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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

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/cm^2). 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.

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* 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.

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ASTM microvacuum method is inadequate for carpets and other woven fabrics

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ENDNOTES AND REFERENCES

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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.

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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

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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

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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 Project[10] 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.

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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 1st 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 1st 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 10th floor hall, no special cleaning since 9/1. No visible dust or difference in discoloration between carpet areas.	65,202
Carpet from inside 9th 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 Zero[14] 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/cm^2. 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/cm^2. 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.

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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.

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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 (AHERA) 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/cm^2). 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 BUILDINGS[23] 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.	less than 200
A western state building with no asbestos containing materials had even lower levels, an average mean concentration of 160 s/cm^2.	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.

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REGION 1's BENCHMARK FOR SETTLED ASBESTOS DUST

EPA Region 1 derived a benchmark, or a safe level, for asbestos in settled dust in order to justify asbestos levels found in the Brookfield, Connecticut school system.[24] A level of 45,000 structures asbestos per square centimeters (s/cm^2) was derived as the benchmark. This is remarkably high considering the universally accepted level of 1000 s/cm^2 as low. (See Table 2.)

As discussed later, the Brookfield School System has roundly rejected EPA Region 1's unsafe level of 45,000 s/cm^2 asbestos dust, and has instead chosen a tentative cleanup level of 5000 s/cm^2 for the schools to be occupied by its children.

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

EPA Region 1 calculated its benchmark by first assigning a level for background ambient outside air. Then, it used a study[25] which found different ratios between the amount of dust on surfaces with the amount of asbestos in the air, depending on the activities going on in a room that would stir up dusts. The ratios of dust levels to air levels are called "K-factors."

For its calculations, Region 1 assigned a false value of 0.045 structures per milliliter (s/mL) as the supposed background ambient outside air level. Then, then chose an incorrect K-factor of 0.000001 (which is the same as 10^{-6} if expressed as an exponential) as the ratio between air levels and dusts. The result was 45,000 structures per square centimeter (s/cm^2) dust on surfaces, using the following formula.

Benchmark for asbestos in Dust, structures per square	x	K-Factor	[K-Factor expressed as exponential	=	Air Level, structures per milliliter (s/mL)
45,000	**x**	**0.000001**	**[10 (-6)]**	**=**	**0.045**
This is the level derived from the formula by Region 1		This is the K-factor, or multiplier, chosen by Region 1			This is the alleged background outdoor air level put into the formula by Region 1. This value is the one highest outlier measurement found in an early 1983 study.

Region 1's Technical Appendix for the Brookfield School System[26] states the following:

> The results ... of the fifty-one (51) Method D5755-95 samples were compared to the benchmark chosen by EPA based on the asbestos fiber levels found in ambient (outside) air measured by Transmission Electron Microscopy (TEM), within the range 0.01 - 0.045 fibers/structures per cubic centimeter (f/cc) *[this is the same as structures per milliliter, or s/mL]*... In order to compare the benchmark levels from cubic centimeter(cc) to settled dust levels in square centimeter (cm2) and allowing for the aerodynamic properties of these fibers, a K-factor must be applied. After the application of the appropriate K-factor we calculated a benchmark of 45,000 structures per square centimeter (s/cm2).
>
> ...
>
> EPA established benchmark levels of ambient (outside) air measured by Transmission Electron Microscopy (TEM) within the range 0.01 - 0.045 fibers/structures per cubic centimeter (f/cc)
>
> ...
>
> More recent studies in which asbestos air and surface dust levels were measured by TEM have been used to calculate additional K-factors. Based on these controlled studies for reentrainment of settled fibers into air, the K-factor of 10-6 [ten to the minus six, or 0.000001] was used. As shown in Section 7.0, the 0.045 f/cc corresponds to 45,000 s/cm2 after the application of the K-factor.

The problems with Region 1's risk assessment are discussed below:

Region 1 misrepresentation of background air levels and safety levels

Region 1 knowing used a false value for the average or background level of asbestos in "ambient" outside air for its risk assessment. The level of 0.045 s/mL came from the one, outlying highest level found in an early 1983 study of outside air.[27] There was actually a wide range of values, most of which showed no detectable asbestos whatsoever. This one high value of 0.045 s/mL was an outlier, the highest recorded. It could well have been measured near an asbestos mine or processing facility, or near a natural rock outcropping of an asbestos mineral deposit.

