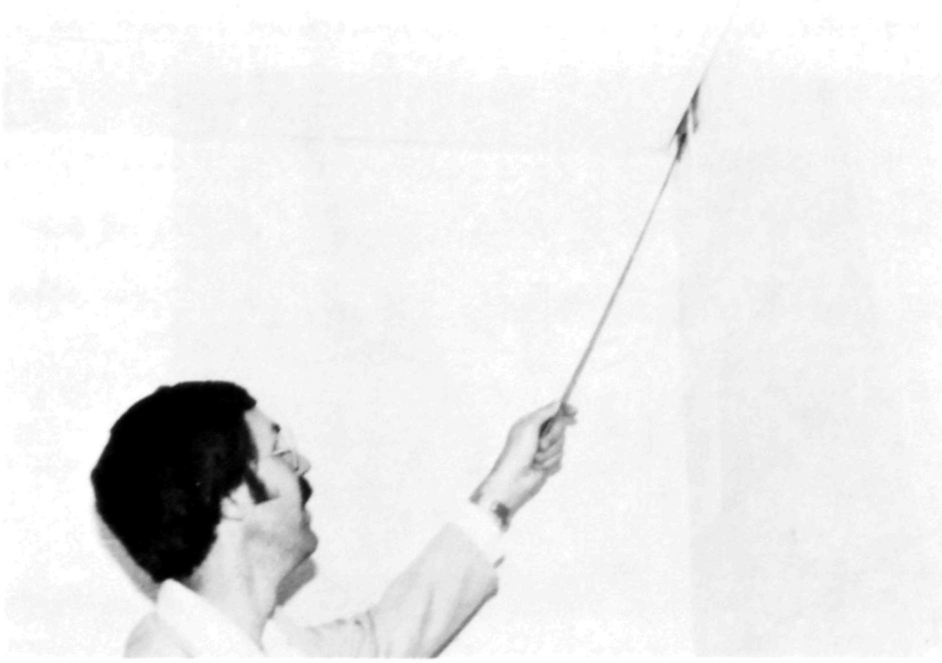
NUMERICAL VALUE: 0



FACTOR THREE. EXPOSED SURFACE AREA:

B. TEN PERCENT OR LESS OF THE MATERIAL IS EXPOSED: A few panels of a suspended ceiling have been removed. Spaces between ceiling tiles exist which would allow fibers to pass through the barrier.

NUMERICAL VALUE: 1



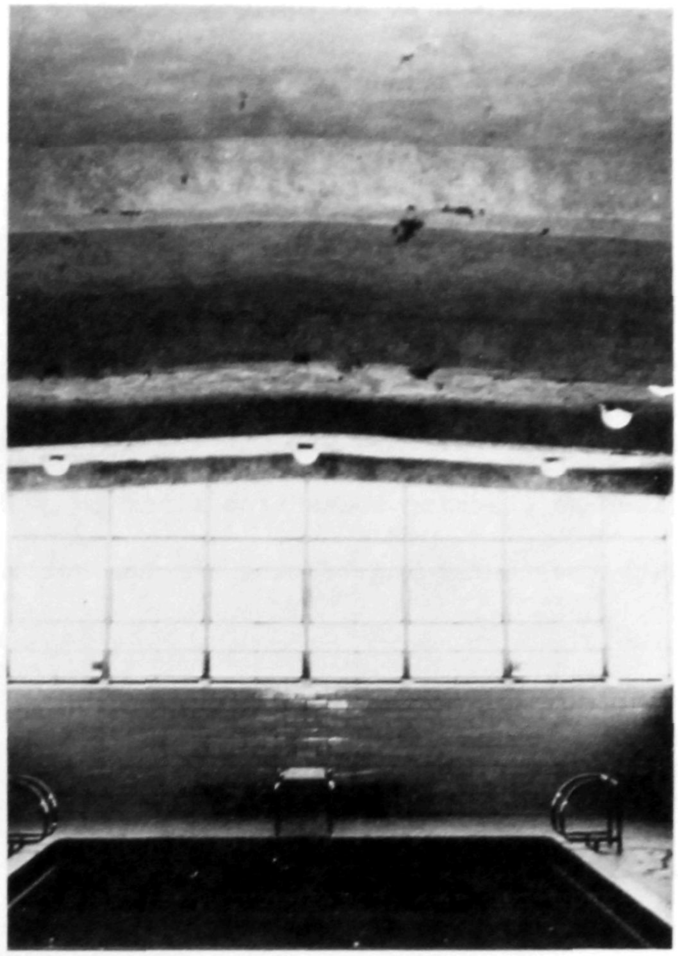
Space between suspended ceiling panels and wall. Asbestos-containing insulation above suspended ceiling.

Light difuser panel missing from suspended ceiling. Light recessed into asbestos-containing insulation.

FACTOR THREE. EXPOSED SURFACE AREA:

C. GREATER THAN 10 PERCENT OF THE MATERIAL IS EXPOSED.

NUMERICAL VALUE: 4



FACTOR FOUR. ACCESSIBILITY:

If the friable asbestos-containing material can be reached by building users or maintenance people either directly or by impact from objects used in the area, it is accessible and subject to accidental or intentional contact and damage. Material which is accessible is most likely to be disturbed in the future.

Evidence of degree of accessibility can also be determined by examining asbestos-containing surfaces for impact marks, gouges, scrapes, finger marks, items thrown into the material, etc. Even coated ceilings 25 feet high have been observed with pencils, pens, forks and other items stuck in the material. Also note such practices as stacking boxes from floor to ceiling. The top box may scrape the asbestos-containing coating off the ceiling when it is moved.

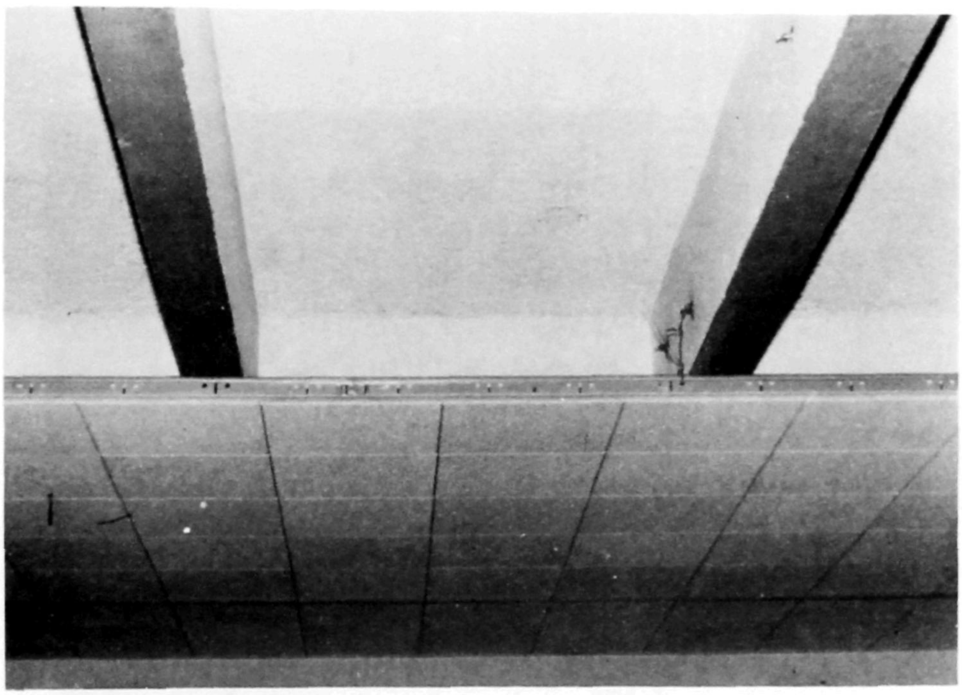
The proximity of the friable asbestos-containing material to heating, ventilation, lighting and plumbing systems requiring maintenance or repair may increase its accessibility.

