



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

DATE: June 9, 2002

SUBJECT: TESTING CARPET, THE ASBESTOS RESERVOIR

- **Best test for carpets; EPA ultrasonication method**
- **No consultants needed; only cost is the lab fee**
- **EPA shows HEPA vacuuming does not remove asbestos**
- **EPA and other asbestos dust benchmarks/safety levels**

FROM: Cate Jenkins, Ph.D.*
jenkins.cate@epa.gov
Waste Identification Branch (Mail Code 5304 W)
Hazardous Waste Identification Division

C Jenkins

TO: Affected Parties and Responsible Officials

This memorandum describes EPA's ultrasonication test method for dust in carpets and woven fabrics. This state-of-the-art test gives results as the number of asbestos structures per square centimeter (s/cm²). The results can then be related to background levels and safety guidelines. A major advantage in this test is that you do not need a consultant or industrial hygienist to take samples.

Carpets and other woven fabrics are reservoirs for asbestos and are a source of continued release. EPA studies show that carpet cannot be decontaminated with any type of HEPA vacuuming, even in combination with water or steam extraction.

There is no reason why EPA should not be offer this superior test to residents during the free testing and cleanup of residences below Canal Street, especially since this is an established EPA method specially designed for carpets.

* The conclusions and opinions in this memorandum are those of the author and do not necessarily reflect those of the U.S. Environmental Protection Agency.

The sections in this memorandum include:

HOW TO USE EPA's ULTRASONICATION EXTRACTION TEST

Finding a lab and submitting samples

Ideas for taking carpet and other fabric samples

ASTM microvacuum method is inadequate for carpets and other woven fabrics

NYC APARTMENT BUILDING USES EPA's ULTRASONIC CARPET TESTING

**EPA FINDS HEPA VACUUMING DOES NOT REMOVE ASBESTOS FROM CARPETS, AND
EPA POLICY ON CONTAMINATED CARPETS**

Regulations and policy on replacing asbestos-contaminated carpet

RELATING ASBESTOS DUST LEVELS WITH HEALTH RISKS

EPA's zero standard for asbestos in dust

Data showing background levels of asbestos in dust inside buildings

Estimating air concentrations and risks from settled dust levels

REGION 1's BENCHMARK - SETTLED ASBESTOS DUST - BROOKFIELD SCHOOLS

Description of Region 2's risk assessment for settled asbestos dust:

Use of a "K-factor" to back-calculate dust levels from background air levels

Region 1 misrepresentation of background air levels and safety levels

Region 1 chose an inapplicable K-factor to justify a higher dust level

Region 1 failed to use real-world background dust levels

Re-calculation of Region 1 dust benchmark with more appropriate values

Brookfield School System and community rejection of EPA Region 1 benchmark of
45,000 s/cm² for dust

EPA REGION 2 BENCHMARK OF 1% ASBESTOS IN WTC DUST

Region 2 cafeteria-style derivation of 1% asbestos dust standard from out-of-context
NESHAP regulations

EPA has established that 1% asbestos is not a safe level

EPA always regulates toxic dusts on interior surfaces by the amount per surface area,
not the % in a dust

Region 2 reverses 1% standard for settled asbestos dust

APPENDIX A – CHART FOR ESTIMATING AIR ASBESTOS LEVELS FROM DUST

APPENDIX B – ASBESTOS AIR CONCENTRATIONS AND RISKS

ENDNOTES AND REFERENCES

HOW TO USE EPA's ULTRASONICATION EXTRACTION TEST FOR CARPET, DRAPES, AND UPHOLSTERY

The most meaningful asbestos test that a resident can have, whether or not they have a consultant to take samples, is EPA's ultrasonication extraction test for carpeting, draperies, or upholstery fabric. This method was developed specifically for carpeting by EPA's Risk Reduction Laboratory.¹ The method number is EPA 600/J-93/167, the Millette ultrasonication carpet method. Over 100 times the amount of asbestos will be found in carpet using EPA's ultrasonication test, compared to the ASTM microvacuum sampling method.²

The ultrasonication extraction test does not require any special equipment, such a micro-vacuum pump, or an air testing pump. Therefore, no industrial hygienist or other consultant needs to be hired to do the sampling. The only cost will be the lab fee. However, this means cutting out at least 16 square inches (100 square centimeters) of carpeting or other fabrics and sending it to the laboratory. See below for ideas on how to take samples without incurring unreasonable replacement costs for carpet, drapery, or upholstery.