It is unconscionable for Region 1 to have used the 0.045 s/mL highest outlier value from the study. At a minimum, it should have used the mean (average) for all of the measurements, most of which showed no asbestos at all.

Since 1983, however, much more definitive studies with increased sensitivity have become available for background air levels. Region 1 should have used the peer reviewed level for ambient outside air from these more recent studies established by the Agency for Toxic Substances and Disease Registry (ATSDR) of the Centers for Disease Control (CDC). The ATSDR is an authoritative source for this information for EPA, and is funded through EPA statutes to develop this information in a Toxicological Profile for Asbestos.[28] The early 1983 study used by Region 1 was not even mentioned by the ATSDR.

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ATSDR's findings are given in Table 3, along with asbestos levels found in buildings with and without asbestos contamination problems. The level for rural areas is 0.00001 s/mL, and urban air is 0.0001 s/mL.[29] (These levels would be the equivalent of 0.0000002 PCM f/mL and 0.000002 PCM f/mL.) Compare 0.00001 s/mL and 0.0001 s/mL with the level of 0.045 s/mL used by Region 1 for the Brookfield schools!

This 0.045 s/mL level is not a safe level, much less a background level. It is even higher than EPA found for air inside of 41 schools where there was an asbestos contamination problem (0.03 s/mL). It is also more than 2 times higher than the AHERA TEM air clearance test level of 70 structures/square millimeter (which is the same as 0.02 s/mL, or about 0.01 f/mL-PCM), which itself is not a safety level.[30] See Appendix B of this memorandum for the cancer risks associated with different air asbestos levels.

Region 1 also falsely claimed that 0.01 to 0.045 s/mL asbestos in air is the EPA benchmark for ambient air.[31] The fact is, EPA has no benchmark or ambient air standard for asbestos. This is made clear in EPA statutes, regulations, and publications.[32] As stated earlier, EPA does not consider any exposure level to asbestos to be safe. The only benchmark is zero asbestos levels, zero exposure.

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

Region 1 needed to do more than use an incorrect value for background air in order to make its risk level for settled dust high enough to cover existing contamination levels in the Brookfield School System. To do this, Region 1 also intentionally chose an inappropriate, low K-factor for its calculations. The study used by Region 1 for K-factors had data for 6 different controlled, real world situations. See the endnotes/references for a table of all the K-factors from this study.[33] Region 1 chose the K-factor at the 10^{-6} level (0.000001) associated with cleaning a storage area and cleaning a carpet with a conventional vacuum cleaner. However, there were two activities which were much more likely to be associated with a school, namely gymnastic activities and cleaning with a broom, where the K-factor was at the 10^{-5} level (0.00001). Region 1 chose to ignore this more applicable K-factor, because it would have resulted in a dust benchmark 10 times lower! See Table 4.

Because of the uncertainty of the data in the K-factor study, Region 1 also should have allowed for a large margin of error, or should at least have used the average for all six K-factors. If it had used the average of the six, then the K-factor would have been 10^{-4}, or 0.000001. This would make dust benchmark 100 times lower! See Table 4.

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Table 3. ATSDR AIR LEVEL FINDINGS COMPARED TO LEVEL CHOSEN BY REGION 1

Background ambient air levels are from studies determined to be the most credible by the ATSDR[34]

	Concentration in TEM structures per milliliter (s/mL). This includes all asbestos fibers and bundles of fibers, and so is higher than "PCM" fibers.		Equivalent concentration in PCM fibers per milliliter (PCM f/mL). PCM fibers are only those single fibers which are longer than 5 micrometers with a certain aspect ratio.	
		expressed as exponential		expressed as exponential
ATSDR finding: outside air, rural, no known source of asbestos contamination nearby	0.00001	(1×10^{-5})	0.0000002	(2×10^{-7})
ATSDR finding: outside air, urban, no know source of asbestos contamination nearby	0.0001	(1×10^{-4})	0.000002	(2×10^{-6})
ATSDR finding: 1988 EPA survey of 94 public buildings containing asbestos materials, mean concentration	0.006	(6×10^{-3})	0.0001	(1×10^{-4})
ATSDR finding: 1988 EPA survey of 41 schools containing asbestos materials, mean concentration	0.03	(3×10^{-2})	0.005	(5×10^{-4})
AHERA TEM clearance test level, the "70 structures per square centimeter" level, converted to s/mL and PCM equivalent f/mL. This is an unsafe level for long term exposures.[35]	0.02	(2×10^{-2})	0.01 approximately	(1×10^{-2})
Region 1 level for background outside air, used for risk assessment	0.045	(4.5×10^{-2})	unknown	

Region 1 failed to use real-world background dust levels

There was no reason for Region 1 to have gone through any calculation process to project background dust levels from air levels. Typical background dust levels are well established, just like typical air levels.