In addition, the activities and behavior of persons using the building should be included in the assessment of whether the material is accessible. For example, persons involved in athletic activities may accidentally cause damage to the material on the walls and ceilings of gymnasiums through contact by balls or athletic equipment. To become fully aware of the uses of the building by its occupants, the inspector should consult with building staff or personnel familiar with routine building activities.

This factor is comprised of three levels:

A. NOT ACCESSIBLE: The material is located above a tight suspended ceiling or is concealed by ducts or piping. The building occupants cannot contact the material.

NUMERICAL VALUE: 0

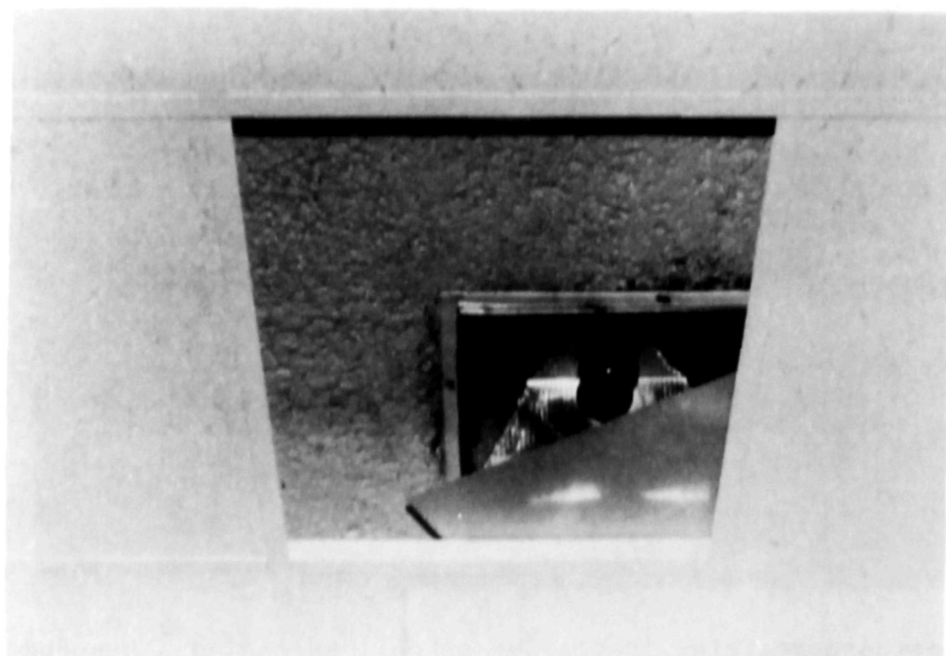


Asbestos-containing insulation on ceiling behind a suspended, splined-tile ceiling.

FACTOR FOUR. ACCESSIBILITY:

B. RARELY ACCESSIBLE: The material is contacted only during abnormal activity such as infrequent maintenance or repair of nearby heating ventilation, lighting or plumbing systems. Building occupants rarely touch the material or throw objects against it.

NUMERICAL VALUE: 1



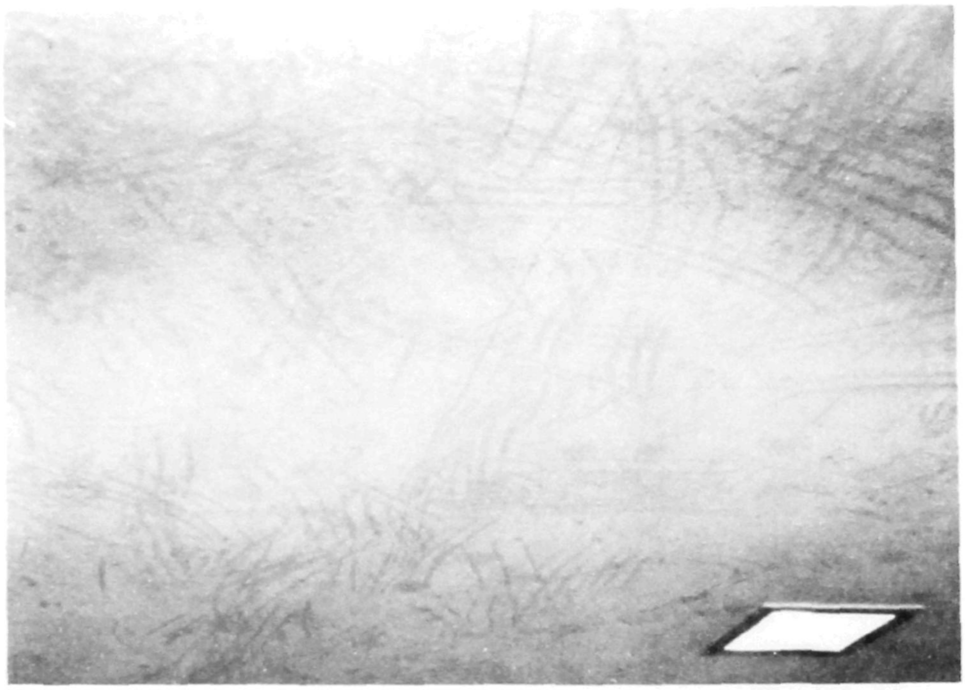
Light fixture recessed into asbestos-containing insulation. Space above suspended ceiling rarely entered, only for maintenance activities such as changing light bulbs.

FACTOR FOUR. <u>ACCESSIBILITY:</u>

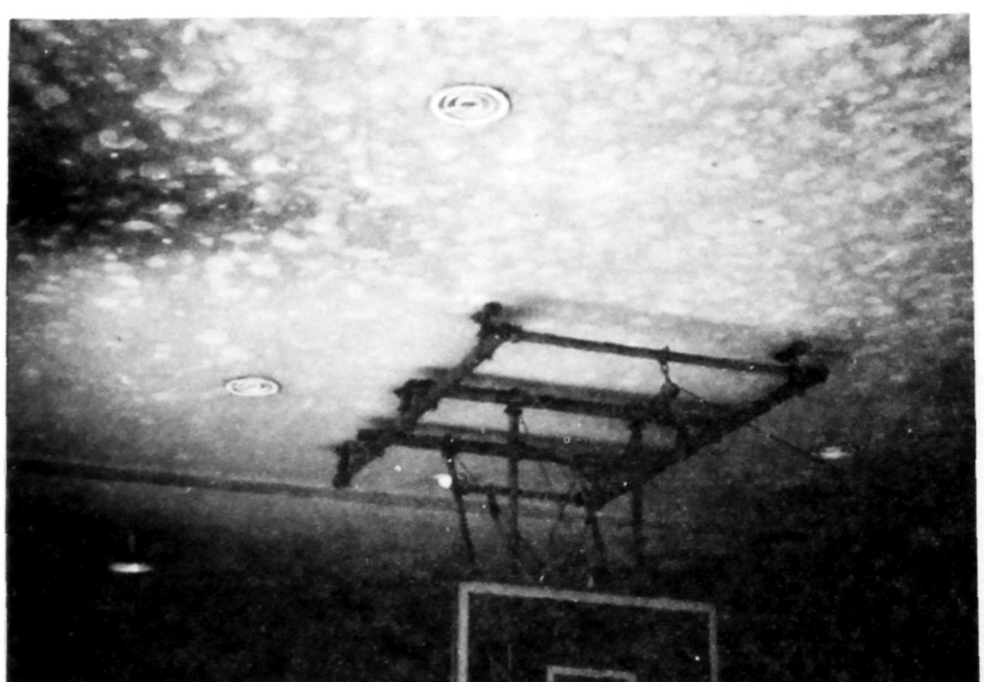
C. HIGHLY ACCESSIBLE: Material is contacted frequently due to routine maintenance. The building occupants can contact the material during normal activity at which time they routinely touch and dislodge the materials or throw objects against it. NUMERICAL VALUE: 4