An ultrasonication test may be the best way to tell if asbestos is present in a residence or office. Carpeting and upholstered fabric can be tested to see if it needs abatement, or it can be tested after abatement to determine whether it was decontaminated. Hard smooth surfaces may show no asbestos contamination with the ASTM microvacuum method if tested soon after cleaning. But carpeting cannot be cleaned effectively, and will show any residual asbestos.

Air testing is problematic for determining whether there is an asbestos problem. The aggressive AHERA TEM clearance test, using a leaf blower, may not show any asbestos at all, much less over 70 structures/square millimeter, even when there are extremely high levels of asbestos dust on surfaces. This was found to be true for the Brookfield, Connecticut school system, where schools were cleaned in the year 2000, and the AHERA TEM clearance test showed no problems.³ Recently, however, asbestos dust levels on some surfaces in several schools was several thousand structures per square centimeter (s/cm^2), and in two instances over 3 million and 14 million s/cm^2 .⁴

The AHERA TEM clearance test also can be highly erratic, giving very different readings when it is repeated at the same location.⁵ Furthermore, there is too much temptation to control the results to certify that the area has no asbestos problems.

Even if the air was tested using large volumes of air in order to increase the sensitivity, compared to the AHERA TEM clearance test, it may not be practical. This is because of the long time required (8 hours for a 4800 liter sample) hours, and the expense (around \$400 for the lab fee if 32 "grids" of the filter are read by the analyst). There would need to be people present during the 8 hours not only to insure that no one sabotaged the test by cutting the pump off or spread asbestos during pumping, but also because the test would need to represent air conditions during normal human activities. If the air was tested with no people present, the results would be unrealistically low, since normal human activities stir up asbestos and cause it to become airborne.

The ultrasonication method is not likely to result in an over-count of asbestos fibers due to the separation of bundles of fibers during the sonication procedure. This is particularly true for WTC fallout, which is already finely divided.⁶ High impacts, such as foot traffic or children playing with toys on carpets, would certainly result in the breakdown of asbestos fibers that are bundled together into individual asbestos, resulting in an increase in the number of fibers, and also an increase in the hazard.

Finding a lab and submitting samples

First, locate a laboratory who will perform ultrasonication tests of carpet, upholstery, and draperies. There is a list of accredited asbestos laboratories maintained by the National Institute for Standards and Technology (NIST) on the internet, or call the NIST at the number in the reference section.⁷

Then call the lab and ask if they can perform "EPA's ultrasonication extraction asbestos method for carpet, the Millette method."⁸ Use this phrase to describe the test when talking to the lab. The EPA method number is EPA-600/J-93/167, but most lab receptionists will not recognize the method by just this number. Because this is a less common method, you may need to speak to the lab director.

Ask which particular one of their labs does this test, and where to send the sample. This test is usually done at only one of their lab locations. Ask the lab for instructions for sending the sample. Labs will refuse your samples if you do not follow their instructions exactly. Carpet and fabric samples should be enclosed in double Ziplock® sealed baggies.

Laboratories will require that you fill out their Chain of Custody form. Often you can download the chain of custody form from their web site, or they will fax it to you. You must indicate on

the form that the carpet is to be tested by the EPA ultrasonication Millette method. You may need to fill in this information in the "OTHER" section of the form. If you do not clearly indicate the test method, the carpet may be analyzed by the bulk PLM method, which you do not want.

Ask them about pre-payment. A credit card number is the most convenient way. The cost of an ultrasonication carpet extraction test is around \$250 for a 3-day turnaround, and \$200 for a 5-day turnaround.

Ideas for taking carpet and other fabric samples

Choose a part of the carpet that would be most contaminated. A high traffic area would be a good choice. Also, a corner of a carpet that cannot be cleaned easily with a vacuum cleaner might be a good choice. A strip along a floorboard under a window that gets dusty is another possibility.

Cutting out 16 square inches of carpet may be a problem, especially if you are a renter. Here are a few strategies: The carpet sample does not need to be in a square shape (4 x 4 inches). It also can be a narrow strip, like 1 x 16 inches or 2 x 8 inches. It also does not necessarily have to be in one piece, but a large number of small pieces will make it very difficult for the lab to measure the exact area.

If you do not have extra matching carpeting to replace the part that is cut out, you may be able to find matching replacement pieces in a closet, under a desk or bookshelf, etc. The carpet sample that would be tested would still come from the place that is most contaminated. However, carpet from the closet or under a desk would be used to fill in the hole left by taking the sample.