Region 1 chose to ignore the fact that the same reference[36] they used for K-factors also contained real world data for typical dust levels, which are widely recognized by industrial hygienists and other asbestos abatement specialists. See Table 2 for typical dust levels for buildings with or without asbestos contamination problems. Compare 200 s/cm^2, a real world background level for buildings that do not contain asbestos materials, with Region 1's calculated level of 45,000 s/cm^2.

Even if Region 1 did not want to use this published data on typical dust levels, it had it own data, developed during the testing of the Brookfield schools, that showed that clean surfaces and clean schools had much, much lower background dust levels.

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

Table 4 gives re-calculated values for dust benchmarks using more appropriate, accurate, and defensible values for ambient background air and K-factors. A range of different calculations is given, showing the effect of substituting several different values. In all cases, the result is a much lower dust benchmark than the one contrived by Region 1.

Brookfield School System and community rejection of EPA Region 1 benchmark of 45,000 s/cm^2 for dust

The Brookfield School System in Connecticut and the community has rejected EPA Region 1's benchmark for dust of 45,000 s/cm^2 as not being well founded or protective. It has been tentatively decided that a level of 5000 s/cm^2 is the cleanup goal.[37] Because data clearly demonstrate that a cleaned surface, even in an asbestos-contaminated building, will only have 86 to 320 s/cm^2 asbestos (see Table 2) there is no reason why the cleanup standard should not be much lower.

As a brief history of the problem, recently teachers at the Huckleberry Hill elementary school in Brookfield, Connecticut were concerned with an asbestos abatement in the year 2000 where the Region 1 benchmark of 45,000 s/cm^2 was the standard. The teachers hired an independent industrial hygienist. Side-by-side testing was performed with the school system's testing consultant. High levels of asbestos were found by the ASTM 5755 microvacuum method in two carpets (over 462,240 and 329,560 s/cm^2) as well as on top of a fire alarm box (over 3 million s/cm^2) and on bare floors in another corridor (around 150,000 s/cm^2).[38]

The students were to be transferred to a middle school to finish the year, but this school was tested and also found to have high asbestos dust levels, and failed the AHERA air test. At another school, asbestos was found in surface dusts at concentrations as high as 14 million s/cm^2. The whole school system was then shut down for the rest of the school year for further testing and inspection.[39]

Table 4. RE-CALCULATION OF REGION 1 DUST BENCHMARKS USING MORE VALID VALUES

FORMULA USED BY REGION 1:

Benchmark for asbestos in Dust (s/cm2)	x	K-Factor	(K-Factor expressed as an exponential)	=	Air Level, structures per milliliter (s/mL)
45,000	x	0.000001	(10^{-6})	=	0.045
This is the level derived from the formula by Region 1		This is the K-factor chosen by Region 1 for their calculations, from the 2 highest ones from a total of six K-factors. A higher K-factor results in a calculation of a higher, less protective dust level. The two K-factors with 10(-6) values were for a person cleaning out a storage room and for a person vacuum cleaning.			This is the alleged background outdoor air level put into the formula by Region 1. This value is the one highest measurement found in an early 1983 study. For most of the measurements, asbestos was not even detectable.
1,000	x	0.00001	(10^{-5})	=	0.01
Dust level if detection limit of the early 1983 study is used, and K-factors more applicable to a school are used.		This is the K-factor more applicable to a school, representing gym activities and a person sweeping floors with a broom			This is the detection limit of the study cited. Most of the actual measure air levels were below this detection limit
100	x	0.000001	(10^{-6})	=	0.0001
Dust level if air concentration is urban level cited by the CDC's ATSDR, but still using the inappropriate K-factor.		This is STILL the inappropriate K-factor chosen by Region 1 for their calculations			Outside ambient air level, urban areas, found credible by the CDC's ATSDR
10	x	0.000001	(10^{-6})	=	0.00001
Dust level if air concentration is rural level cited by the CDC's ATSDR, but still using the inappropriate K-factor.		This is STILL the K-factor chosen by Region 1 for their calculations			Outside ambient air level, rural areas, found credible by the CDC's ATSDR
10	x	0.00001	(10^{-5})	=	0.0001
Dust level if K-factors more relevant to school used, and ATSDR value for urban outdoor air used.		This is the K-factor more applicable to a school, representing gym activities and a person sweeping floors with a broom			Outside ambient air level, urban air, found by the CDC's ATSDR
1	x	0.00001	(10^{-5})	=	0.00001
Dust level if K-factors more relevant to school used, and ATSDR value for rural outdoor air used.		This is the K-factor more applicable to a school, representing gym activities and a person sweeping floors with a broom			Outside ambient air level, rural areas, found by the CDC's ATSDR
1	x	0.0001	(10^{-4})	=	0.0001
Dust level if average of the six K-factors used, and ATSDR value for urban outdoor air used.		Average of six different K-factors in study, allowing for a safety margin of error			Outside ambient air level, urban air, found by the CDC's ATSDR
0.1	x	0.0001	(10^{-4})	=	0.00001
Dust level if average of the six K-factors used, and ATSDR value for rural outdoor air used.		Average of six different K-factors in study, allowing for a safety margin of error			Outside ambient air level, urban areas, found by the CDC's ATSDR