FACTOR FOUR. ACCESSIBILITY:

C. HIGHLY ACCESSIBLE: (continued)



Look for evidence of contact and damage such as finger marks in acoustical plaster ceilings.



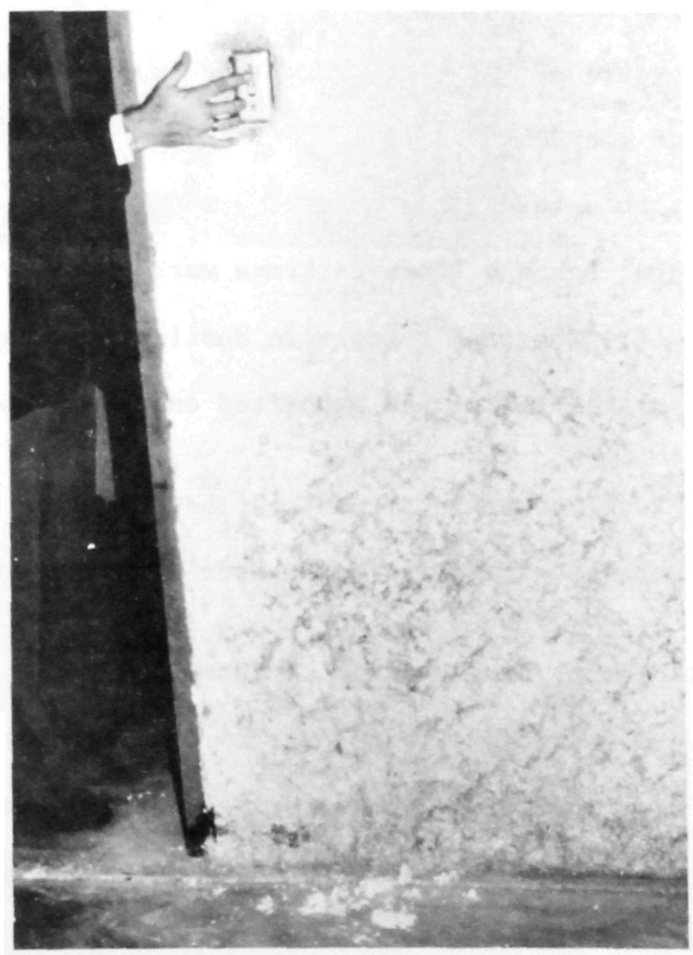
Although some ceilings may be more than 18 feet high, evidence of ball impact damage is observable on the ceiling.

FACTOR FOUR. ACCESSIBILITY:

C. HIGHLY ACCESSIBLE: (continued)

Although some asbestos-containing ceiling insulation may be out of the reach of building occupants, a ceiling is still considered highly accessible if items have been thrown at it. In many cases such items remain embedded in the insulation, as the paper airplanes in the photograph.

Another example of highly accessible, asbestos-containing insluation is wall coatings. Normal activities such as flipping a light switch can result in knocking pieces of the wall insulation to the floor.



FACTOR FIVE. ACTIVITY AND MOVEMENT:

The level of activity and movement in the vicinity of the astestos-containing material can affect both the potential for disturbance of the material as well as the level of resuspension of the fibers which have come loose from the material. Consider not only the movement caused by the activities of people in the area but also movement from other sources such as high vibration from adjacent rooms, highways, etc.

Another source of vibration is sound, such as music and noise. Sound sets air-waves in motion at certain frequencies. As these sound waves impact on asbestos-containing material, they may vibrate this material and contribute to fiber release. Therefore fibers may be released to a greater extent in a band room, music practice room, or auditorium than in the remainder of the building. Aircraft noise also has the ability to vibrate buildings; therefore, the inspector should determine if the building is in a direct flight path. Although I am not aware of any research data which would substantiate my hypothesis that sound vibrations could contribute to fiber release, common sense would indicate that this theory has merit. During our inspections we have learned that in several schools whose ceilings were coated with asbestos-containing acoustical plaster, the band rooms were dustier than any other room in the school and granular material was deposited on floors and desks after music practice sessions.

The level of activity can best be described by identifying the purpose of the area as well as estimating the number of persons who enter the area on a typical day.

This factor is comprised of three levels:

A. NONE OR LOW ACTIVITY: This level would normally include areas such as administrative offices, libraries, and those classrooms where the population is quiet and non-destructive.

NUMERICAL VALUE: 0

FACTOR FIVE. ACTIVITY AND MOVEMENT:

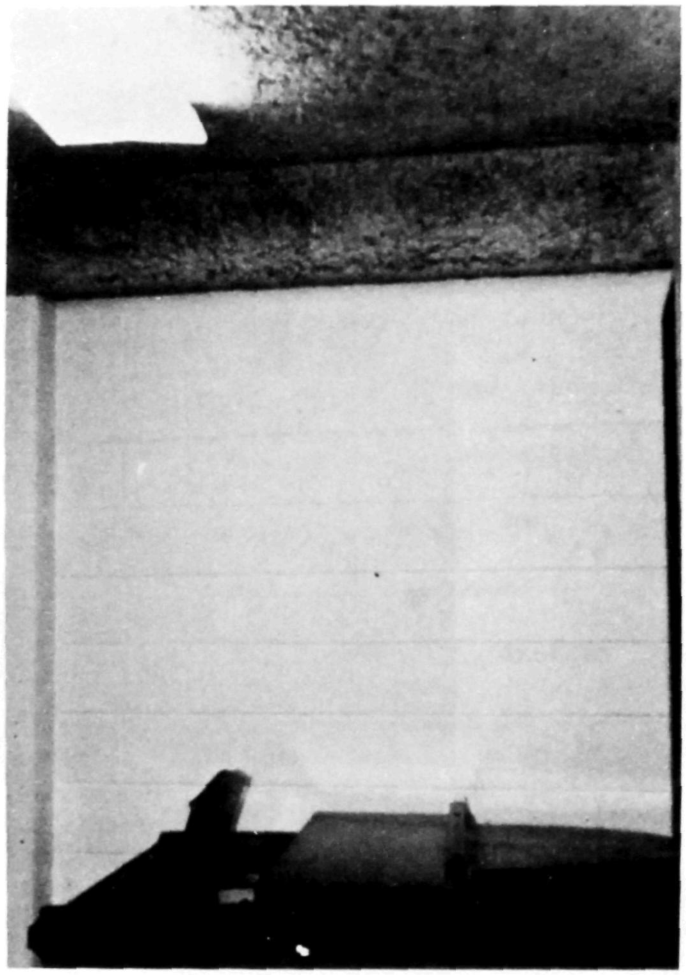
B. MODERATE ACTIVITY: This level describes corridors, classrooms or other areas where activities exist that could create undue vibration. This vibration could result in fibers being released from the material into the immediate area.