Another idea would be to take a carpet sample from the center of hallway, and then replacing just the center of the hallway with contrasting carpeting. An inset rectangle or diamond shape would be very attractive.

For common areas in a building, a carpet-type floor mat could be tested if there is concern about cutting out a piece of a rug or wall-to-wall carpeting. First, purchase a replacement mat yourself. Then, retrieve, replace, and test the old mat.

A long narrow strip from the hem of draperies can be used for the samples, or the drapery lining can be used. For upholstered furniture, a side that does not show can be tested, but it would be

preferable to test a piece from a flat, upper horizontal surface which would be more contaminated.

ASTM microvacuum method is inadequate for carpets and other woven fabrics

Some argue that testing carpet and fabrics with the hand-held ASTM microvacuum suction pump would be a good enough test, since it would get out the easily releasable asbestos. In this method, carpet and other fabrics are sampled by a hand-held air suction pump. The fabric is essentially vacuumed by the pump. The asbestos is caught on a filter, and then the filter is sent to the lab for testing.

However, this ASTM microvacuum sampling pump is only a first-line test for carpet and other woven fabrics, and is not definitive. The microvacuum pump does not apply any greater suction than a good vacuum cleaner. High impacts, such as a child running or rolling on the carpet, will release much more asbestos than any vacuuming process. The EPA ultrasonication method will extract over 100 times the amount of asbestos from carpet compared to the ASTM microvacuum method. The ultrasonication method is also an official EPA method specific to carpet, and is thus preferred.⁹

NYC APT. BUILDING USES ULTRASONIC CARPET TESTING

The New York Environmental Law and Justice Project¹⁰ obtained carpet samples from one NYC apartment building on Hudson St., near the intersection with Thomas St. The samples were taken on May 29, 2002, over 8 months after the collapse of the WTC. The samples were tested by EPA's ultrasonication method. The results are given in Table 1. The building is 9 blocks north of Ground Zero, and 4 blocks north of Warren St. Warren St. was defined by the New York City Department of Health as the northernmost point of contamination from WTC fallout.

The building does not have central forced air heating and cooling. Heat is by floorboard hot water pipes. Air conditioning is by individual window units. There is forced air circulation in the hallways only. The building is a well maintained with a clean boiler room and basement. As seen in a later section of this memo, these levels are high, indicating a major asbestos release. The pattern of the contamination, roof and lower hallway, is indicative of the asbestos source being the World Trade Center.

TABLE 1. Hudson St. carpet: levels of asbestos found using EPA's ultrasonication test method Data from the New York Environmental Law and Justice Project. ¹¹ Samples taken on May 29, 2002	
Building has no forced air heating and cooling that would redistribute asbestos from common areas to apartments, or from apartment to apartment.	asbestos structures per square centimeter (s/cm ²)
Carpet from roof, no special cleaning since 9/11. No visible dust on carpet. Indoor-outdoor carpeting on deck on roof.	624,717
Carpet from 1 st floor hall, no special cleaning since 9/11. Sample taken 4 to 5 feet from front door. No visible dust or discoloration for different areas of carpet (such as higher dirt levels in high traffic center of carpet).	645,200
Carpet from 1 st floor hall by bicycle rack, no special cleaning since 9/11. No visible dust or difference in discoloration between carpet areas.	329,427
Carpet from 10 th floor hall, no special cleaning since 9/1. No visible dust or difference in discoloration between carpet areas.	65,202
Carpet from inside 9 th floor apartment, mat which had been HEPA vacuumed. (Does not mean that HEPA vacuuming removed asbestos. Probably not that contaminated to begin with, since windows not open, not facing WTC, and no central forced air in building to re-distribute asbestos.)	less than 15,788

The EPA tested dust lying on the street 2 blocks south of this building, and found asbestos on September 11.¹² The asbestos was less than 1% using the polarized light microscopy (PLM) method, but definitely present in the dust. EPA did not test any outdoor sites closer to the building, or immediately to the north. The PLM method used by EPA was a major problem in determining the actual levels of asbestos. If EPA had used TEM tests instead, the asbestos levels could have been many times over 1% near the Hudson St. apartment building.¹³

The asbestos levels in the carpet at the Hudson St. address, more than 8 months after 9/11, can be compared to carpet that was known to be more heavily contaminated. A building near Ground Zero¹⁴ had a dust layer over 1 ½ inches thick on surfaces, including carpet. The first abatement only involved dry HEPA vacuuming of the carpet. This carpet was tested after HEPA vacuuming by the ASTM 5755 microvacuum method and found to have over 300,000 s/cm². If the EPA ultrasonication method had been used, the level for the previously HEPA vacuumed carpet could have been as high as 30 million s/cm². Thus, the levels in the carpet at the Hudson St. building are probably not be as high as carpets that had thick layers of WTC dust. However, the carpet levels in the Hudson St. building are highly significant, as can be seen from a later section in this memo on comparing dust levels and health risks.