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EPA REGION 2 BENCHMARK OF 1% ASBESTOS IN WTC DUST

Unfortunately, the different EPA regions are autonomous in many ways, and are free to set health standards to meet the needs of individual situations. There is no oversight or control by the experts in EPA's Headquarters or other centers of technical excellence, such as EPA's Office of Research and Development satellite campuses in Cincinnati and Research Triangle Park. Thus, the unilateral setting of an incorrect health standard in direct conflict with EPA regulations, statutes, and precedents by perhaps one lone toxicologist at an isolated regional office is not uncommon.

The preceding section described Region 1's actions in the case of the Brookfield School System, setting an asbestos dust benchmark of 45,000 s/cm^2. This section will describe what Region 2 did in setting a completely different, but also false, unsupported health standard for asbestos dust after the collapse of the World Trade Center (WTC). The Region 2 asbestos dust benchmark is 1%. The NYC Department of Environmental Protection (NYC DEP) also decided to set their benchmark at 1% asbestos. It is obvious that the Region 1 and Region 2 benchmarks are quite different from each other. This fact alone demonstrates that there is no consistency between health standards set by the different EPA regions.

The following statements are made at the EPA web site relating to the WTC disaster.[40] Region 2 clearly states that 1% is the "level of concern for health."

> If a substance contains 1% or more asbestos, it is considered to be an "asbestos-containing material." EPA is using the 1% definition in evaluating dust samples from in and around ground zero and other areas potentially impacted by the World Trade Center collapse. The majority of areas in which EPA has found levels of asbestos in dust above 1% are in the vicinity of the World Trade Center work zone. Daily summaries of this data and how it compares to the level of concern for health are also available. *[emphasis added]*
>
> In Dust. If a substance contains 1% or more asbestos, it is considered to be an "asbestos-containing material." There are federal regulations in place to ensure the proper handling and disposal of asbestos-containing material. If a substance contains less than 1% asbestos, these regulations do not apply.
>
> EPA is using the 1% definition in evaluating dust samples from in and around ground zero. The vast majority of the samples taken to date have levels of asbestos below 1%. In fact, in an urban environment like New York City, we can expect the presence of a low level of asbestos under normal circumstances (these low everyday levels are called "background levels").

Counsel for Region 2 supported the choice of this benchmark by claiming that only asbestos over 1% was "significant":[41]

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> One of the first decisions that EPA had to make when sampling for asbestos in the dust from the WTC collapse was what reference value to use when reporting the data – in other words, at what concentration of asbestos in the bulk dust samples would the Agency characterize the dust as containing asbestos in quantities of significance? EPA elected to use the definition of ACM [asbestos containing material] from the NESHAPs regulations – *i.e.*, the 1% asbestos content standard.

The NYC DEP also claimed that only 1% or higher asbestos inside of buildings was regulated.[42] The following is an excerpt from a notice to building owners in Lower Manhattan:

> If a substance contains more than 1% asbestos, it is considered to be an "asbestos-containing material." There are Federal, State, and City regulations in place to ensure the proper handling and disposal of asbestos-containing material. If a substance contains 1% of less asbestos, these regulations do not apply.
>
> EPA is using the 1% definition in evaluating exterior dust samples in the Lower Manhattan area near the World Trade Center. All affected landlords have been instructed to test dust samples within their buildings utilizing this standard.