NUMERICAL VALUE: 1

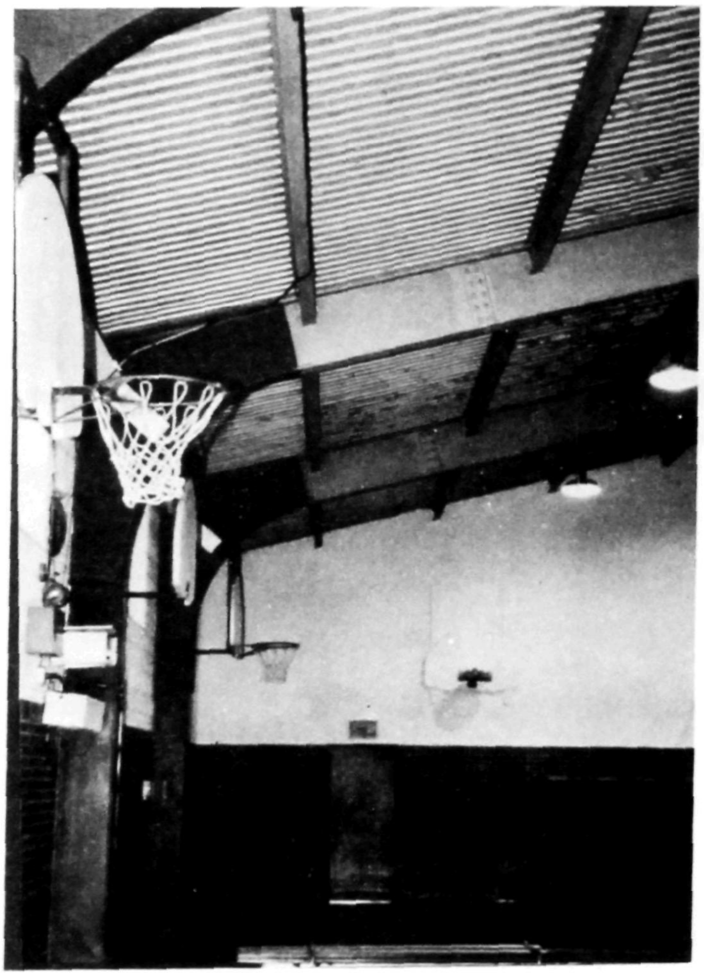
FACTOR FIVE. ACTIVITY AND MOVEMENT:

C. HIGH ACTIVITY LEVEL: This level may be found in cafeterias and corridors whose occupants are vandalous or disruptive in their activities. This also includes all gymnasiums, swimming pools and rooms containing machinery.

NUMERICAL VALUE: 2



Although the activity level of the room occupants may be low, sound waves generated by the musical instruments may vibrate the asbestos-containing insulation and result in fiber release.



Gymnasiums are high activity level areas and ceiling damage is usually evident.

FACTOR SIX. AIR PLENUM OR DIRECT AIR STREAM:

An air plenum exists when the return (or, in rare cases, conditioned) air leaves a room or hall through vents in a suspended ceiling and travels at low speed and pressure through the space between the actual ceiling and the suspended ceiling or ducts. In evaluating whether an air plenum or direct air stream is present the inspector must look for evidence of ducts or cavities used to convey air to and from heating or cooling equipment or the presence of air vents or outlets which blow air directly onto friable material.

A typical construction technique is to use the space between a suspended ceiling and the actual ceiling as a return air plenum. In many cases you will have to lift the tiles in the suspended ceiling to check if this is the case. Inspection of the air handling or HVAC equipment rooms may also provide evidence of the presence of this material in the plenums.

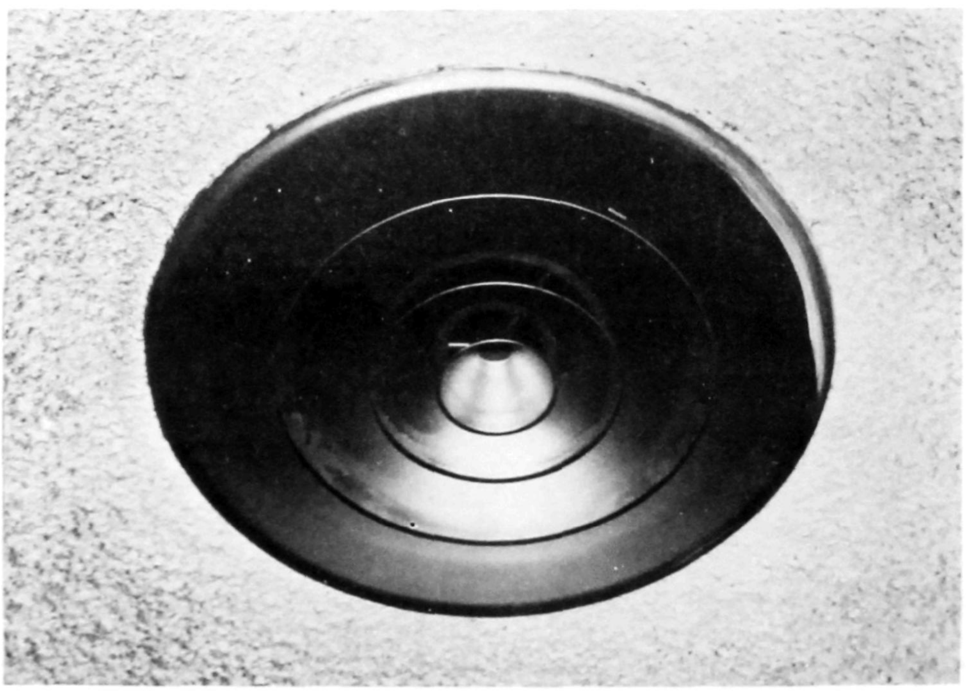
Special attention should be paid to whether activities such as maintenance frequently occur which would disturb the material in the plenum. Also any evidence that the material is being released or eroded (i.e. is it damaged or deteriorated so that the material is free to circulate in the airstream) such as accumulations of the material in the plenum should be noted.

The presence of a direct air stream is indicated by discoloration of the asbestos coating in the vicinity of a vent or erosion patterns may be evident in the asbestos-containing material.