I would be highly interested in any carpet ultrasonication test results from New York City, and any other related tests such as ASTM microvacuum analyses of the same carpet. The exact address of the building, names of occupants, etc. are not necessary.

EPA FINDS HEPA VACUUMING DOES NOT REMOVE ASBESTOS FROM CARPETS, AND EPA POLICY ON CONTAMINATED CARPETS

EPA studies show asbestos that is embedded in a carpet will not be removed with a HEPA vacuum cleaner. EPA studies also found that even wet process HEPA vacuum systems (steam or water extraction combined with a HEPA vacuum) will only remove 60% of the asbestos. The abstracts of these EPA studies are included in the endnotes/references, and the full studies are available online.¹⁵ HEPA stands for “high efficiency particulate air filter.” A HEPA vacuum does not have more suction power for removing dirt from carpet, it only has an additional filter that does not allow very small particles, including asbestos fibers, to be released in the exhaust.

High impacts such as foot traffic, hitting, or playing on carpet, upholstered furniture, or draperies will release asbestos even if these items were HEPA vacuumed. In addition, asbestos will work its way through the rug backing and settle on the floor or cushioning, which cannot be reached by any kind of vacuum.

Intuitively, if any kind of vacuum really could remove all dust and dirt, then carpeting would always return to its original pristine condition after vacuuming, never getting dirty and needing replacement. There is nothing magic about a HEPA vacuum in its cleaning powers – it only has a better filter to reduce emissions.

Regulations and policy on replacing asbestos-contaminated carpet

Neither the EPA regulations under the Asbestos Hazard Emergency Response Act (AHERA), which covers schools, nor the Clean Air Act (CAA) asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) specifically require the removal of asbestos-contaminated carpet. The regulations instead only require cleaning surfaces to background levels, as well as requiring no visible dust. You would need to argue that if you pulled the carpet back and folded it, you could see dust in the fibers along the backing, or on the cushioning or under the cushioning.

However, the U.S. Army Corps of Engineers has guidelines that are clearer on asbestos-contaminated carpet.¹⁶ They specifically require that carpet to be removed if contaminated with any level of asbestos, not just levels over 1%. The only abatement option is removal, not cleaning.

In Libby, Montana, the Superfund site, EPA is requiring that all contaminated residences receive new carpet and upholstered furniture at no expense to the homeowner, because it was determined that asbestos could not be removed by any cost effective process, even HEPA vacuuming with wet extraction.

In NYC, the Federal Emergency Management Agency has advised residents to dispose of any contaminated carpet or upholstered furniture, according to available news reports.

In my opinion, NYC residents should receive replacement carpet and upholstered furniture at no cost to themselves during the cleanup.

RELATING ASBESTOS DUST LEVELS WITH HEALTH RISKS

EPA's zero standard for asbestos in dust

The following are EPA's official statutes, regulations, and findings establishing zero exposure as the only standard or benchmark for asbestos, whether in air, dust, water, etc. EPA does not find any exposure to asbestos to be acceptable,¹⁷ and EPA states there is no safe exposure to asbestos.¹⁸

Available evidence supports the conclusion that there is no safe level of exposure to asbestos. This conclusion is consistent with present theory of cancer etiology and is further supported by the many documented cases where low or short term exposure has been shown to cause asbestos-related disease.

...

Most occupational studies have been conducted on populations exposed to high airborne concentrations of asbestos for long periods of time. However, short term occupational exposures, have also been shown to increase the risk of lung cancer and mesothelioma. In addition, there are many documented cases of mesothelioma linked to extremely brief exposures to high concentrations or long-term exposure to low concentrations.

The Asbestos School Hazard Detection and Control Act (ASHERA) states that the only standard or safe exposure level to asbestos is ZERO:¹⁹

[C]hildren may be particularly vulnerable to environmentally induced cancers ... medical science has not established any minimum level of exposure to asbestos fibers which is considered to be safe to individuals exposed to the fibers.