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

Region 2 derived the 1% standard for dust by selecting a non-applicable part of the Clean Air Act asbestos National Emission Standards for Hazardous Air Pollutants (NESHAPs). Region 2 first concluded that the asbestos NESHAP did not apply to the WTC collapse. After that, they went on to conclude that if it did, then the dusts should be regulated just like intact "asbestos containing materials" (ACM) under the NESHAP.[43] ACM is a technical term in the NESHAP regulations that defines ACM as intact building materials themselves made with asbestos. Examples would be asbestos acoustical ceiling tiles, insulation on pipes, asbestos containing floor tiles, and sprayed on asbestos fireproofing.

Since Region 2 said that the NESHAP regulations did not apply, they felt free to take only what supported their position from these regulations. Region 2 ignored the other, much more applicable parts of the asbestos NESHAP. These parts require first removal/encapsulation of any 1% or greater intact "asbestos containing building materials" followed by cleanup of the site and the surrounding soils **to background levels**.[44]

The fallout from the World Trade Center, contaminating the surrounding area, is much more analogous to the NESHAP requirements for soil, debris, and emissions from a demolition site, than it is to specific types of intact asbestos-containing building materials. If Region 2 had drawn the analogy to the soil, debris, and emissions covered by the NESHAP regulations for a demolition site, then their WTC dust benchmark would have been much lower than 1%.

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Background levels of asbestos in dusts and soils are much, much lower than 1%.

Even better would be for Region 2 to use the comprehensive authority of the National Contingency Plan (NCP) statutory authority. Then it would have flexible regulations that would apply to the situation, namely a major release of hazardous substances requiring the expertise and resources of the federal government for cleanup. Then Region 2 would have been obligated to look at the true hazards posed by any asbestos, and require cleanup to these levels, not to the unsafe level of 1%.

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

In the NESHAP regulation guidance documents, EPA has made definitive statements that the 1% level for asbestos containing materials is not in any way a safety standard or a health benchmark.[45]

> In April 1973, the US Environmental Protection Agency (EPA) issued the National Emission Standards for Hazardous Air Pollutants (NESHAP) for asbestos (38 FR 8820). The NESHAP regulation governs the removal, demolition and disposal of asbestos containing bulk waste. An asbestos-containing product, as stated by the regulation was defined for the first time to be a product with greater than 1% asbestos, by weight. The intent of the 1% limit was:
>
> ... to ban the use of materials which contain significant quantities of asbestos, but to allow the use of materials which would (1) contain trace amounts of asbestos which occur in numerous natural substances, and (2) include very small quantities of asbestos (less than 1 percent) added to enhance the material's effectiveness. (38 FR 8821).
>
> It most be clearly understood that the EPA NESHAP definition of 1% by weight was not established to be a health-based standard. [*emphasis added*]

Even the legal counsel for EPA Region 2 has stated in writing several months after the WTC collapse (but only after exposing large numbers of people) that the 1% level is not in any way related to safety or health.[46]

> Note that the 1% standard is not necessarily health- or risk-based, but rather keyed to the detection limits of the specified analytical method.

EPA has also made it clear in Superfund guidance that 1% asbestos in soils is not a safe level, if the soils are stirred up and asbestos gets in the air.[47]

Questions and Answers about Asbestos and EPA's Libby Investigation

> Q : I recently read that EPA found less than 1% (or trace levels) asbestos at Fireman's Park and other locations that were sampled. Is that a safe level?
>
> A : This is a very difficult question, and at this time we are not sure. Levels at 1% or less may be

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> safe. Even higher levels could be considered safe at remote locations where no one comes in contact with the material. The key to determining whether there is a risk is exposure. If there is no exposure pathway i.e., a way for the asbestos to get into your body, such as contact with the material, or people driving over the material so that they breathe in the fibers, there is no risk. Levels of 1% or less could present a risk where there is enough activity to stir up soil and cause asbestos fibers to become airborne.

A research study found that soils containing as little as 0.001% asbestos can lead to hazardous air concentrations.[48]

> Suitable Action Levels ... Airborne dust clouds were generated from mixtures of soils with different asbestos varieties in bulk concentrations ranging from 1 to 0.001 % asbestos. ... The experiments showed very clearly that even the lowest bulk amphibole asbestos content tested (0.001%) was still capable of producing measurable airborne asbestos concentrations (greater than 0.01 fibers mL^{-1}).