This factor is comprised of two levels:

A. NO AIR PLENUM OR DIRECT AIR STREAM PRESENT:

NUMERICAL VALUE: 0

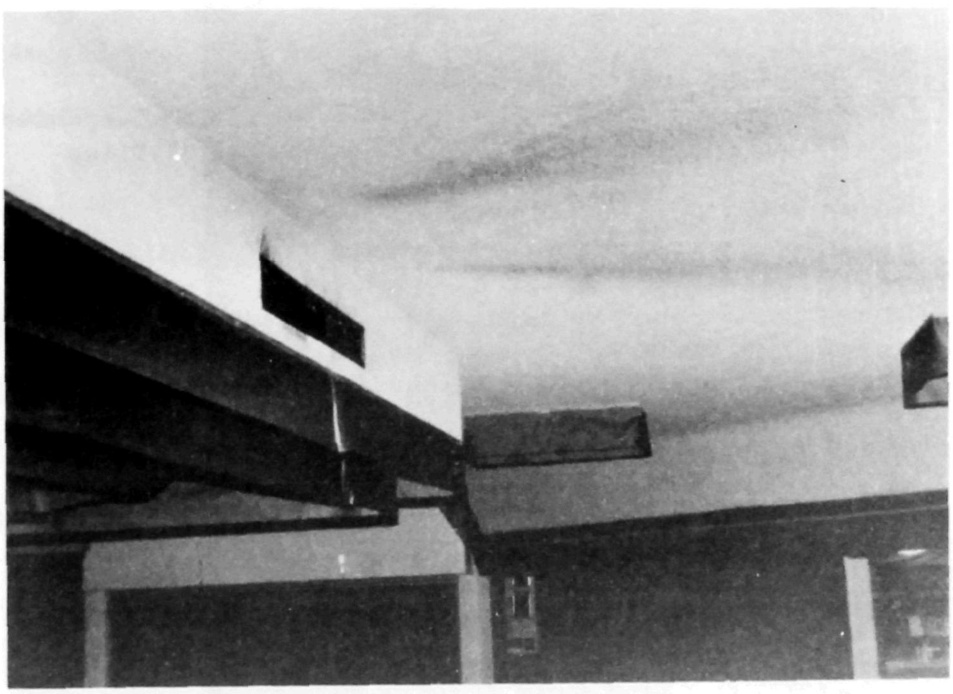


An Anemostat - air diffuser designed to direct the air stream downward in a circular pattern, usually directing no air passage across ceiling surface. No dust patterns are evident either on the ceiling or on nearby walls.

FACTOR SIX. AIR PLENUM OR DIRECT AIR STREAM:

B. AIR PLENUM OR DIRECT AIR STREAM PRESENT: Look for dust patterns deposited by an air stream on surfaces next to air supply diffusers. Fan rooms coated with asbestos-containing material may be contributing asbestos fibers to the building air if the circulation system draws air from such a coated room. Look for debris from the asbestos-containing material being deposited on dampers and filters of the air intake.

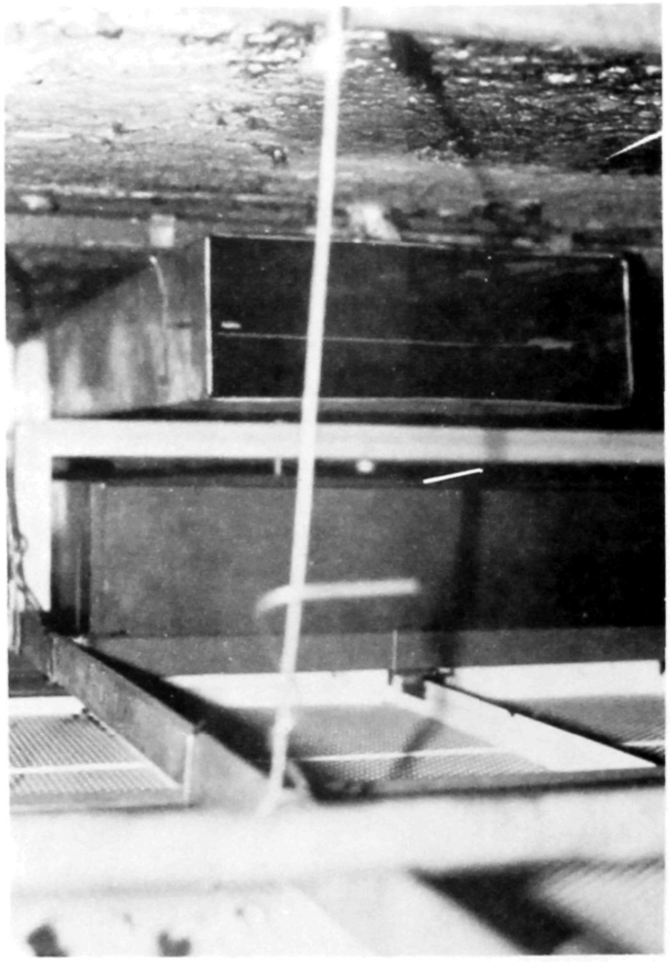
NUMERICAL VALUE: 1



Look for air erosion patterns in the ceiling or wall coating.

FACTOR SIX. AIR PLENUM OR DIRECT AIR STREAM:

B. AIR PLENUM OR DIRECT AIR STREAM PRESENT: (continued)



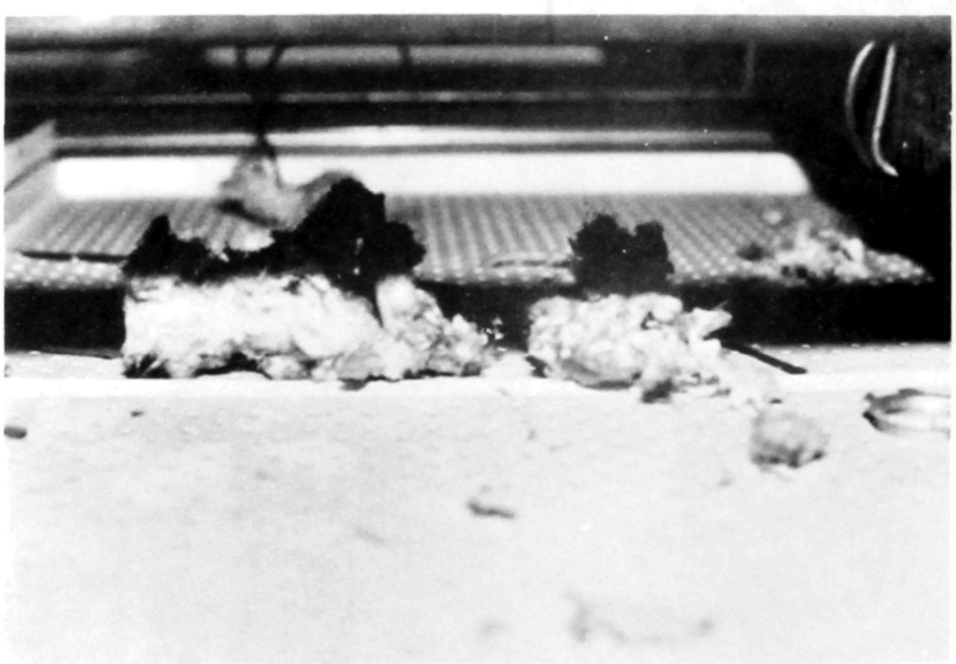
Erosion Pattern in Asbestos Ceiling Insulation.

Open End Air Duct

Suspended Ceiling Tiles

Insulation debris on ceiling tiles

Air Plenum Space Above Suspended Tile Ceiling



Asbestos-Containing insulation debris

Perforated Metal Ceiling Tiles (Note numerous 1/8 inch holes in tiles)

Close-up of lower portion of photo above.