The Asbestos Hazard Emergency Response Act (AHERA) regulations for schools also are explicit, saying there are no safe exposures to asbestos.²⁰

Potential health effects related to asbestos exposure. The nature of asbestos-related diseases; routes of exposure; dose-response relationships and the lack of a safe exposure level; the synergistic effect between cigarette smoking and asbestos exposure; the latency periods for asbestos-related diseases; a discussion of the relationship of asbestos exposure to asbestosis, lung cancer, mesothelioma, and cancers of other organs. [*emphasis added*]

Data showing background levels of asbestos in dust inside buildings

Because it is impossible to get away from all asbestos pollution because of the widespread past use of this material in brake linings, building insulation, etc., it is not realistic to clean up asbestos contamination to zero levels, even though this would be desirable. Cleaning up to background levels is the only solution. Under the CAA, all areas around an asbestos site must be tested and cleaned up so that there is no asbestos above background levels.²¹

A widely accepted guideline for asbestos dust levels in relation to background is given in Table 2. If "background level" is defined as the dust levels inside buildings where no asbestos containing materials are used, then the level is less than 200 asbestos structures per square centimeter of surface area (s/cm²). There are also levels categorized as low, above background, and high, based on measurements of a large number of surfaces inside buildings.

Estimating air concentrations and risks from settled dust levels

When air concentrations are unknown, or when available air testing is not sensitive enough to detect asbestos at the extremely low levels related to cancer, it is possible to use settled dust levels as a way of predicting air levels. Appendix A provides a chart for estimating air levels of asbestos from measured asbestos levels in settled dusts. Appendix B provides a chart relating air levels to cancer risks.

This method is widely recognized. It is used not only in the field of asbestos, but also for dusts containing other toxic substances such as lead, beryllium, uranium particles, alpha emitters, radioactive iodine, zinc sulfur powder, and microorganisms.²² It involves using experimentally determined ratios of levels in surface dusts to air levels, depending on the amount of human activity that would stir up the dusts. These ratios are called "K-factors".

The air test that EPA is providing, the AHERA TEM clearance test, is not sensitive enough to measure asbestos at the very low concentrations that can cause asbestos-related diseases such as lung cancer, mesothelioma, and asbestosis. The "passing" level of 70 structures per square millimeter is the same as about 0.01 PCM-equivalent fibers per milliliter (PCM f/mL).

Table 2. TYPICAL ASBESTOS DUST LEVELS INSIDE BUILDINGS²³ Levels of asbestos found from testing of a large number of interiors with or without asbestos building materials and/or asbestos contamination problems	
	structures per square centimeter (s/cm ²)
"BACKGROUND" – If "background" is defined as the level in a building where there are no asbestos containing building materials, then background should be considered to be at or below 200 s/cm ² . Testing of three government buildings in Maryland with no asbestos containing materials showed levels below 200 s/cm ² . A western state building with no asbestos containing materials had even lower levels, an average mean concentration of 160 s/cm ² .	less than 200 less than 160
"RECENTLY CLEANED HARD SURFACES" – Buildings with asbestos containing materials where hard surfaces had been recently cleaned.	86 to 320
"LOW" – Average of a wide range of measurement (6.5 to over 4.3 million s/cm ²) for buildings with asbestos containing materials. This level was described as "low," but not "background." See the earlier entry in this table for levels inside buildings where no asbestos containing materials are used. If "background" is defined as the levels found in buildings not containing asbestos materials, then the "low" level of 1000 s/cm ² is high in comparison.	1000
"ABOVE BACKGROUND" – Levels that are considered to be definitively above background	10,000
"HIGH" – Levels considered high and "in the range of a significant accidental release from an abatement site"	100,000

Appendix B shows that if a person were exposed over a lifetime to this level, the risk of cancer would be more than 2 in 1000. The AHERA TEM clearance test is also erratic and not reproducible, and the failure to use full aggressive conditions (leaf blower directed at all surfaces) can result in abnormally low readings. Thus, the use of K-factors, combined with the results of an ultrasonication test of carpet, or the ASTM 5755 microvacuum method for smooth surfaces, may provide a rough indicator of a potential for hazardous exposures.

As discussed in the following section, EPA's Region 1 also uses these K-factors as a way of estimating asbestos air concentrations from settled dust levels. However, the values Region 1 inserted into the K-factor risk assessment formula were questionable for its year 2000 Brookfield, Connecticut School System risk assessment.