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

Region 2 and the NYC DEP benchmark for asbestos dust inside buildings is flawed on its face just because it is based on a percentage, and not on a concentration per surface area. There are no EPA standards for dusts or other solid contaminants inside buildings that are expressed in terms of mass/mass or volume/volume, such as percent or parts per million. Instead, EPA sets safety standards based on the amount of solid toxic material on a given surface area for inside exposures. This is because that is the way exposures occur. Consider the following:

> A child puts her tongue on a certain area of a window sill.
> Which is worse, Example A or B?
> A: The window sill has a layer of dust 1/100 inch thick. The dust is 0.5% lead.
> B: The window sill has a layer of dust 1/10,000 inch thick. The dust is 5% lead.
> Answer: Example A is worse, even though the absolute concentration of the lead in the dust itself is lower. The exposure, or the total amount of lead, is 10 time higher in Example A, even though the concentration of the lead in the dust itself is lower in Example A.

> A room is covered with asbestos-contaminated dust. Children come into the room to practice gymnastics. The activity level is enough to stir up all of the dust on the floor causing it to be airborne, whether it is 1/1000 or even 1/10 inch thick.
> Which is worse, Example C or D?
> C: The floor is covered with 1/100 inch of dust containing 0.5% asbestos.
> D: The floor is covered with 1/10,000 inch of dust containing 5% asbestos.
> Answer: Example C is worse, since 10 times as much asbestos will become airborne in Example C compared to Example D, even though the concentration of the asbestos in the dust itself is lower in Example C.

The "surface concentration" is what is important for solid toxics like asbestos inside homes, businesses, and schools. The concentration of the asbestos in the dust itself is less relevant. What is important is the total amount of asbestos on a given surfaces. Although EPA does not have any regulations for the surface concentration of asbestos in interior dusts, it does have

regulations for other solid toxics indoors, based on the amount of the toxic substance per surface area.[49]

This is why tests for settled asbestos dust inside building are based on the number of asbestos structures per square centimeter (s/cm^2). This is true for either EPA's ultrasonication test for carpet, as well as for the ASTM 5755 microvacuum method for dusts on hard surfaces.

At least Region 1 was correct in deriving its interior dust standard for asbestos based on a surface concentration level (asbestos structures per square centimeter, or s/cm^2).

Region 2 reverses 1% standard for settled asbestos dust

EPA Region 2 has recently reversed their position that 1% asbestos in dusts is the benchmark for the WTC cleanup. In a March 21, 2002 statement to the press, EPA stated that the 1% level was only a "guideline," but not a health standard.[50]

> In the days after Sept. 11, federal officials repeatedly referred to two "standards," one for asbestos in dust and debris and another for asbestos fibers in air. For dust and debris, the agency standard was 1% asbestos content. . . . But as Jenkins explains in her memo, federal regulations never meant the 1% figure to be considered a health standard or even to be applied to measure dust.
> ...
> "We have never said it was a health standard," said the EPA's Mears about the 1%. "We're only using it as a guideline. We say clean up the dust and get rid of the dust regardless of whether it's 1% or below 1% — it doesn't matter."

In a January 25, 2002 speech, Counsel for Region 2, Walter Mugdan also stated that the 1% level was not a health standard, but only the detection limit of an older test method for asbestos:[51]

> Note that the 1% standard is not necessarily health- or risk-based, but rather keyed to the detection limits of the specified analytical method [PLM].

Even though Region 2 has backed off its 1% standard in the statements quoted above, it has yet to change its official statements on the EPA website which advise citizens of NYC on the hazards of WTC fallout.[52]

Will NYC DEP change its position on 1% asbestos dust inside buildings?

It remains to be seen whether or not the NYC DEP will reverse it position on 1% asbestos in dusts inside buildings. This is particularly important since the NYC DEP will be in charge of the decontamination of the most heavily impacted buildings near Ground Zero, those not even

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occupied at the present time.

NYC DEP's imposition of the unsafe 1% standard is compounded by their insistence on using the insensitive PLM method to detect asbestos. As documented by analyses of the exact same dust samples by both Region 2 and NYC DEP, PLM tests will find no detectable asbestos whatsoever, while the use of the more sensitive EPA transmission electron microscopy (TEM) method can show up to 5%.[53] A news story in the Wall Street Journal documents the hazard posed by the NYC DEP's use of their 1% dust standard and the PLM method.[54]

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