FACTOR SEVEN. FRIABILITY:

The term "friable" is applied to material that can be crumbled, pulverized, or reduced to powder by hand pressure. In order to evaluate the friability of the material it must be touched. The asbestos-containing material can vary in degree of friability. The more friable the material, the greater the potential for asbestos fiber release and contamination. Spray applied asbestos-containing material is generally more friable than trowel applied material.

This factor is comprised of four levels:

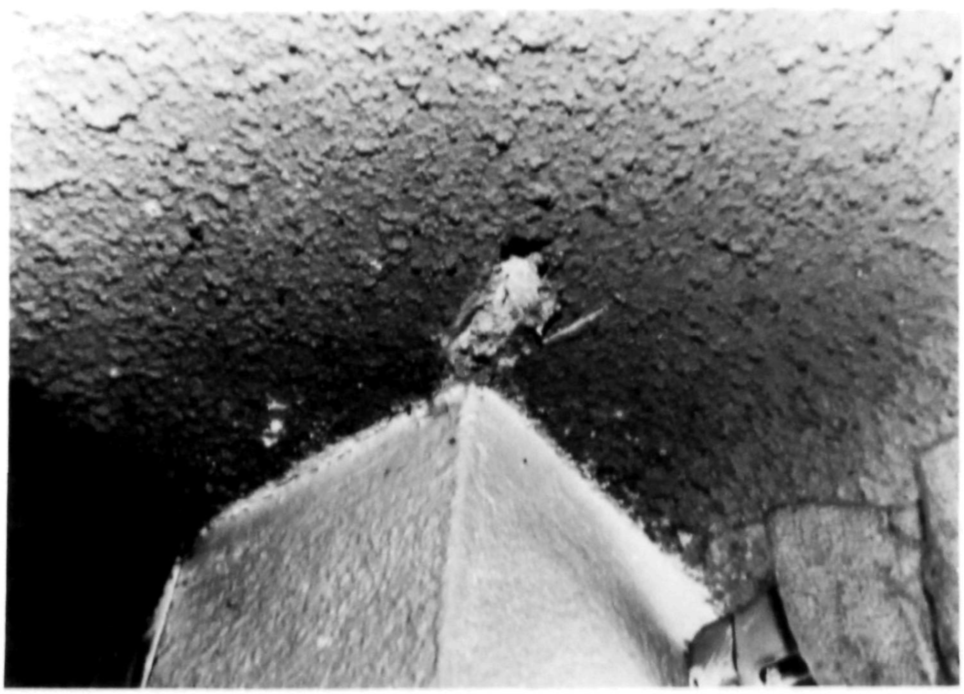
A. NOT FRIABLE: Material that is hard and crusty. Cannot be damaged by hand. Sharp tools required to penetrate material.
NUMERICAL VALUE: 0

B. LOW FRIABILITY: Material that is difficult yet possible to damage by hand. Material can be indented by forceful impact. If the granular, cementitious asbestos-containing material is rubbed, it leaves granules on the hand but no powder.
NUMERICAL VALUE: 1

FACTOR SEVEN. FRIABILITY:

C. MODERATE FRIABILITY: Fairly easy to dislodge and crush or pulverize. Material may be removed in small or large pieces. Material is soft and can easily be indented by hand pressure. The granular, cementitious asbestos-containing material leaves a powder residue on the hands when rubbed.

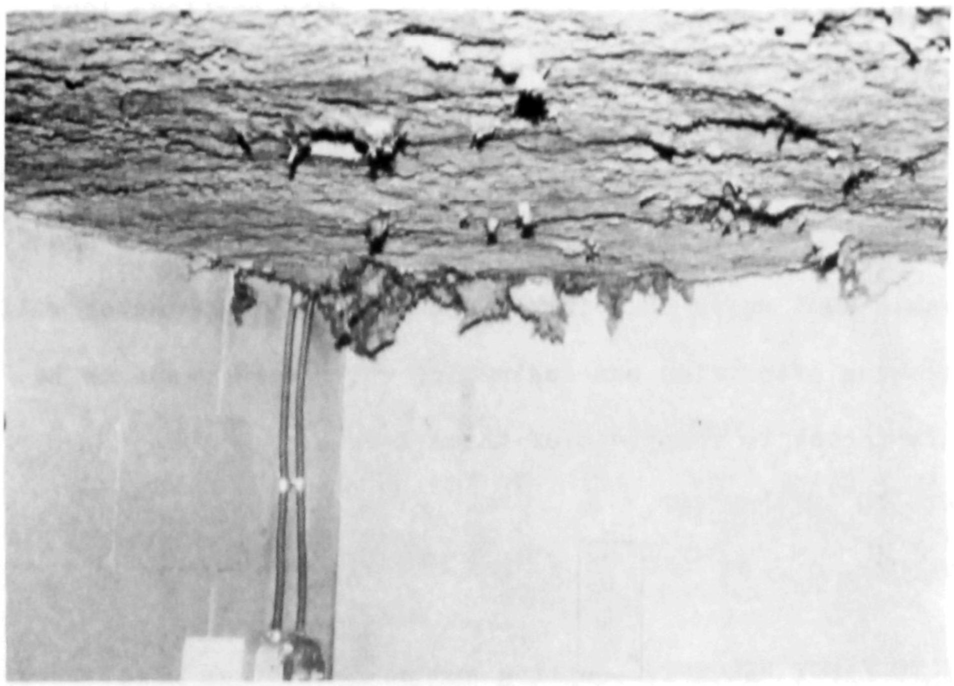
NUMERICAL VALUE: 2

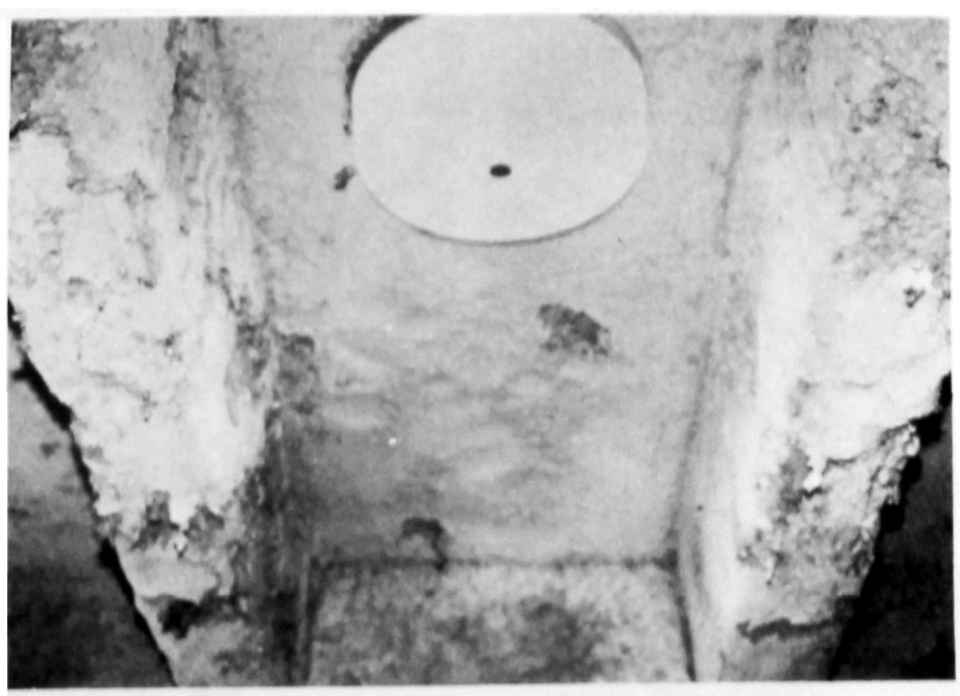


FACTOR SEVEN. FRIABILITY:

D. HIGH FRIABILITY: The material is fluffy, spongy, or flaking and may have pieces hanging down. Easily crushed or pulverized by minimal hand pressure. Material may disintegrate or fall apart when touched.

NUMERICAL VALUE: 3





FACTOR EIGHT. ASBESTOS CONTENT:

The percentage for all types of asbestos present should be added for the total asbestos content. The numerical value is assigned based upon the report of analysis, not on appearance of the material. The photographs are included only to demonstrate the appearance of coatings most frequently observed that contain asbestos at the concentrations describing this factor. Many coatings look just like those represented in the pictures, but do not contain any asbestos.

With a high percentage of asbestos, there are more fibers that can be released and contaminate the building environment. Therefore, if certain areas are identical in their assessment using the other seven factors, this factor will be helpful in establishing priorities and indicating which area needs to be addressed first. This factor is comprised of three levels:

A. TRACE AMOUNTS TO ONE PERCENT.

NUMERICAL VALUE: 0

B. ONE PERCENT TO FIFTY PERCENT. Ceiling and wall coatings most frequently encountered in this category were the granular, cementitious acoustical plasters.

NUMERICAL VALUE: 2

FACTOR EIGHT. ASBESTOS CONTENT:

C. FIFTY PERCENT TO ONE HUNDRED PERCENT. Most frequently materials containing over 50% asbestos were pipe and boiler wrapping or the fibrous, cotton candy, type sprayed-on insulation.

NUMERICAL VALUE: 3

Step 2: Exposure Number Calculation

The Exposure Number is derived from the Factor Scores by a formula. After entering the chosen Factor Scores on lines 1 through 8 of Form #2:

a) Sum factors 1 through 6 and enter opposite SUM;

b) Multiply factor 7 times factor 8, and enter opposite PRODUCT;

c) Multiply SUM times PRODUCT and enter opposite EXPOSURE NUMBER.

This number represents the result of your assessment for each area of the building. The values can range from 0 to 162. The higher the numerical value, the greater the potential for fiber release and therefore the more hazardous the situation. The Exposure Number must now be compared to the Corrective Action Scale, which is Step 3.

Step 3: Comparison of Exposure Number to Corrective Action Scale

Table II, Corrective Action Scale, presents four types of corrective action, a brief description of each, and a range of Exposure Numbers for which that Corrective Action is appropriate. Compare the Exposure Number derived in Step 2 to the ranges in Table II to determine whether action is needed. For example, an Exposure Number of 60 clearly indicates that the asbestos should be removed. An Exposure Number of 10, however, might suggest encapsulation or deferral of action. In this case it is necessary to further analyze the situation, perhaps to consider factors such as length of time that action could be deferred.

The Exposure Number can be used:

(1) To determine whether corrective action can be deferred or initiated. With a score of zero to twelve, corrective action can usually be deferred. This is assuming that a continuing inspection program will be implemented and that inadvertent damage to the material will be avoided.

(2) To set priorities for decision making. The higher the exposure number, the higher the priority.

(3) To select a corrective action. The exposure number indicates methods found to be appropriate in school exposure situations. The corrective action scale is to be considered as a guideline for decision making. Local conditions will have significant influence on corrective action selection.

TABLE 2

CORRECTIVE ACTION SCALE

CORRECTIVE ACTION	EXPOSURE NUMBER RANGE
Deferred Action	0-12
Encapsulation There appears to be a wide range of numbers and conditions where use of a sealant has provided a satisfactory solution. Encapsulation seems to be appropriate especially for conditions where there is a large area exposed (Factor 3) and there is a low score for the other factors. It is inappropriate to use encapsulation where severe water damage or the potential for water damage is evident (Factor 2). A high accessibility factor (Factor 4) also indicates that encapsulation is inappropriate.	
Enclosure Enclosure has been used over virtually the entire range from below 10 to above	10-50

100. It is also, by far, the least used corrective method. It is an inappropriate corrective method in the same situations where encapsulation is inappropriate (Factors 3, 2, and 4).

<u>Removal</u>	40 and over

Removal is the only complete solution. It is usually appropriate where the exposure number indicates a high exposure problem. Removal can be inappropriate if the asbestos material must be removed from a complex surface (such as pipes, lines, and ducts) which is relatively inaccessible.

USE OF ALGORITHM SCORES TO DETERMINE POTENTIAL FOR FIBER RELEASE

In the previous publication of this manual examples were provided demonstrating the use of algorithm scores to determine appropriate corrective actions. During four years of use by EPA Regional Office inspectors as well as by state inspectors, the algorithm was found to be more useful as an indicator of the degree of hazard than as a justification method for a particular corrective action. Experience has shown that the corrective action chosen by a building owner often is determined by none of the algorithm factors; instead, it is determined by available financial resources and by employee as well as public pressure. The algorithm proved to be a useful tool in setting priorities. The assumption was made that the higher the algorithm exposure number, the more hazardous the situation and the more likely for asbestos fibers to be released into the building air. In this manner school districts as well as building owners could be advised of which buildings or areas within buildings needed correction on a priority basis and which ones could be postponed.

The use of an algorithm or any other assessment system for determining the need to take corrective actions relies on estimating the likelihood of fiber release from asbestos-containing materials. Factors are evaluated which are assumed to represent a relationship between the asbestos-containing materials and airborne, asbestos fiber levels. Such an assessment tool has the advantage of being practical by allowing an inspector the use of the powers of observation to reveal the potential for future fiber release even when actual levels of airborne asbestos fibers are relatively low. An inspector trained in the use of the algorithm can evaluate the asbestos-containing materials in various locations within a single building or in different buildings and compare results. This type of comparative rating system can then be used for setting asbestos control priorities.

To determine the validity of the assumed relationships between the eight algorithm factors and actual concentrations of airborne asbestos fiber levels, EPA sponsored a comprehensive study in an urban school district comparing algorithm scores with air monitoring. Of the eight algorithm factors assumed to be positively correlated to measured levels of airborne asbestos fibers, only two were confirmed: the presence of water damage and proximity of the asbestos-containing material to an airstream created by the ventilation system. Results for the degree of friability, percent asbestos content and degree of activity did not confirm prior expectations of a direct relationship with airborne asbestos fiber levels. The factors of accessibility, degree of exposed surface area, and condition of the material did not receive a fair evaluation because little or no variation in algorithm scores was observed in the schools. These and other findings indicate that ratings derived from subjective assessments of fiber release potential are not reliable indicators of measured airborne asbestos levels. This conclusion illustrates that air monitoring only provides information on current airborne fiber levels and cannot be used as a tool to predict potential fiber release. The algorithm was intended as a device to measure the potential for fiber release and as such is a useful evaluation mechanism in the hands of a trained inspector. By recognizing the limits of the algorithm, as demonstrated by the recent EPA study, it can still be a useful hazard evaluation tool.

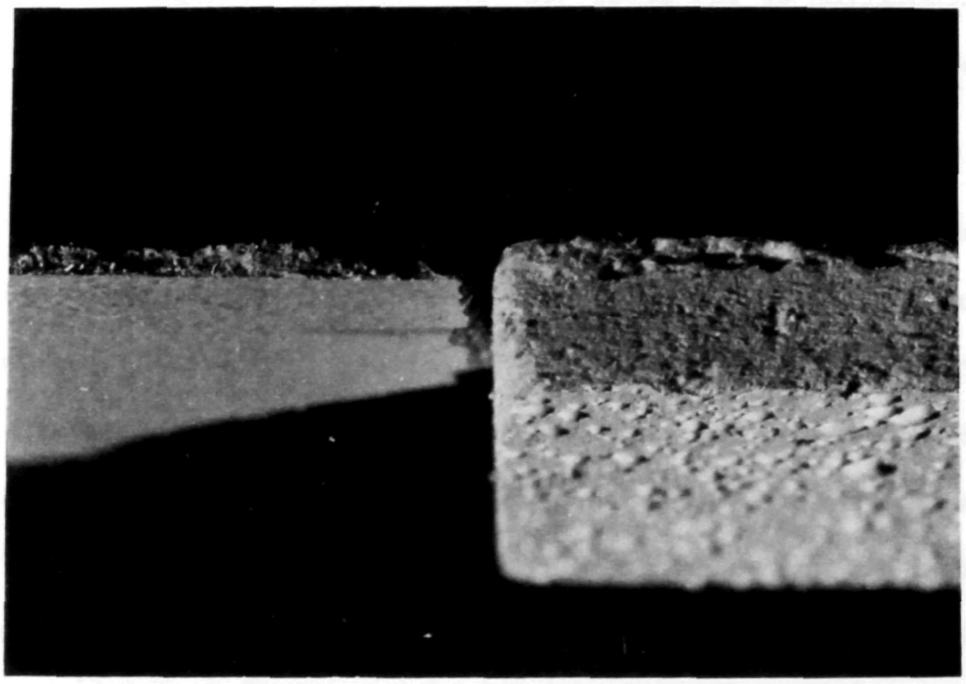
In our experience, we recognized that the algorithm was not sufficient within itself to allow us to make asbestos abatement suggestions to school officials and building owners. Therefore, Evaluation Form #1 and the front of Evaluation Form #2 were developed. By combining the algorithm scores with information from these forms abatement decisions could be reached. For example, if the algorithm score was high, over 60, and there was asbestos debris on the floor and almost every square inch of ceiling was covered by ball impact marks, the prudent decision was made to close and seal the gymnasium until asbestos removal could be undertaken. Conversely, if the algorithm score was low, below 15, and there was no asbestos debris on horizontal surfaces, the asbestos-containing ceiling coating was out of the reach of the building occupants, objects had not been thrown into the ceiling coating, and neither curtains nor expandable partitions were brushing across the asbestos-containing material, no abatement actions were needed but periodic re-inspections and wet cleaning methods were instituted.

An algorithm score of between 10 and 40 indicated an asbestos-containing material that was still in relatively good condition but was likely to be releasing asbestos fibers. Such material could be considered for encapsulation. In addition to the algorithm score, the appropriateness of encapsulation was in part determined by the thickness of the asbestos-containing material and whether this thickness was uniform throughout the spray-applied material. Based on previous encapsulation studies by Battelle Laboratories under contract to EPA, most penetrating encapsulants could only penetrate through 3/4 inch of fibrous material. Only two encapsulants were capable of penetrating to 1 1/4 inch. Therefore, fibrous coatings thicker than 3/4 inch were considered for encapsulation only after testing to determine if the encapsulant could penetrate through the coating and re-attach it to the substrate. Such other factors as adherence of the asbestos-containing material to the substrate and cohesive strength within the material itself also had to be evaluated before a decision on encapsulation could be reached, especially if an encapsulant was to be used which formed a membrane over the material rather than penetrate through it. In many instances encapsulation was found to be a useful abatement technique for use on granular/cementitious acoustical plaster. Before encapsulation is selected as the abatement choice, the encapsulant should be applied to test patches of the asbestos-containing material and a determination made that asbestos fibers are not released from the treated material even when subjected to inadvertent abuse. The decision to encapsulate must be made with the understanding that periodic re-application of the encapsulant will be required during the remaining useful life of the building and before demolition of the structure can occur, the encapsulated asbestos must be removed as required by EPA regulation.

Perhaps the most important lesson learned form recent evaluations of the algorithm factors is that decisions to undertake corrective action to control asbestos exposures must rely on informed judgement. The algorithm is only one of several tools which can be used to collect information upon which a judgement to conduct asbestos abatement can be based. Until new and more accurate evaluation techniques are developed, the algorithm and the associated forms described in this document represent one practical approach to detecting and evaluating existing asbestos exposure hazards and determining the potential for future asbestos fiber release.

CEILING TILES AND PIPE AND BOILER WRAPPING

Although this manual concetrates more on inspecting and evaluating asbestos-containing ceiling and wall coatings, suspended ceiling tiles as well as pipe and boiler wrapping should not be overlooked as potential sources of asbestos fibers. The familiar suspended ceiling panels, approximately 1/2" thick, have in almost all cases been found to be composed of non-asbestos materials. However some thin, 1/8" thick, suspended ceiling tiles have been found to be composed of as much as 30% asbestos. These thin tiles are a hard, non-friable material and under normal use conditions are not expected to release asbestos fibers. If these thin tiles are broken as a result of being dropped or some other activity, they will shatter and release fibers. The inspection program should note the existence of such tiles so that care can be taken not to damage the tiles.



Asbestos-containing, 1/8 inch thick, suspended ceiling tile. (End view of broken tile, note fibers.)

Non-asbestos, 1/2 inch thick, suspended ceiling panel. (End view)

Asbestos-containing pipe and boiler wrapping has been manufactured in various forms, the most common having the appearance of a white, chalky material. Often this material has been preformed to accomodate a certain diameter pipe or molded into bricks for attachment around boilers. Other types of pipe and boiler wrapping have the appearance of mud or an insulating blanket. Some pipe wrapping has been made from corrugated, asbestos-containing paper. Pipe and boiler wrapping is covered on the outside with a protective jacket constructed of such materials as cloth, canvas or metal. Undamaged and intact protective jackets should prevent spontaneous asbestos fiber release. Care must be exercised to prevent the tearing of the fabric jackets and the release of asbestos fibers. Such common practices as laying ladders against pipes and boilers or storing boxes against wrapped pipes may have to be eliminated to prevent destruction of the asbestos-containing insulation and fiber release. Correcting minor damage to pipe and boiler wrapping can often be accomplished with duct tape or re-wrapping torn protective jackets. Replastering of the pipe and boiler wrapping may be required for larger damaged areas. If damage to the protective jacket and wrapping is so extensive that removal is the only option, the same containment and worker protection measures must be implemented as required for safe asbestos removal from ceilings or walls.

Asbestos-containing, corrugated paper, pipe wrapping covered by a protective jacket.

Preformed, asbestos/magnesia, pipe wrapping covered by a protective jacket.

NOTES

✡ U.S. GOVERNMENT PRINTING OFFICE: 1983-666-113/252